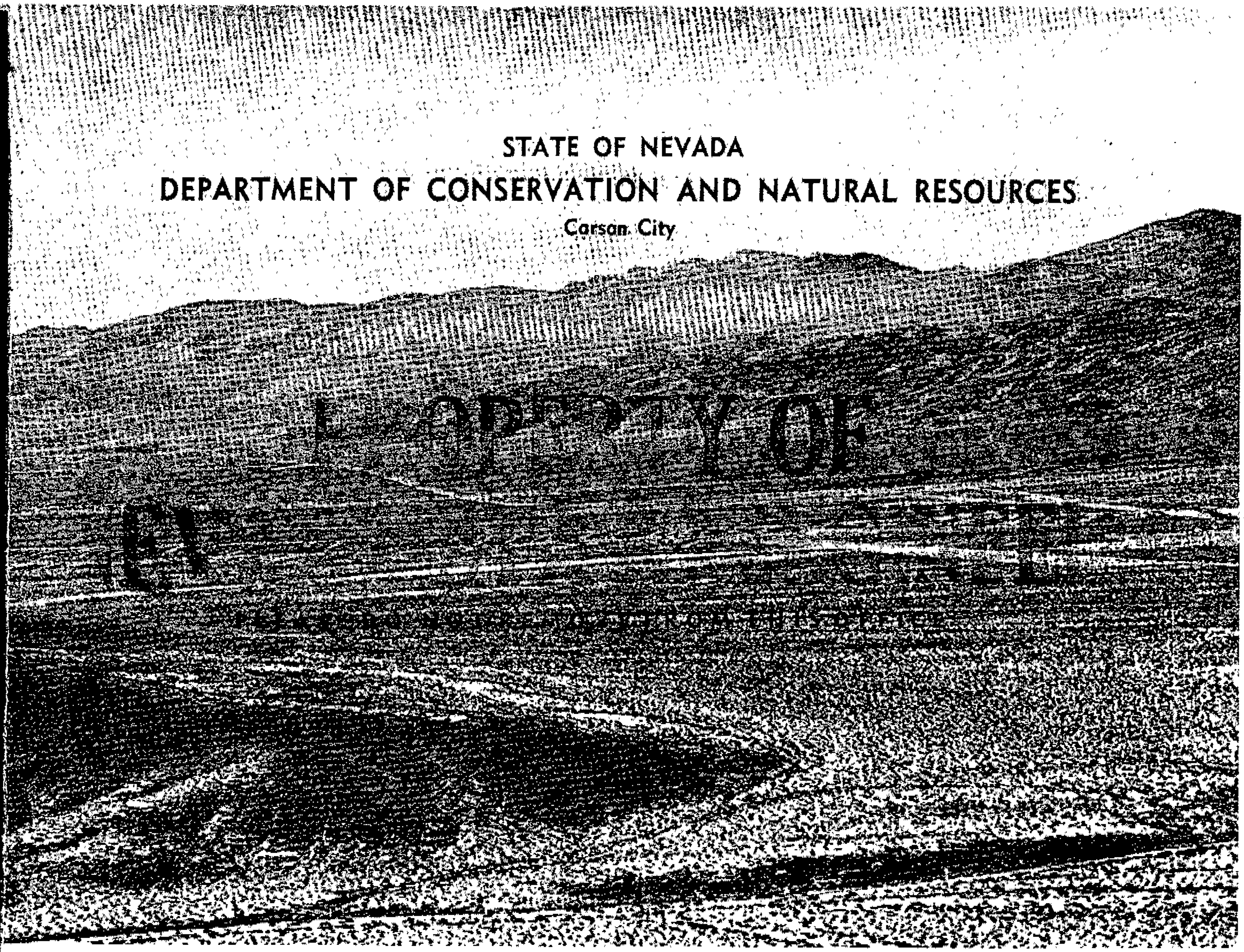
STATE OF NEVADA

DEPARTMENT OF CONSERVATION AND NATURAL RESOURCES

Carson City



Gabbs Valley—View of Paradise Range, near Gabbs

GROUND-WATER RESOURCES - RECONNAISSANCE SERIES

REPORT 9

GROUND-WATER APPRAISAL OF GABBS VALLEY, MINERAL AND NYE COUNTIES, NEVADA

By

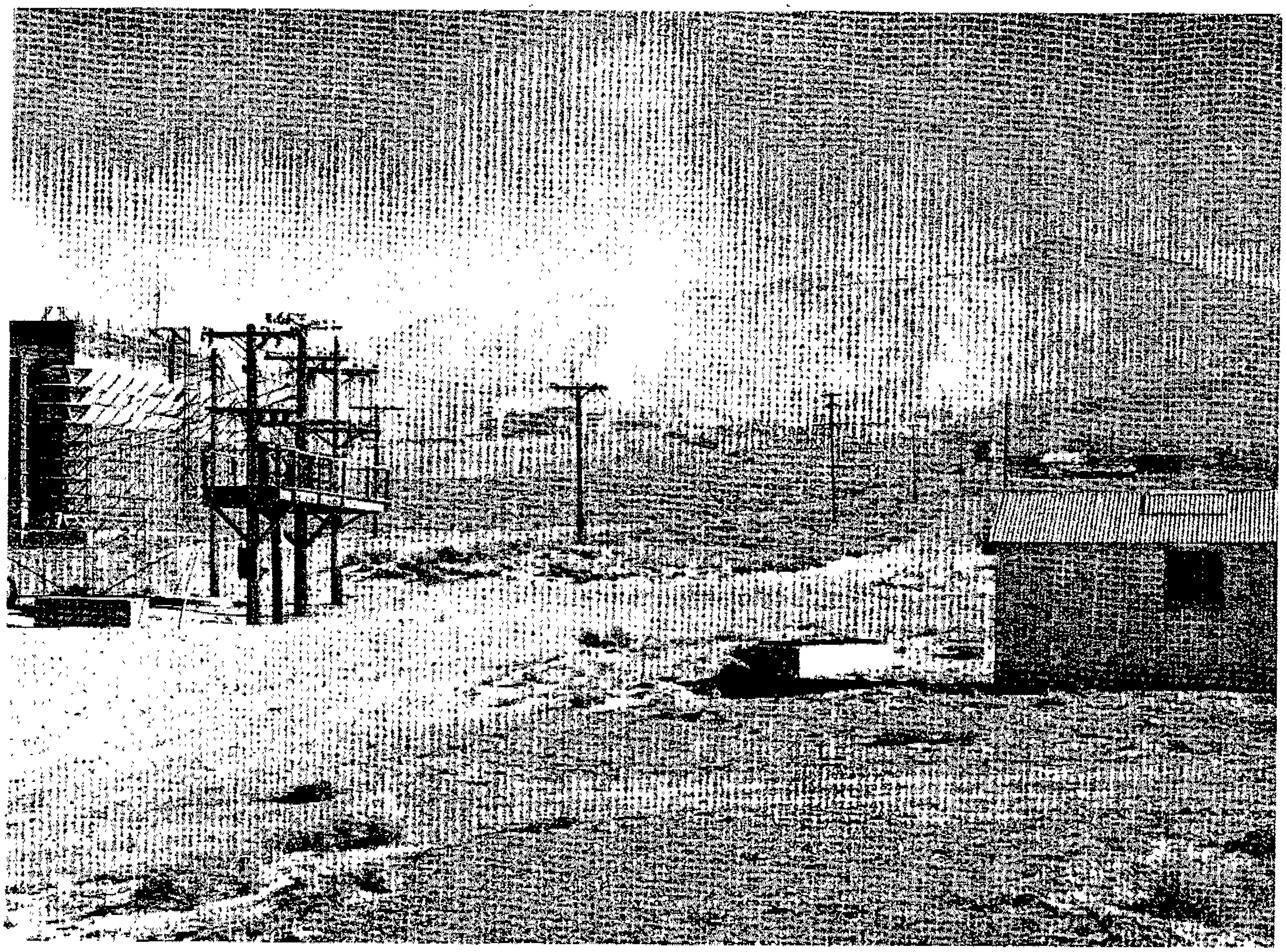
THOMAS E. EAKIN

Geologist

Price $1.00

Prepared cooperatively by the

Geological Survey, U. S. Department of the Interior



VIEW TOWARD PLANT OF BASIC, INC.

Well 12/36–28D2, beneath shed in right foreground one of production wells of Basic, Inc. Yield reported as 163 and 297 gallons a minute in different tests. Water temperature, 155°F. The high temperature of ground water from several wells requires the water to be run through cooling tower shown at left of photo.

COVER PHOTOGRAPH

View to the northeast of the western flank of the Paradise Range in east part of Gabbs Valley. Gabbs is in left middle distance. Smoke obscuring part of the mountains is from plant of Basic, Inc.

