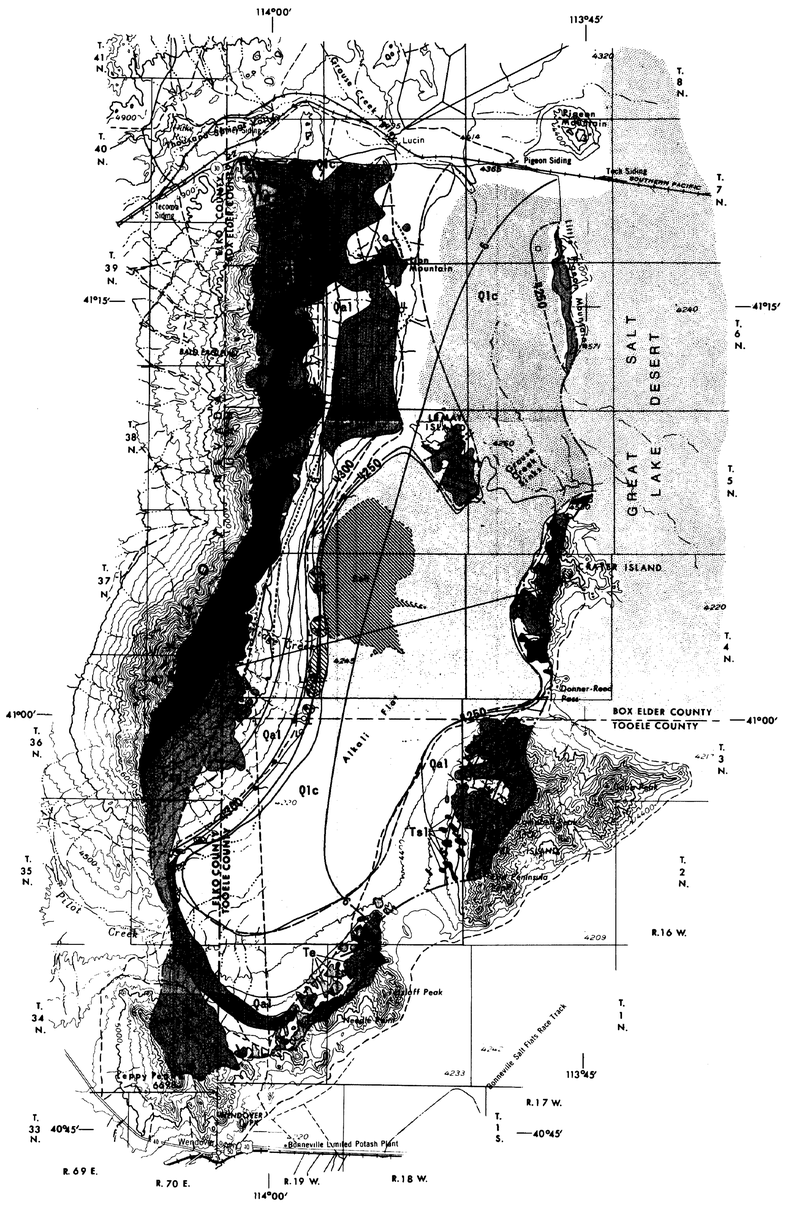


Generalized hydrogeology

EXPLANATION

GEOLOGY
(See table I)

Qal — Alluvium and colluvium
Unconsolidated materials ranging in size from clay to boulders; includes youngest surficial deposits and pre-Lake Bonneville valley fill

Lakeshore deposits
Deposits of Lake Bonneville; chiefly sand and gravel in spits, bars, and terraces

Qlc — Lake-bottom deposits
Deposits of Lake Bonneville; chiefly clay, silt, and fine sand

(Includes Tertiary in subsurface) — QUATERNARY

Te — Extrusive igneous rocks
Chiefly rhyolitic and andesitic flows and pyroclastic deposits

Salt Lake Formation
Yellowish to tan limestone interbedded with tan and gray sandstone, siltstone, vitric tuff, pebble-conglomerate, and carbonaceous shale

Intrusive igneous rocks
Chiefly light-colored granitic rocks; includes small outcrops of basaltic rocks in T. 6 N., R. 19 W.

TERTIARY

Pzu — Sedimentary rocks undivided
Mostly limestone and dolomite; some sandstone, shale, and quartzite

MIDDLE CAMBRIAN to PERMIAN

Quartzite and associated metamorphic rocks undivided
White to light-brown massive quartzite mapped as Prospect Mountain Quartzite in Utah. Includes units mapped in Nevada as Precambrian McCoy Creek Group of Misch and Hazzard (1962), consisting of slate, argillite, phyllite, metasiltstone, quartzite, and conglomerate

PRECAMBRIAN and CAMBRIAN

Approximate contact

Fault
Dashed where inferred, dotted where concealed by alluvium

Thrust fault
Barbs on side of thrust sheet

HYDROLOGY

4300 — Water-level contour
Shows approximate altitude of water level in alluvial deposits; dashed where inferred. Contour interval 50 feet. Datum is mean sea level

L Abandoned — Well
Wells listed in table 8.
L, driller's log in table 9

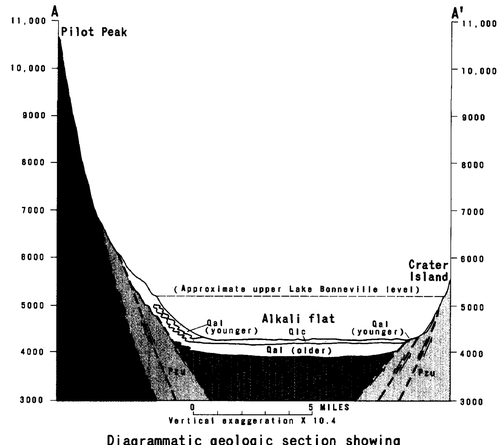
S 2 — Spring
Springs listed in table 10.
S, several springs in immediate vicinity.
Number by spring symbol indicates more than one spring at same location

6 — Line of equal normal annual precipitation, 1931-60
Interval 2 and 4 inches; dashed where adjusted

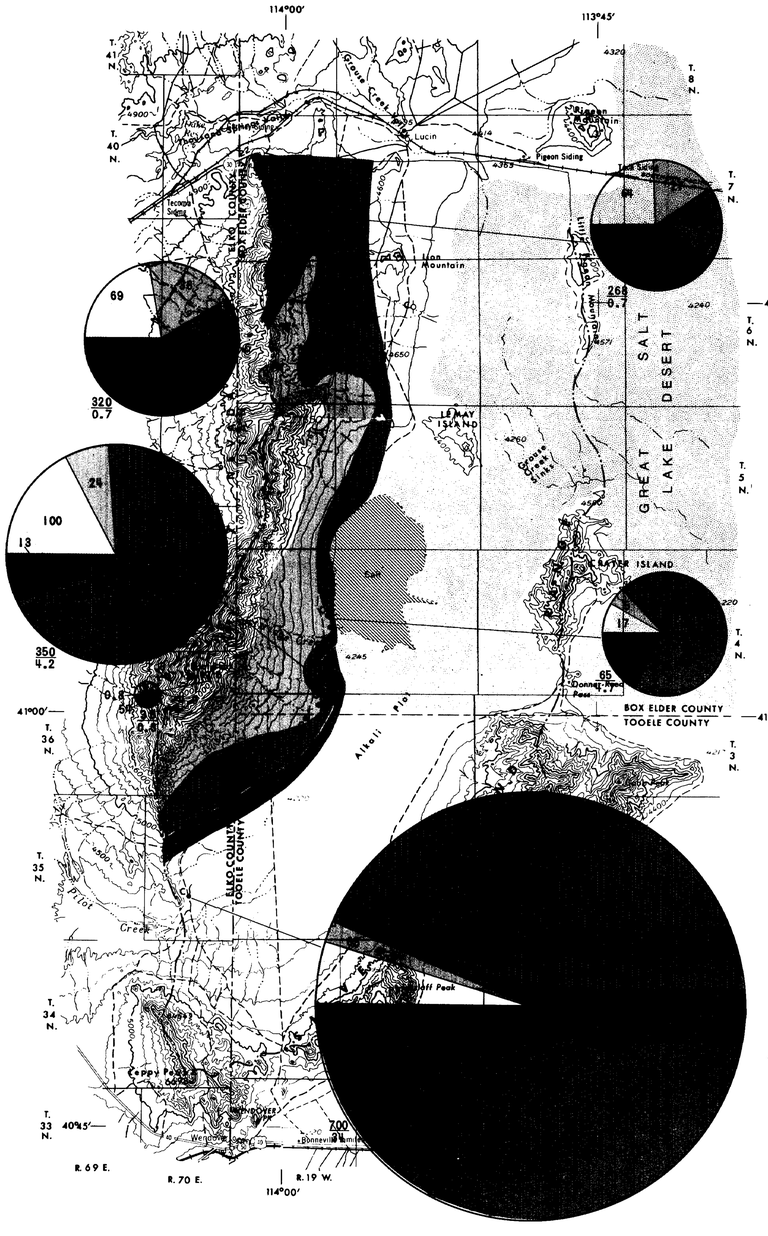
Approximate area of significant water consumption by phreatophytes referred to in table 5

Surface-drainage divide

A — A′ Line of geologic section



Diagrammatic geologic section showing inferred relationships among rock units.



EXPLANATION

CHEMICAL QUALITY OF WATER

C Abandoned — Well

C 2 — Spring
Specific conductance of all springs listed in table 10
C, chemical data listed in table 11.
S, several springs in immediate vicinity.
Number by spring symbol indicates more than one spring at same location

GENERAL DISSOLVED-SOLIDS CONCENTRATION, IN MILLIGRAMS PER LITER

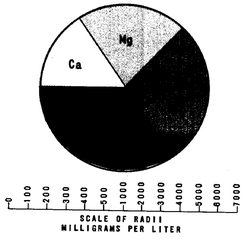
- Less than 150
- 150-300
- 300-1000
- 1000-5000
- Inadequate data; generally 5,000 or more in center of valley; locally more than 10,000

REPRESENTATIVE CHEMICAL ANALYSIS

Radius of circle is in proportion to dissolved-solids concentration. Upper half of circle represents cations: Ca, calcium; Mg, magnesium; Na, sodium; K, potassium. Lower half of circle represents anions: Cl, chloride; HCO_3, bicarbonate; SO_4, sulfate.

Size of segment is in proportion to concentration, in milliequivalents per liter. Number in segment is concentration, in milligrams per liter

350 — Hardness as $CaCO_3$, in milligrams per liter
4.2 — Sodium-adsorption ratio



Surface-drainage divide

Generalized dissolved-solids distribution in ground water and chemical character of representative water samples

Base from U.S. Geological Survey 1:250,000 series: Brigham City (1962), Tooele (1962), Elko (1962), and Wells (1961)

5 0 5 MILES
5 0 5 KILOMETERS
CONTOUR INTERVAL 200 FEET
DATUM IS MEAN SEA LEVEL

Hydrology by Jerry C. Stephens, 1971. Geology in Utah adapted from Stokes (1964); in Nevada adapted from Granger and others (1957) and Woodward (1967) and modified by photogeologic methods. Climatologic data from U.S. Weather Bureau (1963a) and Hardman (1965); adjusted along State line and in Nevada to reconcile the two sources by Jerry C. Stephens.

