STATE OF NEVADA
DEPARTMENT OF CONSERVATION AND NATURAL RESOURCES
Carson City

View of Smith Creek Valley. *Photograph by Robert D. Lamke*

GROUND-WATER RESOURCES – RECONNAISSANCE SERIES

REPORT 28

GROUND–WATER APPRAISAL OF SMITH CREEK AND IONE VALLEYS, LANDER AND NYE COUNTIES, NEVADA

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Price $1.00

Prepared Cooperatively by the
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FOREWORD

Starting in 1960, as the result of legislative action, the United States Geological Survey has been carrying on a special ground-water reconnaissance program in cooperation with the State Department of Conservation and Natural Resources. This report, the 28th in the series, gives the ground-water appraisal of Smith Creek and Ione Valleys in Lander and Nye Counties.

This study was made and report prepared by D. E. Everett, Chemist, and F. Eugene Rush, Geologist for the 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

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GROUND-WATER APPRAISAL OF SMITH CREEK AND IONE VALLEYS, LANDER AND NYE COUNTIES, NEVADA

by

D. E. Everett and F. Eugene Rush

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SUMMARY

Smith Creek valley is a topographically and hydrologically closed valley; however, Ione Valley has surface and subsurface drainage through Ione Draw into Big Smoky valley. The source of practically all the ground water is precipitation within the drainage basins.

The estimated average annual increments of recharge to the ground-water reservoirs in Smith Creek and Ione valleys are 12,000 acre-feet and 8,000 acre-feet, respectively. Most of the ground water is discharged by evaporation from land surface, evapotranspiration by phreatophytes, and subsurface outflow through Ione Draw. The preliminary estimates of perennial yield are 10,000 acre-feet for Smith Creek valley and 6,000 acre-feet for Ione valley.

Most of the available ground water occurs in the alluvium; about 28,000 acre-feet is in storage in each saturated foot of alluvial deposits. Thus, a very large amount of ground water is in storage and is available as a reserve for pumping during periods of drought.

The available data indicate the ground-water generally is suitable for most agricultural uses; however, water beneath the playa in Smith Creek valley is highly mineralized and unsuitable for most uses.

Ground water at present is used mainly for domestic and stock supplies. Little or no ground water is used for irrigation. The most favorable areas for development are north and south of the playa in Smith Creek valley. About 400 acres of alfalfa and pasture grass is being irrigated with water diverted from Smith, Campbells, and Peterson Creeks.

INTRODUCTION

Purpose and Scope of the Study:

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

Recognizing this need, the State Legislature enacted special legislation (chapt. 181, Stats. 1960) for beginning a series of reconnaissance studies of the ground-water resources of Nevada. As provided in the legislation, these studies are being made by the U.S. Geological Survey in cooperation with the Nevada Department of Conservation and Natural Resources. This is the twenty-eighth report prepared as part of the reconnaissance studies (fig. 1).

The objectives of the reconnaissance studies and this report are to (1) appraise the source, occurrence, movement, storage, and chemical quality of the ground water, (2) estimate average annual recharge to and discharge from the ground-water reservoir, and (3) provide a preliminary estimate of the perennial yield of the basin.

The investigation was made under the general supervision of G. F. Worts, district chief in charge of hydrologic studies by the Geological Survey in Nevada.

Location and General Geographic Features:

Smith Creek valley is in west-central Nevada and is approximately enclosed by latitude 39°00' and 39°35' N., and longitude 117°25' and 117°45' W. It is largely in the southwestern part of Lander County; however, the southern part is in Nye County (pl. 1). Ione Valley lies immediately south of Smith Creek valley and is approximately enclosed by latitude 38°30' and 39°00' N., and longitude 117°30' and 117°50' W. It is in the northern part of Nye County; however, the extreme southern part is in Mineral County (pl. 1). The area comprising Smith Creek and Ione Valleys is about 70 miles long and ranges from 12 to 18 miles in width; its total area is about 1,075 square miles.

Principal access to the area is by U.S. Highway 50 which passes through Smith Creek Valley. A northeast-trending gravel road joins U.S. Highway 50 about 1 mile east of Campbells Creek Ranch and provides access to the western and northern part of Smith Creek valley. A south-trending gravel road at Peterson Station provides access to Ione Valley. Trails or unimproved roads provide access to other points in the area.

Physiography and Drainage:

Smith Creek valley is a hydrologically and topographically closed valley in the Great Basin Section of the Basin and Range physiographic province. It