ILLUSTRATIONS

TABLES

GROUND-WATER APPRAISAL OF GABBS VALLEY

MINERAL AND NYE COUNTIES, NEVADA

by
Thomas E. Eakin

SUMMARY

This reconnaissance indicates that the estimated average annual recharge to the ground-water reservoir in Gabbs Valley is on the order of 5,000 acre-feet and that the estimated average annual discharge from the ground-water reservoir is at least 4,000 acre-feet. These estimates in turn suggest that the perennial yield of the ground-water reservoir tentatively is on the order of 5,000 acre-feet a year. Re-evaluation of these estimates may be warranted after sufficient development has occurred to provide the necessary additional data and when the needs would justify an intensive investigation.

The amount of water stored in the ground-water reservoir of the valley fill is 50 or more times the estimated average annual recharge. Ground-water storage of this magnitude provides an excellent reserve to maintain withdrawals during protracted periods of drought or during periods of emergency high-use demand.

The success of development of ground water in Gabbs Valley may be largely dependent on the chemical suitability for the intended uses. Limited data indicate that ground-water, locally, is relatively high in sodium, sulfate, fluoride, and possibly boron. Excess quantities of some or all of these constituents can render the water unsuitable for many common uses. Thus, the chemical quality of the ground water locally may be a limiting factor in successful development.

Present development is relatively small. An estimated 300 acre-feet of ground water is pumped annually, largely for industrial purposes near Gabbs. Additional pumpage of ground water probably does not exceed another 300 acre-feet a year from widely scattered wells in the valley including, in 1961, pumpage for irrigation in sec. 3, T. 11 N., R. 33 E.

INTRODUCTION

The development of ground water in Nevada has shown a substantial increase in recent years. A part of this increase is due to the effort to bring new land into cultivation. The increasing interest in ground-water development has created a substantial demand for information of ground-water resources throughout the State.

Recognizing this need, the State Legislature enacted special legislation (Chapt. 181, Stats. 1960) for beginning a series of reconnaissance studies of the ground-water resources of Nevada. As provided in the legislation, these studies are being made by the U.S. Geological Survey in cooperation with the Nevada Department of Conservation and Natural Resources.

Interest in ground-water resources currently includes many areas and is extending to additional areas almost continuously. Thus, the emphasis of the studies under this special legislation is to provide as quickly as possible a general appraisal of the ground-water resources in particular valleys or areas where information is urgently needed. For this reason each reconnaissance study is limited severely in time, the field work for each area generally averaging about 2 weeks.

Additionally, the Department of Conservation and Natural Resources has established a special report series to expedite publication of the results of these reconnaissance studies. Figure 1 shows the areas for which reports have been published in this series. The present report is the nineth in the reconnaissance series. It describes the physical conditions of Gabbs Valley and includes observations of the interrelation of climate, geology, and hydrology as they affect ground-water resources. It also includes a preliminary estimate of the average annual discharge from the ground-water reservoir.

The investigation was made under the administrative supervision of Omar J. Loeltz, district engineer in charge of ground-water studies by the Geological Survey in Nevada. The writer wishes to acknowledge his appreciation to personnel of the district office for constructive discussions and review relative to this report, all of which have been most helpful.

Location and General Features:

Gabbs Valley and its tributary drainage areas are principally in northeastern Mineral and northwestern Nye Counties and within an area enclosed by lat 38°30' and 39°15' N. and long 117°45' and 118°30' W. Gabbs Valley is about 32 miles long and about 20 miles wide, the long axis of the valley trends about west. The valley as defined is about 950 square miles. The total drainage area, including tributary valleys, is about 1,150 square miles.

The principal tributary valleys are Lodi Valley, from the northeast, Stewart Valley from the southeast, and the valley drained by Nugent Wash from the west. The lowest part of the valley is about 4,100 feet above sea level in the alkali flat in the west-central part of the valley.

The crests of the Paradise Range on the east side of the valley are higher than 8, 000 feet above sea level for about half of the 12-mile distance between Sherman and Paradise Peaks. Sherman Peak, altitude 8,672 feet is the highest point.

Principal access to the valley is by State Highway 23, which connects with U.S. Highway 95 on the south at Luning and U.S. Highway 50 on the north, about 10 miles west of Eastgate. State Highway 23 traverses the east side of the valley and passes through the mining town of Gabbs. Trails or unimproved roads provide access to various points in the valley during dry weather.

The mountains adjacent to Gabbs Valley have been the scene of considerable mining activity. Couch and Carpenter (1943, p. 100-102, 112) list gross yield through 1940 of $1,011,838 for the Bell district, $176,000 for the Bovard district, $179,995 for the Broken Hills district, and $956,554 for the Rawhide district in Mineral County and $809,905 for the Lodi district in Nye County. The principal mineral production was gold, silver, lead, copper, and zinc.

Karl (1951, p. 103) reports that 225,000 tons of magnesite and 444,000 tons of brucite were shipped from the Gabbs area during the period 1942-49. Reaves, Shawe, and Kral (1958, p. 41) report that 400,000 long tons of ore, averaging nearly 60 percent iron, were shipped from the Gabbs area during the period April 1951 to March 1953.

Climate:

The climate of west-central Nevada is characterized by low precipitation and humidity and high summer temperatures and rates of evaporation. Precipitation is very irregular in areal distribution but generally is least on the floors of the valleys and greatest in the higher parts of the mountains. Winter precipitation generally occurs as snow. Summer precipitation usually occurs as localized showers. The temperature range is large both daily and seasonally. The growing season is somewhat limited.

Records of precipitation at Downeyville, published by the U.S. Weather Bureau for the period 1889-97, indicate that the average annual precipitation was 6.47 inches for the period of record.

Possibly a more useful indication of precipitation in Gabbs Valley may be obtained by reference to the records for the stations at Austin, Fallon, and Mina. Austin is about 65 miles northeast of Gabbs Valley, Fallon is about 50 miles northwest, and Mina is about 30 miles south. The altitudes of these stations, 6,543, 3,965, and 4,552 feet, respectively, span the altitude range comparable to that of most of the area of Gabbs Valley. Commonly, there is a general relationship between precipitation and altitude in similarly oriented areas.

Table 1a lists the average monthly and annual precipitation for the period 1931-60 for the 3 stations. Table 1b lists annual precipitation at the 3 stations for the 10 years 1951-60. Annual precipitation was below the 1931-60 average reported at Austin, Fallon, and Mina for 7, 6, and 3 years respectively, during the period 1951-60.

TABLE 1. Summary of precipitation at Austin, Fallon, and Mina, Nevada. (from records of the U.S. Weather Bureau)

1a.--Average monthly and annual precipitation, in inches (1931-60)

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
Austin	1.18	1.18	1.44	1.53	1.31	.83	.55	.43	.45	1.07	.87	1.11	11.95
Fallon	.54	.62	.48	.47	.59	.41	.18	.14	.22	.45	.34	.57	5.01
Mina	.32	.26	.29	.42	.42	.26	.26	.28	.16	.40	.23	.32	3.62

1b.-- Annual precipitation, in inches (1951-60)

Year	Austin	Fallon	Mina	Year	Austin	Fallon	Mina
1951	11.38	5.45	5.83	1956	12.30	4.01	4.14
1952	10.34	5.11	5.24	1957	12.70	3.86	4.38
1953	6.73	3.26	1.45	1958	e 8.98	5.27	e5.75
1954	9.92	5.55	4.78	1959	e 5.90	1.66	1.75
1955	e12.12	3.51	e5.19	1960	8.49	2.02	2.95

e. Estimated by U.S. Weather Bureau

Table 2 lists the maximum and minimum monthly and annual precipitation during the period 1931-60 for Austin, Fallon, and Mina.

On the basis of the above records and general conditions in Gabbs Valley, it appears likely that annual precipitation in the lower parts of the valley floor may be on the order of 4 inches. The amount and distribution of precipitation probably are similar to that for the Fallon and Mina Stations. In the higher areas, such as the west side of the Paradise Range, the precipitation may be comparable to that of the Austin station.

Table 2. --Maximum and minimum monthly and annual precipitation, in inches, for Austin, Fallon, and Mina, Nev. 1931-60
(From records of the U.S. Weather Bureau)

Month	Austin		Fallon		Mina	
	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum
January	4.00	.02	2.98	.00	1.50	.00
February	2.80	.21	2.06	T	1.35	.00
March	5.36	.13	1.63	T	1.10	.00
April	3.50	.03	1.84	.03	1.94	.00
May	3.87	T	1.84	.00	1.43	.00
June	2.95	T	1.84	.00	.95	.00
July	2.53	.00	.79	.00	1.19	.00
August	1.67	.00	.91	.00	2.23	.00
September	1.71	T	1.07	.00	1.10	.00
October	3.72	.00	1.39	.00	1.96	.00
November	2.13	.00	1.15	.00	1.34	.00
December	2.99	e .05	2.15	.00	1.64	.00
Annual	19.36	e5.90	9.18	1.66	7.39	1.30

e Estimated by U.S. Weather Bureau.

