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HYDROLOGIC RECONNAISSANCE OF THE SINK VALLEY AREA, TOOELE AND BOX ELDER COUNTIES, UTAH

by

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in cooperation with the
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HYDROLOGIC RECONNAISSANCE OF THE SINK VALLEY AREA, TOOELE AND BOX ELDER COUNTIES, UTAH

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ABSTRACT

The Sink Valley (Puddle Valley) area covers about 330 square miles between Great Salt Lake and the Great Salt Lake Desert in northwestern Utah. It is divided into Sink Valley, the north valley subarea, and the west shore subarea. It is a dry, sparsely populated area utilized partly as a military reservation and partly as winter range for sheep. Normal annual precipitation in the area ranges from less than 6 inches in the lowlands to a maximum of about 12 inches in the mountains, and the total volume is about 115,000 acre-feet a year. Because of a high potential evaporation (estimated to be about 58 inches a year), there is virtually no overland runoff from the area and very little ground-water recharge. All streams in the area are dry most of the year.

The principal source of water for development in the area is ground water that occurs chiefly under water-table conditions in unconsolidated and partly consolidated Quaternary and Tertiary valley fill. Sand and gravel aquifers in the valley fill yield as much as a few hundred gallons of water per minute to individual wells. However, the water in even the shallowest water-bearing zones generally contains more than 2,000 mg/l (milligrams per liter) of dissolved solids, and mineral content of the water apparently increases markedly with depth. The principal dissolved constituents generally are sodium and chloride.

The ground water is utilized chiefly for domestic supplies at a U. S. Air Force facility and for stock watering. In 1967, about 37 acre-feet of water was pumped and demineralized for domestic supply at the Hill Air Force Range. An average of about 1.5 acre-feet per year is pumped for stock in the entire Sink Valley area.

A rough quantitative appraisal of the ground-water reservoir in Sink Valley alone indicates that about 370,000 acre-feet of recoverable ground water is stored in the upper 40-60 feet of the saturated fill, but that the annual amount of recharge to the reservoir is only about 1,000 acre-feet. Natural discharge from the reservoir, which occurs entirely as subsurface outflow, is also on the order of 1,000 acre-feet per year. The small quantity of water that moves through the reservoir annually and the poor quality of the water are the principal limiting factors in any major development of water resources in Sink Valley and the adjacent areas. Total ground-water recharge of the total area is estimated to be less than 2,000 acre-feet annually.

INTRODUCTION

Purpose and scope of the investigation

This is the sixth in a series of reports by the U. S. Geological Survey in cooperation with the Utah Department of Natural Resources, Division of Water Rights, which describe the water resources of selected basins in western Utah. Areas covered by previously published reports in this series are shown in figure 1 and are listed on page 29. The purpose of this report is to present available hydrologic data on the Sink Valley (Puddle Valley) area, to provide an evaluation of the potential for water-resource development in the area, and to serve as a basis for planning possible later detailed investigations.

The investigation on which this report is based was made during the last half of 1967 and consisted chiefly of a study of available data on the ground-water resources of the Sink Valley area. Consideration of surface-water resources was minimal because there are no perennial streams in the area, and utilization of the usually meager ephemeral streamflow is limited to stock watering during the winter and spring grazing season. Most of the geologic and hydrologic data used in the investigation were obtained from the files of the U. S. Geological Survey and the Utah Division of Water Rights. Fieldwork consisted of several brief trips to the area to examine the geology and natural vegetation, to check well locations, and to collect additional hydrologic data pertinent to the investigation.

Location and general description of the area

The Sink Valley area is in northwestern Utah between latitude 40° 45′ and 41°15′ north and longitude 112°45′ and 113°05′ west. It extends northward from the vicinity of the Low highway station, which is on Interstate Highway 80 (U. S. Highway 40) about 50 miles west of Salt Lake City, across the Tooele-Box Elder County line to Lakeside, which is on the west-central shore of Great Salt Lake (fig. 1). The irregularly shaped area covers about 330 square miles. It includes the entire drainage basin of Sink Valley (about 150 sq mi), an unnamed valley to the north referred to in this report as the north valley subarea (about 60 sq mi), and a narrow stretch of land between Sink Valley and the west shore of Great Salt Lake referred to in this report as the west shore subarea (about 120 sq mi). These subdivisions are shown on plate 1.

