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

Castle Park well, 37/69–9c; Pilot Range in background.

WATER RESOURCES – RECONNAISSANCE SERIES

REPORT 56

WATER–RESOURCES APPRAISAL OF THE PILOT CREEK VALLEY AREA, ELKO AND WHITE PINE COUNTIES, NEVADA

By
J. R. Harrill

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

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FOREWORD

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

This report is the 56th in the series to be prepared by the staff of the Nevada District Office of the U.S. Geological Survey. These 56 reports describe the hydrology of 194 valleys.

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

Roland D. Westergard
State Engineer

1971

Division of Water Resources

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WATER-RESOURCES APPRAISAL OF THE PILOT CREEK VALLEY AREA,

ELKO AND WHITE PINE COUNTIES, NEVADA

By J. R. Harrill

INTRODUCTION

Purpose and Scope of the Study

Ground-water development 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 on ground-water resources throughout the State.

Recognizing this need, the State Legislature enacted special legislation (Chapter 181, Statutes of 1960) to begin a series of reconnaissance studies of the ground-water resources of Nevada. As provided in the legislation, these studies are being made by the U.S. Geological Survey in cooperation with the Nevada Department of Conservation and Natural Resources, Division of Water Resources. This is the 56th report prepared as part of the reconnaissance studies.

During the course of the earlier ground-water studies, little information on surface-water resources was presented. Later, the reconnaissance series was broadened to include preliminary quantitative evaluations of the surface-water resources in the valleys studied.

The objectives of the reconnaissance studies and this report are to (1) describe the hydrologic environment, (2) appraise the source, occurrence, movement, and chemical quality of water in the area, (3) estimate average annual recharge to and discharge from the ground-water reservoir, (4) provide preliminary estimates of perennial yield and transitional storage reserve, and (5) estimate present and evaluate potential development in the area.

Field work for this report was done in October 1969.

Analog Model Simulation

Electrical analog models are scaled-down versions of the aquifer-flow system constructed from suitable electric components. Electrical flow through a model and water flow through an aquifer are defined by congruent laws.

A steady-state electrical analog model of part of the study area (Pilot Creek Valley) was built to simulate the interrelation of recharge, discharge, hydraulic gradients, transmissivity, and boundary conditions of the valley-fill reservoir under natural conditions. The model was constructed from conductive paper at twice the scale of plate 1 and provided a two-dimensional analysis of the flow system. Evaluation of modeled results provided information used to help define the flow system, to estimate average transmissivity, and to check the compatibility of recharge and discharge estimates with hydraulic gradients measured in the field. These results are discussed in the appropriate sections of the text.

Location and General Features

The area covered by this report is along the eastern border of Nevada (fig. 1). The area is about 100 miles long and extends from about 6 miles south of Montello, Nevada, to about 40 miles northeast of Ely, Nevada. Wendover, Utah, is on the east boundary of the area.

The area covers about 1,780 square miles and is composed of five hydrographic areas (Rush, 1968). The areas are shown on plate 1. From north to south they are (1) Pilot Creek Valley; (2) Great Salt Lake Desert; (3) Antelope Valley (which is subdivided into a northern and a southern part); (4) Deep Creek Valley; and (5) Tippett Valley. The Great Salt Lake Desert and Deep Creek Valley are Nevada parts of areas located mostly in Utah.

Location and names of mountain ranges and principal roads are shown on plate 1.

Previous Work

The geology of the entire area has been mapped at reconnaissance level. That part in Elko County is covered by Granger and others (1957) and that part in White Pine County by Hose and Blake (1970). Localized areas are covered by unpublished theses: Berge (1960), Blue (1960), Avent (1962), Snow (1963), and Schaffer (1961).

Hydrologic studies have been made of parts of the area. The northern part of Antelope Valley was included in a study by Eakin and others (1951) of ground water in Goshute and Antelope Valleys. Some information on Tippett and Deep Creek Valleys was reported by Snyder (1963). In 1943, Eldon P. Dennis of the U.S. Geological Survey collected hydrologic data in the vicinity of Wendover, Utah, to evaluate water-supply possibilities for the Wendover Army Base. Many of those data have been used in this report. A hydrologic reconnaissance of the water resources of Deep Creek Valley, Utah and Nevada (Hood and Waddell, 1969), describes the hydrology of that area. Many of the estimates developed for the Nevada part of Deep Creek Valley are based on information in that report.

Adjacent areas in Nevada have been studied at reconnaissance level by Eakin (1951), Eakin and others (1967), Rush (1968), Hood and Rush (1965), and Rush and Kazmi (1965).

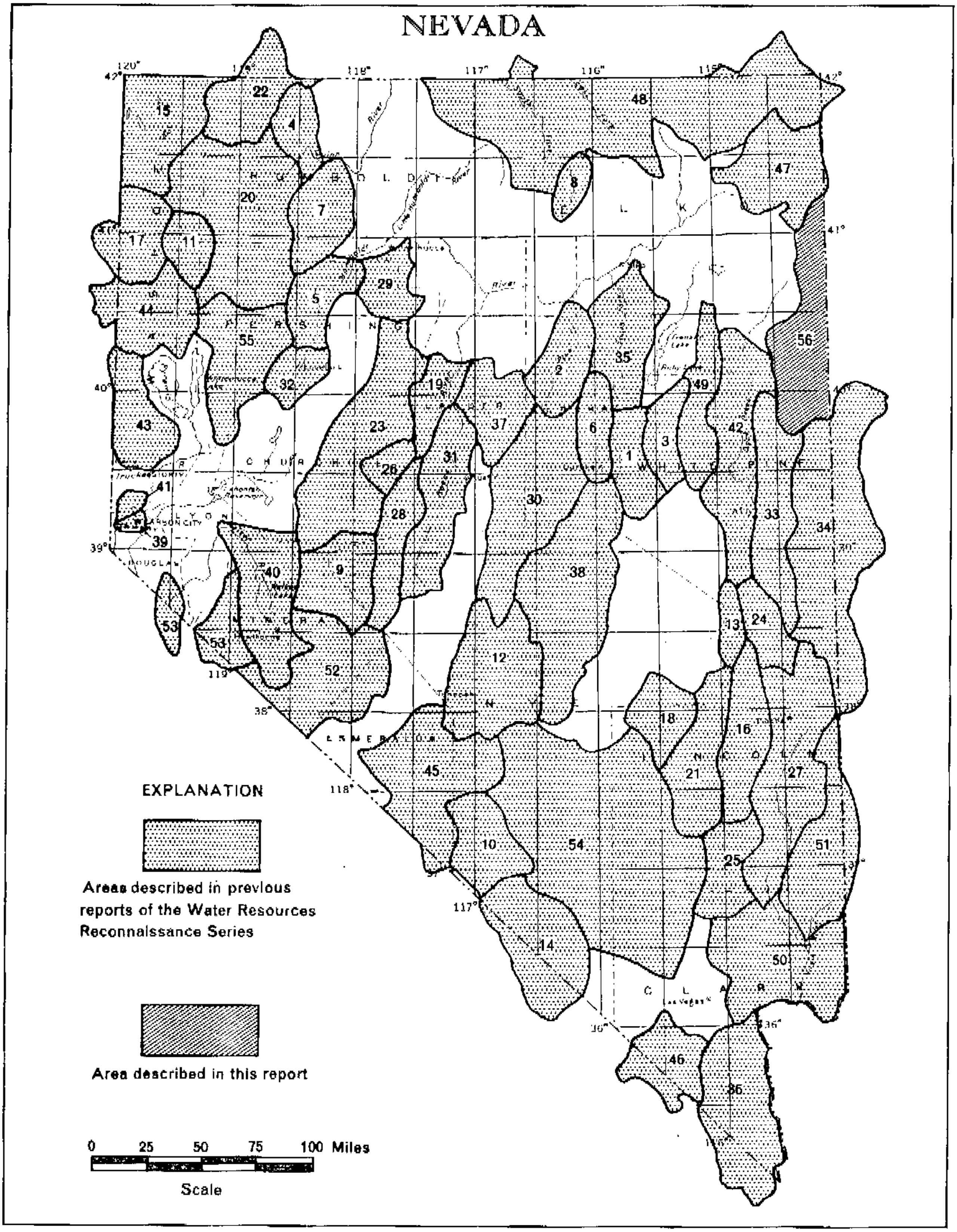


Figure 1.— Area described in this report and others in previous reports of the Water Resources Reconnaissance Series

Numbering System for Hydrologic Sites

The numbering system for hydrologic sites in this report is based on the rectangular subdivision of the public lands, referenced to the Mount Diablo base line and meridian. It consists of three units: The first is the township north (N) of the base line; the second unit, separated from the first by a slant, is the range east (E) of the meridian; the third unit, separated from the second by a dash, designates the section number. The section number is followed by a letter that indicates the quarter section and quarter-quarter section where applicable, the letters a, b, c, and d designate the northeast, northwest, southwest, and southeast quarters, respectively. For example, well 34/69-5ab is the well recorded in the NW¼NE¼ sec. 5, T. 34 N., R. 69 E., Mount Diablo base line and meridian.

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

HYDROLOGIC ENVIRONMENT

Physiography and Drainage

Valleys in the study area are structural depressions which have been partly filled by debris from the surrounding mountains. Tippett Valley is the only topographically closed basin in the study area.

Principal landforms in the valleys are alluvial aprons, which border the mountains and which consist of coalescing alluvial fans and pediments sloping toward the valley floor. The comparatively flat valley floors may contain playas, as in the Great Salt Lake Desert, a well-defined ephemeral drainage, as in Pilot Creek Valley, a poorly defined drainage, as in Antelope Valley, or flat-lying lake-bottom deposits which support sparse vegetation, as in Tippett Valley.

Ancient shore lines are present in all areas except Deep Creek Valley. Three separate lakes occupied parts of the area. Pilot Creek Valley and the Great Salt Lake Desert were occupied by Lake Bonneville, Antelope Valley by Waring Lake, and Tippett Valley by Antelope Lake (Snyder and others, 1964). The highest shore lines are shown on plate 1. The maximum shore line of Lake Bonneville is at an altitude about 600 feet below the maximum shore line altitude of Waring Lake and about 550 feet below the maximum shore line altitude of Antelope Lake.

All drainage in Tippett Valley is toward the valley floor. Antelope Valley drains north to Goshute Valley, and Pilot Creek Valley drains south and east to the Great Salt Lake Desert. In 1969, outflow from Pilot Creek Valley to the Great Salt Lake Desert was blocked by road fill and ponds in parts of secs. 31 and 32, T. 35 N., R. 70 E. The Nevada parts of the Great Salt Lake Desert and Deep Creek Valley drain toward Utah. The drainage network is shown on plate 1. All streams are ephemeral, except a few perennial stream segments on the east flank of the Antelope Range and on the west flank of the Pilot Range.

Lithologic Units

Lithologic units in the report area are divided into two major groups on the basis of their hydrologic properties. These are (1) unconsolidated deposits which form the valley fill, are highly porous, and commonly transmit water readily, and (2) consolidated rocks which occur in the mountains and at depth beneath the valley fill. The latter commonly have low porosities and permeabilities, and except where highly fractured or altered by other secondary features do not readily transmit water.

The unconsolidated deposits consist primarily of alluvial and colluvial deposits of sand, gravel, silt, and clay. Materials range from well-sorted to poorly sorted and form lenticular deposits. Younger surficial deposits along ephemeral channels in the central parts of the valleys are unconsolidated. Older deposits exposed on dissected fans and at depth may be partly consolidated in localized areas. Sand and gravel deposits are moderately to highly permeable and may yield large quantities of water to wells. Fine-grained sand, silt, and clay, which form lake-bottom and playa deposits, are less capable of yielding water to wells.

Consolidated rocks in the Pilot Range, Toana Range, Goshute Mountains, and Kern Mountains (pl. 1) are predominately sequences of carbonate sedimentary rocks, although volcanic and intrusive rocks may predominate in local areas. Volcanic rocks and carbonate sedimentary rocks are present in about equal parts in the Dolly Varden Mountains and the Antelope Range (pl. 1).

Fractures in carbonate rocks are subject to enlargement by solution. Where this has happened, these rocks may store and transmit considerable quantities of water.