Table 3 lists average monthly and annual temperature at Austin, Fallon, and Mina for the period 1931-60.

Table 3.--Average monthly and annual temperature, in degrees Fahrenheit, at Austin, Fallon, and Mina, Nev. for the period 1931-60
(From records of the U.S. Weather Bureau)

Station	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
Austin	28.1	30.8	35.8	43.8	51.4	59.9	70.3	68.6	60.9	49.6	37.8	31.9	47.3
Fallon	30.5	35.9	42.4	50.4	57.6	64.6	72.7	70.2	62.4	51.9	39.5	32.7	50.9
Mina	32.0	36.8	43.2	51.8	60.3	69.8	78.2	75.7	66.5	54.3	41.2	34.2	53.8

Freeze data are published by the U.S. Weather Bureau. The dates are listed for the last spring minimum and the first fall minimum by the following temperature groups: 32°F or below, 28°F or below, 24°F or below, 20°F or below, and 16°F or below. Also published by the Weather Bureau is the number of days between the last spring minimum and the first fall minimum for each temperature group. The following tabulation shows the number of days for three of the temperature groups for years 1951-60 as recorded at Austin, Fallon, and Mina.

	Number of days between temperatures of:								
	32°F or below			28°F or below			24°F or below		
Year	Fallon	Mina	Austin	Fallon	Mina	Austin	Fallon	Mina	Austin
1951	144	157	125	156	204	141	203	204	174
1952	125	189	90	143	202	90	207	224	--
1953	132	130	126	145	178	147	169	209	163
1954	150	151	111	152	175	115	213	211	174
1955	130	144	115	161	180	154	182	188	164
1956	129	152	128	158	184	162	204	199	192
1957	154	166	--	174	171	--	213	213	--
1958	150	151	134	152	179	150	179	--	152
1959	136	160	108	161	197	132	197	229	177
1960	122	151	120	143	199	138	171	232	144

Houston (1950, p. 1-18) lists the average growing season for the Fallon, Lower Truckee, and Lower Walker River areas as follows:

Area	Average at	Growing Season (days)	Dates	Latitude	Altitude (feet above sea level)
Fallon	Fallon	127	May 20 to Sept. 24	39 1/2°	4,000
Lower Truckee River	Nixon 1/	137	May 13 to Sept. 27	40°	3,900
Lower Walker River	Schurz 2/	136	May 15 to Sept. 28	39°	4,100

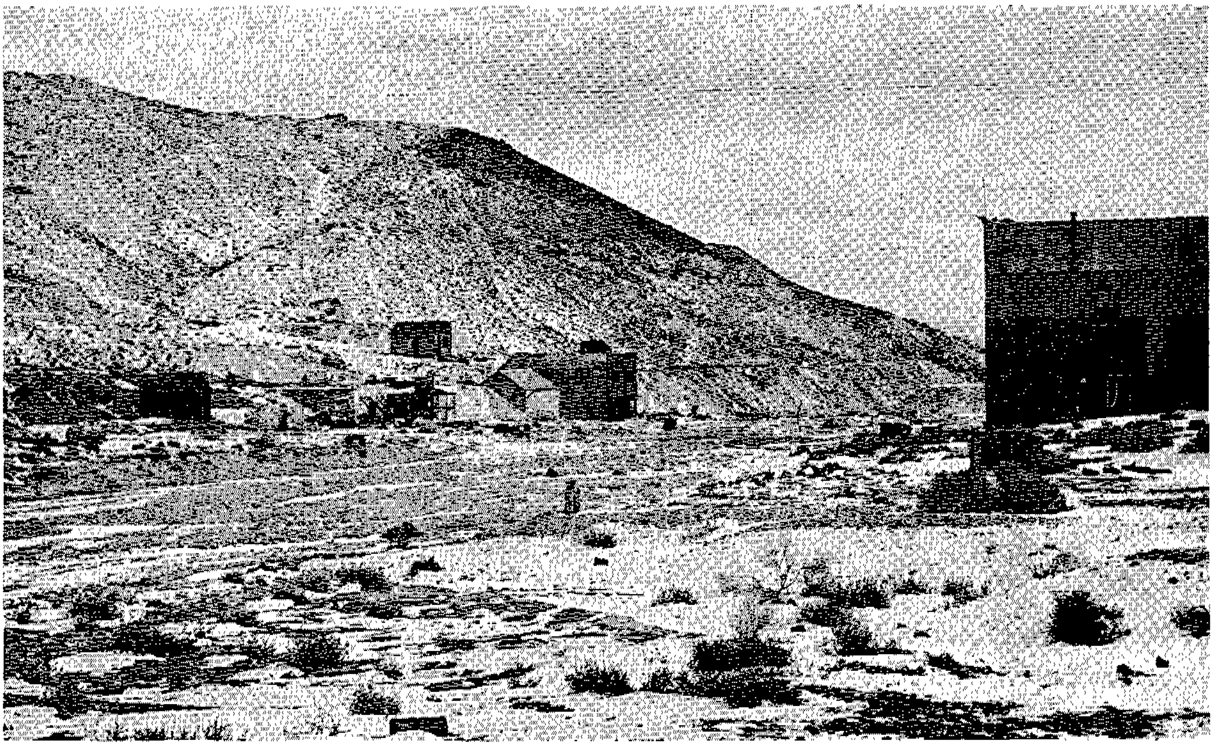
1/ About 100 miles northwest of Gabbs
2/ About 50 miles west of Gabbs

The floor of Gabbs Valley lies between 4,100 and about 4,500 feet above sea level. The higher altitude of the floor of Gabbs Valley suggests that the average growing season probably is somewhat shorter than those listed for Fallon, Nixon, and Schurz.

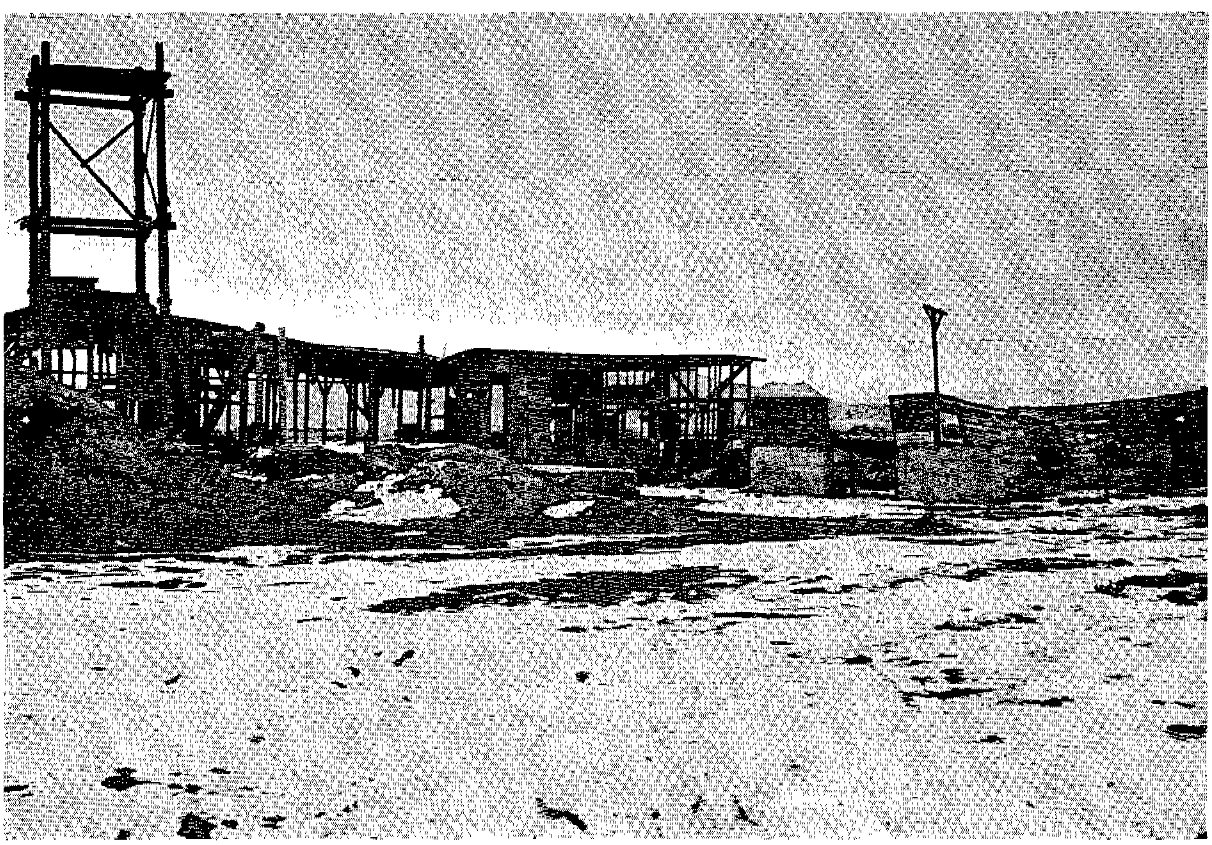
Physiography and Drainage:

Gabbs Valley is a closed valley. In the lower parts of the valley floor the gradients are 50 feet per mile or less. Gradients increase on the alluvial apron to about 200 feet per mile near the contact between the valley fill and the bedrock. In the mountains, land-surface gradients locally may reach 1,000 feet per mile.

