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Ground Water In Paradise Valley, Humboldt County, Nevada

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FOREWORD

The ground-water resources of Nevada are of immediate and lasting concern to the citizens of the State since the wise development of this valuable resource will create a foundation upon which may be built a permanent and lasting economy. Recognition of the importance of underground water to Nevada was realized by the State Legislature as early as 1879. At that time, and later in 1887, the Nevada Legislature provided Acts to encourage the sinking of wells and the development of flowing artesian water. In 1903 the office of the State Engineer was created and with it came many of the laws governing the conservation and utilization of the waters of the State. The Statutes of 1913 provided a law for the conservation of underground water in Nevada, and wisely provided for the casing and capping of artesian wells. Later, in 1915, underground waters of the State, "Save and excepting percolating water, the course and boundaries of which are incapable of determination," were declared subject to appropriation under the laws of the State relating to the appropriation and use of water. Since that time the laws governing the appropriation of underground water have undergone many changes, but they have all been prompted by the recognition that the supply of water is limited and not inexhaustible.

Wise conservation calls first of all for an evaluation of the ground-water resources of the State. It was for this purpose that in 1944 the State entered into a cooperative agreement with the Director of the U. S. Geological Survey for the study of the ground-water resources of Las Vegas Valley, Clark County, Nevada. Beginning July 1, 1945, funds have been appropriated by the State and matched by the Federal Government for the continuation of ground-water studies on a State-wide basis. The cooperative program is under the supervision of Hugh A. Shamberger, Assistant State Engineer of Nevada, and Thomas W. Robinson, District Engineer, Ground Water Branch, Geological Survey.

Since 1945 ground-water work has been carried on in about 50 of the 80-odd valleys in the State by geologists and engineers of the Ground Water Branch of the Geological Survey, and a

series of 10 reports have been released by the State Engineer of Nevada covering a part of these investigations. This report is the tenth in the series of Nevada Water Resources Bulletins.

ALFRED MERRITT SMITH,
State Engineer.

April 20, 1949.

ABSTRACT

Paradise Valley is a north-south-trending valley in eastern Humboldt County in north-central Nevada. It is bounded on the west and north by the Santa Rosa Range, on the east by the Hot Springs Range and the Osgood Mountains, and on the south by the Humboldt River. The entire drainage area includes 1,600 square miles. The valley floor, ranging in altitude from 4,300 to 4,600 feet, is about 36 miles long and 8 miles wide. The town of Paradise Valley is near the north end of the valley, Winnemucca, the county seat, near the southwest corner, and Golconda, a small settlement, near the southeast corner. The area is served by the main lines of the Southern Pacific and Western Pacific Railroads, U. S. Highways 40 and 95, and Nevada State Highway 8B.

Settlement along the Little Humboldt River began in 1863 with the raising of cattle and sheep and the growing of wheat, oats, hay, potatoes, and fruit. Some mining, principally of gold and silver, was undertaken later.

The climate is semiarid, the average annual precipitation on the valley floor being less than 9 inches. Most of the precipitation occurs during the winter months as snow. The mean annual temperature is somewhat less than 50° F. The length of the growing season at Winnemucca since 1916 has never been less than 114 days.

The Santa Rosa Range, forming the west boundary of Paradise Valley, is the highest range in the area. Santa Rosa Peak, the highest peak, is more than 9,600 feet above sea level. Spring Peak and Paradise Peak are 9,400 and 9,200 feet above sea level, respectively. The southern segment of this range, containing Bloody Run Peak and Winnemucca Mountain, lies at considerably lower elevations.

A spur of the Santa Rosa Range forms the north boundary of Paradise Valley from Spring to Thimble Peaks.

Low volcanic mesas bound the east edge of the valley as far south as the mouth of the canyon of the Little Humboldt River. Farther south the eastern boundary is formed by the Hot Springs Range, whose symmetrical, rolling hills rarely exceed 6,700 feet in altitude. The southern end of the Osgood Mountain Range extends beyond the Hot Springs Range to complete the eastern boundary of the valley.

Martin Creek, entering the valley at the northeast corner, and

the Little Humboldt River, entering the east side of the valley, are the principal streams. Martin Creek has a drainage area of about 170 square miles and the Little Humboldt River about 1,030 square miles. Martin Creek and the other streams that head in the north end of the valley eventually drain into the Little Humboldt River. Sand dunes in the south part of the valley have choked the channel of the Little Humboldt River so that in years of high runoff, water is impounded and forms the ephemeral Gumboot Lake. It appears that courses antecedent to Basin Range faulting are followed by Martin Creek, Little Humboldt River, and the Humboldt River, inasmuch as these watercourses pass through mountainous barriers which otherwise would have diverted them.

Alluvial fans extend away from the range fronts as much as 4 miles. Although inundated by Lake Lahontan, no well-defined lake terraces or beaches are readily apparent. Stream terraces are found on the floor of the valley. The most prominent stream terrace starts at the mouth of the canyon of the Little Humboldt River and trends southward for 18 miles along the east side of the valley floor. The valley floor slopes southward, the slope being steepest at the north end.

Paleozoic(?) and Mesozoic(?) sediments cut by igneous intrusives underlie part of the Santa Rosa and Hot Springs Ranges. Clay slates, calcareous slates, limestone, and quartzite are believed to be the predominant rocks. Tertiary basalt flows unconformably overlie the older rocks. In part they occur as "flatirons" along parts of the east side of the Santa Rosa Range and pass beneath the alluvium of the valley floor, presumably reappearing in the Hot Springs Range. The rocks in the ranges are cut by numerous faults. Although the rocks in the ranges contain ground water, they do not constitute the important aquifers of the area.

The rocks of the valley fill consist of the deep valley fill (possibly the Humboldt formation), and the shallow valley fill composed of stream or delta sand and gravels, alluvial-fan debris, late Quaternary lake sediments, and sand-dune materials.

Stream or delta sands and gravels extending to depths of about 300 feet are the principal aquifers. Clays and silts (possibly the Humboldt formation) underlie these deposits to a depth of at least 800 feet. Large yields have not been obtained from wells penetrating alluvial-fan material. The late Quaternary lake sediments and the sand dunes do not contain appreciable quantities of ground water.

The most important geologic event insofar as the occurrence of permeable sediments is concerned was the down-cutting to a depth of about 300 feet into the Humboldt(?) formation by the Little Humboldt and the Humboldt Rivers, and the subsequent aggradation of these rivers. This resulted in the deposition of the highly permeable sands and gravels which today are the important aquifers.

Ground water in the shallow valley fill generally occurs under water-table conditions and is usually less than 10 feet below the land surface in the floor of the valley. Ground-water movement is southward. The gradient of the water table ranges from about 50 feet per mile at the extreme north end of the valley to about 3 feet per mile at the south end.

The source of ground water is the precipitation within the drainage basin of the valley. Recharge is effected mainly by the infiltration of stream flow and the downward percolation of irrigation water. About 40,000 acres of land in the valley have surface-water rights. The average annual runoff onto the valley floor is estimated as about 70,500 acre-feet. During years of normal runoff most of the water is diverted for irrigation. It is estimated, after deducting necessary evapo-transpiration losses, that only about one-third of the average annual runoff recharges the ground-water reservoir.

The principal way in which ground water is discharged is by evaporation and transpiration from about 47,000 acres of land covered by salt grass, greasewood, and willows. It is estimated that the annual evapo-transpiration from this land is about 23,000 acre-feet. In addition, about 3,200 acre-feet is discharged as underflow into the Humboldt River Valley. The total average annual discharge of ground water is estimated to be about 26,000 acre-feet.

Annual fluctuations of the water table range from 9 feet in the north end of the valley to about 2 feet in the south end. Artesian heads ranging from 1 to 3 feet above the water table are found in the shallow valley fill in the central and southern parts of the valley. Except for the thermal well, the heads are insufficient to cause wells to flow. One well (39/39-24B2) (see page 57 for explanation of well number) 800 feet deep, penetrated the deep valley fill in search of artesian water. The well did not flow and the yield was low.

The quality of the water in the shallow valley fill generally is suitable for domestic use and for the irrigation of all but the most sensitive crop plants.

Prior to 1948 most of the development of ground water was for domestic and stock use. The only drilled irrigation well pumped prior to 1948 yielded 2,200 gallons per minute with a drawdown of 45 feet. In the spring of 1948 the efficiency of the well was increased as the result of removing accumulated sand from the bottom of the well. Several other wells that were drilled for irrigation, but never used, should have high yields, judging from the character of the materials penetrated.

The average annual amount of ground water available for development by pumping for irrigation and other uses may be considered as the recoverable part of the average annual underflow into the Humboldt River Valley and that part of the evaporation and transpiration losses that can be salvaged by a lowering of the water table. It is estimated that a lowering of the water table of 20 feet near the south boundary of T. 38 N. would make about 15,000 acre-feet available annually for pumping. The most favorable area for efficient development of the ground-water supply of the valley appears to extend from the middle of T. 40 N. to about the south line of T. 38 N.

GROUND WATER IN PARADISE VALLEY, HUMBOLDT COUNTY, NEVADA

By Omar J. Loeltz, David A. Phoenix, and Thomas W. Robinson

INTRODUCTION

PURPOSE AND SCOPE OF THE INVESTIGATION

The investigation of the geology and ground-water resources of Paradise Valley is part of the State-wide cooperative program between the United States Geological Survey and the State Engineer of Nevada to determine the ground-water resources of the State.

The geologic portion of the report includes a description of the general geologic features of the area, a brief geologic history, and a discussion of the water-bearing properties of the rocks. The hydrologic portion includes a discussion of the occurrence and movement of ground water, estimates of average annual recharge and discharge by various processes, a brief discussion of the quality of water for irrigation, and an estimate of the average annual amount of water available for pumping. At the end of the report are tables giving information pertinent to the wells in the valley.

The field work was begun in 1945 by T. W. Robinson, District Engineer for the Ground Water Branch of the United States Geological Survey. Intensive field work was carried on in the summer of 1947 by O. J. Loeltz and D. A. Phoenix under the general supervision of T. W. Robinson.

GEOGRAPHICAL SKETCH

Paradise Valley is a north-south-trending valley in eastern Humboldt County in north-central Nevada, north of the Humboldt River (see fig. 1). The axis of the valley is slightly west of 117½° west longitude and extends from 41°00′ to about 41°45′ north latitude. The town of Winnemucca is near the southwest corner, Golconda near the southeast corner, and the town of Paradise Valley near the north end of the valley.

The Santa Rosa Range on the west, a spur of this range on the north, the Hot Springs Range and the Osgood Mountains on the east, and the Humboldt River on the south form the principal physiographic boundaries.

The entire drainage area includes about 1,600 square miles, of which somewhat more than 1,000 square miles lies outside the

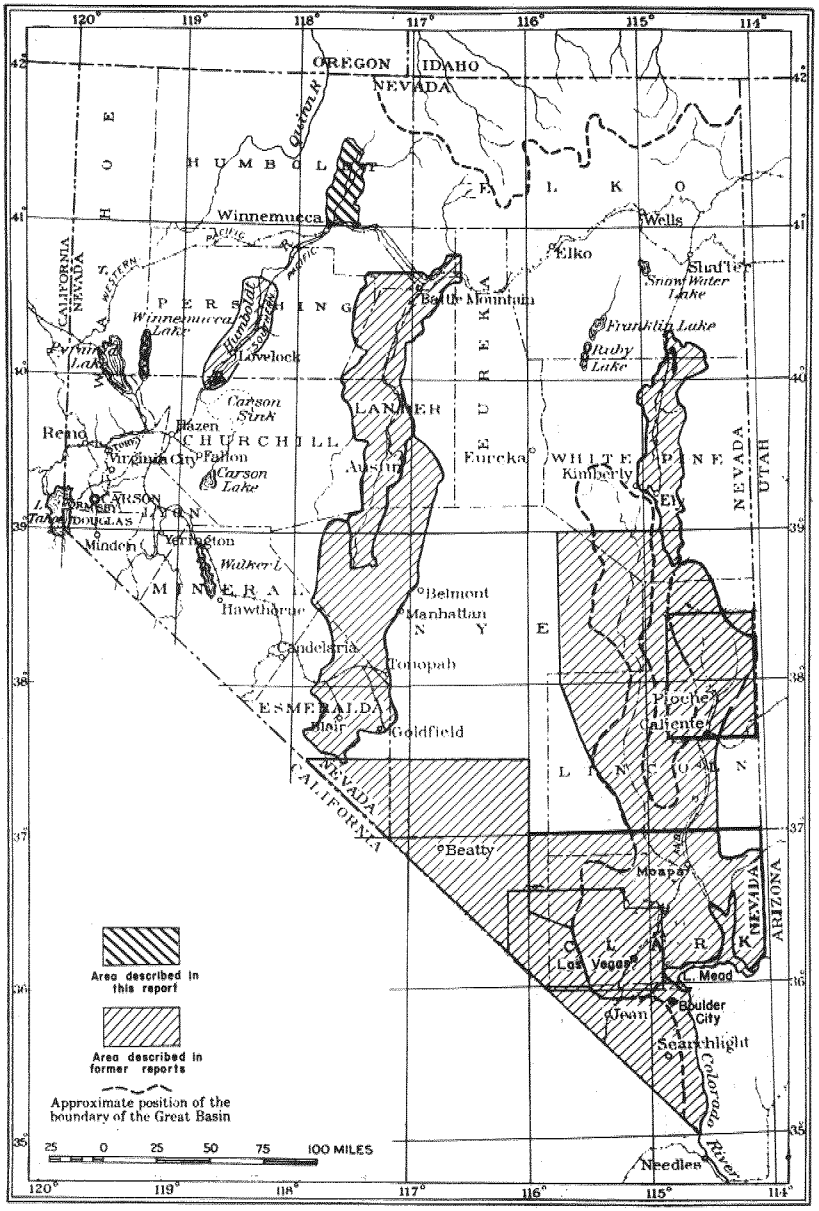


FIGURE 1
Map of Nevada showing areas covered by previous ground-water reports and by the present report.

valley proper. Martin Creek and the Little Humboldt River, entering the valley through deep cuts in the bedrock at the northeast and east boundaries of the valley, respectively, bring the runoff from these outside drainage areas to the valley.

The valley proper (see pl. 1), bounded by ranges on the west, north, and east sides and the Humboldt River on the south side, is about 45 miles long and averages 13 miles wide. The valley floor has a length of about 36 miles and an average width of about 8 miles.

The town of Paradise Valley near the north end of the valley is the local supply center for the ranchers and farmers in the vicinity. The population of the town of Paradise Valley is estimated to have been about 100 in 1946. Nevada State Highway 8B connects it with U. S. Highway 95, and provides bituminous-surfaced highways to outside markets.

Winnemucca, near the southwest corner of the valley, is the county seat of Humboldt County. According to the Winnemucca Chamber of Commerce the population was approximately 3,000 in 1946. It is an important business and supply center for miners and ranchers for many miles around. Winnemucca is the junction point of the transcontinental highway U. S. 40, running east and west, and U. S. Highway 95 north to Oregon and Idaho. The main lines of two railroad companies, the Southern Pacific and the Western Pacific, bring many transcontinental trains to the community daily.