The project area is one of the driest, most sparsely populated areas studied in this series of investigations. Natural vegetation consists chiefly of stunted sagebrush (***Artemisia*** sp.), shadscale (***Atriplex*** sp.), cheatgrass (***Bromus tectorum***), and other plants and grasses typical of desert-steppe regions. Some rabbitbrush (***Chrysothamnus*** sp.) and greasewood (***Sarcobatus vermiculatus***) grow on sand dunes and along some stream channels. Only the more salt-tolerant phreatophytes such as greasewood and pickleweed (***Allenrolfea occidentalis***) grow around the margins of the bare saltflats of Great Salt Lake. The only trees in the area are a few widely scattered juniper (***Juniperus*** sp.) in the mountains.

Most of the land in the Sink Valley area is owned by the Federal Government and is used partly as a military reservation (Hill Air Force Range) and partly as winter range for sheep. The only residents are the families of several railroad workers at Lakeside and a small detachment of

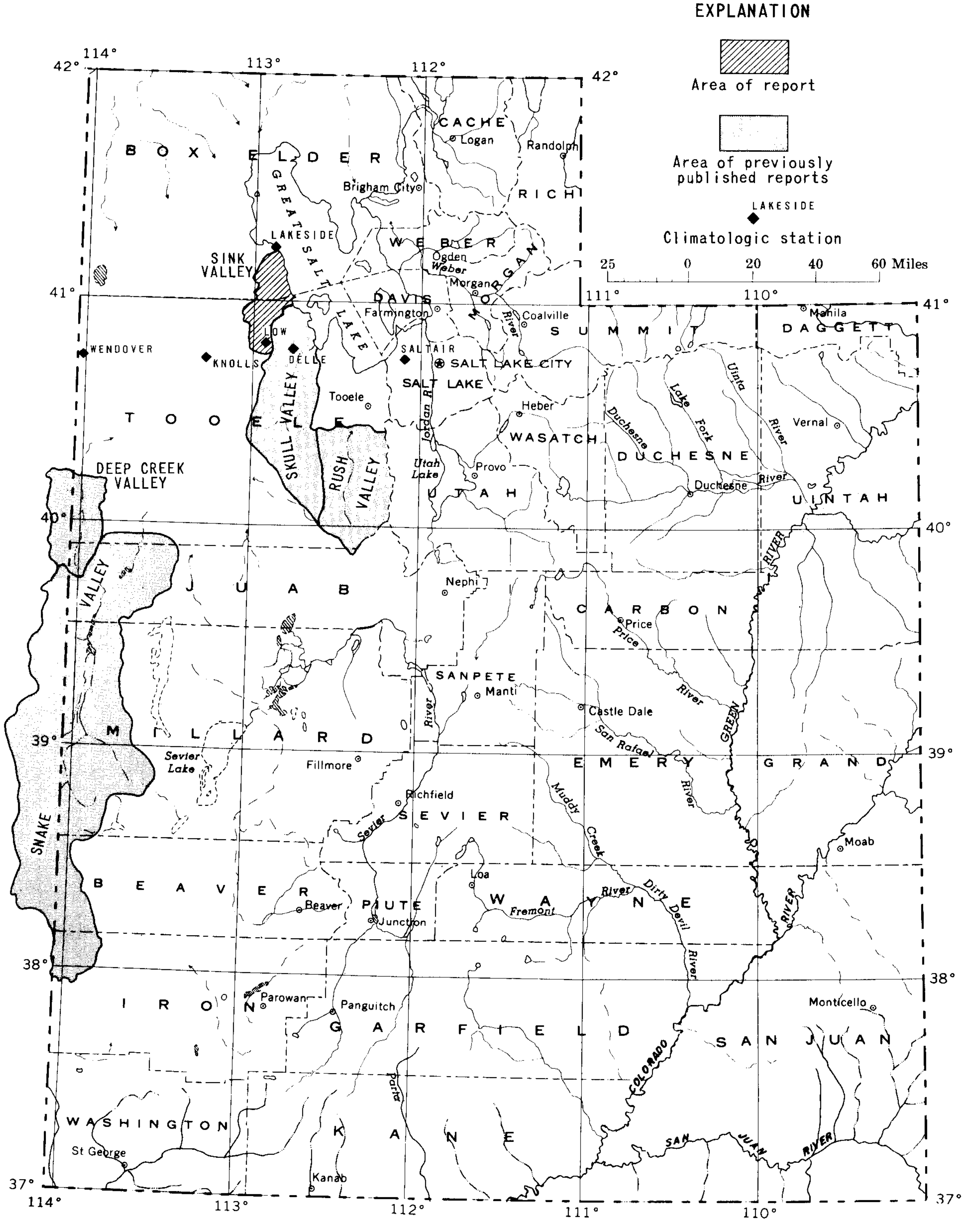

Figure 1.—Locations of the Sink Valley area, selected climatologic stations in and near the Sink Valley area, and areas covered by previously published reports in this series.

civilian and U. S. Air Force personnel (generally less than 100 men) at the Hill Range test facility about 12 miles southwest of Lakeside.

The area can be reached by Interstate Highway 80, which skirts the south end of Sink Valley and by the Southern Pacific Co. railroad which passes through Lakeside. Most of the area is accessible by a paved service road that passes through Sink Valley from Interstate Highway 80 to the Hill Range test facility and by dirt service roads leading to wells and stock-watering points. Permission should be obtained at the Hill Range test facility before traveling in the Box Elder County segment of the project area.

Previous investigations