There are no perennial streams in Gabbs Valley, and runoff is limited to short periods after high intensity storms or rapid snow melt. When conditions for runoff are most favorable, streamflow may reach Gabbs Valley from Lodi Valley to the northeast, Stewart Valley to the southeast, and the headwater area of Nugent Wash to the west. Summer storms of high intensity during August and September 1961 caused several flash floods in Gabbs Valley and the tributary valleys. Flood flow occurred in Fingerrock Wash, Lodi Valley, and the wash through which State Highway 23 enters Gabbs Valley from the north. Water from these floods reached the alkali flat in the western part of Gabbs Valley. Flash floods occurred elsewhere, including the wash in which Rawhide, T. 13 N., R. 32 E. is located (Photograph 3), and the canyon in which the Nevada Scheelite plant, NE 1/4, T. 13 N., R. 32 E., is located. Mr. Caldwell, Superintendent at the Nevada Scheelite plant, reported that two floods occurred in the summer of 1961--one in August and the other in September.



Photograph 3. View northeast of part of the mining town of Rawhide. Graded road between buildings was route of runoff of flash flood of August 1961 that occurred in small drainage area to the left (west) of picture.



Photograph 4. View north of ruins of mill at Deadhorse Wells (T. 12 N., R. 32 E.) in western part of Gabbs Valley. Depth to water in this area is less than 10 feet below land surface. The western margin of the phreatophyte areas passes through this location.

Although the tributary valleys have a large combined area, the total runoff to Gabbs Valley from them probably is small and occurs infrequently. Ground-water underflow from these tributary valleys to Gabbs Valley also is believed to be small.

The Paradise Range is the highest of the mountains surrounding Gabbs Valley (cover photograph); about 6 miles of the crest is 8,000 feet or more above sea level. Gabbs Valley Range on the south has a crest altitude generally between 7,000 and 8,000 feet. The crests of the mountains on the west and north side of Gabbs Valley commonly are less than 6,500 feet above sea level.

GENERAL GEOLOGY

As a part of the cooperative geologic investigation program of the Nevada Bureau of Mines and the U.S. Geological Survey, geologic reconnaissance studies of Mineral County have been made and a report is in preparation for publication. Geologic reconnaissance studies of northern Nye County also are in progress. These two county studies encompass the study area described in this report. Ferguson and Muller (1949) described the geology of the Hawthorne and Tonopah quadrangles. The report includes a description of the geology and structure of the Paradise Range within Gabbs Valley. D. I. Axelrod (1956) has described the Miocene and Pliocene flora and related geology of west-central Nevada. One of the specific localities of his investigations, the Middlegate area (Axelrod, 1956, p. 179-229) about 10 miles north of Gabbs Valley, permits some inferences of the Miocene and Pliocene geology in the Gabbs Valley area.

Detailed geologic investigations within the study area have been made in the mining area in the vicinity of Gabbs, and have been reported upon by Vitaliano, Callaghan, and Silberling (1957), among others.

For this reconnaissance study, the rocks of Gabbs Valley have been divided into two principal areas on the basis of topography and occurrence of ground water as shown on plate 1. Consolidated rocks of Tertiary age and older are exposed in the mountains; the valley is underlain by unconsolidated deposits of Quaternary age near the surface and by the older consolidated rocks of the mountains at depth.

Bedrock in the Mountains:

The bedrock in the mountains includes rocks principally of Permian (?), Mesozoic, and Tertiary age. Ferguson and Muller (1949, pl. 1) show Permian (?) metavolcanic rocks fairly extensively exposed in the Paradise Range east of Lodi Valley, Triassic sedimentary rocks of the Luning Formation and Jurassic (?) intrusives in the southern Paradise Range and the mountains on the west side of Lodi Valley, and Triassic volcanic and sedimentary rocks of the Excelsior Formation and Jurassic (?) intrusives in the spur extending into Gabbs Valley east of the alkali flat and in the mountains north of the Alkali

Flat. The Gabbs Valley Range on the south and west sides of Gabbs Valley generally is underlain by Tertiary volcanics, pyroclastics, and sedimentary rocks.

The pre-Tertiary rocks have been extensively folded and thrust faulted. Late Cenozoic faulting and tilting have raised a block of Tertiary rocks, extending southward with decreasing altitude, from the western part of T. 13 N., R. 35 E. through the southwest corner of T. 11 N., R. 35 E. to the Gabbs Valley Range. Surface drainage has breached this topographic high through Fingerrock Wash and the unnamed topographic low which drains the northeastern part of Gabbs Valley.

A Tertiary sequence in the Middlegate area, which includes the Clan Alpine volcanics, the Middlegate Formation, and the Monarch Mill Formation, was described and the formations were named by Axelrod (1956, p. 182). The Clan Alpine volcanics are composed of more than 3,000 feet of rhyolite, quartz latite and dacite tuffs, breccias, and flows. The Middlegate Formation includes about 1,300 feet of volcanic debris, conglomerate, sandstone, and tuff interbedded with lake clay and shale. The Monarch Mill Formation includes more than 2,500 feet of tuffaceous clay interbedded with volcanic conglomerate, pebbly sandstone, rhyolite, tuffaceous silt and pumice, diatomite and tuffaceous silt, volcanic pebble conglomerate, and rhyolite tuff, pumice and silt. Flora from the Middlegate Formation are assigned an early Pliocene age by Axelrod (1956, p. 206).

The area described by Axelrod is about 25 miles north of Gabbs. Rocks of somewhat similar lithology and age probably occur in Gabbs Valley. Ferguson and Muller (1949, p. 7) refer to Tertiary lavas, which are considered to be of Miocene age. These are overlain by the Esmeralda Formation of late Miocene and early Pliocene age. This agrees generally with the sequence given by Axelrod.

Valley Fill:

The valley fill includes unconsolidated silt, sand, and gravel of Quaternary age and underlying lavas, pyroclastics, and sedimentary deposits of Tertiary age. The thickness of the Quaternary deposits is generally unknown. Along the margin of the valley fill, their thickness is negligible. In some places, such as in the vicinity of Gabbs, it may be several hundred feet.

In this report the Tertiary rocks are included with the valley fill where they underlie the Quaternary deposits and their position is favorable for storing substantial amounts of water in the zone of saturation. In the mountains, similar lavas and pyroclastic rocks are not saturated because of their topographic position.

Water-Bearing Properties of the Rocks:

The Permian (?) metovolcanic rocks reported in the Paradise Range are of low permeability, but water undoubtedly is transmitted through fractures, a part of which supplies water to a few small springs in the Paradise Range adjacent to Lodi Valley.

The Mesozoic rocks have been deformed by folding and faulting and locally are metamorphosed. Movement of ground water through them probably is limited to fractures. Several springs in the southern Paradise Range apparently are supplied by ground water moving through fractures in these rocks. No large springs are known to occur in Gabbs Valley that might suggest substantial quantities of water being transmitted through solution openings in the Mesozoic carbonate rocks. The Jurassic (?) intrusive rocks are relatively impermeable, except along fractures or weathered zones through which small quantities of ground water may be transmitted.

Tertiary rocks in the mountains contain some ground water but to a large extent are above the zone of saturation. Small quantities of ground water moving in these rocks supply several small springs in the Gabbs Valley Range and elsewhere.

Beneath the Quaternary deposits in the valley fill, Tertiary pyroclastics and sedimentary rocks store a substantial amount of ground water in intergranular spaces. In general, however, the permeability probably is low and water would not be transmitted freely except in lenses of sand and gravel.

The unconsolidated Quaternary deposits are the principal water-bearing deposits in the area and contain a considerable amount of ground water in storage below the water table. Generally they transmit ground water more freely than the Tertiary rocks. However, where silt or clay is abundant, such as beneath the Alkali Flat, the permeability of the Quaternary deposits also is very small.

GROUND-WATER APPRAISAL

General Conditions:

Ground water in Gabbs Valley is presumed to originate largely or entirely from precipitation within the drinage basin, which includes Lodi and Stewart Valleys and the area drained by Nugent Wash. Precipitation on the flanks of the mountains is the source of virtually all of the ground water in the valley fill. In part, precipitation in the mountains collects into intermittent streams which flow from the mountains. Some of this streamflow seeps to the ground-water reservoir through the unconcolidated deposits of the valley fill. Part of the precipitation seeps into the bedrock in the mountains and through fractures or other secondary openings in the bedrock, and eventually moves into the valley fill. However, most of the precipitation on the mountains is evaporated or transpired. Ground water is stored largely in the valley fill and moves slowly towards areas of natural discharge.

