STATE OF NEVADA
DEPARTMENT OF CONSERVATION AND NATURAL RESOURCES
Carson City

View northeast showing mouth of Antelope Valley

GROUND-WATER RESOURCES – RECONNAISSANCE SERIES
REPORT 19

GROUND–WATER APPRAISAL OF ANTELOPE AND MIDDLE REESE RIVER VALLEYS, LANDER COUNTY, NEVADA

By
E. G. CROSTHWAITE
Geologist

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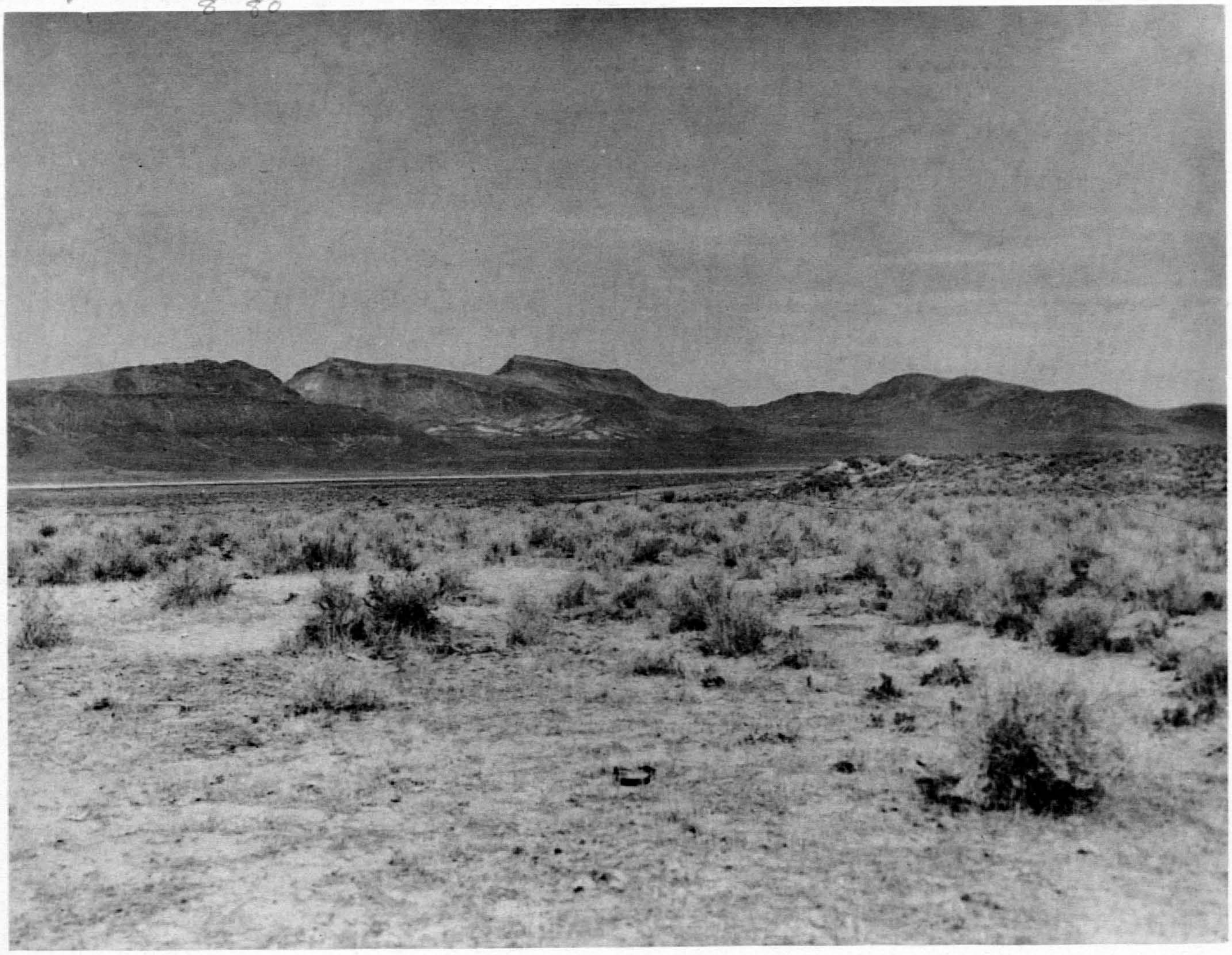

View northwest across Middle Reese River Valley toward the Fish Creek Mountains.

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16. Ground-Water Appraisal of Dry Lake and Delamar Valleys, Lincoln County, Nevada. May 1963, by Thomas E. Eakin.

17. Ground-Water Appraisal of Duck Lake Valley, Washoe County, Nevada. June 1963, by William C. Sinclair.

18. Ground-Water Appraisal of Garden and Coal Valleys, Lincoln and Nye Counties, Nevada. July, 1963. by Thomas E. Eakin.

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GROUND-WATER APPRAISAL OF ANTELOPE AND MIDDLE REESE RIVER VALLEYS, LANDER COUNTY, NEVADA.

by
E. G. Crosthwaite.

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SUMMARY

Antelope and Middle Reese River Valleys are underlain by valley fill, which is the principal source of ground-water supply. For Antelope Valley the estimated average annual recharge and discharge is in the range of 7,000 to 11,000 acre-feet, and the estimated perennial yield is about 9,000 acre-feet; pumpage in 1962 was about 700 acre-feet. For Middle Reese River valley the estimated average annual recharge and discharge is about 14,000 acre-feet, and the estimated perennial yield is the same; pumpage in 1962 was about 2,300 acre-feet. Most of the natural discharge from the two valleys is by underflow through the valley fill. Because these valleys are hydrologically part of the overall Reese River system, development in upstream areas may somewhat reduce the supply reaching the study area; similarly, substantial development in Middle Reese River valley may reduce the supply reaching downstream areas.

Natural discharge could be reduced by pumping, but an appreciable thickness of the saturated valley fill would have to be dewatered before any significant reduction in natural discharge would occur. Pumping in Middle Reese River valley probably will have very little effect on increasing discharge from Antelope Valley, but if any significant lowering of water levels should occur in lower Antelope Valley, discharge from Antelope Valley to Middle Reese River valley would be reduced.

The amount of ground water in storage is estimated to be on the order of 10,000 acre-feet per foot of saturated thickness of valley fill within an area of 100,000 acres in the two valleys. This indicates that there is a very large amount of ground water in storage which is available for pumping during periods of drought or other emergencies.

About 48 wells have been drilled for irrigation. Reported yields range from 500 to 3,200 gpm (gallons per minute) and drawdowns range from 7 to 130 feet. The average specific capacity of 12 wells in Antelope Valley is 100 gpm per foot of drawdown and the average of 12 wells in Middle Reese River valley is 60 gpm per foot of drawdown. Computations suggest that a well in Antelope Valley pumping 2,000 gpm for 100 days may affect water levels as far away as 10,000 feet from the well. Under the assumed conditions a drawdown of about 2 feet may be expected in wells half a mile from the pumped well.

Three chemical analyses of ground water suggest that locally some of the ground water may have a medium to high salinity hazard. Ground water has been used for 12 years to irrigate alfalfa and meadow hay with no apparent serious effects on these crops.

The U. S. Bureau of Land Management has classified about 28,600 acres as suitable for agricultural development and issued patents on about 1,200 acres. About 23,000 acres are under Desert Land Entry applications.

Because of the rapid rate of ground-water development since 1959, an intensive basic data program should be started to provide the necessary information for future, more detailed studies and for administration of the two valleys.

INTRODUCTION

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

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

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

Additionally, the Department of Conservation and Natural Resources has established a special report series to expedite publication of the results of these reconnaissance studies. Figure 1 shows the areas for which reports have been published in this series. This report, the nineteenth in the reconnaissance series, describes the physical conditions of Antelope and Middle Reese River valleys and includes observations of the interrelation of climate, geology, and hydrology as they are related to the ground-water resources. The report also includes preliminary estimates of the average annual recharge to, discharge from, and the perennial yield of the two ground-water reservoirs.

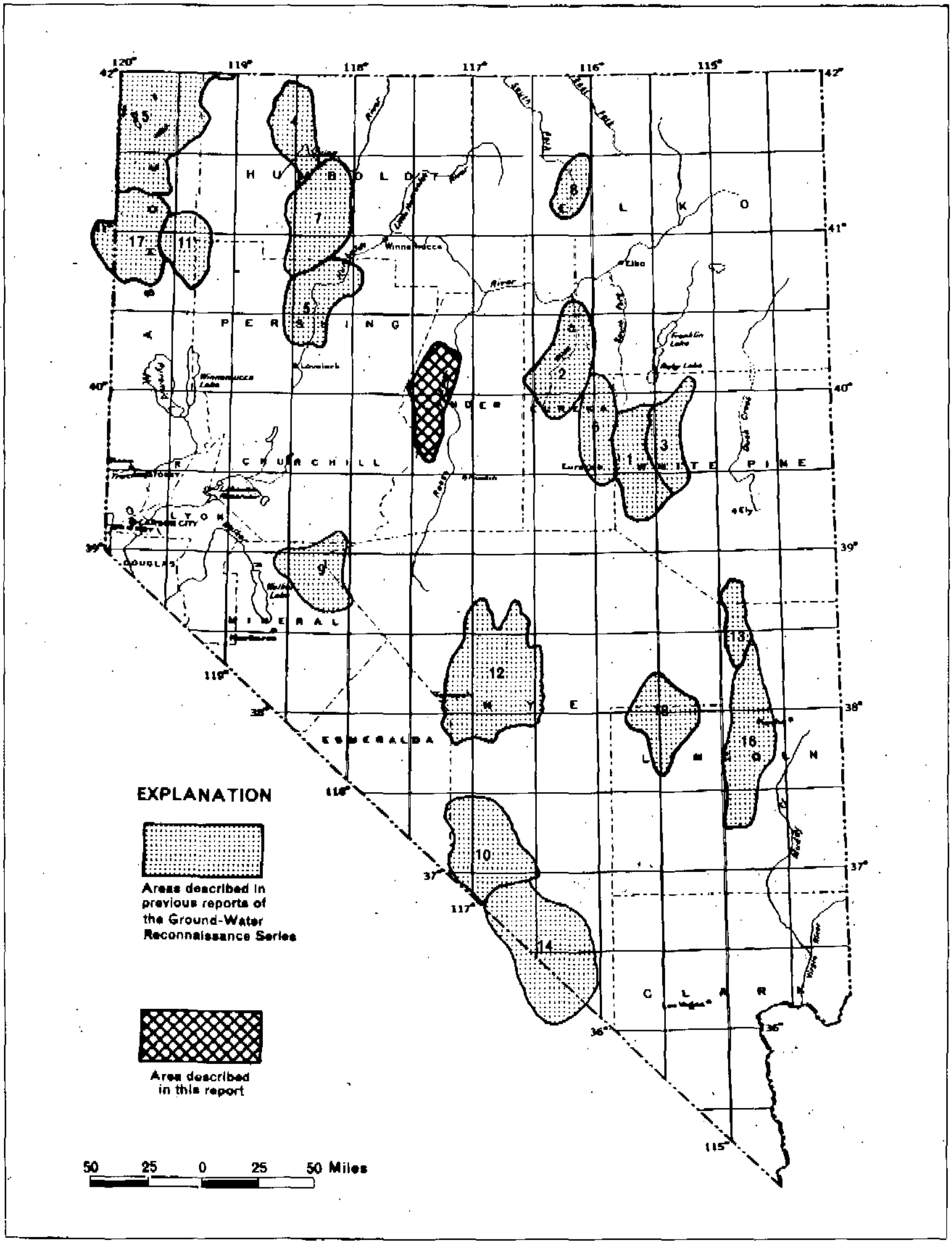

Figure 1.— MAP OF NEVADA showing areas described in previous reports of the Ground-Water Reconnaissance Series and the area of this report.