During the period 1948-57, several stock-well site investigations were made in the Sink Valley area by the U. S. Geological Survey in cooperation with the U. S. Bureau of Land Management. Much of the information gained during these investigations is given in a report on the hydrology of stock-water development on the public domain in western Utah (Snyder, 1963).

The only other report on water in the area is a reconnaissance report of the chemical quality of water in western basins of Utah (Waddell, 1967). That report is the source of much of the data on the chemical quality of water, which are included in this report.

The geology of parts of the Sink Valley area has been studied by a number of geologists, most of whom were interested in the geologic features of Lake Bonneville and Great Salt Lake. The most recent published geologic maps were compiled by Young (1955) and by Stokes (1964).

Well-numbering system

Wells are numbered in this report according to the system of numbering wells in Utah, which is based on the cadastral land-survey system of the Federal Government. The number, in addition to designating the well, locates its position to the nearest 10-acre tract in the land net. By this system the State is divided into four quadrants by the Salt Lake Base Line and Meridian. 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 within the 10-acre tract. Thus, well (B-2-10)17dba-1, in Tooele County, is in the NE¼NW¼SE¼ sec. 17, T. 2 N., R. 10 W., and is the first well constructed or visited in that tract. (See fig. 2.)

Use of metric units

In this report, the units which indicate concentrations of dissolved solids and individual ions determined by chemical analysis and the temperatures of water are metric units. This change from reporting in "English units" has been made as a part of a gradual change to the metric system that is in general use by the scientific community. The change is intended to promote