Natural ground-water discharge occurs where the water table is near the land surface. In Gabbs Valley there are two such areas. The principal area is the topographically low area in and adjacent to Alkali Flat in the western part of the valley. The second area is near Gabbs, principally in the southwest part of T. 12 N., R. 36 E. This area is about 400 feet higher than the Alkali Flat, and is an area where the water table ordinarily would be expected to be fairly deep. The shallow water apparently results from the combination of a nearby source of recharge, the Paradise Range, and a damming effect caused by a reduction of transmissibility of the valley fill westward from the mountains. The reduction of transmissibility may be due either to a decrease in the permeability of the valley fill away from the mountain front or to a partial barrier resulting from a constriction or faulting and tilting of the Tertiary rocks in the western part of Tps. 11 and 12 N., R. 35 E.

Estimated Average Annual Recharge:

The average annual recharge to the ground-water reservoir may crudely be estimated from the average annual precipitation within the valley. This method was described by Eakin and others (1951, p. 79-81) in reconnaissance studies of eastern Nevada. A brief description of the method follows: Zones in which the average annual precipitation ranges between specified limits are delineated on a map, and a percentage of the precipitation is assigned to each zone which represents the probable average annual recharge from the average annual precipitation on that zone. The degree of reliability of the estimate so obtained, of course, is related to the degree to which the values approximate the actual precipitation, and the degree to which the assumed percentages represent the actual percentage of recharge. Neither of these factors is known precisely enough to assure a high degree of reliability for any one valley. However, the method has proved useful for reconnaissance estimates, and experience suggests that in many areas the estimates probably are relatively close to the actual long-time average annual recharge.

The precipitation map of Nevada (Hardman and Mason, 1949, p. 10) was compared with the topographic base map of plate 1. Precipitation zones were modified slightly to fit the better controlled topographic map. The division between the zones of less than 8 inches and 8 to 12 inches was delineated at the 5,000-foot contour and between 8 to 12 inches and 12 to 15 inches at the 7,000-foot contour. The average precipitation assumed for the respective zones, beginning with the zone of less than 8 inches, is 4 inches (0.33 ft.) 10 inches (0.83 ft.), and 13 inches (1.08 ft.). The recharge estimated as a percentage of the average precipitation for each zone is as follows: Less than 8 inches, none; 8 to 12 inches, 1 percent; and 12 to 15 inches, 7 percent.

Ordinarily, the recharge used for the 8- to 12-inch zone is 3 percent. It was reduced for Gabbs Valley because extensive parts of this zone commonly have a substantial depth to water, that is, in excess of 100 feet. This results in a substantial vertical thickness of unsaturated deposits through which water must move to recharge the ground-water reservoir. In effect, there is a much greater vertical section in which soil moisture deficiencies must be overcome. This condition, in effect, results in infrequent recharge to the underlying ground-water reservoir.

Table 4 summarizes the computation of recharge. The approximate recharge (column 5) for each zone is obtained by multiplying the figures in columns 2, 3, and 4. Thus, for the zone of more than 12 inches of precipitation the recharge is 20,000 acres x 1.12 feet x 0.07 (7 percent) = 1,600 acre-feet. The total average annual recharge to the ground-water reservoir in the valley fill, thus estimated, is about 5,000 acre-feet.

TABLE 4.--Estimated average annual ground-water recharge from precipitation in Gabbs Valley

Precipitation zone (inches) (1)	Approximate area of zone (acres) (2)	Average annual precipitation (feet) (3)	Percent recharged (4)	Estimated recharge (acre-feet) (2x3x4÷ 100) (5)
12 - 15	20,000	1.12	7	1,600
8 - 12	435,000	.83	1	3,600
8	280,000	not computed.	0	0
Total	735,000 (about 1,150 sq.mi.)	Estimated average annual recharge		5,200
		(rounded)		5,000

It is estimated that approximately one-third of the total recharge to Gabbs Valley is supplied from the tributary areas of Lodi Valley, Stewart Valley, and the area drained by Nugent Wash.

Estimated Average Annual Discharge:

Ground water is discharged naturally from Gabbs Valley by transpiration of phreatophytes (water-loving vegetation) and by evaporation from the soil or free-water surfaces. Nearly all of the discharge from springs and wells eventually is evaporated or transpired.

The scope of this reconnaissance precluded any detailed study of the ground-water discharge by evapotranspiration. Rather, the basis used for estimating the discharge by phreatophytes was developed from studies in the

Great Basin by Lee (1912) and White (1932) and elsewhere as reported by Young and Blaney (1942).

The areas of evapotranspiration shown on plate 1 aggregate about 27,000 acres. The principal phreatophytes include greasewood, salt grass, and rabbitbrush. Areal density of the phreatophytes generally is low but locally is moderate to high. The depth to ground water in the areas of phreatophytes ranges from a few feet to perhaps 35 feet and probably averages 15 to 20 feet below land surface. The average annual rate at which the phreatophytes use ground water is estimated to be about 0.1 foot, and is based on vegetative types, density, and depth to the water table. Accordingly, the estimated average annual use of ground water by phreatophytes is about 2,700 acre-feet (27,000 acres x 0.1 foot, the rate of use).

The area of the alkali flat or playa shown on plate 1 is about 18,000 acres. The depth to water beneath the playa generally is less than 5 feet, based on observations at a limited number of points. Data are not available on which to estimate accurately the average annual rate of evaporation from the playa. However, the annual rate probably does not exceed 0.1 foot, which would amount to at least 1,000 acre-feet per year. In the absence of direct data, this conservative value is used as a measure of the ground water evaporated from the playa area.

Ground water currently is pumped from wells for industrial and domestic supply in the vicinity of Gabbs, at the Nevada Scheelite property in the northeast part of T. 13 N., R. 32 E., and for irrigation (1961) in the northern part of T. 11 N., R. 33 E. Elsewhere there is a minor amount of pumpage for stock, domestic, and mining uses. The total annual production from wells, based on limited reported information, is on the order of 600 acre-feet.

Thus, the total average annual ground-water discharge in Gabbs Valley is estimated to be at least 4,000 acre-feet.

Perennial Yield:

The perennial yield of a ground-water system is ultimately limited by the average annual recharge to or natural discharge from the system. It is the upper limit of the amount of water than can be withdrawn for an indefinite period of time from a ground-water system without permanent depletion.

In a closed basin, the average recharge from precipitation and the average discharge by evapotranspiration are measures of the natural regimen of the ground-water system.

In an estimate of perennial yield, consideration should be given to the effects that ground-water development by wells may have on the natural regimen of the ground-water system. Discharge of ground water by wells may or may not induce recharge in addition to that received under natural conditions. Part of the ground water discharged by wells may re-enter the ground-water reservoir by downward percolation, especially if the water is used for irrigation. Ground water discharged by wells usually is offset eventually by a reduction of the natural discharge. In practice, however, it is difficult to offset fully the discharge by wells by a decrease in the natural discharge, except when the water table has been lowered sufficiently to eliminate both underground outflow, if any, and evapotranspiration in the area of natural discharge. The numerous pertinent factors are so complex that, in effect, specific determination of perennial yield of a valley requires a very extensive investigation, based in part on data that can be obtained economically only after there has been substantial development of ground water for several years.

As an initial guide for the development of Gabbs Valley, the preliminary estimates of ground-water recharge and discharge, previously discussed, can be used. Thus, the respective preliminary estimates of 5,000 acre-feet of recharge and at least 4,000 acre-feet of discharge suggest that the perennial yield is on the order of 5,000 acre-feet a year, neglecting any return of pumped water to the ground-water reservoir.

The crude data and assumed values used in reaching the estimates make it apparent that the actual perennial yield of the natural ground-water system may be somewhat more or less than this estimate.

Storage:

A relatively large amount of ground water is stored in the valley fill in Gabbs Valley. It is many times the volume of the annual ground-water recharge and discharge. Some concept of the magnitude of the ground water in storage may be obtained by the following illustration: The surface area of the valley fill within a block 2 miles wide and 20 miles long, in the lower part of the valley between Gabbs and the Alkali Flat is about 25,000 acres. If it is assumed that the valley fill is saturated beneath the 25,000-acre area, and if a value of 10 percent is assumed as the specific yield (drainable pore space) of the saturated fill, then about 2,500 acre-feet of ground water is theoretically available from storage for each saturated foot of thickness of valley fill. On this basis, the amount of ground water in storage in a 100-foot thick section of the valley fill, for the area cited, would be equal to about 250,000 acre-feet or 50 times the natural annual recharge from the ground-water reservoir.

The valley fill is saturated beneath a much larger area than the example given, and the total amount of ground water in storage is much larger than 250,000 acre-feet.

In addition, there is an unknown amount of ground water stored in the bedrock. The water so stored provides an additional reserve for maintaining an adequate supply for pumping during protracted periods of drought or for limited periods of high demand under emergency conditions. This reserve further increases the reliability of ground water as a dependable source of irrigation supply and is an important asset in semiarid regions where surface-water supplies and recharge vary widely from year to year.