The distribution of alluvium and consolidated rocks is shown on plate 1. Some of the area mapped as consolidated rocks in Deep Creek Valley contains semiconsolidated Tertiary sedimentary deposits and interbedded volcanic rocks.

Climate

Climate in the study area ranges from arid in the valleys to subhumid in the higher mountains. Precipitation and humidity generally are low and summer temperatures and evaporation are high. Precipitation varies widely in amount but is generally least on the valley floors and greatest in the mountains. Snow is common during the winter months, and localized thunderstorms provide most of the summer precipitation.

The average monthly and annual precipitation is listed in table 1 for seven stations in and adjacent to the area. Locations of the stations are shown on plate 1.

Freeze data published by the U.S. Weather Bureau for Currie Highway Station, Montello, Pequop, and Wendover WBAP are listed in table 2. They may be used to estimate the approximate length of the growing season in the study area. For example, a crop which experiences a killing frost at 28°F should have a growing season of about 200 days in the Great Salt Lake Desert and about 100 to 120 days in the higher valleys of the study area.

Table 1.--Average monthly and annual precipitation, in inches, at seven stations in eastern Nevada and western Utah

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

Station[1]	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1 Currie Highway Station, Nev.	0.26	0.40	0.52	0.58	0.59	1.50	0.59	0.69	0.54	0.35	0.35	0.69	7.06
2 Ibapah, Utah	.60	.79	.92	1.29	1.50	1.06	.75	1.03	.63	.90	.59	.68	10.74
3 Montello, Nev.	.54	.46	.31	.53	.77	.69	.61	.39	.37	.46	.43	.53	6.09
4 Pequop, Nev.	.98	.85	1.01	.89	1.24	1.16	.40	.68	.54	.62	.93	1.03	10.33
5 Wendover WBAP, Utah	.28	.32	.35	.47	.68	.61	.31	.33	.36	.43	.27	.33	4.74
6 Schellbourne Pass, Nev.	--	--	--	--	--	--	--	--	--	--	--	--	12.57
7 White Horse Pass, Nev.	--	--	--	--	--	--	--	--	--	--	--	--	8.36

1. Station data are tabulated below:

Altitude	Location: Section	Township	Range	Period of record	Remarks
1 5,820	27	28 N.	64 E.	1962-67	
2 5,400	16	9 S.	19 W.	1914-42, 1946-68	
3 4,877	30	40 N.	70 E.	1877-1968	
4 6,000	29	37 N.	66 E.	1948-68	Some months missing
5 4,234	18	1 N.	19 W.	1911-68	
6 8,150	8	22 N.	65 E.	1954-68	Storage gage
7 6,590	31	29 N.	69 E.	1958-65	Storage gage

Table 2.--Longest period, in days, in which temperatures did not go below the indicated values at four stations in eastern Nevada and western Utah

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

Year	Currie Highway Station[1/]			Montello[2/]			Pequop[3/]			Wendover WBAP[4/]		
	24°F	28°F	32°F	24°F	28°F	32°F	24°F	28°F	32°F	24°F	28°F	32°F
1950	--	--	--	132	132	78	--	--	--	--	--	--
1951	--	--	--	144	105	82	--	--	--	--	--	--
1952	--	--	--	190	168	91	--	--	--	--	--	--
1953	--	--	--	143	131	120	--	--	--	262	211	192
1954	--	--	--	126	109	105	--	--	--	242	233	203
1955	--	--	--	162	116	80	--	--	--	220	203	186
1956	--	--	--	165	144	113	--	--	--	223	202	200
1957	--	--	--	146	138	89	--	--	--	241	238	204
1958	--	--	--	147	142	101	--	--	--	251	225	180
1959	--	--	--	130	112	73	130	124	74	--	--	--
1960	--	--	--	143	65	62	150	63	63	254	227	188
1961	--	--	--	139	128	109	139	133	118	243	229	171
1962	131	78	67	131	94	78	170	94	78	260	228	191
1963	174	102	53	182	174	150	182	178	125	233	208	191
1964	117	95	59	--	110	71	164	--	68	236	225	169
1965	113	106	58	--	96	83	130	113	74	248	242	133
1966	101	77	66	133	133	48	135	--	101	218	178	170
1967	123	102	95	135	132	126	156	123	103	216	196	179
1968	76	65	51	120	84	76	84	84	--	274	206	156
Average	139	104	75	145	122	91	144	114	89	241	217	180

1. Altitude 5,820 feet.
2. Altitude 4,877 feet.
3. Altitude 6,000 feet.
4. Altitude 4,234 feet.

CARBONATE-ROCK RESERVOIR

Carbonate rocks that have been intensively fractured or have had fractures enlarged by solution may store and transmit appreciable quantities of water. The carbonate rocks in the area probably form a large ground-water reservoir, which underlies both mountains and valleys, and transmit significant interbasin flow.

Information concerning hydrologic characteristics of the carbonate rocks is sparse. A test well drilled about 2 miles west of Wendover (33/70-21b) is reported to have derived its water from solution cavities or fracture zones in limestone, because all alluvial aquifers were cased and cemented off. This well yielded about 380 gpm (gallons per minute) of salty water from the limestone aquifer. Two other indications of the ability of some carbonate rocks in the area to transmit water are: (1) two large springs, Big Salt Spring and Little Salt Spring in Utah just east of the study area (pl. 1), are immediately downgradient from outcrops of carbonate rocks. The combined discharge of these springs was estimated to be about 11 cfs (cubic feet per second). (2) Mountain areas of carbonate rocks, such as parts of the Goshute Mountains, have very little surface runoff in comparison to the size of stream drainages and the altitude of the mountains. This may be due in part to high infiltration through permeable bedrock.

Generally, greater depths to water and uncertainty that a well will penetrate a high-yielding solution channel or fracture zone make carbonate-rock reservoirs less predictable for development than valley-fill reservoirs.

Extent and Boundaries

The alluvial deposits of the valleys, as shown on plate 1, form the valley-fill reservoirs that are the principal source of ground water in the area. There is insufficient information to evaluate adequately the thickness of the valley fill. In Pilot Creek Valley, well 37/69-1cc at the north end of the valley and well 35/68-24bc in the west-central part of the valley were bottomed in alluvium at depths of 631 and 493 feet, respectively. In the Great Salt Lake Desert, well 32/69-2b encountered limestone at 446 feet. Thus, much of the valley fill in Pilot Creek Valley is at least 500 feet thick and much of the valley fill in the Great Salt Lake Desert (Nevada part) may not be much thicker than 500 feet.

Available data for Antelope and Tippett Valleys suggest that the valley fill is at least several hundred feet thick. Insufficient information is available in Deep Creek Valley to estimate the thickness of valley fill.

External hydraulic boundaries are formed by the consolidated rocks (pl. 1) that underlie and form the sides of the valley-fill reservoirs. These boundaries are leaky to varying degrees. Leakiness depends on the type of rocks, the degree of structural deformation, and the amount of solution enlargement of openings. Considerable flow across the boundary between the consolidated rocks and valley fill may occur in areas where carbonate rocks are present. Flow across this boundary may be in either direction, depending on the hydraulic gradient present.

Transmissivity and Storage Coefficient

Transmissivity is a measure of the capacity for ground water to flow in an aquifer system. The storage coefficient in a heterogeneous valley-fill reservoir is a measure of the amount of water that will drain by gravity. When utilized together in certain types of mathematical or analog models, the transmissivity and storage coefficient can be used to define the distribution and amount of water-level decline that would result under certain conditions of pumping and boundary conditions.

Transmissivity values were approximated for Pilot Creek Valley from the specific capacities of three wells and by constructing a steady-state electrical analog model based on the distribution of recharge and discharge as estimated in this report, the boundaries of the valley-fill reservoir, and measured water-level altitudes in wells. Transmissivity estimated from the specific capacity of well 35/68-24bc was about 12,000 gpd (gallons per day) per foot, and from the specific capacities of wells 37/69-1ac and 37/69-1cc was about 13,000 gpd per foot (table 10). Best agreement between the actual and model water-level altitudes was obtained when transmissivity values of 20,000 to 40,000 gpd per foot were used in the model.

The higher values obtained from the model probably represent transmissivity of a greater thickness of valley fill than do the estimates obtained from wells. which represent only that part of the valley fill affected by pumping. The average values obtained from the model are first approximations which suggest probable transmissivity values for large areas of the valley fill. Values for actual wells are affected by local conditions and may vary significantly from the average values.

The reports in drillers' logs of wells (table 11) of considerable thicknesses of gravel or sand--even of boulders--not only in the present area of study but throughout Nevada, imply that the transmissivity of the total sequence of basin-fill deposits is significantly greater than the estimates obtained from specific-capacity data for individual wells. Although substantial lengths of perforated casing are installed, it appears that many wells produce water from only limited zones within the saturated thickness of aquifer penetrated. Thus, transmissivity estimates obtained from specific-capacity data may not be truly indicative of the capability of the aquifer to transmit water, but reflect only selected zones or beds within the aquifer. As more well data accumulate, and as additional methods of interpreting these data are applied, it is possible that reevaluation of transmissivity of many Nevada basins will be needed. In short, estimates made in the reconnaissance program may prove to have been conservative.

Because of a lack of data and the uncertain nature of reservoir boundaries (due to interbasin leakage), no estimates were made of valley-fill transmissivity in Antelope, Tippett, and Deep Creek Valleys, and the Great Salt Lake Desert.

A valley-fill reservoir under long-term pumping conditions generally functions as an unconfined aquifer or water-bearing zone; under such conditions the storage coefficient may be nearly equal to the specific yield. The storage coefficient of the valley fill is estimated from well logs and field observations to be at least 0.1, which is equivalent to a specific yield of 10 percent.

Source, Occurrence, and Flow of Ground Water

Virtually all ground water in the study area is derived from infiltration of precipitation within the basins. In most situations, deep infiltration is from runoff and occurs on the slopes of the alluvial apron. However, in this area, significant deep infiltration also occurs in permeable carbonate rocks in the mountains where percolating water moves along bedrock fractures to the zone of saturation.

Ground water occurs in the saturated part of the valley fill where it occupies the interstices in the granular clastic deposits. It is generally at shallow depths near the centers of valleys which discharge ground water by evapotranspiration but may be at depths of several hundred feet along the upper margins of the valleys. The minimum depth to water in valleys that drain by subsurface flow to other areas is commonly greater than 50 feet. Depths to water in wells in this area in the fall of 1969 are listed in table 10 (at the end of this report).

Ground water moves from areas of high hydraulic head to areas of lower hydraulic head. The rate of movement depends on the hydraulic gradient and the permeability and porosity of the material through which the water is moving. Typical rates range from several feet per year to several hundred feet per year. The horizontal movement of ground water in the valley fill is parallel to the slope of the water surface. A downward component of movement occurs in areas of recharge and an upward component occurs in areas of evapotranspiration. The approximate slope of the water surface may be determined from plate 1 which shows point water-level altitudes for autumn 1969.

The point water-level altitudes on plate 1 suggest leakage from Tippett and Antelope Valleys. Some water probably flows southward from Tippett Valley to Spring Valley; however, most of the water probably flows north to Antelope Valley and then eastward toward Great Salt Lake Desert. A low ground-water divide is present just north of the Antelope Valley-Goshute Valley boundary, and probably only a small amount of water flows southward into Antelope Valley from Goshute Valley. Interbasin leakage eastward beneath the Goshute Mountains seems to occur primarily south of T. 31 N. and north of T. 24 N. However, additional leakage may occur north of this area.

INFLOW TO THE VALLEY-FILL RESERVOIR

Precipitation

Precipitation, falling as snow or rain, is the principal source of water entering the hydrologic systems of the study area. Part of the precipitation is evaporated directly from vegetation or the ground surface, part runs off as surface flow, part infiltrates to shallow depths where it replenishes soil moisture, and part eventually infiltrates to the zone of saturation where it recharges the ground-water system.

The precipitation pattern in Nevada is related principally to the topography (Hardman, 1936); the stations at the higher altitudes generally receive more precipitation than those at lower altitudes. However, this general relation may be considerably modified by local conditions. The valley floors of the area generally receive less than 8 inches of precipitation per year.

