Exhibit 4513

Few published sources of information about water in Deep Creek valley are available. Meinzer (field notes in files of U. S. Geological Survey, 1908-09) noted a few individual hydrologic data for the valley. The U. S. Geological Survey has measured streamflow in the valley since 1958 (U. S. Geological Survey, 1961-66) and has measured water levels in observation wells since 1962. The U. S. Weather Bureau (1963a and b) and Hardman (1936, map revised 1965) have compiled maps showing annual precipitation; and Bagley, Jeppson, and Milligan (1964) included the Utah part of the valley in their analysis of water yields in Utah. The water resources of adjacent areas are described by Eakin, Maxey, and Robinson (1949)--Goshute-Antelope Valley, Nev.; by Rush and Kazmi (1965)--Spring Valley, Nev.; and by Hood and Rush (1965)--Snake Valley, Utah and Nev. Figure 1 shows the location of these adjacent areas.

Sources of geologic data are more abundant. The main sources consulted were Nolan (1935), Heylmun (1965), and Stokes (1964). These and other sources are given in the list of selected references.

See the appendix for a description of the system of numbering wells and springs and the use of metric units in this report.

PHYSIOGRAPHY

The Deep Creek valley drainage basin is in the Great Basin section of the Basin and Range physiographic province (Fenneman, 1931, 1946), and it drains to the southwestern side of the Great Salt Lake Desert (pl. 1). Deep Creek valley is bounded on the east and south by the Deep Creek Mountains, on the west by the Goshute Mountains, and on the north by low hills and upland flats.

The Deep Creek Mountains, which separate Deep Creek valley from Snake Valley to the southeast, are high and very steep. Haystack Peak has an altitude of 12,101 feet, and the mountains have fairly extensive areas above 10,000 feet. The southwestern end of the J-shaped range has peaks that are above 8,000 feet. The Goshute Mountains, which separate Deep Creek valley from Antelope Valley to the west, are low in relation to the Deep Creek Mountains and reach a maximum altitude of only 7,005 feet within the drainage basin. The drainage divide between Deep Creek valley and the Great Salt Lake Desert crosses peaks that reach 6,000-6,600 feet, except at Ochre Mountain which reaches 7,541 feet.

The east side of the drainage basin slopes more steeply toward the valley than the west side. Level areas in the drainage basin are scarce and are restricted mainly to the valley flat surrounding Deep Creek and its largest tributaries. The entire valley gives a visual impression of recent uplift and currently active erosion.

Deep Creek and part of lower Spring Creek flow in a flood plain or valley flat that has been cut into the adjacent slopes and in places is bounded by low bluffs. The bed of Deep Creek ranges in altitude from about 6,400 feet at the mouth of Johnson Canyon to about 5,100 feet at the head of the gorge that leads out of the valley.

The shapes of the mountains are due partly to geologic structure and partly to the types of rock that are exposed. In the Deep Creek Mountains, the rocks are complexly folded and faulted and have been intruded by masses of granitoid rocks. The present height of the Deep Creek Mountains is due mainly to movement along north-trending faults; but in the mountain area, rocks resistant to erosion stand high above the valley, as at Haystack Peak (pl. 1). The sharp ridges and asymmetric shapes of the mountains in the southern part of the drainage basin are due mainly to differential erosion among the fault blocks and thrust plates.

The rolling uplands and moderate slopes along much of the western drainage divide are due to erosion of the extrusive volcanic rocks that cap part of the uplands. Where the volcanic rocks are faulted, however, and where sedimentary rocks and agglomerate of Tertiary age are exposed, rugged badlands of low relief have resulted from both structural movement and differential erosion.

Debris eroded from the mountains has been deposited in large alluvial fans on the eastern and southern sides of the valley. The fans coalesce laterally and form an undulating slope or alluvial apron. Parts of the alluvial apron are missing on some steep slopes, either because they were removed by later erosion, or possibly because they were never deposited on the steep slopes.

Deep Creek, the master stream in the valley, heads in the Deep Creek Mountains and flows northward. Most flow in the upper part of Deep Creek is from Fifteenmile, Steve's, and Sam's Creeks which head near Haystack Peak. Tributaries along the east side of Deep Creek are short, straight, and steep; tributaries from the west side drain large areas and have dendritic patterns. Although geologic structure influences the drainage pattern throughout the drainage basin, the influence is particularly striking in the vicinity of Spring Creek (Round Valley Creek), the largest western tributary to Deep Creek. Spring Creek heads at a large spring less than 1 mile west of Deep Creek, flows northwestward to Round Valley, thence flows northeastward, and joins Deep Creek near Ibapah, about 16 miles downstream from the headspring (pl. 1).

Water in Deep Creek flows out of the valley through a narrow gorge cut in consolidated rocks, and thence flows north-northeastward to the Great Salt Lake Desert.

CLIMATE

Because of the wide range of altitudes in the Deep Creek valley drainage basin, parts of the basin are semiarid, whereas the uppermost slopes of the Deep Creek Mountains are humid to subalpine. The availability of climatologic data is summarized in table 1, and the locations of climatologic stations are shown in figure 2. Ibapah is the only station in Deep Creek valley itself, but that station has a long record. Most of the stations are at relatively low altitudes (4,237-5,280 feet), but records are available for two storage gages in Nevada at medium (6,590 feet) to high altitudes (8,150 feet). Useful regional interpretations of climatic data are also available, such as the Nevada precipitation map by Hardman (1965), the paper by Peck and Brown (1962) who produced the isohyetal maps of Utah (U. S. Weather Bureau, 1963a and b), and the tables of freezing-temperature probabilities by Ashcroft and Derksen (1963, p. 20-21).

Average annual precipitation in Deep Creek valley is about 8 inches in the western part of the drainage basin and is more than 30 inches in the highest part of the Deep Creek Mountains

The quantity of water that is evaporated from the Deep Creek valley drainage basin under natural conditions cannot be estimated accurately from the available records. Of greater importance to this hydrologic reconnaissance is an estimate of the potential evapotranspiration. This estimate, based on the essentially continuous long-term record of temperatures at Ibapah, is given in the section on potential evapotranspiration.