Chemical Quality:

The chemical quality of ground water in interior valleys generally varies considerably as the water moves through the ground-water system. In general, the dissolved-solids content of the water is a few hundred parts per million. As the water moves toward areas of discharge it is in contact with rock materials. The extent to which the water dissolves chemical constituents from the rock materials is governed by the solubility, volume, and distribution of the different rock materials, the time the water is in contact with the rocks, and the temperature and pressure in the ground-water system. In areas of natural discharge, ground water is evaporated or transpired. These processes concentrate the dissolved chemical constituents in the remaining ground water.

Table 5 lists partial chemical analyses of ground water from several wells and a hot spring in Gabbs Valley. The analyses, by the University of Nevada Department of Food and Drugs (Reno) and the Newland Field Station (Fallon), were previously reported by Miller, Hardman, and Mason (1953, p. 50, 51).

Table 5. --Partial chemical analyses of water from selected wells and a spring in Gabbs Valley [1]

Sample location	Well (W) or Spring (Sp)	Date Collected	Specific conductance (micromohos at 25°C)	Constituents in p. p. m.									
				Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Carbonate (CO_3)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Boron (B)	Percent Sodium
10/35-3B1	W	1-9-46	3,325	290	105	109	--	510	1,249	66	--	17
11/34-21A1	W	1-9-46	443	34	12	41	--	100	88	35	--	40
11/36-18D1	W	3-3-50	1,254	41	14	219	5	122	394	84	0.8	75
12/32-21B1	W	9-20-35	1,294	111	22	159	--	102	396	119	--	52
12/34-7 SW 1/4 Hot Spring	Sp	2-18-34	1,290	16	0	262	--	210	315	78	1.6	93
12/34-7 SW 1/4 Hot Spring	Sp	9-20-35	1,370	50	13	216	--	220	254	94	--	72
12/36-22B1	W	7-29-42	1,064	66	23	127	--	115	382	32	--	51
Gabbs [2]	W	12-3-42	976	31	8	170	--	110	332	32	--	76

1/ Analyses from Miller, Hardman, and Mason (1953, p. 50, 51).

2/ Analysis of mixed water from wells 12/36-27B2, 12/36-27B3, and 12/36-28D1.

The analysis of water from wells 12/36-22B1 and 11/36-18D1 and the analysis of the mixed sample from wells 12/36-27B2, 12/36-27B3, and 12/36-28D1 indicate a relatively high concentration of sulfate and sodium. Ground water from wells in the vicinity of Gabbs is reported to contain excessively high concentrations, several parts per million, of fluoride (oral communication, Mr. A. M. Dixon, 1961). Water pumped from wells of Basic, Inc. is used only for industrial purposes. Bottled water is trucked in for drinking water.

The temperature of water from many but not all of the Basic, Inc. wells near Gabbs is hot; a maximum of 155°F is reported for well 12/36-28D2 (photograph 2). According to Mr. Duggan, Superintendent of Gabbs Exploration Co., thermal water also was found in well 13/36-28B1, about 5 miles north of the Basic, Inc. wells. However, not all the ground water in the Gabbs area is hot. For example, the temperature of water from well 12/36-22B1, depth 285 feet, is reported to be 70°F, but the reported temperature of well 12/36-27B1, depth 254 feet, is 98°F, and of well 12/36-28D2, depth 325 feet, 155°F. The temperature of the ground water from the several wells used by Basic, Inc. is so high that the water must be cooled before use. Available information does not suggest that either the temperature or the dissolved-solids content increases with depth in a simple relationship. Limited data indicate that the temperature of the ground water in the area adjacent to the Paradise Range near Gabbs is higher than the temperature of water usually found in the upper few hundred feet of the saturated zone. The relatively high ground-water temperatures may result from either deep circulation of the water or movement of ground water through rocks having above-normal temperature due to structural or volcanic activity.

The specific conductance of water from well 10/35-3B1, in Fingerock Wash indicates a dissolved-solids content that exceeds U. S. Public Health Service (1961) drinking water standards of 500 ppm. Water from well 11/34-21A1, which is several miles downgradient from well 10/35-3B1, has a much lower specific conductance and dissolved-solids content than ground water from the latter well. The decrease in dissolved mineral matter probably results from dilution from a source other than underflow through Fingerock Wash.

Generally, the dissolved-solids content of ground water in Gabbs Valley differs from place to place. Commonly, the analyses of ground water show that the water is relatively high in sodium (more than 100 ppm) and sulfate (more than 300 ppm). Where ground water is being developed in Gabbs Valley, chemical analyses of the water should be made to determine suitability of the water for the intended use.

Development:

Ground water has been used for about 20 years in processing magnesite and brucite ore at the Basic, Inc. Plant at Gabbs and for some domestic and garden irrigation at the townsite of Gabbs. As mentioned earlier, bottled spring water is used generally for drinking and cooking in Gabbs townsite.

According to A. M. Dixon, Mine Superintendent, Basic, Inc., pumpage from company wells was about 106 million gallons (ab out 300 acre-feet) in 1960, when the plant was operating at slightly less than capacity.

Well 13/33-30B2 supplies water for processing at the Nevada Scheelite property. According to Mr. Caldwell, Superintendent, the production of ground water has been as much as 125 gallons per minute continuously during years of maximum operation. This amounts to about 200 acre-feet per year.

During 1961, ground water from well 11/33-3D1 was used to irrigate 50-60 acres of wheat. According to Mr. Bishop, the operator, the well yields about 600 gallons per minute with a drawdown of about 30 feet. On the basis of acreage irrigated and the type of crop, the pumpage probably did not exceed 100 acre-feet during 1961 and may have been nearer 50 acre-feet.

Other wells in Gabbs Valley provide water for stock, domestic, and mining requirements but the aggregate pumpage is small.

At different times in the past, ground water has been used for mining and milling operations at Rawhide, in the area west of the Alkali Flat (photograph 4), and elsewhere.

Some attempts at developing water from wells for irrigation have been made in the past; however, only meager information on these efforts is available. Mr. Bishop reports that irrigation from wells was successful, presumably for several years, in the southern part of T. 12 N., R. 33 E. However, after the owner died no efforts were made to continue irrigation on that land. Other attempts at irrigation were made in T. 11 N., R. 34 E. Also, it is reported that water from well 11/33-4A1 was used to raise one crop.

In two of the samples analyzed, the boron concentration is not excessively high, although the water might have been unsuitable for crops that are sensitive to boron.

On the bais of the estimated average annual recharge to and discharge from the ground-water reservoir, additional ground-water development could be sustained in Gabbs Valley. Depending upon the intended use, the chemical quality of the ground water may represent a problem, at least locally. Development of ground water for irrigation may be limited to the areas where the present water level is 100 feet or less below land surface. These areas cannot be closely defined with present data but generally include the areas of evapotranspiration plus an outlying band around the areas of evapotranspiration. The width of the band surrounding the playa varies considerably and is largely dependent upon the slope of the land surface. Where the land-surface slope is relatively steep, such as north of the Alkali Flat, the band probably is less than 1 mile wide. Where the gradient of the land-surface is relatively flat, such as the area south and southeast of the Alkali Flat, the band may be several miles wide.

DESIGNATION OF WELLS

The wells in this report are designated by a single numbering system. The number assigned to the well is both an identification number and a location number. It is referenced to the Mount Diablo base line and meridian established by the General Land Office.

A typical number usually consists of three units. The first unit is the township north of the Mount Diablo base line. The second unit, a number separated by a slant line from the first, is the range east of the Mount Diablo meridian. The third unit, separated from the second by a dash, is the number of the section in the township. The section number is followed by an upper case letter, which designates the quarter section, and finally, a number designating the order in which the well was recorded in the smallest subdivision of the section. The letters A, B, C, and D designate, respectively, the northeast, northwest, southwest, and southeast quarters of the section.

For example, well number 12/32-21B1 indicates the first well recorded in the northwest quarter of sec. 21, T. 12 N., R. 32 E.

Owing to limitation of space, wells on plate 1 are identified only by the section number, quarter section letter, and serial number. The township in which the well is located can be ascertained by the township and range numbers shown at the margin of plate 1.

Wells listed in table 6 are shown on plate 1.

Table 6.--Records of selected wells in Gabbs Valley

10/35-3B1. Owner, Bureau of Land Management. Drilled stock well, depth 175 feet; casing diameter 8 inches. Casing perforated 120 to 140 feet. Equipped with generator pump and gasoline engine. Depth to water below land surface reported as 115 feet, March 19, 1943; measured 109.73 feet, December 14, 1961. Driller's log:

Material	Thickness (feet)	Depth (feet)
Sand, gray, medium	5	5
Gravel, gray, hard; boulders	90	95
Clay, red, medium	15	110
Sand, red, soft - water	5	115
Rock, red, hard - water	10	125
Clay, tan, medium - water	35	160
Sand, soft -water	10	170
Total depth		170

10/35-11D1. Owner, William Stinson. Drilled stock well, depth 265 feet; casing diameter 6 inches. Equipped with pump and gasoline engine.