Golconda, near the southeast corner of the valley, is 16 miles east of Winnemucca, and lies north of and adjacent to U. S. Highway 40. It has a population of about 350, and is a local supply and trading center.

HISTORICAL SKETCH

As early as 1842 John C. Fremont and the famous scout, Kit Carson, leading a group of California gold seekers along the Humboldt River on their way from Great Salt Lake to the Sierra Nevada, passed through the south end of Paradise Valley. In 1850 a Frenchman set up business at French Ford (present site of Winnemucca), selling supplies to the gold seekers passing through to California. French Ford grew into a thriving town in 1868 when construction of the Central Pacific Company railroad, now the Southern Pacific, reached the area. Its name was then changed to Winnemucca in honor of the famous Paiute Indian Chief.

Ranchers and farmers began settling along the Little Humboldt River in Paradise Valley as early as 1863. Paradise City, now the town of Paradise Valley, was established in 1866. Cattle and sheep raising, and the growing of wheat, oats, hay, potatoes, and fruit, quickly became the important means of livelihood. The 1880 and later issues of *The Silver State,* the daily newspaper published in Winnemucca, are filled with glowing accounts of the bumper crops raised in the valley.

Golconda was famous as a resort and health center where the early settlers often spent several weeks at its large hotel drinking and bathing in the mineral waters issuing from the Golconda Hot Springs.

The raising of cattle and growing of hay are the principal activities in Paradise Valley today. The more than 40,000 acres of cultivated or cropped land, some of which have surface-water rights dating back to 1864, attest to the fact that Paradise Valley has been and is a very good agricultural area.

CLIMATE

The climate of Paradise Valley is semiarid, the average annual precipitation on the valley floor being somewhat less than 9 inches. Cereals and other crops having comparably low water requirements can be grown satisfactorily in years in which the amount of precipitation and its distribution is favorable; generally, however, these crops must be irrigated to obtain satisfactory yields. Most of the precipitation occurs during the winter months as snow. Except for occasional thunder storms very little precipitation falls during the summer, July and August being the months of least precipitation.

The mean annual temperature is somewhat less than 50° F. The average temperature in January is about 28° and in July about 73°, although temperatures as low as —35° and as high as 110° F. have been recorded in Winnemucca.

Humidity is normally low, making the heat of the summer and cold of the winter less noticeable. There is an abundance of sunshine, as the average amount of sunshine at Winnemucca is about 74 percent of the greatest amount possible.

The range of the daily temperature is large, so that even after the hottest days the nights are cool. At Winnemucca the average range in daily temperature is about 25° F. in January and 38° in July.

Although there are no published records of evaporation rates in Paradise Valley, the available records of climatological stations

in the State indicate that the annual rate is probably between 40 and 50 inches.

The following average dates and length of growing season at Winnemucca and Golconda are taken from a United States Weather Bureau publication:[1]

Location	Years of record	Average date, last killing frost (spring)	Average date, first killing frost (autumn)	Average length growing season (days)
Winnemucca	40	May 11	Sept. 29	141
Golconda	33	May 20	Sept. 19	122

During the 40-year period preceding 1939, the period used in the above table, the length of growing season at Winnemucca ranged from 81 days in 1916 to 175 days in 1934. However, from 1916 to 1947 the growing season at Winnemucca has never been less than 114 days, indicating that rarely is the growing season less than 4 months.

Monthly and annual precipitation and temperature data compiled from publications of the United States Weather Bureau are given in Tables 1 and 2.

[1]Climate of the States, Nevada: U. S. Dept. Commerce, Agr. Yearbook Separate No. 1846, pp. 979–988, 1941.

TABLE 1

Average monthly and annual precipitation, in inches, at three climatological stations in or near Paradise Valley, Nevada.

(Data from U. S. Department of Commerce, Weather Bureau. Period of record from establishment of station to 1947, inclusive.)

Location	Altitude (feet)	Years of record	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
Paradise Valley	4,650	44	1.34	1.15	.68	.75	.80	.75	.27	.17	.41	.69	.77	1.09	8.87
Winnemucca	4,287	79	1.03	.91	.96	.84	.88	.72	.21	.20	.41	.62	.68	1.08	8.54
Golconda	4,392	69	.68	.56	.56	.56	.72	.56	.17	.12	.29	.45	.47	.75	5.89

TABLE 2

Monthly and annual mean temperatures, in degrees Fahrenheit, at two climatological stations in or near Paradise Valley, Nevada.

(Data from U. S. Department of Commerce, Weather Bureau. Period of record from establishment of station to 1947, inclusive.)

Location	Years of record	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
Winnemucca	69	28.6	33.5	40.0	46.7	53.9	62.8	70.6	69.3	59.2	48.3	38.4	30.0	48.4
Golconda	55	27.9	33.5	40.5	47.9	56.4	65.4	74.6	71.0	59.8	49.3	38.5	29.7	49.5

Since 1932 the Nevada Cooperative Snow Survey has maintained five snow-survey courses in the drainage area tributary to the north end of Paradise Valley. The results of these snow surveys, compiled by Clyde Houston,[2] is given in the following tabulation:

1. LOWER BUCKSKIN SNOW COURSE

Established in 1932 by A. J. Shaver and Paul Travis. Located on Toiyabe National Forest, in sec. 25, T. 45 N., R. 39 E. Elevation 6,700 feet. *Course revised in 1947 to 12 samples at 50 feet.* Surveys by private party. (Figures are for course as revised in 1947.)

Year	Date	Snow (Inches)	Water (Inches)	Date	Snow (Inches)	Water (Inches)
1932	3/4	27.1	11.2			
1933	3/3	27.0	8.3			
1934	3/4	19.9	5.9			
1935	3/6	28.8	8.7			
1936	3/5	31.7	10.3			
1937	3/2	26.7	8.8			
1938	3/3	29.1	8.5			
1939	3/3	30.3	7.2			
1940	3/1	19.9	6.6			
1941	3/2	26.6	8.5	3/27	17.6	6.3
1942	3/2	28.4	8.0	4/2	23.5	6.9
1943	2/28	29.3	10.4	3/31	21.8	9.2
1944	.....	*	*	3/26	26.0	9.0
1945	3/10	33.0	9.3	3/25	31.0	12.0
1946	3/4	29.5	8.1	4/8	20.8	6.6
1947	.....	*	*	4/1	0.0	0.0
1948	2/27	21.7	7.8	4/2	30.2	10.2
Average	.....	27.3	8.5		21.4	7.5

*No survey.

2. UPPER BUCKSKIN SNOW COURSE

Established in 1932 by Paul Travis and A. J. Shaver. Located on Toiyabe National Forest, in sec. 11, T. 45 N., R. 39 E. Elevation 7,200 feet. *Course revised in 1947 to 10 samples at 50 feet.* Surveys by private party. (Figures are for course as revised in 1947.)

Year	Date	Snow (Inches)	Water (Inches)	Date	Snow (Inches)	Water (Inches)
1932	3/3	33.9	14.4			
1933	3/2	22.3	7.4			
1934	3/3	30.6	6.9			
1935	3/5	24.3	7.8			
1936	3/4	41.0	15.1	4/3	34.0	15.2
1937	3/1	21.4	7.6	3/31	24.1	8.8
1938	3/2	22.8	7.1	4/1	45.2	17.9
1939	3/1	26 2	8.4	4/1	10.0	4.0
1940	2/29	27.3	10.7	3/31	23.3	8.9
1941	3/1	35.9	13.5	3/27	30.2	12.5
1942	3/2	33.6	11.1	4/2	31.6	11.6
1943	2/28	38.0	15.4	3/31	36.6	17.1
1944	.....	*	*	3/27	32.3	12.2
1945	3/10	35.0	15.3	3/25	40.9	15.1
1946	3/4	21.4	6.8	4/8	24.5	9.1
1947	3/1	*	*	4/1	4.1	1.4
1948	2/26	21.5	8.2	4/3	30.6	10.4
Average	.....	29.0	10.4		28.3	11.1

*No survey.

3. MARTIN CREEK SNOW COURSE

Established in 1932 by A. J. Shaver and Paul Travis. Located on Toiyabe National Forest, in sec. 18, T. 44 N., R. 40 E. Elevation 6,700 feet. *Course*

[2]Houston, Clyde. Federal-State cooperative snow surveys, summary for Nevada 1910 through 1948; U. S. Dept. Agr., Soil Cons. Service, pp. 26–30, 1948.

revised in 1946 to 12 samples at 50 feet. Surveys by private party. (Figures are for course as revised in 1946.)

Year	Date	Snow (Inches)	Water (Inches)	Date	Snow (Inches)	Water (Inches)
1932	3/4	33.3	13.3			
1933	3/1	20.1	6.5			
1934	3/2	20.9	6.4			
1935	3/7	30.2	7.9			
1936	3/3	30.5	9.4			
1937	2/28	23.4	7.0			
1938	3/1	30.0	8.9			
1939	3/4	29.2	6.3			
1940	2/28	24.3	7.9			
1941	2/28	28.6	9.0	3/29	21.6	8.1
1942	3/3	33.3	9.5	3/31	28.9	9.8
1943	3/1	31.7	11.9	4/2	21.3	8.4
1944	2/23	29.8	4.3	3/24	26.4	8.4
1945	3/1	26.4	8.1	3/27	43.0	13.4
1946	3/3	30.5	7.2	4/7	26.7	7.8
1947	2/28	10.8	3.8	3/31	2.4	1.1
1948	2/28	18.1	6.8	4/1	28.1	9.7
Average		26.5	7.9		24.8	8.3

*No survey.

4. GRANITE PEAK SNOW COURSE

Established in 1932 by Paul Travis and A. J. Shaver. Located on Toiyabe National Forest, in sec. 22, T. 44 N., R. 39 E. Elevation 7,800 feet. *Course revised in 1946 to 11 samples at 50 feet.* Surveys by private party. (Figures are for course as revised in 1946.)

Year	Date	Snow (Inches)	Water (Inches)	Date	Snow (Inches)	Water (Inches)
1932	3/2	41.3	16.5			
1933	3/1	12.6	4.5			
1934	3/5	19.0	5.2			
1935	3/8	31.9	7.8			
1936	3/3	28.7	9.1	4/2	27.2	9.4
1937	3/3	15.0	4.4	--------	*	*
1938	3/4	38.4	12.3	--------	*	*
1939	3/5	27.5	6.8	--------	*	*
1940	3/3	37.5	12.6	--------	*	*
1941	3/3	43.7	14.6	3/30	41.6	15.1
1942	3/4	34.6	11.0	4/1	32.2	11.0
1943	3/2	44.5	16.3	4/3	41.1	16.3
1944	2/24	32.9	7.3	3/24	32.5	11.5
1945	3/2	38.6	9.5	4/5	32.5	9.3
1946	3/3	37.5	11.2	4/6	46.6	16.6
1947	2/28	19.5	6.8	3/30	19.0	7.2
1948	2/28	18.7	6.4	4/1	32.9	9.7
Average		30.7	9.5		34.0	11.8

*No survey.

5. LAMANCE CREEK SNOW COURSE

Established in 1932 by A. J. Shaver and Paul Travis. Located on Toiyabe National Forest, in sec. 13, T. 42 N., R. 38 E. Elevation 6,000 feet. 24 samples at 50 feet. Surveys by private party.

Year	Date	Snow (Inches)	Water (Inches)	Date	Snow (Inches)	Water (Inches)
1932	2/26	49.4	16.6			
1933	2/25	35.3	11.7			
1934	3/1	23.3	6.6			
1935	3/1	23.1	7.1			
1936	2/29	55.6	19.0			
1937	2/26	34.8	11.0			
1938	2/26	26.4	6.9			
1939	2/26	31.0	8.7			
1940	2/27	29.0	9.9			
1941	2/26	34.6	12.0			
1942	2/26	33.0	10.4			
1943	2/24	37.7	13.6			
1944	2/25	35.8	7.0			
1945	2/27	33.0	9.6	4/4	26.6	9.0
1946	3/5	30.9	10.3	4/5	24.7	9.4
1947	2/28	*	*	3/30	0.0	0.0
1948	2/25	9.7	3.8	4/4	16.3	5.3
Average		32.7	10.3		16.9	5.9

*No survey.

PHYSIOGRAPHY AND DRAINAGE

GENERAL FEATURES

Paradise Valley is a broad northerly trending valley lying north of the Humboldt River. Physiographically it is the northern segment of a north-south series of connected depressions including, to the south, Grass, Pleasant, Dixie, and Fairview Valleys. Together they total about 180 miles in length and extend from latitude 39°00′ N. near the center of the State to latitude 41°30′ N. 30 miles south of the north boundary of Nevada. Paradise Valley slopes from north to south. The west side of the valley is bordered along its entire length by the Santa Rosa Range, the north side by a southeasterly trending spur of this range and a short segment of the Owyhee Plateau, and the east side by the Hot Springs Range and the southern segment of the Osgood Mountains. The southern boundary of Paradise Valley is formed by the Humboldt River. The more important perennial and intermittent streams flow from the northern end of the valley and approach its trough by a network of channels which merge and pass diagonally down the valley floor to join the Humboldt River at the southwest corner of the valley. (See pl. 2.)