Estimates of average precipitation in the five areas are summarized by altitude zones in table 4. The estimates are based on the precipitation-altitude relation shown by Hardman's (1936) map, as revised in 1964, and on the precipitation data listed in table 1.

Runoff

by T. L. Katzer

Available Records

There are no continuous recording gaging-station records in the project area. A measurement of Spring Creek, Oct. 7, 1969, showed the discharge to be 6.4 cfs. The measurement was made in Utah near the upper end of the creek about 0.4 mile east of the State line. A second measurement made on the same day, about 7 miles downstream from the first measurement and above the first irrigation diversion, showed the discharge to be 4.9 cfs. Spring Creek is the only significant perennial fresh-water stream in the project area. It originates from springs in Utah, flows about 10 miles through Nevada, and becomes a tributary to Deep Creek in Utah, about 4 miles southwest of Ibapah, Utah.

The records of two partial-record stations (crest-stage gages), in the study area are as follows:

Dead Cedar Wash, near Wendover, Utah[1]		Millick Canyon Tributary near Currie, Nevada[2]	
Date	Peak discharge (in cfs)	Date	Peak discharge (in cfs)
June 1963	50	February 1968	24
November 1963	280	March 1969	19
August 1965	620	May 1969	a 0.2
October 1965	750	November 1969	a 0.1
June 1967	15		
August 1967	490		
June 1968	a 0.1		
August 1968	a 6		
September 1968	a 0.2		
July 1969	280		
November 1969	12		

1. In Great Salt Lake Desert in N½ sec. 4, T. 29 N., R. 69 E. Gage installed July 1962.
2. In Antelope Valley near center sec. 8, T. 27 N., R.67 E. Gage installed June 1967.
a. Estimated.

Streamflow Characteristics

Ephemeral streams, which flow only during periods of snowmelt and high intensity precipitation, predominate in the project area. The seasonal distribution of runoff in the project area is similar to that of Trout Creek near Callao, Utah, which is the natural-flow recording station closest to the project area. The distribution of runoff of this stream is shown in figure 2. The mean monthly discharge is expressed as a percentage of the mean annual flow, and the graph shows that slightly more than 70 percent of the mean annual flow occurs in the period May through July. This is a direct result of the spring snowmelt runoff. The previously listed record for the crest-stage gage at Dead Cedar Wash shows that maximum peak flows are most common during the June to October period. These are generally a direct result of high intensity precipitation.

Estimate of Runoff

Because of few streamflow records in the project area, the amount of runoff cannot be computed directly. Estimates of runoff were made based on methods described by Moore (1968). The amount of runoff reaching the canyon mouths at about the 7,000-foot elevation was computed on the basis of an altitude-runoff relation and by measuring the channel geometry. Table 3 shows the estimated runoff from the mountain blocks to each of the valleys within the project area.

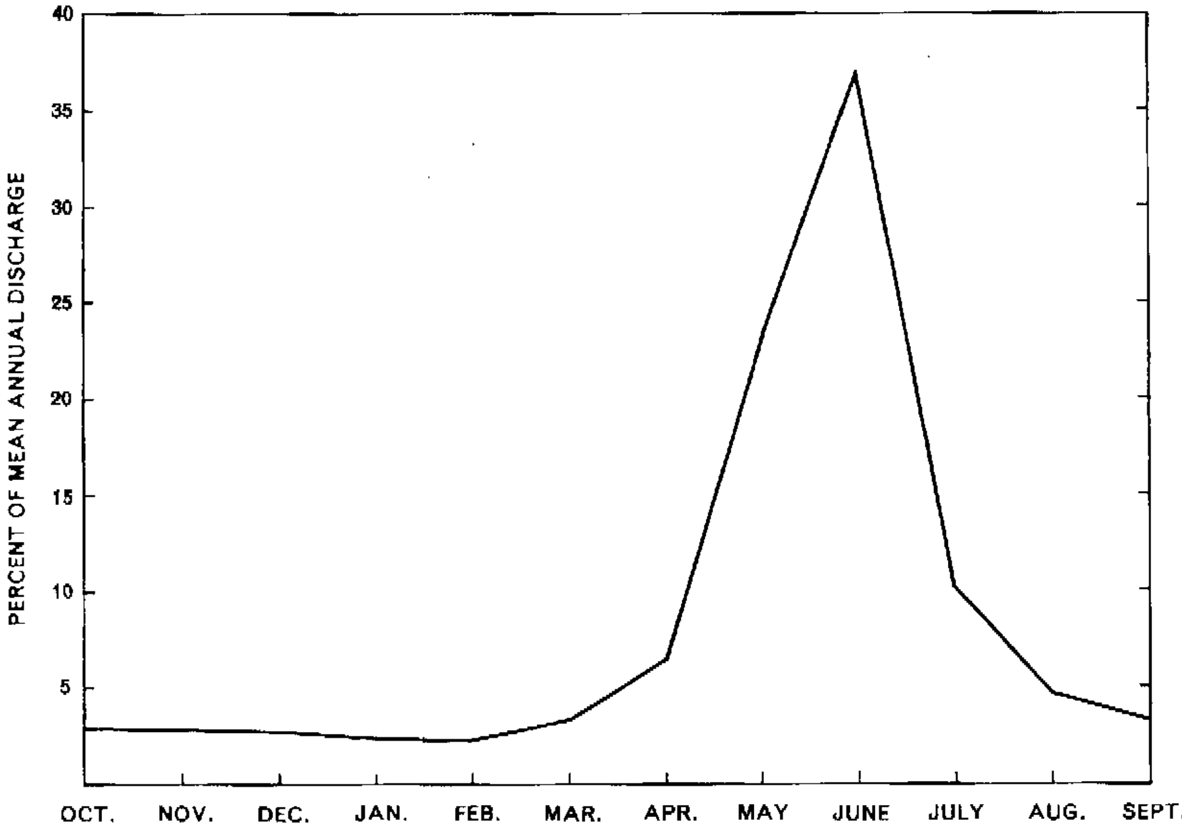


Figure 2.— Mean monthly discharge, in percent of mean annual discharge, of Trout Creek near Callao, Utah

Table 3.--Estimated average annual runoff

Area	Area above 7,000-foot altitude (acres)	Estimated annual runoff (acre-feet)
Pilot Creek Valley	13,000	740
Great Salt Lake Desert	27,600	1,300
Deep Creek Valley	9,700	a 200
Antelope Valley		
Southern part	4,400	40
Northern part	15,700	190
Tippett Valley	26,800	560

a. Ephemeral runoff only. If spring-fed flow of Spring Creek is included, runoff would be about 5,000 acre-feet per year.

The estimates exclude the flow of Spring Creek and the other drainage systems which drain into Deep Creek. If the spring-fed flow of Spring Creek is included, the total estimated runoff in the Nevada part of Deep Creek Valley would be about 5,000 acre-feet per year. This is in reasonably good agreement with the estimate of 6,000 acre-feet per year derived by Hood and Waddell (1969, p. 17) for the Nevada part of Deep Creek Valley.

The estimated surface flow across the Nevada-Utah State line is about 100 acre-feet per year in the Great Salt Lake Desert and about 3,500 acre-feet per year in Deep Creek Valley.

Recharge from Precipitation

On the valley floors where precipitation is small, little water infiltrates directly to the ground-water reservoir. Much of the precipitation is evaporated before and after infiltration. Some adds to soil moisture and is later transpired. Greater precipitation in the mountains provides most of the recharge. Water reaches the ground-water reservoir by infiltration of runoff in the mountains, on the alluvial apron and the valley floor, and by lateral underflow from the consolidated rocks.

A method described by Eakin and others (1951, p. 79-81) is used to estimate the average annual recharge from precipitation. The method assumes that a percentage of the average annual precipitation becomes ground-water recharge. The estimated average annual recharge for the five valleys listed in table 4 ranges from about 2 to 4 percent of the estimated total precipitation. A range of 3 to 7 percent is typical of the amounts usually calculated by this method for the desert basins of Nevada. Thus, the estimated recharge for Pilot Creek Valley, Great Salt Lake Desert, Antelope Valley, and Deep Creek Valley, which is less than 3 percent of the estimated precipitation, may be slightly low.

Subsurface Inflow from Goshute Valley

A potential hydraulic gradient exists from Goshute Valley to the Great Salt Lake Desert and part of Pilot Creek Valley. Interbasin flow is possible where consolidated rocks in the Toana Range and northern Goshute Mountains, which separate the valleys, are sufficiently permeable. The best agreement between measured and modeled water-level altitudes in Pilot Creek Valley was obtained after assuming that about 1,000 acre-feet per year of subsurface inflow from Goshute Valley occurred. However, these analog results are inconclusive because of other unresolved hydrologic factors. Moreover, there is about 10,000 acre-feet of ground-water discharge in Goshute Valley, and no large imbalance between recharge and discharge was noted by Eakin (1951). Consequently, the amount of subsurface inflow may be small in comparison to the magnitude of leakage from Tippett and Antelope Valleys. Provisional estimates of subsurface inflow of about 1,000 acre-feet per year to the Great Salt Lake Desert and 1,000 acre-feet per year to Pilot Creek Valley are used in this report. These estimates should be revised when additional data are available.

Table 4.--Estimated average annual precipitation and ground-water recharge

Precipitation zone (altitude in feet)	Area (acres)	Estimated annual precipitation: Range (inches)	Average (feet)	Average (acre-feet)	Estimated recharge from precipitation: Percentage of precipitation	Acre-feet per year
PILOT CREEK VALLEY						
Above 9,000	778	>20	1.8	1,400	25	350
8,000-9,000	2,270	15-20	1.5	3,400	15	510
7,000-8,000	9,950	12-15	1.1	11,000	7	770
6,000-7,000	29,500	8-12	.8	24,000	3	720
Below 6,000	171,000	<8	.5	86,000	--	--
Total (rounded)	213,000			130,000	2	2,400
GREAT SALT LAKE DESERT						
Above 9,000	1,460	>20	1.8	2,600	25	650
8,000-9,000	5,320	15-20	1.5	8,000	15	1,200
7,000-8,000	20,800	12-15	1.1	23,000	7	1,600
6,000-7,000	55,100	8-12	.8	44,000	3	1,300
Below 6,000	244,000	<8	.5	120,000	--	--
Total (rounded)	327,000			200,000	2	4,800
ANTELOPE VALLEY (Northern part)						
Above 9,000	47	>20	1.8	85	25	21
8,000-9,000	2,190	15-20	1.5	3,300	15	500
7,000-8,000	13,500	12-15	1.1	15,000	7	1,000
6,000-7,000	69,400	8-12	.8	56,000	3	1,700
Below 6,000	85,400	<8	.5	43,000	--	--
Total (rounded)	171,000			120,000	3	3,200
ANTELOPE VALLEY (Southern part)						
8,000-9,000	156	15-20	1.5	230	15	34
7,000-8,000	4,200	12-15	1.1	4,600	7	320
6,000-7,000	47,700	8-12	.8	38,000	3	1,100
Below 6,000	30,000	<8	.5	15,000	--	--
Total (rounded)	82,100			58,000	3	1,500
DEEP CREEK VALLEY (Nevada part)						
Above 9,000	404	>20	1.8	730	25	180
8,000-9,000	1,710	15-20	1.5	2,600	15	390
7,000-8,000	7,620	12-15	1.1	8,400	7	590
6,000-7,000	41,500	8-12	.8	33,000	3	1,000
Below 6,000	82,800	<8	.5	41,000	--	--
Total (rounded)	134,000			86,000	3	2,200

(Continued)

Table 4.--Estimated precipitation and recharge--Continued

Precipitation zone (altitude in feet)	Area (acres)	Estimated annual precipitation: Range (inches)	Average (feet)	Average (acre-feet)	Estimated recharge from precipitation: Percentage of precipitation	Acre-feet per year
TIPPETT VALLEY						
Above 9,000	280	>20	1.8	500	25	120
8,000-9,000	11,300	15-20	1.5	17,000	15	2,600
7,000-8,000	28,200	12-15	1.1	31,000	7	2,200
6,000-7,000	81,300	8-12	.8	65,000	3	2,000
Below 6,000	102,000	<8	.5	51,000	--	--
Total (rounded)	223,000			160,000	4	6,900

A hydraulic gradient in the valley fill also exists from part of Goshute Valley to northern Antelope Valley (pl. 1). Assuming a gradient of about 3 feet per mile, an effective underflow width of about 4 miles, and a moderately low transmissivity of about 25,000 gpd per foot, underflow from Goshute Valley to northern Antelope Valley is computed to be about 300 acre-feet per year.