GENERALIZED HYDROGEOLOGIC MAPS OF THE PILOT VALLEY AREA, UTAH AND NEVADA

STATE OF UTAH

DEPARTMENT OF NATURAL RESOURCES

Technical Publication No. 41

HYDROLOGIC RECONNAISSANCE OF PILOT VALLEY, UTAH AND NEVADA

by

Jerry C. Stephens and J. W. Hood

Hydrologists, U.S. Geological Survey

Prepared by

the United States Geological Survey

in cooperation with

the Utah Department of Natural Resources

Division of Water Rights

1973

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HYDROLOGIC RECONNAISSANCE OF PILOT VALLEY, UTAH AND NEVADA

by

Jerry C. Stephens and J. W. Hood
Hydrologists, U.S. Geological Survey

ABSTRACT

Pilot Valley is an area of about 470 square miles in southwestern Box Elder and northwestern Tooele Counties, Utah, and eastern Elko County, Nevada. The valley is bounded on the east and south by the Silver Island Range, and on the west by the Pilot Range. The bottom of the valley, about two-thirds of which is a barren alkali flat, is part of the Great Salt Lake Desert.

The climate of Pilot Valley is arid to semiarid. The principal source of runoff and ground-water recharge is the snowpack that accumulates on the mountains in winter. Total precipitation on the area averages about 184,000 acre-feet annually, and nearly the entire amount ultimately is consumed by evapotranspiration within the valley. The only perennial streamflow in the area occurs in short spring-fed reaches above altitudes of about 5,600 feet. Below that altitude the flow is lost to infiltration and evaporation. The ground-water reservoir in Pilot Valley consists of unconsolidated materials of Quaternary and Tertiary age and consolidated sedimentary, metamorphic, and igneous rocks ranging in age from Precambrian to Tertiary. Annual ground-water recharge is estimated to be 7,500 acre-feet. About 3,400 acre-feet of recharge is derived from precipitation on the area above an altitude of 5,600 feet. The remaining 4,100 acre-feet of recharge is ground-water inflow from adjacent areas.

Annual discharge of ground water in Pilot Valley approximately equals annual recharge. An estimated 3,400 acre-feet of ground water is discharged annually by evapotranspiration by phreatophytes, and at least 4,000 acre-feet is evaporated directly from the water table under the alkali flat. Irrigation wells discharge 200 acre-feet annually, and about 400 acre-feet of water from springs is exported annually to supply municipal water for the town of Wendover.

The maximum amount of ground water chemically suitable for present uses that could be withdrawn annually without excessively depleting storage is estimated to be about 2,000 acre-feet, all of which would represent capture of water that would otherwise be consumed by evapotranspiration. Additional withdrawals by pumping from wells would probably cause a deterioration in the quality of the water withdrawn.

The ground-water reservoir above an altitude of about 4,250 feet contains water of satisfactory quality for most uses. Below 4,250 feet, water in the alluvial deposits is generally too saline for most uses. Water containing less than 100 milligrams per liter of dissolved solids is discharged by springs issuing from the quartzites in the Pilot Range, whereas water from a well in alluvial deposits under the valley floor contained more than 11,000 milligrams per liter of dissolved solids. Water from alluvium under the intermediate slopes between the mountain core and the valley flat generally contains less than 1,000 milligrams per liter of dissolved solids.

INTRODUCTION

This report, prepared by the U.S. Geological Survey in cooperation with the Utah Department of Natural Resources, Division of Water Rights, is the twelfth in a series of reports that describe the water resources of the western basins of Utah. (See fig. 1.) Its purpose is to present available hydrologic data on the Pilot Valley area, to provide an evaluation of the

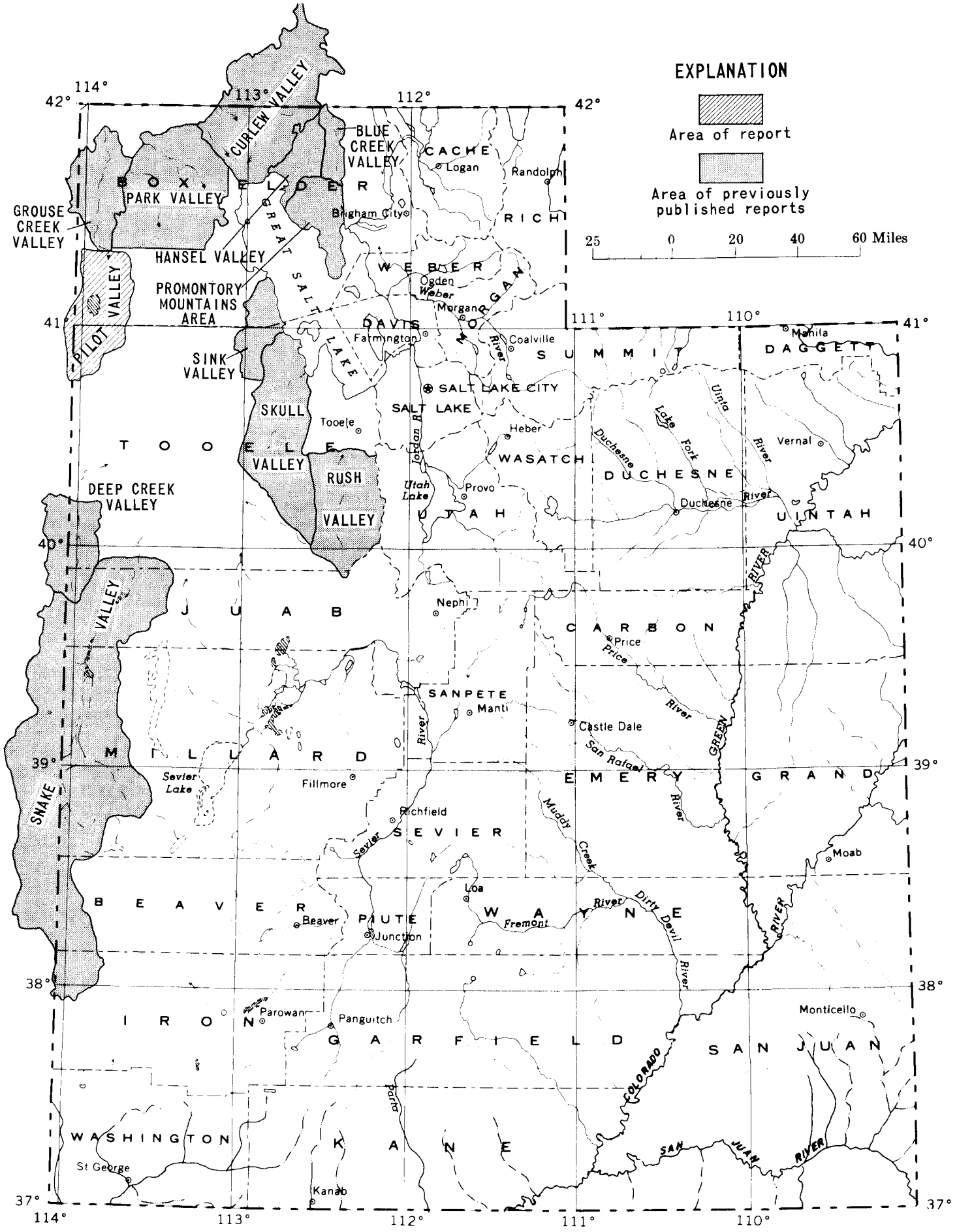

Figure 1.—Location of Pilot Valley and other areas described in previous reconnaissance investigations in this series.

potential for water-resource development in the area, and to identify studies that would improve understanding of the area's water supply.

The investigation on which the report is based consisted largely of a study of available data for geology, streams, wells, springs, climate, and water use in the Pilot Valley area. These data were supplemented with field data on landforms, vegetation, geology, and water resources collected during a 1-week reconnaissance in September 1971.

Pilot Valley, as described in this report, is an area of about 470 square miles in southwestern Box Elder and northwestern Tooele Counties, Utah, and eastern Elko County, Nevada (pl. 1). The area includes parts of the drainage basins of Pilot Creek, Thousand Springs Creek, and Grouse Creek; most of the valley is included in the Great Salt Lake Desert. Less than 300 acres in Pilot Valley is cultivated; most of the area is Federal, State, and private grazing land or barren alkali flats. The present population of the valley consists of a single family.

Little has been published that specifically describes the water resources of Pilot Valley. Water resources of adjoining areas in Nevada and Utah are described in reports of reconnaissance studies by Hood (1971), Hood and Price (1970), Rush (1968), and Harrill (1971). Principal sources of information for Pilot Valley are a U.S. Geological Survey Water-Supply Paper by Carpenter (1913), which supplies some early data, and the unpublished results of a water-supply investigation in 1943 by Geological Survey personnel for the former Wendover Army Air Base. Principal sources of basic data are the files of the Geological Survey and those of the Utah State Engineer. Selected data from the files and from field observations made during the present reconnaissance are tabulated in the basic data section at the end of this report.

Descriptions of the geology of the area, which provide data on the hydrogeologic framework of the water-resources system, include the geologic map of Utah (Stokes, 1964) and reports by Granger and others (1957), Schaeffer (1960), Blue (1963), Heylmun (1965), and Woodward (1967).

GENERAL HYDROLOGIC ENVIRONMENT

Physiography

Pilot Valley is in the northeastern part of the Great Basin section of the Basin and Range physiographic province (Fenneman and Johnson, 1946). The valley is a trough-shaped depression about 35 miles long and 15 miles wide, bounded by the Pilot Range on the west and the Silver Island Range on the south and east (pl. 1). The southwestern boundary coincides with a low ridge extending southward from the Pilot Range toward Leppy Peak north of Wendover. The valley opens on the northeast through the gaps between Crater Island, the Little Pigeon Mountains, and Pigeon Mountain into the Great Salt Lake Desert; on the northwest, it joins the Grouse Creek-Thousand Springs Creek drainage that extends northward and northwestward into Nevada.

Altitudes along the drainage divides bounding Pilot Valley are generally between 7,000 and 10,000 feet in the Pilot Range and between 4,500 and 7,000 feet in the Silver Island Range. The highest point in the area is Pilot Peak (altitude 10,716 ft) near the southern end of the Pilot Range, and the lowest point (about 4,235 ft) is on the Great Salt Lake Desert just north of Crater Island at the northern tip of the Silver Island Range. Thus, total relief in the area is nearly 6,500 feet.

Below an altitude of about 5,200 feet the surface of the entire Pilot Valley area has been modified by the wave and current action of Pleistocene Lake Bonneville (see Gilbert, 1890, and Crittenden, 1963, fig. 3). The shoreline of the Bonneville stage, the highest level of the ancient lake, appears prominently in aerial photographs of the area; on the ground, the shoreline is

Table 1.—Generalized columnar section and water-bearing characteristics of geologic units in Pilot Valley

Age			Geologic unit and map symbol (pl. 1)	Description and extent	Water-bearing characteristics
CENOZOIC	Quaternary	Pleistocene and Holocene	Alluvium and colluvium (Qal)	Surficial deposits ranging in size from clay to boulders. Thickest and coarsest near mountain front and at base of consolidated rock outcrops in valley. Undifferentiated on pl. 1 from older alluvium, with which it is interbedded near mountain fronts. Forms surface of alluvial slopes at base of Pilot and Silver Island Ranges. Maximum thickness unknown, but probably less than 100 feet thick in most places.	Moderately to highly permeable; intake area for recharge from precipitation and runoff in mountain streams. Water table generally below bottom of these deposits except locally near edge of alkali flat; discharge water by evapotranspiration on lower slopes; may supply some water to springs and wells.
		Pleistocene	Lakeshore deposits (Qls)	Deposits of Lake Bonneville; consist chiefly of sand and gravel in spits, bars, and terraces. Maximum thickness probably less than 50 feet. Form land surface in much of western half of Tps. 5-7 N., R. 18 W.; smaller deposits occur at the southwest end of Pilot Valley and locally along the western margin of the alkali flat.	Moderately to highly permeable, but generally too thin to be an important aquifer. No known wells or springs in these deposits. Intake area for recharge to underlying alluvium from local precipitation and runoff in ephemeral streams.
			Lake-bottom deposits (Qlc)	Deposits of Lake Bonneville; chiefly clay, silt, and fine sand; maximum thickness probably less than 100 feet. Forms land surface of nearly all of area below altitude of 4,300 feet, and underlies most of area below about 5,200 feet.	Slightly permeable; yields little or no water to wells or springs. Precipitation falling on these deposits in the northern third of the area is retained as soil moisture or is consumed by evapotranspiration. In the southern two-thirds of the area, these deposits are water saturated to or within a few feet of the land surface; water rises by capillary action and is discharged by evaporation. Residue from evaporation of ground water and accumulated surface runoff has resulted in extensive alkali flat. Water in these deposits below altitude of about 4,250 feet is probably highly saline.
			Alluvium (Qal)	Chiefly clay, silt, sand, and gravel. Thickness and extent unknown; probably underlies most of area where older consolidated rocks do not crop out, and probably less than 200 feet thick in most places. Upper part of unit near mountains is equivalent in age to and interfingers with younger alluvium and colluvium.	Moderately to highly permeable in most areas; highly permeable along upper edge near mountain front. Major aquifer in valley; supplies most of the water discharged by springs and wells below altitude of 5,400 feet. Discharges some water by evapotranspiration near edge of valley flat. Water from this unit generally fresh in western half of area, becoming more saline toward the east; probably contains saline water only below altitude of about 4,250 feet.
	Tertiary		Extrusive igneous rocks (Te)	Small, isolated areas of rhyolitic and andesitic flows and pyroclastic deposits at extreme northern end of Pilot Range and southwestern part of Silver Island Range.	Slightly permeable overall, but locally transmit water through fractures, joints, and vesicular or rubbly zones. No known springs or wells discharge water from these rocks in Pilot Valley area.

