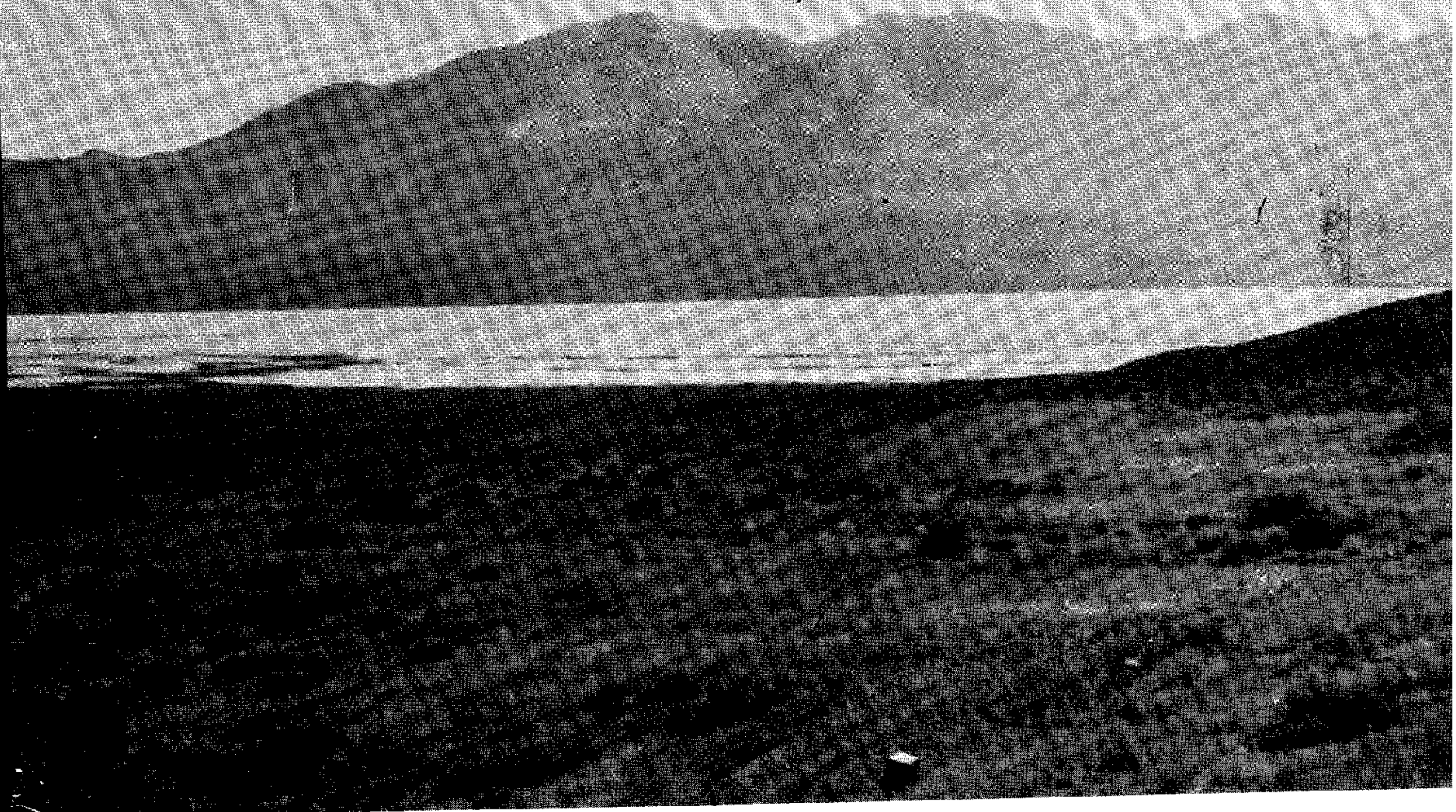
STATE OF NEVADA
DEPARTMENT OF CONSERVATION AND NATURAL RESOURCES
Carson City



View of Fairview Valley. Labou Flat is in the foreground; Fairview Peak is in the background.

GROUND-WATER RESOURCES – RECONNAISSANCE SERIES

REPORT 23

A BRIEF APPRAISAL OF THE GROUND-WATER HYDROLOGY OF THE DIXIE-FAIRVIEW VALLEY AREA, NEVADA

By
PHILIP COHEN, Geologist
and
D. E. EVERETT, Chemist

Price $1.00

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

NOVEMBER 1963

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FOREWORD

This report, the 23rd in the series of reconnaissance ground-water studies which were initiated by action of the Legislature in 1960, deals with the underground water resources of the Dixie-Fairview Valley area. The area lies largely in Churchill County but extends into Lander and Eureka Counties.

The present appraisal was made by Philip Cohen, geologist, and D. E. Everett, chemist, U. S. Geological Survey.

These reconnaissance ground-water resources surveys make available pertinent information of great and immediate value to many State and Federal agencies. 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 type studies are timely and adequately meet the immediate needs for information on the ground-water resources of the areas covered by the reports.

Hugh A. Shamberger
Director
Department of Conservation
and Natural Resources

November 1963

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A BRIEF APPRAISAL OF THE GROUND-WATER HYDROLOGY OF THE DIXIE-FAIRVIEW VALLEY AREA, NEVADA

by

Philip Cohen and D. E. Everett

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SUMMARY

The Dixie-Fairview Valley area includes seven valleys in west-central Nevada: Fairview Valley which is a topographically closed basin, Dixie Valley, and five smaller valleys that drain into Dixie Valley--Jersey, Pleasant, Eastgate, Cowkick, and Stingaree Valleys. All are hydrologically connected with Dixie Valley in the subsurface. Thus, the seven valleys form a closed hydrologic unit.

Precipitation within the topographic drainage basin is the source of virtually all the ground water in the project area. Most of the ground water is stored in and transmitted through upper Tertiary and Quaternary sedimentary deposits that are at least 1,000 feet thick. The consolidated rocks, which range in age from Paleozoic to Cenozoic and which border and underlie the unconsolidated deposits, are structurally deformed, highly fractured, and have little or no interstitial permeability. Locally, ground water moves through the fractures and through solution openings.

The estimated average annual natural recharge to and discharge from the ground-water reservoir of the entire project area is on the order of 18,000 acre-feet. Precipitation in the Dixie Valley drainage basin is the source of about 40 percent of the average annual recharge, and precipitation in the Eastgate, Cowkick, and Stingaree Valley drainage basins is the source of about 40 percent of the average annual recharge. Most of the remainder of the recharge, about 3,000 acre-feet per year, occurs in Pleasant Valley. Recharge is only a few hundred acre-feet per year in Jersey and Fairview Valleys.

About 90 percent of the estimated average annual discharge of 18,000 acre-feet in the project area occurs in Dixie Valley largely as a result of transpiration by phreatophytes and evaporation from bare soil in the Humboldt Salt Marsh -- a playa in the valley lowlands. The imbalance between recharge derived from precipitation and discharge by evapotranspiration in Dixie Valley occurs because of subsurface ground-water inflow to Dixie Valley from the other valleys in the project area.

The estimated perennial yield of the entire project area is on the order of 18,000 acre-feet per year. If ground-water development is restricted in Fairview, Eastgate, Cowkick, and Jersey Valleys, so as not to intercept subsurface inflow to Dixie Valley, the estimated perennially available supply of ground water in Dixie Valley, or the net pumpage that the valley could sustain without eventually depleting the ground-water reservoir, is on the order of 15,000 acre-feet per year.

All but one of the nine ground-water samples obtained during the study were chemically suitable for irrigation. However, some of the samples contained fluoride in excess of the amount recommended by the U.S. Public Health Service for drinking purposes.

INTRODUCTION

Purpose and Scope of the Study:

Prior to 1960 information regarding the occurrence, quantity, and quality of ground water was available for only a few of the approximately 100 valleys in Nevada; little was known about the ground-water resources of most of the State. To obtain preliminary information needed to help effectively develop and manage the ground-water resources of the State, the Nevada State Legislature enacted a statute (Chapt. 181, Stats. 1960) providing for reconnaissance ground-water studies to be conducted by the United States Geological Survey in cooperation with the Nevada Department of Conservation and Natural Resources. These studies were intended to supplement the established cooperative program between the two agencies.

The objectives of the reconnaissance studies and, accordingly, the objectives of the study described in this report are to provide reconnaissance appraisals of (a) the source, occurrence, movement, and storage of ground water, (b) the estimated average annual recharge to and discharge from the ground-water reservoir, (c) the chemical quality of the ground water and (d) the perennial yield of the basin.

This is the 23rd report prepared as a result of the reconnaissance studies (fig. 1). Most of the field work was done in June and July of 1963. It consisted of a brief study of the general geologic features of the area including the hydrologic properties of the rocks, an inventory of wells and springs, reconnaissance mapping of areas of evapotranspiration of ground water, and collection of water samples for chemical analyses. The study was made under the direction of G. F. Worts, Jr., district chief in charge of hydrologic studies by the U.S. Geological Survey in Nevada.

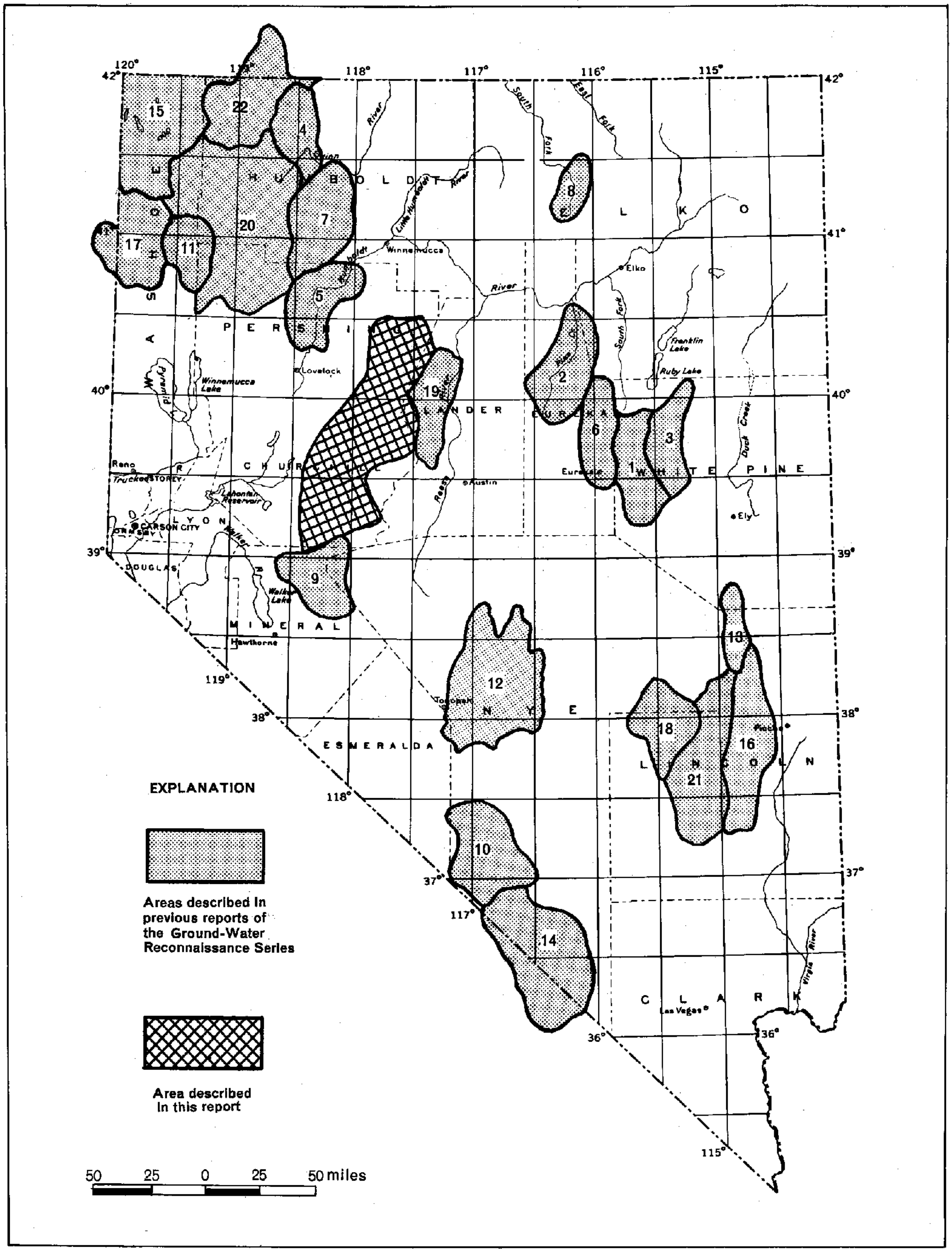

Figure 1. Map of Nevada showing areas described in previous reports of the ground-water reconnaissance series and the area described in this report

Location and General Geographic Features:

The Dixie-Fairview Valley area is in west-central Nevada and is approximately enclosed by latitude 39°00' N. and 40°30' N., and longitude 117°30' W. and 118°25' W. It is largely in Churchill County; however, the northern part is in Pershing and Lander Counties and the extreme southern part is in Mineral County (fig. 1). The project area includes the drainage basins of Fairview Valley to the south, Dixie Valley to the north, and five smaller basins tributary to Dixie Valley -- Pleasant and Jersey Valleys which drain southward into Dixie Valley, and Eastgate, Cowkick, and Stingaree Valleys which drain westward into Dixie Valley. The project area is about 100 miles long and ranges from about 10 to 30 miles in width; its total area is about 2,360 square miles.

Principal access to the area is by U.S. Highway 50, which passes eastward through Fairview, Stingaree, Cowkick, and East Gate Valleys. A north-trending graded road joins Highway 50 about 5 miles east of Frenchman Station and provides the principal access to Dixie Valley. A graded south-trending road joining Highway 50 about 2 miles west of Frenchman Station provides access to Fairview Valley. Numerous unimproved roads and trails cross the area.