Location and General Features of the Area

Antelope and Middle Reese River valleys, in west-central Lander County, Nev., lie within an area enclosed by about latitude 39°30' N. and 40°15' N. and longitude 117°0' W. and 117°35' W. (pl. 1). Antelope Valley is about 45 miles long and 12 miles wide and includes a drainage area of about 460 square miles. The long axis of the valley trends northward. Antelope Valley is southwest of and tributary to Middle Reese River valley. Middle Reese River valley, as here defined, extends northward about 20 miles from the mouth of the Reese River canyon and includes a drainage area of about 320 square miles, excluding Antelope Valley and the drainage area upstream from the mouth of the canyon. The maximum width of this part of the Reese River drainage area is about 25 miles. Reese River is an ephemeral stream that is tributary to the Humboldt River, about 30 miles north of the area; however, it rarely discharges into the Humboldt River.

The lowest part of Middle Reese River valley is 4,750 feet above sea level and the lowest part of Antelope Valley is about 4,900 feet.

The Shoshone Mountains form the east sides of both Middle Reese River and Antelope Valleys. Crest altitudes of the Shoshone Mountains exceed 7,000 feet above sea level in the Middle Reese River valley segment and 7,500 feet adjacent to Antelop Valley. The Fish Creek Mountains bound the northwest side of Middle Reese River valley and the north side of Antelope Valley. Their crest altitudes average about 7,000 feet with peaks above 8,400 feet. The Augusta Mountains, having altitudes comparable to the Fish Creek Mountains, form the west side of Antelope Valley. The New Pass Mountains are at the south end of Antelope Valley, and bedrock spurs connect with the Augusta Mountains to the north and the Shoshone Mountains to the east. The highest altitude in the New Pass Mountains is almost 9,000 feet above sea level.

Direct access to Middle Reese River valley is by paved State Highway 8A, which connects with U.S. Highway 40 to the north and U.S. Highway 50 to the south. A graveled county road provides access to Antelope Valley from the Middle Reese River valley, and graded dirt roads connect the west and south sides of Antelope Valley with adjacent areas.

Economic Development

Until recently both valleys were used principally for livestock range. Two active ranches are in the Middle Reese River valley, and one ranch, now largely unused, is in Antelope Valley. About a dozen wells and half a dozen springs supply water for livestock. Mining used to be a principal part of the economy in the nearby mountains, but now only one mine in the New Pass Mountains is active.

Ground-water irrigation was started in about 1950 when two wells were drilled--one to irrigate alfalfa on the Fish Creek Ranch and one to supplement the flow of the hot springs on the Hot Springs Ranch (fig. 5). The latter is used to irrigate meadow and alfalfa. In 1959 eight irrigation wells were drilled to test whether the valley fill could yield water in quantities sufficient for irrigation. Five of the wells were drilled in Antelope Valley and three wells in Middle Reese River valley. Since that time more than 50 applications for desert land entries have been filed with the U. S. Bureau of Land Management, and the number may eventually reach 100. In 1962 about 18 wells supplied some irrigation water to about 2, 500 acres of land. Probably about 2, 000 acres was harvested. About 50 irrigation wells have been drilled and several more are planned.

Climate

The climate of central Nevada generally is semiarid in the valleys and subhumid in the higher mountains. In the valleys precipitation and humidity are generally low, and summer temperatures, wind movement, and evaporation rates are high. Precipitation is greatest in the higher mountains. Most of the winter precipitation occurs as snow and is moderately well distributed over several months. Summer precipitation commonly is localized as thundershowers. The range in temperature is large, both daily and seasonally. The growing season is relatively short.

Precipitation has been recorded at Austin, about 30 miles south of the project area, since 1877, but the record has broken periods from 1879-90, 1898-1900, and 1908-11. The average annual precipitation for the period of record is 12. 06 inches. The precipitation record at Battle Mountain, about 30 miles north of the project area, has been continuous since 1870. Average annual precipitation at Battle Mountain is 6. 64 inches. Maximum precipitation occurred at Austin in 1891 when 21. 07 inches was recorded, and the minimum was 5. 90 inches in 1959. At Battle Mountain, the maximum precipitation recorded was 14. 03 inches in 1884 and the minimum was 2. 40 inches in 1918. The average monthly and annual precipitation is given in table 1.

Generally, precipitation on the floors of Antelope and Middle Reese River valleys averages 8 inches or less. The average precipitation on the surrounding mountains is much greater, and in the higher parts of the New Pass, Augusta, Fish Creek, and Shoshone Mountains may exceed 20 inches.

The mean annual temperature for the period of record at Austin and Battle Mountain is 47. 5°F and 48. 8°F, respectively. Extremes of temperature at Austin for the period of record are 105°F on August 4, 1922, and August 20, 1931, and -25°F on January 19, 1922. At Battle Mountain the recorded extremes are 109°F on July 19, 1923, and -40°F on January 20, 1937. Mean monthly and annual temperatures at the two stations are shown in table 2.

Houston (1950, p. 14, 16) lists the growing season in the Middle Humboldt River (Battle Mountain) and Upper Reese River (Austin) areas as 120 and 117 days, respectively. These data suggest that the length of the growing season in Antelope and Middle Reese River valleys is about the same (approximately May 26 to September 23). Obviously, the growing season varies considerably from year to year in accordance with the weather pattern. Locally, the growing season will vary from place to place because of variations of topography, orientation, and exposure.

Physiography and Drainage

Antelope Valley is an intermontane valley, is elongate in a northerly direction, and is tributary to the Reese River. It is a hydrologic and a drainage unit surrounded by mountains, except on the northeast side where ephemeral Cane Creek drains the valley through a narrow bedrock gap to the Reese River. This stream is fed principally by runoff from the south slope of the Fish Creek Mountain and the east slope of the Augusta Mountains. Antelope and Gilbert's Creeks and other ephemeral streams which drain the south part of Antelope Valley occasionally discharge water to Cane Creek.

The northern one-fourth of the valley floor has a gradient of about 20 feet per mile. The southern part of the valley is characterized by a gentle northward gradient; however, many low hills rise several tens of feet above the general land surface at several places. Many stream channels extend across the slopes from the foot of the bordering mountains to the valley lowlands.

The lowland of Middle Reese River valley ranges in width from 1 to 3 miles and slopes northward at an average gradient of about 15 feet per mile. Alluvial fans rise from the valley floor and form aprons at the foot of the bordering mountains. Several bedrock hills rise from a few to several tens of feet above the valley floor. Reese River is an ephemeral stream in most of the reach across the valley but its channel contains a small perennial flow most of the time for a short distance below the Hot Springs Ranch. The water is largely waste from irrigation.

Surface Water

No perennial streams occur in Antelope and Middle Reese River valleys and Cane Creek and Reese River carry water only infrequently. They commonly flow only after intense thundershowers or during periods of extremely rapid snowmelt. Persons working in and near the area report that flow may occur for a few hours two or three times a year in the main-stem channels. Thus, occasional flood flows of short duration enter and cross Middle Reese River valley from Upper Reese River valley and from Antelope Valley and discharge into Lower Reese River valley.

Record-breaking floods occurred in northeastern Nevada in February 1962 (Thomas and Lamke, 1962, p. 5) and the normally dry Reese River flooded Battle Mountain. Reportedly, Antelope Valley and Upper Reese River valley contributed a significant but unknown part of the flood flow. E. E. Harris (oral communication, May 2, 1963) estimated that the peak flow in Reese River Canyon, just upstream from Middle Reese River valley, was about 400 cubic feet per second. A flood of similar magnitude occurred in 1910.

Streamflow of short duration in Cane Creek and Reese River probably contributes only a small amount of recharge to the ground-water reservoir in Middle Reese River valley. For the most part the channel of Cane Creek

Table 1.--Average monthly and annual precipitation, in inches, at two stations near Antelope and Middle Reese River valleys, (from published records of the U.S. Weather Bureau)

Station	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
Austin[1]	1.14	1.14	1.46	1.64	1.43	0.80	0.60	0.53	0.48	0.93	0.85	1.06	12.06
Battle Mountain[2]	.79	.69	.64	.75	.79	.54	.19	.16	.28	.51	.56	.74	6.64

1. Altitude 6,594 feet. Location Sec. 19, T. 19 N., R. 44 E. Period of record 1911-62 (continuing)
2. Altitude 4,513 feet. Location Sec. 35, T. 32 N., R. 45 E. Period of record 1870-1962 (continuing)

Table 2.--Average monthly and annual temperatures, in degrees Fahrenheit, at two stations near Antelope and Middle Reese River valleys (from published records of the U.S. Weather Bureau)

Station	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
Austin[1]	28.6	31.4	36.0	43.8	51.6	60.6	70.4	68.4	60.2	49.4	38.0	31.7	47.5
Battle Mountain[1]	26.1	32.8	38.9	46.8	55.7	64.3	73.9	70.5	60.2	49.7	37.3	29.2	48.8

1. Partial records from 1920-62.

is shallow and narrow and is cut in heavy soil. The channel of Reese River is 5 to 10 feet deep and 20 to 40 feet wide. The bottom and sides of the channel consist of clay, silt, and fine sand containing a few small stringers of sand and gravel. When the carrying capacity of the channel is exceeded, flood waters spread over heavy fine-grained soils. The low permeability of the material mantling the stream beds and flood plain suggest that seepage losses during flood stages in Cane Creek and Reese River probably are low.

Fish Creek in the Fish Creek Mountains is a perennial stream and Cottonwood Creek, also in the Fish Creek Mountains, probably has some reaches that are perennial, but both streams are ephemeral in the lowlands.

GENERAL GEOLOGY

Ferguson, Muller, and Roberts (1951) mapped the geology of the Middle Reese River valley and the northern part of Antelope Valley. Waring (1917) prepared a reconnaissance geologic map of the Reese River drainage basin. These two reports, field inspection, and photogeology techniques were used in compiling the geology of the two valleys shown on plate 1.

In this report the geologic units are divided into two general groups; bedrock in the mountains and valley fill in the lowlands. The valley fill is further divided into two major units. The distribution of the three units is shown on plate 1.

The bedrock includes slate, quartzite, limestone, and altered basic lava flows and pyroclastic rocks of Paleozoic age; limestone, dolomite, quartzite, shale, chert, sandstone, conglomerate, and granitic rocks of Mesozoic age; and volcanic and clastic rocks of Tertiary age. These rocks crop out in the mountains and underlie the valley fill at depth.

The valley fill includes some pyroclastic material, clay, silt, sand, gravel, and marl of Tertiary age, and clay, silt, sand, and gravel of Quaternary age. The sedimentary deposits of Tertiary age are moderately consolidated, whereas the deposits of Quaternary age are largely unconsolidated. The general character of the valley fill is shown by the drillers' logs in table 8.

Bedrock in the Mountains

During Tertiary time the entire area probably was covered by volcanic rocks. The older bedrock units now are exposed where erosion has cut through them and where faulting has brought them to the surface. Rhyolite is the dominant lava, andesite is common, and a few outcrops of basalt were observed. They are interbedded with sandstone, tuff, and other debris derived from the volcanic rocks. Ferguson, Muller, and Roberts (1951) estimate that the rhyolite and andesite attain a maximum thickness of 2,500 feet in the Fish Creek Mountains. The sandstone and tuffaceous deposits make the total thickness of the rocks of Tertiary age much greater. Faulting and erosion have exposed small areas of the older bedrock at scattered localities throughout the area. The bedrock has been greatly deformed by folding and faulting. Most of the major faults occur at or near the foot of the mountains along the contact between the bedrock and valley fill. Several major faults are shown on plate 1.

Valley Fill

The older unconsolidated to partly consolidated sedimentary deposits of the valley fill are of late Tertiary and Quaternary age and are comprised of clay, silt, sand, and gravel. The older unit was deposited partly under subaerial and partly under lacustrine conditions.

The younger alluvial deposits are of Quaternary age and consist of gravel, sand, silt, and clay. Most of the younger unit was deposited under subaerial conditions. The geologic features of the area and drillers' logs (table 7) suggest that the deposits of Quaternary age are only a few hundred feet thick.