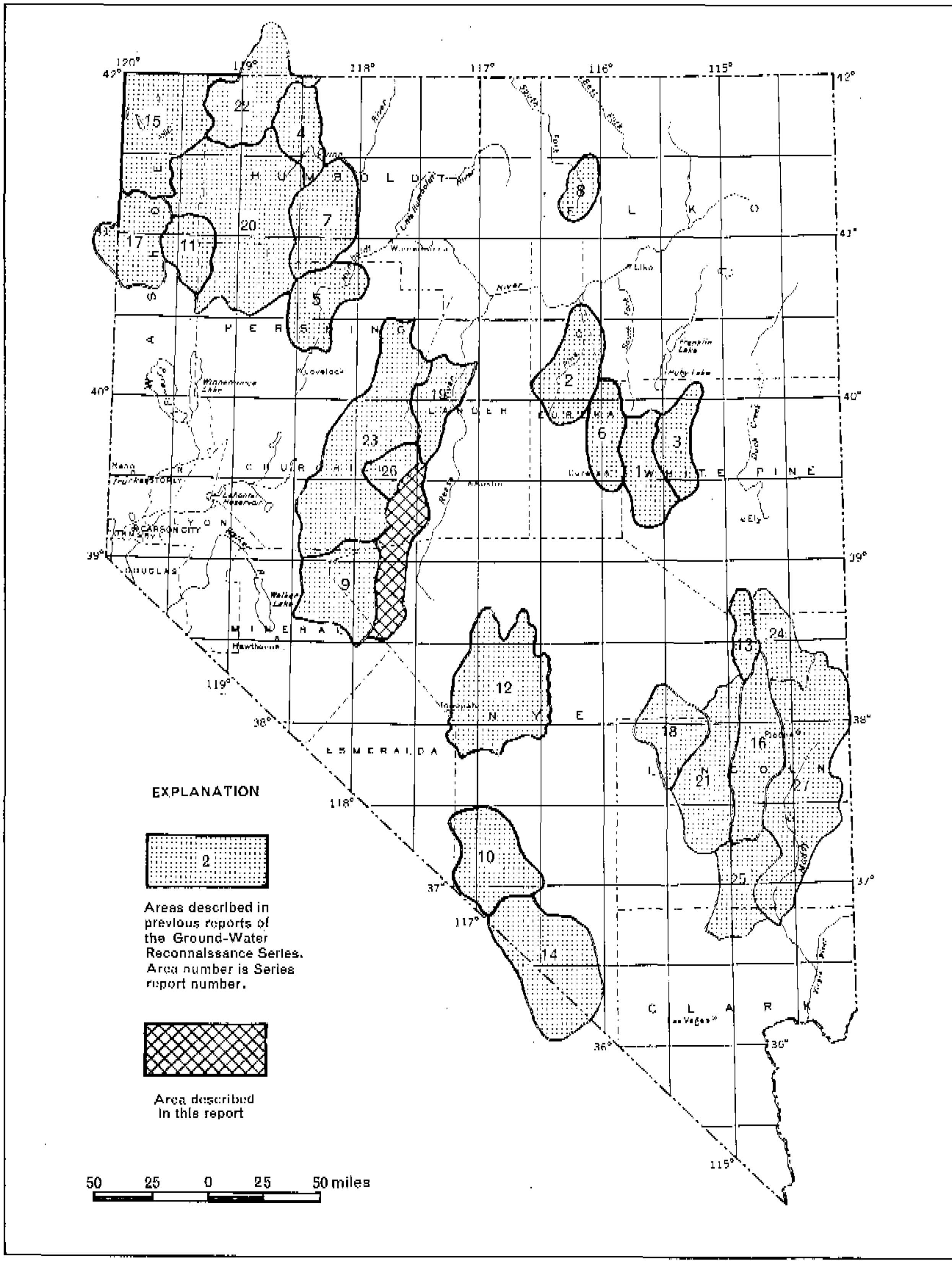

Figure 1. MAP OF NEVADA showing areas described in previous reports of the ground-water reconnaissance series and the area described in this report.

is a north-trending valley bordered on the east by the Shoshone Mountains, on the north by the New Pass Range, and on the west by the Desatoya Mountains. An alluvial divide, which separates Smith Creek and Ione Valleys, connects the Desatoya and Shoshone Mountains and forms the southern boundary.

North Shoshone Peak, altitude 10,350 feet, in the Shoshone Mountains, is the highest peak in the area. However, South Shoshone Peak has an altitude greater than 10,000 feet. Several other peaks in the area have altitudes greater than 9,000 feet. The lowest point in the valley, 6,050 feet, is at the playa. The maximum relief is about 4,000 feet.

Ione Valley, which is also in the Great Basin section of the Basin and Range physiographic province, is a north-trending valley bordered on the east by the Shoshone Mountains, on the west by the Paradise Range, and on the southwest by the Cedar Mountains.

The highest peak in the area, altitude 9,460 feet, is in the Shoshone Mountains. However, other peaks in the area have altitudes greater than 9,000 feet. The lowest point, Ione Draw at the south end of the valley, is at an altitude of 5,500 feet. Accordingly, the maximum relief is about 4,000 feet.

The principal surface drainage in Smith Creek Valley is toward the playa. In the valley lowland, south of the playa, the gradient is about 25 feet per mile, whereas north of the playa it is about 15 feet per mile. In Ione Valley, the principal drainage is through Ione Draw into Big Smoky Valley. In the valley lowland, the gradient is about 30 feet per mile. In the project area, gradients on the alluvial apron, which lies between the mountains and the lowlands, commonly range from 100 to 300 feet per mile. In the mountains, erosion has produced steep-sided canyons, and stream-channel gradients generally are in excess of 300 feet per mile. Locally they may be as much as 1,000 feet per mile. Along the main stream channel in central and southern Ione Valley, the toes of the alluvial fans have been removed by erosion resulting in the flood plain of the channel lying several tens of feet below the projected level of the fans.

Climate:

The climate in the project area generally is semiarid in the valleys and subhumid in the higher mountains. Precipitation and humidity generally are low, and summer temperatures and evaporation rates are high. Precipitation varies widely in amount but generally is least on the valley floor and greatest in the mountains. Snow is common during the winter months and localized thundershowers provide much of the summer precipitation. The daily and seasonal temperature ranges are relatively large.

Although records of precipitation are not available for Smith Creek or Ione Valleys, the magnitude of monthly and annual precipitation in the lower parts of the valleys may be approximately represented by the records for Eastgate, which is 7 miles west of the area. The record of precipitation for Austin, about 20 miles northeast of the area, may represent approximately the precipitation on the higher parts of the alluvial aprons. Only 7 years of data are available for Eastgate, but long-term data are available for Austin (table 1). These data indicate the general precipitation pattern in Nevada--the areas of lowest altitude commonly receive the least precipitation.

The average monthly and annual temperatures for the period of record at Eastgate and Austin are listed in table 2. The average growing season has not been determined, but an approximation may be obtained by reference to the upper Reese River area. Houston (1950, p. 16) states that the average growing season for the upper Reese River area is 117 days. This information suggests that the length of the growing season in Smith Creek and Ione Valleys also may be about the same, because these valleys border the reference area and are at about the same altitude.