MOUNTAINS

The Santa Rosa Range, the highest range in the area, parallels the west side of Paradise Valley for about 40 miles and then continues northward beyond the Nevada-Oregon boundary. The highest portion of this range is adjacent to the northern portion of Paradise Valley and reaches altitudes of more than 9,000 feet. Santa Rosa Peak, the highest peak in the range, rises about 5,000 feet above the town of Paradise Valley, and is more than 9,600 feet above mean sea level. Spring Peak, 12 miles north, and Paradise Peak, 7 miles west of the town of Paradise Valley and in the same range, reach altitudes of about 9,400 and 9,200 feet, respectively. Other prominent landmarks in this range, but considerably lower in altitude, are Bloody Run Peak, 12 miles north of Winnemucca, and Winnemucca Mountain, about 2 miles northwest of Winnemucca. The Santa Rosa Range is broken by low passes. Beginning at the south end, just north of Winnemucca Mountain, the range crest falls to low hills locally covered by sand dunes. Here, a dirt road winds its way westerly over the pass and into the south end of Quinn River Valley. The range crest then rises abruptly to the summit of Bloody Run Peak, and altitudes generally above 7,000 feet prevail northward for 10 miles until the crest again falls to the lower elevations of the Paradise Hill pass, over which passes U. S. Highway 95. The

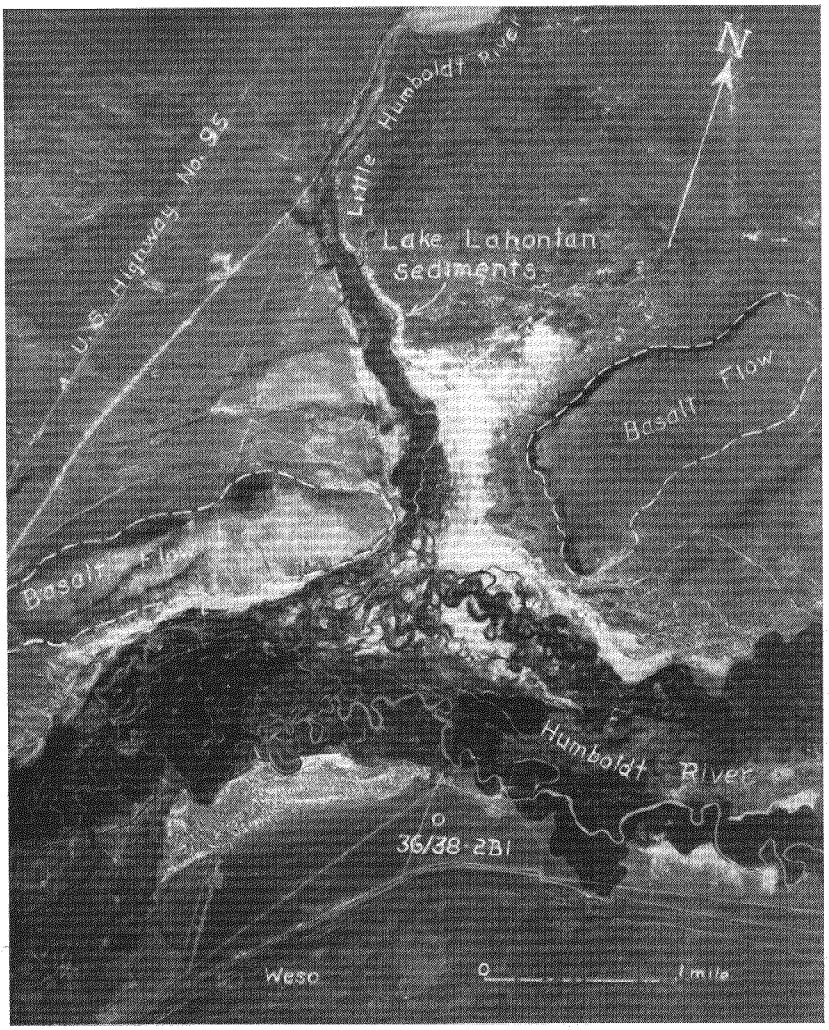


PLATE 2
Aerial view showing confluence of Little Humboldt and Humboldt Rivers.

crest rises to altitudes generally greater than 8,000 feet north from this pass to the vicinity of Paradise, Santa Rosa, and Spring Peaks, a distance of 20 miles. From Spring Peak northward to the Oregon State line 24 miles distant the range broadens toward the Owyhee Desert plateau and generally lies at lower altitudes. It is broken locally by prominent peaks, of which Buckskin Peak is the highest.

A prominent spur of the Santa Rosa Range trends southeast for 8 miles along the northern boundary of Paradise Valley from Spring Peak to Thimble Peak. Hinkey Summit, a pass through which the road from Paradise Valley to the town of McDermitt winds its way, separates this spur from the main crest of the Santa Rosa Range. From the crest of this spur the land slopes gently to the north and east, conforming generally with the northeasterly dip of the underlying lava flows. The southwesterly facing slope of this spur is broken by precipitous cliffs of volcanic rock.

Low volcanic mesas rise abruptly at the east edge of the valley from Martin Creek to the Little Humboldt River, and extend northeastward, merging into the Owyhee Plateau. South of the Little Humboldt River the north end of the Hot Springs Range rises sharply to an elevation of 6,450 feet at Hot Springs Peak. This peak, although not the highest point in this range, is isolated and therefore prominent. From Hot Springs Peak the crest of the Hot Springs Range falls rapidly southward for 4 miles. The range then broadens somewhat and rises to mature symmetrical rolling hills whose altitudes rarely exceed 6,700 feet above mean sea level. The south end of this range ends a short distance north of the southern end of Paradise Valley. An isolated island of bedrock between the south end of the Hot Springs Range and the Humboldt River may have been a part of the range in earlier geologic times. The Osgood Mountain Range lies a short distance east of the Hot Springs Range and closely parallels it. The southern end of this range extends southward beyond the south end of the Hot Springs Range and forms the physiographic boundary for a small section of the southeast corner of Paradise Valley. It is through the southern end of the Osgood Range that the Humboldt River has eroded its way to carve the Humboldt River Valley.

Three physiographic types of mountain features occur in the Paradise Valley area. They are: (1) Youthful features, or those

that show only the early stages of progressive erosion and indicate that relative late geologic events have caused their appearance as landscape features; (2) mature features, or those which indicate that the mountains have been stable for a long period of time and have been subject to progressive headward erosion without interruption; and (3) landscape features that are believed to have been superimposed on the mature stage as the result of alpine glaciation.

The most typical feature of youthful erosion is the canyon of Martin Creek. There, the watercourse, antecedent to late Basin Range faulting, is deeply incised into almost flat-lying lava flows. The walls of the canyon are sheer cliffs which rise abruptly to a mesa top of relatively low relief.

The Hot Springs Range and portions of the Santa Rosa Range from Paradise Peak south to Winnemucca Mountain are characteristic of mature mountains. They are not incised by steep-walled canyons but are rounded and subdued. The cycle of erosion to which they have been subjected has been uninterrupted and has progressed far enough to leave little indication of any preceding land form.

Pleistocene glaciers existed in the highest portion of the Santa Rosa Range. On the east and north slopes of Santa Rosa Peak, Paradise Peak, and the north and west slopes of Spring Peak are steep-walled but gently concave amphitheaters which are suggestive of glaciation. These features have been modified by later stream erosion, and farther down the mountain slopes the valleys become steep-walled and V-shaped and the evidence for glaciation has been lost.

STREAMS

The two major streams that enter Paradise Valley are Martin Creek and the Little Humboldt River. Martin Creek enters the valley at the northeast corner, about 6 miles northeast of the town of Paradise Valley, and the Little Humboldt River enters the east side of the valley about 7½ miles southeast of the town of Paradise Valley. The greater part of the drainage basins of both Martin Creek and the Little Humboldt River are separated from the valley proper by intervening crests of the Santa Rosa and Hot Springs Ranges. The drainage basin of Martin Creek is about 170 square miles, and the drainage basin of the Little Humboldt River and its two tributaries, the North and South Forks, is about 1,030 square miles. Tributaries of both Martin Creek and the Little Humboldt River drain the east slope of Buckskin Peak.

Many smaller streams head on the east slope of the Santa Rosa Range in the north part of the valley and descend rapidly to alluvial fans over which they flow onto the valley floor. These streams from south to north are Provo, Wash O'Neal, Stonehouse, Beef, Colony, Handy, Lamance, Little Cottonwood, Dry, Cottonwood, and Mullinax Creeks. Indian Creek, heading near Spring Peak, is the principal stream entering the north end of the valley.

The streams flow throughout the year in the mountains. Runoff in these streams during late winter and spring reaches the valley floor where it is diverted for irrigation or enters an intricate network of channels in the north-central portion of the valley. From there the channels merge to the south to join with the channel of the Little Humboldt River. During years of high runoff, water flows down this channel as far as the sand-dune area at the south end of the valley. There, dunes that have drifted across the channel of the Little Humboldt River form a natural barrier, and in wet years water collects behind this barrier to form what is known as Gumboot Lake. South of the sand-dune area the channel of the Little Humboldt River is dry. The channel, however, continues until it enters the Humboldt River Valley at the southwest corner of the valley (see pl. 2).

Drainage antecedent to Basin Range faulting is indicated where the Little Humboldt River has cut its way through the north end of the Hot Springs Range, and through the basalt flows at its confluence with the Humboldt River. Martin Creek and the Humboldt River are likewise believed to indicate antecedent drainage, as both these watercourses pass through mountainous barriers which otherwise would have served to divert their course of flow. It is recognized, however, that some of the stream features herein termed antecedent may be due to lake overflow from one valley to another at points where the stream canyons now exist.

ALLUVIAL FANS AND VALLEY FLOOR

Alluvial fans have been built along the base of the ranges surrounding Paradise Valley and extend as much as 4 miles away from the range fronts. They have a gently rolling surface parallel to the base of the range, and away from the range front they fall with decreasing gradient towards the valley floor.

No well-defined lake terraces or beaches are found on the alluvial fans, although the valley was inundated by Lake Lahontan. It is possible that this arm of the lake was too short-lived to form beaches.

The central floor of the valley trends north-south and is bounded by the lower edge of the alluvial fans. The approximate boundary between the alluvial fans and the valley floor is shown on Plate 1. The floor slopes from north to south towards the Humboldt River. The gradient in the north end is about 20 feet per mile, but it decreases rapidly to about 2 feet per mile in the southern half of the valley. In the southern part of the valley the floor slopes very gently to the southwest. The Little Humboldt River reflects this slope as, in seeking the lowest point in the valley, it has migrated diagonally across the valley floor to flow into the Humboldt River.

Stream terraces are found on the floor of the valley. The most nearly continuous terrace starts at the point where the Little Humboldt River flows onto the floor of the valley, and trends southward along the east side of the valley floor. The base and upper edge of this terrace both slope southward with the same gradient as the valley floor, and hence it is not believed to have been formed by a lake. This terrace limits the lower edge of the alluvial fans south of the mouth of the Little Humboldt River. It is rarely over 15 feet high and finally dies out 18 miles to the south. Other stream terraces are found at the mouth of Martin Creek, in the stretch where Martin Creek has cut into the alluvial fan below its mouth, and in the southern third of the valley floor where the combined surface flow from the streams reaching the floor of the valley has carved a pronounced channel to the Humboldt River. This is commonly referred to as the channel of the Little Humboldt River.

A belt of sand dunes traverses the valley just south of Toll House and Gumboot Lake from west to east. The shape of the dunes and their direction of migration indicate they were formed by prevailing westerly winds and that the sand entered the valley through the pass lying between Winnemucca Mountain and Bloody Run Peak. These sand dunes have migrated across the channel of the Little Humboldt River, choking it with sand.

Lake terraces and other related lake features around Gumboot Lake are found in the southern part of the valley floor north of the sand-dune barrier. They are shown on Plate 1. Below these terraces, which rarely exceed 10 feet in height, the floor is flat and locally is covered with abundant remains of fresh-water gastropods.

GENERAL GEOLOGY AND WATER-BEARING PROPERTIES OF THE SEDIMENTS

The rocks of the Paradise Valley area, as they affect the occurrence of ground water, may be divided into two main groups, those of the mountain ranges and those of the valley fill. The ranges are composed largely of rocks in which ground water generally does not circulate freely. These rocks are metamorphosed and indurated sediments, igneous intrusives, and lava flows. They are collectively known as the bedrock. The valley fill is composed largely of unconsolidated sediments, some of which are important aquifers. These sediments, occupying a basin whose bottom and sides are formed by the bedrock, consist of clay, silt, sand, and gravel. This fill is younger than the rocks of the mountains, having been derived from them by erosion.

ROCKS BORDERING PARADISE VALLEY

The rocks bordering Paradise Valley are divided regionally into two groups: (1) Older group, consisting of Paleozoic(?) and Mesozoic(?) sediments cut by igneous intrusives, and (2) younger group, consisting of Tertiary (Miocene(?)) basalt flows.

The older sediments and intrusives underlie the Santa Rosa Range on the west from Spring Peak south to Winnemucca Mountain, and the Hot Springs Range on the east from the Little Humboldt River south almost to the Humboldt River. Very little geologic mapping has been done in these two ranges, but it is believed that the predominant rocks in the Santa Rosa Range are clay slates, calcareous slates, and some limestone,[1] whereas the rocks in the Hot Springs Range are interbedded quartzite and limestone. These rocks, particularly in the Santa Rosa Range, have been intruded by stocks of granodiorite or quartz monzonite; and they are all cut by numerous faults. Generally the sediments in the northern part of the Santa Rosa Range dip at high angles to the east and are strongly folded and compressed.

The Tertiary basalt flows, possibly of Miocene age, unconformably overlie the older rocks. They compose the Santa Rosa Range from Spring Peak north to the Nevada-Oregon State boundary and from Spring Peak southeast to the north end of the Hot Springs Range. Elsewhere, they form "flatirons" on the east side of the Santa Rosa Range from Trap Butte north to the base of Spring Peak, and they again crop out in the south end of Paradise Valley on the east flank of Winnemucca Mountain.

The regional structure of the Tertiary (Miocene(?)) lava flows

[1]Lindgren, Waldemar, Geology and mineral deposits of the National mining district, Nevada: U. S. Geol. Survey Bull. 601, p. 11, 1915.

is simple. From the scarp bordering the north and east edge of Paradise Valley they dip 15° to 18° to the northeast, forming a plateau dissected by the headwaters of Martin Creek and the Little Humboldt River. "Flatirons" of basalt at the base of the Santa Rosa Range dip 10° to 20° to the northeast and pass beneath the alluvium of the valley floor. It is believed that a large part of the mountain uplift occurred after the lava flows were extruded. These flows may be the same that reappear, bordering the valley, between the mouths of Martin Creek and the Little Humboldt River about 8 miles to the east. In the south end of the valley the basalt flows flanking the east side of Winnemucca Mountain also pass beneath the floor of the valley. These flows are believed to be bounded on the north by a fault which is obscured by late valley fill.

Water may occur in these lava flows, as they are commonly jointed and fractured, and they compose the highlands over which many of the streams in the area flow. Prospecting for water in these volcanic rocks has never been undertaken in Paradise Valley, as they are covered by at least several hundred feet of valley fill.

VALLEY FILL

The rocks of the valley fill consist of the deep valley fill (possibly the Humboldt formation), and the shallow valley fill of stream or delta sand and gravels, alluvial-fan debris, late Quaternary lake sediments, and sand-dune materials. The more permeable of these sediments lying below the water table are those from which ground water may be withdrawn economically for various needs.

The deep valley fill is believed to consist of interbedded clay and silt and underlies the coarser materials generally prospected by wells in the valley. The deep fill is believed to have been penetrated by only one well. This well (39/39–24B2) (see page 57 for explanation of well number) was bored in 1889 to a reported depth of 800 feet. Items appearing in the Winnemucca newspaper at that time state that sandstone was encountered from 274 to 294 feet below the land surface, and that from 294 to 800 feet the formation consisted of "soft ground" and "clay formations" through which it was possible to bore at the rate of 75 to 80 feet a day. No highly permeable materials were reported below 274 feet. If the material reported to have been encountered in the well is representative of the material in the deep valley fill, the water-bearing properties of the deep valley fill are not good.

Stream or delta sand and gravel overlie the deeper valley fill, and consists of interbedded and mixed sand, gravel, and some silt and clay.