Less than 100 people live in the project area. Most earn their living by raising cattle. Numerous mines are in the area, but all are abandoned. Part of Fairview Valley is used as a U.S. Navy bombing range, and the Atomic Energy Commission is conducting experiments in the mountains bordering the west side of Fairview Valley.

Less than 1,000 acres were irrigated in 1963. Wells and springs supplied all the irrigation water. Forage crops, largely alfalfa and meadow grasses, are the principal crops.

Topography:

The Dixie-Fairview Valley area is a northeast-trending trough bordered by elongate mountain ranges. The trough is bounded on the west by the East, Stillwater, and Sand Springs Ranges, and on the east by the Tobin Range, the Fish Creek, Augusta, Clan Alpine, and Desatoya Mountains, Fairview Peak, and Slate Mountain. The south end of the trough is bounded by a low range of hills joining the Sand Springs Range and Slate Mountain. An alluvial divide at an altitude of about 4,900 feet connects the East and Tobin Ranges and forms the northern boundary of Pleasant Valley; an alluvial divide also at an altitude of about 4,900 feet connects the Tobin Range and the Fish Creek Mountains and forms the northern boundary of Jersey Valley.

The highest peak in the area is in the Clan Alpine Mountains and is at an altitude of about 9,990 feet. Peaks in the Tobin Range and the Desatoya Mountains also are more than 9,000 feet above sea level. Several other peaks are more than 8,000 feet above sea level. The lowest point in the area, which is also the lowest point in northern Nevada, is the Humboldt Salt Marsh, a playa in Dixie Valley; its altitude is about 3,360 feet. Accordingly, the maximum relief of the area is about 6,600 feet.

Fairview Valley is topographically separated from Dixie Valley by a southeast trending alluvial divide which joins the Stillwater Range and Fairview peak. Nearly 90 percent of the total project area drains into Dixie Valley; the remainder drains into Fairview Valley.

Previous Work:

The geology of most of the project area north of latitude 40°00' N. was mapped by Muller, Ferguson, and Roberts (1951) who emphasized the stratigraphy and structure of the consolidated rocks of the mountains. Axlerod (1956) described the stratigraphy and paleontology of the Tertiary rocks in a small portion of Eastgate Valley.

Earthquakes in the area have been described by several writers including Jones (1915). More recently an entire edition of the Bulletin of the Seismological Society of America (October, 1957) described various aspects of earthquake activity in the area. Of special interest is a paper by Zones (1957, p. 387-396) describing changes in hydrologic conditions resulting from two earthquakes in December 1954.

The results of recently completed geologic, geophysical, and hydrologic studies in and adjacent to Fairview Valley are described in a report prepared by the University of Nevada (1962).

Acknowledgments:

The writers are grateful to the residents of the project area who permitted access to their property and supplied information regarding wells, springs, and irrigated acreage. Personnel of the U.S. Bureau of Land Management were most helpful in supplying preliminary range-forage data and information regarding proposed development in the area. The Nevada Desert Research Institute supplied data on the hydrology and geology of parts of Fairview Valley.

Numbering System for Wells and Springs:

The numbering system for wells and springs used in this report is based on the rectangular subdivisions of the public lands referenced to the Mount Diablo base line and meridian. It consists of three units; the first is the township north of the base line. The second unit, separated from the first by a slant, is the range east of the meridian. The third unit is separated from the second by a dash and designates the section number. The section number is followed by a letter that indicates the quarter section; the letters a, b, c, and d designating the northeast, northwest, southeast, and southwest quarters, respectively. Following the letter, a number indicates the order in which the well or spring was recorded within the 160-acre tract. For example, well 16/35-2bl is the first well recorded in the northwest quarter of sec. 2, T. 16 N., R. 35 E., Mount Diablo base line and meridian.

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

CLIMATE

The dominant factors that control the climate of the area are the Sierra Nevada, about 100 miles to the west, and the prevailing eastward flow of air. Warm moist air masses moving eastward from the Pacific Ocean are forced aloft by the Sierra Nevada, causing large amounts of precipitation in the mountains. As a result, air masses moving into the project area normally are deficient in moisture, and the climate of the valley lowlands is arid. Orographic effects similar to those of the Sierra Nevada but of a lesser magnitude cause the climate of the mountains in the study area to be subhumid.

Precipitation data are available for only one site in the project area, Eastgate, and for only 7 years. These data and long-term data obtained at Fallon about 25 miles to the west and at Lovelock about 35 miles to the northwest are listed in table 1. Although it is hazardous to attempt to compare the short-term data for Eastgate with those for Lovelock and Fallon, the data indicate the general precipitation pattern in Nevada--the station at the lowest altitude recorded the least precipitation. Precipitation in the topographically lowest part of Dixie Valley probably averages less than 5 inches per year, and that on the highest peaks may average more than 20 inches per year. On the valley lowlands most of the precipitation occurs in the spring and summer as relatively intense thunderstorms; in the mountains most of it occurs in the winter as snow.

The climate of the project area is further characterized by extreme diurnal temperature fluctuations, commonly more than 50°F, which largely are the result of the relatively high altitude and the extreme aridity. Table 2 lists temperature data for Eastgate, Fallon, and Lovelock. Based on these data, the estimated average annual temperature in the valley lowlands of the project area is about 52°F. Maximum temperaturs, commonly more than 100°F, occur in July and August; minimum temperatures of less than zero occur in the winter.

Table 1.--Average monthly and annual precipitation, in inches, at three stations near Dixie Valley, Nev. (from published records of the U.S. Weather Bureau)

Station	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
Eastgate 1/	0.48	0.39	0.70	0.37	0.90	0.54	0.39	0.65	0.74	0.43	0.70	0.52	6.81
Fallon 2/	.57	.70	.56	.50	.63	.42	.17	.12	.20	.49	.35	.67	5.38
Lovelock 3/	.81	.75	.55	.52	.48	.61	.13	.14	.20	.53	.42	.64	5.78

1/ Altitude 5,020 feet. In sec. 25, T. 17 N., R. 36 E. Period of record 1949-1950, 1957-1961.
2/ Altitude 3,965 feet. In sec. 6, T. 18 N., R. 29 E., 25 miles west of project area. Period of record 1908-1962
3/ Altitude 3,977 feet. In sec. 26, T. 27 N., R. 31 E., 35 miles northwest of project area. Period of record 1908-1962.

Table 2.--Average monthly and annual temperatures, in degrees Fahrenheit, at three stations near Dixie Valley, Nevada (from published records of the U.S. Weather Bu.)

Station	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
Eastgate 1/	32.4	38.9	42.2	49.0	56.3	68.2	64.1	70.6	62.8	51.4	39.4	35.5	51.7
Fallon 2/	30.4	36.0	42.5	50.6	57.5	65.3	72.8	70.3	62.4	52.0	39.5	32.7	51.0
Lovelock 3/	30.2	35.8	42.5	50.9	58.7	66.6	75.1	72.5	64.5	53.1	40.0	32.2	51.8

1/ Period of Record 1957-1961. 2/ Period of record 1931-1962. 3/ Period of record 1931-1962.

The length of the growing season varies from year to year and also depends on the type of crop. Some crops can survive one or more light frosts, others cannot. Moreover, because of orographic effects, the growing season probably varies from place to place within the valley. According to Houston (1950), the average growing season near Lovelock is 128 days (May 18 to September 23), and that near Fallon is 127 days (May 20 to September 24). According to residents in Dixie Valley, the growing season near the topographically lowest part of the valley averaged nearly 220 days in the past few years, allowing for four cuttings of alfalfa. This is not surprising considering that the floor of Dixie Valley is nearly 700 feet lower than the valley floor in the Fallon and Lovelock areas.

Evaporation-pan data are not available for the project area. Data obtained near Fallon and Lovelock and data listed by Kohler, Nordenson, and Baker (1959) suggest that the average annual rate of evaporation from free-water surfaces in the valley lowlands may be on the order of 4 to 5 feet or about 10 times the average annual precipitation.

THE HYDROGEOLOGIC ENVIRONMENT

The distribution and the physical and chemical characteristics of the consolidated and unconsolidated rocks of the area are major factors controlling the source, occurrence, movement, and chemical quality of the ground water. Accordingly, these aspects of the hydrogeologic environment are described briefly in this section of the report. In addition, the formation of the hydrogeologic environment is summarized.

Geomorphic Features:

The Dixie-Fairview Valley area is in the Great Basin Section of the Basin and Range physiographic province. This section of the province is characterized by elongate north-trending mountains and intervening valleys of approximately equal width. It is called the Great Basin because it is a closed hydrologic unit in which almost all the water originates as precipitation and ultimately is discharged by evapotranspiration.

Mountains: The ranges in the project area are deeply dissected, complex, fault-block mountains composed of igneous, metamorphic, and sedimentary rocks, and are characterized by complex internal folding and thrust-faulting. However, the overall aspect of the present topographic relief largely is a result of relative uplift and gentle warping associated with movement along roughly north-trending normal faults. The term relative uplift is used because it is uncertain whether the mountains have been raised or whether the valleys have been depressed; both may have occurred. In either event, movement along normal faults resulted in thousands of feet of vertical displacement.

Alluvial Apron: The alluvial apron is the area of intermediate slope between the mountains and the comparatively flat valley floor. It includes two major physiographic features of principal hydrologic significance, pediments and alluvial fans. The pediments are relatively subdued erosional surfaces that were formed largely on Tertiary rocks that dip valleyward at slopes ranging from a few feet per mile to more than 200 feet per mile. The largest pediments in the project area occur near the southern margin of Pleasant Valley, in the northern half of Jersey Valley, along the south-eastern portion of the Stillwater Range, and along the southern slopes of the Clan Alpine Mountains. The pediment in Pleasant Valley is nearly 12 miles long and has a maximum width of about 4 miles. Most of the slopes along the ranges bordering Stingaree, Cowkick, and Eastgate Valleys are dissected pediments, as are some of the slopes along the western front of the Clan Alpine Mountains.

The entire alluvial apron in Fairview Valley south of Highway 50 is composed of alluvial fans that merge gently and almost imperceptibly with the valley floor. In addition, virtually the entire alluvial apron along the eastern slope of the Stillwater Range in Dixie Valley and most of the alluvial apron along the western slope of Clan Alpine range are composed of coalescing alluvial fans.

Alluvial fans of at least two ages occur in the area. The older fans are deeply dissected and are characterized by moderate to intense structural deformation. The younger fans are less dissected and are characterized by little or no structural deformation.

Valley Lowlands: In the southern half of Fairview Valley, the Alluvial fans bordering the Sand Springs Range and Slate Mountain almost merge along the axis of the valley. In T. 15 N., R. 33 E., the slope of the axis of the valley is nearly 70 feet per mile to the north; at Labou Flat about three miles further north, the valley floor is nearly flat.

The valley floor near the topographic divide at the north end of Fairview Valley is moderately dissected and characterized by gently rolling topography. Alluvial fans bordering the Stillwater Range and the Clan Alpine Mountains merge along the axis of Dixie Valley northward from the divide for about 18 miles. In this area the slope of the axis of Dixie Valley ranges from about 30 to 60 feet per mile northward. In T. 20 N., R. 34 E., the width of the floor of Dixie Valley increase abruptly and the northward gradient become gentler. Near the Humboldt Salt Marsh the valley floor is nearly flat. North of the Humboldt Salt Marsh the floor of Dixie Valley slopes southward and becomes progressively narrower northward.

The floors of Jersey and Pleasant Valleys consist largely of moderately dissected coalescing alluvial fans and pediments. From T. 29 N. northward, the floor of Pleasant Valley consists mostly of coalescing alluvial fans. In T. 28 N., the flood plain of Spring Creek, which is about half a mile wide, is entrenched about 35 to 50 feet below the toes of the alluvial fans. Southward, the floodplain becomes progressively narrower and more deeply entrenched. In T. 27 N., where Spring Creek is entrenched into a pediment surface, the flood plain narrows to less than a quarter of a mile and is entrenched more than 100 feet below the pediment surface.

Much of northwestern Nevada was covered by a series of Pleistocene lakes. The youngest of these, Lake Lahontan, had a maximum altitude of nearly 4,400 feet (Russell, 1885, and Morrison, 1961) and occupied the valleys immediately west and north of the project area. Inasmuch as the altitudes of the topographic divides bordering the project area are above an altitude of 4,400 feet, the lake that occupied Dixie Valley in late Pleistocene time was not continuous with Lake Lahontan.

Several features of the valley lowlands were formed near the margins of and within lakes that occupied parts of the project area in Pleistocene time. Wave-cut scarps and terraces are best developed in Dixie Valley near the northeastern margin of the Humboldt Salt Marsh. The highest of these occurs at an altitude of about 3,700 feet, or about 340 feet above the altitude of the playa. Thinly laminated beds of fine-grained silt and clay that were deposited in the lake cover much of the floor of Dixie Valley below an altitude of about 3,500 feet.

Fine-grained strata that probably were deposited in lakes contemporaneous with but at a somewhat higher altitude than the lake in Dixie Valley are exposed along the banks of Campbell Creek in Eastgate and Cowkick Valleys. These deposits are at least 30 feet thick and locally may be considerably thicker.

Streams: All streams in the project area are ephemeral; however, some are perennial for short distances where springs discharge into the channels. Most of the streamflow normally occurs in the spring and early summer as the snowpack that accumulated during the previous winter melts; the resulting peak flows commonly occur in May and June. Localized flooding resulting in considerable damage to roads and other structures is common during the spring runoff.