Water-Bearing Properties of the Rocks

Rocks of Paleozoic and Mesozoic age have low interstitial permeability, but transmit small amounts of water through joints and other fractures. However, the few carbonate rocks in the area may transmit water more freely through joints enlarged by solution. The water issuing from the hot springs in secs. 23 and 26, T. 27 N., R. 43 E., probably has moved through carbonate rocks because calcareous sinter is being deposited by the springs.

The volcanic rocks and sedimentary deposits of Tertiary age exposed in the mountains are moderately to well consolidated. These rocks have some interstitial permeability but much of the limited amount of ground water in them moves through joints and other fractures. In general, the capability of these rocks to transmit water probably is moderately low.

The older of the two units designated as "valley fill" on plate 1 probably has low permeability because it is derived principally from erosion of the bedrock of Tertiary age and contains a high proportion of clay and silt. It probably will not yield water readily to wells. Nevertheless, because of its large volume, it probably contains a considerable amount of ground water in storage.

The unconsolidated sand and gravel deposits of Quaternary age are capable of transmitting ground water freely. However, the fine sand, silt, and clay have low permeability and transmit water slowly. These deposits contain a large volume of water in storage. As a whole the sand and gravel deposits supply most of the water to wells in Antelope and Middle Reese River valleys.

GROUND-WATER APPRAISAL

General Conditions

The source of almost all the ground water in Antelope and Middle Reese River valleys is precipitation on their drainage basins. Some of the precipitation is evaporated from the land surface, some is transpired by vegetation, and some runs off as surface water. The remainder of the precipitation becomes ground-water recharge. Because the mountains receive more precipitation than the lowlands, they contribute a larger part of the recharge. Some precipitation on the mountains percolates downward and laterally to the ground-water reservoir in the valley fill. In addition, some ground-water recharge results from infiltration of runoff in stream channels. Very little precipitation on the valley floors infiltrates to the ground-water reservoir largely because of the small amount of precipitation.

Ground water generally moves from the recharge area on the flanks of the mountains toward the axis of the valleys and then northward. In the northern part of Antelope Valley ground water moves eastward to the Middle Reese River valley. A very small amount of ground-water underflow from the Upper Reese River valley moves through the alluvial fill in Reese River canyon and discharges into the Middle Reese River valley.

The water-level contours on plate 1 show the general position and configuration of the water table in two areas where reasonable hydrologic control is available. The water-level gradient is very low in Antelope Valley largely because of the bedrock constriction in the mouth of the valley. This constriction reduces the cross-sectional area of the valley fill which in turn reduces the amount of water that can be transmitted through it. One response to the reduction in cross-sectional area is a local steepening of the water-level gradient in the constriction as shown on plate 1. Also, the constriction causes the water level to be close to land surface, and some ground water is discharged by phreatophytes immediately west of the constriction. East of the constriction the cross-sectional area of the valley fill increases, thereby causing an increase in the depth to water.

A somewhat similar constriction occurs at the north end of Middle Reese River valley. However, the constriction is not as narrow, and the thickness of the valley fill is inferred to be greater than at the mouth of Antelope Valley. The constriction causes the water table to be near land surface in and immediately south of the constriction, and some ground water is transpired by phreatophytes.

The depth to water in the valley fill in Antelope Valley ranges from about 20 feet below land surface at the bedrock constriction to about 460 feet in well 21/41-24bb1 near the south end of the valley. However, the depth to water probably is greater south of well 21/41-24bb1. The depth to water in the northern part of Antelope Valley where development of ground water for irrigation is occurring, ranges from about 20 to 130 feet.

Depth to water in the valley fill in Middle Reese River valley ranges from about 15 feet along the Reese River near the south line of T. 27 N. to about 120 feet at the south end of the valley and about 150 feet near the upper edges of the alluvial fans east of State Highway 8A.

Estimated Average Annual Recharge

According to Eakin (1962b, p. 11):

> "The average annual recharge to the ground-water reservoir may be estimated as a percentage of the average annual precipitation within the valley (Eakin and others, 1951, p. 79-81). A brief description of the method follows: Zones in which the average precipitation ranges between specified limits are delineated on a map, and a percentage of the precipitation is assigned to each zone which represents the probable average recharge from the average annual precipitation on that zone. The degree of reliability of the estimate so obtained, of course, is related to the degree to which the values approximate the actual precipitation, and the degree to which the assumed percentages represent the actual percentage of recharge. Neither of these factors is known precisely enough to assure a high degree of reliability for any one valley. However, the method has proved useful for reconnaissance estimates, and experience suggests that in many areas the estimate probably are relatively close to the actual long-time average annual recharge.
>
> "The precipitation map of Nevada (Hardman and Mason, 1949, p. 10) has been modified by Hardman (oral communication, 1962) in part to adjust to recent topographic base maps for the region."

Hardman's and Mason's map is the same base used for plate 1 of this report. The range in elevation was great enough to conveniently divide the report area into five precipitation zones: The 5,000-foot contour interval divides the zone of less than 8 inches of precipitation from the zone of 8 to 12 inches of precipitation, the 6,000-foot contour divides the 8 to 12 from the 12 to 15, the 7,000-foot contour divides the 12 to 15 from the 15 to 20, and the 8,000-foot contour divides the 15 to 20 from the more than 20 inches.

The average precipitation used for the respective zones, beginning with the zone of 8 to 12 inches of precipitation, is 10 inches (0.83 foot), 13.5 inches (1.12 feet), 17.5 inches (1.46 feet), and 21 inches (1.75 feet).

Eakin (1962a, p. 7) estimates that the recharge, as a percentage of the average annual precipitation for each zone is as follows: less than 8 inches, 0; 8 to 12 inches, 1 percent; 12 to 15 inches, 7 percent; 15 to 20 inches, 15 percent; and more than 20 inches, 25 percent.

Tables 3 and 4 summarize the recharge computations. The approximate recharge (column 5) for each zone is obtained by multiplying the figures in columns 2, 3, and 4. Thus, for the zone receiving more than 20 inches of precipitation in Antelope Valley, the computed recharge is 1,100 acres x 1.75 feet x 0.25 (25 percent) = about 500 acre-feet. Accordingly, the estimated average annual ground-water recharge derived from precipitation in Antelope Valley is about 11,000 acre-feet, and in Middle Reese River valley is about 7,000 acre-feet.

Table 3.--Estimated average annual ground-water recharge from precipitation in Antelope Valley.

Precipitation zone (inches)	Approximate area of zone (acres)	Average annual precipitation (feet)	Percent recharged	Estimated recharge (acre-feet) (2 x 3 x 4 ÷ 100)
20+	1,100	1.75	25	500
15-20	12,000	1.46	15	2,600
12-15	89,000	1. .2	7	7,000
8-12	146,000	.83	1	1,200
8-	42,000	.5	0	0
	290,000 (460 sq. mi.)		Estimated average annual recharge (rounded)	11,000

Table 4.--Estimated average annual ground-water recharge from precipitation in Middle Reese River valley

Precipitation zone (inches)	Approximate area of zone (acres)	Average annual precipitation (feet)	Percent recharged	Estimated recharge (acre-feet) (2 x 3 x 4 ÷ 100)
20+	470	1.75	25	200
15-20	9,300	1.46	15	2,000
12-15	46,300	1.12	7	3,600
8-12	91,000	.83	1	800
8-	58,400	.5	0	0
	205,500 (320 sq. mi.)		Estimated average annual recharge (rounded)	7,000

Estimated Average Annual Discharge

Some ground water is discharged from both Antelope and Middle Reese River valleys by transpiration of water-loving vegetation (phreatophytes) and some is discharged by wells, but most of the water is discharged by underflow to the Lower Reese River valley.

The amount of ground water discharged by phreatophytes is estimated by considering the area covered, types of phreatophytes, density, and depth to ground water. As shown on plate 1, the areas of evapotranspiration are in the northern parts of both Antelope and Middle Reese River valleys, and cover 5,000 and 15,000 acres, respectively. The principal phreatophyte is greasewood, which has a low to moderate density in Antelope Valley and a moderate to high density in Middle Reese River valley. The depth to water in both areas ranges from about 10 to 65 feet. These factors suggests that the average use of water by greasewood is roughly 0.1 foot per year in Antelope Valley and 0.2 foot per year in Middle Reese River valley; or 500 acre-feet and 3,000 acre-feet per year, respectively.

The source of the water discharged by hot spring 27/43-23ad1 is not known (fig. 5), but part if not all of it probably fell as precipitation in the report area, percolated to great depth, became heated, and then rose through fractures associated with a fault passing through the spring area. Although the water could have migrated from adjacent basins, it is assumed that all the water discharged originates in the report area; it is consumed by evapotranspiration in the vicinity of the spring.

The estimated gross pumpage in Antelope and Middle Reese River valleys in 1962 was 4,000 acre-feet, including about 25 acre-feet of stock water. About 3,000 acre-feet probably was used consumptively by crops and evaporated from ditches and bare soil; about 1,000 acre-feet is assumed to have percolated downward to the ground-water reservoir. Thus, the estimated net pumpage in 1962 was about 3,000 acre-feet, about one-fourth of which was pumped in Antelope Valley and the remainder in Middle Reese River valley.

Ground water discharged by underflow through the valley fill from Antelope Valley to Middle Reese River valley and from Middle Reese River valley to Lower Reese River valley is the principal means of natural discharge from both valleys. The underflow out of a valley can be calculated by the formula:

$$Q = 0.00112TIW$$

where Q= quantity of underflow in acre-feet per year, 0.00112 = factor to convert gallons per day to acre-feet per year, T = coefficient of transmissibility of the water-bearing formation [1], in gallons per day per foot, I = ground-water gradient, in feet per mile, and W = width of the section through which the ground water moves, in miles.

---

[1] The coefficient of transmissibility is defined as the flow of water in gallons per day through a section of the aquifer 1 mile wide under a hydraulic gradient of 1 foot per mile.

The transmissibility in the above equation can be estimated from the specific capacity [2] of a well by a method developed by C. V. Theis and others (1954). The average specific capacity of 12 wells in Antelope Valley in 1963 was 100 gpm per foot of drawdown, which suggests a transmissibility of about 200,000 gpd per foot. The average of 12 wells in the Middle Reese River valley was 60 gpm per foot of drawdown, which suggests a transmissibility of about 120,000 gpd per foot.

Assuming that hypothetical wells at the mouth of Antelope Valley would have a specific capacity of 75 gpm per foot of drawdown, which is intermediate between the indicated values for the two valleys, then the transmissibility is computed to be about 150,000 gpd per foot (Theis and others, 1954, fig. 2). The hydraulic gradient, determined from the water-level contours on plate 1, is about 30 feet per mile. The width between the bedrock outcrops on either side of the constriction is about 1 1/2 miles; however, the width of the saturated cross section of the valley fill is slightly less and is interpreted to be about 1 1/4 miles. By substituting the above values into the equation, underflow from Antelope valley to Middle Reese River valley is computed to be about 6,000 acre-feet per year.

The same method is used to compute discharge from the Middle to the Lower Reese River valley. From specific capacity data, the transmissibility is assumed to be about 100,000 gpd per foot; the hydraulic gradient is about 40 feet per mile, and the width of the saturated cross section is about 2 miles. Thus, the underflow is computed to be about 9,000 acre-feet annually.

Table 5 summarizes the estimates of recharge and discharge for the two valleys. Theoretically, the average annual recharge should equal the average annual discharge in a ground-water system. The fact that the estimated values of recharge and discharge for Middle Reese River valley are equal probably is fortuitous. Indeed, the divergence of values indicated for Antelope Valley is more typical of the results obtained in a brief reconnaissance such as this study. Nevertheless, this reconnaissance suggests that the estimates are of about the right order of magnitude.

2/ The specific capacity of a well is defined as the yield in gallons per minute per foot of drawdown.