The manner of deposition of these materials is important to the occurrence of ground water in Paradise Valley. It is believed that during the Pleistocene epoch the channels of Martin Creek and the Little Humboldt River were eroded at least 275 feet below their present levels in the valley floor. These channels and their tributaries were then filled by stream-laid gravels and delta sediments, which in turn were covered by a thin veneer of Lake Lahontan beds (see cross section, pl. 1). The stream terrace along the east side of Paradise Valley may be the only remaining surface expression of this old channel.

The water-bearing properties of the stream-laid gravels and delta sediments are good. Well 39/39–13C3, on the east side of the floor of Paradise Valley, has penetrated these materials 225 feet. Well 39/39–13C1, a few feet distant, is only 105 feet deep but has a specific capacity (yield in gallons per minute per foot of drawdown) greater than 50. The log of well 39/39–16B1, about 3 miles due west, indicates that the material underlying the floor of the valley consists of highly permeable coarse sand and gravel, interbedded with fine sand and silt to a depth of 276 feet. It is reported that in well 40/39–26A1 the materials penetrated consisted almost entirely of sand and gravel. The well was abandoned at a depth of about 300 feet when two strings of drilling tools were lost in the hole.

Alluvial-fan deposits fringe the valley at the base of the mountains. It is believed these deposits have been accumulating throughout a great part of the Quaternary period and are a result of variations in climate, and of progressive changes in land forms throughout this time.

The sediments contained in the alluvial fans are generally crudely bedded and poorly sorted, although both the bedding and the degree of sorting vary with the place of deposition on the fan slope. Near the apex of the fan the materials are generally coarse-textured. Farther out on the slope at lower elevations, approaching the lower edges of the fans, the sediments gradually change to more evenly sorted and finer material until the fan deposits merge with the material of the valley floor. The dip of the bedding in these deposits is toward the toe of the fan, and becomes flatter as the toe is approached. Generally the dip approximates the profile of the fan.

The alluvial-fan deposits contain ground water but the water

cannot be readily developed in all parts of the fan. At the upper end of the fans, near the apexes, the material is poorly sorted and will not readily yield water to wells. There, too, the greater depth to the water level often makes the pumping lift excessive. At the toes of the fans, formed by perennial streams, the fan material is much better suited for the development of ground water, and the pumping lift would not be great. It is believed that the fans opposite the mouths of normally dry canyons are not good places to develop ground water. The material of these fans is, for the most part, poorly sorted throughout, having been deposited largely by torrential floods resulting from cloudbursts of short duration.

During late Quaternary time Lake Lahontan covered the valley floor to about the point where the Little Humboldt River enters the valley proper. However, the valley is unlike many others occupied by the lake in that few clues remain to indicate lake stages. It is believed that the life span of this arm of the lake was of only short duration, so that the lake left no well-marked shore lines or terraces. Shingle gravels and well-sorted sands were found in a borrow pit in sec. 26, T. 41 N., R. 39 E. These sediments are near the upper limit of the highest shore line. The elevation of the pit is about 4,435 feet above mean sea level.

The sediments deposited in the floor of the lake consist predominantly of silt and clay. In part they overlie the stream and delta deposits of the Little Humboldt River. In the floor of the valley, below the narrows of the Little Humboldt River, these sediments are only 5 or 6 feet thick. They form the soil mantle overlying the stream-laid gravels. Farther south, in the vicinity of Gumboot Lake, an augered well (38/39–33B1) penetrated 18 feet of the lake sediments before entering gravel and sand. Part of this material was deposited during the existence of the now ephemeral Gumboot Lake. Thin-shelled fresh-water gastropods are found on the floor of this lake and indicate that in the past this lake was perennial. The sand dunes in the area between Gumboot Lake and the Humboldt River in part represent a reworking of the thin cover of sediments of Lake Lahontan. The lake sediments exposed in the water gap of the Little Humboldt River at its confluence with the Humboldt River are sediments of Lake Lahontan. (See pl. 2.)

Ground water does not occur in appreciable quantities in the Lake Lahontan beds, as the greater part of them lie above the water table.

LATE TERTIARY AND QUATERNARY GEOLOGIC HISTORY

The late Tertiary and Quaternary geologic history of Paradise Valley is important for a clear interpretation of the occurrence of ground water in the area. The geologic processes involved in the development of Paradise Valley explain the presence of the important water-bearing materials underlying the valley floor and help to indicate their distribution. It is believed that the important events insofar as they relate to the occurrence of ground water are as follows:

1. Miocene vulcanism resulting in the distribution of basalt and other types of flow rocks over a large part of north-central Nevada.

2. Tilting of these flow rocks by Basin and Range faulting followed by the accumulation of the Humboldt(?) formation, probably of both Miocene and Pliocene age. These sediments were deposited to a thickness which may reach 2,000 feet or more in some of the basins of northwestern Nevada, and their deposition was probably accompanied by some vulcanism. In Paradise Valley a well (39/39–24B2) exploring these beds encountered a preponderance of clay. It is possible that the deposition of the clay beds was interrupted by abrupt climatic changes, or accompanied by intermittent Basin Range faulting or both.

3. Change to arid climate and dessication of lakes existing prior to Lake Lahontan, followed by the major development of the drainage pattern of the Humboldt River drainage system; continued Basin Range faulting and tilting of the basin sediments; antecedent downcutting by the Humboldt River through the Osgood Range and by the Little Humboldt River through the Hot Springs Range, and through the basalt flows at the south end of Paradise Valley; possible continued downcutting by the Humboldt River and its tributaries into the basin deposits; the beginning of the present day alluvial fans which prior to this were probably deposited as pre-Lake Lahontan shore-line sediments. The alluvial fans were probably accumulating during a great part of the early Pleistocene; at least the bulk of the debris composing them accumulated prior to the advance of the first major cycle of Lake Lahontan.

4. The first major cycle advance of Lake Lahontan, accompanied closely by deposition of sediments, largely sand and gravel in the Humboldt and Little Humboldt River channels. Deposition of small amounts of lake sediments in the floor of Grass Valley, and accumulation of thin lake sediments in the lower end

of Paradise Valley; cutting of lake shore lines, continued alluvial-fan deposition, and probably local Basin Range faulting. According to R. B. Morrison[2] the highest shore-line features of Lake Lahontan seemed to have been almost entirely developed in the early cycle.

5. Retreat and dessication of Lake Lahontan; continued alluvial-fan deposition.

6. The second major cycle advance of Lake Lahontan, accompanied by aggradation of the Humboldt and Little Humboldt Rivers. The lake at this time is again believed to have deposited only small amounts of sediments.

7. Retreat of Lake Lahontan, followed by the development of meander scrolls and ox-bow lakes in the flood plain of the Humboldt River; establishment of drifting sand dune areas (a process which was probably active during prior arid periods); late movement along pre-established Basin Range faults as shown by scarps in the alluvial fans fronting the west side of the Sonoma Range; continued deposition of alluvial-fan debris.

GROUND WATER

OCCURRENCE

Most of the ground water occurs in the part of the valley fill that is composed of stream or delta deposits and alluvial-fan materials. These materials consist of interbedded and mixed sand, gravel, and some clay. The sands and gravels are quite permeable, so that water may enter or be withdrawn from them freely.

Ground water probably occurs also in the deep valley fill underlying the stream or delta deposits and alluvial-fan materials. Little is known regarding the occurrence of water in these materials. They are believed, for the most part, to be fine-grained and of low permeability and, therefore, would not yield water to wells readily.

The water in the stream or delta deposits and alluvial-fan materials generally occurs under water-table conditions. The water table in the floor of the valley is generally less than 10 feet below the land surface. Its slope, as shown by the contours on Plate 1, is from north to south, ranging from about 60 feet per mile at the north end to about 3 feet per mile in the vicinity of Toll House. The movement of ground water is, of course, in the same direction. Eventually, that portion of the

[2]Personal communication.

water which is not lost by evaporation and transpiration reaches the Humboldt River Valley.

RECHARGE

The source of the ground water in Paradise Valley is the precipitation within its drainage basin. Recharge to the ground-water reservoir from this source is effected in four ways: (1) Infiltration of water from perennial streams and of flood waters from normally dry canyons; (2) downward percolation of irrigation water; (3) direct precipitation on the valley floor; and (4) underground inflow of water from the bedrock.

Infiltration of water from perennial streams and of flood waters from normally dry canyons—A substantial part of the water in the valley fill is derived by infiltration of water from perennial streams and of flood waters from normally dry canyons. Infiltration from streams is greatest in the northern end of the valley, as there the streams are quite numerous and the material immediately underlying them is coarse and permeable.

The numerous alluvial fans that extend from the mouths of the canyons toward the axis of the valley also offer an excellent opportunity for recharge, as almost all the runoff from the hills and mountains bordering the valley passes across them. The coarsest and more permeable material is ordinarily found near the apex of each fan, coarse to fine material between the apex and toe of the fan, and the finest material at the toe of the fan.

During the summer of 1947, measurements of stream flow were made at different points on Colony, Stone House, and Provo Creeks to determine the magnitude of the stream losses. The results of these measurements are given in Table 3. There were no surface contributions to or artificial diversions from the streams between the points of measurement. The only losses were those from evaporation and transpiration, and from infiltration. After adjusting for the estimated losses due to evaporation and transpiration, the losses due to infiltration ranged from 0.40 to 0.85 second-foot per mile. The rate of infiltration is not constant. Many factors influence the rate of infiltration for any given reach of a stream. One of the most important factors is the quantity of water. In general, the larger the quantity, the larger the losses. For small flows, as shown by Table 3, the loss appears to be between 0.40 and 0.50 second-foot per mile. In view of the great total length of stream channels passing over the alluvial fans, especially in the north

TABLE 3

Measurement of stream flow and estimated loss by infiltration on Colony, Stone House, and Provo Creeks in Paradise Valley, Nevada.

Date of measurement	Upstream point of measurement	Discharge (second-feet)	Downstream point of measurement	Discharge (second-feet)	Distance between upstream and downstream points (miles)	Total loss (second-feet)	Estimated loss by evaporation and transpiration (second-feet)	Estimated loss by infiltration: Second-feet	Estimated loss by infiltration: Second-feet per mile
			COLONY CREEK						
June 26, 1947	NE¼ NE¼ sec. 31, T. 42 N., R. 39 E.	3.00	NE¼ SW¼ sec. 33, T. 42 N., R. 39 E.	1.58	1.6	1.42	0.06	1.36	0.85
June 26, 1947	NE¼ SW¼ sec. 33, T. 42 N., R. 39 E.	1.58	SE¼ SW¼ sec. 34, T. 42 N., R. 39 E.	1.12	1.0	.46	.04	.42	.42
June 26, 1947	NE¼ NE¼ sec. 31, T. 42 N., R. 39 E.	3.00	SE¼ SW¼ sec. 34, T. 42 N., R. 39 E.	1.12	2.6	1.88	.05	1.83	.70
			STONE HOUSE CREEK						
Aug. 15, 1947	NW¼ SE¼ sec. 20, T. 41 N., R. 39 E.	1.13	SE¼ SE¼ sec. 21, T. 41 N., R. 39 E.	.46	1.5	.67	.06	.61	.41
			PROVO CREEK						
June 26, 1947	NE¼ NE¼ sec. 6, T. 40 N., R. 39 E.	.55	NE¼ SE¼ sec. 5, T. 40 N., R. 39 E.	.0	1.25	.55	.05	.50	.40
July 27, 1947	NE¼ SW¼ sec. 10, T. 40 N., R. 39 E.	.10	NW¼ SE¼ sec. 10, T. 40 N., R. 39 E.	.0	.2	.10	.01	.09	.45

part of the valley, it is evident that there is considerable recharge to the ground water by infiltration.

Downward percolation of irrigation water—The largest contribution of water to the underground reservoir in Paradise Valley is believed to be by the downward percolation of irrigation water. During the irrigation season almost all the stream flow reaching the valley is diverted and spread for irrigation. About 40,000 acres of land in the valley have surface-water rights for irrigation. Most of this land lies in the northern part of the valley where the soil mantle is relatively thin, and the underlying materials quite coarse and highly permeable. The common method of irrigation is by flooding, and generally more water is applied than is necessary for the crop requirements. Consequently, that part of the irrigation water not lost by evaporation or transpiration is available for recharge to the ground-water reservoir. As a result of this combination of favorable factors, the opportunity for recharge is excellent. Actually, although not intentionally, this is a successful example of artificial recharge by water spreading.

Direct precipitation on the valley floor—It is believed that the average annual precipitation, which is only 8.87 inches at Paradise Valley and 8.54 inches at Winnemucca, is not sufficient to contribute materially to the ground water in the valley. The greater part of the precipitation is believed to be utilized in supporting the growth of vegetation, or is lost by evaporation. Consequently, the annual recharge to the ground-water reservoir from precipitation is believed to be negligible.

Underground inflow of water from the bedrock—The contributions to the ground-water supply from the bedrock are believed to be relatively unimportant. Probably most of this recharge is derived from the source or sources supplying the several thermal springs and well that are found within the drainage area of the valley. Warm springs are reported in the channel of Martin Creek less than 1 mile upstream from the Geological Survey gaging station. The Hot Springs (41/41–19A1) adjacent to the channel of the Little Humboldt River are the most picturesque evidence of the present-day thermal-spring activity in the region. The flow of the Hot Springs on February 26, 1948, was 60 gallons per minute, and the temperature of the water 135° F. Well 37/39–3D1, in the south end of the valley, is 61 feet deep and flows at the rate of 2¼ gallons per minute. The temperature of the water is 158° F. It is reported that this well was drilled at

the site of a small spring which ceased to flow after the well was drilled.

The distribution of the thermal springs and well suggests that thermal water from the bedrock may be recharging the ground-water reservoir in other parts of the valley. In some areas, especially where the permeability of the valley fill is high and the rate of recharge is small, no surface indication of such thermal activity may be apparent. Even where such activity is indicated at the land surface, the flow of the spring or well represents only a part of the recharge, the rest moving laterally underground into the valley fill. It is possible, therefore, that the annual contribution of thermal water from the bedrock is larger than the flows of the thermal springs and well might suggest. However, if the contributions were large the water in wells in the immediate vicinity of points of such recharge would have a somewhat higher temperature than the water in wells some distance away. No reports of thermal water in any of the wells in the valley, other than well 37/39–3D1, were received from the inhabitants of the valley. Furthermore, the temperatures of the water pumped from wells in different parts of the valley were found to be consistently low. It is therefore believed that, although the contributions to the ground-water reservoir from the bedrock may be larger than the total flow of the thermal springs and well, the magnitude of the contribution is but a small percentage of the total annual recharge.

Average annual recharge—Over long periods of time the ground-water recharge of a basin is equal to the ground-water discharge. Therefore, when making a study of the ground-water resources of a basin it is desirable to determine independently both the average annual recharge and the average annual discharge in order to see that they are in essential agreement.

In Paradise Valley it was impracticable to obtain exact figures for the average annual contributions to ground water from each of the four sources of recharge. It is desirable, nevertheless, to make as close an estimate as possible of the average annual recharge in order to see if it is in essential agreement with the estimated average annual discharge.