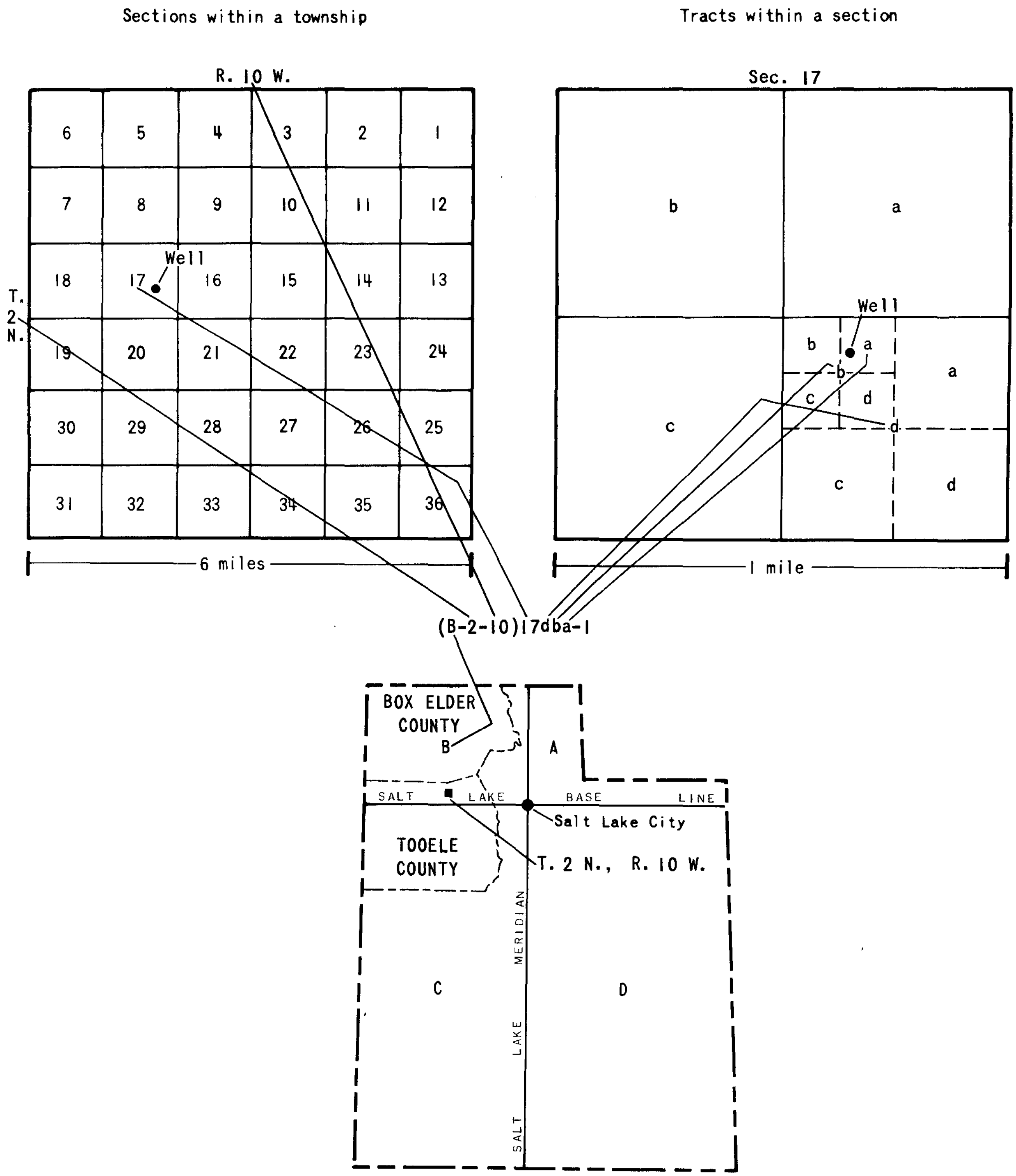

Figure 2.—Well-numbering system.

greater uniformity in reporting of data. Chemical data on concentrations are reported in milligrams per liter (mg/l) rather than in parts per million (ppm), the units used in earlier reports in this series. For concentrations less than 7,000 mg/l, the numbers reported are about the same as for concentrations in parts per million. 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, and the concentration in parts per million will be a smaller number than the equivalent milligrams per liter. For example, a concentration of dissolved solids of 48,100 mg/l (the most highly mineralized water reported in this study) is equivalent to 46,700 ppm.

Water temperature is reported in degrees Celsius (centigrade or °C), but the customary English unit of degrees Fahrenheit (°F) follows in parentheses in the text. Air temperature is reported in °F, but the equivalent temperature in °C follows in parentheses in the text for easier comparison with water temperature in tables. The reporting of temperatures in both metric and English units is done to assist those readers who are not familiar with the Celsius temperature scale. The following conversion table will also help to clarify the relation between degrees Fahrenheit and degrees Celsuis:

TEMPERATURE-CONVERSION TABLE

For conversion of temperature in degrees Celsius (°C) to degrees Fahrenheit (°F). Conversions are based on the equation, $°F = 1.8°C + 32$; Temperatures in °F are rounded to nearest degree. Underscored equivalent temperatures are exact equivalents. For temperature conversions beyond the limits of the table, use the equation given, and for converting from °F to °C, use $°C = 0.5556 (°F - 32)$. The equations say, in effect, that from the freezing point (0°C, 32°F) the temperature rises (or falls) 5°C for every rise (or fall) of 9°F.