Water-level measurements, in feet, below land surface

Date	Measurement	Date	Measurement
5-14-48	185.95	3-12-51	181.40
3-28-49	181.70	9-10-51	181.16
9-14-49	181.45	3-24-52	180.80
3-20-50	182.08	9- 8-52	181.10
9-14-50	181.46	9-14-53	180.97

11/33-3B1. Owner, Jack Bishop. Drilled irrigation well, depth 90 feet; casing diameter 10 inches. Equipped with 4-inch turbine pump. Depth to water below land surface 33.88 feet, December 14, 1961.

11/33-3D1. Owner, Jack Bishop. Drilled irrigation well, depth 120 feet; casing diameter 16 inches. Equipped with turbine pump. Yield reported as 600 gpm with a drawdown of 30 feet. Depth to water below land surface 42.72 feet, December 14, 1961. Driller's log:

Material	Thickness (feet)	Depth (feet)
Silt and clay	40	40
Pebbles	68	108
Cobbles	4	112
Cobbles (deepened)	8	120
Total depth		120

11/33-13C1. Owner, H. H. Holloway. Drilled unused well. Casing diameter 10 inches. Not equipped. Depth to water below land surface 67.67 feet, December 14, 1961.

11/34-4A1. Owner, H. H. Holloway. Drilled observation well, depth 82.5 feet; casing diameter 12 inches. Reported yield 500 gpm.

Depth to water, in feet, below land surface:

Date	Measurement	Date	Measurement
3-15-46	59.30	9-14-49	59.26
5-14-48	59.25	9-19-50	59.26
3-28-49	59.27	12-13-61	59.35

11/34-28A1. Owner, Bureau of Land Management. Drilled stock well, depth 212 feet; casing diameter 8 inches. Casing perforated 180 to 210 feet with 3-by 3/8-inch perforations. Depth to water below land surface reported as 200 feet, April 10, 1943. Driller's log:

Material	Thickness (feet)	Depth (feet)
Boulders, gray, hard; gravel	175	175
Sandstone, gray	25	200
Sand, black - water	10	210
Bedrock, blue	2	212
Total depth		212

11/36-4C1. Owner, Ray W. Suter. Drilled domestic and industrial well, depth 139 feet; casing diameter 6 inches. Casing perforated 30 to 48 feet, and 108 to 136 feet. Depth to water below land surface reported as 30 feet June 2, 1951. Driller's log:

Material	Thickness (feet)	Depth (feet)
Sand and silt	30	30
Sand, clay and silt	18	48
Clay, gray; some gravel	60	108
Gravel and sand; some clay	31	139
Total depth		139

11/36-18D1. Owner not determined. Drilled stock well, casing diameter 10 inches. Equipped with cylinder pump and windmill. Depth to water below land surface 36.68 feet, December 13, 1961.

12/32-21B1. Owner not determined. Dug emergency well, depth about 25 feet; casing diameter 3 feet. Not equipped. Depth to water below land surface 18.07 feet, December 14, 1961.

12/36-22B1. Owner's well number 8. Owner, Basic, Inc. Drilled domestic and industrial well, depth 285 feet; casing diameter 12 inches. Casing perforated 140 to 190 feet with 16-inch perforations and 140 to 280 feet with 12-inch perforations. Temperature of water reported as 70°F. Yield reported as 650 gpm with small drawdown. Depth to water below land surface reported as 107.5 feet. Driller's log:

Material	Thickness (feet)	Depth (feet)
Gravel, boulders and silt	110	110
Unknown	15	125
Sand, gravel, saturated	4	129
Increase in water	5	134
Sand, saturated; gravel, small boulders	151	285
Total depth		285

12/36-27B1. Owner's well number 1. Owner, Basic, Inc. Drilled domestic and industrial well; depth 254 feet; casing diameter 8 inches. Casing perforated 50 to 164 feet with 5/16-by 8-inch perforations. Yield reported as 40 gpm. Temperature reported as 98°F. Depth to water reported as 56.5 feet, July 10, 1940 and 57.6 feet in 1947. Driller's log:

Material	Thickness (feet)	Depth (feet)
Gravel and granite boulders	62	62
Gravel and clay	30	92
Clay and gravel	28	120
Gravel - water	5	125
Clay and gravel	18	143
Granite, loose; clay	39	182
Gravel, loose, and granite boulders	30	212
Granite, decomposed, and boulders	42	154
Total depth		154

12/36-27B2. Owner's well number 3. Owner, Basic, Inc. Drilled well, depth 215 feet; casing diameter 8 inches. Temperature reported as 118°F. Depth to water below land surface reported as 62 feet, February 1942; 69 feet, May 1952; and 58 feet September 1960.

12/36-27B3. Owner's well number 4. Owner, Basic, Inc. Drilled well, depth 457 feet; casing diameter 8 inches. Temperature reported as 135°F. Yield reported as 162 gpm. Depth to water below land surface reported as 93 feet, February 1942 and 90 feet, September 1960.

12/36-28D1. Owner's well number 5. Owner, Basic, Inc. Drilled well, depth 250 feet; casing diameter 8 inches. Yield reported as 187 gpm. Temperature reported as 145°F. Depth to water below land surface reported as 58 feet, February 1942 and 62 feet September 1960.

12/36-28D2. Owner's well number 6. Owner, Basic, Inc. Drilled well, depth 325 feet; casing diameter 8 inches. Yield reported as 163 gpm August 4, 1948 and 297 gpm May 7, 1952. Temperature reported as 155°F. Depth to water below land surface reported as 48 feet February 1942 and 53 feet September 1960.

12/36-28D3. Owner's well number 7. Owner, Basic, Inc. Drilled well, depth 625 feet; casing diameter 10 inches. Yield reported as 297 gpm Temperature reported as 140°F. Depth to water below land surface reported as 27 feet February 1942 and 27 feet September 1960.

12/36-33D1. Owner's well number 10. Owner, Basic, Inc. Drilled unused well, depth 200 feet; casing diameter 16 inches. Casing perforated 70 to 184 feet with 1/2- by 3-inch perforations. Temperature reported as 125°F. Depth to water below land surface reported as about 50 feet November 9, 1942 and measured 46.50 feet December 18, 1961. Driller's log:

Material	Thickness (feet)	Depth (feet)
Rocks	14	14
Gravel, clay	8	22
Clay, gray	32	54
Clay, blue, hot	21	75
Gravel	1	76
Clay, blue	14	90
Gravel	1	91
Clay, blue	1	92
Clay, gray	18	110
Clay, gray - water	10	120
Clay, gray, hard	10	130
Clay, gray, soft	10	140
Clay, gray, hard	2	142
Clay, gray - water	14	156
Clay, gray, hard	4	160
Gravel and water	4	164
Unknown	8	172
Gravel and water	4	176
Clay, gray, hard	2	178
Clay, gray, soft	6	184
Rocks	2	186
Clay, gray, hard	14	200
Total depth		200

13/33-30B1. Owner, Nevada Scheelite, Inc. Drilled industrial well, depth 250 feet; casing diameter 10 inches. Equipped with turbine pump and electric engine. Yield reported as 125 gpm. Depth to water below land surface reported as about 100 feet.

13/36-28B1. Owner, Gabbs Exploration Co. Drilled domestic and industrial well, depth 296 feet, casing diameter 10 3/4 inches. Casing perforated 243 to 279 feet with 1/4- by 2-inch perforations. Temperature reported as 129°F. Depth to water below land surface reported as 143 feet May 29, 1951. Driller's log:

Material	Thickness (feet)	Depth (feet)
Sand, some clay	162	162
Boulders	2	164
Sand, gravel and some clay	86	250
Gravel, coarse; sand - water	23	273
Gravel, small amount of clay	6	279
Rock, black	5	284
Gravel, cemented	12	296
Total depth		296

13/36-36C2. Owner, W. W. Whitaker. Drilled domestic and stock well, depth 189 feet; casing diameter 6 inches. Casing perforated 155 to 198 feet with 1/4- by 1-1/2 inch perforations. Bailer test reported yield of 20 gpm. Temperature reported as cold. Depth to water below land surface reported as 140 feet December 3, 1948. Driller's log:

Material	Thickness (feet)	Depth (feet)
Sand	6	6
Gravel	16	22
Clay, soft, sandy	22	44
Gravel	32	76
Clay, gray	64	140
Sand, fine - water	15	155
Gravel, small - water	34	189
Total depth		189