Lower than normal amounts of precipitation have occurred in recent years, according to reports of local residents. The spring runoff from snowmelt in 1959, 1960, and 1961 was less than normal and the local hay production was small. The spring runoff in 1962, 1963, and 1964 was above normal, and the runoff was adequate for irrigation until about mid-June.

Table 1.--Average monthly and annual precipitation, in inches, at two stations near Smith Creek and Ione Valleys, 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
Austin 2/	1.14	1.14	1.46	1.64	1.43	.80	.60	.53	.48	.93	.85	1.06	12.06

1/ Altitude 5,020 feet. In sec. 25, T. 17 N., R. 36 E., 6 miles west of project area. Average for period 1949-50, 1957-61.

2/ Altitude 6,594 feet. In sec. 19, T. 19 N., R. 44 E., 18 miles east of project area. Average for period 1911-62; continuing record.

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Table 2.--Average monthly and annual temperature, in degrees Fahrenheit, at two stations near Smith Creek and Ione Valleys, Nev.

(from published records of the U.S. Weather Bureau)

	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	50.9
Austin 2/	28.6	31.4	3.60	43.8	51.6	60.6	70.4	68.4	60.2	49.4	38.0	31.7	47.5

1/ Period of record 1958-61.

2/ Average for period 1931-62; continuing record.

Surface-Water Features:

All streams in the project area are ephemeral; however, Smith, Campbells, and Peterson Creeks have some reaches that are perennial. The water from these streams is used to irrigate about 400 acres of alfalfa and pasture. Streamflow of Campbells Creek resulting from high-intensity storms or rapid snowmelt may flow several miles beyond the irrigated pasture in the western part of T. 16 N., R. 38 E., but perhaps only seldom reaches the playa. Streamflow of Smith Creek and Peterson Creek is stored in reservoirs and is used almost entirely for irrigation. Water is released only during periods of large runoff and probably rarely reaches the playa.

Although most of the water is used for irrigation, part is lost by evapotranspiration of natural vegetation and part seeps to the ground-water reservoir in the valley fill.

Numbering System for Wells and Springs:

The numbering system for wells and springs 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, southwest, and southeast 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 17/40-8c1 is the first well recorded in the southwest quarter of section 8, T. 17 N., R. 40 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 number indicating the order in which they were located. Township and range numbers are shown along the margins of the area on plate 1.

LITHOLOGIC AND HYDROLOGIC FEATURES OF THE ROCKS

In this report the rocks of the study area are grouped into three principal lithologic units: consolidated rocks, older alluvium, and younger alluvium. This division is based largely on the hydrologic properties of the rock units. The surface exposures of these units are shown on plate 1. The reconnaissance geologic information is based on field work and on aerial-photo interpretation by the authors.

The mountains in the project area are comprised mainly of consolidated rocks. These rocks range in age from Paleozoic to Cenozoic, but are principally of Tertiary age. Most of the consolidated rocks have little or no interstitial permeability; however, locally they transmit small to moderate amounts of ground water through fractures and other openings.

The older alluvium is characteristically late Tertiary to early Quaternary unconsolidated or poorly consolidated, dissected and commonly deformed, poorly sorted gravel, sand, silt, and clay. The deposits consist of terrace and fan gravels formed from debris derived from the mountains. By contrast, the younger alluvium generally is unconsolidated, undissected, and structurally undisturbed. It is composed of gravel, sand, silt, and clay deposited by streams during late Pleistocene and Recent Epochs. These deposits are better sorted and are more porous and permeable than the older alluvium.

During the late Pleistocene, two prominent lakes occupied Smith Creek valley. The largest occupied much of the northern half of the valley lowland. The highest recognized lake deposits, which mark the known maximum extent of the lake, are shown on plate 1. These deposits are at an altitude of about 6,200 feet and only about 25 feet lower than the low-point of the present divide at New Pass. New Pass probably was the control for the high level of the lake, and any excess water flowed westward through the pass into Edwards Creek valley.

A smaller late Pleistocene lake was in the southern part of Smith Creek valley, as shown on plate 1. This area was a topographically closed basin, but erosion since the desiccation of the lake has cut a surface drainage way through the bedrock constriction. The area now drains northward toward the playa in Smith Creek valley. The lake had its highest recognized shore line at an altitude of about 6,450 feet.

Faulting in the report area caused the rejuvenation of the streams that cross the faults. As a result, younger alluvium has been deposited locally on top of the older alluvial-fan deposits on the valley-floor side of the faults (pl. 1). The thickness of these younger deposits probably is controlled largely by the amount of vertical displacement of the faults. The amount of displacement is unknown; however, the thickness of the younger deposits is believed to be thin in most cases. No attempt has been made to show all the faults of the area; rather only those faults that cut the alluvium and are young enough to be visible in aerial photos are shown.

Most of the economically available ground water in the report area is stored in the younger and older alluviums which comprise the ground-water reservoir. The older alluvium, composed of low to moderately permeable silt, sand, and gravel, characteristically yields water to wells at low to moderate rates. Moderate to large water supplies can be developed in the younger alluvium where it is saturated.

GROUND-WATER HYDROLOGY

Source:

The source of the ground water is precipitation within the drainage basin. The mountains, which receive more precipitation than the lowlands, contribute most of the runoff and recharge to the basin. During the spring as the snow melts, some of the resulting streamflow infiltrates into cracks or other openings in the consolidated rocks and moves toward the valley as ground-water underflow. A small part of the precipitation on the alluvial apron and some of the streamflow crossing the alluvial apron also infiltrates to the ground-water reservoir in the alluvium. Because of the small amount of precipitation on the valley floor, very little precipitation infiltrates to the ground-water reservoir. However, during years of above-average precipitation, some rain probably percolates downward to the ground-water reservoir where the water table is only a few feet below land surface or where the capillary fringe extends to land surface.