Table 5.--Estimated average annual recharge to and discharge from Antelope and Middle Reese River Valleys.

	Antelope Valley (acre-feet)	Middle Reese River valley (acre-feet)
RECHARGE		
Precipitation	11,000	7,000
Underflow from Upper Reese River valley (assumed)	--	500
Underflow from Antelope Valley	--	6,000
Total (rounded)	11,000	14,000
DISCHARGE		
Underflow from the valleys	6,000	9,000
Phreatophytes (evapotranspiration)	500	3,000
Wells (pumpage)	[a] 700	[a] 2,300
Totals (rounded)	7,000	14,000
Difference: Recharge minus discharge	4,000	0

a. Pumpage probably in large part from storage.

Perennial Yield

Eakin (1962a, p. 16) states:

> "The perennial yield of a ground-water system is limited ultimately by the average annual recharge to and discharge from the aquifer system. It is the upper limit of the amount of water that can be withdrawn for an indefinite period of time from an aquifer system without causing a continuing depletion of storage. The average recharge from precipitation and the average discharge by evapotranspiration, discharge to streams, and underflow from a valley are measures of the natural inflow and outflow from the aquifer system.
>
> "In an estimate of perennial yield, consideration should be given to the effects that ground-water development by wells may have on the natural circulation in the ground-water system. Development by wells may or may not induce recharge in addition to that received under natural conditions. Part of the water discharged by wells may reenter the ground-water reservoir by downward percolation, especially if the water is used for irrigation. Ground water discharged by wells usually is offset eventually by a reduction of the natural discharge. In practice, however, it is difficult to offset fully the discharge by wells by an equal decrease in the natural discharge, except when the water table has been lowered to a level that eliminates both underground outflow and evapotranspiration in the area of natural discharge. The numerous pertinent factors are so complex that, in effect, specific determination of perennial yield of a valley requires a very extensive investigation, based in part on data that can be obtained economically only after there has been substantial development of ground water for several years."

For the purposes of this reconnaissance it is assumed that the perennial yield is equal to the average of the estimated recharge to and discharge from each valley; that is, 9,000 acre-feet for Antelope Valley and 14,000 acre-feet for Middle Reese River valley. Because of possible inaccuracies in the estimated values used, the perennial yields may be several thousand acre-feet more or less than the estimates made herein. Full development of the supply in Antelope Valley and the consequent lowering of water levels eventually would result in a reduction in underflow from Antelope Valley to Middle Reese River valley. In turn this would reduce the recharge to and, of course, the perennial yield of Middle Reese River valley. In other words, if all the estimated 6,000 acre-feet of underflow moving from Antelope Valley were intercepted, the estimated yield of Middle Reese River valley would be reduced from 14,000 to 8,000 acre-feet (table 5.).

Storage

A large amount of ground water is stored in the valley fill of the two valleys. Present data are not adequate to determine accurately the amount of water in storage, but a rough approximation can be made to indicate its magnitude. The areal extent of the valley fill that is saturated with ground water totals about 100, 000 acres in the two valleys. If it is assumed that a reasonably thick section of saturated valley fill underlies the 100, 000 acres and further if it is assumed that the specific yield (drainage pore space) is 10 percent, about 10, 000 acre-feet of ground water is in storage in each saturated foot of valley fill. Thus, the upper 100 feet of saturated valley fill alone would contain a million acre-feet of ground water in storage.

In an area where ground-water development is based on the perennial yield, ground water in storage provides a reserve which can be used during long periods of drought or temporary periods of high demand. This is an important asset in arid regions where other sources of water supply vary widely from year to year.

Effects of Pumping Wells

When a well is pumped, water levels in the vicinity of the well are lowered. Theis (1935, p. 519-524) developed an equation to compute the drawdown at any point near the well at some specific time. As the use of the equation is laborious, Theis (1952) also developed a chart for solving the drawdown, in feet, at any point in the vicinity of the pumping well at a given time. For the purpose of illustrating the extent to which water levels may decline in the vicinity of a well in Antelope Valley, it is assumed that the average coefficient of transmissibility is 200, 000 gpd per foot (p. 15), and that the average coefficient of storage is 0. 1. It is further assumed that the well is pumped continuously for 100 days (about the length of the growing season) at a constant rate of 2, 000 gpm. The results of the analysis are shown in figure 2. At the end of the pumping period the water level in the aquifer ten feet from the pumping well would have declined about 15 feet, and half a mile away the water level would have declined about 2 feet. The effect of pumping would extend almost 10, 000 feet from the pumping well. This analysis suggests that irrigation wells half a mile apart will cause mutual interference affects of several feet.

The effect of pumping in Antelope Valley on underflow through the constriction between Antelope Valley and Middle Reese River valley also should be considered in the development of the supply. Underflow through this constriction presently is moving in response to a head differential of about 60 feet through the gap. If pumping in the area immediately west of the gap lowered water levels about 60 feet, underflow would become negligible, provided that water levels were not similarly lowered by pumping in Middle Reese River valley. Pumpage in Antelope Valley near the gap would have to exceed the estimated underflow of 6, 000 acre-feet per year to intercept most of the ground water now moving through the gap to Middle Reese River valley.

As explained previously, a constriction also exists at the lower end of Middle Reese River valley through which an estimated 9, 000 acre-feet per year of underflow discharges to Lower Reese River valley. The annual pumpage at the lower end of the valley would have to equal or exceed this amount to intercept the bulk of the underflow.

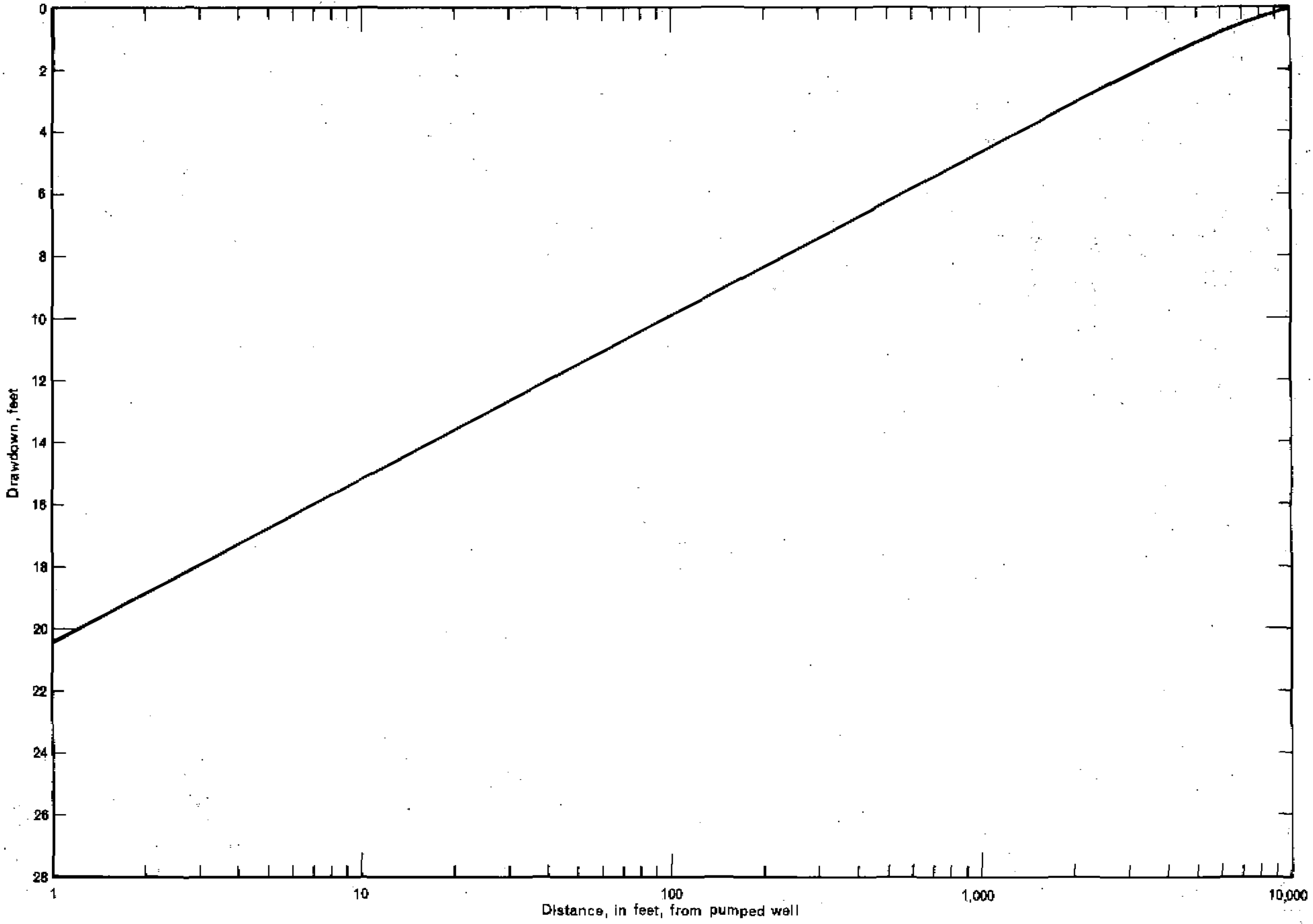

Figure 2.- Drawdown in the vicinity of a pumped well in northern Antelope Valley after 100 days of pumping at a rate of 2,000 gallons per minute

Pumping in Middle Reese River valley will have little effect on the water supply in Antelope Valley, unless the hydraulic gradient through the gap is steepened appreciably; the increased underflow would vary directly with the gradient. Water levels below the gap in Middle Reese River valley would have to be drawn down several tens of feet before any noticeable increase in underflow would occur.

Chemical Quality

The mineral constituents of ground water determine its suitability for irrigation and other uses. In general, the dissolved-solids content is low in recharge areas, and increases as water dissolves and retains soluble products of rock weathering and decomposition enroute to areas of discharge. Evaporation and transpiration tend to concentrate soluble salts in the water that remains in the ground. The use of water for irrigation increases the content of soluble salts. As the water moves across the fields, part is evaporated, part is consumed by the vegetation, and part percolates back into the ground.

Table 6 gives the analyses of water from three wells and hot spring 27/43-23ac1 in Antelope and Middle Reese River valleys. The maximum concentration of certain constituents which determine water of acceptable quality by the U.S. Public Health Service are shown in the table also. The iron content of water from well 26/43-22cd1 probably would stain clothes and porcelain bathroom fixtures, and the fluoride content of 3.9 ppm (parts per million) in the Hot Spring would tend to cause mottled teeth in children.

The analyses suggest that, in general, the sodium hazard of the ground water is low, but it may have a medium to high salinity hazard, according to a method of classification suggested by the U.S. Salinity Laboratory Staff (1954, p. 79-80). Water of medium to high salinity hazard can be used successfully if the soil can be leached moderately and if salt tolerant crops are grown. Boron in small quantities is essential to plant growth but amounts in excess of about 4 ppm are toxic even to boron tolerant plants.

The analyses indicate that the ground water is suitable for stock purposes.