GEOLOGY

The Deep Creek valley drainage basin is a structural basin of the basin and range type. It was formed by the deformation of consolidated Tertiary and older rocks and is partly filled with unconsolidated or semiconsolidated rocks of Tertiary and Quaternary age. The unconsolidated deposits form the main ground-water reservoir in the valley.

Rocks ranging in age from Precambrian to Permian and from early Tertiary to Holocene (Recent) are exposed or have been penetrated by wells in the basin. The pre-Tertiary rocks consist of consolidated metasedimentary and sedimentary rocks. The consolidated rocks of Tertiary age include both igneous and sedimentary rocks, including appreciable quantities of pyroclastics. The detritus that forms the unconsolidated rocks was derived from the older rocks as the result of weathering processes, including glaciation of the high mountain areas during the Pleistocene Epoch.

The geology shown on plate 1 is based on existing maps, on photogeology, and on a small amount of field checking. The geology in Utah is based on work by Stokes (1964). The geology in the western and northern parts of the drainage basin in Nevada was mapped by photogeologic methods, and the geology in the southern part of the area in Nevada is simplified after sources reported by the Intermountain Association of Petroleum Geologists-Eastern Nevada Geological Society (1960).

For the purpose of this report, geologic units having similar water-bearing characteristics were mapped as single units in order to emphasize the relation of geology to hydrology. Plate 1 shows the distribution of the major rock units and table 4 gives a general description of their lithology and water-bearing characteristics.

WATER RESOURCES

Volume of precipitation

All water in Deep Creek valley is derived from precipitation within the drainage basin. The average annual precipitation ranges from 8 to 30 inches (see "Climate"), and the distribution is shown on the isohyetal map in figure 2.

The volume of precipitation on the valley was estimated from figure 2. The area between each pair of isohyetal lines within the drainage basin was measured with a planimeter, and the area obtained was multiplied by the average or weighted average of the values for the two

Table 4.—Lithology and water-bearing characteristics of rocks in the Deep Creek valley drainage basin

[See pl. 1 for locations of units described]

Age	Lithologic unit	Character of material	Water-bearing properties
Pleistocene(?) and Holocene	Alluvium	Mainly clay and silt, but includes some sand and coarser deposits. Channel fill confined mainly to bottom of Deep Creek valley and mouths of largest tributaries.	Generally low in permeability. Most of these deposits are saturated at or near the land surface and capillary rise conveys ground water to the land surface where the water is discharged by evapotranspiration.
Pleistocene	Glacial outwash	Fine- to coarse-grained deposits in small patches in highest parts of Deep Creek Mountains (not shown on pl. 1) and in about 6 square miles at the foot of the mountains south of the Tooele-Juab County line.	Permeability probably is high in part of the deposits. Outwash at base of mountains is an important recharge area because of the coarseness of some of the deposits and the availability of recharge from perennial streams.
	Alluvium and colluvium	Alluvial fans and aprons along the bases of the high mountain ranges. Coarse-grained gravel and sand interbedded with some silt or clay; sorting near heads of fans is poor but increases downslope and grain size decreases. May underlie young channel fill in the valley. On gentler slopes and in stream valleys on west side of drainage basin deposits are fine to coarse grained. Old channel fill in some tributaries contains interbeds of silt similar to loess which is being dissected.	Coarse-grained deposits in upper slopes of alluvial fans and aprons are the main recharge area for ground water in Deep Creek valley, and have moderate to high permeability. Deposits in lower slopes and probable equivalents that underlie the valley have moderate permeability. Silt similar to loess in tributary channels has low permeability and inhibits recharge along those channels. This unit, together with part of the channel fill in the main valley and probably the youngest part of the sedimentary rocks of Tertiary age, is the main water-bearing formation in Deep Creek valley.
Eocene(?) to Pliocene(?)	Consolidated and semi-consolidated sedimentary rocks and interbedded pyroclastics	Basal red conglomerate, White Sage Formation of Eocene age, claystone, siltstone, sandstone, conglomerate, shale, limestone, and tuff. Contains abundant pyroclastic interbeds in middle part, of Miocene and Pliocene(?) age. Intercalated with extrusive igneous rocks (Tv on pl. 1). Section is structurally distorted and degree of distortion increases downward in section.	Generally low in permeability, but uppermost part of section estimated to be moderate in permeability. Uppermost part is dry on west side of drainage basin but may be part of the section that yields water to wells in Deep Creek valley.
Oligocene to Pliocene(?)	Extrusive igneous rocks and associated pyroclastics	Includes rocks of rhyolitic, andesitic, and basaltic(?) composition. Includes small areas of associated intrusive rocks. In the subsurface, part of these rocks intercalated with sedimentary rocks of Tertiary age (Tn on pl. 1).	Generally low in permeability. Some "lava" locally may have moderate to high permeability. See log of well 26/70-20cl. These rocks are the source of some springs and where saturated probably could yield water to wells.
Late Eocene(?) or Oligocene(?)	Intrusive igneous rocks	Massive intrusion of granitoid rock that now forms the highest peaks in the southern Deep Creek Mountains.	Low in permeability except along joints and fault zones. Inhibits ground-water recharge and therefore enhances runoff from an area where precipitation is greatest in Deep Creek valley drainage basin.
Middle Cambrian to Permian	Consolidated sedimentary and metasedimentary rocks	Siltstone, shale, sandstone, conglomerate, limestone, dolomite, and quartzite.	Bulk permeability is low, but absorbs and transmits some ground-water recharge to valley because of secondary permeability. Repeated fracturing by faulting and folding of the sedimentary section has developed secondary openings which in the carbonate rocks have been enlarged to cavernous zones by solution. Evidence of solution is seen in such locations as the large spring, (C-11-19)19caa-S1, and the oil test, 26/70-20cl. In the oil test permeability at depth in the carbonate rocks is evident from the recovery of reportedly fresh water from drill-stem tests.
Precambrian and Early Cambrian	Consolidated sedimentary and metasedimentary rocks	Mainly argillite and quartzite, includes some sandstone and shale. Lies adjacent to intrusive granitoid rocks. Quartzites are extensively jointed in some locations.	Low in permeability, except along joints and fault zones. Inhibits ground-water recharge and enhances runoff from area of high precipitation.

bounding lines. Averages were weighted downward where the shape of the land surface causes a nonuniform distribution of precipitation. The following summary gives the estimated quantities of precipitation for the various intervals.