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NEVADA DEPARTMENT OF CONSERVATION AND NATURAL RESOURCES

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of the
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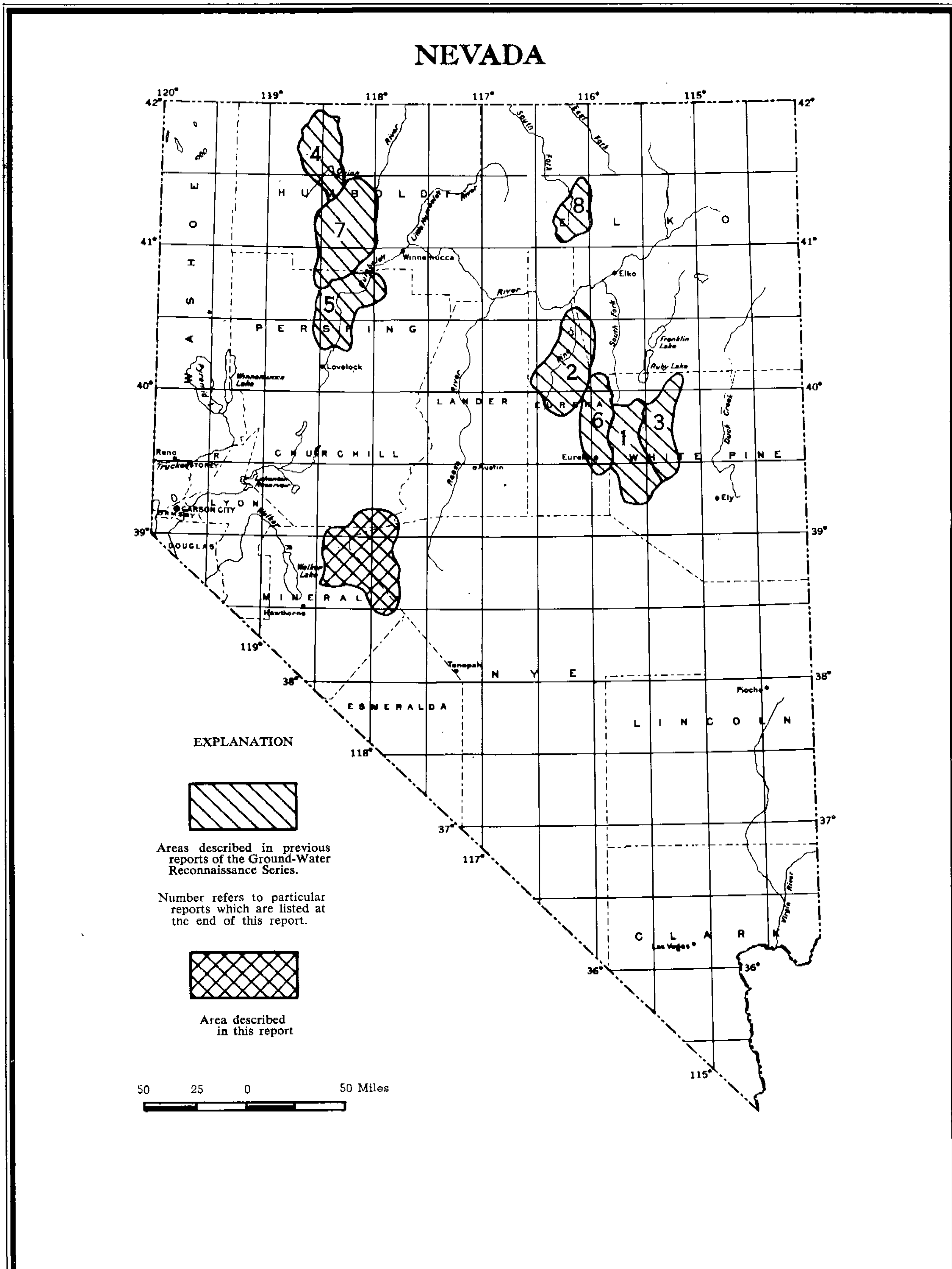

Figure 1.—Map of Nevada showing areas described in previous reports of the Ground-Water Reconnaissance Series and in this report.

GROUND-WATER RESOURCES - RECONNAISSANCE SERIES

Report 9

GROUND-WATER APPRAISAL OF GABBS VALLEY, MINERAL AND NYE COUNTIES, NEVADA

by

Thomas E. Eakin

Geologist

Prepared cooperatively by the

Geological Survey, U. S. Department of the Interior

June

1962

FORWARD

The ninth report in the current series of Ground-Water Reconnaissance reports covers Gabbs Valley in Mineral and Nye Counties. Reports of this type will be forthcoming at the approximate rate of one per month. The cover, maps and pictures are printed by the State Printing Office and the balance of the work is done in this office.

These reports are of importance because they will indicate within limits the amounts and quality of the given water resources. In time, most of the valleys covered by the reconnaissance type studies will be studied in more detail and on a yearly cooperative ground-water program.

Hugh A. Shamberger
Director
Department of Conservation
and Natural Resources

June 1962

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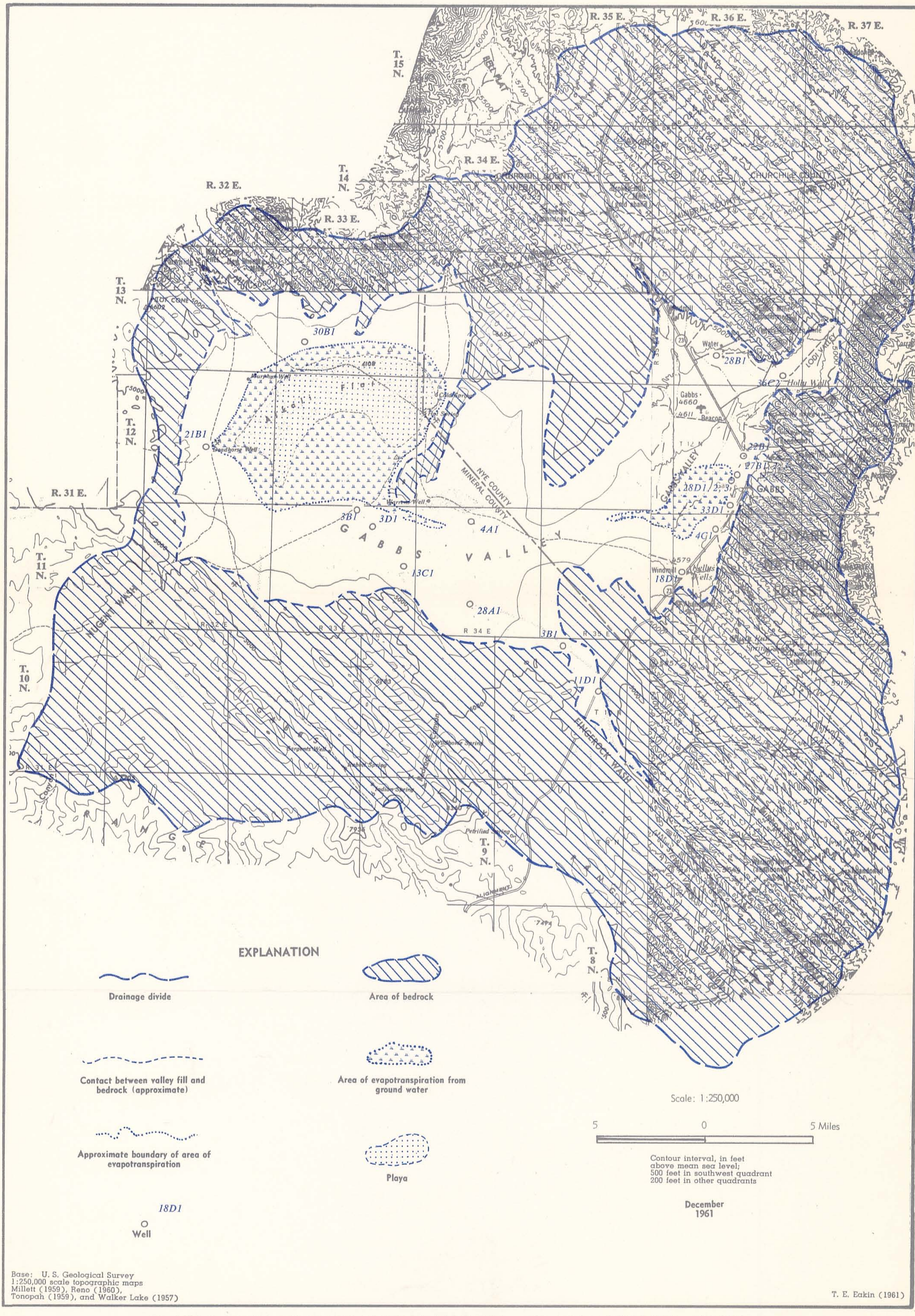

PLATE 1. MAP OF GABBS VALLEY, MINERAL AND NYE COUNTIES, NEVADA

SHOWING AREAS OF BEDROCK, VALLEY FILL, EVAPOTRANSPIRATION FROM GROUND WATER, AND LOCATION OF WELLS.