The average annual recharge may be estimated by computing the amount of water available for recharge and then deducting therefrom all losses that occur before the water reaches the water table.

The amount of water available for recharge may be considered

to be the precipitation within the drainage basin less that part which is evaporated or transpired before running off.

That part of the precipitation lost by evaporation or transpiration before running off can be obtained by considering it to be the difference between the total precipitation in a drainage area and the runoff out of the area, provided that little water infiltrates into the ground.

The Martin Creek drainage basin at the northeast corner of the valley is the most suitable for computing these evaporation and transpiration losses. Martin Creek has the largest runoff of all the streams in the valley and also has the longest record of runoff. A Geological Survey gaging station at the mouth of Martin Creek canyon has been in operation continuously, except for the year 1927, since 1921 (see pl. 1). There are no diversions above the gaging station and the underflow is believed to be negligible. The average annual runoff of Martin Creek at the station therefore should approximate the average annual precipitation less the evapo-transpiration requirements in the Martin Creek drainage basin.

The total precipitation in the Martin Creek drainage basin was computed, using as a basis the precipitation map of Nevada prepared under the direction of George Hardman.[3] Hardman's map shows the average annual precipitation by areas and precipitation zones. The zones are those of 5 to 8 inches, 8 to 12 inches, 12 to 15 inches, 15 to 20 inches, and more than 20 inches of precipitation. On the basis of the zones as shown on this map, it was found that the average annual runoff of Martin Creek during the 25-year period for which records are available was equal to the total precipitation over its drainage basin less 9 inches over the drainage basin. In other words, 9 inches of precipitation was required to satisfy evapo-transpiration requirements in the Martin Creek drainage basin. In estimating the probable amount of water available for recharge in drainage areas for which stream runoff records were not available, a similar deduction of 9 inches was made from the total precipitation. Where streamflow records were available they were considered to be the best indication of the amount of water available for recharge.

Discharge records for Martin Creek are available for the 25-year period 1922–1926 and 1928–1947; for the Little Humboldt River, 1944–1947; and for Cottonwood Creek, 1945–1947

[3]Hardman, George, Nevada precipitation and acreages of land by rainfall zones, Nev. Univ. Agr. Exper. Sta. mimeographed report and map, 10 pp., June 1936.

(see table 4). The average annual discharge of Martin Creek during this 25-year period was 20,140 acre-feet. The average annual discharge of the Little Humboldt River during the 4-year period of record was 15,240 acre-feet. An average based on only 4 years of record, however, probably only approximates the 25-year average, so it is desirable to adjust the 4-year average to the probable 25-year average. This may be done by establishing the relationship of the average discharge of Martin Creek for the 4-year period 1944–1947 to the 25-year period of record. It was found that the average discharge of Martin Creek in the 4-year period was 108 percent of the 25-year average. Adjusting the average discharge of the Little Humboldt River on this basis, it was found that the average annual discharge for the 25-year period would be about 16,500 acre-feet.

Although a gaging station has been in operation on Cottonwood Creek near the town of Paradise Valley since 1944, the records are of little value in estimating the runoff, as there are several unmeasured diversions above the gaging station and undetermined but probably substantial seepage losses from the stream as it passes over its alluvial fan before reaching the gaging station. Consequently, it is necessary to estimate the runoff of Cottonwood Creek and the other minor streams, using as a basis Hardman's precipitation map and deducting 9 inches of precipitation over each of the drainage basins. The yearly discharges, in second-feet, at gaging stations on Martin Creek, Little Humboldt River, and Cottonwood Creek are given in Table 4. The estimated average annual runoff in acre-feet for the various drainage areas in Paradise Valley are given in the table following Table 4.

TABLE 4

Yearly discharge, in ~~second~~ acre-feet, at gaging stations on Martin Creek, Little Humboldt River, and Cottonwood Creek in Paradise Valley, Nevada.

Period	Water Year Ending September 30		
	Martin Creek	Little Humboldt River	Cottonwood Creek
1922	28,400		
1923	13,700		
1924	8,800		
1925	16,900		
1926	17,600		
1927	.....		
1928	20,700		
1929	11,300		
1930	13,500		
1931	5,910		
1932	33,200		
1933	13,500		
1934	8,640		
1935	21,360		
1936	19,910		
1937	16,590		
1938	34,240		
1939	15,760		
1940	21,150		
1941	24,170		
1942	25,950		
1943	46,070		
1944	17,300	10,090	
1945	34,120	25,490	11,310
1946	22,700	16,090	9,260
1947	13,110	9,280	916

Estimated Average Annual Runoff, in Acre-Feet, in Paradise Valley

Martin Creek	20,100
Little Humboldt River	16,500
Cottonwood Creek and tributaries	13,000
Indian Creek	6,900
Provo, Wash O'Neal, Stone House, and Beef Creeks	10,000
Runoff from Santa Rosa Range south of Paradise Peak	2,800
Runoff from Hot Springs Range south of the Little Humboldt River	1,200
Total	70,500

As shown in the above table, the estimated average annual runoff is 70,500 acre-feet. This approximates the quantity of water available for ground-water recharge. However, because of evaporation and transpiration of water used for irrigation and of other unavoidable losses, the actual quantity that recharges the ground water is a great deal less.

The principal loss from the estimated average annual runoff is the amount of water evaporated and transpired in the growing of crops being irrigated with surface water. It is difficult to make an estimate of the average annual amount of surface water used in the growing of irrigated crops, as the number of acres irrigated and the amount of water applied vary greatly

from year to year, depending on the available supply and the time of its availability.

The surface-water rights for the irrigated land are classified as A, B, and C rights. According to the Little Humboldt River decree, No. 3157, the classification of lands and length of irrigation season are summarized as follows:

> Class A, or harvest-crop lands, include all lands devoted to cultivated crops, and, also, all irrigated native or other grass lands which normally receive sufficient water to produce a crop which will justify cutting for hay. The irrigation season for these lands is limited to 180 days. Class B, or meadow-pasture lands include all lands free from brush which receive sufficient water to produce what may be classified as good pasture, but not of sufficient character to warrant cutting hay thereon. The irrigation season for these lands is limited to 90 days. Class C, or diversified-pasture lands include all lands from which the brush has not been cleared, but which are irrigated to some extent for the production of grasses or pasturage. Diversified pasture may be watered only when the stream system is in flood, or when there is excess water above the needs of higher class culture. The irrigation season for these lands is limited to 30 days.

The water is diverted for irrigation according to the priority of the right, the earliest rights having first priority, and the latest rights the lowest priority. Thus, in years of low runoff only the holders of earlier rights would receive water, as none would be available for the later rights. The runoff and hence the acreage irrigated have ranged widely. This may be seen by inspecting the discharge of Martin Creek for the 25-year period. It will be seen that the maximum discharge of 46,070 acre-feet in 1943 was approximately 8 times the minimum of 5,910 acre-feet in 1931. In 1943 the requirements of all users were satisfied, and in addition a considerable quantity of unused water passed through the valley and into Gumboot Lake.

According to the records in the office of the State Engineer of Nevada, about 40,400 acres of land in the valley have surface-water rights. Approximately 30,400 acres have Class A rights; 1,200 acres, Class B rights; and 8,800 acres, Class C rights. Inasmuch as lands having Class A rights are entitled to 3.6 acre-feet per acre annually; lands having Class B rights, 1.8 acre-feet

per acre annually; and lands having Class C rights, 0.9 acre-foot per acre annually, the surface-water rights total about 118,000 acre-feet annually.

Obviously during a year of average runoff there is insufficient water to satisfy all the rights. Therefore, during years of normal runoff most of the estimated 70,500 acre-feet available is probably diverted for irrigation. The amount of the water thus diverted that reaches the ground-water reservoir depends largely on the acreage irrigated and the consumptive use of the crops grown. It seems reasonable to assume that about 20,000 acres are irrigated during a year of average runoff. Inasmuch as a large part of the irrigation is accomplished by flooding lands devoted to the growing of native hay and other grasses, the consumptive use is believed to be about 2 acre-feet per acre or about 40,000 acre-feet. Evaporation and transpiration losses along stream channels and ditches further reduces the amount available for ground-water recharge.

It appears on this basis that the average annual recharge is less than half the average annual runoff—probably about one-third.

DISCHARGE

In Paradise Valley the principal way in which ground water is discharged is by the process of evaporation and transpiration. Some water is discharged by underflow out of the valley into the Humboldt River. There was no pumping for irrigation in 1947, and the withdrawals by pumping for stock and domestic use from approximately 100 wells was insignificant as compared to the total discharge. The capacities of the pumps in the majority of wells is about 5 gallons per minute. As the pumps were not in continuous operation, it may be seen that the quantity of water pumped was not large, probably between 100 and 200 acre-feet.

Discharge by evaporation and transpiration—Ground water is discharged by evaporation where the water table is sufficiently shallow so that the capillary fringe extends to the land surface. It is also discharged by water-loving plants, called phreatophytes, that obtain their water supply from the water table or from the overlying capillary fringe. Generally, phreatophytes grow where the water table is so shallow that both evaporation and transpiration go on simultaneously. The principal species of phreatophytes in Paradise Valley are greasewood and saltgrass. Other phreatophytes found in the valley are ryegrass, rabbitbrush, pickleweed, and willows.

The areas in which phreatophytes are the dominant vegetation

were mapped in the field. In general, it was found that saltgrass was the dominant plant in the trough of the valley south of T. 40 N. In T. 40 N. and northward the plants in the trough of the valley are largely native grasses which are cut for hay.

In the north part of the valley the various distributory channels are usually lined with a dense growth of willows. The saltgrass and pasture land area is bordered on either side of the valley by a strip of greasewood that ranges from a quarter of a mile to 2 miles in width. These greasewood strips south of 41 N. correspond very closely to the area in which the depth to water below land surface ranges from 10 to 15 feet, shown on Plate 1. The areas covered by saltgrass and greasewood are shown by townships in the following table:

Township	Saltgrass (acres)	Greasewood (acres)
T. 37 N., R. 38 E.	1,000	1,200
T. 38 N., Rs. 38 and 39 E.	1,700	11,800
T. 39 N., Rs. 39 and 40 E.	5,800	6,000
T. 40 N., Rs. 39 and 40 E.	2,000	4,000
T. 41 N., Rs. 39 and 40 E.	.....	7,300
T. 42 N., Rs. 39 and 40 E.	.....	5,500
Total	10,500	35,800

In the area of saltgrass the depth of water ranged up to 11 feet, although over most of the area it was less than 10 feet. During the growing season it ranged from 3 to 8 feet, and averaged about 5 feet. It is estimated on the basis of findings of other workers[4] on the use of water by phreatophytes that the annual draft on ground water is about 0.7-foot per acre. In arriving at this figure, consideration was given to the depth to water, and also to the difference in length of growing season. On this basis, the quantity of ground water discharged by evaporation and transpiration from the area covered by saltgrass is estimated to be about 7,400 acre-feet per year.

On the same basis it is estimated that the draft on ground water in the area covered by greasewood where the depth to water ranges from 10 to 15 feet is about 0.4 acre-foot per acre. Using this figure, the quantity of ground water discharged from the area covered by greasewood is about 14,300 acre-feet a year.

In addition to the ground water discharged by saltgrass and greasewood, there is also discharge by willows and associated brush. North of Shelton Lane, and to some extent south of it,

[4]White, W. N., A method of estimating ground-water supplies, based on discharge by plants and evaporation from soil—results of investigations in Escalante Valley, Utah: U. S. Geol. Survey Water-Supply Paper 659-A, p. 87, 1932.
Young, A. A., and Blaney, H. F., Use of water by native vegetation: Calif. Dept. of Public Works, Div. of Water Resources Bull. No. 50, 1942.

the various distributory channels are lined with a thick growth of willows and other brush. Willows have a much higher use than saltgrass or greasewood. In the latitude of Paradise Valley it is estimated to be between 4 and 5 acre-feet per acre. No effort was made to map the area of willows but it is known to aggregate several hundred acres.

The annual discharge of water by evapo-transpiration from the areas of saltgrass, greasewood, and willows is estimated to be not less than 23,000 acre-feet.

Discharge by underflow—As indicated by the contours of the water table (see pl. 1) the ground water moves southward through the valley fill and thence into the Humboldt River (see pl. 2).

In order to estimate the amount of underflow out of Paradise Valley, stream-discharge measurements were made during the late summer of 1947 at several points on the Humboldt River, upstream and downstream from the confluence of the channel of the Little Humboldt River with the Humboldt River Valley. The location of points at which the stream was measured are shown on Plate 1 and the results of the discharge measurements are given in Table 5.

TABLE 5

Flow of the Humboldt River at four places between a point 2 miles north of Golconda and a point 1½ miles north of Winnemucca, Nevada.

Station in downstream order	Location	Date of measurement (1947)	Discharge (second-feet)
1	SW¼ sec. 21, T. 36 N., R. 40 E., 50 feet downstream from bridge, 2 miles north of Golconda	Sept. 6	1.98
2	NW¼ sec. 3, T. 36 N., R. 39 E., 50 yards upstream from footbridge, and about ¼ mile northwest of Bullhead Ranch headquarters	Sept. 4	4.01
		Oct. 1	1.97
3	NE¼ sec. 3, T. 36 N., R. 38 E., ¼ mile north of Kearns ranch headquarters	Sept. 4	5.08
		Oct. 1	3.16
4	NE¼ sec. 17, T. 36 N., R. 38 E., 200 yards downstream from bridge	Sept. 5	8.65
		Oct. 1	6.16

Conditions for determining the seepage gain or loss in the Humboldt River during the period were excellent. The flow of the river, as indicated by the Geological Survey gaging station at Comus about 25 miles upstream from Winnemucca, had been less than 1.0 second-foot since August 15, and the flow from August 24 to September 6 had been constant at 0.2 second-foot. During the month of September the flow at Comus was between 0.2 and 0.4 second-foot. As a result of the long period of low flow, bank storage from previous high flows was at a minimum,

and the increase in flow was due to the inflow of ground water rather than to return flow from bank storage. There were no diversions from the river immediately preceding or during each set of measurements.

After careful consideration of the geologic and hydrologic conditions, it appears that the increase in flow between stations 2 and 4 is a measure of the underflow out of Paradise Valley. The known or inferred position of the bedrock, and the water-table contours, indicate that there is little opportunity for underflow into the Humboldt River Valley above or below these stations. The average discharge for the two sets of measurements on September 4 and 5 and on October 1, 1947, between stations 2 and 4, is 4.41 second-feet. This is equivalent to an annual discharge of 3,200 acre-feet.

The greater part of the 3,200 acre-feet is believed to come from Paradise Valley. There may be some inflow of ground water from the north end of the Sonoma Mountains south of the river. However, this inflow cannot be large because the drainage area is small. Consequently, it is believed that the underflow out of Paradise Valley closely approximates 3,200 acre-feet annually.