Occurrence and Movement:

Little is known of the occurrence of the ground water in the report area; however, it probably occurs under both confined (artesian) and unconfined (water-table) conditions. Well 20/40-36b1, at the north end of Smith Creek valley in a spring area, was the only flowing well in the area. Its head probably does not represent the normal head in the area because the water has a temperature of 85°F, indicating deep circulation and possible association with local faults.

Several small springs were found along the mountain fronts, but their flow was generally less than 5 gallons per minute in April 1964 and probably is less during the summer. Along the southwest edge of the playa, a group of hot springs discharge water at a temperature of 209°F. It is reported by a local rancher that about 20 springs make up the group; however, the flow from each spring is small.

The thickness of the ground-water reservoir is not known; the deepest wells do not penetrate the full thickness of the alluvium. The deppest known well (19/38-19c1) was drilled to a reported depth of 600 feet.

In general, the movement of ground water is in the direction of surface flow; that is, from the mountain areas through the alluvium toward areas of discharge. In most of Smith Creek valley, the flow is toward the playa. However, in the southern-most part of Smith Creek valley the water levels in the few wells indicate that flow probably is toward Ione valley. The ground-water divide probably is about 8 miles north of the topographic divide where a bedrock constriction extends across the valley (plate No. 1). Flow in Ione valley is generally toward the axis of the valley and southward where ground water and surface water drain from the valley through Ione Draw.

Estimated Average Annual Recharge:

Recharge to the project area is derived from precipitation within the drainage area. However, only a small percentage of the precipitation recharges the ground-water reservoir. The estimated average annual recharge is computed as a percentage of the average annual precipitation within the valley--a method developed by Eakin and others, (1951, p. 79-81). The method is based on the assumption that a fixed percentage of the average annual precipitation ultimately recharges the ground-water reservoir. Because of the numerous variables that influence the percentage of precipitation that becomes recharge in any particular locality, the computations based on this method provide only highly generalized estimates.

The precipitation map of Nevada (Hardman and Mason, 1949, p. 10) has been adjusted (Hardman, oral communication, 1962) to the improved topographic base maps (scale 1:250,000) now available for the whole State. Hardman showed that the average annual precipitation is closely related to altitude. The altitude zones, the estimated average annual precipitation, and the percentage of precipitation in each zone that ultimately recharges the ground-water reservoir are listed in table 3. At altitudes below 7,000 feet in the project area, no recharge is assumed to occur, because this part of the valley is underlain by alluvium, and the small amounts of precipitation probably are not sufficient to penetrate to the water table.

The estimated average annual precipitation for Smith Creek and Ione Valleys is 276,000 acre-feet and 230,000 acre-feet, respectively, and the estimated average annual recharge is 12,000 acre-feet and 8,000 acre-feet, respectively or about 4 percent of the total precipitation.

Estimated Average Annual Discharge:

Prior to development by man, all the ground water in the area was discharged by evaporation, transpiration, and by surface and subsurface outflow to Big Smoky Valley. With the advent of mining and agriculture in the 1860's, spring flow was diverted and wells were pumped to satisfy irrigation, domestic, stock, and mining needs. The result has been a slight increase in the draft on the ground-water reservoir and a modest depletion of streamflow.

Much of the ground water discharged by evapotranspiration is consumed by phreatophytes. These plants grow in a band enclosing the playa in Smith Creek valley and along the main drainage channel in the southern half of Ione Valley. The principal phreatophytes are greasewood, rabbitbrush, and saltgrass. Cottonwood and willow are found along some of the principal mountain creeks and at some of the springs.

Table 4 lists the estimated average annual evapotranspiration for each valley. These estimates are based on the rates of evapotranspiration determined by Lee (1912), White (1932), Young and Blaney (1942), and Houston (1950). The estimated total average annual evapotranspiration of ground water

Table 3.--Estimated average annual precipitation and ground-water recharge in Smith Creek and Ione Valleys, Nev.

Altitude zone (feet)	Area (acres)	Estimated annual precipitation: Range (in inches)	Estimated annual precipitation: Average (in feet)	Estimated annual precipitation: Average (in acre-feet)	Estimated recharge: (assumed percentage of precipitation)	Estimated recharge: (acre-feet per year)
SMITH CREEK VALLEY						
Above 9,000	4,400	More than 20	1.75	7,700	25	1,900
8,000 to 9,000	21,100	15 to 20	1.46	30,800	15	4,600
7,000 to 8,000	71,700	12 to 15	1.12	80,300	7	5,600
Below 7,000	262,000	Less than 12	.60	157,000	0	0
Subtotal (rounded)	359,000			276,000		12,000
IONE VALLEY						
Above 9,000	1,500	More than 20	1.75	2,620	25	700
8,000 to 9,000	11,100	15 to 20	1.46	16,200	15	2,400
7,000 to 8,000	63,200	12 to 15	1.12	70,800	7	5,000
Below 7,000	233,000	Less than 12	.60	140,000	0	0
Subtotal (rounded)	309,000			230,000		8,000
TOTAL (rounded)	668,000			506,000		20,000

by phreatophytes is about 6,600 acre-feet in Smith Creek Valley and 1,300 acre-feet in Ione Valley.

Domestic and stock wells are numerous in both valleys; however, their total discharge in each valley is estimated to be less than 100 acre-feet per year.

Cold-water springs occur in both Smith Creek and Ione Valleys, but hot springs are found only in Smith Creek valley. The cold-water springs are numerous, but their flows are small and they commonly become dry in the summer. The total discharge of ground water from cold-water springs in each valley is estimated to be not more than 100 acre-feet per year. A group of about 20 hot springs are in sec. 23, and 24, T. 17 N., R. 39 E., on the northwest side of the Smith Creek valley playa. The flow from each spring is small but the water is nearly boiling. The springs appear to be associated with recent faults (pl. 1) which cut the younger alluvium. The estimated discharge of the hot springs is about 200 acre-feet per year.