Isohyetal interval (inches)	Area (acres)	Volume of precipitation (acre-feet)
Less than 8	200	100
8-12	161,000	134,000
12-16	80,200	89,700
16-20	23,400	33,900
20-25	10,700	19,800
25-30	4,000	9,000
More than 30	1,200	3,100
Totals (rounded)	281,000	290,000

Much of the basin receives small quantities of precipitation, and therefore nearly half of the precipitation does little more than sustain soil moisture in the lowlands. A more detailed analysis of the precipitation distribution is given in the discussion on estimating average annual recharge.

Surface water

General conditions

A part of the precipitation that falls on the mountains of the Deep Creek valley drainage basin runs off as streamflow. On the upper slopes of the valley, much streamflow is lost by infiltration and by evapotranspiration in areas of native and cultivated vegetation. Part of the runoff reaches Deep and Spring Creeks in the valley, where most of the water is diverted for the irrigation of farm and pasture lands. A small amount of surface water intermittently flows out of the valley in Deep Creek.

Most runoff in the drainage basin results from two sources—snowmelt during late winter, spring, and early summer and summer thunderstorms. The melting of snow in the valley produces runoff in Deep Creek during February, March, or April of most years. (See crest-stage gage record in fig. 5.) Snowmelt in the mountains begins generally about the middle of May, and high runoff continues into July. (See records for Sam's, Steve's, and Fifteenmile Creeks in fig. 5.) Floodflow from thunderstorms may occur during the period July-October.

The perennial streams in the Deep Creek valley drainage basin are Deep, Spring, Sam's, Steve's, and Fifteenmile Creeks. Water in these streams is derived directly or indirectly from precipitation mainly at high altitudes; and together with the intermittent flow in other mountain streams, water in the perennial streams constitutes the principal source of surface water for irrigation and ground-water recharge to the valley. Spring Creek is directly sustained by the discharge of a large spring, (C-11-19)19caa-S1, at the south end of the valley; and the flow of Deep Creek at Ibapah is augmented by the discharge of numerous springs in the valley. (See pl. 1.) Sam's, Steve's, and Fifteenmile Creeks all head in the highest parts of the Deep Creek Mountains and are tributary to Deep Creek.

Available records of flow

Sites at which data for flow of surface water have been obtained in the Deep Creek valley drainage basin are shown in figure 1 and are described in table 10. These sites include gaging station 10-1728.93, Deep Creek near Goshute, where a daily record of streamflow has been obtained since the gage was installed in April 1964 (table 5); four sites where flows are measured at intervals of about 1 month (table 11); two crest-stage gages north of Deep Creek valley, where momentary peak gage heights are measured (table 12); and seven other sites, where miscellaneous measurements and estimates were made (table 10).

Table 5.—Summary of mean monthly and mean annual streamflow and annual runoff at gaging station 10-1728.93 Deep Creek near Goshute, 1964-67 (See U. S. Geological Survey, 1964-67)

Location: Lat 39°53'00", long 113°59'50", in SW¼NW¼ sec. 9, T. 11 S., R. 19 W., on left bank 60 ft upstream from masonry diversion structure, three-quarters of a mile north of Goshute, 1.4 miles south of Goshute Indian Reservation boundary, and 10½ miles south of Ibapah.

Drainage area: 43 sq mi, approximately.

Records available: April 1964 to September 1967.

Gage: Water-stage recorder. Altitude of gage is 6,100 ft (from topographic map).

Extremes: Maximum discharge, 32 cfs June 21, 1967 (gage height, 2.52 ft).

Remarks: Records good. Results of discharge measurements, in cubic feet per second, made above diversions on three perennial tributary streams upstream from station, and on ditch carrying return flow from Steve's Creek and Sam's Creek, entering 50 ft below station, are in table 11.

Year	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Mean annual streamflow (cfs)	Annual runoff (acre-feet)
1964	-	-	-	-	-	-	0.55	4.70	11.3	2.33	0.75	0.5	-	-
1965	0.25	0.11	0.21	1.26	0.14	0.01	.05	3.47	12.4	4.08	3.31	2.65	2.33	1,680
1966	2.04	1.86	1.21	.36	.99	1.25	1.33	2.78	.26	0	0	0	1.01	729
1967	0	0	0	0	0	0	0	.74	13.5	5.08	2.27	1.67	1.94	1,400
Average	.76	.66	.47	.54	.38	.42	.48	2.92	9.36	2.87	1.58	1.20	1.8	1,300

Records from the gaging station 10-1728.93 and from the four sites on the streams and ditch tributary to Deep Creek are generally indicative of the quantity of streamflow in the vicinity of Goshute, although flows at the gaging station are affected by upstream diversions.

The crest-stage gages on Deep and Bar Creeks are located so that when flow is recorded at both sites, precipitation is known to have occurred in the northeastern part of Deep Creek valley. When flow is recorded only at the Deep Creek crest-stage gage, the precipitation that caused it is known to have occurred at some point in Deep Creek valley other than the northeastern part.

Runoff

The amount of surface-water runoff that reaches Deep Creek valley from the adjacent uplands cannot be computed directly, because adequate records are not available. An estimate of the average annual runoff in the Utah part of the drainage basin was made from the isogram worksheets described by Bagley, Jeppson, and Milligan (1964, p. 54-56). For the purpose of this study, the runoff in the Nevada part of the drainage basin was estimated by extrapolating isolines of mean annual runoff from the Utah part into Nevada. The extrapolation was based mainly on altitude zones, but it was generally adjusted to account for the effects of the shape and orientation of the mountains on distribution of precipitation.