Average annual discharge—As mentioned earlier, the average annual discharge of a ground-water area under natural conditions over a long period of time is equal to the average annual recharge. Much better data are available with which to estimate the average annual discharge than are available for estimating the average annual recharge. A summary of the estimates given in the preceding pages shows that not less than 23,000 acre-feet of ground water is discharged by evaporation and transpiration, and about 3,200 acre-feet by underflow out of the valley. Thus, the total ground-water discharge is in the neighborhood of 26,000 acre-feet per year. This shows that the estimate for recharge of about a third of the average annual runoff of 70,500 acre-feet is in the correct order of magnitude.

FLUCTUATIONS OF THE WATER TABLE

Periodic measurements of water level in 10 observation wells strategically located throughout the valley were begun in the autumn of 1945. The measurements were made and are still being made at approximately 1-month intervals. Hydrographs showing the changes in water level in these wells, together with the runoff as measured at the Geological Survey gaging station on Martin Creek, are shown in Figure 2. Contributions to the ground-water supply are made not only by the water naturally

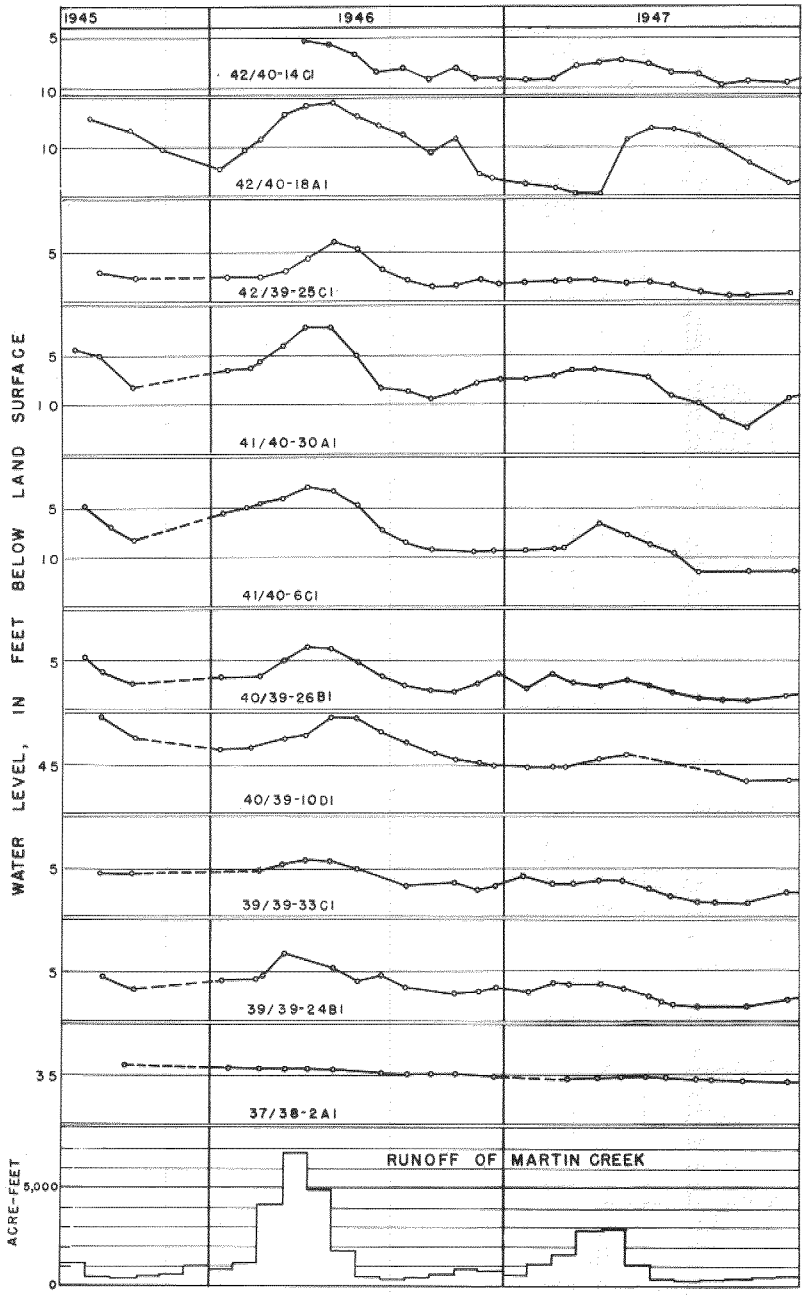


FIGURE 2
Hydrographs of 10 wells downstream from Martin Creek and runoff of Martin Creek, Paradise Valley, July 1945 to December 1947.

infiltrating into the alluvium but, also, by infiltration of surface water used for irrigation. In the northern end of the valley, where most of the important streams and the irrigated land are located, there is a direct correlation between runoff and changes in water level. The ground-water level begins to rise with the beginning of the runoff in the spring, reaches its highest level at the peak of the runoff, and then declines slowly until the next season. Toward the south end of the valley, far removed from the points of recharge, minor changes in runoff are not reflected by varying water-level stages.

The hydrographs indicate that the maximum annual range in water levels is about 9 feet in the northern part of the valley, about 5 feet in the central part of the valley, and 2 feet in the southern part of the valley.

A general downward trend in water levels during the years 1946 and 1947 is also apparent. In many parts of the valley the lowest stage in 1947 was somewhat more than 2 feet lower than the lowest stage in 1945. This general lowering is not the result of increased withdrawals of ground water during the period but rather reflects a decline in the annual recharge. In the following tabulation are listed the amounts of precipitation recorded at the town of Paradise Valley precipitation station, and the runoff of Martin Creek as measured at the Geological Survey gaging station.

Year ending Sept. 30	Precipitation at Paradise Valley (inches)	Runoff at Martin Creek (acre-feet)
1945	12.13	34,120
1946	8.54	22,696
1947	7.85	13,111

The runoff of Martin Creek is a more reliable index of recharge for the valley than is the precipitation at the town of Paradise Valley, for, as discussed earlier, infiltration of stream flow and irrigation water accounts for most of the recharge to the underground supply.

Both the precipitation and runoff data indicate that 1946 was very nearly a normal year.

ARTESIAN CONDITIONS

No known wells encounter water under artesian head in the valley fill in the northern part of the valley. In the southern part of the valley artesian heads 2 or 3 feet above the water table were reported in test wells drilled in T. 38 N., R. 39 E. These heads, however, were sufficient to raise the static water level in test holes only to within 3 or 4 feet of the land surface. Well

a guide for classifying waters with respect to their suitability for irrigation:[1]

	CLASS I Excellent to good	CLASS II Good to injurious	CLASS III Injurious to unsatisfactory
Dissolved solids (parts per million)	Less than 700	700 to 2,000	More than 2,000
Boron (parts per million)	0.5	0.5 to 2.0	More than 2.0
Percent sodium	60	60 to 75	More than 75
Chloride concentration (equivalent parts per million)	5	5 to 10	More than 10

The boron content of an irrigation water is significant because of the relative sensitiveness of certain plants to boron. Beans are extremely sensitive whereas garden beets have a great tolerance for boron.[2] Sodium, in combination with the sulfate and carbonate radicals, form the salts that are most commonly referred to as alkalies in agricultural and soil studies. Potassium occurs only in small concentrations in the waters of Paradise Valley, therefore, it has been calculated and reported with the sodium. The percentage of sodium is calculated from analytical results expressed in milligram equivalents per kilogram. When the results of the analyses are expressed in parts per million they can be expressed as milligram equivalents per kilogram by dividing the parts per million of sodium, calcium, and magnesium, by their chemical combining weights, which are 23, 20, and 12.2, respectively. Then, 100 times the milligram equivalents of sodium is divided by the sum of the milligram equivalents of sodium, calcium, and magnesium. Water in which the percentage of sodium is more than 60 may injure a soil having poor drainage, whereas a sandy soil with good drainage may not be adversely affected with water containing as much as 80 percent sodium. Chloride concentration is expressed as equivalent parts per million. Equivalent parts per million, for practical purposes, can be computed by dividing the chloride concentration expressed in parts per million by 35.5.

Class I water is considered to be suitable for most plants under most conditions. Class II water will probably be harmful to the more sensitive crops. Class III water probably will be harmful to most crops and unsatisfactory for all but the most tolerant.

Applying the above criteria to the analyses in Table 6 indicates that the water from well 39/39–13C1 is the best water for irrigation. Water from well 39/39–24B1 is very similar to it. Both these waters are Class I waters. The water from well

[1]Magistad, O. C., and Christiansen, J. E., Saline soils, their nature and management: U. S. Dept. Agr. Circ. 707, 1944.

[2]Magistad, O. C., and Christiansen, J. E., op. cit., p. 9.

TABLE 6

Analyses and classification of water from selected wells, a spring, and streams in Paradise Valley, Nevada.*

Well, spring, or stream sampled and location	Date of collection	Temperature, °F.	Parts Per Million									Percent sodium	Quality for irrigation (class)
			Boron (B)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Carbonate (CO_3)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Dissolved solids		
37/38–2A1	8–15–45	.....	0.53	27	8.0	120	Tr.	232	74	67	†430	72	II
37/39–3D1	10–25–47	158	.....	29	10	467	.....	1,240	73	22	1,250	90	II
39–39–13C1‡	2–5–48	.....	Tr.	38	9.7	70	.....	214	46	45	339	53	I
39/39–24B1	8–15–45	50	.22	41	9.5	78	Tr.	243	45	45	†370	54	I
41/41–19A1	8–14–45	135	2.54	26	8.5	334	.....	920	34	26	†930	88	III
42/40–16A1	8–14–45	49	.40	52	13	126	.....	329	45	66	†480	60	I
Little Humboldt River, SW¼ sec. 23, T. 41 N., R. 40 E.	10–5–48	.....	.16	33	8	48	nil	180	33	27	†260	48	I
Little Humboldt River, NE¼ sec. 19, T. 41 N., R. 41 E.	10–5–48	.....	.09	34	8	40	Tr.	165	31	27	†240	42	I
Cottonwood Creek, NW¼ sec. 25, T. 42 N., R. 39 E.	10–7–48	.....	.19	44	11	63	nil	323	10	11	†330	47	I
Colony Creek, SW¼ sec. 34, T. 42 N., R. 39 E.	10–7–48	.....	nil	11	4	9	nil	70	3	2	†70	31	I
Martin Creek, NW¼ sec. 12, T. 42 N., R. 40 E.	10–7–48	.....	nil	19	6	28	nil	110	18	18	†160	46	I

*Analyses by M. R. Miller, University of Nevada, Agricultural Experiment Station, or W. B. Adams, University of Nevada, Department of Food and Drugs, Public Service Division, except as noted.

†Computed by O. J. Loeltz.

‡Analysis by Smith-Emery Company, Los Angeles, California.

42/40–16A1, 4 miles northeast of the town of Paradise Valley, is also Class I water for irrigation, although it approaches Class II water because of its boron content and percentage of sodium. It is probably representative of the water in the north end of the valley in those areas where the infiltration of water from streams is but a small percentage of the recharge to the ground water. The quality of the ground water in the north end of the valley will be somewhat better where it receives substantial recharge by infiltration of water from the more important streams.

The analyses of the water from well 37/38–2A1 indicates that special care will be required in growing crops sensitive to boron and alkali salts. However, this water occurs only in a very limited area in comparison with the areas in which large quantities of good water can be obtained; therefore, it need not retard the complete development of ground water in the valley.

Water from the thermal well 37/39–3D1 is Class III water because of its high percentage of sodium. It would probably be harmful to most crops and unsatisfactory for all but the most alkali resistant plants.

The water from the Hot Springs, 41/41–19A1, is also Class III water. Inasmuch as the springs are about 2 miles east of the valley, the quality of the water is significant only insofar as it affects the quality of the water of the Little Humboldt River into which it eventually flows. The discharge from the springs has been measured as 60 gallons per minute, and the flow of the Little Humboldt River is rarely less than 6 second-feet, so the poor quality of the water from the springs has little effect on the quality of the water in the Little Humboldt River.

The small effect that the flow from the Hot Springs has on the quality of the water of the Little Humboldt River is shown by comparing the quality of the water of the river just above and below the Hot Springs. As shown in Table 6, the sample of the river water obtained at a point in the SW¼ sec. 23, T. 41 N., R. 40 E., about 2¼ miles downstream from the Hot Springs, was almost as good in quality as the sample collected at a point in the NE¼ sec. 19, T. 41 N., R. 41 E., just upstream from the Hot Springs. The samples of Cottonwood, Colony, and Martin Creeks show these waters to be Class I waters for irrigation. The analyses of water from streams, as shown in Table 6, indicate that the quality of the water in all streams in Paradise Valley is probably Class I for irrigation.

The analyses of the nonthermal ground water in the valley

indicate that it is generally suitable for growing all the common crop plants.

DEVELOPMENT OF GROUND WATER

STATUS OF GROUND-WATER DEVELOPMENT, 1947

Most of the development of ground water in Paradise Valley has been for domestic and stock use. With the exception of well 37/39–3D1, which flows at the rate of 2¼ gallons per minute, all other wells in use in the valley are pumped. There are approximately 100 pumped wells in the valley, more than half of which are equipped with lift pumps having capacities of about 5 gallons per minute. Perhaps a dozen wells are equipped with pumps having capacities of about 50 gallons per minute. The water from these wells is used to irrigate small lawns and gardens and represents most of the ground water pumped for irrigation.

An attempt to obtain artesian water was made in 1889 when well 39/39–24B2 was bored to a depth of more than 800 feet before being abandoned because of a broken boring rod which could not be extricated from the hole. The artesian head of 2 feet above land surface when the well was at a depth of 87 feet, if the report is correct, is believed to be a local condition. The 3-inch casing evidently sealed off the reported artesian stratum, as the water level in the well in 1947 was at the same level as the water table. It is doubtful if this well was ever pumped.

Well 39/39–13C1 has been pumped at a higher rate than any other well thus far drilled in the valley. At the end of a 4-hour performance test, February 25, 1948, the well yielded 2,350 gallons per minute with a lift to land surface of about 45 feet. As the drawdown was only 38½ feet, the specific capacity of the well at the time of the test was about 60 gallons per minute per foot of drawdown. The specific capacity is not constant but varies with pumping rates, length of pumping periods, seasonal changes in water level, and other factors. However, the rate at which the water level was declining at the end of the test was so small that no change in the reading of the air-line gage was apparent during the last 2 hours of pumping. It can, therefore, be inferred that even with prolonged pumping the specific capacity, although decreasing somewhat, will still be in excess of 50 gallons per minute per foot of drawdown. The well was drilled and equipped with a turbine pump in 1941, but as late as 1947 had never been used for irrigation. However, an adequate power plant was installed in the early spring of 1948 and water was pumped for irrigation in the 1948 season.

Well 39/39–13C2 is a pit about 30 feet wide, 200 feet long, and

17 feet deep that had been used intermittently to irrigate alfalfa. It is reported that during the years when the pit was pumped the yield was as much as 2,500 gallons per minute in June when the water table was at its highest stage, but that the yield declined later in the summer because of a seasonal decline of the water table.