Intense and commonly highly localized thunderstorms result in peak flows of considerable magnitude. For example, in August 1961 a flow of about 500 cfs (cubic feet per second) occurred in a tributary of Campbell Creek in the SW 1/4 sec. 10, T. 16 N., R. 38 E.; the flow in Dixie Valley Wash during the same flood was about 9,800 cfs in the SE 1/4, sec. 26, T. 17 N., R. 34 E. (U.S. Geological Survey, 1961, p. 113-114). The average annual flow in these streams is not known but probably is only a fraction of a cubic foot per second; throughout much of the year both streams are dry.

Drainage in Fairview Valley is toward the playa at Labou flat. South of Highway 50 streams draining the Sand Springs Range drain eastward toward the axis of the valley, and streams draining Fairview Peak and Slate Mountain drain westward toward the axis where they join an unnamed north-trending stream that flows along the axis of the valley and discharges into Labou Flat. North of Highway 50 most of the streams in Fairview Valley drain southward toward Labou Flat.

Campbell Creek, which drains part of the Desatoya Mountains, flows westward through a narrow bedrock gap into Eastgate Valley where the channel locally is incised about 30 feet into fine-grained lacustrine deposits. The stream discharges into Cowkick Valley through a bedrock constriction locally referred to as Middlegate. Here the channel is incised into highly fractured rhyolite, and the stream cascades over a 20-foot high water fall. From Middlegate the stream flows westward through Cowkick Valley to another bedrock gap locally referred to as Westgate. It discharges through Westgate into Stingaree Valley and then flows northwestward into Dixie Valley where it joins Dixie Wash. Dixie Wash, which locally is incised nearly 75 feet into alluvial-fan and lacustrine deposits, flows northward along the axis of Dixie Valley for about 40 miles and discharges into the Humboldt Salt Marsh. Streams draining the Stillwater Range and the Clan Alpine Mountains south of the playa flow across the alluvial apron and join Dixie Valley Wash at almost right angles.

Spring Creek and its tributaries drain Pleasant Valley. The stream flows southward along the axis of the valley and discharges into Dixie Valley through a narrow steep-walled bedrock canyon composed partly of limestone. Jersey Valley is drained by a southwest-trending ephemeral stream. Where it discharges into Dixie Valley the stream branches into numerous distributaries. These distributaries and Spring Creek receive tributary streamflow from the Stillwater Range, Fish Creek Mountains, and the northern part of the Clan Alpine Mountains and ultimately discharge into Humboldt Salt Marsh.

In summary, the ultimate discharge point of nearly all the streams in the Fairview Valley drainage basin is the playa at Labou Flat, and that of nearly all the streams in the Dixie Valley drainage basin is the Humboldt Salt Marsh. Normally, only a small fraction of the tributary streamflow reaches these playas; most evaporates, is transpired, or seeps into the ground before reaching the playas. Water commonly reaches the playas only during the spring runoff or following intense storms.

Lithologic and Hydrologic Properties of the Rocks:

In this report the rocks of the study area are divided into three units, based largely on their hydrologic properties: consolidated rocks, older alluvium, and younger alluvium. The distribution of these units is shown in plate 1. The geologic information shown on the map is based largely on examination of aerial photographs and about 10 days of fieldwork; therefore, the geologic contacts are approximate and the distribution of some of the lithologic units locally is inferred.

Consolidated Rocks: The consolidated rocks range in age from Paleozoic to Cenozoic. Their lithology, distribution, thickness, and other pertinent features in the project area north of latitude 40° 00' N. are described in considerable detail by Muller, Ferguson, and Roberts (1951). The consolidated rocks in the study area south of latitude 40°00' N. seemingly are similar to those north of this latitude. Except where noted, much of the geologic information given in this section of the report regarding the consolidated rocks is adapted from the work of Muller, Ferguson, and Roberts.

The Paleozoic rocks consist largely of indurated marine deposits having a maximum thickness of nearly 25,000 feet. They include virtually every common type of sedimentary rock, such as limestone, dolomite, shale, sandstone, and conglomerate. Other less common sedimentary rocks and some volcanic rocks occur locally, but they comprise only a few percent of the total Paleozoic section. Locally the sedimentary rocks have been intensely altered by heat and pressure, yielding such metamorphic rocks as marble, slate, phyllite, schist, quartzite, and quartzite conglomerate.

The Paleozoic rocks have very little interstitial porosity and permeability and, accordingly, store and transmit only small quantities of water. Locally, however, small to moderate amounts of water are transmitted through fractures, solution openings, and other openings.

The consolidated rocks of Mesozoic age include about 5,000 feet of marine strata, a considerable thickness of granitic rocks, and a lesser amount of other volcanic rocks. The granitic rocks, which are at least several thousand feet thick, have intruded and locally metamorphosed the older Paleozoic and Mesozoic rocks. The Mesozoic rocks also have very little interstitial porosity and permeability; nevertheless, locally they store and transmit water in and through fractures and other openings. Test drilling in granitic rocks in the Sand Springs range indicates that some water occurs even in these dense and highly crystalline rocks. Reportedly the interstitial permeability of the granitic rocks is on the order of a thousandth to a millionth of that of sedimentary rocks (University of Nevada, 1962, p. 45 and table 2). Thus, the occurrence of most of the ground water in these rocks probably is related to fractures.

The Cenozoic consolidated rocks range in age from Oligocene (?) to Pleistocene (?) and consist of lava flows and intrusive igneous rocks that range in composition from basalt and gabro to rhyolite and granite. Also included in this unit is a thick sequence of partly to moderately consolidated sedimentary and volcanic deposits of Miocene and Pliocene age. These deposits, which locally are more than 4,000 feet thick, include alternating layers of fluviatile sand and gravel; tuff, volcanic ash, and lava flows; and lacustrine deposits of sand, silt, clay, diatomite, limestone, and dolomite (axlerod, 1956, fig 11). The pediments, described in a previous section of the report, are formed largely on the Miocene and Pliocene rocks. At least 50 percent of the Miocene and Pliocene rocks have a moderate to high porosity; however, because they are fine-grained, structurally deformed, and partly compacted, they are poorly permeable.

In summary, the consolidated rocks are at least 35,000 feet thick and may be considerably thicker in some parts of the project area. In overall aspect they are barriers to the movement of ground water. Locally, they may yield small quantities of water to wells and springs; however, it is doubtful that many large capacity wells can be developed in these rocks.

Younger and Older Alluvium: Most of the economically available ground water in the project area occurs in the unconsolidated deposits mapped as younger and older alluvium (pl. 1). Where saturated these deposits are termed the ground-water reservoir. At land surface the criteria used to distinguish between the older and younger alluvium are as follows: (1) the older alluvium is moderately to intensely deformed, whereas the younger alluvium is characterized by little or no structural deformation; (2) the younger alluvium is not appreciably eroded, whereas the older alluvium forms a well dissected rolling topography; and (3) the younger alluvium has a weak to moderately developed soil profile, and the older alluvium is characterized by a well developed soil profile.

The older alluvium consists largely of erosional debris derived from the bordering mountains. It is composed principally of alluvial-fan deposits and lacustrine strata of late Miocene to early Pleistocene age that unconformably overlie the older consolidated rocks. The alluvial-fan deposits, which are exposed largely on the alluvial apron, consist mostly of clastic sedimentary particles that range in size from clay to boulders and that locally are moderately compacted and cemented. These deposits have a low to moderate permeability and probably will yield small to moderate quantities of water to wells.

The lacustrine deposits of the older alluvium were recognized only near the alluvial divide between Dixie and Fairview Valleys where they are exposed as a result of uplift along normal faults and subsequent erosion by Dixie Wash and other smaller streams. These deposits consist of fine-grained and thinly laminated strata of silt and clay of high porosity and low permeability and will yield little water to wells.

The deposits mapped as younger alluvium range in age from Pleistocene to Recent and include windblown material, stream-channel deposits, alluvial-fan deposits, and lacustrine strata. These deposits unconformably overlie the older alluvium and locally the older consolidated rocks.

The windblown material covers the largest area of any of the deposits of the younger alluvium. However, throughout most of the area it forms a veneer only a few inches to a few feet thick. Locally, stablized sand dunes more than 20 feet in height occur in the valley lowlands.

Deposits in the present stream channels range from coarse-grained, moderately permeable sand and gravel to fine-grained, poorly permeable silt and clay. In the mountains and on the alluvial apron, the stream-channel deposits are largely coarse grained; the degree of assortment increases with increasing distance from the ranges. On the valley lowlands, deposits in the present stream channels are largely fine-grained; however, during periods of large runoff, many of the streams carry moderately coarse material far out into the valley lowlands.

Most of the alluvial apron is composed of alluvial-fan deposits of the younger alluvium. The lithology and hydrologic properties of these deposits range from highly permeable stringers of sand and gravel to relative impermeable slope wash. In general, the deposits are coarsest and least sorted near the apexes of the fans and become progressively finer valleyward; the deposits near the toes of most of the fans are composed of relatively impermeable silt and fine sand. The alluvial fans formed by streams draining areas underlain by limestone, quartzite, and basic volcanic rocks, such as those bordering parts of the Stillwater Range and Clan Alpine Mountains, contain proportionally more coarse water-bearing material than those formed by streams draining areas underlain by granitic rocks and some types of sedimentary and metamorphic rocks, such as shale and slate.

Most of the lacustrine strata of the younger alluvium were deposited in Pleistocene and Recent lakes, including the ephemeral lakes that occupied Labou Flat and the Humboldt Salt Marsh. These strata consist largely of silt and clay deposited in the deeper parts of the lakes, and sand and gravel deposited near the margins of the lakes as beaches, bars, and other shoreline features. The fine-grained strata are highly porous but are comparatively impermeable; the coarse-grained strata are moderately porous and moderately to highly permeable.

As previously described, Eastgate and Cowkick Valleys drain westward through narrow bedrock constrictions into Stingaree Valley and thence into Dixie Valley. During late Pleistocene time, increased precipitation and the moderately small channel capacity of Campbell Creek at the bedrock constictions probably caused frequent overbank flooding and possibly the formation of perennial lakes in these valleys. It is inferred that the fine-grained strata exposed along the banks of Campbell Creek were deposited at that time.

It is difficult to distinguish between the older and younger alluvium in the subsurface because the criteria used to distinguish the two units at land surface cannot readily be applied to the information given in drillers' logs. The deposits penetrated at land surface by most of the wells in the project area are younger alluvium; in the subsurface most of the wells tap either one or both of the units. Well 16/33-32b2 was drilled to a depth of 935 feet and is the deepest well in the study area (table 9). It penetrated alternating layers of silt, sand, and gravel largely of granitic composition derived from the Sand Springs Range to the west. These strata probably include both younder and older alluvium.

The wells in the central part of Dixie Valley penetrated alternating layers of coarse and fine material to a maximum depth of about 200 feet.

(See logs of wells 21/35-8c1 and 21/35-8c5, table 9). These deposits are interpreted as being younger alluvium. The fine-grained strata probably are largely of lacustrine origin; most of the coarse material is of subaerial origin and probably was deposited during periods of desiccation. The hydrologic significance of these alternating layers of coarse and fine material is discussed subsequently in the report.

Because of erosion and displacement along normal faults, the bedrock surfaces underlying and bordering the deposits forming the ground-water reservoir are highly irregular. Thus, the range in thickness of the ground-water reservoir is considerable. In Cowkick Valley the reservoir probably is less than 150 feet thick. (See log of well 17/35-34d1, table 9). Similarly, in Eastgate Valley, in the southern part of Pleasant Valley, and in the northern part of Jersey Valley the reservoirs probably are not more than a few hundred feet thick. Along the margins of the basins, where saturated deposits overlap the consolidated rocks of the bordering mountains, the ground-water reservoirs thin to a feather edge.

Geologic Structure:

The Paleozoic and Mesozoic rocks are tightly folded and broken by low-angle thrust faults. In addition, these rocks, the younger Tertiary rocks, and the unconsolidated deposits of the ground-water reservoir are cut by roughly north-trending, high-angle, normal faults.

Structural deformation associated with movement along normal faults is still occurring in and adjacent to the project area. In fact, the Dixie-Fairview Valley area is one of the most active earthquake areas in North America. The earthquakes are caused by movement along the normal faults. A severe earthquake occurred in Pleasant Valley on October 2, 1915 (Jones, 1915). Vertical fault scarps more than 30 feet in height were formed as a result of movement along a north-trending fault zone near the base of the western slope of the Tobin Range. These scarps have been modified only slightly by erosion and are still very prominent.

On December 16, 1954, two severe earthquakes occured in the project area. The epicenter of the first shock was along the eastern slope of Fairview Peak; that of the second shock was along the eastern slope of the Stillwater Range, about 30 miles north of Fairview Peak (Romney, 1957, p. 301-319). Both shocks resulted in marked surface faulting; scarps averaging about 10 feet in height but locally more than 20 feet in height were formed in the alluvium. In addition to destroying property, the earthquakes had marked hydrologic effects. These are described in detail by Zones (1957).

Formation of the Hydrogeologic Environment:

The following brief summary of the formation of the hydrogeologic environment is partly adapted from Muller, Ferguson, and Roberts (1951), and Axlerod (1956):

1. Deposition of marine strata and lesser amounts of volcanic rocks during early and middle Paleozoic time.

2. Folding, thrust faulting, and regional uplift above sea level in late Paleozoic time.

3. Regional depression below sea level, volcanism, and sedimentation (chiefly in a marine environment) during most of early Mesozoic time.

4. Thrust faulting, folding, and emplacement of intrusive rocks, largely of granitic composition, in middle (?) and late Mesozoic time.

5. Regional uplift above sea level and erosion during late Mesozoic and early Tertiary (?) time.

6. Normal faulting and volcanism in early (?) and middle Tertiary time.

7. Volcanism and lacustrine sedimentation in middle and late Tertiary (Miocene and Pliocene) time.

8. Continued normal faulting in late Pliocene time which outlined the present gross topographic features of the project area. Deposition of part of the older alluvium.