OUTFLOW FROM THE VALLEY-FILL RESERVOIR

Evapotranspiration

Natural evapotranspiration of ground water occurs where the saturated part of the valley fill is at shallow depth. Discharge occurs principally in three ways: (1) by evapotranspiration in areas of phreatophytes; (2) by direct evaporation from bare soil where the capillary fringe extends to within a short distance of the land surface; and (3) by evapotranspiration in areas of spring discharge where ground water intersects the land surface.

The principal phreatophyte in the areas shown on plate 1 is greasewood. Some shadscale and rabbitbrush are included in the area along Pilot Creek, and saltbush is present along the margins of playas in the Great Salt Lake Desert. Local patches of greasewood are present on the valley floor of northern Antelope Valley and are not shown on plate 1. The estimated depth to water beneath these areas is 80 to 100 feet. Field observations indicated that this occurrence of greasewood is most commonly associated with stabilized sand dunes of low relief or local surficial depressions, and the plants probably receive most of their moisture from local precipitation that falls on the valley floor and not ground-water inflow from the surrounding mountains.

Phreatophytes, mainly greasewood, are established on areas at the south end of Pilot Creek Valley and in parts of the Great Salt Lake Desert north of Wendover, which in the early 1950's were primarily bare-soil playas. This recent growth was noticed when areal photographs taken in 1954 were compared with the 1969 distribution of vegetation and was confirmed by residents of Wendover, who reported that they had formerly driven across these areas at high speed but could no longer do so because of the vegetation. Determination of the cause for this growth of phreatophytes was beyond the scope of this report.

Estimates of the natural evapotranspiration of ground water are given in table 5. The estimates are based on rates of consumption of ground water as described by Lee (1912), White (1932), Young and Blaney (1943), Houston (1950), and Robinson (1962). Little information is available concerning the rate at which ground water is evaporated from bare soil on playas. Depth to water below playas on the Great Salt Lake Desert is probably less than 10 feet. An estimated ground-water evaporation rate of 0.1 foot per year is used in these areas.

Water levels beneath the southern part of Antelope Valley and Tippett Valley are greater than 50 feet. Hence, evapotranspiration losses from ground water in these areas are considered negligible.

Table 5.--Estimated evapotranspiration of ground water

Phreatophyte assemblage or type surface	Areal density	Approximate depth to water (feet)	Area (acres)	Annual evapotranspiration: Acre-feet per acre	Annual evapotranspiration: Acre-feet
		PILOT CREEK VALLEY			
Principally greasewood, some shadscale and rabbitbrush, and localized areas of salt grass	Low to moderate	5-40	23,000	.2	4,600
Bare soil	--	10±	460	.1	50
Total (rounded)					4,600
		GREAT SALT LAKE DESERT			
Principally greasewood; some saltbush	Low to moderate	10-40	16,700	.2	3,300
Spring-supported vegetation	Moderate to dense	<5	140	1.5	200
Bare soil (playa)	--	<10	11,700	.1	1,200
Total (rounded)					4,700
		ANTELOPE VALLEY (Northern part)			
Greasewood	Low to moderate	20-50	550	.2	100
Total (rounded)					100
		DEEP CREEK VALLEY (Nevada part)			
Meadow, including irrigated hay and pasture	Moderate to dense	<10	800	1.5	1,200
Greasewood	Low to moderate	5-50	1,500	.2	300
Total (rounded)					1,500

Subsurface Outflow

The hydraulic gradients and lack of phreatophytes shown on plate 1, and the depths to water listed in table 10 indicate that most recharge in Tippett Valley and Antelope Valley leaks as underflow to other areas.

A low ground-water divide is present in Tippett Valley, and water drains south to Spring Valley as well as north beneath southern Antelope Valley and the northwest corner of Deep Creek Valley to the Great Salt Lake Desert. The exact position of the divide cannot be determined from available information, but it probably is in the southern half of Tippett Valley. For purposes of this report, it is assumed that: (1) all recharge generated south of T. 23 N. on the west side of the valley and south of T. 22 N. on the east side of the valley drains to Spring Valley. This is about 2,000 acre-feet per year; and (2) the remainder of the recharge, about 5,000 acre-feet per year, drains to the Great Salt Lake Desert.

All estimated recharge in southern Antelope Valley and all estimated recharge and subsurface inflow in northern Antelope Valley, less an estimated evapotranspiration loss of about 100 acre-feet per year (table 5), is believed to drain to the Great Salt Lake Desert. This amounts to nearly 5,000 acre-feet per year. Thus, the total estimated interbasin flow to the Great Salt Lake Desert from Antelope and Tippett Valleys is about 10,000 acre-feet per year.

Two springs, Big Salt Spring and Little Salt Springs in Utah just east of the study area, may derive much of their discharge from underflow from Tippett and Antelope Valleys. Both springs are downgradient from outcrops of carbonate rocks. In October 1969, discharge of Big Salt Springs was estimated to be about 10 cfs and discharge of Little Salt Springs was estimated to be about 1 cfs. The combined discharge of about 11 cfs, or nearly 8,000 acre-feet per year, amounts to about 80 percent of the estimated leakage from Tippett and Antelope Valleys. However, water samples from both springs (table 8) contained higher dissolved solids than samples obtained in the two tributary valleys. The reason for the marked difference in water quality was not determined; however, assuming that these springs discharge some interbasin flow, solution of soluble constituents from bedrock and partial mixing with saline water present beneath much of the Great Salt Lake Desert may account for much of the increase.

A hydraulic gradient exists from Pilot Creek Valley to the Great Salt Lake Desert (pl. 1). The quantity of outflow cannot be precisely estimated because of insufficient data. However, based on an outflow section about a mile wide, a hydraulic gradient of about 10 feet per mile, and an estimated transmissivity of 25,000 gpd per foot, the outflow may be on the order of 300 acre-feet per year.

That part of the estimated ground-water inflow to Great Salt Lake Desert in Nevada not consumed by phreatophytes or evaporated from shallow ground water moves as underflow to the Great Salt Lake Desert in Utah where it is ultimately consumed by evaporation. This inflow includes 4,800 acre-feet from precipitation, 1,000 acre-feet subsurface inflow from Goshute Valley, and 300 acre-feet subsurface inflow from Pilot Creek Valley. Estimated evapotranspiration in the Nevada part of the area is about 4,700 acre-feet. Thus, underflow to the Great Salt Lake Desert in Utah is about 1,400 acre-feet per year.

In Deep Creek Valley, underflow to Utah is assumed to be the difference between the estimated recharge and the estimated discharge, or roughly 700 acre-feet per year.

About 10,000 acre-feet per year of interbasin flow from Tippett and Antelope Valleys also moves beneath the valley-fill reservoirs of parts of the Great Salt Lake Desert in Nevada and Deep Creek Valley as it flows toward discharge areas in Utah.

Springs

Locations and discharges of the more significant springs in or associated with the area are listed in table 6. Discharges from Big Salt and Little Salt Springs in the Great Salt Lake Desert and Spring Creek in Deep Creek Valley are large enough to be significant elements of the hydrologic system in each of these areas. Spring discharge in other areas is small in relation to other hydrologic elements but is significant in that it represents the most available part of the water supply.

With the exception of Big Salt and Little Salt Springs, discharge for springs in the valley fill listed in the table is included in the evapotranspiration estimates listed in table 5. Discharge of spring-fed streams or other springs in the mountains are not included in table 5 because this water has not yet entered the valley-fill reservoir.

Table 6.--Location and discharge of selected springs

Location	Name or owner	Discharge Date	Discharge gpm[1/]	Remarks
		PILOT CREEK VALLEY		
35/69-10b	Little Cedar Spring	10-22-69	70 E	
36/68-21a	Collar and Elbow Springs	10-21-69	1-2 E	These springs had formerly been used as a supply for Proctor by the Western Pacific Railroad. They are reported to have yielded 20 gpm.
36/69-1b	Pilot Mountain Ranch	1- 9-43	a 350-400	Spring-fed streams diverted near mountain front and piped to Pilot Mountain Ranch for irrigation water.
-2d	do.	1- 9-43	a 50-100	
37/69-24d	Bar O Ranch	1- 9-43	a 350	Discharge from this spring and a spring-fed stream (in 37/70-16) are diverted to ranch for irrigation water. Flow into reservoir at ranch was about 100 gpm on 10-22-69.
-35c	Pilot Mountain Ranch	3-13-43	a 30-40	Domestic supply for Pilot Mountain Ranch.
5N/19W-29d	Cove Springs	10-21-69	15 E	In Utah; discharge piped to Montello, Nev., for public supply.
		GREAT SALT LAKE DESERT		
4S/19W-6d	Big Salt Springs	10-26-69	4,500 E	In Utah; flow maintains Blue Lake.
-20a	Little Salt Springs	10-26-69	450 E	In Utah; not used.
35/70-29a	--	10-21-69	100 E	Also called Little Salt Springs; discharge estimated from area of spring-supported vegetation.
36/70-4	Cottonwood Spring	--	b 55 R	Discharge piped to Wendover.
-9	Cedar Spring	--	b 55 R	Do.
-20	Miners Canyon Springs	--	b 50 R	Do.
		ANTELOPE VALLEY (northern part)		
28/67-10b	Dolly Varden Spring	10-24-69	5-10 E	Additional seepage supports vegetation in vicinity of spring. Total discharge probably about 50 gpm, as estimated by Eakin (1951, p. 28).

(Continued)

Table 6.--Location and discharge of selected springs--Continued

Location	Name or owner	Discharge		Remarks
		Date	gpm[1]	
		DEEP CREEK VALLEY		
11S/19W-19c	Spring Creek	10- 9-69	2,900 M	In Utah; flow measured near Nevada border.
		TIPPETT VALLEY		
23/67-10a	--	10-22-69	150 M	Spring-fed stream; domestic supply for Tippett.
-34b	--	10-22-69	70 E	Seepage area; flow developed by ditches.

1. Flow in gallons per minute; E, estimated; M, measured; R, reported.
a. Discharge reported by E. P. Dennis, U.S. Geological Survey.
b. Average flow estimated from data furnished by Hoot Gibson, manager, Wendover Town Water Supply.

DEVELOPMENT

Irrigation in 1969 was limited to about 100 acres of alfalfa and about 60 acres of hay in Pilot Creek Valley, about 800 acres of meadow along Spring Creek in Deep Creek Valley, and about 40 acres of hay and pasture in Tippett Valley. Areas in Pilot Creek and Tippett Valleys are irrigated by streamflow (in part spring-fed) piped or diverted in ditches from nearby mountains. The area in Deep Creek Valley is irrigated by diversions from Spring Creek and from shallow ground water. Two irrigation wells had been drilled in Pilot Creek Valley, but in 1969, no crops had been irrigated by pumping ground water.

Springs and spring-fed streams have been developed for stock and domestic purposes in all of the valleys. About 20 acre-feet per year of spring discharge is piped from Pilot Creek Valley to Montello, Nevada, for use as a public supply, and about 260 acre-feet per year of discharge from Cottonwood, Cedars, and Miners Canyon Springs is piped into the Wendover public-supply system and used mostly in Utah. Additional stock-water supplies have been developed by drilling stock wells (see table 10 at the back of report) and in parts of Antelope, Tippett, and Deep Creek Valleys by constructing retaining reservoirs along ephemeral stream channels.

In 1969, pumpage for stock and domestic purposes probably did not exceed 10 acre-feet in any of the valleys. Streamflow diversions for irrigation were about 400 acre-feet in Pilot Creek Valley, and about 1,000 acre-feet in Deep Creek Valley.