The estimated average annual runoff from the uplands is 28,000 acre-feet of water (table 6); about 22,000 acre-feet runs off uplands in Utah, and about 6,000 acre-feet runs off uplands in Nevada. About 17,000 of the estimated 28,000 acre-feet of upland runoff infiltrates the ground (see section on recharge) and 11,000 acre-feet flows to the valley as surface water. About half of this surface water reaches the valley in Sam's, Steve's, and Fifteenmile Creeks, and the other half reaches the valley as snowmelt in intermittent streams and as flow in ephemeral streams after thunderstorms.

Table 6.—Estimated average annual runoff from the uplands of the Deep Creek valley drainage basin

Interval between lines of equal runoff (inches)	Runoff (inches)	Area (acres)	Total runoff (acre-feet) (rounded)
1-2	1.5	13,850	1,700
2-4	3	9,190	2,300
4-8	6	19,160	9,600
8-12	10	10,750	9,000
More than 12	13	5,470	5,900
Total (rounded)		58,000	28,000

Outflow from the valley

The estimated average annual surface-water outflow from Deep Creek valley is about 2,000 acre-feet; about 1,000 acre-feet is upland runoff and 1,000 acre-feet is spring discharge, principally along the main channel of Deep Creek. This 2,000 acre-feet represents about 0.7 percent of the annual precipitation on the drainage basin.

Most streamflow is consumed in Deep Creek valley; but after thunderstorms, during periods of peak snowmelt, and during some winters, water flows out of the valley and northward to the Great Salt Lake Desert. Thunderstorms produce large ephemeral flows of a few hours duration; about 1,250 cfs (cubic feet per second) of water flowed past the crest-stage gage on Deep Creek as a result of a thunderstorm in August 1961. Melting snow and ice in the valley also cause a few large peak flows, but the flow is of slightly greater duration than flow from thunderstorms. Average winter outflow generally is on the order of 1 cfs but may be of several months duration in wet years.

Ground water

Source

Ground water in Deep Creek valley is derived entirely from precipitation that falls on the drainage basin, mostly on lands above 6,500 feet. Some of this water is lost directly by evapotranspiration, some infiltrates the consolidated rocks, and some collects in streams that discharge onto the adjacent permeable alluvial aprons. Of the water that infiltrates the rocks, much is lost by evapotranspiration after infiltration and a part eventually reaches the ground-water reservoir in the valley.

Only a small part of the precipitation that falls on lands below 6,500 feet reaches the ground-water reservoir, because the amount of precipitation is generally small and much of the water that infiltrates the soil is held in the soil and subsequently discharged by evapotranspiration. Precipitation on lands below 6,500 feet does recharge the ground-water reservoir when water from intense local storms falls on coarse-grained alluvium (Qag and Qgo on pl. 1), but recharge is least or nonexistent when water falls on fine-grained deposits (Qal and Tu on pl. 1).

Estimated average annual recharge

The annual ground-water recharge to Deep Creek valley was estimated by using a method described by Hood and Waddell (1968, p. 22). This method assumes that a fixed percentage of the average annual precipitation on the drainage basin enters the ground-water reservoir in the valley, and relates the quantity of recharge to the sum of quantities of water originating from precipitation in several isohyetal intervals. The amounts of precipitation were obtained for the isohyetal intervals shown in figure 2 by means of a planimeter, and the percentage of recharge from each of the isohyetal intervals was estimated on the basis of variations in geology and topography. Recharge percentage values are smallest where small quantities of precipitation fell on unconsolidated or semiconsolidated rocks with gentle slopes. Recharge percentages are greater in areas of moderate to high altitude—6,500-9,000 feet—where much of the Deep Creek Mountains is underlain by consolidated sedimentary rocks. The steep surface of these rocks rapidly delivers surface water to the permeable alluvial aprons at the edge of the valley. These rocks, moreover, may absorb a part of the precipitation which then percolates downdip through fractures and solution openings in the rocks and directly recharges the ground-water reservoir in Deep Creek valley. The largest recharge percentages are assigned to the highest parts of the Deep Creek Mountains—9,000-12,000 feet—where precipitation is greatest, the slope of the land surface is greatest, the soils are thin or missing, and the underlying rock is essentially impermeable. This area delivers surface water to recharge areas at the edge of the valley with the least initial loss.

The estimated average annual recharge to Deep Creek valley (table 7) is 17,000 acre-feet, or about 6 percent of the estimated 290,000 acre-feet of average annual precipitation on the drainage basin.

Table 7.--Estimated volumes of precipitation and ground-water recharge in the Deep Creek valley drainage basin

(Areas of precipitation zones measured from geologic and isohyetal maps, pl. 1 and fig. 2. Estimates of average annual precipitation are weighted for steeply sloping mountain areas.)

Precipitation zone (inches)	Area (acres)	Estimated annual precipitation: Feet	Estimated annual precipitation: Acre-feet	Estimated annual recharge: Percentage of precipitation	Estimated annual recharge: Acre-feet
		Areas of Quaternary and Tertiary rocks			
8-12	131,000	0.83	109,000	0	0
12-16	55,900	1.13	63,000	3	1,900
16-20	2,000	1.46	2,900	8	200
20-25	1,000	1.83	1,800	12	200
Subtotal (rounded)	190,000		177,000		2,300
		Areas of Precambrian and Paleozoic consolidated rocks			
Less than 8	200	0.63	130	1	0
8-12	29,800	.83	25,000	2	500
12-13[1]	3,600	1.04	3,700	5	200
12-16	20,700	1.13	23,000	10	2,300
16-20	21,400	1.46	31,000	15	4,700
20-25	9,700	1.83	18,000	20	3,600
25-30	4,000	2.25	9,000	25	2,200
More than 30	1,200	2.61	3,100	30	900
Subtotal (rounded)	91,000		113,000		14,400
Total	281,000		290,000		17,000

[1] Estimated range of precipitation for northwestern part of drainage basin inside 12-16-inch isohyetal interval.