°C	°F	°C	°F	°C	°F	°C	°F	°C	°F	°C	°F	°C	°F
-20	-4	-10	14	0	32	10	50	20	68	30	86	40	104
-19	-2	-9	16	+1	34	11	52	21	70	31	88	41	106
-18	0	-8	18	2	36	12	54	22	72	32	90	42	108
-17	+1	-7	19	3	37	13	55	23	73	33	91	43	109
-16	3	-6	21	4	39	14	57	24	75	34	93	44	111
-15	5	-5	23	5	41	15	59	25	77	35	95	45	113
-14	7	-4	25	6	43	16	61	26	79	36	97	46	115
-13	9	-3	27	7	45	17	63	27	81	37	99	47	117
-12	10	-2	28	8	46	18	64	28	82	38	100	48	118
-11	12	-1	30	9	48	19	66	29	84	39	102	49	120

Acknowledgments

Mr. Eugene M. Craner, Chief, Civil Engineering Branch, Hill Air Force Range, provided information on the wells and water-supply system at the test facility and guided the authors across part of the military reservation. Mr. Terrel King, Lakeside Area Manager, U. S. Bureau of Land Management, provided information on stock-supply wells and the only spring in the area. Their helpful cooperation is gratefully acknowledged.

CLIMATE

The climate of the Sink Valley area is temperate and semiarid to arid. The summers are generally hot and dry and the winters are cold and moderately moist. Normal annual precipitation during the period 1931-60 ranged from less than 6 inches in the lowlands to a maximum of about 12 inches in the mountains (pl. 1). Most of the precipitation falls as winter snow and as spring and fall rains, but in some years a single local summer cloudburst can account for a large percentage of the total annual precipitation. Table 1 shows the monthly and annual precipitation recorded at Low (1911-19), Delle (1919-27), Knolls (1943-49), and Lakeside (1953-56). Locations of these climate stations are shown in figure 1.

Temperatures vary widely both annually and diurnally in the Sink Valley area. The average mean monthly temperatures ranged from 28°F (–2°C) in January to 77°F (25°C) in July at Low for the period 1911-19, and from 28°F (–2°C) in December to 81°F (27°C) in July at Lakeside for the period 1953-56. Midsummer daytime temperatures generally reach 90°F (32°C) and midwinter nighttime temperatures are generally below freezing.

The average number of days (variable, dependent on the type of crop) that occur between spring and fall temperatures considered harmful to crops are given in the following table:

	Minimum temperature of:		
	24°F (–4°C)	**28°F (–2°C)**	**32°F (0°C)**
No. of days between	**199**	**205**	**237**

The temperatures listed are freezing temperatures of the hardiest to the most sensitive agricultural crops.

Evaporation data have not been collected in the Sink Valley area, but data collected at Saltair, which is near the shore of Great Salt Lake about 42 miles east of Low (fig. 1), may be somewhat indicative of the potential evaporation in the Sink Valley area. Table 2 shows the average measured pan evaporation at Saltair for the months May through October (1956-66) and the estimated average annual evaporation for the same period of record. The estimate of about 58 inches at Saltair is probably slightly greater than actual evaporation from a free water body in the Sink Valley area.

Table 1.—Monthly and annual precipitation, in inches, recorded at Delle, Low, Knolls, and Lakeside

[Records from U. S. Weather Bureau]