Table 1.—Generalized columnar section and water-bearing characteristics of geologic units in Pilot Valley (Continued)

Age		Geologic unit and map symbol (pl. 1)	Description and extent	Water-bearing characteristics
CENEZOIC	Tertiary	Salt Lake Formation (Tsl)	Yellowish to tan limestone, interbedded with tan and gray sandstone, siltstone, vitric tuff, pebble-conglomerate, and carbonaceous shale (Heylmun, 1965, p. 16). Crops out along north end of Pilot Range and locally along Silver Island Range; probably underlies most of area where older rocks do not crop out.	Unit as a whole probably only slightly permeable, but some interbeds of sand and conglomerate might yield small to moderate quantities of water to wells. Probably contains saline water below altitude of about 4,250 feet. No known springs or wells discharge water from these rocks in Pilot Valley area.
		Intrusive igneous rocks (Ti)	Chiefly light-colored granitic rocks; crop out over much of northern end of Pilot Range and locally at north end of Silver Island Range. Includes small outcrops of basaltic intrusives in T. 6 N., R. 19 W.	General characteristics similar to extrusive igneous rocks (Te); granitic rocks yield fresh water to numerous springs in T. 6 N., R. 19 W. Most precipitation falling on outcrop area of these rocks runs off rapidly because of steep slopes and slight permeability.
PALEOZOIC	Middle Cambrian to Permian	Sedimentary rocks undivided (Pzu)	Consolidated rocks forming northern and southern ends of Pilot Range and most of Silver Island Range, and the cores of the Little Pigeon Mountains, Lemay Island, and Lion Mountain; mostly limestone and dolomite, some sandstone, shale, and quartzite. Rocks highly contorted by folding and complex faulting; may be locally metamorphosed. Probably underlie most of the area at considerable depth.	Unit as a whole slightly permeable, but locally may transmit large volumes of water through fractures and joints. Limestones and dolomites contain solution channels and cavities in outcrop and probably at depth. This unit yields fresh water to numerous small (discharge generally less than 50 gpm) springs in Pilot Range.
PALEOZOIC & PRECAMBRIAN	Precambrian and Cambrian	Quartzite and associated metamorphic rocks undivided (€p€u)	White to light-brown massive quartzite, mapped as Cambrian Prospect Mountain Quartzite in Utah (Stokes, 1964). Includes Precambrian McCoy Creek Group of Misch and Hazzard (1962) (slate, argillite, phyllite, metasiltstone, quartzite, and conglomerate) in Elko County, Nev. (Woodward, 1967). Crops out in central Pilot Range; Pilot Peak and other highest peaks in range composed of these rocks. Subsurface extent unknown. Rocks are structurally deformed by complex faulting and folding.	Unit as a whole slightly permeable, but where structurally deformed contains open fractures and joints that transmit water readily. Yields small to moderate (generally less than 100 gpm) amounts of water to springs along fracture zones; Wendover public supply obtained from springs in this unit. Most of the precipitation falling on outcrop area of these rocks runs off rapidly because of steep slopes and slight permeability.

Table 2.—Average monthly precipitation and temperature at climatologic stations near Pilot Valley

[See table 7 in appendix for details on station and record; years of record in parentheses]

	Lucin				Lemay				Wendover				Montello			
	Precipitation (inches)		Temperature (°F)		Precipitation (inches)		Temperature (°F)		Precipitatation (inches)		Temperature (°F)		Precipitation (inches)		Temperature (°F)	
January	0.57	(41)	22.7	(37)	0.33	(20)	24.5	(19)	0.30	(49)	27.3	(45)	0.55	(68)	23.0	(71)
February	.43	(39)	29.4	(37)	.34	(20)	32.0	(19)	.31	(49)	33.5	(45)	.48	(68)	28.5	(73)
March	.36	(39)	38.4	(36)	.38	(20)	41.0	(19)	.35	(49)	42.5	(45)	.32	(68)	37.1	(74)
April	.52	(40)	47.5	(36)	.37	(20)	50.0	(19)	.48	(49)	52.0	(44)	.51	(68)	46.1	(71)
May	.76	(39)	55.4	(36)	.53	(20)	60.0	(19)	.64	(49)	61.9	(44)	.77	(68)	54.6	(72)
June	.58	(40)	64.7	(36)	.60	(20)	69.9	(19)	.50	(50)	70.9	(44)	.63	(68)	62.8	(74)
July	.47	(40)	73.8	(36)	.23	(20)	77.8	(19)	.32	(50)	79.9	(44)	.27	(68)	72.2	(74)
August	.46	(39)	71.3	(36)	.26	(20)	74.5	(19)	.33	(50)	77.4	(44)	.34	(68)	69.5	(73)
September	.40	(37)	61.1	(35)	.40	(20)	62.8	(19)	.37	(50)	66.6	(44)	.38	(68)	59.2	(71)
October	.56	(40)	47.9	(36)	.49	(20)	49.5	(19)	.44	(50)	53.3	(45)	.47	(68)	47.0	(71)
November	.34	(38)	35.2	(35)	.25	(20)	37.5	(19)	.26	(50)	38.6	(45)	.40	(68)	34.3	(72)
December	.47	(38)	24.3	(36)	.33	(20)	27.1	(19)	.32	(50)	29.7	(45)	.53	(68)	25.7	(71)
Average annual	5.92		47.6		4.51		50.6		4.62		52.8		5.65		46.6	

marked in many places by coarse-grained beach deposits. In parts of the area, especially in the Silver Island Range, wave-cut terraces are well developed on consolidated rocks at several levels, and numerous old shorelines are marked on the alluvial slopes. Gravel bars and spits deposited in the lake extend from many of the consolidated rock outliers; such a bar forms a part of the southwestern boundary of the area described in this report.

A prominent physiographic feature in Pilot Valley is the alkali flat that includes about 85,000 acres of the valley bottom (see pl. 1). This flat is nearly everywhere at an altitude of 4,245 to 4,248 feet and is covered with salt deposits that inhibit vegetative growth, resulting in a white, featureless expanse of salt desert.

Geology

Geologic formations exposed in Pilot Valley range in age from Precambrian to Permian and from Tertiary to Holocene. Formations having similar hydrologic characteristics have been combined into geohydrologic units for discussion in this report. Plate 1 shows the distribution of these units in Pilot Valley, and table 1 gives a general description of their lithology and water-bearing character.

Pilot Valley, like many of the other intermontane valleys of the Great Basin, is a structural depression created by the deformation of Tertiary and older rocks. The unconsolidated and semiconsolidated rocks that partially fill this depression contain the main ground-water reservoir in the valley.

Climate

The climate in Pilot Valley is arid to semiarid. Average annual precipitation (pl. 1) is less than 6 inches over much of the valley floor; precipitation of 10 inches or more occurs only above altitudes of about 5,400 feet in the Pilot Range and about 6,000 feet in the Silver Island Range.

Selected climatologic data from stations near Pilot Valley are summarized in figure 2 and table 2. These data indicate the pronounced annual, seasonal,and monthly fluctuations in precipitation and temperature that occur in Pilot Valley.

Other climatologic data indicative of conditions in Pilot Valley are tabulated below for stations near the northern and southern ends of the valley:

	Lucin	Wendover
Average annual snowfall (inches)	16.1	7.9
Average frost date (32°F or less)		
last spring	June 1	April 21
first fall	Sept. 20	Sept. 21
Average length of growing season (days)	111	153
Average number of days each year with		
temperature exceeding 90°F	-	58
Highest recorded temperature (°F)	105	112
Lowest recorded temperature (°F)	-28	-19

Much of the precipitation in the Pilot and Silver Island Ranges occurs as snow during the period December-March. The snowpack that accumulates at high altitudes during this period is the principal source of water in Pilot Valley.

HYDROLOGY

Precipitation on the Pilot Valley area is the source of nearly all the water available there. Total precipitation on the area is estimated to average 184,000 acre-feet annually, as shown in table 3.

Table 3.—Estimated average annual volumes of precipitation and ground-water recharge in Pilot Valley

(Areas of precipitation zones measured from pl. 1)

Precipitation zone (inches)	Area (acres)	Precipitation Feet	Precipitation Acre-feet (rounded)	Recharge Percent of precipitation	Recharge Acre-feet (rounded)
		Areas underlain by lake-bottom deposits			
Less than 6	96,100	0.46	44,200	0	0
6-8	77,100	.58	44,700	0	0
Subtotal (rounded)	173,000		89,000		0
		Areas underlain by alluvial and lakeshore deposits			
Less than 6	6,100	.46	2,800	0	0
6-8	39,000	.58	22,600	1	230
8-12	12,900	.83	10,700	5	540
Subtotal (rounded)	58,000		36,000		800
		Areas underlain by consolidated rocks			
Less than 6	10,200	.46	4,700	0	0
6-8	14,400	.58	8,400	0	0
8-12	28,400	.83	23,600	2	470
12-16	17,700[1]	1.17	20,700	10	2,070
More than 16	1,100	1.38	1,500	5[2]	80
Subtotal (rounded)	72,000		59,000		2,600
Total (rounded)	303,000		184,000		3,400

[1] Locally includes small, thin unconsolidated deposits mantling consolidated rocks.

[2] Areas receiving more than 16 inches of precipitation are extremely steep, have scant vegetation, and are underlain by hard, dense rocks. Most of the precipitation runs off on surface; recharge estimate for downslope areas is weighted accordingly.

Surface water

Surface-water inflow to Pilot Valley from adjacent areas is estimated to average about 1,600 acre-feet annually. Inflow from Thousand Springs Valley at the Utah State line averages about 800 acre-feet (Rush, 1968, p. 32). Hood and Price (1970, p. 10, 26) estimated average annual surface flow from Grouse Creek valley to be 760 acre-feet.

Average surface flow from the valley of Pilot Creek in Nevada into Pilot Valley is assumed to be negligible. Severe thunderstorms that occurred in the area in the summer of 1971 could have been expected to produce outflow to Pilot Valley, but when the area was visited in September 1971, there were no indications of recent flow through the gap in the low divide in T. 35 N., R. 70 E.