Occurrence and movement

Most of the ground water in Deep Creek valley is under artesian (confined) conditions. Drillers' logs of wells in the valley indicate that the permeable, water-bearing beds are intercalated with thick beds of clay (table 14). Thus, in most wells the water level is above the top of the permeable bed in which the water is found. Most wells in the valley are, therefore, artesian; but only three wells in the valley were known to flow in 1967. (See pl. 1 and table 13.) A few wells tap water under water-table (unconfined) conditions. Such conditions probably are prevalent beneath the alluvial fans adjacent to the valley, but the extent of water-table conditions is not known.

Artesian conditions in the valley are also indicated by the occurrence of springs which yield water that is warmer than the average annual air temperature. Water from Chadman Spring, (C-9-19)13cbc-S1, along the edge of the valley, and water from spring (C-9-19)33adc-S1 in the valley bottom have temperatures of 53° and 58°F (12° and 14°C), respectively, well above the average annual air temperatures of 46°F (8°C) at Ibapah. The relatively high temperature of the spring water indicates that the water probably is discharged from water-bearing beds several hundred feet below the land surface. Similar temperatures of water from shallow wells near the springs may indicate that a part of the well water is upward leakage from deep sources.

A reliable contour map of the ground-water surface in Deep Creek valley cannot be constructed because of the scarcity of well data away from the axis of the valley. Altitudes of the water surface in the wells indicate that the ground-water surface slopes generally northward in the same direction as the valley floor. In general, the ground water moves from the edges of the valley toward the axis and thence northward. The gradient of the ground-water surface along the axis of the valley is about 100 feet per mile, from the south end of the valley to the vicinity of Ibapah. The gradient of the ground-water surface is about 20 feet per mile from Ibapah to the north end of the valley. Although the gentler gradient in the northern part of the valley may be partly related to a thicker aquifer, the available data indicate that the gradient of the ground-water surface north of Ibapah is related to continuous ground-water discharge along the axis of the valley by evapotranspiration and springs.

Ground water in the consolidated rocks in the adjacent mountains can be inferred to move toward the valley because many of the consolidated rocks dip into the valley and because several springs discharge from bedrock. For example, spring (C-11-19)19caa-S1 issues from limestone and sustains the base flow of Spring Creek.

Information on water in the rocks beneath the valley is available only from the Gulf Refining Co. oil test 26/70-2cl. The water level in consolidated carbonate rocks encountered in this test is inferred from drill-stem test data to be about 800 feet below the land surface. The inferred altitude of that water level is 4,700 feet, which is below that of water levels in wells in the valley; but it is above the water level in well (C-7-19)9acc-1 and above the altitude of the floor of the Great Salt Lake Desert, both north of Deep Creek valley. Because there is no other potential discharge area for the deep-seated water in the consolidated rocks in Deep Creek valley, water that passes through the consolidated rocks moves to the area of the Great Salt Lake Desert. The amount of water moving in the rocks probably is small.

Table 10.—Discharge of streams at sites in the Deep Creek valley drainage basin

Site location: See appendix for description of location-numbering system.
Stream and site description: Number is U.S. Geological Survey station number.
Discharge: Measured, unless indicated by e, estimated.

Site location	Stream and site description	Approximate drainage area (square miles)	Date	Discharge (cfs)	Remarks and other data available
(C-7-19)3aac	10-1729. Bar Creek near Ibapah	12	-	See remarks	Crest-stage gage on road to Gold Hill, north of Deep Creek valley. Concurrent flood peaks at this station and station 10-1728.95 indicate runoff in Deep Creek from precipitation in north end of Deep Creek valley. See table 12 for separate listing of discharge measurements and estimates.
3abb	10-1728.95 Deep Creek near Ibapah	460	-	do	Crest-stage gage at bridge on road to Gold Hill, north of Deep Creek valley. Indicates peak flow or lack of flow from Deep Creek valley. See table 12 for separate listing of discharge measurements and estimates.
(C-8-19)4bdd	Deep Creek at bridge at north end of Deep Creek valley	-	1-19-67	0	
			2-21-67	25.0	Current-meter measurement. Water contained pieces of ice from thaw.
			5- 2-67	6.01	Current-meter measurement.
34caa	Deep Creek at temporary diversion dam	-	2-17-66	2e	Temperature is 18°C. See chemical analysis in table 15.
(C-9-19)21acc	Middle Fork Deep Creek, south of county road, southwest of Ibapah	-	8-16-66	3e	Temperature is 19°C. See chemical analysis in table 15.
21bdc	Spring Creek, south of county road, southwest of Ibapah	-	8-16-66	0	
		-	1-19-67	5.74	Current-meter measurement 150 feet above junction with parallel streams.
21dab	East fork of Deep Creek above diversions, south of Ibapah	-	1-19-67	2.07	Current-meter measurement.
			2-21-67	2.75	Do.
21dcb	Middle Fork Deep Creek 0.5 mile south of county road, southwest of Ibapah	-	2-21-67	1.5	Do.
29baa	Spring Creek at ranch road crossing	-	2-21-67	9.38	Do.
(C-11-19)9bcb	Ditch at junction with Deep Creek	-	-	See remarks	Mouth of ditch is 50 feet below station 10-1728.93. Water is return flow of irrigation diversions from Sam's and Steve's Creeks. See table 11 for separate listing of discharge measurements.
9bcb	10-1728.93 Deep Creek near Goshute	43	-	do	Gaging station. See table 5 for summary of record. Flow at this station is affected by diversions from Sam's, Steve's, and Fifteenmile Creeks which supply the base flow at this station.
15adc	Sam's Creek above diversions	-	-	do	See table 11 for separate listing of discharge measurements. See chemical analysis in table 15.
15ccc	Steve's Creek above diversions	-	-	do	Do.
28bad	Fifteenmile Creek above diversions	7.8	-	do	Do.