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
						Delle (altitude, 4,219 feet)							
1919	-	-	-	-	-	-	0.20	0.46	0.35	1.46	0.24	0.37	-
1920	0.08	0.43	2.35	1.36	0.41	(1)	.59	.36	(1)	1.95	.88	.14	8.55
1921	.30	.40	(1)	.90	1.68	(1)	(1)	1.38	.20	.89	.25	.97	6.97
1922	.36	1.00	.08	.49	1.00	0.54	.55	.93	.00	.10	.85	.73	6.63
1923	1.13	.10[2]	.03	1.41	1.08	.29	.20	.50[2]	.70	1.86	.30	.59	8.19[2]
1924	.60[2]	.05[2]	.70[2]	.50	.98	.00	.69	.03	.01	.12	.50	.75	4.93[2]
1925	.40	.28	2.50	.85	.70	1.25	.50	-	-	-	1.00	-	-
1926	.45[2]	1.19	.23	.95	1.08	1.02	.98	1.98	.72	.00	.96	(1)	9.56[2]
1927	-	.88	.95	.09	.33	.46	(1)	-	-	-	-	-	-
Average	.47	.54	.86	.82	.91	.44	.41	.81	.28	.91	.62	.51	7.59
						Low (altitude, 4,602 feet)							
1911	-	-	-	-	-	-	(1)	0.00	1.18	0.45	0.15	0.65	-
1912	0.40	0.30	1.65	1.02	0.08	0.07	1.30	.55	.50	1.95	.00	.10	7.92
1913	.20	1.50	.45	.50	1.50	1.45	1.50	.00	.00	.00	.80	.70	7.60
1914	1.07	.00	.40	1.60	.00	2.43	.00	.00	1.04	.00	.00	.06	6.60
1915	.16	.59	.22	1.15	2.01	.65	.00	.00	1.56	.02	.20	.40	6.90
1916	.80	.20	1.12	1.23[2]	.50	.65	.01	.42	.23	1.39	.20	.59[2]	7.34[2]
1917	-	-	-	-	-	-	-	.00	.00	.00	.00	.00	-
1918	.40	.40	.00	.05	.20[2]	.05[2]	.40[2]	.00	.00	.00	.30	.00	1.80[2]
1919	.00	.80	.00	.10	-	-	-	-	-	-	-	-	-
Average	.43	.54	.55	.81	.55	.88	.46	.12	.56	.48	.21	.31	5.90
						Knolls (altitude, 4,260 feet)							
1943	0.07	0.59	0.35	1.69	0.61	0.85	0.08	0.19	0.10	0.96	0.12	0.78	6.39
1944	.34	.37	.59	2.05	.30	1.07	.11	.00	.58	.54	.44	.22	6.61
1945	.15	.55	1.19	.45	.77	2.20	.00	.47[2]	.43	.65	.88	.47[2]	8.21[2]
1946	.34	.00	1.07	.21	1.10	.00	.51	1.07	.00	1.92	1.12	1.01	8.35
1947	.39	.48	.20	1.42	.95	.73	.00	.49	2.15	1.07	.49	.48	8.85
1948	.03	.69	.53	1.01	.15	1.33	.00	.18	.40	.42	-	.51	5.25
1949	1.37	.23	1.30	.73	1.68	.00	.00	.66	.04	1.40	.46	.59	8.46
Average	.39	.42	.75	1.08	.79	.88	.10	.44	.53	.99	.58	.58	7.44
						Lakeside (altitude, 4,218 feet)							
1953	0.57	0.20	0.31	2.05	0.44	0.74	0.58	0.10	0.19	0.58	0.51	0.45	6.72
1954	.91	.13	.62	.73	.20	.71	.18	.14	.15	.58	.64	.58	5.57
1955	.84	.74	.17	.68	1.06	.72	.69	1.57	.45	.24	.22	1.50	8.88
1956	1.64	.16	.03	.68	.85	.12	.65	.10	(1)	1.18	.01	.72	6.14
Average	.99	.31	.28	1.04	.64	.57	.52	.47	.20	.64	.34	.81	6.82

1 Trace.
2 Estimated by U. S. Weather Bureau.

Table 2.—May through October pan evaporation and estimated average annual evaporation from a free water surface at Saltair

[After Hood, Price, and Waddell, 1968; measured evaporation from pan reported by U. S. Weather Bureau.]

Station: Location, lat. 40°46′, long. 112°06′, 42 miles east of Low; altitude, 4,210 feet.

Year	Pan evaporation, in inches						
	May	June	July	Aug.	Sept.	Oct.	Total for May-October[1]
1956	8.31[2]	12.93[2]	15.52	13.78	9.77	5.83[2]	66.14
1957	8.07	11.75	14.62	14.16	9.14	4.78	62.52
1958	11.49	14.39	15.38	13.28	9.93	6.37	70.84
1959	8.71	12.95	14.12	12.94	8.09	4.94	61.75
1960	10.34	13.65	16.16	13.11	9.76	5.29	68.31
1961	11.07	14.94	14.89	13.04	8.48	5.41[2]	67.83
1962	9.10	12.44	13.93	14.33	9.70	8.83[2]	68.33
1963	9.84	10.17	16.90	13.88	8.10	6.61	65.50
1964	9.12	9.58	15.85	13.10	9.97	5.36	62.98
1965	8.73[2]	10.51	14.46	11.54	7.18	4.77	57.19
1966	12.03	18.13	17.35	13.54	9.49	4.61	75.15
Average							66.05

[1] May-October evaporation is estimated to be 80 percent of annual; therefore, average annual pan evaporation is about 83 inches. Estimated evaporation from a free water surface is 70 percent of pan evaporation, or about 58 inches.