Ground water outflow from Ione Valley occurs at Ione Draw (T. 8 N., R. 39 E.). No measurement of the outflow was made; however, it is estimated to be on the order of 2,000 to 3,000 acre-feet per year. This estimate is based on the assumption that the alluvium in the draw may have a transmissibility of about 50,000 gallons per day per foot, a ground-water gradient of about 40 feet in a quarter mile, and a draw width of a quarter of a mile.

In Smith Creek valley, runoff from snowmelt in Smith, Campbells, and Peterson Creeks is diverted for irrigation of alfalfa and pasture grass. The consumptive use of these crops is estimated to average about 1,000 acre-feet per year.

Leakage from the valleys through the bedrock to adjacent valleys having a lower altitude is a possibility, but there is no field evidence to indicate that it occurs. Ground water moving to the surface and then flowing from Smith Creek valley in a stream is not possible, and from Ione Valley is unlikely.

The estimated average annual discharge is summarized below:

Type of discharge	Smith Creek valley (acre-feet)	Ione valley (acre-feet)
Ground water:		
Evapotranspiration	6,600	1,300
Wells	100	100
Cold springs	100	100
Hot springs	200	0
Subsurface outflow	0	2,000 to 3,000
Leakage through bedrock	(unknown)	(unknown)
Surface water:		
Irrigation use (net)	1,000	0
Streamflow	0	trace
TOTAL (rounded)	8,000	3,500 to 4,500

The estimated total average annual discharge from Smith Creek valley is about 8, 000 acre-feet, and from Ione valley is about 4, 000 acre-feet.

Perennial Yield:

The perennial yield of a ground-water reservoir is the maximum amount of water of usable chemical quality that can be withdrawn economically each year for an indefinite period of time. If the perennial yield is continually exceeded, water levels will decline until the ground-water reservoir is depleted of water of usable quality or the pumping lifts become uneconomical to maintain. Perennial yield cannot, therefore, exceed the natural recharge to an area unless induced or artificial recharge is started. On the other hand, the yield may be limited to the amount of natural discharge that can be economically salvaged for beneficial use.

As defined, the maximum perennial yield is equal to the natural annual recharge to or discharge from the valleys. Under natural conditions, when the valley had no long-term net change in the volume of ground water in storage, the average annual recharge and discharge were equal. In Smith Creek valley, the estimated average annual recharge is 12, 000 acre-feet and the estimated average annual ground-water discharge is at least 7, 000 acre-feet. These quantities are not equal because of inaccuracies in the values used to compute the several elements of recharge and discharge. Because the two values theoretically should be equal and neither value in this study appears to be more exact, the preliminary estimate of the perennial yield is taken as the average of the two, or about 10, 000 acre-feet.

In Ione Valley, the estimated average annual recharge is 8, 000 acre-feet and the estimated average annual discharge is at least 4, 000 acre-feet. The preliminary estimate of the perennial yield for Ione Valley is also taken as the average of the two, or about 6, 000 acre-feet.

Storage:

The amount of ground water in the ground-water reservoirs of Smith Creek and Ione Valleys is equal to the volume of saturated material multiplied by the specific yield of the material. Specific yield is the ratio of the volume of water that will drain by gravity from the zone of saturation to the volume of the saturated material drained, commonly expressed as a percentage.

The specific yield of the uppermost 100 feet of saturated material in the two valleys probably is on the order of 10 percent. The estimated area underlain by 100 or more feet of saturated material is 280, 000 acres, or about 70 percent of the 400, 000 acres mapped as younger and older alluvium (pl. 1). Accordingly, the amount of ground water in storage in the uppermost 100 feet of the zone of saturation beneath this area is estimated to be 2, 800, 000 acre-feet, or about 28, 000 acre-feet for each foot of saturated material.

The volume of ground water recoverable from storage in the upper few feet of saturated deposits provides a large reserve for maintaining adequate supplies for pumping during extended periods of drought.

The amount of useable ground water in storage that is available on an economic basis depends in part on the distribution of water-storing deposits, the distribution and range in chemical concentration of the ground water, the number and distribution of wells, and the quantities of water withdrawn.

Chemical Quality:

Eleven water samples were analyzed as part of the present study (table 5) to make a generalized appraisal of the suitability of the ground water for agricultural use and to help define potential water-quality problems.

Suitability for Agricultural Use: According to the U. S. Department of Agriculture (1954, p. 69), 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 to other cations as "alkali hazard".

Specific conductance is used to express the salinity hazard because of its ease of determination and its relationship to 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	C-1
Medium	251 to 750	C-2
High	651 to 2, 250	C-3
Very high	Greater than 2, 250	C-4

The specific conductance of the samples taken range from 178 to 2, 460 micromhos per centimeter and the salinity hazard as defined range from low to very high.