On the basis of studies by Bagley and others (1964) and Busby (1966), annual runoff in Pilot Valley is estimated to average less than 500 acre-feet or about 0.1 inch of runoff from the 61,500-acre upland area that is underlain by consolidated rocks and receives more than 6 inches of precipitation annually. Summer thunderstorms produce rapid runoff on the steep slopes along both sides of the valley. In the southern two-thirds of the valley, most of this runoff infiltrates into the alluvium within a short distance from the mountain front; the remainder becomes concentrated in ephemeral stream channels and discharges onto the valley floor, where it spreads out over the alkali flat and evaporates. A much larger volume of runoff occurs during spring snowmelt and is consumed in the same manner.

Much of the surface outflow from Thousand Springs Valley is consumed by evapotranspiration in the channel reach between the State line and Lucin. Inflow from Grouse Creek joins that from Thousand Springs Creek near Lucin. This combined flow, together with whatever runoff occurs in the northern part of Pilot Valley, drains southeastward across the northern part of the Pilot Valley area. A complex network of shallow channels, floored by lake-bottom deposits and bordered by dense greasewood, distributes the flow over a large area known as Grouse Creek Sinks (pl. 1) where nearly all the water is consumed by evapotranspiration.

From field observations in the lowest part of the Pilot Valley area, between Crater Island and the Little Pigeon Mountains, it is assumed that average annual surface outflow from Pilot Valley is negligible.

Some streams that drain the higher parts of the Pilot Range are sustained by perennial springflow in their upper reaches. However, once the flow in these streams reaches the alluvial slopes, it infiltrates readily and the stream disappears except during and immediately after the spring snowmelt. Virtually all perennial flow originates above altitudes of about 5,600 feet on the slopes of the Pilot Range.

Streams draining the Silver Island Range are all ephemeral. There are no known perennial springs in these mountains, and therefore no source of sustained flow. Runoff occurs only in direct response to thunderstorms or snowmelt and ceases immediately thereafter.

Some water is diverted from ephemeral streams in T. 4 N., R. 19 W., for irrigation on the lower edge of the alluvial slope. Because the water flows in unlined ditches constructed in relatively coarse, permeable alluvium for as much as 3 miles before reaching the area of use, most of the water originally diverted is lost by infiltration. No surface storage is provided on the streams, so that water generally is available in quantities sufficient to sustain flow to the point of use only during the snowmelt season. During the remainder of the year, the base flow contributed by the discharge of perennial springs is inadequate to sustain streamflow for more than a few tenths of a mile beyond the mountain front.

Unpublished data in the files of the U.S. Geological Survey indicate that the discharge of Bettridge Creek (also called Gaulier Creek) in sec. 16(?), T. 4 N., R. 19 W., was estimated to be 1 cfs (cubic foot per second) on January 10, 1943. This flow, which consisted entirely of discharge from springs, disappeared into the alluvium within a short distance. A flow of 3 cfs was measured for this same creek at an unspecified location in May 1942. During 1941, a year of abnormally high precipitation (see fig. 2), flow from Bettridge Creek was reported by M. L. Warburton to have reached his ranch at the foot of the alluvial slope even during the winter months, when spring discharge was probably near the seasonal minimum and little or no runoff from snowmelt occurred.

Ground water

The major sources of usable ground water in Pilot Valley are the saturated alluvial deposits on the eastern flank of the Pilot Range and the fractured consolidated rocks that make up the core of the range. The stratigraphic relationships of these units and their general hydrologic properties are given on plate 1 and table 1.

All the available well logs (table 9) indicate the presence of coarse-grained alluvial deposits (probably the older alluvial unit) at depths of less than 100 feet. These deposits make up the most permeable aquifer in the valley fill. The overlying lakebed deposits that mantle the valley floor contain large volumes of water, but the water is yielded slowly to wells and is too saline for most uses.

Water levels in the unconsolidated materials range from land surface along the west edge of the alkali flat in the central and southern part of the valley to an estimated 220 feet below land surface just south of Lucin. In general, the depth to water is greatest under the upper slopes near the mountain front and least under the alkali flat in the valley bottom. Water levels in the mountain cores vary considerably over short distances because of variations in topographic relief and conditions of ground-water occurrence.

The consolidated rocks that form the Pilot and Silver Island Ranges and underlie all of Pilot Valley vary greatly in their ability to store and transmit water, as indicated in table 1. The consolidated rocks that form most of the core of the Pilot Range yield water to numerous springs that issue along faults and fracture zones. Discharge of these springs is highly variable, fluctuating in direct response to snowmelt and probably in many cases to summer thunderstorms. Many of the springs are perennial and sustain the flow of surface streams for short distances.

Recharge

Recharge to the ground-water reservoir in Pilot Valley is derived from two sources: infiltration of precipitation on the area and ground-water underflow from adjacent areas. Recharge from precipitation is discussed in the following paragraphs, and the estimated quantities of underflow from adjacent areas are given in table 6.

The estimated average annual recharge to the ground-water reservoir in Pilot Valley from precipitation on the area is 3,400 acre-feet (table 3), or less than 2 percent of the estimated 184,000 acre-feet of average annual precipitation. The recharge estimate was made using a method developed by Eakin and others (1951, p. 79-81) for use in Nevada and modified by Hood (see Hood and Waddell, 1968, p. 22-23 for a discussion of the method) for use in western Utah.

Ground-water recharge is derived mainly from precipitation on lands above an altitude of 5,600 feet. A part of the recharge infiltrates directly to the ground-water reservoir through the rocks on which it falls; the major recharge to the unconsolidated deposits, however, is derived from runoff from consolidated rocks upslope and from discharge from springs in the consolidated rocks above an altitude of about 5,400 feet.

Little recharge is derived from precipitation on the land below an altitude of 5,600 feet. Precipitation there is scanty, and most of the water is retained as soil moisture by the surficial materials.

Occurrence and movement

Water in the saturated part of the younger alluvium and in the lake-bottom deposits on the valley floor is under water- table (unconfined) conditions. Water in the older alluvial deposits and the Salt Lake Formation underlying the valley floor and slopes may be under either water-table or artesian (confined) conditions. The lake-bottom deposits overlying the older alluvium in the lower slopes serve as a confining layer, although throughout much of the area along the margin of the alkali flat in Tps. 4 and 5 N., R. 19 W., water apparently moves upward through the clays and discharges at the land surface from artesian springs. Elsewhere in the valley bottom, few wells or springs exist and conditions within the ground-water reservoir are not known.

Ground water in the consolidated rocks exposed in the Pilot Range is probably confined, at least in part. Water temperatures (tables 10 and 11) of several springs that discharge from these rocks along faults and fractures in and adjacent to the mountain core are generally 3°C to 5°C (5°F to 9°F) higher than the average annual air temperature of 8.5°C (47°F), estimated from Lucin and Montello temperature data (table 2). This slight temperature increase probably indicates that the water has risen from greater depth to the discharge points and has been heated during the circulation by the warmer rocks at depth.

Ground water in the alluvial deposits, and probably also in the underlying Salt Lake Formation, moves generally in flow patterns related to the surface topography. The hydraulic gradient is toward the bottom of the valley from the intake areas at high altitudes in the Pilot and Silver Island Ranges (pl. 1); beneath the alluvial slopes at the base of the Pilot Range, the gradient may exceed 100 feet per mile. The alkali-flat area appears to be a closed depression, both topographically and from the standpoint of ground-water movement. Current topographic mapping by the U.S. Geological Survey, together with aerial photographs and field evidence, indicates that the area between Crater Island and the Little Pigeon Mountains probably is a ground-water divide.

The direction of ground-water movement in the older rocks underlying the area is not known. No wells have penetrated these rocks in the area, and water-level data are nonexistent.

Storage

Under natural conditions, a ground-water system is in dynamic equilibrium; long-term average annual recharge and discharge are equal, and the amount of ground water in transient storage remains nearly constant.

Water-level fluctuations.—Changes in the volume of ground water in storage result in corresponding changes in discharge from springs and water levels in wells. Available data are inadequate to define such changes in Pilot Valley in the past. Fluctuations in discharge from the Western Pacific Railroad Co. pipeline (now owned by the town of Wendover) in 1938-42 (table 4) provide some indication of the magnitude of annual and seasonal fluctuations in discharge of high-altitude springs in the Pilot Range, but no correlation is possible between these changes and storage changes in the ground-water reservoir.

It is probable that in Pilot Valley, seasonal and annual changes tend to balance out in the long-term average, and the condition of dynamic equilibrium is maintained. Ground-water development by man is negligible; at most, withdrawals from wells have only reduced evapotranspiration by phreatophytes.

Estimated storage.—The total volume of ground water in storage in Pilot Valley is unknown, and data are lacking on which to base an estimate. Because much of the ground water below an altitude of about 4,250 feet is too saline for most uses, however, an estimate of water recoverable from the ground-water reservoir above that altitude provides an approximation of the amount of usable ground water in the valley.

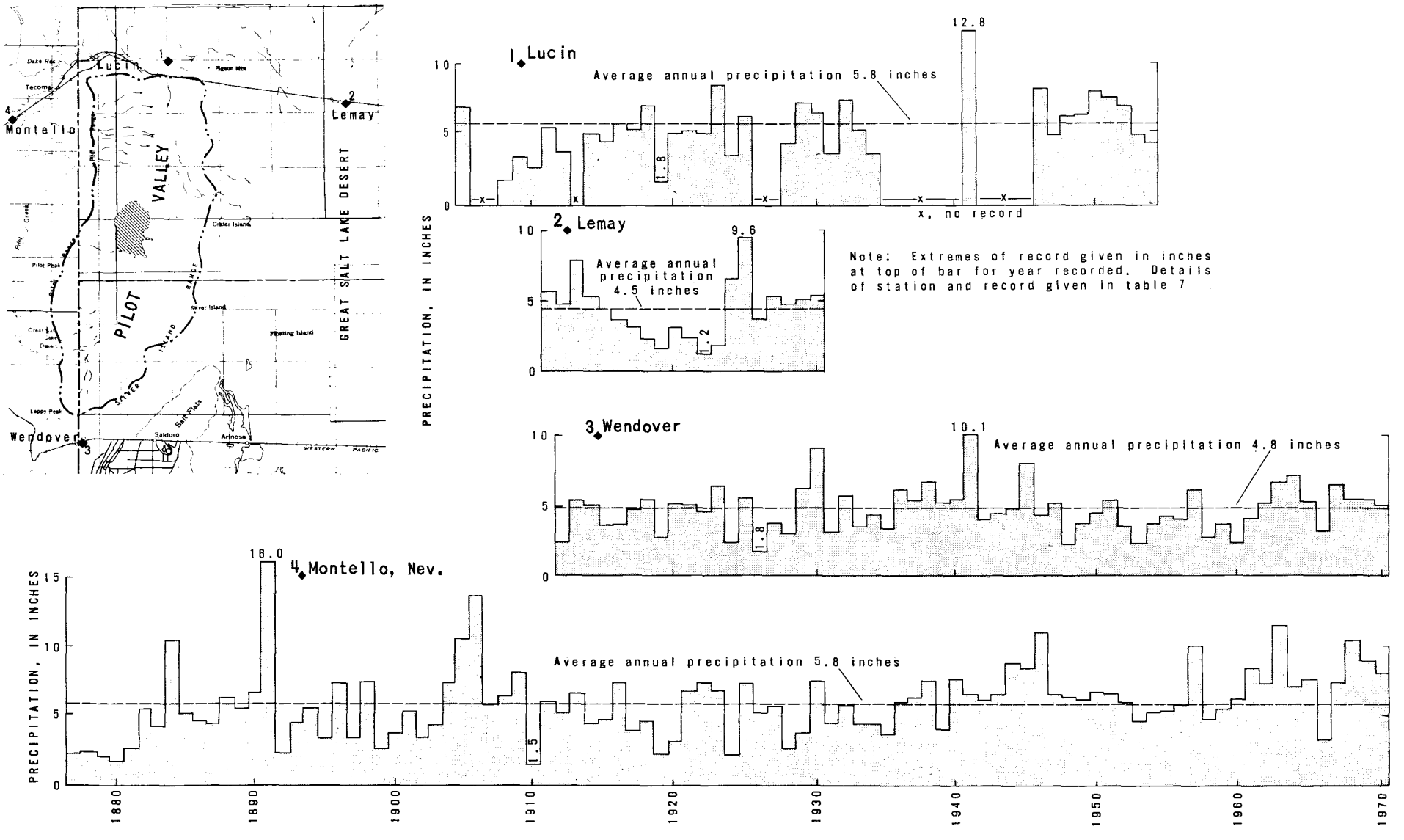

Figure 2.—Annual precipitation at climatologic stations near Pilot Valley.