Table 11.—Records of miscellaneous streamflow measurements near Goshute

(Discharge, in cubic feet per second)

Water year	October		November		December		January		February		March		April		May		June		July		August		September	
	Day	Discharge	Day	Discharge	Day	Discharge	Day	Discharge	Day	Discharge	Day	Discharge	Day	Discharge	Day	Discharge	Day	Discharge	Day	Discharge	Day	Discharge	Day	Discharge
FIFTEENMILE CREEK																								
1964	-	-	-	-	-	-	-	-	-	-	-	-	23	3.29	14	8.12	5 17	8.14 15.6	16	5.86	18	3.19	15	2.68
1965	6	2.80	5	2.71	2 30	2.86 2.21	27	3.48	25	3.82	25	3.66	21	3.37	10 20	3.49 7.20	2 15	10.2 14.5	19	7.16	17	4.89	-	-
1966	14	3.99	16	3.69	6	3.60	4	3.08	3	2.83	29	3.80	29	3.52	19	5.33	1 28	4.17 2.75	27	1.99	16	[illegible]	-	-
1967	4	2.26	8	2.40	14	2.77	19	2.36	-	-	29	2.24	-	-	2 23	3.21 7.39	20	23.3	18	8.16	23	5.26	20	3.39
SAM'S CREEK																								
1964	-	-	-	-	-	-	-	-	-	-	-	-	22	0.62	14	2.65	5 17	4.01 11.2	16	3.23	18	0.75	15	0.36
1965	6	1.35	5	0.42	2 30	1/0.40 1/.26	27	1/0.44	25	1/0.56	25	0.91	21	.93	10 20	1.38 5.62	2	8.60	19	7.82	17	.68	-	-
1966	14	1.00	16	.47	6	.25	4	.29	3	0	1 29	.17 .30	5	1.14	19	2.38	1 28	3.70 1.18	27	[illegible]	16	[illegible]	-	
1967	4	.34	8	.30	14	.30	19	.21	-	-	29	.22	-	-	2 23	.77 6.92	20	19.2	18	[illegible]	23	[illegible]	20	.57
STEVE'S CREEK																								
1964	-	-	-	-	-	-	-	-	-	-	-	-	22	1.24	14	20.9	[illegible] 17	7.30 7.11	16	4.09	18	1.53	15	1.69
1965	6	1.37	5	1.33	2 30	1.22 1/.88	27	1/1.17	25	1.15	25	1.76	21	1.16	10	1.60	2 17	3.82 6.69	19	4.78	19	3.23	-	-
1966	14	2.31	16	1.71	6	1.63	4	1.65	3	1.31	2 29	1.49 1.24	29	1.42	19	1.98	1 28	1.91 1.53	27	1.27	16	.93	-	-
1967	4	1.08	8	.84	14	.64	19	.96	-	-	29	.83	-	-	2 23	.93 3.16	20	8.46	18	6.61	23	2.74	20	1.86
DITCH AT JUNCTION WITH DEEP CREEK																								
1964	-	-	-	-	-	-	-	-	-	-	-	-	23	0.55	14	1.61	5 17	6.40 8.45	-	-	18	0	15	0.12
1965	6	0.44	-	-	2	0.57	27	0.92	25	0.64	25	0	21	1.06	10 20	1.56 5.06	2 15 29	7.50 5.20 1.82	19	6.33	19	.96	15	2.40
1966	14	1.98	16	1.23	6	1.20	4	1.15	3	.95	2 29	1.16 .66	29	1.05	19	3.22	1 28	1.76 1.52	27	.50				-
1967	4	.76	8	.22	14	.33	19	.37	21	.99	29	.37	-	-	2 23	.47 4.86	20	9.50	18	4.56	23	1.55	20	.40

1/ Stage-discharge relation affected by ice.

Table 12.—Discharges obtained from crest-stage gage records for Deep Creek near Ibapah (10-1728.95) and Bar Creek near Ibapah (10-1729.), 1959-67

Discharge: Measured unless indicated by e, estimated.

Inspection date	DEEP CREEK Probable date of peak	DEEP CREEK Discharge (cfs)	BAR CREEK Probable date of peak	BAR CREEK Discharge (cfs)	Remarks
Dec. 8, 1958	-	-	-	-	Stations established.
Mar. 4, 1959	-	0	-	0	
Apr. 2	-	2e	-	0	
July 21	-	0	-	0	
Aug. 6	July 24, 1959	20	July 24, 1959	15	
Aug. 20	-	0	-	0	
Aug. 25	Aug. 20	21e	Aug. 20	80e	
Sept. 15	-	0	-	10-15e	
Oct. 12	-	0	-	0	
Apr. 26, 1960	Apr. 23, 1960	81	-	0	
June 2	-	0	-	0	
July 6	-	0	June 10, 1960	120	
Aug. 4	See remarks	10e	Aug. 1	5e	Peak occurred during previous week.
Aug. 30	-	0	-	0	
Sept. 20	See remarks	5e	Sept. 2	1-5	Peak occurred during previous week.
Aug. 8, 1961	-	0	-	0	
Aug. 15	Aug. 15, 1961	2.32	-	0	Current-meter measurement.
Aug. 30	Aug. 25	1,250	Aug. 25, 1961	2,690	Peak discharge determined indirectly by slope-area method.
Sept. 27	Sept.18	80	Sept.18	120	From rating curve.
Oct. 25	-	0	-	0	
Feb. 15, 1962	Feb. 14, 1962	175	-	0	
Apr. 2	Mar. 30	1.5e	-	0	
Apr. 19	Apr. 19	.3e	-	0	
Oct. 17	-	0	-	0	
Feb. 13, 1963	Feb. 9, 1963	47	-	0	
	Feb. 19	9.96	-	0	Current-meter measurement.
Apr. 23	See remarks	15e	-	0	Date of peak unknown.
May 14	-	0	-	0	
May 29	May 25	45	-	0	
June 13	June 10	70	June 10, 1963	41e	
	June 13	40e	-	-	
July 9	June 16	60	-	0	
	July 9	.45e	-	-	
Aug. 29	-	0	-	2e	
Sept. 19	-	0	Sept. 5	40e	
Nov. 13	-	0	-	0	
Apr. 22, 1964	Apr. 5 to Apr. 10, 1964	25e	-	0	
	Apr. 22	5.50	-	-	Current-meter measurement.
May 14	May 14	3e	-	0	
June 23	June 17	57e	June 17, 1964	8e	
	June 23	12.3	-	-	
Aug. 18	-	0	-	0	
May 16, 1965	See remarks	1.8e	-	0	Date of peak unknown.
June 29	June 10, 1965	50e	June 26, 1965	24e	
	June 29	8.4e	-	-	
Aug. 19	Aug. 17	84e	Aug. 17	75e	
May 19, 1966	Mar. 10, 1966	88	-	0	
July 27	-	0	-	0	
Oct. 11	Oct. 2	173e	Oct. 2, 1966	187e	
Nov. 7	-	0	-	0	
Mar. 29, 1967	Mar. 29, 1967	4	-	0	Flowing.
May 2	May 2	.1	-	0	
May 23	-	See remarks	-	0	Same flow since May 2, 1967.
July 18	July 18	3e	June 13-14, 1967	14.2	
Aug. 22	-	-	-	0	
Sept. 20	-	0	-	2e	