Well 39/39–16B1, about 3 miles west of the above well, was drilled in 1948 to a depth of 291 feet. From the surface to a depth of 276 feet the log indicates at least 144 feet of highly permeable coarse sand and gravel.

Well 40/39–26B1 was drilled in an effort to obtain artesian water but was abandoned at about 300 feet when two strings of drilling tools were lost in the hole. It is reported that the formation consisted almost entirely of sand and gravel, and that the drawdown is less than 1 foot when the well is pumped at the rate of 50 gallons per minute. Inasmuch as the water level is only about 9 feet below the land surface, it is probable that yields of several second-feet could be obtained with a lift of less than 50 feet.

The development of ground water for irrigation in Paradise Valley up to 1947 may be summarized as follows: With the exception of water for gardens and lawns, the only irrigation pumpage has been from well 39/39–13C2, and this has been intermittent. It has been demonstrated that water-bearing material capable of yielding large supplies of water suitable for irrigation underlies much of the valley floor. Large supplies of water can be obtained with pumping lifts of less than 50 feet in parts of T. 39 and 40 N., R. 39 E.

FUTURE DEVELOPMENT FOR IRRIGATION OR OTHER LARGE USES

Quantity available—The average annual amount of ground water available for pumping in Paradise Valley may be considered as the sum of the recoverable part of the average annual outflow out of the valley and the savings in evaporation and transpiration losses that can be effected by a feasible lowering of the water levels in the areas where these losses are large.

The contours of the water-table map indicate that a general lowering of the water levels of about 20 feet near the south boundary of T. 38 N. would be sufficient to stop practically all underflow from the valley. This general lowering of the water table would also eliminate practically all the evaporation and transpiration losses in areas in which saltgrass is the dominant vegetation. In addition, the greater depth to water would reduce the average rate of use of water by greasewood. The amount of

water that would be made available for pumping because of lessened evaporation and transpiration losses in greasewood areas is believed to be between one-third and one-fourth of the amount lost, or about 4,000 acre-feet annually.

Under these conditions the annual amount of water available for pumping then would be 3,200 acre-feet of underflow out of the valley; 7,400 acre-feet now being evaporated or transpired in areas where saltgrass is the dominant vegetation; and about 4,000 acre-feet now being lost by evaporation and transpiration in greasewood areas; making a total of about 15,000 acre-feet.

The available data do not permit a precise estimate of the average annual amount of water that can be pumped. As development of ground water proceeds, the amount and effect of pumping should be carefully determined and the climatic conditions noted. These data will form a basis for a closer determination of the safe yield of the ground-water reservoir.

FAVORABLE AREAS

Wells that are feasible for irrigation or other purposes probably can be developed in the alluvium underlying the floor of Paradise Valley from the mouth of Martin Creek canyon to about the south line of T. 38 N. South of this line it is possible that similar wells may be developed along the old channel of the Little Humboldt River, but the quality of the water may not be suitable for irrigation.

Inasmuch as most of the stream flow is used for irrigation in the north end of the valley, there would appear to be little need for developing ground water for irrigation in this part of the valley. The development of ground water in the area from about the middle of T. 40 N. to about the south line of T. 38 N. would effect the best salvage of ground water now being lost by evapotranspiration, and on the whole bring about the most efficient utilization of the ground-water supply of the valley.

TABLES

The three tables that follow, 7, 8, and 9, contain data concerning wells in Paradise Valley and the adjacent portion of the Humboldt River Valley.

These wells are identified by a numbering system based on the network of surveys established by the General Land Office. This numbering system serves to locate each well in the township, range, and section. The first unit is the number of the township; the second unit, separated from the first by a diagonal line, is the

range; the next unit, separated by a dash, shows the section, quarter section, and individual well number. The section has been divided into four 160-acre tracts, each of which has been assigned a symbol. Beginning with the northeast quarter the letters have been assigned in a counterclockwise direction. Thus, the northeast quarter is "A," the northwest quarter "B," the southwest quarter "C," and the southeast quarter "D." The first well recorded in a given quarter section is designed by the numeral 1, the second by 2, and so forth. Thus, the first well located in the northwest quarter of section 13, T. 39 N., R. 39 E., would be numbered 39/39–13B1, the second would be 39/39–13B2, and so forth.

On Plate 1, only that part of the number designating the quarter section, and the order in which the well was recorded is shown. The section number in any township can be found from the corresponding sections numbered in T. 39 N., R. 40 E. The township and range numbers are shown on the edges of Plate 1.

Table 7 is a list of most of the wells in Paradise Valley and adjacent portion of the Humboldt River Valley. The list contains data for 112 wells. The locations of these wells are shown on Plate 1. Some of the data were reported orally, but most of the data were taken from written records or were collected in the field.

Table 8 is a list of the available well logs and casing records.

Table 9 is a list of observation wells and the measurements of water levels made for the period July 1945 to January 1948, inclusive.

TABLE 8

Logs and casing records of wells in Paradise Valley and adjacent portion of Humboldt River Valley, Nevada.

36/38–2B1. Jack Kearns. Drilled by Mel Meyer. Casing diameter 12 inches to a depth of 304 feet, open hole below. Land-surface altitude 4,301 feet above mean sea level.

Material	Thickness (feet)	Depth (feet)
Sand, fine, to grit, gray; 30% of sample greater than ¼ inch in diameter	6	6
Sand, fine, to grit, gray, subrounded to subangular; 10% of sample larger than ¼ inch in diameter; silt, less than 5% of volume	24	30
Sand, medium, to fine gravel, rounded to subrounded; reddish clay, less than 5% of volume	10	40
Sand, medium, to grit, rounded to subrounded; reddish silt and clay, less than 10% of volume	35	75
Sand, medium, to medium gravel, rounded to subrounded; light-brown silt, less than 10% of volume	50	125
Sand, coarse, to fine gravel, rounded to subrounded; light-brown silt, less than 10% of volume	35	160
Sand, coarse, to fine gravel, rounded to subangular; brown silt and clay, about 30% of volume	40	200
Sand, coarse, to medium gravel, rounded to subangular; light-brown silt and clay, less than 4% of volume	51	251
Rock, broken, brown	13	264
Rock, broken; gray clay	12	276
Rock, broken; brown clay	8	284
Rock, broken; green clay	20	304
Rock, brown; main water	10	314
Total depth	----	314

38/39–16A1. J. C. Cordoza. Drilled by C. R. Keener. Diameter 12 inches to a depth of 75+ feet, no casing installed. Land-surface altitude 4,313 feet above mean sea level. Owner's log (from memory).

Material	Thickness (feet)	Depth (feet)
Soil, top	12½	12½
Clay	5	17½
Sand and gravel streaks in clay	5	22½
Clay	7½	30
Sand and gravel	45	75
Clay	?	?
Total depth	----	75+

38/39–21B1. J. C. Cordoza. Drilled by C. R. Keener. Casing diameter 6 inches to a depth of 75 feet. Land-surface altitude 4,314 feet above mean sea level. Owner's log (from memory).

Material	Thickness (feet)	Depth (feet)
Soil, top	12½	12½
Clay	5	17½
Sand	5	22½
Clay, some gravel	12½	35
Sand and gravel	40	75
Total depth	----	75

TABLE 8—*Continued*

39/39–13C3. Bennett and Biltz (Johnson well). Drilled by Underwood. Land-surface altitude 4,334 feet above mean sea level. Driller's log. This well filled in shortly after being drilled because casing was twisted off 100 feet below land surface. Well 39/39–13C1 was drilled 50 feet west of this well.

Material	Thickness (feet)	Depth (feet)
Soil, top	15	15
Sand and gravel	52	67
Gravel, heavy (egg-size)	23	90
Hardpan	1	91
Sand, small gravel	3	94
Clay, hard	3	97
Gravel, small ribs of clay	15	112
Gravel, heavy	25	137
Gravel, ribs of clay	44	181
Gravel	9	190
Clay and sand	12	202
Gravel	9	211
Clay and gravel, gravel in bottom	14	225
Total depth	----	225

39/39–16B1. Bennett and Biltz. Drilled by A. E. Hosack and Son. Casing diameter 20 inches to a depth of 291 feet. Factory-perforated casing from 70 to 270 feet.

Material	Thickness (feet)	Depth (feet)
Soil, black	9	9
Sand to silt, medium, ill-sorted; light brown	7	16
Silt, light brown	4	20
Gravel, coarse, to fine sand; gravel 20% of sample and subangular to rounded, consists of volcanic and metamorphic rocks	1	21
Silt and clay, light brown	28	49
Same as from 20 to 21 feet. Gravel 50% of sample	11	60
Clay, white, less than 10% coarse sand	9	69
Gravel, coarse to medium, rounded to subrounded, 60% of sample is volcanic rock	1	70
Sand, fine, to medium gravel, angular to subrounded	5	75
Clay, silt, sand, and gravel. Sample is coherent	3	78
Gravel, coarse, to fine sand; subangular to rounded	8	86
Clay and silt, light brown to white, with less than 10% sand grains	8	94
Silt, light gray	11	105
Silt and clay, light gray, cementing fine sand	7	112
Sand, medium, to coarse gravel; rounded	23	135
Silt and clay, gray, and fine sand	2	137
Silt and clay, cementing medium gravel to fine sand	5	142
Gravel, medium, to coarse sand, with less than 5% silt and clay	20	162
Silt and fine sand, gray	5	167
Sand, medium, to coarse gravel; well-rounded	17	184
Silt and clay, light brown	16	200
Sand, medium, to coarse gravel, well-rounded	32	232
Silt, clay, and fine sand, light-brown	14	246
Gravel and coarse sand, well-rounded	26	272
Clay and silt, yellow	4	276
Silt and fine to coarse sand	9	285
Clay and silt, yellow	6	291
Total depth	----	291

TABLE 8—*Continued*

39/39–24B2. Bennett and Biltz. Well bored in 1889 by a group of Paradise Valley ranchers. Casing diameter 3 inches, measured depth in 1947, 61 feet. Land-surface altitude 4,334 feet above mean sea level. Log compiled from daily editions of The Silver State, Winnemucca, Nevada, newspaper, during the period June 8, 1889, to July 29, 1889.

Material	Thickness (feet)	Depth (feet)
Loam, topsoil	9	9
Gravel, hard and cemented, water level at 84 feet, 2 feet above land surface	80	89
Gravel and sand	14	103
Gravel, cemented. Gravel sample consists of quartz and slate worn smooth. Some of the specimens forced up by the pump were flat and smooth and nearly as large as a dime	50	153
Unknown	121	274
Sandstone, hard	20	294
Ground, soft, drilling 10 feet an hour	*	294
Ground, soft	†	450
Clay, drilling 85 feet a day	†	540
Clay, drilling 75 feet a day	†	700
Unknown, drill rod broken, well abandoned	*	800
Total depth	----	800+

*Below. †Above and below.

41/39–3A1. Gavica Land Co. Drilled by Mel Meyer. Casing diameter 6 inches to a depth of 166 feet, casing perforated from 152 to 162 feet. Driller's log.

Material	Thickness (feet)	Depth (feet)
Soil, top	5	5
Gravel and clay	9	14
Clay, sandy	51	65
Clay and gravel	55	120
Clay, sandy	30	150
Rock, hard, and clay	4	154
Clay, sandy	2	156
Sand, water	10	166
Clay	14	180
Total depth	----	180

41/39–3A2. Gavica Land Co. Drilled by Mel Meyer. Casing diameter 6 inches to a depth of 219 feet, casing perforated from 148 to 170 feet, 6-inch by ⅜-inch slots. Driller's log.

Material	Thickness (feet)	Depth (feet)
Soil, top	5	5
Clay and rock	9	14
Clay, gray	2	16
Clay, sandy	59	75
Rock, boulders	71	146
Gravel and clay	29	175
Clay, sandy	30	205
Gravel (water)	14	219
Sand and clay	10	229
Gravel	2	231
Total depth	----	231

41/39–24C2. George J. Miller. Drilled by Mel Meyer. Owner's log from memory 0 to 137 feet; driller's log 137 to 190 feet.

Material	Thickness (feet)	Depth (feet)
Sediments, interstratified with water seeps	50	50
Clay	87	137
Clay and small amount of gravel	37	174
Sand and gravel, water	16	190
Total depth	----	190

TABLE 8—*Continued*

41/40–16B1. E. Gondra. Drilled by owner. Casing diameter 8 inches to a depth of 65 feet. Driller's log (from memory).

Material	Thickness (feet)	Depth (feet)
Soil, top	2	2
Hardpan (clay)	7	9
Gravel and boulders, water	56	65
Total depth		65

42/39–23D1. R. H. Schwartz. Drilled by E. Gondra. Casing diameter 8 inches. Reported depth 230 feet. Land-surface altitude 4,373 feet above mean sea level. Owner's log (from memory): No good water-bearing strata penetrated by well. Material from surface to bottom of the hole resembles fine alluvial-fan gravels cemented with clay.

TABLE 9

Measurement of water level in observation wells in Paradise Valley and adjacent portion of the Humboldt River Valley, Nevada, 1945–1948

37/38–2A1. Bureau of Land Management. Known as Toll House well. Drilled stock well, diameter 6 inches, depth 79 feet. Measuring point, top of 4- by 4-inch wood block, 4,335.4 feet above mean sea level, 0.3 foot above concrete floor of corrugated iron pump shed, 1.1 feet above land surface.

Water level, in feet below measuring point, 1945–1948

Date	Water level	Date	Water level	Date	Water level
Sept. 20, 1945	34.0	Oct. 2, 1946	34.96	June 24, 1947	35.24
Jan. 16, 1946	34.4	Oct. 31	35.0	July 18	35.34
Mar. 3	34.5	Nov. 29	*30.5	July 31	35.34
Apr. 1	34.4	Dec. 20	35.2	Aug. 25	35.47
Apr. 25	34.62	Jan. 24, 1947	*30.5	Sept. 9	35.58
May 28	34.7	Mar. 3	*31.7	Oct. 24	35.65
June 28	36.13	Mar. 18	35.08	Dec. 18	35.77
July 29	34.90	Apr. 22	35.14	Jan. 30, 1948	†35.77
Aug. 28	35.02	May 20	35.19		

*Measurement probably inaccurate.
†Well pumped 1 hour before measurement.

37/39–33B1. Bureau of Land Management. Drilled stock well, diameter 12 inches, depth 26 feet. Measuring point, top of casing, 4,310.8 feet above mean sea level, 1.2 feet above land surface.

Water level, in feet below measuring point, 1947

Date	Water level	Date	Water level	Date	Water level
June 27	7.82	July 25	9.81	Oct. 1	12.26
July 15	9.14	Sept. 6	11.83		

38/39–9C1. Godcheaux Cattle Co. Drilled stock well, diameter 8 inches, depth 78 feet. Measuring point, top of casing, 4,315.3 feet above mean sea level, at land surface. Water levels, in feet below measuring point: August 16, 1945, 6.01; May 20, 1947, 8.20; July 18, 8.99; September 9, 9.63.