GROUND-WATER BUDGETS

Under natural conditions, long-term inflow to and outflow from a valley are equal and there is no net change in the quantity of water stored in a system. Ground-water budgets were prepared for each of the valleys to compare estimates of inflow and outflow, to determine the magnitude of the difference between estimates, and to select a value that may reasonably represent both inflow and outflow. Table 7 shows the ground-water budgets for the study area.

The imbalance shown for Pilot Creek is equal to about one-third the estimated discharge. This imbalance may be due to errors in estimates or to unresolved hydrologic factors. One possible error is that the estimated recharge is low because the high altitude (maximum of 10,704 feet) and comparatively high relief of the Pilot Range may result in localized higher precipitation on the west flanks of the Pilot Range. The most apparent unresolved hydrologic factor is subsurface inflow from Goshute Valley. The best analog model results were obtained with a subsurface inflow from Goshute Valley of about 1,000 acre-feet per year and an additional 1,500 acre-feet per year of recharge generated from the Pilot Range. A value of 4,500 acre-feet per year was selected to represent natural inflow and outflow because the discharge estimate is considered more accurate than the recharge estimate.

For some valleys there is no imbalance, because some budget elements were determined by difference. Budgets for these areas should be considered no more accurate than the budget for Pilot Creek Valley.

Table 7.--Preliminary ground-water budgets

[All estimates in acre-feet per year and rounded]

Budget elements	Pilot Creek Valley	Great Salt Lake Desert	Autelope Valley northern part	Autelope Valley southern part	Deep Creek Valley	Tippett Valley
INFLOW						
Ground-water recharge from precipitation (table 4)	2,400	4,800	3,200	1,500	2,200	6,900
Subsurface inflow From Goshute Valley (p. 17)	1,000	1,000	300	--	--	--
From Pilot Creek Valley (p. 23)	--	300	--	--	--	--
Total (rounded) (1)	3,400	6,100	3,500	1,500	2,200	7,000
NATURAL OUTFLOW						
Evapotranspiration (table 5)	4,600	4,700	100	--	1,500	--
Subsurface outflow To Great Salt Lake Desert (p. 23)	300	--	--	--	--	--
To Utah part of Great Salt Lake Desert (p. 23, 24)	--	a 1,400	a 3,400	a 1,500	--	a 5,000
To Spring Valley (p. 23)	--	--	--	--	--	a 2,000
To Utah part of Deep Creek Valley (p. 24)	--	--	--	--	700	--
Total (rounded) (2)	4,900	6,100	3,500	1,500	2,200	7,000
IMBALANCE						
Excess of outflow over inflow (2) - (1)	1,500	(b)	(b)	(b)	(b)	(b)
VALUES SELECTED TO REPRESENT INFLOW AND NATURAL OUTFLOW	4,500	5,000	3,500	1,500	2,000	7,000

a. Evapotranspiration plus subsurface outflow assumed to be the same as the estimated recharge.

b. Imbalance is zero because some elements were determined by difference.

CHEMICAL QUALITY OF WATER

Fifteen water samples were collected and analyzed as part of the present study to make a generalized appraisal of the suitability of the water for use and to help define potential water-quality problems. These analyses are listed in table 8 along with 22 others made prior to this study.

Types of Water

For purposes of this report, waters are classified on the basis of their dominant anion and cation. Samples from the northern part of Pilot Creek Valley were calcium bicarbonate waters; however, samples from the southern part of the valley were sodium chloride waters. Samples from the Great Salt Lake Desert were sodium chloride waters, typically with a high dissolved-solids content (one exception is a sample from the east flank of the Pilot Range which was a calcium bicarbonate water with a low dissolved-solids content). Samples from Antelope, Deep Creek, and Tippett Valleys were mostly calcium bicarbonate waters.

Suitability for Use

Based on the data in table 8, water samples from the northern part of Pilot Creek Valley and from springs above the old Bonneville shoreline were of suitable quality for irrigation and domestic use. Well water from the southern part of Pilot Creek Valley exceeded limits recommended as drinking water standards by the U.S. Public Health Service (1962) and had from medium to very high salinity and sodium hazards in regard to irrigation use. All water samples from the Great Salt Lake Desert, except the one from springs on the east flank of the Pilot Range, also exceeded the limits recommended as drinking water standards and were poorly suited for irrigation purposes. Samples from Antelope, Deep Creek, and Tippett Valleys were suitable for irrigation and domestic purposes.

For more specific information regarding the suitability of water for use, the reader is referred to the following published references:

Type of use	Reference
Agricultural	U.S. Salinity Laboratory (1954) Scofield (1936) McKee and Wolf (1963) Wilcox (1955) Bernstein (1964)
Domestic	U.S. Public Health Service (1962)

The bacteriological quality of drinking water is important but is outside the scope of this report. If any doubt exists regarding the acceptability of a drinking-water supply, contact the Nevada Bureau of Environmental Health, Carson City.

Table 8.--Partial and detailed chemical analyses of water from wells, springs, and streams

[Field-office analyses by the U.S. Geological Survey, except as indicated]

Location	Source	Date sampled	Temperature °F	Temperature °C	Silica (SiO_2)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na) plus potassium (K)[3]	Bicarbonate (HCO_3)[4]	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Dissolved-solids content[5]	Hardness as $CaCO_3$	Specific conductance (micromhos per cm at 25°C)	pH (lab. determination)	Salinity hazard	Sodium-adsorption ratio (SAR)	Sodium hazard	Residual sodium carbonate (RSC)
					Milligrams per liter (upper number) and milliequivalents per liter (lower number)[1]												Factors affecting suitability for irrigation[2]			
								PILOT CREEK VALLEY												
34/69-5ab[6]	Well	1-10-43	--	--	20	116 5.79	37 3.04	719 31.28	249 4.08	36 0.75	1,250 35.26	0.3 0.02	2,500	442 8.83	(a)	7.9	V	15	V	S
-5dd[6]	Well	1-29-43	--	--	10	102 5.09	36 2.96	654 28.44	226 3.70	30 0.62	1,140 32.16	0.2 0.01	2,370	403 8.05	(a)	7.4	V	14	V	S
35/68-24bc[6]	Well (at 230 ft)	2-15-43	--	--	19	104 5.19	43 3.54	681 29.61	171 2.80	39 0.81	1,230 34.70	0.65 0.03	2,480	437 8.73	(a)	7.6	V	14	V	S
-24bc[6]	Well (at 265 ft)	2-26-43	--	--	26	125 6.24	52 4.28	678 29.46	189 3.10	36 0.75	1,280 36.11	0.35 0.02	2,660	527 10.52	(a)	7.5	V	13	V	S
-24bc[6]	Well (at 395 ft)	2-19-43	--	--	9.4	108 5.39	52 4.28	654 28.44	159 2.61	37 0.77	1,230 34.70	0.55 0.03	2,500	484 9.67	(a)	7.2	V	13	H	S
-24bc[6]	Well (at 440 ft)	2-21-43	--	--	12	111 5.54	52 4.28	632 27.47	178 2.92	37 0.77	1,190 33.57	0.5 0.03	2,530	491 9.82	(a)	7.3	V	12	H	S
35/69-10b	Little Cedar Spring	10-22-69	--	--	--	--	--	--	--	--	176 4.96	--	--	100 2.00	--	--	-	--	-	-
-10b[6]	do.	1-11-43	--	--	41	27 1.35	10 0.80	193 8.41	263 4.31	45 0.94	187 5.28	0.9 0.05	630	109 2.17	(a)	7.8	M	7.0	H	M
-10c[6]	Well	1-10-43	--	--	58	50 2.50	16 1.32	268 11.64	271 4.44	224 4.66	224 6.32	0.75 0.04	977	191 3.82	(a)	7.8	M	8.2	M	S
36/68-21a	Elbow Spring	10-21-69	--	--	--	27 1.35	5 0.45	19 0.82	116 1.90	13 0.27	16 0.45	--	--	90 1.80	270	8.2	L	0.9	L	S
36/69-17a[6]	Seep in Pilot Creek channel	1-29-43	--	--	33	72 3.59	10 0.82	202 8.80	132 2.16	312 6.50	161 4.54	0.25 0.01	870	221 4.91	(a)	7.2	M	5.9	M	S
37/69-16da1	Well	10-22-69	--	--	--	46 2.30	8 0.64	16 0.69	190 3.11	10 0.21	11 0.31	--	--	147 2.94	360	8.1	L	0.6	L	S
37/69-35b	Spring	10-22-69	--	--	--	12 0.60	3 0.22	7 0.32	53 0.87	5 0.10	6 0.17	--	--	41 0.82	110	7.4	L	0.5	L	S
-35b[6]	Spring	1-29-43	--	--	9.0	11 0.55	2 0.16	14 0.61	46 0.75	8 0.17	14 0.39	0.15 0.01	70	36 0.71	(a)	7.3	L	1.0	L	S
37/70-30[6]	Spring	1-14-43	--	--	10.0	21 1.05	3 0.25	19 0.81	87 1.43	13 0.27	14 0.39	0.35 0.02	127	65 1.30	(a)	7.2	L	0.9	L	S
5N/19W-29d (Utah)	Cove Springs	10-21-69	48	9	--	15 0.75	4 0.31	13 0.55	72 1.18	7 0.15	10 0.28	--	--	53 1.06	160	7.9	L	0.8	L	S
								GREAT SALT LAKE DESERT												
4S/19W-6d (Utah)	Big Salt Spring	10-26-69	74	23½	--	124 6.19	59 4.86	1,590 69.24	215 3.52	232 4.83	2,550 71.94	--	--	553 11.05	8,900	8.0	U	30	V	S
-20a (Utah)	Little Salt Spring	10-26-69	78	25½	--	128 6.39	60 4.90	1,450 63.05	260 4.26	236 4.91	2,310 65.17	--	--	565 11.29	8,000	8.1	U	27	V	S
33/69-34dd[6]	Well (at 435 ft)	12-10-42	--	--	23	100 4.99	47 3.87	239 10.39	155 2.54	93 1.94	522 14.73	0.7 0.04	1,350	443 8.86	(a)	7.5	H	5.5	M	S
-34d[6]	Well (at 495 ft)	12-18-42	--	--	25	133 6.64	55 4.52	278 12.08	144 2.36	83 1.73	676 19.07	0.4 0.02	1,620	559 11.16	(a)	7.3	H	5.1	M	S
-34d[6]	Well (at 655 ft)	12-31-42	--	--	19	475 23.70	143 11.76	1,590 69.29	109 1.79	242 5.04	3,470 97.89	0.65 0.03	7,360	1,770 35.46	(a)	7.5	U	16	V	S
-34d[6]	Well (at 655 ft)	1-5-43	--	--	13	1,550 77.34	329 27.06	6,300 274.09	95 1.56	759 15.80	12,800 361.09	0.7 0.04	22,900	5,230 104.40	(a)	7.5	U	38	V	S
-34d[6]	Well (at 655+ ft)	2-10-43	--	--	49	2,090 104.29	434 35.70	8,200 356.44	98 1.61	1,000 20.82	16,800 473.93	1.3 0.07	31,500	7,010 139.99	(a)	7.3	U	43	V	S
33/70-21b[6]	Well (at 580 ft)	11-27-42	--	--	8.4	527 26.30	0 0.00	3,420 148.81	30 0.49	135 2.81	4,270 120.46	0.4 0.02	9,340	1,320 26.30	(a)	>8.0	U	34	V	U
-21b[6]	Well (at 682 ft)	11-27-42	--	--	--	--	--	--	--	--	43,100 1,215.85	1.1 0.06	76,100	--	(a)	--	U	--	-	-
-21b[3]	Well (at 750 ft)	1-6-43	--	--	140	1,510 75.35	1,060 87.20	b 44,300 1,927.05	--	5,250 109.30	69,900 1,971.88	2.1 0.11	132,000	8,140 162.55	(a)	--	U	210	V	-
35/70-9d	Spring	10-22-69	--	--	--	--	--	--	--	--	--	--	--	--	28,000	--	U	--	-	-
-29a	Spring	10-22-69	59	15	--	180 8.98	63 5.21	--	250 4.10	--	3,290 92.81	--	--	710 14.19	10,000	8.2	U	--	-	S
-29a[6]	Spring	1-10-43	--	--	32	176 8.78	51 4.20	2,120 92.13	262 4.29	152 3.16	3,460 97.61	0.9 0.05	6,750	650 12.98	(a)	7.6	U	36	U	S
36/70-4, 9, 20[7]	Cottonwood, Cedar, and Miners Canyon Springs	6-10-44	--	--	9.3	16 0.80	3 0.25	10 0.45	62 1.02	8 0.17	11 0.31	0 0.00	94	53 1.05	(a)	7.8	L	0.7	L	S
								ANTELOPE VALLEY												
28/67-9b	Dolly Varden Spring	10-24-69	55	13	--	48 2.40	28 2.32	--	178 2.92	--	14 0.39	--	--	236 4.72	--	8.2	L	--	-	S
								DEEP CREEK VALLEY												
11S/20W-13a (Utah)	Spring Creek	10-9-69	--	--	--	33 1.05	14 1.17	5 0.23	168 2.75	5 0.10	7 0.20	--	--	141 2.82	300	8.2	L	0.2	L	S
24/70-3a	Spring Creek	10-9-69	--	--	--	70 3.49	32 2.62	--	288 4.72	--	21 0.59	--	--	306 6.11	660	8.2	L	--	-	S
25/70-34c	Well	8-16-66	--	--	12	18 0.91	1.8 0.14	(c)	110 1.80	12 0.25	14 0.40	0.4 0.02	d 161	53 1.05	250	7.6	L	2.0	L	M
								TIPPETT VALLEY												
22/67-36c	Well	10-23-69	--	--	--	29 1.45	17 1.43	--	158 2.59	--	18 0.50	--	--	144 2.88	430	8.2	L	--	-	S
23/67-11d	Spring	10-22-69	65	18½	--	33 1.65	30 2.47	--	232 3.80	--	7 0.20	--	--	206 4.12	420	8.2	L	--	-	S
23/67-34b	Spring	10-22-69	45	7	--	59 2.94	28 2.30	--	280 4.59	--	10 0.28	--	--	262 5.24	530	8.2	L	--	-	S