9. Continued normal faulting, volcanism, and deposition of older alluvium in early Pleistocene time.

10. Intermittent inundation of the valley lowlands by lakes during middle and late Pleistocene time. Deposition of the younger alluvium. Continued normal faulting with Dixie Valley being depressed relative to the bordering mountains and tributary valleys. Entrenchment of streams tributary to Dixie Valley. Structural deformation of the older alluvium.

11. Desiccation of the youngest (most recent) Pleistocene lakes in Dixie, Cowkick, and Eastgate Valleys. Continued entrenchment of streams tributary to Dixie Valley, owing to declining base level related to the desiccation of the lake in Dixie Valley and to continued relative deprdssion of the valley as a result of movement along normal faults.

12. Continued normal faulting and erosion and deposition by streams draining into Dixie Valley in Recent Time. Erosion and deposition by wind action, and the formation of intermittent lakes in Dixie and Fairview Valleys.

GROUND-WATER HYDROLOGY

Source:

Nearly all the ground water in the Dixie-Fairview Valley area is derived from precipitation within the drainage basin. Most of the rain occurs as scattered and infrequent showers and evaporates soon after it occurs or is stored in the zone of aeration and subsequently is consumed by evapotranspiration. Some rain probably percolates downward to the water table in and near the Humboldt Salt Marsh where the water table locally is only a few feet below land surface and where the capillary fringe extends to land surface.

Infiltration of streamflow derived from the winter snowpack is the source of most of the ground water. During the spring as the snowpack melts, some of the resulting streamflow infiltrates into cracks or other openings in the consolidated rocks and moves valleyward as ground-water underflow. In addition, part of the streamflow that discharges onto the alluvial apron infiltrates into the underlying sedimentary deposits and percolates downward to the zone of saturation. Most of this recharge occurs on the alluvial fans rather than the pediments which, as previously noted, are underlain by relatively impermeable rocks.

Because of the extremely flashy nature of the runoff associated with thunderstorms, the resulting streamflow probably supplies only a small and perhaps negligible percentage of the average annual recharge to the ground-water reservoir. Most of this streamflow ponds in the valley lowlands and is lost by evaporation.

Occurrence:

Ground water occurs under water-table (unconfined) and artesian (confined) conditions in the unconsolidated deposits forming the ground-water reservoir. All other factors being equal, well-sorted deposits have the largest volume of pore spaces and coarse-grained strata have the greatest permeability. Accordingly, well sorted deposits of sand and gravel yield the most water to wells; poorly sorted deposits of silt and clay yield the least water.

Artesian conditions occur in several parts of the study area. Hydrostatic heads in about 40 wells in T. 21 N., R. 34 and 35 E. in Dixie Valley are above land surface, causing the wells to flow (pl. 1). The maximum known head is about 9 feet above land surface at well 21/35-16dl. Most of these wells are less than 200 feet deep and flow at rates ranging from less than 1 gpm (gallons per minute) to more than 200 gpm; their estimated average flow is 15 gpm. These flowing wells penetrate alternating layers of fairly permeable sand and gravel and comparatively impermeable silt and clay. The layers of silt and clay are the confining beds that hold the water in the intervening aquifers under artesian pressure.

The only other flowing wells in the project area, wells 27/38-2bl and 28/38-14al are in Pleasant Valley. Well 27/38-28bl, which is 500 feet deep and which penetrated sand and gravel to a depth of 90 feet and red clay from 90 feet to the bottom of the hole, flows at a rate of 10 gpm. The artesian flow reportedly comes from strata at or near the contact between the red clay and the overlying deposits. The water flowing from the well is thermal, having a temperature 71°F. Well 28/38-14al discharges less than 5 gpm. Thermal artesian water also is discharged by springs in Jersey and Pleasant Valleys and near the northern margin of Dixie Valley. The highest known temperature, 175°F., occurs at spring 25/38-28cl.

Artesian conditions also occur in Fairview Valley in the deposits tapped by wells 16/35-32bl and 16/35-32b2. As the wells were deepened the water levels which initially stood at about 300 feet below land surface rose about 10 feet (University of Nevada, 1962, p. 103, 121).

Nearly all the drillers' logs (table 9) indicate rapid and marked vertical changes in lithology. These changes also denote marked changes in permeability. Accordingly, slight to moderate artesian heads probably occur in most of the saturated deposits beneath the valley lowlands. Throughout most of the study area, however, these artesian heads are not sufficient to cause ground water to rise to the land surface.

Movement

Ground water moves from areas of higher to areas of lower hydrostatic head. The water-level contours of plate 1 show the altitude of water levels in wells and at springs. The contours are generalized because the altitude of the water levels of some wells and springs are based on single measurements made over a period of several years. Nevertheless, the contours indicate the general direction of ground-water movement; the horizontal component of the direction of ground-water movement is perpendicular to the contours.

The water-level contours indicate that the direction of ground-water movement in most of the project area, except in the northern part of Fairview Valley, is similar to the direction of surface-water flow. Ground water moves southward from Jersey and Pleasant Valleys into Dixie Valley. Ground water in Eastgate, Cowkick, and Stingaree Valleys moves westward into Dixie Valley and thence northward toward the Humboldt Salt Marsh. In the central part of Dixie Valley ground water moves radially from the margins of the valley toward the playa.

Although there are no available data, it is inferred that ground water in the southern part of Fairview Valley moves from the mountains toward the axis of the valley and thence northward. In the northern half of Fairview Valley, in contrast to the direction of surface-water flow which is largely southward toward Labou Flat, ground water moves northward beneath the topographic divide into Dixie Valley. Thus, although Fairview Valley is a topographically closed basin, in the sub-surface it is hydrologically connected with Dixie Valley.

Ground water moves from Fairview and Jersey Valleys into Dixie Valley principally through the younger and older alluvium. Movement from Pleasant Valley to Dixie Valley is largely through fractures and perhaps solution openings in the consolidated rocks. Similarly, movement from Eastgate Valley into Cowkick Valley and from Cowkick Valley into Stingaree Valley probably also occurs through fractures in the consolidated rocks. These rocks are partial barriers to the movement of ground water and cause ground-water levels to be fairly close to land surface immediately upgradient from the bedrock constrictions. Ground water discharges from Stingaree into Dixie Valley probably largely through the younger and older alluvium.

Recharge:

Although precipitation within the drainage basin probably is the source of nearly all the ground water in the project area, only a small percentage of the precipitation recharges the ground-water reservoir. For the purpose of this report, a method described by Eakin and others (1951) is used to obtain a preliminary estimate of the average annual ground-water recharge derived from precipitation in the Dixie-Fairview Valley drainage area. The method is based on the assumption that a fixed percentage of a given average annual rate of precipitation ultimately recharges the ground-water reservoir.

Hardman (1936) showed that in gross aspect the average annual precipitation in Nevada is related closely to altitude, and that it can be estimated with a reasonable degree of accuracy by assigning precipitation rates to various altitude zones. The altitude zones in the project area and the estimated average annual precipitation in these zones are listed in table 3. In addition, the table shows the assumed percentage of precipitation in each zone that ultimately recharges the ground-water reservoir. The estimated average annual precipitation in the entire area is 887,000 acre-feet, and the estimated average annual recharge resulting from the infiltration of this precipitation is 16,000 acre-feet. Accordingly, only about 2 percent of the total precipitation recharges the ground-water reservoir.

Table 3.--Estimated average annual precipitation and ground-water recharge in the Dixie-Fairview Valley area, Nev.

Altitude zone (feet)	Area (acres)	Estimated annual precipitation: range (in inches)	average (in feet)	average (in acre-feet)	Estimated recharge: (assumed precentage of precipitation	(acre-feet per year)
			DIXIE VALLEY			
above 9,000	1,540	more than 20	1.75	2,700	25	700
8,000 to 9,000	2,110	15 to 20	1.46	3,100	15	500
7,000 to 8,000	32,590	12 to 15	1.12	36,500	7	2,600
6,000 to 7,000	89,020	8 to 12	.83	73,900	3	2,200
below 6,000	678,600	less than 8	.50	339,300	0	0
Subtotal (rounded)	804,000	--	--	456,000	--	6,000
			JERSEY VALLEY			
8,000 to 9,000	490	15 to 20	1.46	720	15	100
7,000 to 8,000	3,410	12 to 15	1.12	3,820	7	300
6,000 to 7,000	14,980	8 to 12	.83	12,430	3	400
below 6,000	78,400	less than 8	.50	39,200	0	0
Subtotal (rounded)	97,000	--	--	56,000	--	800
			PLEASANT VALLEY			
above 9,000	1,080	more than 20	1.75	1,900	25	500
8,000 to 9,000	2,500	15 to 20	1.46	3,600	15	600
7,000 to 8,000	10,000	12 to 15	1.12	11,200	7	800
6,000 to 7,000	34,000	8 to 12	.83	28,200	3	800
below 6,000	133,000	less than 8	.50	66,500	0	0
Subtotal (rounded)	181,000	--	--	111,000	--	3,000
			FAIRVIEW VALLEY			
7,000 to 8,000	1,500	12 to 15	1.12	1,700	7	100
6,000 to 7,000	18,000	8 to 12	.83	14,900	3	400
below 6,000	169,000	less than 8	.50	84,500	0	0
Subtotal (rounded)	188,000	--	--	101,000	--	500
			EASTGATE, COWKICK, AND STINGAREE VALLEYS			
above 9,000	2,300	more than 20	1.75	4,000	25	1,000
8,000 to 9,000	5,680	15 to 20	1.46	8,300	15	1,200
7,000 to 8,000	18,900	12 to 15	1.12	21,200	7	1,500
6,000 to 7,000	73,000	8 to 12	.83	60,600	3	1,800
below 6,000	138,000	less than 8	.50	69,000	0	0
Subtotal (rounded)	238,000	--	--	163,000	--	6,000
TOTAL (rounded)	1,508,000	--	--	887,000	--	16,000

In table 3, the project area is divided into five subareas, (1) Dixie Valley, (2) Jersey Valley, (3) Pleasant Valley, (4) Fairview Valley, and (5) Eastgate, Cowkick, and Stingaree Valleys. The percentage of the total drainage area represented by each subarea, and the percentage of the estimated average annual precipitation and ground-water recharge in the subareas are:

Subarea	Percentage of total drainage area	Percentage of average annual precipitation	Percentage of average annual ground-water recharge
Dixie Valley	53	51	37
Jersey Valley	7	7	5
Pleasant Valley	12	13	19
Fairview Valley	12	11	3
Eastgate, Cowkick, and Stingaree Valleys	16	18	36
Total	100	100	100

The percentage of the total area represented by each subarea agrees reasonably well with the percentage of precipitation in the subareas; however, the percentage of recharge within each subarea is not proportional to the percentage of the precipitation. The Fairview Valley subarea contributes proportionally less recharge, and the Eastgate, Cowkick, and Stingaree Valley subarea contributes proportionally more, largely because most of the range crests in the Fairview Valley drainage basin are below an altitude of 7,000 feet. Accordingly, these ranges receive only small amounts of snow. On the other hand, the altitudes of many of the range crests in the Eastgate, Cowkick, and Stingaree Valley drainage basin are more than 8,000 feet, and some are more than 9,000 feet. Thus, a moderate-to-large snowpack normally accumulates in these ranges. Melting of the snowpack is the source of a comparatively large amount of runoff during the spring which, in turn, is the source of most of the ground-water recharge.

Discharge:

Prior to development by man, virtually all the ground water in the area was discharged by evapotranspiration, the combined processes of evaporation from land surface and transpiration by phreatophytes, which are plants that obtain most of their water from the ground-water reservoir or the overlying capillary fringe. The activities of man, including the pumping and flow of wells and the diversion of springflow for irrigation, have increased the draft on the ground-water reservoir. However, natural discharge is still the predominant form of discharge in the area.

Wells: About 40 flowing wells in Dixie Valley discharged about 1,300 acre-feet in 1962, and the two flowing wells in Pleasant Valley discharged about 25 acre-feet. In 1962, only three moderately large-capacity wells were pumped for irrigation --wells 21/34-35d2 and 21/34-36c1 in Dixie Valley, and well 17/35-34d1 in Cowkick Valley. Those in Dixie Valley discharged about 800 to 1,000 acre-feet, and the well in Cowkick Valley discharged about 250 acre-feet. Most of the remainder of the wells in the project area are used for stock or domestic purposes, and in aggregate probably discharge only a few hundred acre-feet per year.

Total discharge by wells in 1962 was on the order of 2,500 acre-feet. It is inferred that about one-third of the amount discharged, or about 800 acre-feet, seeped back to the ground-water reservoir; the remainder was consumed by evapotranspiration. Thus, in 1962 the estimated net draft on the ground-water reservoir resulting from the discharge by wells was about 1,700 acre-feet.

Springs: Numerous springs occur in the project area. Virtually all are thermal and most discharge only a few gallons per minute. However, some discharge more than 500 gpm (table 8). Total spring discharge in the project area in 1962 is estimated to have been about 3,000 acre-feet. It is inferred that about 1,000 acre-feet returned to the ground-water reservoir and that the remainder, about 2,000 acre-feet, was consumed by evapotranspiration, partly by native phreatophytes and partly by irrigated crops.

Natural Evapotranspiration: Most of the ground water discharged by evapotranspiration is consumed by phreatophytes. Greasewood is the most abundant variety. The other native phreatophytes are, in decreasing order of abundance, grass, rabbitbrush, willow, and wildrose. Ground water also is discharged by evaporation from the water table or the capillary fringe, principally in the Humboldt Salt Marsh. The amount of water discharged by phreatophytes is related to many factors, some of the more significant of which are plant species, density of the vegetation, and depth to the water table. Evaporation from bare soil is related largely to the depth to the water table or capillary fringe and the physical character of the soil.