Table 13.—Records of selected wells and spring in and near the Deep Creek valley drainage basin

Location No.: See appendix for description of well- and spring-numbering system.
State Engineer No.: A, application number; C, claim number; WDR, well driller's report number.
Type of well: C, cable tool; D, dug; H, hydraulic rotary; J, jetted; Z, drilled, but method not known.
Depth of well: Reported by owner or driller.
Water-bearing zone: Character of material - C, conglomerate; D, dolomite; G, gravel; L, limestone; S, sand; U, unconsolidated sediments (sand, gravel, and clay).
Water level: Measured depths given in tenths of feet; reported depths given in feet; F, flows.
Method of lift and type of power: First letter - C, centrifugal pump; F, flows; J, jet pump; N, none; P, piston pump (plunger or cylinder); T, turbine pump. Second letter - E, electric; D, diesel; G, gasoline. Number in parentheses indicates horsepower.
Well performance: Yield - B, bailed (rate reported by driller); E, estimated; M, measured; R, reported by driller, owner, or operator.
Use of water: H, domestic; I, irrigation; S, stock; U, unused.
Remarks and other data available: C, chemical analysis in table 16; H, hydrograph of water levels in figure 6; L, driller's log of well in table 14; Perf., casing perforated; Temp., temperature of water in degrees Celsius (see appendix for explanation of conversion to degrees Fahrenheit).