Table 4.—Discharge from Wendover pipeline, 1938-42

[Discharge reported by Western Pacific Railroad Co.]

Year	Average monthly flow in gallons per minute and month of occurrence		
	Maximum[1]	Minimum[2]	Average
1938	431 (June)	212 (January)	378
1939	431 (June)	225 (December)	339
1940	460 (May)	261 (January)	386
1941	460 (May)	283 (January)	439
1942	460 (August)	406 (November)	455

[1]Represents pipeline capacity; total springflow exceeded this amount during period of maximum discharge.

[2]Probably less than total springflow because of incomplete diversion and conveyance losses.

Assuming a specific yield of 0.1 for the aquifer materials, an estimated 500,000 acre-feet of water could be withdrawn from ground-water storage by dewatering the upper 100 feet of saturated alluvial and lakeshore deposits along the west side of Pilot Valley. The 50,000-acre area where these deposits form the land surface approximately coincides with the area where 100 feet or more of saturated material is present above an altitude of 4,250 feet. Alluvial deposits at the base of the Silver Island Range are excluded from the estimate because the thickness of water-saturated material there is thought to be generally less than 100 feet.

Little, if any, ground water is recoverable from storage in the consolidated Paleozoic and Precambrian rocks in the mountains bordering Pilot Valley. These rocks store water in joints and fractures (and probably in solution openings in the limestones) which transmit water readily. As a result, storage where these rocks are exposed is only short term; in the absence of continued recharge, storage would be depleted rapidly and the springs issuing from these rocks would cease to flow. If additional water were pumped from the consolidated rocks, the overall effect would be to reduce springflow; the limit of yield from this source is the average annual volume of recharge, or the average annual natural discharge from springs, which amounts to the same thing.

Considerable ground water is stored in the consolidated Paleozoic and Precambrian rocks and in the Salt Lake Formation where these units are overlain by younger deposits under the lower slopes and floor of Pilot Valley. This water is probably saline, but in the absence of reliable subsurface data for the area, no definite conclusions can be drawn.

Recovery, by pumping from wells, of the estimated 500,000 acre-feet of water available from storage in the upper 100 feet of saturated unconsolidated materials would require consideration of several factors. Because the ground-water system in Pilot Valley at present is in a natural condition of dynamic equilibrium between recharge and discharge, any substantial increase in withdrawals from wells would have far-reaching effects on the system. The most pronounced of these effects would probably be related to water quality. Near the margin of the alkali flat, where irrigation wells and springs now yield fresh water, increased pumping of moderate to large quantities of ground water very probably would result in local reversal of the hydraulic gradient, so that saline water from under the alkali flat would be brought into the wells.

An additional complication is that most of the springs discharging along the margin of the valley bottom are artesian springs. Increased withdrawals from wells would lower the pressure on the water in the alluvium underlying the lake clays, and eventually springflow would diminish or cease.

Discharge

More than 90 percent of the discharge of ground water in Pilot Valley is by evapotranspiration. Withdrawal from wells is estimated to average about 200 acre-feet annually. Total discharge by springs in Pilot Valley is estimated to average about 3,000 acre-feet annually. This springflow, except for a minor amount consumed by livestock and an estimated 400 acre-feet diverted annually to Wendover, supports phreatophytic vegetation or evaporates directly.

Consumption by phreatophytes.—An estimated 3,400 acre-feet of water is discharged annually by transpiration from native and cultivated vegetation in Pilot Valley. Included in this total is a minor amount consumed by direct evaporation from the numerous spring pools and other small bodies of open water. Table 5 lists the approximate areas where ground water is discharged by phreatophytes and estimates of the quantities of water discharged, based on depth to water and the type and relative density of the phreatophytes.

Table 5.—Estimated average annual ground-water discharge by evapotranspiration in Pilot Valley

Terrain and phreatophytes (See Robinson, 1958, for description of phreatophyte species)	Approximate area (acres)	Depth to water (feet)	Average annual evapotranspiration: Acre-feet per acre	Average annual evapotranspiration: Total acre-feet (rounded)
Evapotranspiration by phreatophytes:				
Lower alluvial slopes near margin of alkali flat, and most of valley bottom land in Tps. 6 and 7 N. and N half of T. 5 N. Sparse to locally dense greasewood, with varying amounts of shadscale (where depth to water greatest), sage, and rabbitbrush (where depth to water least) intermixed.	31,000	0-more than 50	0.08	2,500
Lower alluvial slopes near western margin of alkali flat in Tps. 3 and 4 N. (pl. 1). Meadowgrass, locally dense willow thickets, some greasewood, sage, and rabbitbrush. Some cleared areas irrigated by springflow; cultivated fields of alfalfa irrigated by ground water from wells.	800	0-15	.80	600
Edge of alkali flat in T. 35 N., R. 70 E. (pl. 1). Spring areas: dense saltgrass; reeds and other hydrophytes bordering pools; pickleweed and greasewood adjacent to saltgrass area.	200	0-10	1.50	300
Subtotal	32,000			3,400
Direct evaporation from bare soil:				
Alkali flat. Practically no vegetation. Ground water is consumed directly by evaporation from bare soil where water table or top of capillary fringe is at or near land surface.	85,000	0-5	.05	4,000
Total (rounded)	120,000			7,400

The estimated quantities and rates given in table 5 are for actual evapotranspiration of ground water; potential evapotranspiration, which is the total quantity of water that would be used if adequate water were continuously available, is much greater. Mahoney (1953, p. 31-37) and Hood and Price (1970, p. 24) have calculated average annual potential evapotranspiration at climatologic stations near Pilot Valley; their estimates range from 27.4 to 41.0 inches, depending on location and method of calculation.

Direct evaporation from bare soil.—Ground water is evaporated directly from bare soil where the water table is near or at the land surface under the alkali flat in the southern part of Pilot Valley. An estimated average of 4,000 acre-feet of ground water is discharged annually by this mechanism (table 5). The rate given is believed to be a conservative estimate; calculations based on a procedure described by Rantz and Eakin (1971, p. 28-30) indicate that evaporation of ground water from the alkali flat might be as much as 18,000 acre-feet annually.

Withdrawal from wells.—The estimated average annual withdrawal of water from wells in the area is 200 acre-feet. Only six wells are known to exist in the valley; five of these were constructed for irrigation use, and the other is used during the winter grazing season for stockwater. Table 8 lists the locations and other information about these wells. No records of pumpage are available and the estimated annual withdrawal is based on water-users claims on file with the State Engineer limiting withdrawals to 3 acre- feet per irrigated acre. About 70 acres have been irrigated in recent years with ground water from wells, although claims are on file covering full or supplemental ground-water irrigation of about 280 acres in Pilot Valley.

Ground-water budget

An approximate ground-water budget for Pilot Valley is given in table 6. The difference between total recharge and total discharge for the valley probably is not significant; the individual quantities listed are each subject to errors inherent in the reconnaissance methods used, and the magnitude of the difference shown in table 6 is well within the limits of possible error.

Perennial yield

In this report, the perennial yield of a ground-water reservoir is defined as the maximum amount of water that can be withdrawn each year for an indefinite period of years without causing a permanent and continuing depletion of storage. The perennial yield cannot exceed the amount of natural discharge that can be captured. Perennial yield from the ground-water reservoir in Pilot Valley is equal to total discharge (table 6), estimated to be about 8,000 acre-feet annually. This amount includes present withdrawals from wells that are capturing water that would otherwise be consumed by evapotranspiration.

The capture of any of the 4,000 acre-feet of water discharged by evaporation from the soil of the alkali flat would not contribute to the usable water supply, because the water is not of suitable chemical quality for most present uses. This saline water might be economically usable in the future, however, as a source of minerals or a supply for desalinization.

The remaining 3,400 acre-feet of natural discharge by evapotranspiration includes about 90 percent of the ground water discharged annually by springs. Much of this springflow is now used beneficially, in that it supports livestock grazing in the valley. It would be possible to utilize more of the springflow by eradicating nonbeneficial phreatophytes and substituting plants that could be used for livestock feed or other economically useful purposes.

The 1,000 acre-feet of ground water transpired annually by phreatophytes (predominantly greasewood) in areas where they are not sustained by springflow probably cannot be economically captured. Water levels would have to be lowered uniformly under several thousands of acres of land to accomplish this salvage, and the cost of such an undertaking would probably be prohibitive.

Table 6.—Ground-water budget for Pilot Valley

	Acre-feet per year
Recharge:	
From precipitation on area (table 3)	3,400
Subsurface inflow from adjacent areas:	
Thousand Springs Valley (Rush, 1968, p. 29)	1,800[1]
Grouse Creek valley (Hood and Price, 1970, table 9)	2,000[1]
Pilot Creek valley (Harrill, 1971, p.23)	300
Total recharge	7,500
Discharge:	
Evapotranspiration by phreatophytes (table 5)	3,400
Direct evaporation from water table under alkali flat (table 5)	4,000
Withdrawal from wells (p. 15)	200
Springflow exported to town of Wendover	400[2]
Total discharge	8,000[3]

[1]These quantities are estimated maximum amounts. The boundaries across which outflow from the two valleys occurs do not entirely coincide with the boundary of Pilot Valley; therefore, part of the outflow indicated does not move into the area covered by this report.

[2]Estimate based on information provided by H. Gibson, Wendover water-supply manager (oral commun., 1969).

[3]Total discharge may be significantly higher if estimate of evaporation under alkali flat is conservative.

From the foregoing discussion, it is apparent that for existing types of development, irrigation, and domestic uses, the economically recoverable perennial yield in Pilot Valley is limited to that part of the average annual volume of springflow that can be put to beneficial use plus the existing withdrawal from wells. Under these conditions, maximum useful perennial yield of 2,000 acre-feet is probably reasonable.

Chemical quality of the water

All natural water contains dissolved mineral matter. Water which falls as precipitation contains minute amounts, and additional mineral matter is dissolved as the water moves across the land surface or percolates through the ground. The amount and chemical character of the minerals dissolved in the water depend upon the nature of materials it contacts and the duration of contact. The total concentration of dissolved minerals and the concentrations of individual ions determine the usefulness of the water for various purposes.

Chemical data for water samples from sources in Pilot Valley are given in table 11. The specific conductance of water from several additional springs is given in table 10. Locations of the water-sampling sites and the general chemical quality of water in its source area are shown on plate 1. No information is available on the quality of stream flow in the area except for the analyses of water from Bettridge and Morrison Creeks (table 11), which was totally made up of spring discharge. From the limited available data it is apparent that chemical quality of the ground water in Pilot Valley is highly variable.

Water containing less than 1,000 mg/l (milligrams per liter) of dissolved solids is generally classified as fresh water; saline water contains more than 1,000 mg/l of dissolved solids. Two springs, (B-3-19)22cd-S1 and 35/70-29aad-S1, at the edge of the alkali flat in the southern part of the valley, were the only sources sampled that yielded saline water (see table 11). An abandoned stock well on the northern part of the valley floor, (B-6-18)10cdc-1, was reported to yield saline water. According to information in the U.S. Geological Survey files, water from this well contained 11,100 parts per million of dissolved solids.