Table 4 summarizes the natural ground-water evapotranspiration in the project area in 1962. Areas covered by phreatophytes are shown in plate 1. The estimated evapotranspiration rates are based largely on the work of Lee (1912), White (1932), Young and Blaney (1942), Houston (1950), and experiments currently being made near Winnemucca about 35 miles north of the project area (Nevada Department of Conservation and Natural Resources, 1961, 1962).

Table 4.--Estimated natural evapotranspiration of ground water in the Dixie-Fairview Valley area, Nev., 1962

Phreatophyte	Approximate aerial density: Range (in percent)	Approximate aerial density: Average (in percent)	Depth to water: Range (in feet)	Area (acres)	Evapotranspiration: (acre-feet per acre)	Evapotranspiration: (acre-feet)
DIXIE AND JERSEY VALLEYS						
Greasewood and rabbitbrush	1 to 25	15	10 to 60	125,100	0.1	13,000
Grass	1 to 100	20	1 to 10	3,000	.2	600
Willow and wildrose	1 to 100	50	1 to 5	trace	2	trace
Bare soil	- -	--	0 to 15(?)	29,400	.1	2,900
Subtotal	- -	--	- -	157,500	- -	16,500
PLEASANT VALLEY						
Greasewood and rabbitbrush	1 to 25	15	10 to 60	11,500	0.1	1,200
Grass	1 to 100	50	0 to 10	1,900	.5	1,000
Willow and wildrose	1 to 100	50	1 to 5	trace	2	trace
Bare soil	- -	--	0 to 15(?)	trace	0.1	trace
Subtotal	- -	--	- -	13,400	--	2,200
FAIRVIEW VALLEY						
None	- -	--	- -	- -	--	- -
Subtotal	- -	--	- -	- -	--	- -
EASTGATE, COWKICK, AND STINGAREE VALLEYS						
Greasewood	1 to 25	15	15 to 80	4,450	0.1	400
Rabbitbrush	1 to 10	5	15 to 80	trace	--	trace
Subtotal	- -	--	- -	4,450	--	400
TOTAL (ROUNDED)	- -	--	- -	175,000	--	19,000

Table 4 shows that about 16,500 acre-feet, or about 87 percent of the estimated total natural evapotranspiration of ground water in the project area in 1962, occurred in Dixie and Jersey Valleys. The depth to the water table throughout virtually all of Jersey Valley is more than 100 feet, and the only areas of evapotranspiration of ground water in the valley are those in the immediate vicinity of springs. These are too small to be shown on plate 1, and the estimated loss of ground water by evapotranspiration in Jersey Valley probably was not more than 300 acre-feet in 1962. Thus, about 16,200 acre-feet of ground water was consumed by natural evapotranspiration in Dixie Valley in 1962.

Average Annual Discharge: Natural evapotranspiration losses in the project area in 1962 were about 19,000 acre-feet (table 4). These losses have not changed appreciably as a result of the small amount of ground-water development by man. Accordingly, the estimated total average annual ground-water discharge prior to development was also about 19,000 acre-feet.

As previously noted, an estimated two-thirds of the total well discharge in 1962, or about 1,700 acre-feet, was consumed by evapotranspiration. Thus, the estimated total ground-water discharge in 1962 was nearly 21,000 acre-feet.

Ground-Water Budget:

Under natural conditions before the development of ground water by man, the ground-water system was in dynamic equilibrium; the long-term average annual ground-water recharge and discharge were equal. The estimated total average annual recharge and discharge, as computed in previous sections of the report and summarized in table 5, are 16,000 and 19,000 acre-feet, respectively. The imbalance between the two values is a result of the limited available data. Furthermore, it is recognized that the relatively close agreement between the two estimates does not necessarily indicate a high degree of accuracy for either value. Because the two values theoretically should be equal, it is assumed that the average annual ground-water recharge and discharge were each 18,000 acre-feet.

The ground-water budget analyses for each of the subareas shown in table 5 corroborate several of the conclusions given in previous sections of the report. Even though the estimated average annual recharge to the ground-water reservoir of Fairview Valley is small, the fact that virtually no ground water is discharged within the valley by evapotranspiration indicates that ground water must be discharging from the valley by subsurface outflow. In addition, the fact that the estimated recharge to the Eastgate, Cowkick, and Stingaree Valley subarea is substantially more than the estimated discharge within the subarea suggests that ground water also is discharged from this subarea by subsurface outflow. The substantial excess of ground-water discharge over recharge derived from precipitation in Dixie Valley, substantiates the conclusion that ground-water underflow from the other subareas is discharging into Dixie Valley. The fact that the estimated ground-water recharge is only slightly more than the estimated discharge to Pleasant Valley is not conclusive evidence of underflow from Pleasant Valley to Dixie Valley. Nevertheless, as previously noted the water-level contours suggest that some underflow does occur. If the estimates of recharge and discharge in Pleasant Valley listed in tables 3 and 4 are accurate, underflow from Pleasant Valley to Dixie Valley is only a few hundred acre-feet per year.

The magnitude of the natural movement of ground water from Pleasant, Fairview, Eastgate, Cowkick, Stingaree, and Jersey Valleys to Dixie Valley is shown quantitatively in table 5.

Table 5.--Estimated average annual subsurface flow of ground water from tributary valleys to Dixie Valley.

Valley	Recharge 1/ from precipitation (acre-feet)	Natural 2/ discharge (acre-feet)	Subsurface outflow to Dixie Valley (acre-feet)
Eastgate, Cowkick, and Stingaree	6,000	400	5,600
Fairview	500	0	500
Pleasant	3,000	2,200	800
Jersey	800	300	500
Subtotal (rounded)	10,000	3,000	7,000
			Subsurface inflow to Dixie Valley (acre-feet)
Dixie	6,000	16,200	7,000
			Inbalance 3/
Total (rounded)	16,000	19,000	3,000

1/ From table 3.
2/ From table 4 and p. 22.
3/ Difference between estimated average annual recharge and discharge.

In Table 5 the total recharge to Dixie Valley under natural conditions is the sum of the estimated recharge from precipitation, 6,000 acre-feet, plus the estimated subsurface inflow of 7,000 acre-feet, or a total of about 13,000 acre-feet. As explained above, the estimated recharge is not equal to the natural discharge in Dixie Valley. As a result, the discrepancy in the budget shown in table 4 is about 3,000 acre-feet per year.

Ground Water in Storage:

Ground water in storage is water that will drain by gravity from a given volume of the ground-water reservoir. It is equal to the product of the specific yield of the deposits multiplied by their saturated thickness and area. The specific yield of a rock or soil was defined by Meinzer (1923, p. 28) as "***the ratio of (1) the volume of water which, after being saturated, it will yield by gravity to (2) its own volume. This ratio is stated as a percentage ***".

In the Dixie-Fairview Valley area the average specific yield of the alluvial deposits in the uppermost 100 feet of the zone of saturation probably is at least 10 percent. These saturated deposits underlie an area of about 600,000 acres; their volume is roughly 60 million acre-feet. Accordingly, the estimated amount of ground water in storage in the uppermost 100 feet of the reservoir is at least 6 million acre-feet.

In most valleys of Nevada, the ratio of the stored water to the aver age annual increment of recharge is large. In this area the ratio of stored water in the uppermost 100 feet of saturation to recharge is roughly 300 to 1; the ratio per foot of stored water to recharge is about 3 to 1.

Perennial Yield:

The perennial yield of the ground-water reservoir in the Dixie-Fairview Valley area is the maximum rate at which ground water of suitable chemical quality can be withdrawn economically for an indefinite period of time. A corollary to this definition is that if the perennial yield is exceeded permanently, water will be withdrawn from storage and ground-water levels will decline until the ground-water reservoir is depleted or the pumping lifts become uneconomical to maintain.

Increased ground-water development in the project area will result in over-development and declining ground-water levels unless the net pumpage, the amount consumed by evapotranspiration, is offset by a corresponding increase in natural recharge or a decrease in natural discharge. It is highly unlikely that increased pumpage will induce appreciable amounts of increased natural recharge to the project area. Thus, the perennial yield of the area is limited to the amount of natural discharge that can be salvaged. Accordingly, for the entire project area, it is assumed that the upper limit of the perennial yield is 18,000 acre-feet.

Theoretically, ground-water levels must be lowered to a depth of at least 25 feet and perhaps as much as 60 feet below land surface throughout the areas of evapotranspiration to eliminate the natural water losses. This can be accomplished by a carefully located and spaced network of pumping wells. Depending upon many factors, but especially on the rate and location of pumping and the hydraulic properties of the ground-water reservoir, net ground-water withdrawals in an amount less than the perennial yield can cause ground-water levels locally to decline below economic pumping levels. This occurs when withdrawals are large and are concentrated in a comparatively small part of the project area.

The perennial yield of the subareas, especially Dixie Valley where most of the future development is likely to occur, depends in part on the amount of development in the other subareas. As shown in table 5, the source of 7,000 acre-feet per year (possibly more, if the estimates of recharge are low) of the ground water discharged in Dixie Valley is subsurface inflow derived from the other valleys in the project area--the Eastgate, Cowkick, and Stingaree Valley subarea supplying nearly 6,000 acre-feet per year. Thus, if net ground-water withdrawals in the valleys tributary to Dixie Valley increase to more than the natural discharge by evapotranspiration in these areas, inflow to Dixie Valley will decrease. If all the subsurface inflow to Dixie Valley is intercepted by pumping in the tributary valleys, the upper limit of the perennial yield of Dixie Valley will be equal to the average annual recharge derived from precipitation within the valley, which is estimated to be about 6,000 acre-feet per year (table 3).

CHEMICAL QUALITY OF THE GROUND WATER

Nine water samples were analyzed as part of the present study to make a generalized appraisal of the suitability of the ground water for domestic and agricultural use and to help define potential water-quality problems. The analyses of eight of these samples and of five samples obtained prior to the study are listed in table 5. Sampling sites were chosen to achieve the widest possible areal coverage. However, the small number of samples obviously precludes a comprehensive evaluation of the water quality of the area.

Table 6.--Chemical analyses, in parts per million, of water from selected wells in the Dixie-Fairview Valley area, Nev. (Analyses by U.S. Geological Survey)

Location (well no.)	Date of collection	Temperature (°F)	Silica (SiO_2)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Boron (B)	Dissolved solids (residue at 180°C)	Hardness as $CaCO_3$		SAR	RSC	Specific conductance (micromhos at 25°C)	pH
																	calcium-magnesium	non-carbonate				
16/33-3b1	7-24-63	--	71	--	11	1.8	364	4.7	544	0	179	127	2.6	0.2	1.5	1020	35	0	27	8.2	1570	8.1
16/33-32b1	7-22-63	63	71	0.07	33	4.5	50	6.3	143	0	50	28	.6	3.6	.50	321	101	0	2.2	.32	435	7.7
17/35-33c1	7-22-63	63	52	.96	82	7.2	140	4.9	209	0	262	60	2.5	.8	.30	723	234	63	4.0	.00	1040	7.5
21/34-36c1	7-23-63	73	54	.01	16	2.2	68	3.0	86	0	80	26	6.0	1.1	.30	297	49	0	4.2	.43	435	7.6
21/35-8b1	5- 1-52	61	62	.04	31	3.4	53	4.3	117	0	71	27	1.8	1.4	.16	[a] 313	91	0	2.4	.08	424	7.8
21/35-18c5	5- 1-52	66	59	.06	23	3.2	63	--	104	0	73	26	4.4	1.1	.13	- -	71	0	3.3	.30	- -	8.2
21/35-19a2	7-23-63	67	66	.10	19	1.1	68	4.2	94	0	71	24	5.2	1.4	.30	313	52	0	4.1	.50	446	7.6
21/35-20a1	5- 1-52	71	63	.04	12	.9	72	2.0	98	0	60	21	6.9	.9	.08	287	34	0	5.4	.93	381	8.2
26/39-29d1	7-23-63	--	58	--	79	17	182	11	407	0	154	127	1.9	1.2	1.1	826	265	0	4.9	1.4	1290	8.0
27/38-2b1	5- 1-52	70	36	.05	47	19	98	6.5	204	0	71	126	.3	1.1	.20	[a] 505	196	28	3.0	.00	842	7.6
27/38-2b1	7-24-63	72	39	.04	46	19	101	6.4	205	0	69	124	.5	1.3	.30	503	192	24	3.2	.00	853	7.9
28/38-26d2	8-15-61	58	46	--	58	25	130	4.4	308	0	94	132	.3	.0	.30	[a] 642	247	0	3.6	.10	1070	7.6
30/39-16d1	7-24-63	52	44	--	49	8.9	32	2.8	165	0	35	41	.3	1.5	.10	299	159	24	1.1	.00	460	7.7

a. Calculated.

Suitability for Agricultural Use:

According to the U.S. Department of Agriculture (1954), the most significant factors with regard to the chemical suitability of water for irrigation are dissolved-solids content, the relative proportion of sodium to other cations, and the concentration of elements and compounds that are toxic to plants. Dissolved-solids content commonly is expressed as "salinity hazard", and the relative proportion of sodium as "alkali hazard".

Salinity hazard is defined in terms of specific conductance, which is a measure of the ease with which an electrical current will pass through water, and an approximate measure of the dissolved-solids content. Salinity hazard and its relation to specific conductance are defined by the U.S. Department of Agriculture as follows:

Salinity hazard	Specific conductance (micromhos per centimeter at 25°C)	Classification
Low	0 to 250	C1
Medium	251 to 750	C2
High	751 to 2,250	C3
Very high	greater than 2,250	C4

As shown in figure 2, alkali hazard is related to both sodium-adsorption-ratio (SAR) and specific conductance. Sodium-adsorption-ratio, which is related to the experimentally determined adsorption of sodium in the water by soil and which is expressed in equivalents per million (epm), is defined as follows:

$$SAR = \frac{\text{epm } Na^{+}}{\sqrt{\dfrac{\text{epm } Ca^{++} + \text{epm } Mg^{++}}{2}}}$$

For a given SAR value the alkali hazard increases as the specific conductance increases. Thus, fixed values of SAR cannot be assigned to the various alkali-hazard classes. In figure 2, these classes are designated S1, S2, S3, and S4, and represent water of low, medium, high, and very high alkali hazard, respectively.