Table 6.--Chemical analyses of ground water in Antelope and Middle Reese River valleys (chemical constituents in parts per million)

Constituent or property	Antelope Valley	Middle Reese River Valley				U.S. Public Health Service[2]
	24/40-13cd1	26/43-22cd1	26/43-7dd1	27/43-23ac1[1]		
Silica, SiO_2	68.00	58.00	54.00	39.00	--	--
Iron, Fe	.02	.04	.02	.02	--	0.3
Calcium, Ca	50	46	58	52	66	--
Magnesium, Mg	2.6	5.5	11	7.3	3.9	--
Sodium, Na	48	60	96	116	121	--
Potassium, K	7.2	8.0	6.2	20	--	--
Bicarbonate, HCO_3	144	184	244	428	447	--
Sulfate, SO_4	30	53	98	62	63	250
Chloride, Cl	16	46	80	21	24	250
Fluoride, F	0.6	0.4	0.9	3.9	--	1.3[3]
Nitrate, NO_3	2.7	3.5	4.5	0.8	--	45[4]
Boron, B	0.2	0.2	0.5	0.6	--	--
Dissolved solids	265	374	529	519	--	--
Hardness: Total	55	137	192	160	--	--
Noncarbonate	0	0	0	0	--	--
Percent sodium	62	47	51	58	56	--
Specific conductance micromhos at 25°C	345	554	812	825	1,043	--
pH	7.9	8.4	8.3	7.9	--	--
Temperature, °F	--	--	52±	124	--	--
SAR	2.80	2.22	2.98	3.95	3.6	--
RSC	1.25	0.4	0.16	3.8	--	--
Class	C2, S1	C2, S1	C3, S1	C3, S1	C3, S1	--

1. The last analysis from Miller, Hardman, and Mason (1953, p. 44-45).
2. Drinking water standards announced by U.S. Public Health Service: Title 42, part 72, paragraph 72.205 of Federal Register p. 2154, dated March 6, 1962.
3. Recommended control limit for upper concentration ranges from 0.8 to 1.7 ppm varying according to annual average maximum daily air temperature.
4. In areas in which the nitrate content of water is known to exceed 45 ppm, the public should be warned of the potential dangers of using the water for infant feeding.

Development

Since 1950 ground water has been used to irrigate about 300 acres of alfalfa and wild hay on two long established ranches. In 1959 considerable interest was generated to develop part of the report area under the provisions of the Desert Land Entry Act of 1877. According to the U.S. Bureau of Land Management, about 28,600 acres has been classified as suitable for agricultural development in Antelope and Middle Reese River valleys, and patents have been issued for about 1,200 acres. Desert land entries have been filed on about 23,000 acres. As of April 1963, about 48 wells had been drilled for irrigation (table 7). Several have yet to be equipped with pumps and power plants. Four drilling machines are in the valley, and reportedly three are active almost continuously. Reported yields of wells range from about 500 to about 3,200 gpm, and drawdowns range from 7 to 130 feet (table 7). Many of the yield and drawdown data are those reported when the wells were tested and do not represent the yield produced by the permanent pumping equipment. Few well failures have been reported.

Crops grown are alfalfa, alfalfa and clover seed, small grains, and pasture. According to Buhel Heckathorn (oral communication, April 29, 1963) of the Soil Conservation Service, Department of Agriculture, the following approximate acreages were planted in 1962:

Small grain	600	acres
Alfalfa	1,000	"
Alfalfa seed	700	"
Clover seed	100	"
Pasture	200	"

Some crops were not harvested, and some farmers reported yields of only 15 bushels of small grain to the acre. Apparently, some farmers obtained fair to moderately good yields of hay and seed.

PROPOSALS FOR ADDITIONAL GROUND-WATER STUDIES

The magnitude of the proposed development as compared to the estimated perennial yield of the valleys suggests that selected data should be collected, synthesized, and interpreted to have a better understanding of the hydrologic regimen and the effect that ground-water development will have on the regimen. Hugh A. Shamberger, Director, Department of Conservation and Natural Resources, State of Nevada, has requested that a program for future studies be recommended. The proposed studies that would be useful in administrating the ground-water resources in the Antelope and Middle Reese River valleys and in similar areas of Nevada are listed below.

1. This report estimates the water supply available in Antelope and Middle Reese River valleys. It also describes the effect of development in one valley on the supply in the other. Moreover, the affect of development in

Middle Reese on the supply reaching Lower Reese River valley also is described. Because the Upper, Middle, and Lower Reese River valleys and their tributaries are all part of one large hydrologic system, substantial development in upstream segments may deprive the downstream segments of a part of their supply. The extent to which development will affect the system can be determined only after studies have been completed on the entire Reese River valley.

2. One important need is an observation-well network to obtain water-level data to define the natural annual cycle of fluctuations before substantial ground-water withdrawals begin. These data are necessary to identify artificial and natural water-level fluctuations. Although ground-water development has begun, adequate water-level data can still be obtained. Water levels should be measured in pumped wells, in nearby nonproducing wells, and in wells remote from areas of pumping.

An inventory of annual pumpage is necessary to evaluate the effect of development on the hydrologic system.

3. The geologic and hydrologic character of the water-bearing deposits needs to be determined. Geologic mapping and examination of drill cuttings would yield information on the physical framework of the valleys, and pumping tests would provide data on the transmissibility of the deposits, the amount of water in storage, and the affect that development may have on reducing natural discharge.

Test wells and pumping tests would assist in determining the aquifer characteristics in the mouth of Antelope Valley, a more accurate estimate of the amount of water discharging to Middle Reese River valley, and the position of the water table between the two valleys. Similar data could be obtained to refine the estimate of underflow from Middle Reese River valley.

4. Climatological stations, such as snow courses, precipitation gages, temperature recorders, crest-stage gages, and evaporation pans would be useful in determining precipitation and the pattern of its occurrence, types of crops which might be grown, irrigation requirements of crops, and to provide data on flood frequencies and magnitudes. Also, these data could be used to refine the estimates of recharge to the valleys.

5. Studies of the rate that water will infiltrate into the soil and the amount of water that runs off of irrigated fields as waste water could be made when development has increased substantially. These data would provide information on the consumptive use of water by various crops, and in turn would help refine the amount of depletion of the ground-water resource.

The studies listed above are equivalent in large part to the second-stage quantitative studies as identified in the long-range program of investigations proposed by the Department of Conservation and Natural Resources (Shamberger, 1962).

DESIGNATION OF WELLS

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

A typical number usually consists of three units. The first unit is the township north of the Mount Diablo base line. The second unit, separated by a slant line from the first, is the range east of the Mount Diablo meridian. The third unit, separated from the second by a dash, is the number of the section in the township. The section number is followed by one or two lower case letters, the first of which designates the quarter section; the second, the quarter-quarter section. Finally, a number designates the order in which the well was recorded in the smallest subdivision of the section. The letters a, b, c, and d designate, respectively, the northeast, northwest, southwest, and southeast quarters and quarter-quarters of the section as shown in figure 3.

For example, well 25/40-36cc1 is the first well recorded in the SW 1/4 SW 1/4 sec. 36, T. 25 N., R. 40 E.

Owing to limitation of space, wells on plate 1 and figures 4 and 5 are identified only by the section number, quarter section, and quarter-quarter section letters and serial number. The township in which the well is located can be ascertained by the township and range numbers shown at the margin of plate 1 and figures 4 and 5. Wells listed in table 7 are shown either on plate 1 or figures 4 and 5.

Drillers' logs of wells are included on the following pages. The terminology of the original logs has been slightly modified to achieve uniformity and clarity.

Table 7.--Records of selected wells in Antelope and Middle Reese River valleys, Lander County, Nevada

Depth of well: All depths are reported by owner or driller.
Altitude: Land surface at well site above sea level interpolated from topographic maps.
Measuring point: L, land surface; Tc, top of casing; Ep, entry point.
Height: Feet above land surface.

Water level: In feet and tenths of feet below land surface if measured by U.S.G.S.; in feet only if reported.
Yield: Reported by well owner, driller, or U.S. Bureau of Land Management.
Drawdown: Reported by well owner, driller, or U.S. Bureau of Land Management.
Status or use: D, domestic; I, irrigation; R.R., railroad; S, stock; U, unused.
Remarks: CA, chemical analysis; L, log.