Location	Owner or name	State Engineer No.	Year drilled	Type of well	Depth of well (feet)	Diameter of well (inches)	Water-bearing zone: Depth to top (feet)	Water-bearing zone: Thickness (feet)	Water-bearing zone: Character of material	Altitude above sea level (feet)	Water level: Above(+) or below(-) land-surface datum (feet)	Water level: Date of measurement	Method of lift and type of power	Well performance: Yield (gpm)	Well performance: Drawdown (feet)	Use of water	Remarks and other data available
UTAH																	
(C-7-19)																	
9acc-1	U.S. Bureau of Land Management	A-13071	1935	C	605	6	565	40	S,G	5,990	-500	[illegible]	[illegible]	20R	-	S	In canyon of Deep Creek between Deep Creek valley and Great Salt Lake Desert. Cased to 605 ft, perforated. L.
11bca-1	do	A-33777	1961	C	300	-	-	-	-	5,050	-	-	N		-	U	North of Deep Creek valley. Reported dry and abandoned. Known as Oswald well. L.
(C-8-19)																	
9daa-1	Jay Hicks	A-18189 WDR-4803	1946	C	306	6	54 101 195	2 5 111	G G,S C	5,230	+7.1	10-25-[illegible]	F	40R	-	H,I,S	Cased to [illegible] ft. Perf. 190-203 ft. C,H,L.
34baa-1	W. H. Parrish	C-21062	1865	J	350	2	-	-	-	5,175	-	-	F	[illegible]	-	H,S	Temp. [illegible]
(C-9-19)																	
1cdc-S1	North Spring	-	-	-	-	-	-	-	G(?)	5,490	-	-	-	[illegible]	-	S	Spring improved by U.S. Bureau of Land Management. C.
3bac-1	F. F. Snively	A-31138	-	-	43	6	-	-	-	5,190	-	-	-	-	-	S	
9add-1	S. H. Nicholes	A-16160 WDR-6738	1946	C	535	[illegible]	367	30	S,G	5,230	-16	[illegible]	[illegible]	[illegible]	-	H,S	Cased to 392 ft. Perf. 367-392 ft. Temp. 11. C,L.
12bdd-S1	Secret Spring	-	-	-	-	-	-	-	G(?)	5,470	-		-	1.1M	-	S	Spring improved by U.S. Bureau of Land Management. Temp. 15. C.
13cbc-S1	Chadman Spring	-	-	-	-	-	-	-	G(?)	5,530	-	-	-	1.0M	-	S	Spring improved by U.S. Bureau of Land Management. Temp. 14. C.
15ccb-1	Carl Hall	A-17966 WDR-4807	1946	C	65	6	55	10	S,G	5,280	-14	[illegible]	-	-	-	H,I,S	Cased to 65 ft. Perf. 55-65 ft. L.
16dca-1	Mrs. Wade Parrish	A-25966 WDR-11700	1955	C	58	6	37 50	5 5	G G	5,270	-8.[illegible]	[illegible]-62	-	-	-	H,S	Cased to 58 ft. Perf. 40-55 ft. H,L
16dda-1	W. P. Calloway	A-26216 WDR-11978	1955	C	70	6	50 65	5 5	G G	5,280	-14	[illegible]	C,E	20R	-	H,I,S	Well equipped with two pumps. Cased to 70 ft. Perf. 50-70 ft. Temp. 12. C,L.
16ddc-1	K. P. Bateman	-	-	-	-	-	-	-	-	-	-	-	P,E	5M	-	H,S	Temp. [illegible]
21dac-1	Kenneth Snively	A-26327 WDR-11977	1955	C	50	6	40	10	G	5,290	-2	[illegible]	-	60R	11	H,I,S	Cased to 50 ft. Perf. 40-50 ft. L.
21dcc-1	F. F. Snively	A-17727 WDR-4681	1946	C	70	6	46 56	4 14	S,G S,G	5,300	-14	[illegible]-46	-	17M	-	H,S	Cased to 70 ft. Perf. 50-70 ft. Temp. [illegible]. C,L.
22bac-1	Ibapah Cemetery	A-25937 WDR-11128	1954	C	100	6	27 50 64	1 2 2	S S S	5,315	-15	[illegible]-55	P,G	50R	4	I	Cased to [illegible] ft. Perf. 50-70 ft. Temp. [illegible]. C,L.
22bbb-1	Mathew Chastian	-	-	D	-	-	-	-	-	5,290	-13.9	10-25-[illegible]	N	-	-	U	H.
23daa-S1	Christiansen Spring	-	-	-	-	-	-	-	-	5,595	-	-	-	10E	-	H,S	Temp. 13. [illegible]
[illegible]ddc-S1	Greasewood Spring	-	-	-	-	-	-	-	-	5,570	-	-	-	[illegible]	-	S	Spring improved by U.S. Bureau of Land Management. Temp. 12. C.
[illegible]bdd-1	S. W. Cook	-	-	D	45	36	-	-	-	5,360	-	-	P,[illegible]	[illegible]	-	H,S	Cased to [illegible] ft. Temp. 11. C.
[illegible]dac-S1	Unnamed spring	-	-	-	-	-	-	-	-	5,390	-	-	-	-	-	I,S	Large seepage area at apparent head of Middle Fork Deep Creek; at west side of 50-ft diameter pool. Temp. 12. C.
[illegible]bad-1	S. W. Cook	A-31637	1960	C	147	12	24 55 112 120 143	2 2 5 3 4	G G G G S,G	5,600	F	[illegible]	[illegible]	[illegible]R [illegible]M	37	I,S	Cased to 147 ft. Perf. 112-117, 120-123, 143-147 ft. Yield and drawdown reported after 8 hours of pumping. Temp. [illegible]. C,L.
[illegible]ccd-1	Goshute Day School	-	1936	Z	80	-	-	-	-	5,500	-	-	T[illegible],D	-	-	H	C.
(C-10-18)																	
7ddc-S1	Gold Spring	A-8932-1	-	-	-	-	-	-	-	7,100	-	-	-	10E	-	S	2½ x 3-ft pond; no improvements. Temp. 9. C.
(C-10-19)																	
[illegible]aaa-S1	Goshute Indian Reservation	-	-	-	-	-	-	-	-	5,500	-	-	N	-	-	I,S?	In Deep Creek bottom, 0.1 mile west of road.
22bbd-1	W. A. Weaver	A-17329 WDR-4459	1946	C	114	6	78 87 107	4 13 7	G G G	5,800	[illegible]	[illegible]	[illegible]	60M	-	H	Cased to 114 ft. Perf. 75-114 ft. Water reported to be corrosive. Temp. 13. C,L.
[illegible]bcd-1	do	A-23505 WDR-11125	1954	C	130	12	86 100 115	14 3 15	G,S S G	5,790	-75	[illegible]	-	600R	8	H,I,S	Cased to 130 ft. Perf. 74-125 ft. L.
[illegible]caa-1	C. M. Hibbard	A-14871 WDR-2837	1942	Z	131	4	120	11	S,C	5,800	-85	7-[illegible]	-	51	0	S	Drilled in old [illegible]-ft dug well. Cased to 131 ft, open end. L.
[illegible]dac-1	Merlin Johnson	A-25959	1961	C	195	12	-	-	G	5,850	-130	[illegible]-61	-	900R	8	I	Cased to [illegible] ft. Perf. 150-195 ft. Yield and drawdown measured after [illegible] hours of pumping. L.
(C-11-19)																	
[illegible]caa-S1	Goshute Indian Reservation	-	-	-		-	-	-	L(?)	6,150	-	-	-	-	-	I,S	Spring at head of Spring Creek. Flow from [illegible] north-northwestward [illegible] Valley Creek. Apparently discharges several [illegible] feet per second.

Table 13.—Continued

Location	Owner or name	State Engineer No.	Year drilled	Type of well	Depth of well (feet)	Diameter of well (inches)	Water-bearing zone: Depth to top (feet)	Water-bearing zone: Thickness (feet)	Water-bearing zone: Character of material	Altitude above sea level (feet)	Water level: Above(+) or below(-) land-surface datum (feet)	Water level: Date of measurement	Method of lift and type of power	Well performance: Yield (gpm)	Well performance: Drawdown (feet)	Use of water	Remarks and other data available
									NEVADA								
23/69-13d1	Goshute Indian Reservation	-	-	Z	-	-	-	-	-	6,000	-	-	C	-	-	S	Windmill appears to have been inoperative for years.
24/69-27b1	do	-	-	-	-	-	-	-	-	5,810	-	-	-	-	-	S	
25/70-6d1	U. S. Bureau of Land Management	8135	1964	C	210	-	-	-	-	5,710	-	-	N	-	-	U	Well reported as dry hole. L.
8d1	do	8218	1964	C	240	-	-	-	-	5,700	-	-	N	-	-	U	Do.
34c1	S. [illegible] Sheldon	-	-	Z	100-200	-	-	-	-	5,460	-	-	J,E	-	-	H,S	Well equipped with two pumps. C.
26/70-20c1	U.S. Bureau of Land Management	-	1954	H	4,502	-	3,540 4,135	135 215	D D	5,504	-780 (See remarks)	-	N	-	-	U	Oil test. Gulf Refining Co. No. 1D, Dennison-Federal lease. Driller reported "fresh" water in zones tested. Water level in deeper zone is approximated from drill-stem test data. L.