Figure 2 shows that all but one of the samples obtained in the Dixie-Fairview Valley area had a medium-to-high salinity hazard and a low alkali hazard. For successful irrigation, water having these characteristics would have to be applied to adequately drained and moderately permeable soils. In addition, special management for salinity control might be required (Wilcox, 1955). Water from well 16/33-3b1 had a high salinity hazard and a very high alkali hazard and probably could not be used successfully for irrigation.

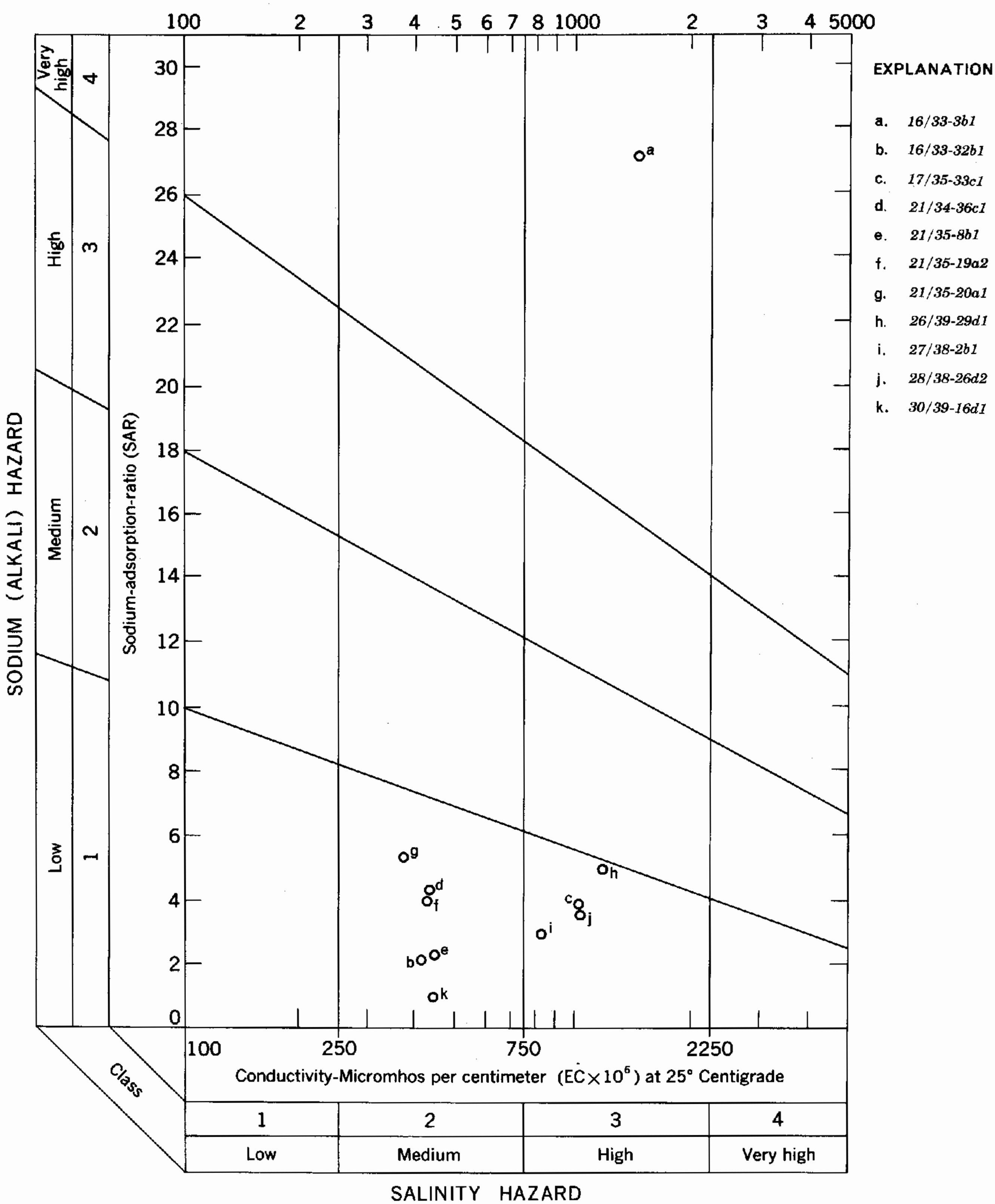

Figure 2.—Classification of irrigation water in the Dixie-Fairview Valley area on the basis of conductivity and sodium-adsorption ratio. (After U.S. Department of Agriculture, 1954)

Residual sodium carbonate (RSC) is expressed in equivalents per million and is defined by the following equation:

$$RSC = (CO^{--} + HCO_3^{-}) - Ca^{++} + Mg^{++})$$

According to Eaton (1950), water having an RSC value larger than 2.5 epm generally is unsuitable for irrigation because calcium and magnesium will be precipitated in the soil. This, in turn, will increase the relative proportion of sodium in the water and, accordingly, increase the alkali hazard. The increased alkali hazard may decrease the permeability of the soil and render it unfit for agriculture. Water containing 1.25 to 2.5 epm of residual sodium carbonate is marginal, and water containing less than 1.25 epm probably is safe. Accordingly, based solely on RSC values, water from well 26/39-29d1 is marginal and water from well 16/33-3b1 is unsuitable for irrigation. The remainder of the samples analyzed probably are safe for irrigation.

Boron is one of the most critical elements in irrigation water. It is necessary for proper plant nutrition in small quantities but highly toxic in amounts only slightly greater than optimum. The permissible limits for boron in irrigation water for semitolerant and tolerant crops, the types of crops currently raised in the area, are as follows (Scofield, 1936):

Classes of water		Boron content, in parts per million	
Rating	Grade	Semitolerant crops	Tolerant crops
1	Excellent	less than 0.67	less than 1.00
2	Good	.67 to 1.33	1.00 to 2.00
3	Permissible	1.33 to 2.00	2.00 to 3.00
4	Doubtful	2.00 to 2.50	3.00 to 3.75
5	Unsuitable	more than 2.50	more than 3.75

As shown in table 6, all the samples contained boron concentrations that are classed as permissible to excellent for semitolerant and tolerant crops.

Suitability for Domestic Use:

The limits recommended by the U.S. Public Health Service (1962) for water used on interstate carriers for drinking purposes commonly are cited as standards for domestic use. Of the elements and compounds listed in table 5, only fluroide occurs in amounts significantly larger than those recommended. Excessive fluroide in drinking water may be harmful to teeth, especially those of children. According to the U.S. Public Health Service, the recommended fluoride content in drinking water is related to air temperature; in the project area it should not exceed 1.7 ppm (parts per million). Of the 13 samples listed in table 6, 8 had more than the recommended amount of fluoride. Water from well 21/35-20a1 contained the most fluoride, 6.9 ppm.

Excessive hardness of water, which is caused principally by calcium and magnesium, adversely affects its suitability for domestic use, especially for cooking and washing. The U.S. Geological Survey uses the following classification of water hardness:

Hardness range (ppm)	Classification
0-60	Soft
61-120	Moderately hard
121-180	Hard
Greater than 180	Very hard

As shown in table 6, water in the project area ranges from soft to very hard. Sample 21/35-20a1 had the least hardness, 34 ppm, and sample 17/35-33c1 had the most hardness, 297 ppm.

Water Quality and its Relation to the Ground-Water System:

Although meager, the water-quality data help corroborate some of the hydrogeologic features described previously in the report. Water from well 16/33-32b1 in the west-central part of Fairview Valley had a dissolved-solids content of 321 ppm (parts per million) and a hardness of 101 ppm. The source of much of this water probably is recharge derived from precipitation on thé Sand Springs Range. As the ground water moves northward it dissolves additional mineral matter from the fine-grained deposits in the north end of Fairview Valley and some of the calcium in the water is exchanged for sodium in the clay minerals. Thus, water from well 16/33-3b1 had a dissolved-solids content of 1,020 ppm but a hardness of only 35 ppm.

The most abundant ions in the water from well 17/35-33c1 were sodium and sulphate. The well penetrates fine-grained lacustrine strata and it is presumed that these ions were derived largely from evaporites in the lacustrine deposits.

The dissolved-solids content of five ground-water samples from the central part of Dixie Valley averaged about 300 ppm, sodium and bicarbonate being the most abundant cation and anion, respectively. Although some of the chemical constituents in the water in this area probably are derived from the tributary valleys to the south, the comparatively low dissolved-solids content indicates that, as suggested by the water-level contours of plate 1, much of the water is derived from recharge resulting from the infiltration of precipitation on those parts of the Stillwater Range and the Clan Alpine Mountains bordering the central part of Dixie Valley. Although no water samples were obtained from the deposits beneath Humboldt Salt Marsh, the ground water underlying the playa at fairly shallow depth probably is highly saline.

In Pleasant Valley water from well 30/39-16d1 had a dissolved-solids content of only 299 ppm, which probably reflects local recharge derived from precipitation on the northern margin of the Tobin Range. Farther southward the water quality deteriorates somewhat, the water from well 27/38-2b1 having a dissolved-solids content of 505 ppm. It is not certain whether the increase in dissolved-solids content is a result of the solution of additional mineral matter owing to the increased time and distance of ground-water movement, or whether the higher dissolved-solids content is related to a thermal source.

CONCLUSIONS

Nearly all the ground-water basins in Nevada currently are being administered under the concept of perennial yield. Permits are being issued by the State for the development of additional ground-water supplies, and Federal land is being allocated by the U. S. Bureau of Land Management for agricultural development only insofar as these new activities do not result in the overdevelopment of the ground-water resources of each basin. Reportedly, there is considerable interest in developing additional ground-water supplies for irrigation in Dixie Valley.

If additional ground-water development is discouraged in Eastgate, Cowkick, Stingaree, Fairview, and Jersey Valleys so as not to intercept ground-water underflow to Dixie Valley, the estimated maximum net draft that the ground-water reservoir in Dixie Valley can sustain is on the order of 15, 000 acre-feet per year. Additional development in Pleasant Valley probably would have no appreciable affect on the available supply in Dixie Valley.

As previously noted, a large amount of ground water is in storage in the project area. This water could sustain agriculture for a considerable length of time if future ground-water development results in a net draft on the ground-water reservoir in excess of the perennial yield. However, if it is desired to limit net ground-water withdrawals to the perennial yield, ground-water development would have to be properly managed so as to eliminate completely the natural ground-water discharge by evapotranspiration. This may necessitate pumping ground water in or near areas of evapotranspiration where the water quality or the soil may not be favorable for agriculture. If this is not feasible and if it is not possible to salvage the total natural discharge, the net draft on the ground-water reservoir would have to be decreased by an amount equal to the remaining natural evapotranspiration losses.

Additional factors that should be considered in developing the ground-water resources of the area are: some of the pumped water will return to the ground-water reservoir and thus be available for reuse, and the water quality, especially in the lowlands of Dixie Valley, may deteriorate with increased and prolonged pumping. Recycling of some of the ground water may permit the average annual pumpage to be somewhat larger, perhaps as much as 30 to 50 percent more, than the perennial yield. However, recycling of water will increase its dissolved-solids content. Moreover, large amounts of pumping around the margins of the Humboldt Salt Marsh may cause saline water beneath the playa to move toward the wells. Thus, it is apparent that the full development of the perennially available ground-water supply will have to be based on careful management of the ground-water system and periodic re-evaluations of the system as development progresses and as additional data become available.

Table 7.--Records of wells in the Dixie-Fairview Valley area, Nevada

Type of well: Dr, drilled; Dg, dug.
Pressure head or water level: M, measured; R, reported.
Use: D, domestic; I, irrigation; S, stock; T, test well; Ind, industrial; U, unused.

Depth: M, measured; R, reported.
Discharge: M, measured; R, reported; E, estimated.