Well number and location	Owner	Year completed	Depth (feet)	Casing			Altitude (feet)	Measuring point		Water level		Yield (gpm)	Drawdown (feet)	Specific capacity (gpm per foot drawdown)	Status or use	Remarks
				Diameter (inches)	Depth (feet)	Perforated zone (feet)		Description	Height (feet)	Below land surface (feet)	Date					
ANTELOPE VALLEY																
21/41-26dd1	Erich Ranches	--	--	6	--	--	5,629	Tc	0.5	458.0	4-24-63	--	--	--	S	
22/41-15aa1	do	1959	502	6	502	--	5,450	Tc	--	362	3- 8-61	--	--	--	S,U	
23/40-23aa1	McCoy Mining Camp	--	--	8	--	--	5,240	Tc	1.0	321.4	4-24-63	--	--	--	U,U	
23/41- 4ad1	Bureau of Land Management	1959	225	6	--	--	5,125	Tc	2.5	316.1	4-24-63	--	--	--	S,U	
23/41-31cd1	Erich Ranches	--	--	6	--	--	5,275	Tc	0	370.9	4-20-63	--	--	--	S	
24/40- 1ba1	Russel Anderson	--	--	16	--	--	4,926	Tc	2	69.9	3- 8-63	--	--	--	I	
24/40-10ad1	Clyde Benson	--	--	16	--	--	4,994	L	0	76.8	3- 6-63	--	--	--	I	
24/40-10dd1	do	--	--	16	--	--	5,006	Tc	0.5	85.0	3- 8-63	--	--	--	I	
24/40-13bd1	Leon French	1961	300	16	--	72-277	5,025	L	0	127.6	3- 8-63	1,760	9	196	I	L
24/40-13cd1	do	1961	244	16	232	84-232	5,004	Tc	0	131.0	3- 8-63	1,960	19	88	I	CA, L
25/40-16aa1	Alpine Bowers	1960	322	16	236	100-236	4,990	Ep	0	92.1	3- 8-63	1,500	18	83	I	L
24/41- 2ca1	Martin and Calvachi	--	--	16	--	--	5,000	Tc	1.0	112.5	3-21-63	2,450	--	--	I	
24/41- 6bc1	E. T. Ross	--	--	16	--	--	4,976	Tc	1.0	64.5	3- 8-63	--	--	--	I	
24/41- 6ca1	do	1959	300	16	229	76-228	4,950	Tc	0.5	75.1	3- 8-63	1,690	10	159	I	L
24/41- 9d 1	Paul Bowers	1959	260	16	208	97-208	5,000	Tc	1.0	98.7	3- 8-63	855	7	122	I	
25/40-36ba1	Don Harris	1963	--	16	--	--	4,972	L	0.0	75.9	4-30-63	--	--	--	I	Uncompleted well as of 5/1/63
25/40-34cd1	do	1963	280	6	100	--	4,950	L	0.0	80	--	--	--	--	D	
25/40-36bc1	Willis Clark	1961	508	16	252	60-252 360-508	4,947	Tc	2.5	45.1	3- 8-63	1,655	48	39	I	L
25/40-36cc1	James Hager	1961	262	16	254	73-254	4,950	Tc	1.0	56.0	3- 8-63	1,700	19	89	I	L
25/41-18cc1	Cottonwood Ranch	--	--	6	--	--	4,930	Tc	0.0	37.9	4-25-63	--	--	--	S,U	
25/41-18ba1	R. M. Cohen	1962	244	16	244	52-244	4,925	Tc	1.5	33.5	4-29-63	3,000	--	--	I	L
25/41-20cd1	R. Hillenbrener	1961	264	16	260	52-260	4,924	Tc	1.0	32.6	3- 8-63	1,450	39	37	I	L
25/41-20cc1	do	1959	265	16	265	--	4,923	Tc	0	35.9	3- 8-63	1,730	11	157	I	L
25/41-26dd1	Percy Bowler	1959	315	16-14	315	208-315	4,948	Tc	1.0	45.2	3- 8-63	1,050	38	28	I	L
25/41-31ba1	R. J. Bane	--	--	16	--	--	4,940	Tc	2.0	51.2	4-30-63	--	--	--	I	
25/41-31cc1	do	1960	264	16	264	72-264	4,945	Tc	1.0	56.4	3- 8-63	3,000	38	79	I	L
25/41-32aa1	Blanche Powers	1961	268	16	268	68-268	4,962	Tc	2.5	56.2	4- 8-63	1,500	51	29	I	L
MIDDLE REESE RIVER VALLEY																
25/42- 2ca1	Jim Ford	1961	200	16	--	70-185	4,890	Tc	2.0	74.8	2-27-63	2,600	--	--	I	L
25/42- 2dd1	Ima and Dalton Ford	1960	172	16	172	76-170	4,892	Tc	0.5	75.1	2-27-63	1,500	42	37	I	L
25/42- 3cd1	Dalton Ford	1959	162	16	162	70-157	4,888	Ep	2.0	73.2	2-27-63	1,270	9	152	I	L
25/42- 3dd1	do	1960	300	16	300	78-300	4,889	Tc	1.0	75.7	2-27-63	3,000	25	120	I	L
25/42- 9cd1	Dewey Ford	1961	200	16	200	80-200	4,898	Tc	0.5	83.3	2-27-63	3,180	--	--	I	L
25/42-11cd1	Reese River Farms	--	--	16	--	--	4,905	Tc	0.5	96.1	2-27-63	--	--	--	I,U	
25/42-11dd1	do	1961	220	16	220	101-210	4,904	Tc	--	98	2-27-63	1,000	9	111	I	L
25/42-12cd1	Henry Filippini	1947	135	6	--	--	4,907	Tc	0.5	90.4	11-19-47	--	--	--	S	
25/42-15cd1	Reese River Farms	1960	180	16	180	110-180	4,915	Tc	0.5	98.4	2-25-63	--	--	--	I	L
25/42-20ad1	R. E. Powers	1961	250	16	192	93-190	4,902	Tc	3.0	70.0	2-25-63	1,255	42	30	I	L
25/42-20ad1	do	1959	110	6	--	--	4,907	Tc	-4.5	87.0	2-25-63	--	--	--	U	
25/42-21ad1	R.J. Sailor, Sr.	--	--	16	--	--	4,914	Tc	0.5	98.6	3-30-63	--	--	--	I	
25/42-21dd1	R.J. Sailor, Jr.	--	--	16	--	--	4,973	Tc	1.0	102.1	2-25-63	--	--	--	I,U	
25/42-22ad1	C. E. Hodges	1960	200	16	200	113-200	4,962	Tc	0.6	115.6	2-25-63	1,050	23	46	I	L
25/42-28ad1	Allice Sailor	1954	--	16	--	--	4,942	Tc	0.5	115.5	4-30-63	--	--	--	I,U	
25/43- 7ac1	Henry Filippini	--	--	--	--	--	4,910	Tc	1.0	108.9	3- 7-63	--	--	--	S	
26/43- 2bb1	do	1933?	--	60x60	27	--	4,819	--	--	25	1948	--	--	--	D,S	
26/43- 2bc1	do	--	85	6	--	--	--	--	--	--	--	--	--	--	D,U	Reportedly salty
26/43- 2bd1	David Mcintosh	1961	220	6	--	--	4,823	--	--	--	--	--	--	--	D	
26/43- 7ad1	--	--	--	6	--	--	4,826	Tc	2.0	74.2	3- 7-63	--	--	--	S	CA
26/43- 9ba1	Henry Filippini	--	60	6	--	--	4,889	Tc	3.8	18.0	11-21-47	--	--	--	S,U	
26/43-10dd1	R.L. Fuller	1960	456	16-12	456	90-452	4,886	Tc	0.5	63.1	3- 7-63	1,003	89	11	I	L
26/43-15bd1	Bart Smith	1963	270	16-12	270	--	4,866	Tc	0.5	65.0	4-24-63	--	--	--	I	
26/43-21dd1	Q. E. Morrison	1961	260	16	260	104-260	4,910	Tc	--	85	2-27-63	1,800	48	38	I	L
26/43-22cd1	Henry Filippini	1947	175	6	--	--	4,962	Tc	0.6	131.2	11-19-47	--	--	--	S	CA
26/43-27ba1	--	--	--	6	--	--	4,957	--	--	--	--	--	--	--	S	
26/43-29cd1	Robert Watson	1959	200	16	200	60-200	4,869	Tc	1.0	53.4	2-27-63	2,090	24	87	I	L
26/43-29dd1	W. T. Jones	1961	240	16	240	108-240	4,908	Tc	0.25	102.8	3- 7-63	2,000	22	91	I	L
26/43-30cc1	Lois Smith	--	200	16-14	--	--	4,867	Tc	1.0	55.3	2-27-63	2,450	--	--	I	
26/43-30da1	W. T. Smith	--	--	16	--	--	4,867	Tc	1.0	53.7	2-27-63	2,450	--	--	I	
26/43-31cd1	A. T. Linders	1961	200	16	200	63-200	4,878	Tc	1.0	65.9	2-27-63	1,765	25	71	I	L
26/43-32bc1	Robert Watson	--	--	6	--	--	4,870	--	--	--	--	--	--	--	S	
27/43-11aa1	O. T. Nolte	--	234	16	--	--	4,780	Ep	0.65	70.9	4-26-63	1,550	--	--	I	
27/43-11ba1	do	--	--	16	--	--	4,762	Tc	0.5	49.7	4-26-63	950	--	--	I,U	
27/43-11da1	C. E. Hodges	--	--	16	--	--	4,800	Tc	1.0	90.1	4-26-63	--	--	--	I,U	
27/43-23ca1	Henry Filippini	1950	125	16	125	48-125	4,780	L	0	17	1950	550	--	--	I	L
27/43-31ac1	Ellison Ranching Co.	--	177	12	177	--	4,873	Tc	1.0	60.8	3- 6-63	--	--	--	I,U	
27/43-31ad1	do	1950	210	12	210	--	4,874	Ep	0.5	36	1951	500	130	4	I	L
27/43-31ba1	do	1946	87	5	--	--	4,898	L	.0	55	1963	--	--	--	S	
27/43-31ba2	do	1962	190	6	190	--	4,887	L	.0	84.6	3- 6-63	--	--	--	D	L
27/43-32aa1	do	--	--	16	--	--	4,861	Tc	1.0	34.4	3- 6-63	900	--	--	I	
27/43-33cd1	--	--	114	6	--	--	4,810	Tc	0.4	13.0	11-19-47	--	--	--	RR	Destroyed