Table 5.--Chemical analyses, in parts per million, of water from selected wells and springs in Smith Creek and Ione Valleys, Nev.
(Field analyses by the U.S. Geological Survey)

Location (well no.)	Date of collection	Temperature (°F)	Calcium (Ca)	Magnesium (mg)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Chloride (Cl)	Sulfate (SO_4)	Hardness as CaCo3: calcium-magnesium	Hardness as CaCo3: non-carbonate	SAR[1]	RSC (epm)	Specific conductance (micromhos at 25°C)	pH
13/38-19c1	3-31-64	45	66	16	248	0	24	118	229	26	1.7	0.00	663	8.2
14/39-17a1	3-30-64	50	24	1.9	205	0	6.2	20	68	0	1.6	.69	244	8.1
15/38-32c1	4-14-64	50	26	3.9	251	0	9.0	25	81	0	1.8	.89	310	7.[illegible]
15/39-22a1	3-30-64	--	4.3	.4	110	0	6.2	24	12	0	6.4	1.56	225	7.5
16/39-3b1	4-13-64	--	37	8.9	1,370	0	73	16	129	0	20	19.9	2,460	7.6
16/39-24a1	3-30-64	--	9.5	2.1	70	0	7.6	23	32	0	2.1	.51	178	7.7
17/40-8c1	4-14-64	52	22	2.2	136	0	23	32	64	0	2.8	.95	344	7.3
18/40-20b1	4-14-64	51	40	5.6	163	0	35	71	123	0	2.4	.21	514	7.7
19/40-16a1	4-14-64	58	21	2.8	113	0	17	40	64	0	2.4	.57	302	7.1
19/40-27c1	4-14-64	57	34	6.6	166	5	97	61	112	0	4.4	.48	750	8.4
20/40-36b1	3-30-64	85	42	20	180	8	19	74	187	40	1.1	.00	477	8.4

1. SAR values are approximate, because sodium was computed by difference.

Alkali hazard, as shown in figure 2, is related to both sodium-adsorption-ratio (SAR) and specific conductance. Sodium-adsorption-ratio is a relation of sodium to calcium and magnesium, expressed in equivalents per million (epm), and is defined in the following equation:

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

The SAR value for water is related to the experimentally determined adsorption of sodium by soil to which the water is added and is a direct means of estimating possible results of using a water for irrigation.

Figure 2 shows that all but one of the samples obtained in Smith Creek and Ione Valleys have a low alkali hazard and a medium to low salinity hazard. Water from well 16/39-3b1 has a very high alkali and salinity hazard and probably could not be used successfully for irrigation.

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 more than 2.5 epm of residual sodium carbonate is generally unsuitable for irrigation. The concentrations of calcium and magnesium are reduced because they have a tendency to precipitate as carbonates and the relative proportion of sodium is increased. 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. All except two of the samples analyzed probably are safe for irrigation on this basis. Water from spring 15/39-22a1 is marginal and water from well 16/39-3b1 probably is unsuitable.

Because no samples were analyzed for Boron content, the suitability of water for irrigation cannot be evaluated as to this element.

In summary, limits of tolerance for irrigation water vary with the crop and type of soil; however, in general water having a low salinity hazard, a low alkali hazard, less than 1.25 epm RSC, and an optimum boron concentration is suitable for irrigation.

Water Quality and its Relation to the Ground-Water System: The quality of ground water in the project area varies from place to place. However, in general, the dissolved-solids content is low in the recharge areas in the mountains and increases in the area of discharge in the lower parts of the valleys. For example, water from well 19/40-16a1 has a specific conductance of 302 micromhos per centimeter. The source of much of this water probably is recharge derived from precipitation on the nearby New Pass Range. As the ground water moves southward, it dissolves additional mineral matter. For example, the specific conductance of water from well 19/40-27c1 is 750 micromhos. However, farther southward, water from wells 18/40-20b1 and 17/40-8c1 have specific-conductance values of 514 and 344 micromhos, respectively.