Well number or location	Owner	Type of well and date completed	Casing diameter (inches)	Depth (feet)	Pressure head or water level: Above(+) or below(-) land surface datum (feet)	Pressure head or water level: Date measured or reported	Use	Discharge (gpm)	Temperature (°F)	Remarks
16/33-3b1	Ed. Weyher	Dr, --	6	280 M	- 224.10 M	4-17-62	D	- -	--	Chemical analysis
16/33-3b2	Ed. Weyher	Dr, --	8	288 M	- 224.60 M	4-17-62	D	- -	--	- - -
16/33-11a1	B.L.M.	Dr, --	8	441 M	- 220.62 M	6- 5-50	S	- -	--	- - -
16/33-32b1	A.E.C.	Dr, --	8	699 M	- 300.14 M	2-17-62	T,Ind	- -	--	Chemical analysis; log
16/33-32b2	A.E.C.	Dr, --	6	935 M	- 299.20 M	2-18-62	T,Ind	- -	--	Log
16/33-32c1	B.L.M.	Dr, 1947	6	364 R	- 340 R	12-13-51	S	- -	--	Log
16/35-2a1	Young and Smith Construction	Dr, 1936	8	200 M	- 100 R	1956	Ind	- -	--	Log
16/35-2b1	Ida Melendy	Dr, 1956	6	118 M	- 84 R	- -	D,I	- -	--	- - -
17/34-18c1	B.L.M.	Dr, --	6	364 R	- 340 R	12-13-51	S	- -	--	Log
17/34-26d1	A.G. Shields Roy Durbin	Dr, --	-	- -	- 204.59 M	12-10-57	U	- -	--	- - -
17/34-35d1	State	Dr, --	8	365 M	- 266.16 M	7-10-62	U	- -	--	- - -
17/35-32d1	B.L.M.	Dr, --	6	98 M	- 52.67 M	6-11-63	U	- -	--	- - -
17/35-33c1	B.L.M.	Dr, --	6	51 M	- 30.00 M	4-10-62	S	- -	--	Chemical analysis
17/35-34d1	Ed. Weyher	Dr, --	10	202 R	- 92.35 M	4-23-62	I	- -	--	Log
17/35-36a1	Angus Dangburg	Dr, 1950	8	502 R	- 27 R	6- 5-50	U	- -	--	Log
18/32-13a1	H. Kent	Dg, --	25 ft	60 M	- 60 R	6- 6-62	S	- -	--	- - -
18/35-36c1	B.L.M.	Dr, 1957	6	606 R	- 541 R	7- 8-57	S	- -	--	Log
19/34-21a1	C. B. Stark	Dr, 1945	6	329 R	- 319 R	4- 3-47	S	- -	--	Log
21/34-1c1	Chester B. Kuittle	Dr, 1958	6	175 R	- - -	- -	D,I	60 R	60	Log; flowing
21/34-13c1	- -	Dr, 1921	4	- -	+ 2.6 M	8-22-51	S	30 E	62	Flowing
21/34-22a1	Navy	Dr, --	6	32 M	- 25.36 M	4-17-63	U	- -	--	- - -
21/34-24a1	Dixie Valley L. and C. Co.	Dr, 1947	6	181 M	- - -	- -	I	3to5 E	68	Logs
21/34-24b1	Dixie Valley L. and C. Co.	Dr, --	6	35 M	- 19.18 M	4- 3-47	D,S	- -	--	- - -
21/34-24b2	Dixie Valley L. and C. Co.	Dr, --	6	188 R	- 2.00 M	5- 1-51	I	- -	--	- - -
21/34-24c1	Dixie Valley L. and C. Co.	Dr, 1947	6	212 R	- 1.5 M	4-22-47	D	- -	--	Log
21/34-24c2	Dixie Valley L. and C. Co.	Dr, --	3	- -	- - -	- -	U	2to3 E	64	Flowing
21/34-27d1	Gregory Homestead	Dr, --	11	114 M	- 32.54 M	5- 1-51	U	- -	--	- - -
21/34-35d1	E. H. Stark	Dr, 1959	16	220 R	- - -	- -	I	1000 R	67	Log
21/34-35d2	E. H. Stark	Dr, 1963	16	250 R	- 40.62	5- 9-63	I	1000 R	--	Log
21/34-36c1	E. H. Stark	Dr, 1959	12	200 R	- - -	6-12-63	I	1000 R	--	Chemical analysis
21/35-5c1	Leon Ellis	Dr, --	6	72 M	+ 6.0 M	12-12-51	I	20 E	60	Flowing
21/35-8a1	Mr. Mathieson	Dr, --	6	106 M	- - -	12-12-51	I	25 E	60	Flowing
21/35-8a2	Mr. Dempsey	Dr, --	3	63 M	- .5 M	5-10-63	S	- -	--	- - -
21/35-8a3	Mr. Dempsey	Dr, --	4	108 M	- - -	5-10-63	U	- -	--	Flowing
21/35-8a4	Mr. Dempsey	Dr, --	3	180 M	- - -	5-10-63	I	- -	--	Flowing
21/35-8a5	Mr. Dempsey	Dr, --	6	120 M	- - -	5-10-63	S,I	- -	--	Flowing
21/35-8b1	Leon Ellis	Dr, --	-	- -	+ 3.5 M	6-25-56	I	20 M	60	Chemical analysis; flowing
21/35-8b2	Leon Ellis	Dr, --	6	111 M	+ 5.5 M	12-12-51	I	15 E	61	Flowing
21/35-8b3	Leon Ellis	Dr, --	4	155 R	- - -	4- 3-47	D	5 E	60	Flowing
21/35-8b4	Leon Ellis	Dr, --	3	122 M	+ 4.2 M	12-12-51	I	8 E	--	Flowing
21/35-8b5	Leon Ellis	Dr, --	6	- -	- - -	12-12-51	I	4 E	60	Flowing
21/35-8c1	Arthur L. Arrance	Dr, 1949	3	130 R	- - -	6- 5-50	I	5 E	62	Log; flowing
21/35-8c2	Arthur L. Arrance	Dr, 1949	3	124 M	- 3.46 M	5- 9-63	I	25 R	--	Log
21/35-8c3	Arthur L. Arrance	- --	3	101 M	- - -	12-11-51	I	2 E	62	Flowing
21/35-8d1	Unknown	Dr, --	5	85 M	- - -	8-24-51	U	3 E	62	Flowing
21/35-9b1	C.B. Stark	Dr, --	4	- -	- - -	12-12-51	D,I	20 M	63	Flowing
21/35-10a1	Unknown	Dr, --	6	- -	+ 1.5 M	5-10-63	S	1.25 M	62	Flowing

Table 7.--Records of wells in theDixie-Fairview Valley area, Nevada (Continued).

Well number or location	Owner	Type of well and date completed		Casing diameter (inches)	Depth (feet)	Pressure head or water level: Above(+) or below (-) land surface datum (feet)	Pressure head or water level: Date measured or reported	Use	Discharge (gpm)	Temperature (°F)	Remarks
21/35-11a1	Wayne Gotshall	Dr,	- -	3	130 M	- -	8-22-51	I	33 M	62	Flowing
21/35-11a2	Wayne Gotshall	Dg,	- -	18	8 M	- -	8-22-51	U	0.5 M	60	Flowing
21/35-11a3	Mr. Nicholson	Dr,	- -	4	72 M	- -	5-10-63	S	- -	--	Flowing
21/35-15b1	Mr. Turell	Dr,	- -	-	- -	- -	12-12-51	I	35 M	65	Flowing
21/35-15c1	Ralph Davis	Dr,	- -	4	- -	+ 6.0 M	8-22-51	U	18 M	64	Flowing
21/35-16b1	Unknown	Dr,	- -	4	90 M	+ 1.5 M	8-24-51	U	1 E	62	Flowing
21/35-16d1	Mr. Rushby	Dr,	- -	3.5	138 M	+ 8.7 M	8-22-51	I	50 E	66	Flowing
21/35-18a1	Howard Turley	Dr,	1961	8	60 R	- 6.0 R	- -	-	- -	--	Log
21/35-18b1	C. B. Stark	Dr,	- -	12	- -	- 5.7 M	4- 3-47	I	- -	--	- - -
21/35-18b2	C. B. Stark	Dr,	- -	6	- -	- -	4- 3-47	I	60 E	65	Flowing
21/35-18b3	C. B. Stark	Dr,	- -	6	154 M	- -	8-22-51	I	5 E	65	Flowing
21/35-18b4	C. B. Stark	Dr,	- -	4	- -	- -	4- 3-47	D,S	10 E	64	Flowing
21/35-18c1	C. B. Stark	Dr,	1949	6	116 M	- -	8-22-51	U	15 E	65	Flowing
21/35-18c2	C. B. Stark	Dg,	1948	60x84	22 M	- 8.5 M	8-22-51	I	- -	--	- - -
21/35-18c3	C. B. Stark	Dg,Dr	- -	14	- -	- 9.58 M	8-22-51	I	- -	--	- - -
21/35-18c4	C. B. Stark	Dr,	- -	10	190 M	- -	8-22-51	U	20 E	67	Flowing
21/35-18c5	C. B. Stark	Dr,	1949	6	180 R	- -	4-30-52	I	15 E	66	Chemical analysis; log; flowing
21/35-18c6	C. B. Stark	Dr,	- -	6	148 M	- -	8-22-51	I	10 E	65	Flowing
21/35-18c7	C. B. Stark	Dr,	- -	12	61 M	- 10.18 M	8-22-51	U	- -	--	- - -
21/35-19a1	Howard Turley	Dr,	- -	6	150 R	- -	8-24-51	I	20 E	67	Flowing
21/35-19a2	Howard Turley	Dr,	1949	14	173 R	- 3.36 M	5- 1-51	I	- -	--	Chemical analysis; log
21/35-19b1	Frank Vinson	Dr,	- -	-	114 M	- -	8-21-51	U	- -	64	Flowing
21/35-19b2	Frank Vinson	Dr,	1950	3	126 M	- 0.04 M	8-22-51	U	- -	--	- - -
21/35-19b3	Frank Vinson	Dr,	- -	4	154 M	- -	8-21-51	I	- -	--	Flowing
21/35-19b4	Frank Vinson	Dr,	- -	4	200 R	- -	8-21-51	U	4 E	68	Flowing
21/35-19b5	Frank Vinson	Dr,	- -	4	200 R	- -	8-21-51	I	25 E	70	Flowing
21/35-20a1	Mr. Hatton	Dr,	- -	4	162 M	+ 6.0 M	8-22-51	D,I	40 E	68	Chemical analysis; flowing
21/35-20a2	Mr. Hatton	Dr,	- -	6	118 M	- -	8-22-51	U	0.25 E	68	Flowing
21/35-20a3	Mr. Hatton	Dr,	- -	4	212 M	+ 5.0 R	8-22-51	I	15 E	71	Flowing
21/35-20a4	Mr. Hatton	Dr,	1948	6	36 M	- -	8-22-51	U	4 E	68	Flowing
21/35-21b1	Frank Vincent	Dr,	- -	8	173 M	- -	8-22-51	U	50 E	67	Flowing
21/35-31d1	C. B. Stark	Dr,	- -	8	50 M	- 34.92 M	12-11-51	S	- -	--	- - -
21/35-35c1	C. B. Stark	Dr,	1959	16	218 R	- 40 M	3-12-59	I	- -	--	- - -
21/36-19b1	C. B. Stark	Dr,	1948	6	118 R	- 72.88 M	8-24-51	S	- -	--	Log
22/36-14c1	C. B. Stark	Dr,	1949	6	181 M	-127.90 M	8-23-51	U	- -	--	Log
24/36-12d1	Don Ferguson	Dr,	- -	-	170 R	- 80 R	8-26-48	D,S	- -	--	- - -
25/38-5a1	Seven Devils Ranch	Dr,	- -	-	129 R	- 50 R	9- 9-48	D,S	- -	--	- - -
25/38-5a2	- -	Dr,	- -	-	109 R	- 78 R	7-28-59	U	- -	--	- - -
26/37-36d1	- -	Dr,	- -	-	- -	- -	5- 1-63	U	- -	--	- - -
26/39-11c1	B.L.M.	Dr,	- -	6	200 R	-138 R	7-28-59	S	- -	--	Chemical analysis; log
26/39-29d1	J.S. Ranch	Dr,	- -	6	107 R	- -	6-12-50	D,S	- -	--	Chemical analysis; log
26/39-30b1	McCoy Ranch	Dr,	- -	6	114 R	- 72.22 M	6- 7-50	S,I	5 E	--	Log
26/39-32a1	J. Saval	Dr,	- -	-	115 R	- 60 R	7-28-59	D,S	- -	--	- - -
27/38-2b1	Arnold Paris	Dr,	- -	-	382 M	- -	6- 6-50	S	10 M	70	Chemical analysis; flowing
27/38-31a1	A. Paris and Siard	Dr,	- -	-	80 M	- -	7-31-59	U	- -	--	- - -
28/38-2d1	Clark Ringling	Dr,	- -	12	- -	- 14.75 M	6- 6-50	I	40 R	--	- - -
28/38-2d2	Clark Ringling	Dr,	- -	-	50 R	- -	6- 6-50	D,S,I	- -	--	- - -
28/38-2d3	Clark Ringling	Dr,	- -	12	40 R	- -	6- 6-50	U	- -	--	- - -
28/38-2d4	Clark Ringling	Dr,	- -	-	20 R	- -	6- 6-50	U	- -	--	- - -
28/38-12b1	Clark Ringling	Dr,	- -	10	49 R	- 16.94 M	8- 1-59	I	130 R	--	- - -
28/38-12b2	Clark Ringling	Dr,	- -	8	18 R	- 13 R	8- 1-59	D,S	- -	--	- - -
28/38-14a1	Mr. Sweeny	Dr,	- -	12	2 M	+ 0.16 M	6- 6-50	U	- -	--	Flowing

Table 7.--Records of wells in the Dixie-Fairview Valley area, Nevada (Continued).

Well number or location	Owner	Type of well and date completed		Casing diameter (inches)	Depth (feet)	Pressure head or water level Above (+) or below (-) land surface datum (feet)	Date measured or reported	Use	Discharge (gpm)	Temperature (°F)	Remarks
28/38-14c1	Mr. Siard	Dr,	- -	6	34 M	- 20.6 M	8- 1-59	D,S	- -	--	- - -
28/38-23a1	Sweeny Ranch	Dr,	- -	6	27 M	- 10.41 M	6- 7-50	U	- -	--	- - -
28/38-26d1	B. L. M.	Dr,	- -	6	- -	- 17.98 M	5- 7-63	S	- -	--	- - -
28/38-26d2	Mr. Siard	--	- -	-	20 M	- 18.18 M	6- 7-50	I	- -	--	Chemical analysis
28/38-26d3	Mr. Siard	Dr,	- -	6	65 M	- 16.98 M	6- 7-50	S	- -	--	- - -
28/40-31b1	J. Savel	Dg,	- -	-	15 R	- -	7-27-59	U	- -	--	- - -
29/38-5d1	- -	Dr,	- -	6	- -	- -	6-12-50	D,S	- -	--	- - -
29/38-25a1	- -	Dr,	- -	8	60 M	- 41.43 M	7- 6-50	S	- -	--	- - -
29/39-4c1	Siard Bros.	Dr,	- -	8	256 M	-179.56 M	8- 5-59	U	- -	--	- - -
29/39-8d1	Mr. Siard	--	- -	-	- -	- -	- -	U	- -	--	- - -
30/39-16d1	- -	Dr,	- -	8	- -	- 15.20 M	- -	S	- -	--	Chemical analysis

Table 8.--Records of springs in the Dixie-Fairview Valley area, Nevada

Discharge: M, measured; E, estimated.
Use: D, domestic; I, irrigation; S, stock; U, unused.