Footnotes to table 8.

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

2. Salinity hazard is based on specific conductance (in micromhos) as follows: 0-750, low hazard (L; water suitable for almost all applications); 750-1,500, medium (M; can be detrimental to sensitive crops); 1,500-3,000, high (H; can be detrimental to many crops); 3,000-7,500, very high (V; should be used only for tolerant plants on permeable soils); >7,500, unsuitable (U). Sodium-adsorption ratio (SAR) provides an indication of what effect an irrigation water will have on soil-drainage characteristics. SAR is calculated as follows, using milliequivalents per liter: $SAR = Na / \sqrt{(Ca + Mg)/2}$. Sodium hazard, low (L), medium (M), high (H), or very high (V), is based on an empirical relation between salinity hazard and sodium-adsorption ratio. Residual sodium carbonate (RSC): safe (S), marginal (M), or unsuitable (U). The several factors should be used as general indicators only, because the suitability of a water for irrigation also depends on climate, type of soil, drainage characteristics, plant type, and amount of water applied. These and other aspects of water quality for irrigation are discussed by the National Technical Advisory Committee (1968, p. 143-177), and the U.S. Salinity Laboratory Staff (1954).

3. Computed as the milliequivalent-per-liter difference between the determined negative and positive ions; expressed as sodium (the concentration of sodium generally is at least 10 times that of potassium). Computation assumes that concentrations of undetermined negative ions--especially nitrate--are small.

4. All carbonate values 0 mg/l.

5. Residue on evaporation at 105°C.

6. Samples collected by P. R. Dennis, U.S. Geol. Survey, Salt Lake City, Utah, analyses by Utah State Dept. Agriculture, Division of Chemistry.

a. Specific conductance may be crudely estimated as 1.5 x dissolved solids.

b. Analyzed value for sodium only.

c. Sodium 34 mg/l, 1.48 me/l; potassium 1.4 mg/l, 0.04 me/l.

d. Computed sum, with bicarbonate expressed as carbonate.

THE AVAILABLE GROUND-WATER SUPPLY

The available ground-water supply of the five valleys in the study area consists of two interrelated entities: (1) the perennial yield, or the maximum amount of natural discharge that economically and legally can be salvaged over the long term by pumping; and (2) the transitional storage reserve (defined below).

Perennial Yield

In Pilot Creek Valley, Great Salt Lake Desert, and Deep Creek Valley, most of the ground-water evapotranspiration and subsurface outflow could be salvaged by properly located wells (table 7); however, water quality would be a limiting factor for agricultural and domestic use in the Great Salt Lake Desert. In Antelope and Tippett Valleys, where subsurface outflow is virtually the sole means of discharge, the amount of salvable discharge is difficult to determine. The possibility of salvaging all or part of the outflow by pumping is uncertain. For the purpose of this reconnaissance it is assumed that the subsurface geohydrologic controls might permit salvage of about half the outflow by partly dewatering the valley-fill reservoir (table 7). The estimated perennial yields of the five valleys are as follows:

Valley	Estimated perennial yield (acre-feet)
Pilot Creek Valley	4,500
Great Salt Lake Desert	5,000
Antelope Valley	
Northern part	1,700
Southern part	800
Deep Creek Valley	2,000
Tippett Valley	3,500

In the Great Salt Lake Desert, water-level declines sufficient to eliminate all ground-water evapotranspiration in Nevada would also reverse the natural ground-water gradient and induce some underflow from Utah. Moreover, there is also a possibility that some of the leakage from Antelope and Tippett Valleys to the Great Salt Lake Desert could be salvaged by pumping in the Nevada part of the area or in Goshute Valley. Development of the entire perennial yield in Deep Creek Valley by pumping may adversely effect some of the existing beneficial evapotranspiration of ground-water or surface outflow to Utah.

Transitional Storage Reserve

Transitional storage reserve has been defined by Worts (1967) as the quantity of water in storage in a particular ground-water reservoir that can be extracted and beneficially used during the transition period between natural equilibrium conditions and the new equilibrium conditions under the perennial yield concept of ground-water development. In the arid environment of the Great Basin, the transitional storage reserve of such a reservoir is the amount of stored water available for withdrawal by pumping during the nonequilibrium period of development, or period of lowering water levels. Therefore, transitional storage reserve is a specific part of the total ground-water resource that can be taken from storage; it is water that is available in addition to the recharge.

Most pertinent is the fact that no ground-water source can be developed without causing some storage depletion. The magnitude of the depletion varies with the distance of development from any recharge and discharge boundaries in the ground-water system. Few desert valleys have well-defined recharge boundaries, such as live streams or lakes; many, however, have well-defined discharge boundaries, such as areas of evapotranspiration.

To compute the transitional storage reserve of the five valleys in the report area, several assumptions are made: (1) wells would be situated in, near, and around the areas of natural discharge so that these natural losses (subsurface outflow and evapotranspiration) could be reduced or stopped with a minimum of water-level drawdown in pumped wells; (2) a perennial water level 50 feet below land surface would curtail virtually all evapotranspiration losses from ground water; (3) over the long term, pumping would cause a moderately uniform depletion of storage throughout most of the valley fill; (4) the specific yield of the valley fill is at least 10 percent; (5) the water levels are within range of economic pumping lift for the intended use; (6) the development would have little or no effect on adjacent areas; and (7) the water is of suitable chemical quality for the intended use.

Table 9 presents the preliminary estimates of transitional storage reserve, based on the above assumptions. For each of the five valleys, the estimated storage reserve is the product of the area beneath which depletion can be expected to occur, average thickness of the valley fill to be dewatered, and specific yield. The area is slightly less than the area of alluvium on plate 1, to allow for any pediments that may occur around the margins of the valleys. The estimated thickness of 50 feet of sediments to be dewatered in Antelope and Tippett Valleys may be low, possibly by as much as a factor of 10, as the exact amount of the valley-fill reservoir that would have to be dewatered to salvage a substantial part of the outflow is not known.

Table 9.--Preliminary estimates of transitional storage reserve

[All quantities rounded]

Valley	Area of depletion (acres) (1)	Thickness to be dewatered (feet) (2)	Transitional storage reserve[1/] (acre-feet) (1) x (2) x 0.10
Pilot Creek Valley	116,000	50	580,000
Great Salt Lake Desert	92,000	40	a 370,000
Antelope Valley			
Northern part	72,000	50	b 360,000
Southern part	24,000	50	b 120,000
Deep Creek Valley	25,000	50	125,000
Tippett Valley	86,000	50	b 430,000

1. Assumes a specific yield of 10 percent.

a. Water may have significantly high dissolved-solids content.

b. Estimate may be considerably in error, owing to unresolved hydrologic factors.

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

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

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

Using the above equation and the estimates for Pilot Creek Valley as an example (transitional storage reserve, 580,000 acre-feet; perennial yield, 4,500 acre-feet) and using a pumping rate (Q) equal to the perennial yield in accordance with the general intent of Nevada water law, the time (t) to deplete the transitional storage reserve is computed to be roughly 250 years. At the end of that time, the transitional storage reserve would be exhausted, subject to the assumptions previously described.

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

During the period of depletion, the ground-water flow net would be substantially modified. The estimated recharge in Pilot Creek Valley of 4,500 acre-feet per year that originally flowed from around the sides of the valley to areas of natural discharge would ultimately flow directly to pumping wells.

To meet the needs of an emergency or other special purpose requiring ground-water pumpage in excess of perennial yield for specified periods of time, the transitional storage reserve could be depleted at a more rapid rate than in the example given. The above equation can be used to compute the time required to exhaust the storage reserve for any selected pumping rate in excess of the perennial yield. However, once the transitional storage reserve was exhausted, the pumping rate should be reduced to the perennial yield as soon as possible. Pumpage in excess of the perennial yield would result in an overdraft, and pumping lifts would continue to increase and stored water would continue to be depleted until some undesired result occurred.

SELECTED WELL DATA AND WELL LOGS

Selected well data are listed in table 10 and selected drillers' logs of wells are listed in table 11. Most of the well data and logs are from the files of the Nevada State Engineer. Because of the sparse development in the area, these tables include most of the information available.

Table 10.--Records of selected wells

Owner or name: WPRR, Western Pacific Railroad
Use: D, domestic; I, irrigation; S, stock; U, unused
Water-level measurement: M, measured; R, reported
Remarks: SLN, Log number in the files of the State Engineer

Location number	Owner or name	Year drilled	Depth (feet)	Diameter (inches)	Use	Yield (gpm) and drawdown (feet)	Land surface altitude (feet)	Water-level measurement: Date	M or R	Depth (feet)	Remarks
				PILOT CREEK VALLEY							
34/69-5ab	Pilot Well	--	--	6	S	--	4,480	10-21-69	M	50.52	
-5d	WPRR	--	565	8	--	--	4,500±	--	R	flowed	Abandoned
35/68-24bc		--	493	--	S	250/43	4,970	10-21-69	M	196.5	
35/69-10c		--	--	--	--	--	--	--	R	52	Not field located
36/69-9db		--	--	24	S	--	4,854	10-23-69	M	97.8	
37/69-1ac	Brown, Walter	1961	610	16	I	800/120	4,990	10-21-69	M	147.17	SLN 6131, 6840
-1cc	Patton, Oscar	1962	631	13	I	1,100/175	4,910	10-14-62	R	75	SLN 6831
-9c	Castle Park Well	--	--	--	S	--	4,990	--	-	--	
-14da$_1$	Richens, Dale	1956	110	6	D	48/8	4,900	3-29-56	R	55	SLN 3383
-14da$_2$	do.	--	--	18	S,I	--	4,920	10-22-69	M	66.4	
-29bd	Deseret Livestock Co.	1956	450	8	S	13/50	4,988	5- 1-56	R	225	SLN 3424
38/69-26c	Montello Well No. 2	--	--	--	S	--	4,947	10-21-69	M	108.87	
				GREAT SALT LAKE DESERT							
32/69-2b	U.S. Government	1940	346	6	--	25/--	4,570	--	R	326	
33/69-34d	do.	1942	800	--	--	--	4,630	--	R	367	
33/70-21b	do.	1942	750	--	--	380/--	4,290±	--	R	34	Well now destroyed
				ANTELOPE VALLEY							
27/67-25ac	Hegan & Sons	1963	75	6	S	--	5,980	10-24-69	M	24.42	SLN 7035
28/67-33b	Edgar, Earl	1958	63	6	S	--	5,780	10-24-69	M	22.88	SLN 4385
28/68-8d	Highway Well	--	--	6	S	--	5,595	6-25-48	M	98.95	
								9-15-49	M	105.21	
29/67-17c	BLM	1967	230	6	S	--	5,730	10-24-69	M	198	SLN 9550
29/68-6c	Sorenson, Lloyd	1962	178	8	S	--	5,610	10-24-69	M	100.15	SLN 6516