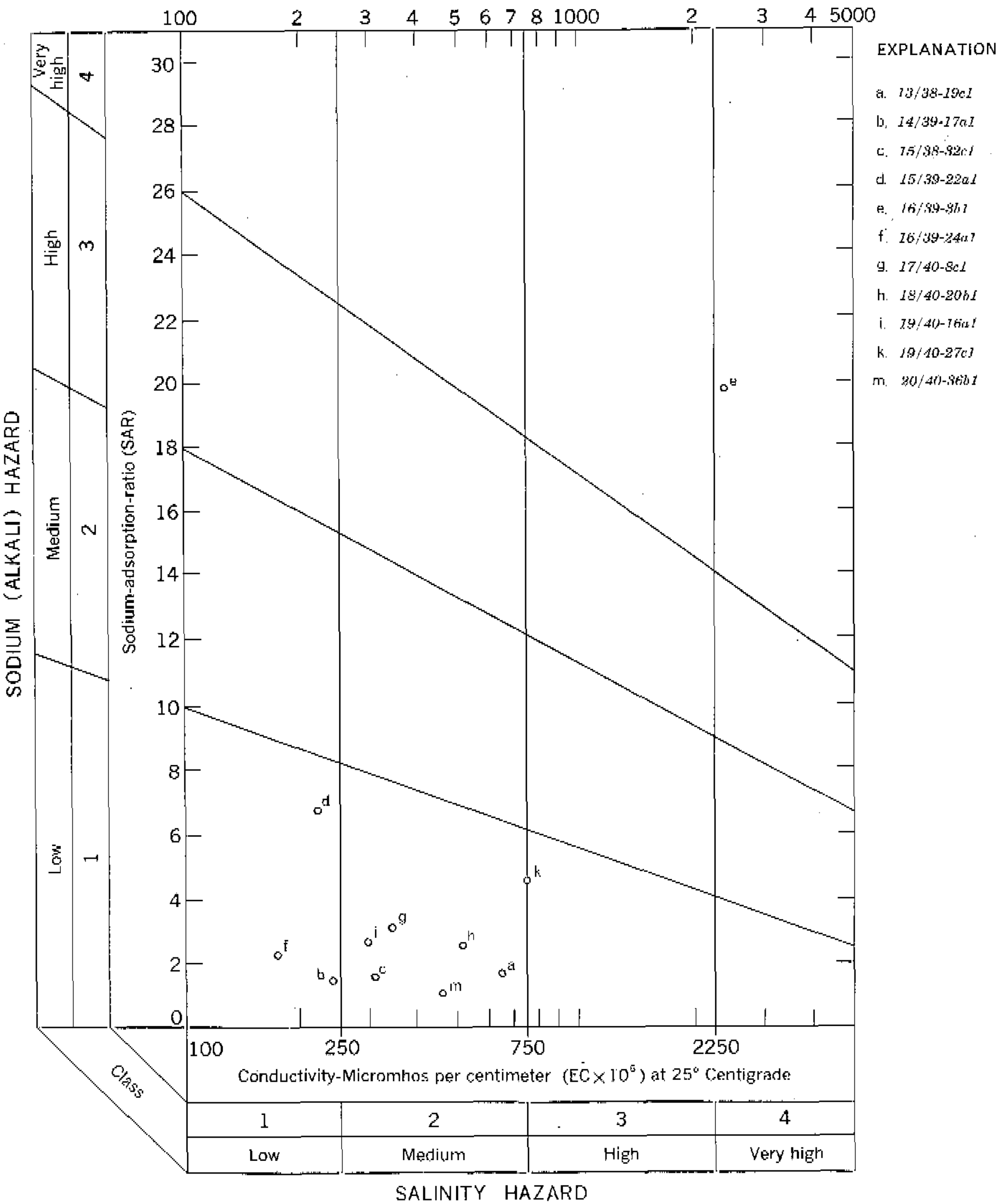

Figure 2.—Classification of irrigation water in the Smith Creek-Ione Valley area, based on conductivity and sodium-adsorption ratio. (After U. S. Department of Agriculture, 1954)

This decrease in specific conductance probably is due to recharge resulting from precipitation on the Desatoya Mountains, a short distance west of the wells.

Most of the ground water in the area is a sodium bicarbonate type. However, water from well 19/40-27c1 is a mixed sodium bicarbonate-chloride type and water from well 20/40-36b1 is a calcium bicarbonate type. Water from springs 13/38-19c1 and 14/39-17a1 are a calcium bicarbonate and a mixed calcium-sodium bicarbonate type, respectively.

In May 1964, several shallow small-diameter observation wells were constructed on the playa in Smith Creek valley. These wells range in depth from 12 to 105 feet. Preliminary data on the quality of water beneath the playa show that the water is highly mineralized, having specific-conductance values as high as 71,400 micromhos per centimeter. The quality varies with depth and location but generally the water is more highly mineralized in the shallow observation wells in the central part of the playa and along the eastern margin.

Development:

Present development of water in Smith Creek valley consists of irrigation of about 160 acres of alfalfa and pasture from Smith Creek, 160 acres of alfalfa and pasture from Campbells Creek, and 100 acres of alfalfa from Petersons Creek. Additionally, a small amount of ground water from flowing or pumped wells supplies livestock and domestic requirements. The total amount of surface and ground water used is only a little more than 1,000 acre-feet per year.

Additional development of ground water in Smith Creek valley is possible. Although data are not available, general geologic and hydrologic conditions suggest that areas north and south of the playa may be the most favorable areas for the development of moderate to large capacity wells, where depths to water are moderate and where the chemical quality of the ground water may be relatively good. However, this does not preclude other areas as being suitable for development. The combination of good water-yielding zones, moderate to shallow depth to water, and suitable chemical quality results in an area favorable for development of ground water. In Smith Creek valley these conditions might be expected generally along the lower parts of the alluvial apron and upper parts of the valley lowlands, marginal to the area of discharge.

The only development of ground water in Ione Valley consists of pumped wells which supply domestic and livestock requirements. The total amount of ground water used is only about 200 acre-feet per year.

Additional ground-water development may be possible in the southern part of Ione Valley where the depth to water is shallow. However, no data are available regarding the chemical quality of the water or whether the alluvium in this area will yield large quantities of water to wells.

Table 6.--Records of selected wells in Smith Creek and Ione Valleys, Lander and Nye Counties, Nevada

Type of well: Dr, drilled; A, augered
Pressure head or water level: M, measured; R, reported
Depth: M, measured; R, reported
Use: D, domestic; I, irrigation; S, stock; T, test well; U, unused

Well number or location	Owner	Type of well	Date completed	Casing diameter (inches)	Depth (feet)	Pressure head or water level: Below land-surface datum (feet)	Pressure head or water level: Date measured or reported	Use	Remarks
10/38-21b1	U.S. Indian Service	Dr.	--	6	128 R	46.1 M	3-31-64	S	Log, table 7.
11/38-14c1	U.S. Indian Service	Dr.	--	6	124 M	81.5 M	3-31-64	S	Log, table 7.
12/38-14a1	Katherine Burbank	Dr.	--	6	300 R	185 R	1-16-62	D	Log, table 7.
13/38-25b1	Yomba Cattlemans Assn.	Dr.	--	6	351 R	310 M	3-31-64	S	
14/38-19c1	Campbells Creek Ranch	Dr.	--	8	600 R	405 M	3-31-64	S	
15/37-13d1	Campbells Creek Ranch	Dr.	--	6	54 R	29 R	4-01-64	S	
15/38-32c1	Campbells Creek Ranch	Dr.	--	6	350 R	310 R	4-01-64	S	
16/38-24a1	Campbells Creek Ranch	Dr.	5-14-64	12	180 R	41.9 M	5-11-64	I	Water temperature 53°F.
16/39- 3b1	--	--	--	48	--	10.5 M	4-01-64	S	
16/39-24a1	State of Nevada	Dr.	--	--	79 R	28 R	4-01-64	D	
16/40- 5a1	U.S.G.S.	A	4-01-64	--	12 M	10.5 M	4-01-64	T	
17/40- 8c1	--	Dr.	--	6	--	12.6 M	4-01-64	S	Log, table 7.
17/40-9d1	U.S.G.S.	A	4-01-64	--	12 M	9.5 M	4-01-64	T	
17/40-22c1	U.S.G.S.	A	4-01-64	--	12 M	9.0 M	4-01-64	T	
17/40-34c1	--	Dr.	--	6	--	24.9 M	5-18-64	U	
18/40-20b1	--	Dr.	--	6	--	--	4-01-64	S	
18/40-23c1	--	Dr.	--	8	106 M	60.6 M	4-01-64	S	
19/40-16a1	--	Dr.	--	--	--	134 M	4-01-64	S	
19/40-27c1	--	Dr.	--	8	120 M	89.5 M	4-01-64	S	
20/40-36b1	--	Dr.	--	6	--	(flowing)	4-01-64	-	Estimated discharge 5 gpm.