California State Water Pollution Control Board (1963, p. 112), summarizing a report by the Western Australia Department of Agriculture (1950), listed the following threshold dissolved-solids concentrations for use in watering stock and poultry:

	Milligrams per liter
Poultry	2,860
Swine	4,290
Horses	6,435
Cattle, dairy	7,150
beef	10,000
Sheep (adult without young)	12,900

On the basis of this classification, all the water sampled in Pilot Valley was suitable for most stock uses (see table 11), although one sample from a spring (35/70-29aad-S1) at the southwest end of the valley contained 6,750 mg/l of dissolved solids, which exceeds the threshold concentration listed for poultry, swine, and horses. Well (B-6-18)10cdc-1 reportedly yielded water that was unacceptable to livestock because of its high salinity.

The U.S. Public Health Service (1962) has recommended maximum limits for certain chemical constituents in public water supplies as follows:

	Milligrams per liter
Iron (Fe)	0.3
Manganese (Mn)	.05
Sulfate (SO_4)	250
Chloride (Cl)	250
Fluoride (F)[1]	1.2
Nitrate (NO_3)	45
Dissolved solids	500

[1]Based on temperature data at Wendover. Optimum concentration recommended 0.9 mg/1. See page 8 of reference cited above for method of determination of limits.

As shown in table 11, the recommended limits for iron and manganese were exceeded in three of the 17 samples from Pilot Valley, and the limits for chloride and dissolved solids were exceeded in four samples. The only water from the valley that is used for public supply comes from springs on Pilot Peak (see table 10 for records of specific springs); samples from these sources revealed no constituents in excess of the recommended limits.

Most of the water samples were hard to very hard according to the classification used by the U.S. Geological Survey (0- 60 mg/l, soft; 61-120 mg/l, moderately hard; 121-180 mg/l, hard; and more than 180 mg/l, very hard).

According to the U.S. Salinity Laboratory Staff (1954, p. 69) the characteristics most important in determining the suitability of water for irrigation are: (1) the concentration of boron (B) and other toxic elements; (2) the concentration of dissolved solids, as indicated by the specific conductance, which determines the salinity hazard; and (3) the relative proportion of sodium (Na) to other cations in the water, as indicated by the SAR (sodium-adsorption ratio), which determines the sodium hazard.

No boron analyses are available for water in Pilot Valley. Samples from Grouse Creek valley to the north (Hood and Price, 1970, p. 27) contained less than hazardous concentrations of boron, and it is probable that water with similar dissolved-solids concentrations in Pilot Valley is also similar in this respect. However, anyone interested in developing a ground-water supply for irrigation use in the area should obtain a boron analysis for the prospective water source to avoid potential problems.

Figure 3 shows the plotted values of specific conductance and SAR of five water samples for which these data were available. All five of the samples had a low sodium hazard and medium or high salinity hazard. Water with low sodium hazard can be used for irrigation on almost all soils with little harmful effect on either the soil or the crop. Water with medium salinity hazard can be used successfully for irrigation if a moderate amount of leaching occurs and if crops with moderate salt tolerance are grown. High-salinity water should not be used for irrigation on soils with restricted drainage. Even with adequate drainage, special management for soil salinity control may be required and crops with high salt tolerance should be selected.

Alfalfa and most common grasses, the only crops presently irrigated in Pilot Valley, are classed as moderately tolerant; saltgrass and certain other forage crops are classed as tolerant (U.S. Salinity Laboratory Staff, 1954, p. 67).

In general, water from the unconsolidated deposits above an altitude of about 4,250 feet on the west side of Pilot Valley should be of excellent quality for most uses. Near the margins of the alkali flat, and in the southwest end of the valley in Nevada, the concentration of dissolved solids in the water increases, and under the flat the water is generally too saline for present uses. Water from springs that issue from the Precambrian and Cambrian quartzites (36/70-4,9,20-S and 37/70-28-S, table 11) tends to be lower in all dissolved constituents than water from other sources. The major variations in chemical quality of water from the unconsolidated deposits near the edge of the alkali flat are probably related to the mixing of saline water from under the flat with water in the adjacent alluvium.

Water from several major springs at the southwest end of the valley (see table 10 and the analysis for 35/70-29aad-S1, table 11) is saline and represents an anomalous situation. The location and discharge of these springs appears to be directly related to the presence of the Paleozoic carbonate rocks that extend in a low ridge southward from the Pilot Range. The quality of the water from the springs, however, is similar to what might be expected to occur under the alkali flat. Water from the Paleozoic carbonate rocks at the north end of the Pilot Range (see analyses for springs (B-6-19)12cda-S1 and (B-7-19)15bab-S1, table 11) is of the calcium magnesium bicarbonate type, more or less typical of water from such rocks, whereas water from spring 35/70-29aad-S1 is a sodium chloride type. The explanation of this apparent anomaly must await further detailed study of the ground-water system in the area.

SUMMARY OF WATER-RESOURCE AVAILABILITY AND POTENTIAL

Pilot Valley contains about 470 square miles (303,000 acres) of land, of which less than 300 acres is cultivated and nearly 30 percent (85,000 acres) is a barren alkali flat. The remaining area is used primarily for livestock grazing. Water needs in the valley are relatively small: existing springs supply ample water for livestock, at least in the western half of the valley; there is little irrigation in the area; and there is no large permanent population to create a demand for domestic water supply.

The total supply of water in Pilot Valley is derived from precipitation on the area, estimated to average 184,000 acre- feet annually (table 3), and from surface and subsurface inflow from adjacent areas, estimated to average about 5,700 acre-feet annually (p. 9 and table 6). Nearly all this water is ultimately consumed by evapotranspiration within the Pilot Valley area; little, if any, surface or subsurface outflow occurs.

The estimated average annual supply of water potentially available for use in the area is about 8,000 acre-feet, composed of annual ground-water recharge (7,500 acre-feet estimated) and surface runoff that reaches the valley floor (estimated to average less than 500 acre-feet annually). The estimated useful perennial yield is about 2,000 acre-feet, the probable maximum

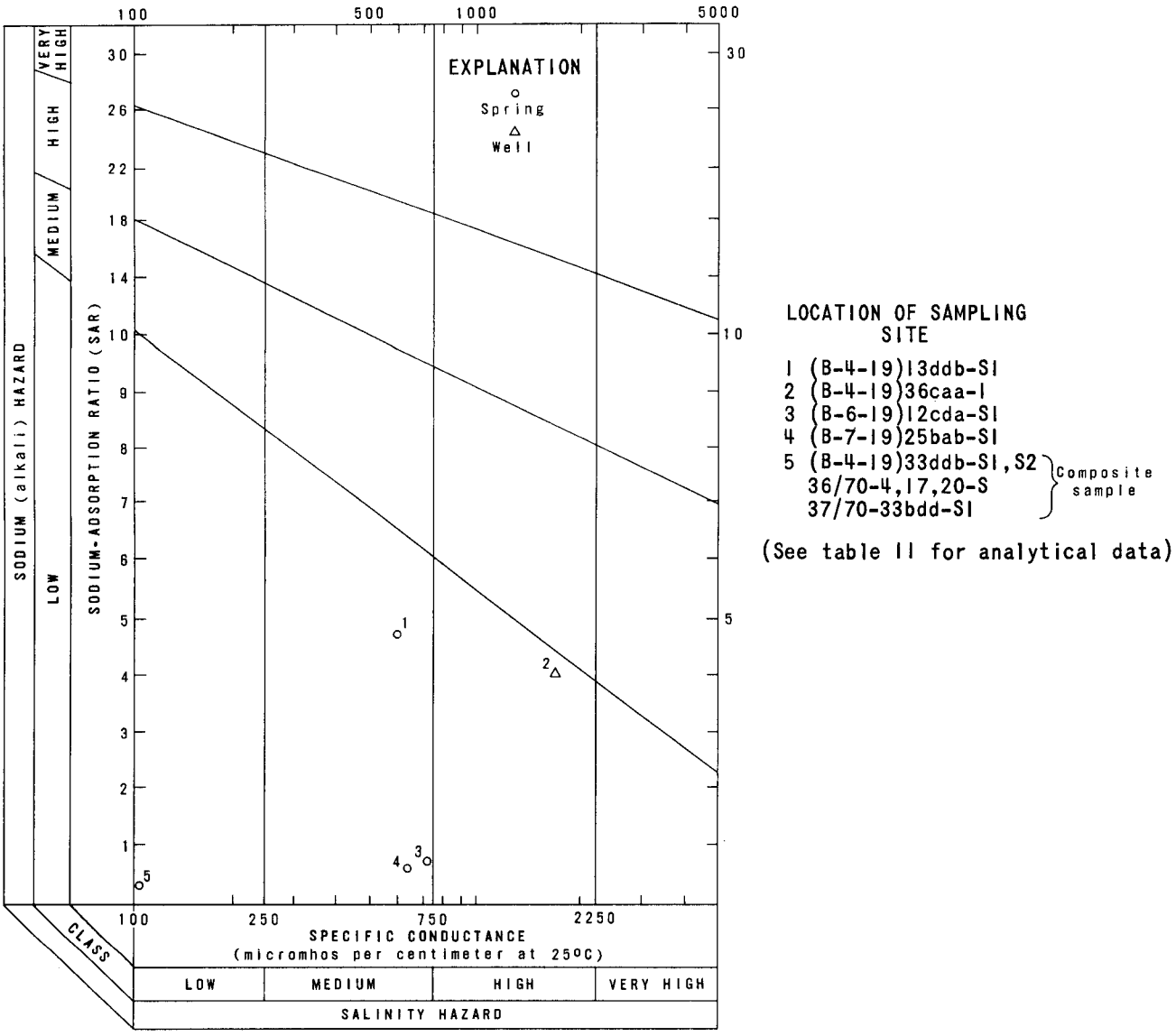

Figure 3.—Classification for irrigation use of ground water from Pilot Valley.

amount of evapotranspiration that can be salvaged economically. The remaining ground water in the valley is, in general, too saline for most present uses, and there are no perennial surface-water sources.

Most of the water used in Pilot Valley is consumed by evapotranspiration, estimated to average 7,500 acre-feet annually. Development of ground-water supplies to date apparently has not altered the long-term natural water balance in the valley—the relatively small amounts of water pumped for irrigation (estimated 200 acre-feet annually) and exported to Wendover (estimated 400 acre-feet annually) represent capture of water that would otherwise have been consumed by nonbeneficial phreatophytes.

The present water supply could be supplemented by pumping ground water from storage, but increased pumping would probably cause a deterioration in water quality as well as reduce discharge from the low-level springs along the west side of the valley.

DATA NEEDED FOR ADDITIONAL STUDIES

Additional hydrologic data are needed to refine the estimates made in this reconnaissance and to provide a basis for planning for the optimum development of the water resources of Pilot Valley. Although the potential for additional water-resource development in the area is small, detailed planning, based on adequate data, might enable salvage of considerable water presently being consumed nonbeneficially by evapotranspiration.

The most significant data deficiencies would be met by a program that included:

1. Test drilling - The lower alluvial slopes and the alkali flat area, in particular, should be explored to determine the extent, thickness, and water-bearing characteristics of the unconsolidated materials.

2. Water quality survey - Detailed information on water quality variations, both laterally and vertically in the unconsolidated alluvium and underlying rocks, is required to fully analyze the hydrologic system.

3. Field and laboratory tests to determine the hydrologic properties of the principal aquifers.

4. Detailed geologic mapping to fully evaluate the hydrogeologic framework.

5. Detailed inventory of existing sources of water supply, including measurement of springflow, determination of surface runoff, and inventory of present water use.

6. Evapotranspiration surveys, particularly mapping of phreatophytes.

7. Soil-evaporation determinations in the alkali flat area.

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APPENDIX

Well- and spring-numbering system

In this report the number assigned to a well or spring is both an identification number and a location number. The number is based on the common method of subdividing lands of the western United States. In Utah, the numbers are referenced to the Salt Lake base line and meridian, and in Nevada to the Mount Diablo base line and meridian.