Table 10.--Records of selected wells--Continued

Location number	Owner or name	Year drilled	Depth (feet)	Diameter (inches)	Use	Yield (gpm) and drawdown (feet)	Land surface altitude (feet)	Water-level measurement Date	M or R	Depth (feet)	Remarks
					GOSHUTE VALLEY						
30/66-20d	Edgar, Earl	1959	130	8	S	--	5,660	10-25-69	M	96.03	SLN 4384
30/67-8a	Sorenson, Lloyd	1967	140	8	S	--	5,595	10-25-69	M	57.05	SLN 9389
-20a		--	--	8	S	--	5,600	10-24-69	M	69.24	
					DEEP CREEK VALLEY						
24/69-27b	Goshute Reservation	--	--	--	S	--	5,810	10-22-69	M	258.2	
26/70-20c	BLM	1954	4,502	8 5/8	U	--	5,504	--	R	780	Oil test
					TIPPETT VALLEY						
22/67-36c	BLM, Rob Hills Well	1956	350	6	S	--	5,800	12- 7-56	R	290	
23/68-5a	Tippett Ranch	--	--	--	S	--	5,680	10-22-69	M	115.18	
23/69-18b	Goshute Reservation	--	--	--	S	--	5,860	10-22-69	M	284	
24/69-8d	do.	--	--	--	S	--	5,880	10-22-69	M	329	
-19d	do.	--	--	--	S	--	5,770	10-22-69	M	225.5	
25/68-26b	BLM	1966	448	8	S	--	5,900	10-22-69	M	378.2	SLN 10,431

Table 11.--Selected well logs

Material	Thickness (feet)	Depth (feet)	Material	Thickness (feet)	Depth (feet)

PILOT CREEK VALLEY

35/68-24bc Army test well no. 3

Material	Thickness (feet)	Depth (feet)
Clay, sand, gravel, boulders	230	230
Sand and gravel to 1 inch	40	270
Sand, gravel, boulders, and conglomerate	140	410
Clay, yellow, tough, with interbedded gravel	28	438
Sand and gravel, tight	55	493

37/69-1ac Walter J. Brown

Material	Thickness (feet)	Depth (feet)
Dirt	4	4
Gravel and boulders	161	165
Gravel	5	170
Gravel, coarse; clay, and sand	77	247
Gravel, fine, and sandy clay	21	268
Silt, sandy, and some gravel	37	305
Gravel	45	350
Boulders	25	375
Gravel	7	382
Gravel with sand	8	390
Boulders	3	393
Gravel and boulders	9	402
Clay, brown	3	405
Sand, hard, and gravel	27	432
Sand, hard, and boulders	19	451
Sand, hard, and gravel	78	529
Sand, hard, with streaks of soft sand	35	564
Sand	6	570
Sand, moderately hard	10	580
Sand, medium hard, with streaks of gravel	18	598
Sand and boulders	9	607
Limestone	3	610

37/69-1cc Oscar Patton

Material	Thickness (feet)	Depth (feet)
Surface soil	4	4
Clay and gravel	11	15
Clay	2	17
Clay, sandy	4	21
Sand and boulders	9	30
Sand, hard, with boulders	17	47
Sand and coarse gravel	22	69
Gravel, small, with sand and clay	22	91
Clay and gravel	7	98
Clay, sandy, and gravel	34	132
Gravel, large	9	141
Sand with streaks of clay	35	176
Sand and boulders	33	209
Sand, hard; fine gravel; boulders	58	267
Sandstone, hard, with boulders	66	333
Sand and boulders	57	390
Sand and gravel	24	414
Sand, streaks of clay, and gravel	78	492
Clay, sandy	38	530
Sand with streaks of clay	96	626
Boulders	5	631

37/69-14dal Dale Richens

Material	Thickness (feet)	Depth (feet)
Clay, gray	40	40
Clay, yellow, sandy	22	62
Gravel and sand	11	73
Clay, yellow, sandy	37	110

37/69-29bd Deseret Livestock Co.

Material	Thickness (feet)	Depth (feet)
Gravel, cemented	130	130
Gravel and light gray clay	130	260
Boulders	3	263
Gravel and clay	7	270
Boulders	6	276
Clay, gray, sandy, and gravel	129	405

Table 11.--Selected well logs--Continued

GREAT SALT LAKE DESERT

33/69-34d. Army test well no. 2

Material	Thickness (feet)	Depth (feet)
Sand and gravel, tight	114	114
Gravel, cemented	4	118
Sand and gravel, tight	2	120
Sand and gravel, cemented	30	150
Sand and gravel, tight, and cemented sand and gravel	32	182
Sand and gravel, tight, some cemented gravel	33	215
Sand and gravel, tight, little conglomerate	20	235
Sand and gravel, tight, little clay mix	20	255
Sand and gravel, little clay	40	295
Sand and gravel, tight, some boulders	5	300
Sand and gravel, little clay	45	345
Gravel, cemented, or conglomerate	45	390
Gravel, cemented	10	400
Gravel, cemented, or conglomerate	8	408
Clay and sand gravel	7	415
Conglomerate or cemented sand and gravel	3	418
Conglomerate	33	451
Clay, hard, and small rock	16	467
Clay; layers soapstone	28	495
Clay, soapstone or talc	55	550
Conglomerate and some rock	10	560
Sand and gravel, tight, little clay	8	568
Rock and little clay	17	585
Sand and gravel, tight, little clay	9	594
Rock, conglomerate, little clay	16	610
Rock or conglomerate	27	637
Rock	9	646
Clay, hard, and rock; struck sand and small gravel; caving; water	7	653
Rock, hard, on bottom, filled up again	2	655
Rock	38	693
Rock and clay	32	725
Rock	50	775
Clay and rock	10	785
Rock	5	790
Rock, pink	5	795
Rock, dark, and clay	10	805
Rock, dark, hard	33	838

33/70-21b. Army test well no. 1

Material	Thickness (feet)	Depth (feet)
Topsoil, sandy clay	18	18
Sand and gravel, tight	8	26
Clay, sandy	8	34
Clay and streaks of sand and gravel	134	168
Sand, gravel to 3 inches	132	300
Sand, gravel boulders, conglomerate	146	446
Limestone, gray	147	593
Lime, black, tough	32	625
Clay, brown	8	633
Lime, black	13	646
Lime, gray and red, clay	39	685
Lime, black	18	703
Lime, black, quartzite	6	709
Lime, black, and clay	41	750

Note: Salt water at 34 feet.

Table 11.--Selected well logs--Continued

Material	Thickness (feet)	Depth (feet)
ANTELOPE VALLEY		
<u>28/67-33b</u> Earl Edgar		
Sand	63	63
<u>29/67-17c</u> Bureau of Land Management		
Clay, red, and broken rock	195	195
Gravel, sand, water	5	200
Clay, dark red, broken stones	30	230
<u>29/68-6c</u> Lloyd Sorenson		
Clay, light gray	105	105
Clay, blue	35	140
Clay, black, sandy	20	160
Clay, light gray	18	178
TIPPETT VALLEY		
<u>22/67-36c</u> Bureau of Land Management		
Gravel, cemented	295	295
Sand and gravel	55	350
<u>25/68-26b</u> Bureau of Land Management		
Clay and gravel	448	448

LIST OF PREVIOUSLY PUBLISHED REPORTS

(See fig. 1)

Report no.	Valley or area
1	Newark (out of print)
2	Pine (out of print)
3	Long (out of print)
4	Pine Forest (out of print)
5	Imlay area (out of print)
6	Diamond (out of print)
7	Desert (out of print)
8	Independence
9	Gabbs (out of print)
10	Sarcobatus and Oasis (out of print)
11	Hualapai Flat
12	Ralston and Stone Cabin
13	Cave
14	Amargosa Desert, Mercury, Rock, Fortymile Canyon, Crater Flat, and Oasis (out of print)
15	Sage Hen, Guano, Swan Lake, Massacre Lake, Long, Macy Flat, Coleman, Mosquito, Warner, and Surprise
16	Dry Lake and Delamar
17	Duck Lake
18	Garden and Coal
19	Middle Reese and Antelope
20	Black Rock Desert, Granite Basin, High Rock Lake, Mud Meadow, and Summit Lake
21	Pahranagat and Pahroc
22	Pueblo, Continental Lake, Virgin, and Gridley Lake
23	Dixie, Stingaree, Fairview, Pleasant, Eastgate, Jersey, and Cowkick
24	Lake
25	Coyote Spring, Kane Springs, and Muddy River Springs
26	Edwards Creek
27	Lower Meadow, Patterson, Spring (near Panaca), Rose, Panaca, Eagle, Clover, and Dry
28	Smith Creek and Ione
29	Grass (near Winnemucca)
30	Monitor, Antelope, Kobeh, and Stevens Basin (out of print)
31	Upper Reese
32	Lovelock
33	Spring (near Ely; out of print)
34	Snake, Hamlin, Antelope, Pleasant, and Ferguson Desert
35	South Fork, Huntington, and Dixie Creek-Tenmile Creek (out of print)
36	Eldorado, Piute, and Colorado River (out of print)
37	Grass (near Austin) and Carico Lake (out of print)
38	Hot Creek, Little Smoky, and Little Fish Lake (out of print)
39	Eagle (Ormsby County)
40	Walker Lake and Rawhide Flats
41	Washoe
42	Steptoe
43	Honey Lake, Warm Springs, Newcomb Lake, Cold Spring, Dry, Lemmon, Red Rock, Spanish Springs, Bedell Flat, Sun, and Antelope
44	Smoke Creek Desert, San Emidio Desert, Pilgrim Flat, Painters Flat, Skedaddle Creek, Dry (near Sand Pass), and Sano
45	Clayton, Stonewall Flat, Alkali Spring, Oriental Wash, Lida, and Grapevine Canyon
46	Mesquite, Ivanpah, Jean Lake, and Hidden
47	Thousand Springs and Grouse Creek
48	Little Owyhee River, South Fork Owyhee River, Independence, Owyhee River, Bruneau River, Jarbidge River, Salmon Falls Creek, and Goose Creek
49	Butte
50	Lower Moapa, Black Mountains, Garnet, Hidden, California Wash, Gold Butte, and Greasewood
51	Virgin River, Tule Desert, and Escalante Desert
52	Columbus, Rhodes, Teels, Adobe, Alkali, Garfield Flat, Huntoon, Mono, Monte Cristo, Queen, Soda Spring
53	Antelope, East Walker area
54	Cactus Flat, Gold Flat, Kawich, Yucca Flat, Frenchman Flat, Papoose Lake, Groom Lake, Tikapoo, Three Lake, Indian Springs, Las Vegas, Buckboard Mesa, Mercury, Rock, Jackass Flat, Crater Flat
55	Granite Springs, Kumiva, Fireball, Bradys Hot Springs Area

REFERENCES CITED

Avent, J. C., 1962, Structure and stratigraphy of the Antelope Range, N.E. White Pine County, Nevada: Unpublished Masters Thesis, University of Washington.

Berge, J. S., 1960, Stratigraphy of the Ferguson Mountain area, Elko County, Nevada: Brigham Young Univ. Research Studies Geology Ser., v. 7, no. 5, 63 p.

Bernstein, Leon, 1964, Salt tolerance of plants: U.S. Dept. Agriculture, Agriculture Inf. Bull. 283, 23 p.

Blue, D. M., 1960, Geology and ore deposits of the Lucin Mining district, Box Elder County, Utah and Elko County, Nev.: Unpublished Masters Thesis, University of Utah.

Eakin, T. E., and others, 1951, Contributions to the hydrology of eastern Nevada: Nevada State Engineer, Water Resources Bull. 12, p. 14-16.