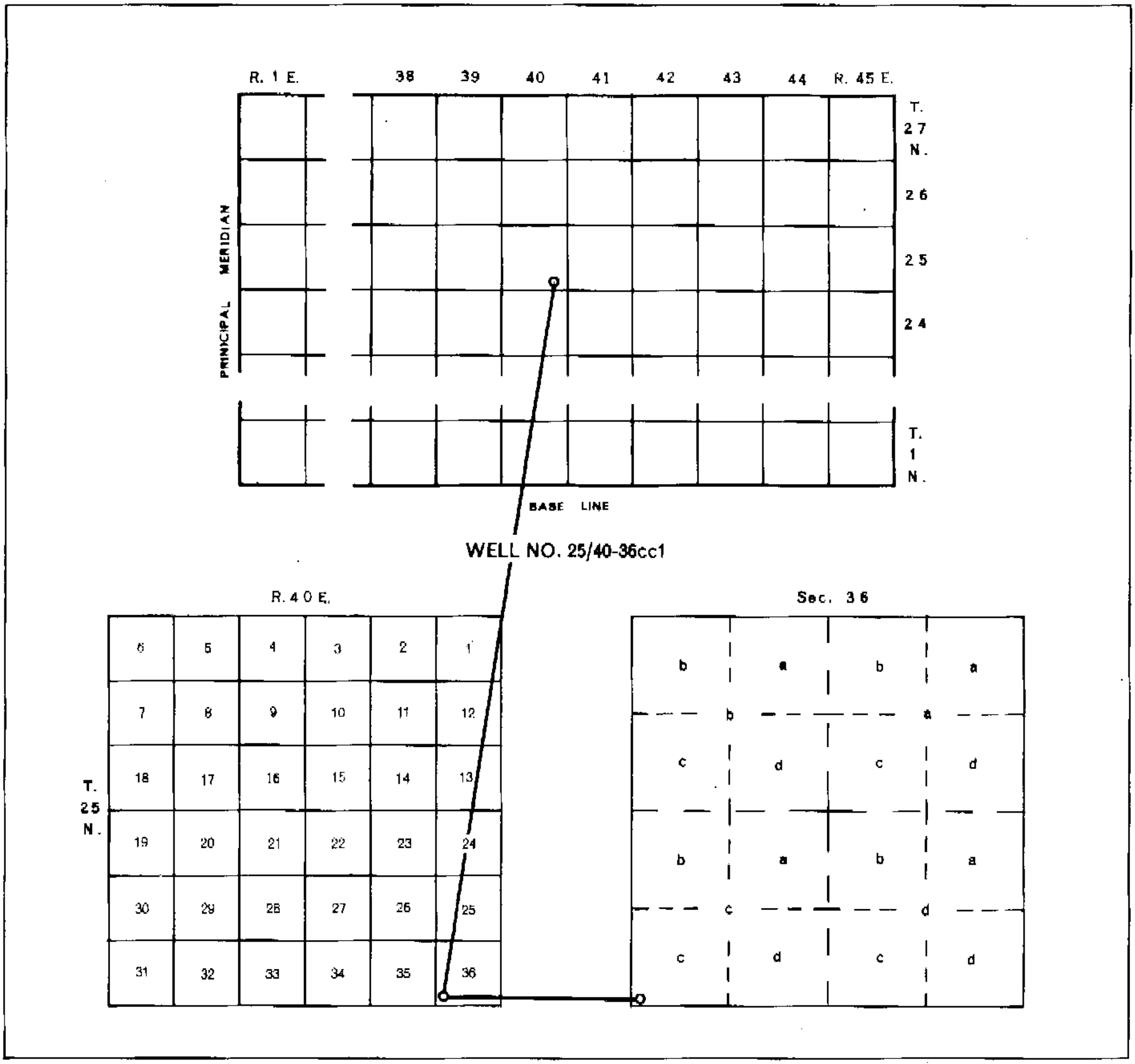

Figure 3. Sketch showing well-numbering system

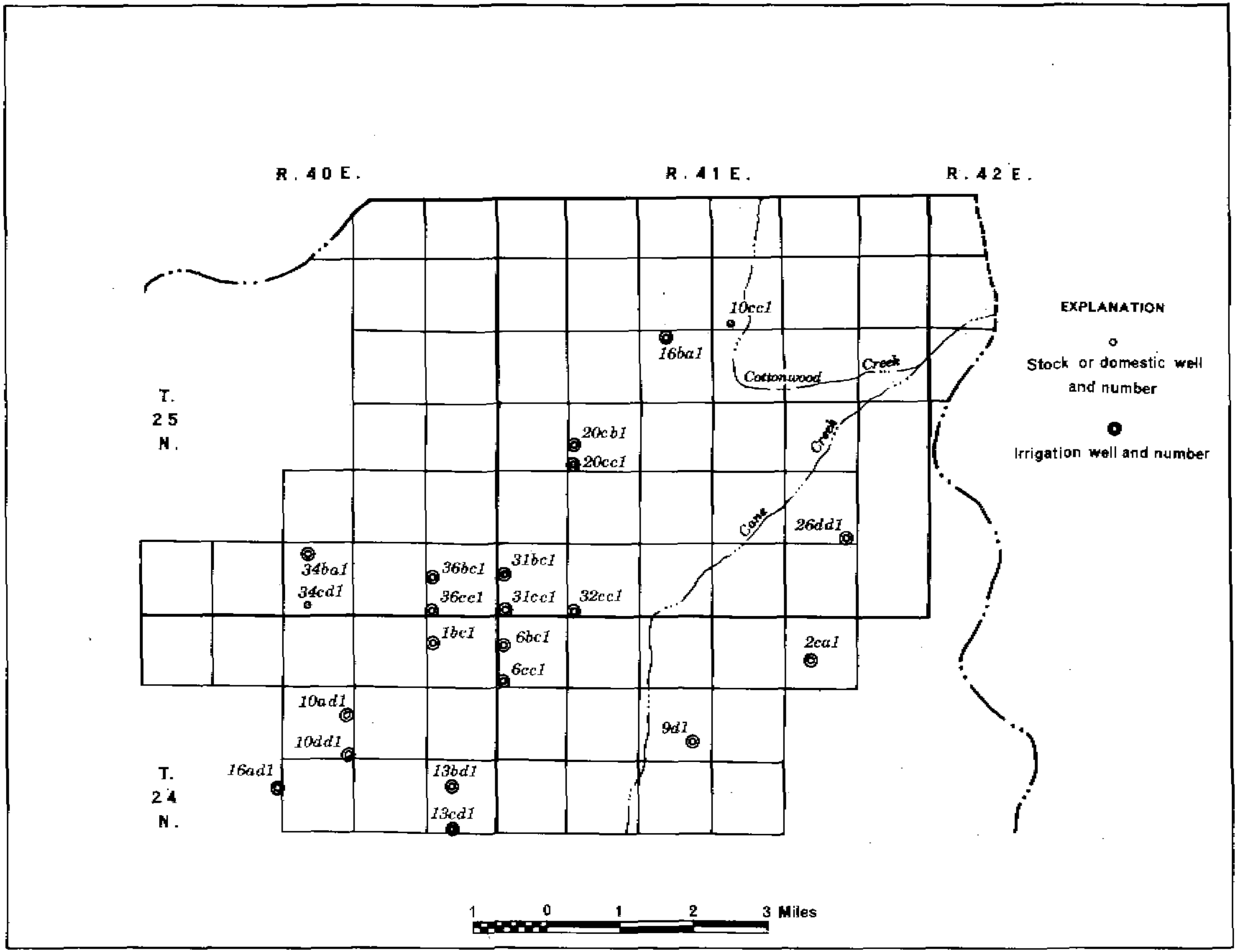

Figure 4. Sketch map of northern Antelope Valley showing location of wells

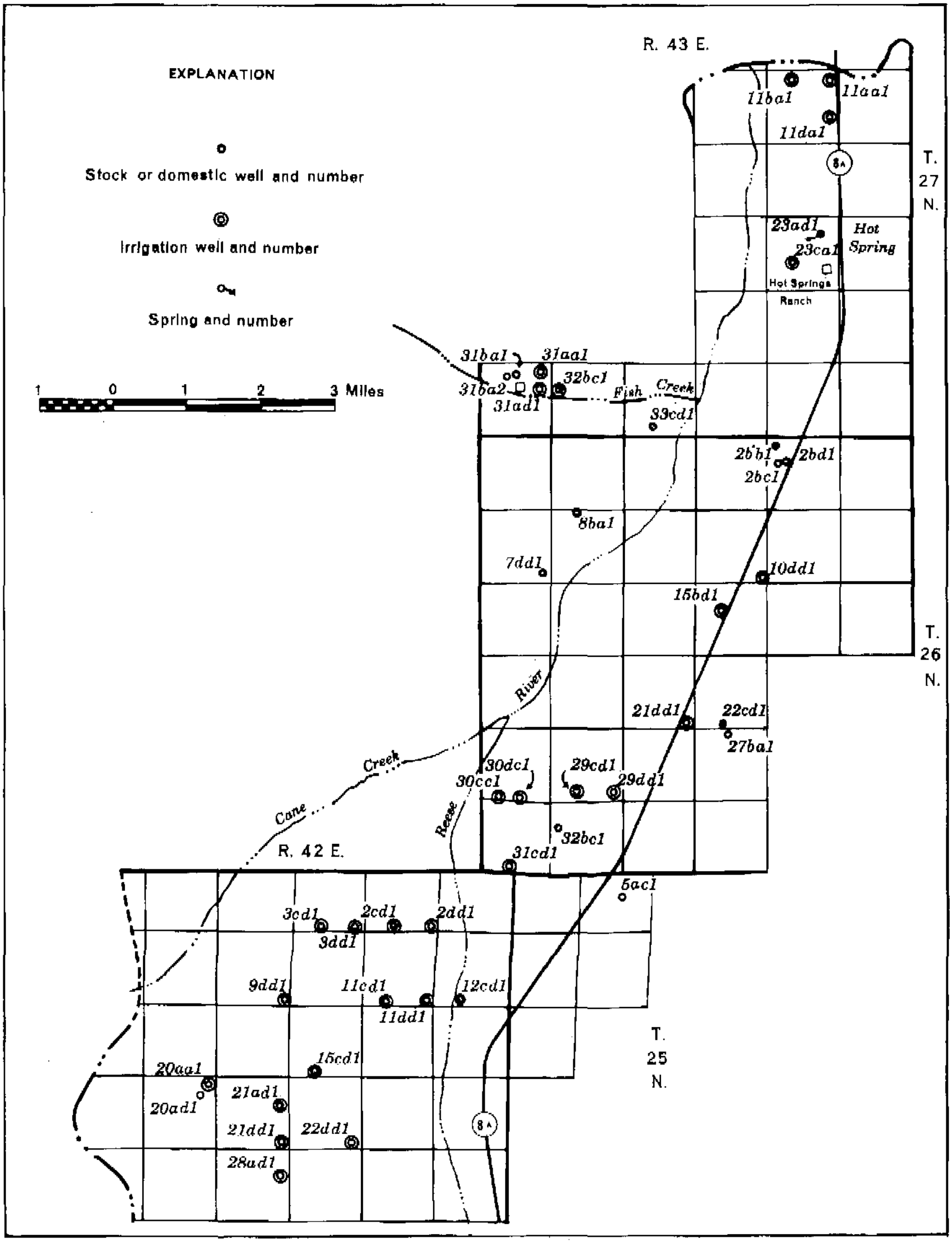

FIGURE 5. Sketch map of Middle Reese River Valley showing location of wells

Table 8.--Driller's Logs of Selected Wells in Antelope and Middle Reese River valleys, Lander County, Nevada.

24/40-13bdl. Owner, Leon French.

	Thickness (feet)	Depth (feet)
Topsoil	3	3
Clay, sandy, and gravel	13	16
Clay, gravel; water	104	120
Gravel	116	236
Gravel, clay, and sand	64	300

24/40-13cdl. Owner, Leon French

	Thickness (feet)	Depth (feet)
Topsoil	3	3
Clay, sandy, and gravel	17	20
Clay and gravel	108	128
Sand and gravel	16	144

24/40-16adl. Owner, Alpha Hensen

	Thickness (feet)	Depth (feet)
Topsoil and sandy clay	9	9
Gravel and clay	39	48
Gravel, dry, loose	8	56
Clay and seams of fine gravel	48	104
Gravel, loose, clean	96	200
Clay, tight	9	209
Clay, soft and loose gravel seams	27	236
Clay, tight	79	315
Gravel, big, clean	7	322

24/41-6ccl. Owner, E. T. Ross

	Thickness (feet)	Depth (feet)
Topsoil and clay	6	6
Clay and gravel	55	61
Gravel and clay	4	65
Clay and gravel	14	79
Gravel and clay; water	1	80
Clay and gravel	15	95
Gravel and clay; water	8	103
Clay, gravel, some sand	121	224
Clay, very little gravel and sand	86	310

25/40-36bcl. Owner, Willis Clark

	Thickness (feet)	Depth (feet)
Topsoil	6	6
Clay and gravel	60	66
Gravel, fine, clean	6	72
Clay and gravel	16	88
Clay, hard	20	108
Gravel, fine, clean	8	116
Clay	32	148
Sand and fine gravel	24	172
Clay	18	190
Sand, fine; water	6	196
Clay	42	238
Sand, fine	11	249
Clay, hard	111	360
Sand, fine	3	363
Clay	125	488
Gravel, clean, loose	20	508

25/40-36ccl. Owner, James Hager

	Thickness (feet)	Depth (feet)
Topsoil and sandy clay	12	12
Gravel, fine, dry	6	18
Clay, brown, hard	26	44
Gravel, fine, dry	4	48
Clay, brown, sandy	24	72
Gravel, clean	13	85
Clay, very hard	3	88
Gravel, fine, and sand	12	100
Gravel, clean, very loose	14	114
Clay, hard	5	119
Clay, sandy, and gravel streaks	25	144
Gravel, loose, very clean	9	153
Clay, hard	17	170
Gravel, clean, loose	6	176
Clay, sandy, and gravel seams	18	194
Clay, tight, sticky	15	209
Gravel, clean	7	216
Clay, sandy, and gravel seams	18	234
Gravel, clean, loose	3	237
Clay and gravel seams	27	264
Gravel, clean, loose	3	267

Table 8.--(continued)

25/41-16ba1. Owner, R. M. Cohen

	Thickness (feet)	Depth (feet)
Clay, sandy	9	9
Clay, hard	14	23
Sand, cemented	21	44
Clay, soft	4	48
Gravel, fine, clean	18	66
Clay, soft, sticky	3	69
Gravel, fine, loose	115	184
Clay, hard	37	221
Gravel, fine, clean	23	244

25/41-20cb1. Owner, E. Dittenberner

	Thickness (feet)	Depth (feet)
Topsoil and sandy clay	9	9
Clay, hard	14	23
Sand, cemented	21	44
Clay, soft	4	48
Gravel, fine, clean	18	66
Clay, soft, sticky	3	69
Gravel, fine, loose, with lots of thin clay seams	115	184
Clay, hard	37	221
Gravel, fine, clean	17	238
Gravel, loose, clean	26	264

25/41-20cc1. Owner, E. Dittenberner

	Thickness (feet)	Depth (feet)
Topsoil	7	7
Clay	12	19
Sand, cemented, very hard	4	23
Clay, brown, sandy	17	40
Sand, cemented	4	44
Clay; water	4	48
Gravel, fine, clean	4	52
Clay	2	54
Gravel, fine, clean, and sand	8	62
Clay	2	64
Gravel, clean	4	68
Clay	3	71
Gravel and clay seams	13	84
Gravel, clean	4	88
Clay, very hard	2	90
Gravel, fine, clean, with 2" and 3" streaks of clay	8	98
Clay	3	101
Gravel, fine	7	108
Clay	5	113
Clay and loose gravel seams	23	136
Clay	16	152
Gravel, clean	5	157
Clay, hard	63	220
Clay and gravel seams	18	238
Gravel, clean	6	244
Gravel, clay streaks	21	265

25/41-26dd1. Owner, Harry Hoosier

	Thickness (feet)	Depth (feet)
Topsoil, sandy	7	7
Clay, sandy	12	19
Clay and gravel	29	48
Clay; water	20	68
Gravel, clean	14	82
Clay	14	96
Gravel, broken	74	170
Clay	8	178
Sand and gravel	25	203
Clay	41	244
Gravel, loose, very clean	71	315

25/41-31cc1. Owner, E. J. Kaae

	Thickness (feet)	Depth (feet)
Topsoil and sandy clay	11	11
Clay and gravel	61	72
Sand and gravel	5	77
Clay, sandy	13	90
Sand and gravel	8	98
Clay, tight	2	100
Sand and fine gravel	42	142
Clay, tight	20	162
Clay, sandy	17	179
Gravel, fine	29	208
Clay, tight	25	233
Gravel, big, clean	31	264

Table 8. (continued)

25/41-32cc1. Owner, Blanche Powers

	Thickness (feet)	Depth (feet)
Topsoil, sandy	7	7
Clay, gravely	16	23
Clay	8	31
Gravel, fine, and clay	13	44
Gravel, fine, dry	8	52
Clay and gravel	9	61
Gravel, loose, dry	5	66
Clay, sticky	2	68
Gravel, clean	4	72
Clay and gravel	36	108
Clay, hard	7	115
Gravel, clean	29	144
Clay and gravel	8	152
Clay, hard	12	164
Gravel, clean; some clay	8	172
Gravel, cemented	16	188
Gravel, clean; some clay	6	194
Gravel, clean	10	204
Clay, hard	39	243
Gravel, clean	25	268