Utah is divided into four quadrants by the Salt Lake base line and meridian (see fig. 4). These quadrants are designated by the uppercase letters A, B, C, and D, thus: A, for the northeast quadrant; B, for the northwest; C, for the southwest; and D, for the southeast quadrant. Numbers designating the township and range, respectively, follow the quadrant letter, and the three are enclosed in parentheses. The number after the parentheses designates the section, and the lowercase letters give the location of the well within the section. The first letter indicates the quarter section, which is generally a tract of 160 acres; the second letter indicates the 40-acre tract, and the third letter indicates the 10-acre tract. The number that follows the letters indicates the serial number of the well or spring within the 10-acre tract. Thus, well (B-6-18)10cdc-1, in Box Elder County, is in the SW¼SE¼SW¼ sec. 10, T. 6 N., R. 18 W., and is the first well constructed or visited in that tract. If a well or spring cannot be located within a 10-acre tract, one or two location letters are used and the serial number is omitted.

When the serial (final) number is preceded by an S the number designates a spring; for example, South Patterson Spring is (B-5-19)36aca-S1 (table 11).

A typical Nevada number consists of three elements. The first element is the township north of the Mount Diablo base line, and the second, separated from the first by a slant line, is the range east of the Mount Diablo meridian. The third element, separated from the second by a dash, is the section in the township. The section number is followed by lowercase letters that indicates the section subdivisions and a number that indicates the order in which the well or spring was recorded in the 10-acre tract in the same manner as in Utah.

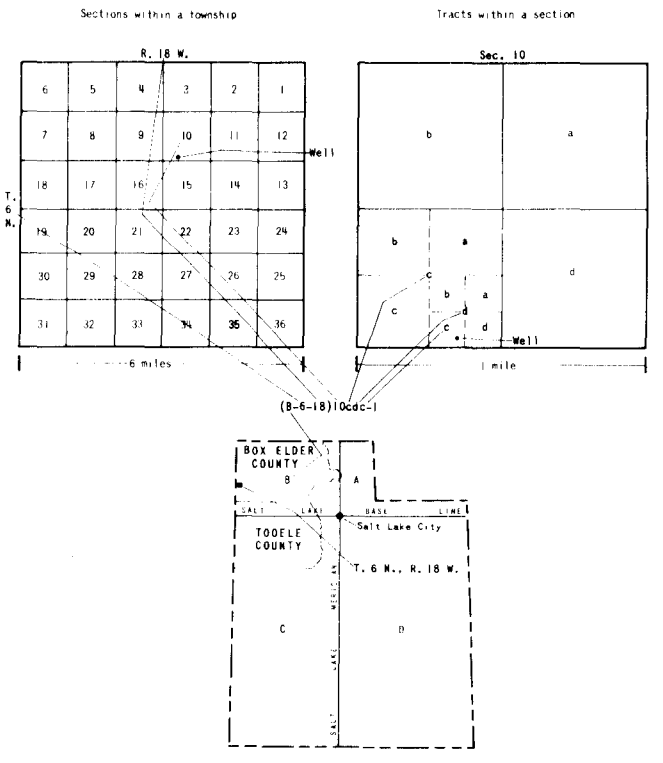

Figure 4.—Well- and spring-numbering system used in Utah.

Use of metric units

In this report, temperatures of water and concentrations of dissolved solids and individual ions determined by chemical analysis are reported in metric units rather than English units. Metric units are used because the metric system is in general use by the scientific community; the change is intended to promote greater uniformity in reporting of data.

Concentrations of chemical constituents are reported in milligrams per liter (mg/l). For concentrations less than about 7,000 mg/l the numbers reported are the same as for concentrations in parts per million (ppm), the units used in earlier reports in this series. For more highly mineralized water, the concentrations reported in milligrams per liter must be adjusted for the density of the sample to get the equivalent parts per million. For such samples, the concentration in parts per million will be a smaller number than the concentration in milligrams per liter.

Water temperature is reported in degrees Celsius (°C). The following conversion table will help to clarify the relation between degrees Fahrenheit and degrees Celsius.

TEMPERATURE-CONVERSION TABLE

Temperatures in °C are rounded to nearest 0.5 degree. Underscored temperatures are exact equivalents. To convert from °F to °C where two lines have the same value for °F, use the line marked with an asterisk (*) to obtain equivalent °C.

°C	°F	°C	°F	°C	°F	°C	°F	°C	°F	°C	°F	°C	°F
-20.0	-4	-10.0	14	0.0	32	10.0	50	20.0	68	30.0	86	40.0	104
-19.5	-3	-9.5	15	+0.5	33	10.5	51	20.5	69	30.5	87	40.5	105
-19.0	-2	-9.0	16	1.0	34	11.0	52	21.0	70	31.0	88	41.0	106
-18.5	-1	-8.5	17	1.5	35	11.5	53	21.5	71	31.5	89	41.5	107
-18.0 *	0	-8.0 *	18	2.0 *	36	12.0 *	54	22.0 *	72	32.0 *	90	42.0 *	108
-17.5	0	-7.5	18	2.5	36	12.5	54	22.5	72	32.5	90	42.5	108
-17.0	1	-7.0	19	3.0	37	13.0	55	23.0	73	33.0	91	43.0	109
-16.5	2	-6.5	20	3.5	38	13.5	56	23.5	74	33.5	92	43.5	110
-16.0	3	-6.0	21	4.0	39	14.0	57	24.0	75	34.0	93	44.0	111
-15.5	4	-5.5	22	4.5	40	14.5	58	24.5	76	34.5	94	44.5	112
-15.0	5	-5.0	23	5.0	41	15.0	59	25.0	77	35.0	95	45.0	113
-14.5	6	-4.5	24	5.5	42	15.5	60	25.5	78	35.5	96	45.5	114
-14.0	7	-4.0	25	6.0	43	16.0	61	26.0	79	36.0	97	46.0	115
-13.5	8	-3.5	26	6.5	44	16.5	62	26.5	80	36.5	98	46.5	116
-13.0	9	-3.0	27	7.0	45	17.0	63	27.0	81	37.0	99	47.0	117
-12.5	10	-2.5	28	7.5	46	17.5	64	27.5	82	37.5	100	47.5	118
-12.0 *	10	-2.0 *	28	8.0 *	46	18.0 *	64	28.0 *	82	38.0 *	100	48.0 *	118
-11.5	11	-1.5	29	8.5	47	18.5	65	28.5	83	38.5	101	48.5	119
-11.0	12	-1.0	30	9.0	48	19.0	66	29.0	84	39.0	102	49.0	120
-10.5	13	-0.5	31	9.5	49	19.5	67	29.5	85	39.5	103	49.5	121

For temperature conversions beyond the limits of the table, use the equations °C = 0.5556 (°F - 32) and °F = 1.8(°C) + 32. The formulae say, in effect, that from the freezing point of water (0°C, 32°F) the temperature in °C rises (or falls) 5° for every rise (or fall) of 9°F.

Table 7.–Selected stations near Pilot Valley at which climatologic data have been collected

Station	Location Lat	Long	Altitude (feet)	Period of record	Type of record	Remarks
Lemay, Utah	41°18′	113°31′	4,221	3- -11 to 3- -31	Precipitation Temperature	50 feet north of Post Office; record incomplete.
Lucin, Utah	41°21′	113°55′	4,478	4-01-05 to 5- -20	Precipitation Temperature	Near railroad station; discontinuous record to 1913.
Do.	41°21′	113°55′	4,478	5- -20 to 5-17-35	Precipitation	100 feet north of railroad station; partial record 1919.
Lucin CCC Camp, Utah	41°25′	113°53′	4,500	12-16-40 to 6-30-42	Precipitation	6 miles northeast of railroad station.
Lucin (FAA) Utah	41°22′	113°50′	4,413	6-24-44 to 6-30-55	Precipitation Temperature	About 3½ miles northeast of railroad station at airport.
Montello, Nevada	41°19′	114°05′	4,812	7-1877 to 8-22-21	Precipitation Temperature	7 miles northeast of Montello at Tecoma station.
Do.	41°16′	114°12′	4,877	9-01-21 to present	Precipitation Temperature	270 feet southeast of Post Office.
Wendover WBAP, Utah	40°44′	114°02′	4,237	6- -11 to present	Precipitation Temperature	1 mile southeast of Post Office, at airport. Record combines data from more than one location.

BASIC DATA

Table 8.--Records of wells in Pilot Valley

Location number: See appendix for explanation of numbering system.
Utah State Engineer numbers: A, application; C, claim.
Water-bearing zone: Type of material - B, boulders; C, clay; G, gravel; S, sand.
Altitude of land surface: Above mean sea level interpolated from U.S. Geological Survey topographic maps.
Water level: Below land surface - Given in feet and tenths if measured by U.S. Geological Survey; all others reported by driller.
Type of pump: N, none; P, piston; T, turbine.
Use of water: I, irrigation; N, none; S, stock.
Remarks and other data available: C, chemical data in table 11; L, driller's log in table 9; other remarks from observations by U.S. Geological Survey personnel or well driller's report.

Location number	Owner	Utah State Engineer numbers	Year drilled	Depth of well (feet)	Diameter of well (inches)	Water-bearing zone: Depth of top (feet)	Water-bearing zone: Thickness (feet)	Water-bearing zone: Type of material	Altitude of land surface (feet)	Water level: Below land surface (feet)	Water level: Date of measurement	Type of pump	Use of water	Remarks and other data available
(B-3-19)12bab-1	D. Stephens	A-33839	1971	100	16	29 55 75	11 15 21	G,C,S G,C,S B	4,290	8	11-26-71	N	I	Pump had not been installed at time of report. L.
12bba-1	do	-	-	-	12	-	-	-	4,290	-	-	T	I	
12cbd-1	do	A-32797	1961	45	12	30	25	C,S,G,B	4,250	10.2	9-23-71	T	I	L.
(B-4-19)24abd-1	R. V. Anderson and sons	C-232; A-32798	1961	52	12	30	22	C,S,G	4,276	12	8-17-61	T	I	L.
36acc-1	D. Stephens	A-17538	1946	68	8	20	48	G	4,300	13	4- 5-46	T	I	C, L.
36dbb-1	do	A-27094	1955	93	12	30	63	G,B,C	4,305	26	7-10-55	T	I	Reported yield 800 gpm with 44 ft of drawdown. L.
(B-6-18)10cdc-1	U.S. Bureau of Land Management	-	1936	233	3½	210	23	S,G,C	4,477	190	2-10-36	N	N	Abandoned because of salinity of water. L.
(B-7-17)33add-1	W. C. Blanthorn	C-260	-	-	5	-	-	-	4,328	72.0 72.5	5-18-68 9-21-71	P	S	Equipped with windmill; pumped only during grazing season.

Table 9.—Drillers' logs of wells in Pilot Valley

Altitudes are for the land surface at well in feet above mean sea level.
Thickness in feet.
Depth to bottom of unit in feet below land surface.