Eakin, T. E., Hughes, J. L., and Moore, D. O., 1967, Water-resources appraisal of Steptoe Valley, White Pine and Elko Counties, Nevada: Nevada Dept. Conserv. and Nat. Resources, Water Resources-Reconn. Ser. Rept. 42, 48 p.

Granger, A. E., Bell, M. M., Simmons, G. C., and Lee, Florence, 1957, Geology and mineral resources of Elko County, Nevada: Nev. Bur. Mines Bull. 54, 190 p.

Hardman, George, 1936, Nevada precipitation and acreages of land by rainfall zones: Nevada Univ. Agr. Expt. Sta. Mimeo. Rept. and Map, 10 p.

_____ 1965, Nevada precipitation map, adapted from map prepared by Hardman and others, 1936: Nevada Univ. Agr. Expt. Sta. Bull. 183, 57 p.

Hood, J. W., and Rush, F. E., 1965, Water-resources appraisal of the Snake Valley area, Nevada and Utah: Nevada Dept. Conserv. and Nat. Resources, Water Resources - Reconn. Ser. Rept. 34, 43 p.

Hood, J. W., and Waddell, K. M., 1969, Hydrologic reconnaissance of Deep Creek Valley, Tooele and Juab Counties, Utah, and Elko and White Pine Counties, Nev.: Utah Dept. of Nat. Resources, Tech. Publication 24, 54 p.

Hose, R. K., and Blake, M. C., Jr., 1970, Geologic map of White Pine County, Nevada: U.S. Geol. Survey open-file map.

Houston, C. E., 1950, Consumptive use of irrigation water by crops in Nevada: Nevada Univ. Bull. 185, 127 p.

Lee, C. H., 1912, An intensive study of the water resources of a part of Owens Valley, California: U.S. Geol. Survey Water-Supply Paper 294, 135 p.

McKee, J. E., and Wolf, H. W., 1963, Water quality criteria, 2d ed.: California Water Quality Control Board Pub. 3-A, 548 p.

Moore, D. O., 1968, Estimating mean runoff in ungaged semiarid areas: Nevada Dept. Conserv. and Nat. Resources, Water Resources Bull. 36, p. 29-39.

National Technical Advisory Committee, 1968, Water quality criteria: Federal Water Pollution Control Adm., 234 p.

Robinson, T. W., 1965, Water use studies utilizing evapotranspiration tanks in Water resources of the Humboldt River Valley near Winnemucca, Nevada: U.S. Geol. Survey Water-Supply Paper 1795, p. 83-104.

Rush, F. E., 1968, Index of hydrographic areas: Nevada Dept. Conserv. and Nat. Resources, Water Resources - Inf. Ser. Rept. 6, 38 p.

_____ 1968, Water-resources appraisal of Thousand Springs Valley, Elko County, Nevada: Nevada Dept. Conserv. and Nat. Resources, Water Resources - Reconn. Ser. Rept. 47, 61 p.

Rush, F. E., and Kazmi, S. A. T., 1965, Water-resources appraisal of Spring Valley, White Pine and Lincoln Counties, Nevada: Nevada Dept. Conserv. and Nat. Resources, Water Resources - Reconn. Ser. Rept. 33, 36 p.

Schaeffer, F. E., Jr., 1961, Geology of the central and southern Silver Island Mountains, Tooele County, Utah, and Elko County, Nev.: Unpublished Doctors Thesis, University of Utah.

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

Snow, G. G., 1960, Plutonic rocks of the Sonoma quadrangle, Nevada: Unpublished Masters Thesis, University of Utah.

Snyder, C. T., 1963, Hydrology of stock-water development in the Ely grazing district, Nevada: U.S. Geol. Survey Water-Supply Paper 1475-L, p. 383-441.

Snyder, C. T., Hardman, George, and Zdenek, F. F., 1964, Pleistocene lakes in the Great Basin: U.S. Geol. Survey, Misc. Geol. Inv. Map I-416.

U.S. Public Health Service, 1962, Drinking water standards, 1962: U.S. Public Health Service Pub. 956, 61 p.

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

Wilcox, L. V., 1955, Classification and use of irrigation waters: U.S. Dept. Agriculture Circ. 969, 19 p.

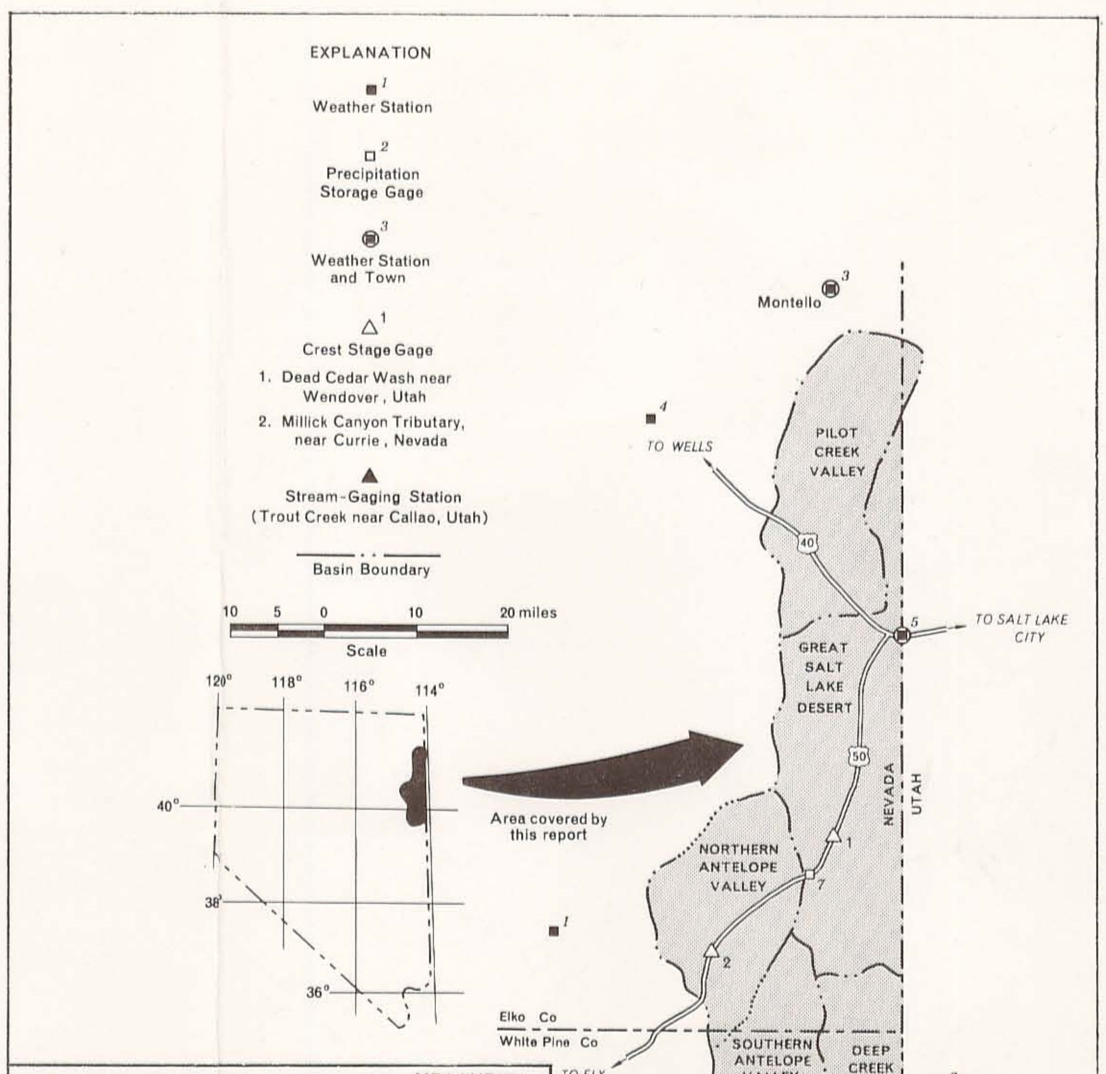
White, W. N., 1932, A method of estimating ground-water supplies based on discharge by plants and evaporation from soil: U.S. Geol. Survey Water-Supply Paper 659-A, p. 1-105.

Worts, G. F., Jr., 1967, The available water supply, in Rush, F. E., and Glancy, P. A., Water-resources appraisal of the Warm Springs-Lemmon Valley area, Washoe County, Nevada: Nevada Dept. Conserv. and Nat. Resources, Water Resources - Reconn. Ser. Rept. 43.

Young, A. A., and Blaney, H. F., 1942, Use of water by native vegetation: California Dept. Public Works, Div. Water Resources Bull. 50, 154 p.

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

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



MAP NUMBER	STATION NAME	APPROXIMATE ALTITUDE (Feet)	MEASURED AVERAGE ANNUAL PRECIPITATION (Inches)
1	Currie Highway Station	5820	7.06
2	Ibapah	5400	10.74
3	Montello	4877	6.09
4	Pequop	6000	10.33
5	Wendover W. B. A. P.	4234	4.74
6	Schellbourne Pass	8150	12.57
7	White Horse Pass	6590	8.36

SUMMARY

The Pilot Creek Valley area covers about 1,780 square miles. It consists of five sparsely populated valleys in eastern Nevada. The valleys are bordered by mountains composed in part of sequences of carbonate sedimentary rocks which may transmit significant interbasin flow where hydraulic gradients are present. Runoff is generally low which suggests that much of the estimated ground-water recharge occurs in the mountains.

Ranching and mining are the principal industries. Irrigation is limited to about 160 acres of hay in Pilot Creek Valley, about 800 acres of meadow along Spring Creek in Deep Creek Valley, and about 40 acres of hay and pasture in Tippett Valley. Samples of well, stream, and spring waters from Antelope Valley, Tippett Valley, Deep Creek Valley, and the northern part of Pilot Creek Valley were generally suitable for irrigation and domestic use, but samples from the southern part of Pilot Creek Valley and from Great Salt Lake Desert were highly mineralized.

The tabulation below summarizes most of the estimated hydrologic quantities for the area.

[All water quantities are average annual volumes, in acre-feet per year, except where noted]

Item	Pilot Creek Valley	Great Salt Lake Desert	Antelope Valley: northern part	Antelope Valley: southern part	Deep Creek Valley	Tippett Valley
Area (square miles)	a 326	507	270	125	208	345
Minimum altitude of valley floor (feet)	4,300	4,250	5,600	5,750	5,450	5,700
Surficial drainage	To Great Salt Lake Desert	To Utah part Great Salt Lake Desert	To Goshute Valley	To northern Antelope Valley	To Utah part Deep Creek Valley	None
Subsurface drainage	do.	do.	To Great Salt Lake Desert	To Great Salt Lake Desert	do.	To Great Salt Lake Desert
Inflow from outside the area	From Goshute Valley	From Goshute Valley	From Goshute Valley	None	None	None
HYDROLOGIC ESTIMATES						
Precipitation	130,000	200,000	120,000	58,000	86,000	160,000
Runoff	740	1,300	200	40	5,000	560
Recharge from precipitation	2,400	4,800	3,200	1,500	2,200	6,900
Inter-valley leakage						
Inflow from Goshute Valley	1,000	1,000	300	--	--	--
Outflow to the Great Salt Lake Desert	300	--	3,400	1,500	--	5,000
Outflow to Spring Valley	--	--	--	--	--	2,000
Evapotranspiration of ground water	4,600	4,700	100	--	1,500	--
Underflow to Utah	--	b 11,300	--	--	700	--
Reconnaissance value of ground-water inflow and outflow	4,500	5,000	3,500	1,500	2,000	7,000
Perennial yield	4,500	5,000	1,700	800	2,000	3,500
Transitional storage reserve[1/]	580,000	370,000	360,000	120,000	125,000	430,000

a. Nevada part only.
b. Includes about 10,000 acre-feet of inter-valley leakage which may flow beneath the Nevada part Great Salt Lake Desert to Utah.

PLATE 1.— HYDROLOGIC MAP OF THE PILOT CREEK VALLEY AREA, ELKO AND WHITE PINE COUNTIES, NEVADA