39/39–13C2. Bennett and Biltz. Dug irrigation pit, 30 by 200 feet, depth 17 feet. Measuring point, top of pipe coupling, 4,333.6 feet above mean sea level, at land surface.

Water level, in feet below measuring point, 1945–1947

Date	Water level	Date	Water level	Date	Water level
July 20, 1945	3.85	May 20, 1947	5.98	July 21, 1947	7.31
Aug. 15	4.70	July 14	7.15		

TABLE 9—*Continued*

39/39–24B1. Bennett and Biltz. Drilled domestic well, diameter 6 inches, depth 24 feet. Measuring point, top of casing, 4,335.3 feet above mean sea level, 1.4 feet above land surface.

Water level, in feet below measuring point, 1945–1948

Date	Water level	Date	Water level	Date	Water level
Aug. 15, 1945	7.04	Aug. 28, 1946	9.10	June 25, 1947	9.04
Sept. 22	8.10	Oct. 31	8.7	July 14	9.47
Jan. 16, 1946	7.40	Nov. 29	8.5	July 21	9.66
Feb. 16	7.35	Dec. 20	8.3	Aug. 25	10.0
Mar. 2	7.00	Jan. 24, 1947	8.5	Sept. 9	10.15
Apr. 5	4.70	Mar. 3	7.8	Oct. 24	10.0
May 28	6.11	Mar. 18	6.8	Dec. 18	9.45
June 28	7.30	Apr. 22	7.76	Jan. 30, 1948	8.3
July 29	6.80	May 21	8.30		

39/39–33C1. Bennett and Biltz. Drilled stock well, diameter 12 inches, depth 37 feet. Measuring point, top of casing, 4,318.9 feet above mean sea level, level with concrete curb, 0.7 foot above land surface.

Water level, in feet below measuring point, 1945–1948

Date	Water level	Date	Water level	Date	Water level
Aug. 16, 1945	5.98	Aug. 25, 1946	7.50	May 20, 1947	6.95
Sept. 23	6.37	Oct. 31	7.1	June 24	7.7
Mar. 3, 1946	5.92	Nov. 29	7.65	July 18	8.47
Apr. 1	5.37	Dec. 20	7.5	Aug. 25	9.0
Apr. 25	4.85	Jan. 24, 1947	6.5	Sept. 13	9.12
May 28	4.95	Mar. 3	7.6	Oct. 24	9.2
June 28	5.77	Mar. 18	7.1	Dec. 18	8.1
July 29	8.48	Apr. 22	6.9	Jan. 30, 1948	8.6

40/39–10D1. Unknown, formerly C. L. Lewis. Unused drilled irrigation well, diameter 12 inches, depth 55 feet. Measuring point, top of casing, 4,422 feet above mean sea level, 0.2 foot above land surface.

Water level, in feet below measuring point, 1945–1948

Date	Water level	Date	Water level	Date	Water level
Aug. 15, 1945	40.34	July 29, 1946	41.80	Apr. 22, 1947	44.69
Sept. 23	42.20	Aug. 25	43.0	May 29	44.22
Jan. 16, 1946	43.7	Oct. 2	44.2	June 24	47.06
Feb. 16	43.6	Oct. 31	44.6	Aug. 25	49.0
Mar. 2	44.4	Nov. 29	45.0	Sept. 23	46.26
Apr. 1	42.72	Dec. 20	45.3	Oct. 24	47.25
Apr. 25	42.23	Jan. 24, 1947	45.5	Dec. 18	47.0
May 28	40.70	Mar. 3	45.7	Jan. 30, 1948	47.08
June 28	40.70	Mar. 18	45.6		

40/39–26B1. Henry McCleary Timber Co. Drilled well, diameter 16 inches, depth 300 feet. Measuring point, top of casing, 4,360.6 feet above mean sea level, 0.6 foot above land surface.

Water level, in feet below measuring point, 1945–1948

Date	Water level	Date	Water level	Date	Water level
July 20, 1945	5.33	July 29, 1946	7.36	Apr. 22, 1947	8.3
Aug. 15	6.82	Aug. 25	8.15	May 29	7.59
Sept. 23	8.00	Oct. 2	8.52	June 24	8.19
Jan. 16, 1946	7.5	Oct. 31	8.9	July 23	8.95
Mar. 3	7.2	Nov. 29	8.1	Aug. 25	9.68
Apr. 1	5.5	Dec. 20	7.2	Sept. 18	9.62
Apr. 25	4.03	Jan. 24, 1947	8.5	Oct. 24	9.75
May 28	4.4	Mar. 3	7.2	Dec. 18	9.30
June 28	5.80	Mar. 18	7.9	Jan. 30, 1948	9.38

TABLE 9—*Continued*

41/40–6C1. Joe Boggio. Unused drilled well, diameter 8 inches, depth 52 feet. Measuring point, top of casing, 4,458 feet above mean sea level, at land surface.

Water level, in feet below measuring point, 1945–1948

Date	Water level	Date	Water level	Date	Water level
July 20, 1945	4.84	June 28, 1946	4.75	Apr. 22, 1947	6.55
Aug. 16	6.86	July 29	7.30	May 29	7.86
Sept. 22	8.39	Aug. 25	8.40	June 24	8.79
Jan. 16, 1946	5.54	Oct. 2	9.25	July 23	9.51
Feb. 16	4.94	Nov. 29	9.6	Aug. 25	11.5
Mar. 2	4.59	Dec. 20	9.5	Oct. 24	11.37
Apr. 1	3.89	Jan. 24, 1947	9.5	Dec. 18	11.25
Apr. 25	2.90	Mar. 3	9.0	Jan. 30, 1948	10.33
May 28	3.35	Mar. 15	8.95		

41/40–30A1. Shelton Lane School. Drilled well, diameter 8 inches, depth 27 feet. Measuring point, bottom edge of break in pump housing, 4,415 feet above mean sea level, 1.7 feet above land surface.

Water level, in feet below measuring point, 1945–1948

Date	Water level	Date	Water level	Date	Water level
July 20, 1945	6.19	June 28, 1946	6.60	Mar. 18, 1947	8.5
Aug. 14	7.80	July 29	10.00	Apr. 22	8.3
Sept. 22	9.85	Aug. 25	10.25	June 24	9.33
Jan. 16, 1946	8.2	Oct. 2	11.01	July 23	10.9
Feb. 16	8.10	Oct. 31	10.38	Aug. 25	11.6
Mar. 2	7.30	Nov. 29	9.6	Sept. 16	13.01
Apr. 1	5.8	Dec. 20	9.2	Oct. 24	14.25
Apr. 25	3.77	Jan. 24, 1947	9.2	Dec. 18	11.3
May 28	3.75	Mar. 3	8.9	Jan. 30, 1948	11.0

42/39–25C1. Civilian Conservation Corps. Unused dug well, diameter 5.5 feet, depth 18 feet. Measuring point, top of concrete pump support spanning well, 4,518 feet above mean sea level, 4.4 feet below land surface.

Water level, in feet below measuring point, 1945–1948

Date	Water level	Date	Water level	Date	Water level
Aug. 17, 1945	2.61	Aug. 25, 1946	3.31	May 29, 1947	3.55
Sept. 23	3.10	Oct. 2	3.84	June 24	3.46
Jan. 16, 1946	3.00	Oct. 31	3.9	July 23	3.72
Mar. 2	2.90	Nov. 29	3.2	Aug. 25	4.47
Apr. 1	2.4	Dec. 20	3.7	Oct. 3	4.88
Apr. 25	1.14	Jan. 24, 1947	3.6	Oct. 24	4.83
May 28	‡+.70	Mar. 3	3.4	Dec. 18	4.76
June 28	.29	Mar. 18	3.27	Jan. 30, 1948	4.41
July 29	2.3	Apr. 22	3.24		

‡Water level above measuring point.

42/40–14C1. J. M. Freeman. Bored domestic well, diameter 12 inches, depth 13 feet. Measuring point, top of concrete platform, 4,606 feet above mean sea level, level with land surface.

Water level, in feet below measuring point, 1946–1948

Date	Water level	Date	Water level	Date	Water level
Apr. 25, 1946	5.08	Nov. 29, 1946	8.95	July 23, 1947	8.61
May 16	6.40	Dec. 20	9.1	Aug. 25	8.86
May 28	5.65	Jan. 24, 1947	9.2	Sept. 23	9.76
June 28	6.70	Mar. 3	9.1	Oct. 24	9.37
July 29	8.41	Mar. 18	7.87	Dec. 18	9.47
Aug. 25	8.0	Apr. 22	7.48	Jan. 30, 1948	8.28
Oct. 2	9.13	May 21	7.18		
Oct. 31	8.0	June 24	7.72		

TABLE 9—*Continued*

42/40–15D1. J. M. Freeman. Unused drilled well, diameter 8 inches, depth 199 feet. Measuring point, top of casing, 4,607 feet above mean sea level, 0.4 foot above land surface.

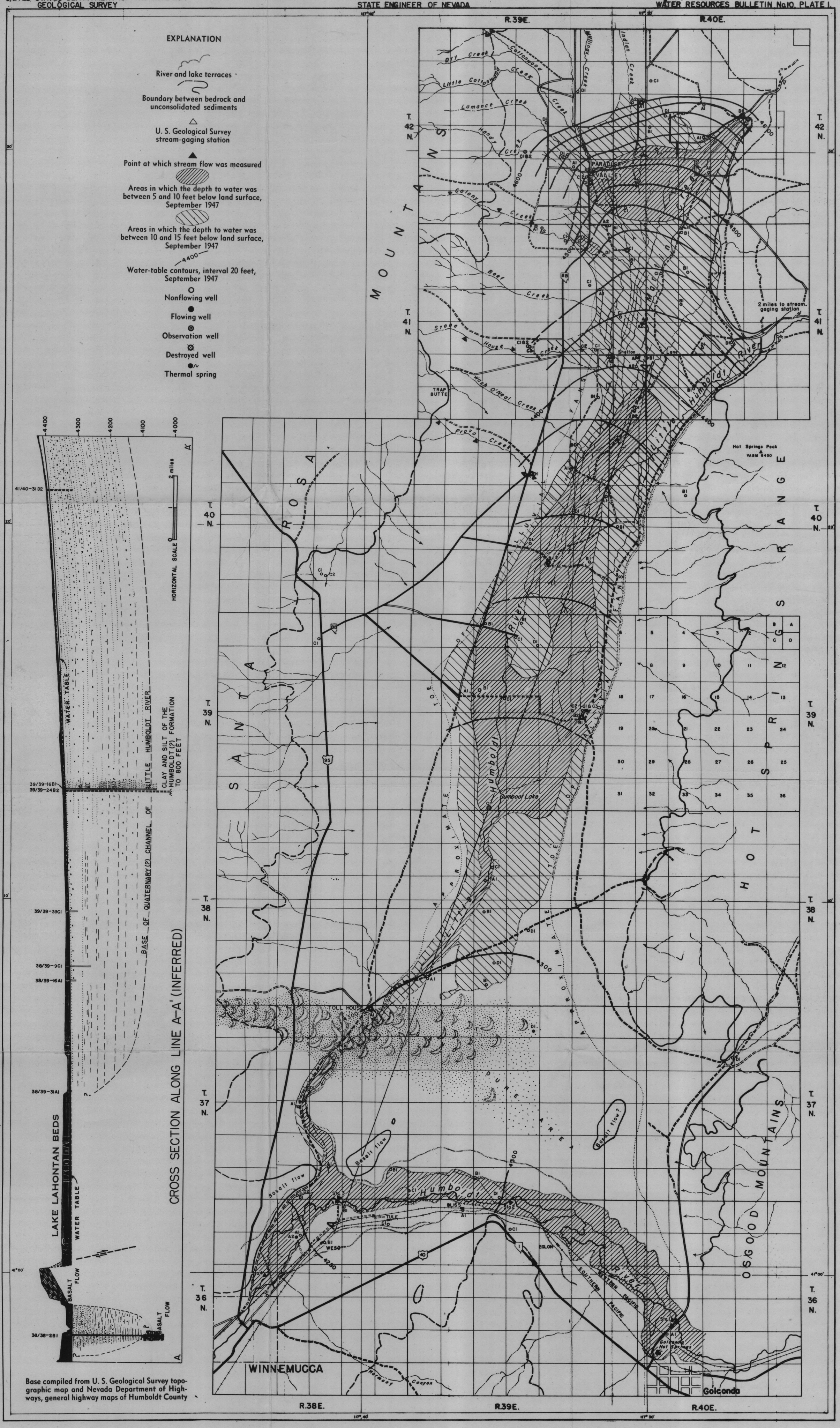
Water level, in feet below measuring point, 1945–1948

Date	Water level	Date	Water level	Date	Water level
July 20, 1945	28.56	May 28, 1946	71.35	June 25, 1947	70.45
Aug. 14	28.95	June 28	72.20	July 23	70.66
Sept. 16	29.40	Nov. 29	72.5	Aug. 25	70.4
Nov. 5	30.90	Dec. 20	72.2	Sept. 9	70.92
Jan. 16, 1946	38.6	Jan. 24, 1947	71.7	Oct. 24	71.74
Mar. 2	55.40	Mar. 3	71.6	Dec. 18	70.35
Apr. 1	68.6	Mar. 18	71.41	Jan. 30, 1948	70.7
Apr. 25	72.16	Apr. 22	71.47		
May 16	71.70	May 21	71.44		

42/40–18A1. E. C. Lye, formerly R. M. Taylor. Unused drilled irrigation well, diameter 12 inches, depth 53 feet. Measuring point, top of casing, 4,614 feet above mean sea level, 0.2 foot above land surface.

Water level, in feet below measuring point, 1945–1948

Date	Water level	Date	Water level	Date	Water level
Aug. 14, 1945	7.16	July 29, 1946	8.07	May 29, 1947	9.35
Sept. 21	8.48	Aug. 25	8.90	June 24	8.27
Nov. 5	10.58	Oct. 2	10.78	July 28	8.28
Jan. 16, 1946	12.38	Oct. 31	9.4	Aug. 25	9.05
Feb. 16	10.58	Nov. 29	12.95	Sept. 23	10.18
Mar. 2	9.48	Dec. 20	13.3	Oct. 24	11.89
Apr. 1	6.96	Jan. 24, 1947	14.0	Dec. 18	13.92
Apr. 25	6.09	Mar. 3	14.40	Jan. 30, 1948	13.6
May 28	5.87	Mar. 18	14.80		
June 28	7.02	Apr. 22	14.7		



MAP OF PARADISE VALLEY AND ADJACENT PORTION OF HUMBOLDT RIVER VALLEY, HUMBOLDT COUNTY, NEVADA

Showing areas of unconsolidated sediments, ground-water conditions, and location of wells and springs, September 1947

Scale

0 2 3 4 5 Miles

1948

Datum is mean sea level