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Table 7.--Drillers' logs of selected wells in Smith Creek and Ione Valleys, Nevada

Material	Thickness (feet)	Depth (feet)
10/38-21b1		
Silt	18	18
Clay	24	42
Gravel	6	48
Clay	34	82
Coarse gravel	3	85
Clay, red	43	128
11/38-14c1		
Silt	32	32
Gravel, tight	11	43
Clay and gravel	42	85
Boulders, sand, and gravel	17	102
Gravel and clay	18	120
Sand, coarse	28	148
12/38-14a1		
Soil	7	7
Silt and gravel	28	35
Clay and gravel	80	115
Gravel and boulders	45	160
Clay and sand	30	190
Sand and gravel	35	225
Clay	17	242
Clay and gravel	18	260
Gravel and boulders	40	300
13/38-25b1		
Silt	27	27
Clay and gravel	143	170
Boulders	5	175
Clay and gravel	155	330
Gravel, coarse	21	351
17/40-8c1		
Clay	5	5
Clay, blue	14	19
Gravel	3	22
Sand, blue	23	45
Gravel	2	47
Sand, blue	8	55

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UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

STATE OF NEVADA
DEPARTMENT OF CONSERVATION AND NATURAL RESOURCES

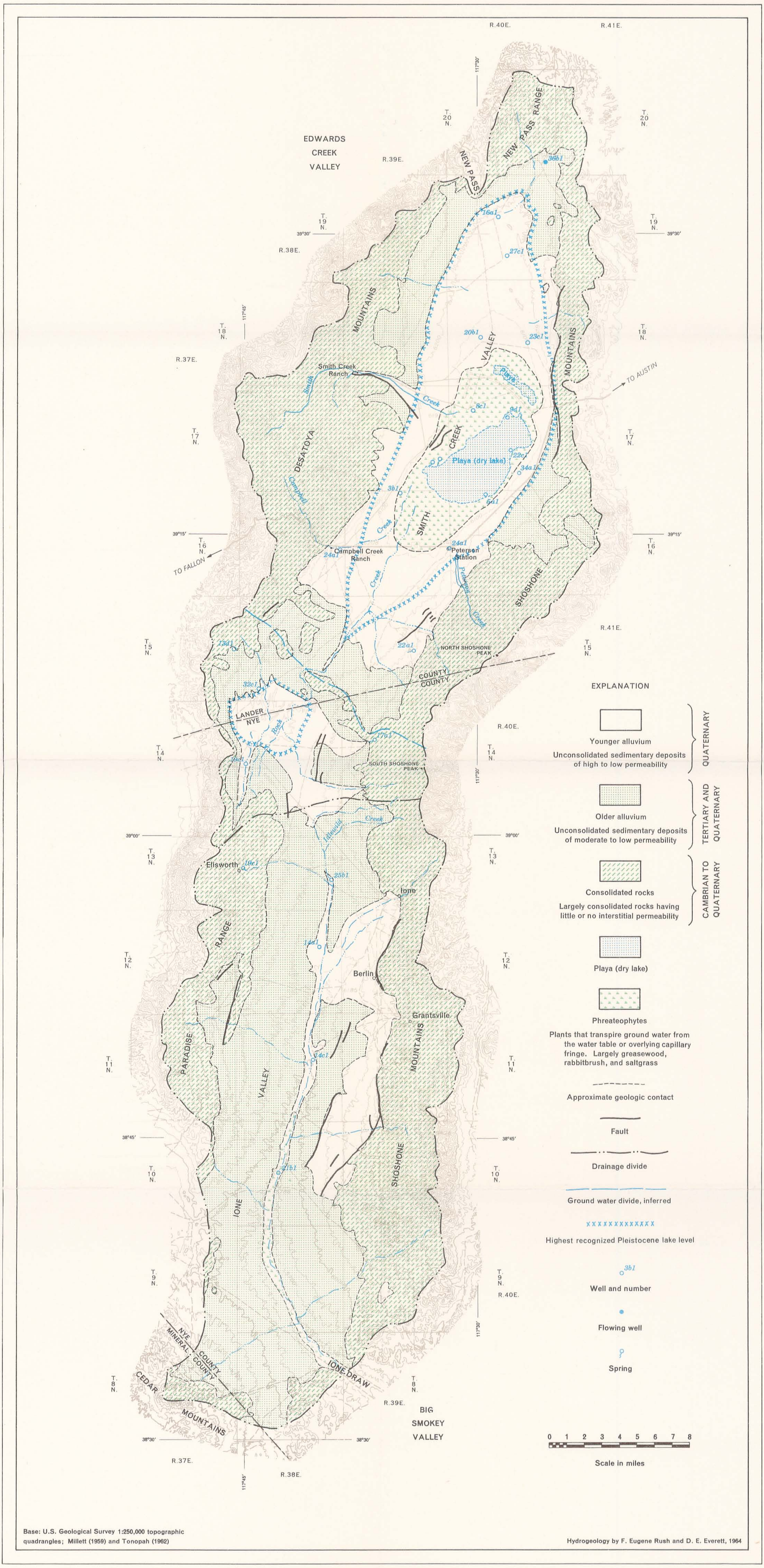

PLATE 1.—GENERALIZED HYDROGEOLOGIC MAP OF SMITH CREEK AND IONE VALLEYS, NEVADA