	Thickness	Depth
(B-3-19)12bab-1. Log by J. Phizacklea, driller. Alt. 4,290 ft.		
Clay and sand, brown; hit water at 20 ft.; water level rose to 11 ft.	23	23
Clay, blue	6	29
Gravel	3	32
Clay and sand, blue	23	55
Clay and sand, brown	4	59
Gravel; water level rose to 8 ft.	2	61
Clay, blue	2	63
Hardpan	6	69
Clay and gravel, brown	7	76
Boulders	24	100
(B-3-19)12cbd-1. Log by E. Tomlinson, driller. Alt. 4,250 ft.		
Clay	30	30
Sand and gravel	14	44
Cobbles	1	45
(B-4-19)24abd-1. Log by E. Tomlinson, driller. Alt. 4,276 ft.		
Clay	3	3
Rock and sand, red	5	8
Lime and quartz sand	11	19
Lime, brown, and quartz (sand?)	21	40
Sand and gravel; hard "sand rock"	12	52
(B-4-19)36acc-1. Log by J. F. O'Brien, driller. Alt. 4,300 ft.		
Soil and rock	10	10
Gravel; water in lower part	10	20
Gravel; water	48	68
(B-4-19)36dbb-1. Log by J. F. O'Brien, driller. Alt. 4,305 ft.		
Gravel, coarse	30	30
Gravel; water	20	50
Boulders and clay	43	93
(B-6-18)10cdc-1. Log by E. E. Bailey, driller. Alt. 4,477 ft.		
Loam, gravel, sand	59	59
Gravel	3	62
Sandstone	5	67
Gravel and sand	31	98
Gravel, fine	20	118
Gravel, coarse	60	178
Sand and gravel	17	195
Gravel, fine	8	203
Shell, black	1	204
Clay, little gravel	6	210
Sand, gravel, clay; water	23	233

Table 10.--Records of selected springs in Pilot Valley

Altitude of land surface: Above mean sea level interpolated from U.S. Geological Survey topographic maps.
Discharge: Rate - r, reported; all others estimated by U.S. Geological Survey personnel.
Use: D, domestic; I, irrigation; P, public supply; RR, railroad use; S, livestock.
Remarks and other data available: Specific conductance, in micromhos per centimeter at 25°C, measured in field; C, chemical data in table 11.

Location number	Name or owner	Altitude of land surface (feet)	Geologic source (see table 1)	Discharge: Rate (gpm)	Discharge: Temperature (°C)	Discharge: Date	Use	Remarks and other data available
				UTAH				
(B-3-19)1caa-S1	-	4,258	Qal	75	14.5	9-23-71	D,I,S	Specific conductance 330.
11aa-S	-	4,300	do	-	-	-	S	C.
14cc-S	-	4,280	do	10	15	9-23-71	S	Specific conductance 1,260.
22cd-S	-	4,280	do	50	15	9-23-71	S	Channeled to stock pond. Specific conductance 2,050.
(B-4-18)31bbc-S1	-	4,243	do					
(B-4-19)1dcd-S1	-	4,255	do	20	13.5	9-23-71	S	Discharge is for all springs and seeps in immediate vicinity; discharge from individual outlet sampled estimated 3 gpm. Specific conductance 620.
12acd-S1	Cut Field Spring No. 2	4,255	do	460r	-	-	I,S	Diverted for irrigation of about 20 acres of grass meadow.
12dba-S1	Cut Field Spring No. 1	4,257	do	80r	-	-	S	
13ddb-S1	-	4,256	do	75	15	9-23-71	S	C.
24aac-S1	-	4,260	do	5	14	9-23-71	D,S	Specific conductance 310.
33ddb-S1	Town of Wendover (Munsee Spring No. 1)	5,430	Pzu	-	-	-	P,I	Conveyed by pipeline to Wendover; surplus, if any, diverted for irrigation in sec. 36, T. 4 N., R. 19 W. C.
33ddb-S2	Town of Wendover (Munsee Spring No. 2)							
36abd-S1	D. Stephens	4,260	Qal	5	15.5	9-23-71	S	Specific conductance 2,500.
36abd-S2	do	4,260	do	5	15.5	9-23-71	S	Specific conductance 2,500.
36aca-S1	do (Reed Spring)	4,256	do	10	16	9-23-71	S	Channeled to stock pond. Specific conductance 2,650.
36acd-S1	D. Stephens (Donner Spring)	4,258	do	200	15.5	9-23-71	S	Channeled to stock pond. Formerly used for irrigation. Specific conductance 1,190. C.
(B-4-19)36dcc-S1	D. Stephens	4,265	do	5	14.5	9-23-71	S	Specific conductance 630. C.
(B-5-18)19dac-S1	-	4,261	do	5	14.5	9-23-71	S	Specific conductance 570.
(B-5-19)36aca-S1	U.S. Bureau of Land Management (South Patterson Spring)	4,265	do	10	14	9-22-71	S	Spring in fenced enclosure; discharge channeled to rock-lined stock pond. Specific conductance 440. C.
(B-6-19)10acc-S1	Crystal Spring	6,550	Pzu (limestone)	5	12	9-22-71	S	Identified as Governors Spring on U.S. Geological Survey topographic map. Specific conductance 680.
12ccb-S1	Tunnel Spring No. 2	5,650	do	5	14	9-22-71	S,RR	Part of flow conveyed to Lucin for railroad use. Flow is from horizontal collector tunnel extending under streambed about 100 ft at a depth of 10-20 ft. Specific conductance 620.
12cda-S1	Tunnel Spring No. 1	5,460	do	3	13	9-22-71	S,RR	Development and use same as (B-6-19)12ccb-S1. C.
25bac-S1	McLaughlin Spring	5,640	do	135r	-	-	S,RR	Conveyed by pipeline to Lucin for railroad use.
35daa-S1	-	5,625	Ti (granite)	40	12	9-22-71	S	Discharge is for area of springs and seeps extending for about 180 ft along bottom of Birch Creek. Specific conductance 340.
(B-7-19)25baa-S1	Coal Bank Spring No. 1	5,280	Pzu (limestone)	35r	-	-	S,RR	Conveyed by pipeline to Lucin for railroad use.
25bab-S1	Coal Bank Spring No. 3	5,290	do	10r	11.5	4-11-68	S	Piped to stock tank. C.
25bad-S1	Coal Bank Spring No. 2	5,250	do	30r	-	-	S,RR	Conveyed by pipeline to Lucin for railroad use.
36bdb-S1	Indian Spring	5,355	do	-				
				NEVADA				
35/70-9ddb-S1	-	4,280	Qal?	-	-	-	S	
17aac-S1	-	4,300	do	-	-	-	S	
17ddc-S1	-	4,280	do	-	-	-	S	30 ft diameter pool bordered by reeds, saltgrass; overflow to salt flats. Specific conductance more than 8,000.
29aad-S1	-	4,280	do	-	-	-	S	100 ft diameter pool bordered by reeds, saltgrass; overflow to salt flats. C.
36/70-4cac-S1	Town of Wendover (Little Cedar Spring)	7,360	€p€u	55r	-	1969	P	Conveyed by pipeline to Wendover. C.
4cdb-S1	Town of Wendover (Cedar Spring)	7,330						
4dbb-S1	Town of Wendover (Cottonwood Spring)	6,830	do	55r	-	1969	P	Conveyed by pipeline to Wendover. C.
17dc-S, 20baa-S1, 20bab-S1	Town of Wendover (Miners Canyon springs)	-	do	50r	-	1969	P	Conveyed by pipeline to Wendover. Discharge is for all springs above collection point in SW¼NE¼ sec. 20, T. 36 N., R. 70 W. C.
37/70-28d-S	Bettridge Canyon springs	6,780-7,300	do	1,350r	-	5- -42	I,S	Diverted for irrigation in secs. 13 and 24, T. 4 N., R. 19 W. Discharge is for all springs discharging into Bettridge Creek upstream from about the State boundary line. C.
33bdd-S1	Town of Wendover (Morrison Creek canyon springs)	7,580	do	70r		1969	P,I	Conveyed by pipeline to Wendover; surplus, if any, diverted for irrigation in sec. 36, T. 4 N., R. 19 W. Discharge is total for all springs discharging into Morrison Creek canyon above collection point at Morrison Dam in NW¼SE¼ sec. 28, T. 4 N., R. 19 W. C.

Table 11.--Chemical analyses of water from selected wells, springs, and streams in Pilot Valley

Numbers between columns are total concentration reported for constituents in both columns

Dissolved solids: c, calculated; all others are residue on evaporation at 180°C or manner of determination unknown.
Source of analytical data: AE, U.S. Army Engineer Office; GS, U.S. Geological Survey; PH, Utah State Department of Public Health; SC, Utah State Chemist.

Location number	Name or owner	Geologic source (See table 1.)	Date of collection	Temperature (°C)	Milligrams per liter: Silica (SiO_2)	Iron (Fe)	Manganese (Mn)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3) (T, trace amount)	Dissolved solids	Hardness as $CaCO_3$	Noncarbonate hardness as $CaCO_3$	Percent sodium	Sodium-adsorption ratio	Specific conductance (micromhos/cm at 25°C)	pH	Source of analytical data
											UTAH														
(B-3-19)11aa-S	-	Qal	3-13-43	-	-	-	-	-	-	-	-	-	-	-	27	-	-	170	-	-	-	-	-	-	AE
22cd-S	-	do	3-13-43	-	-	-	-	-	-	-	-	-	-	-	520	-	-	1,130	-	-	-	-	-	-	AE
(B-4-19)13ddb-S1(?)	-	-	3-13-43	-	-	-	-	-	-	-	-	-	-	-	24	-	-	185	-	-	-	-	-	-	AE
13ddb-S1	-	Qal	9-23-71	15	19	0.04	0.00	17	5.4	86	7.8	101	0	13	130	0.1	0.22	329c	65	0	71	4.7	594	7.4	GS
36acc-1	D. Stephens (north irrigation well)	1/do	9-22-71	16	17	.04	.03	100	24	180	5.4	115	0	13	520	.0	.36	918c	350	250	52	4.2	1,640	7.5	GS
36acd-S1(?)	D. Stephens (Donner Spring)	do	1911	-	-	-	-	50			85	45	0	<30	105	-	-	370	130	-	-	-	-	-	GS
36dcc-S1	D. Stephens	do	3-13-43	-	-	-	-	-	-	-	-	-	-	-	96	-	-	258	-	-	-	-	-	-	AE
(B-5-19)36aca-S1	U.S. Bureau of Land Management (South Patterson Spring)	do	1911	-	-	-	-	50			65	190	0	<30	50	-	-	320	130	-	-	-	-	-	GS
(B-6-19)12cda-S1	Tunnel Spring No. 1	Pzu	9-22-71	13	20	.01	.01	69	36	32	1.3	351	0	53	26	.1	.38	412c	320	33	18	.8	716	7.6	GS
(B-7-19)25bab-S1	Coal Bank Spring No. 3	do	4-11-68	11	10	-	-	64	27	2/28		276	0	42	41	-	2.7	350c	268	42		.7	614	7.6	GS
											NEVADA														
35/70-29aad-S1	-	Qal?	1-10-43	-	33	0.18	-	176	51	2,120	-	-	-	153	3,460	0.9	T	6,750	650	-	-	-	-	7.7	SC
			9-22-71	-	37	.04	0.01	170	68	2,100	160	250	0	150	3,500	.4	0.21	6,310c	700	500	83	34	10,800	7.7	GS
36/70-4,17,20-S, 37/70-33bdd-S1, (B-4-19)33ddb-S1 and S2	Town of Wendover (composite)	€p€u, Pzu	6-10-41	-	9.3	.05	-	16	2.6	11	-	-	-	7.6	11	.0	T	94	-	-	-	-	-	7.8	SC
			9-23-71	11	9.8	.03	.00	13	1.3	4.2	.7	54	0	.8	14	.1	.22	72c	38	0	19	.3	102	7.6	GS
37/70-28d-S	Bettridge (Gaulier) Creek 3/	€p€u	1-10-43	-	12	.06	-	15	1.4	12	-	-	-	8.2	17	.0	.0	85	44	-	-	-	-	7.2	SC
33bdd-S1	Town of Wendover (Morrison Creek) 4/	do	11- 7-46	-	12	.00	-	15	2.3		7.2	54	-	5.7	9.6	.0	.0	82	45	-	-	-	-	-	PH

1/ Water-bearing zone from 20 to 68 feet below land surface.
2/ Calculated Na + K (as Na).
3/ Composite discharge from springs in Bettridge Canyon, collected at SW¼ sec. 16(?), T. 4 N., R. 19 W.
4/ Collected by Union Pacific Railroad Co. at (B-4-19)28dab (Morrison Dam?). Probably represents composite of all springs discharging into Morrison Creek canyon upstream from point of collection.

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