25/42-2cd1. Owner, Ima Ford

	Thickness (feet)	Depth (feet)
Topsoil	5	5
Gravel	21	26
Clay	4	30
Gravel	18	48
Clay	30	78
Gravel; water	1	79
Clay	7	86
Gravel; water	7	93
Clay	9	102
Gravel	4	106
Sand and gravel; water	34	140
Clay	4	144
Sand and gravel; water	28	172
Clay	4	176
Sand and gravel; water	20	196
Sand, fine; water	2	198
Sand and gravel; water	2	200

25/42-2dd1. Owners, Ima and Dalton Ford

	Thickness (feet)	Depth (feet)
Topsoil	8	8
Gravel, dry, loose	36	44
Clay and gravel	11	55
Clay	26	81
Gravel, loose; water	11	92
Clay	11	103
Sand and small gravel	37	140
Clay and gravel	12	152
Gravel and clay in seams	20	172

25/42-3cd1. Owner, Dalton Ford

	Thickness (feet)	Depth (feet)
Topsoil	3	3
Clay	11	14
Sand and gravel	54	68
Clay; water	10	78
Gravel, clean	6	84
Clay	6	90
Gravel, clean	10	100
Clay	4	104
Gravel, clean	6	110
Clay	3	113
Gravel, clean	7	120
Clay	5	125
Gravel, clean	8	133
Clay	6	139
Gravel, clean	9	148
Clay	4	152
Gravel	4	156

Table 8. -- (continued)

25/42-3dd1. Owner, Dalton Ford

	Thickness (feet)	Depth (feet)
Topsoil	2	2
Gravel, large, loose, dry	27	29
Gravel, fine, dry	37	66
Clay, yellow	12	78
Gravel, clean, fine, loose	16	94
Clay, yellow	3	97
Gravel, clean, fine	83	180
Gravel, very large, loose	64	244
Gravel, fine, and sand	32	276
Clay, yellow, sticky	3	279
Gravel, large, clean, loose	21	300

25/42-9dd1. Owner, Dewey Ford

	Thickness (feet)	Depth (feet)
Sandy loam	8	8
Gravel and sand	40	48
Clay	12	60
Clay and gravel	20	80
Gravel, medium and sand; water	120	200

25/42-11dd1. Owner, Reese River Farms

	Thickness (feet)	Depth (feet)
Topsoil	3	3
Gravel; large rock	167	170
Clay and some gravel	28	198
Pea gravel, small	20	218
Clay	2	220

25/42-15cd1. Owner, Reese River Farms.

	Thickness (feet)	Depth (feet)
Topsoil	3	3
Gravel and clay	25	28
Gravel	32	60
Gravel and clay; water	50	110
Gravel, large	70	180

25/42-20aa1. Owner, R. P. Powers

	Thickness (feet)	Depth (feet)
Topsoil, sandy clay	6	6
Clay, tight, and gravel	43	49
Gravel, dry, broken	21	70
Clay and gravel	16	86
Clay, sticky	5	91
Sand and fine gravel	24	115
Clay and gravel	32	147
Gravel, clean	12	159
Clay	17	176
Sand and gravel	12	188
Clay	4	192
Lava rock, sand, gravel	64	256

25/42-22dd1. Owner, G. S. Hodges

	Thickness (feet)	Depth (feet)
Topsoil	3	3
Clay and gravel; water	110	113
Gravel	37	150
Clay, sand, and gravel	50	200

26/43-10dd1. Owner, E. L. Fuller

	Thickness (feet)	Depth (feet)
Topsoil	2	2
Gravel, cemented	36	38
Clay	2	40
Gravel, cemented	35	75
Clay	18	93
Gravel, cemented	10	103
Clay, sandy; water	3	106
Gravel	2	108
Gravel and clay, streaks of gravel	157	265
Gravel, clean	7	272
Clay and gravel	28	300
Gravel	1	301
Clay and gravel	57	358
Gravel	1	359
Clay	5	364
Clay	4	368
Gravel, clean	2	370
Gravel	2	372

(continued, next page)

Table 8. (continued)

	Thickness (feet)	Depth (feet)
26/43-10ddl. (continued)		
Gravel, fine	10	382
Gravel, big, clean	8	390
Sand	4	394
Gravel, big	1	395
Clay and gravel	3	398
Gravel, fine, clean	24	422
Clay and gravel	5	427
Gravel, clean	24	451
Clay, yellow, soft	5	456
26/43-21ddl. Owner Q. Z. Morrison		
Topsoil	4	4
Clay, hard	15	19
Gravel, fine, dry	49	68
Clay	12	80
Clay and gravel	24	104
Gravel, fine, loose, in seams	129	233
Gravel, big, loose	27	260
26/43-29cdl. Owner, Robert Watson		
Topsoil	7	7
Clay with streaks of gravel	21	28
Gravel, big, clean, dry	5	33
Gravel, sandy	1	34
Gravel and clay seams	4	38
Gravel, clean	2	40
Clay and gravel	4	44
Clay	15	59
Gravel, big, dry	9	68
Gravel; water	6	74
Clay	3	77
Gravel	17	94
Clay, sandy	5	99
Gravel, clean	9	108
Clay	2	110
Gravel, loose	23	133
Gravel, cemented	2	135
Gravel, fine, clean	17	152
Clay streak	3	155
26/43-29cdl (continued)		
Gravel, big, clean	4	159
Gravel, cemented	2	161
Gravel, big, clean	5	166
Clay	1	167
Gravel, big, clean	15	182
Gravel; trace of clay	2	184
Gravel, clean	10	194
Gravel, clean; small clay streaks	6	200
26/43-29ddl. Owner, W. T. Jones		
Clay topsoil, sandy	4	4
Clay, tight	5	9
Gravel, dry, broken	47	56
Clay and gravel	49	105
Clay, white, soft	3	108
Gravel, clean, loose	16	124
Clay, sandy; gravel seams	22	146
Gravel, clean, loose	12	158
Sand and gravel	16	174
Clay	14	188
Gravel, large, clean	52	240
Clay, sticky	4	244

(continued)

Table 8 (continued)

26/43-31cd1. Owner, A. T. Linders

	Thickness (feet)	Depth (feet)
Topsoil	7	7
Pea gravel, dry, fine	29	36
Clay and gravel	18	54
Gravel, big	7	61
Clay, yellow	2	63
Gravel, loose; thin layer of clay	13	76
Sand and fine gravel	8	84
Gravel, cemented, hard, fine	17	101
Clay, yellow, in streaks	3	104
Clay, red, and large gravel	8	112
Gravel, cemented, fine, very hard	2	114
Gravel, big, loose; rocks	9	123
Gravel, cemented, fine, very hard	34	157
Gravel, clean, loose	43	200

27/43-23ca1. Owner, Henry Filippini

	Thickness (feet)	Depth (feet)
Topsoil	12	12
Hardpan	6	18
Gravel; water	100	118
Rock and clay	5	123

27/43-31ad1. Owner, Ellison Ranching Co.

	Thickness (feet)	Depth (feet)
Clay	15	15
Boulders	4	19
Clay and gravel	16	35
Boulders	5	40
Clay and gravel mixed	54	94
Gravel	5	99
Clay, sandy	17	116
Boulders	6	122
Clay and gravel	18	140
Gravel	7	147
Clay, sandy	7	154
Gravel	26	180
Clay and gravel	24	204
Sand	6	210

27/43-31ba2. Owner, Ellison Ranching Co.

	Thickness (feet)	Depth (feet)
Boulders, gravel, and clay	81	81
Gravel and sand	15	96
Lava rock, loose	94	190

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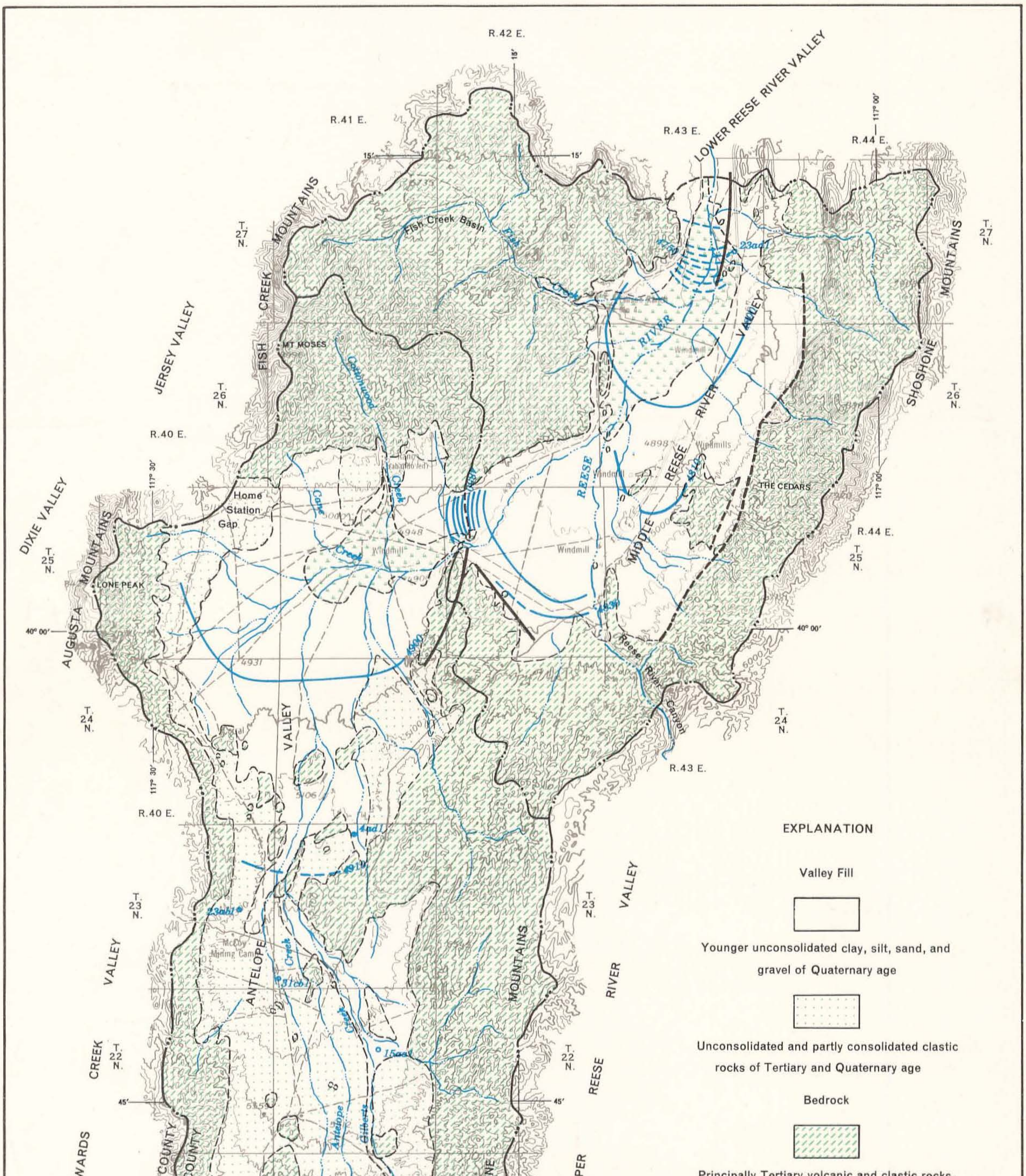
UNITED STATES DEPARTMENT OF INTERIOR
GEOLOGICAL SURVEY

STATE OF NEVADA
DEPARTMENT OF CONSERVATION AND NATURAL RESOURCES



Base: U.S. Geological Survey 1:250,000 scale topographic quadrangle; Millett (1958) and Winnemucca (1959)

Geology by E. G. Crosthwaite, modified from Ferguson, Muller, and Roberts, (1951) north of latitude 40° 00′ North and compiled from aerial photos south of latitude 40° 00′ North

PLATE 1.—MAP OF ANTELOPE AND MIDDLE REESE RIVER VALLEYS, LANDER COUNTY, NEVADA
SHOWING AREAS OF BEDROCK, VALLEY FILL, LOCATION OF WELLS, AND WATER-LEVEL CONTOURS