Spring number and location	Owner	Discharge (gpm)	Date measured or estimated	Use	Temperature (°F)	Remarks
15/32-36b1	B. L. M.	--	7- 3-62	U	-	Small Discharge
20/34-5a1	Unknown	dry	6-12-63	U	-	--
25/38-28c1	Unknown	--	6- 7-50	S	175	--
25/39-8a1	Unknown	--	7-30-59	S	-	--
25/39-8d1	Unknown	--	7-31-59	-	-	--
25/39-16a1	Unknown	5 E	7-29-59	D	-	--
25/39-16b1	Unknown	--	7-31-59	D, I	-	--
25/39-19b1	Unknown	50 E	6- 7-50	S, I	83	--
26/38-32a1	Unknown	100 E	6- 8-50	S, I	-	--
26/39-33b1	J. Saval	--	7-28-59	I	120	--
26/39-33c1	J.S. Ranch	670 E	6- 7-50	I	119	--
26/40-8c1	Jenkins Bros.	150 E	7-27-59	D, S	64	--
27/37-24b1	Paris Bros.	0.5 M	7-31-59	S	--	--
27/38-11c1	Arnold Paris	500 E	7-31-59	S, I	-	--
27/40-28c1	J. Saval	1 E	7-29-59	S	-	Hot
27/40-29d1	Home Station Ranch	50 E	6- 8-50	D, I	135	--

Table 9.--Drillers' logs of wells in the Dixie-Fairview Valley area, Nevada

Material	Thickness (feet)	Depth (feet)
16/33-32b1 (See University of Nevada, 1962, Appendix C)		
Sand and silt	6	6
Sand and gravel, micaceous	19	25
Sand, silt, and gravel	13	38
Sand, silt, and gravel; some clay	11	49
Sand, silt, and gravel	51	100
Sand, silt, and gravel; some rock fragments	24	124
Sand, silt, and gravel	79	203
Sand and gravel	17	220
Sand, silty	13	233
Sand and gravel, silty	12	245
Silty sand, water	75	320
Sand	15	335
Sand, some silt, and gravel	140	475
Sand	45	520
Sand, silty	5	525
Sand and silt, clayey	40	565
Sand, silty; some gravel and rock fragments	60	625
Sand and silt, clayey	30	655
Sand	44	699
16/33-32b2 (See University of Nevada, 1962, Appendix F)		
Sand, some silt and gravel	58	58
Sand, silty; some gravel	13	71
Sand and silt, clayey	11	82
Sand, silty; some gravel	31	113
Sand, silty; some gravel and rock fragments	52	165
Sand and silt, some gravel	39	204
Sand, gravelly	16	220
Sand, silty, water	94	314
Sand, gravelly	23	337
Sand; some silt and gravel	55	392
Sand and silt, gravelly	49	441
Sand, silty; some gravel	49	490
Sand and silt	40	530
Sand and silt, clayey	35	565
Sand, silt, and clay; some gravel	55	620
Sand and silt, clayey	65	685
Sand, clayey	10	695
Sand; trace of clay, silt, and gravel	70	765
Sand, silty; some gravel	48	813
Sand and silt; partly compacted	122	935
16/33-32c1		
Decomposed granite	335	335
Gravel and sand, water	30	365

Table 9.--continued

Material	Thickness (feet)	Depth (feet)
16/35-2a1		
Silt	7	7
Clay and gravel	23	30
Boulders, small	20	50
Clay and gravel	40	90
Gravel and sand	110	200
17/34-18c1		
Clay, gravel, and sand	316	316
Gravel, water	48	364
17/35-34d1		
Silt and sand	30	30
Clay	12	42
Sand and gravel	13	55
Clay and gravel	89	144
Gravel, coarse	4	148
Clay, white	22	170
Sandstone	53	223
Sand and silt, thin gravel layers	60	283
Clay, white	5	288
17/35-36a1		
Silt, sand, and clay	94	94
Sand and gravel	5	99
Clay, gray	48	147
Clay, brown , and gravel	23	170
Clay, gray	6	176
Clay, black	11	187
Clay, hard, gray	59	246
Clay, gray	28	274
Clay, black	54	328
Clay, hard, gray	10	338
Lime rock, white	30	368
Clay, white	11	379
Clay, brown	24	403
Clay, hard, brown	51	454
Clay, white	22	476
Clay, soft, brown	26	502

Material	Thickness (feet)	Depth (feet)
18/35-36c1		
Clay	7	7
Boulders and gravel	61	68
Clay, yellow	3	71
Boulders and gravel	37	108
Clay, yellow	2	110
Boulders and gravel	27	137
Clay, yellow	4	141
Boulders and gravel	67	208
Clay, yellow	1	209
Boulders and gravel	82	291
Clay and gravel	250	541
Gravel, water	7	548
Clay, brown	6	554
Gravel, water	5	559
Clay, brown	24	583
Gravel, water	23	606
19/34-21a1		
Sand and gravel	30	30
Boulders and gravel	205	235
Clay, gray	7	242
Boulders, gravel, and clay	77	319
Gravel, coarse, water	10	329
21/34-1c1		
Topsoil	25	25
Sand and gravel	65	90
Gravel	2	92
Sand and gravel	78	170
Sand	5	175
21/34-24a1		
Silt and clay	20	20
Sand and gravel, water	45	65
Gravel, coarse, loose	17	82
Clay	50	132
Clay, gray	28	160
Gravel and sand	18	178
Gravel, fine, loose	2	180
Gravel, coarse	16	196

Table 9. --Continued

Material	Thickness (feet)	Depth (feet)
21/34-24cl		
Topsoil	20	20
Sand and gravel	64	84
Clay	40	124
Gravel	21	145
Clay	8	153
Gravel	59	212
21/34-35dl		
Silt and gravel	45	45
Sand and gravel	21	66
Clay	25	91
Gravel	44	135
Sand and gravel, some clay	35	170
Sand, cemented	16	186
Gravel	14	200
Clay and sand	20	220
21/34-35d2		
Topsoil	22	22
Gravel	3	25
Sand and clay, brown	15	40
Sand and gravel	20	60
Clay, cemented, brown	38	98
Clay, cemented, red	18	116
Sand and gravel	84	200
Sand and gravel, layered	15	215
Sand and gravel, cemented	20	235
Sand and gravel, water	4	239
Clay and gravel, cemented	20	259

Material	Thickness (feet)	Depth (feet)
21/34-36cl		
Silt and clay	25	25
Sand and gravel	30	55
Clay and sand	8	63
Gravel	5	68
Clay	22	90
Sand	20	110
Gravel	20	130
Clay	2	132
Gravel	6	138
Sand and gravel	7	145
Gravel	13	158
Sandstone, soft	10	168
Clay	10	178
21/35-8cl		
Clay	6	6
Sand, coarse	4	10
Clay	4	14
Sand, coarse, blue	8	22
Clay	4	26
Sand	8	34
Clay	13	47
Gravel	13	60
Clay	12	72
Sand	6	78
Clay	26	104
Gravel	26	130

Table 9.--continued

Material	Thickness (feet)	Depth (feet)	Material	Thickness (feet)	Depth (feet)
21/35-8c2			21/35-19a2		
Topsoil	6	6	Silt	15	15
Sand	8	14	Sand, fine	5	20
Clay	8	22	Sand, coarse	11	31
Sand, coarse, blue	6	28	Gravel, fine	4	35
Clay	4	32	Clay	2	37
Sand, coarse, brown	13	45	Sand and gravel	4	41
Gravel and clay	7	52	Gravel	9	50
Clay	12	64	Boulders	15	65
Sand	17	81	Clay and sand	7	72
Clay	33	114	Gravel and boulders	23	95
Sand	6	120	Clay and sand	30	125
Clay	10	130	Clay	15	140
Gravel	25	155	Gravel, coarse	33	173
Clay	5	160	Boulder or rock	0	173
Gravel, coarse	8	168			
			21/36-19b1		
21/35-18a1					
			Clay and gravel	67	67
Silt and clay	20	20	Sand and gravel	21	88
Sand	10	30	Gravel, water	29	117
Clay	5	35			
Gravel, fine, and sand	27	62	22/36-14c1		
21/35-18c5					
			Gravel and small boulders	44	44
Silt and clay	16	16	Clay and gravel, yellow	54	98
Sand and gravel	14	30	Clay, yellow	4	102
Clay, gray	7	37	Boulders and gravel	40	142
Gravel, sand, and clay	49	86	Gravel, water	15	157
Clay, tough, blue	48	134	Clay and gravel	11	168
Clay, brown	5	161	Clay and boulders	16	184
Gravel, coarse, water	19	180	Boulders and gravel	4	188

Table 9--continued

Material	Thickness (feet)	Depth (feet)
26/39-11c1		
Topsoil	3	3
Clay	17	20
Clay and gravel	75	95
Clay	15	110
Clay and gravel	18	128
Clay	7	135
Clay and gravel	10	145
Gravel	3	148
Clay	5	153
Gravel	7	160
Clay	15	175
Gravel	10	185
Clay	5	190
Gravel	6	196
Clay	4	200
26/39-29d1		
Topsoil	17	17
Clay and gravel	43	60
Gravel and clay	8	68
Clay	7	75
Gravel and clay	32	107
26/39-30b1		
Topsoil	12	12
Clay and gravel	73	85
Gravel and clay	29	114

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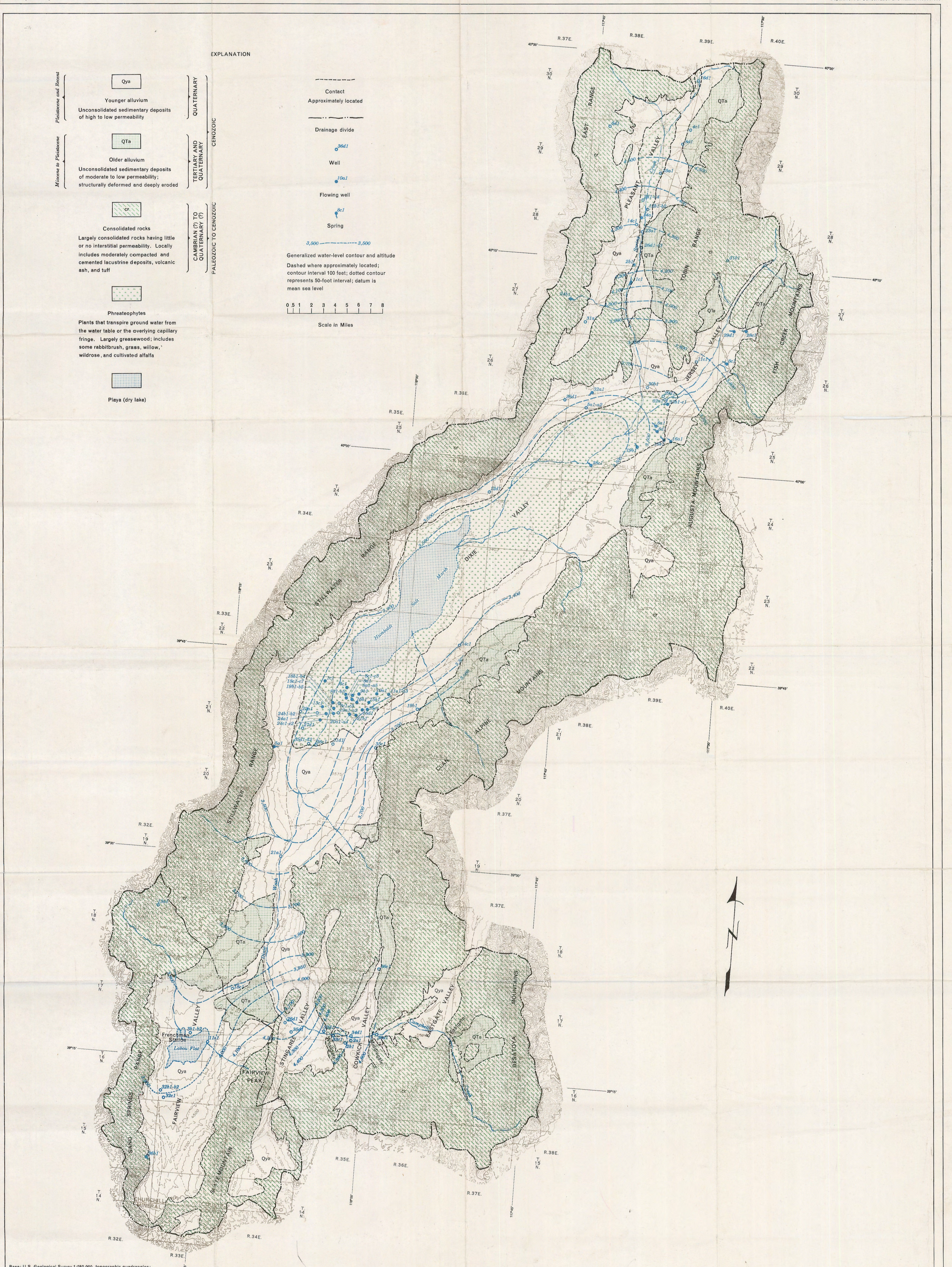

Base: U.S. Geological Survey 1:250,000 topographic quadrangles: Millet (1956), Reno (1960), and Winnemucca (1958)

Hydrogeology by Philip Cohen and D. E. Everett (1963)

PLATE 1.—GENERALIZED HYDROGEOLOGIC MAP OF THE DIXIE-FAIRVIEW VALLEY AREA, NEVADA