[2] Partial monthly record adjusted to a full month.

PHYSIOGRAPHY

The Sink Valley area lies between Great Salt Lake on the east and the Great Salt Lake Desert on the west in the Basin and Range physiographic province. Sink Valley is a small, topographically closed basin bounded on the east by the Lakeside Mountains, on the south by the Cedar Mountains, and on the west by the Grassy Mountains (pl. 1); low passes between the mountain ranges complete the closure of the basin. The north valley subarea lies between the northern parts of the Lakeside and Grassy Mountains and opens northwestward to the Great Salt Lake Desert from a low divide at the northern boundary of Sink Valley. The west shore subarea lies between the Lakeside Mountains and Great Salt Lake, north of Skull Valley.

The altitude in the Sink Valley area ranges from about 4,200 feet along the shore of Great Salt Lake to about 6,620 feet on the highest peaks of the Lakeside and Grassy Mountains. However, the altitude along most reaches of the mountain crests is less than 6,000 feet. The mountains, although not high, are rugged and are characterized by local high relief because of structural deformation and erosion.

The floor of Sink Valley is relatively flat and featureless, and its axis slopes gently northward. The altitude of the valley ranges from about 4,350 feet near the Tooele-Box Elder County line to about 5,000 feet at places along the bedrock boundary of the valley. Shoreline features of Pleistocene Lake Bonneville are visible in both the valley and the surrounding mountains, chiefly in the form of bars, spits, and terraces.

No surface water drains from Sink Valley itself. The north valley subarea drains toward the Great Salt Lake Desert and the west shore subarea drains directly into Great Salt Lake.

GEOLOGY

Sink Valley is a structural basin of the Basin and Range type. It was formed by the deformation of Tertiary and older rocks and is partly filled with unconsolidated and partly consolidated alluvial and lacustrine deposits of Tertiary and Quaternary age. The valley was inundated by Pleistocene Lake Bonneville, which at one time reached a maximum surface altitude of about 5,200 feet; sand and gravel deposits marking shores of this ancient lake blanket much of the Grassy Mountains, and are present locally in other parts of the project area.

Rocks ranging in age from Cambrian to Permian and from Tertiary to Holocene are exposed or have been penetrated by wells in the Sink Valley area. The rocks of Paleozoic age consist chiefly of limestone, dolomite, shale, and some quartzite. The rocks of Tertiary and Quaternary age that form the valley fill have been derived chiefly from rocks of Paleozoic age and, therefore, have a similar composition. The rocks of Tertiary age are not exposed in the area, but where they crop out in other parts of northwestern Utah, they contain tuffs, marlstone, and pyroclastic material (Heylmun, 1965) as well as detritus from the rocks of Paleozoic age. Table 3 gives a general description of the lithology and water-bearing properties of the major rock units in the Sink Valley area, and plate 1 shows the areal distribution and stratigraphic relations of those rocks.

Table 3.—General description and water-bearing properties of lithologic units in the Sink Valley area

Lithologic unit	Area of exposure and character of material	Water-bearing properties
Dune sand	Underlies about 3 square miles northwest of Lakeside and at southeast boundary of project area; maximum thickness 50 feet; smaller dunes scattered throughout the area; consists chiefly of fine to very fine windblown siliceous sand.	Retains sufficient moisture from snowmelt and rainstorms to support a more luxuriant growth of vegetation, including some phreatophytes, than the surrounding lakebed deposits.
Alluvium and colluvium	Thin deposits of sand, gravel, and boulders underlie the larger stream channels near the mountains; colluvium and alluvium, consisting largely of angular rock fragments up to boulder size underlie about 5 square miles along the lower slopes in the north end of the Cedar Mountains and the southwest side of the Lakeside Mountains.	Deposits are too thin to store significant quantities of water and are usually unsaturated; they do enhance recharge by absorbing precipitation and snowmelt and transmitting the water to underlying rocks.
Lakebed deposits	Underlie the floors of Sink Valley (about 100 square miles) and the north valley and west shore subareas (about 130 square miles); consist chiefly of clay and silt having a moderate to large salt content.	Deposits around the margins of Great Salt Lake are permanently moist and discharge ground water by evaporation; in higher altitudes the deposits retain sufficient moisture from snowmelt and rain to support the growth of various plants such as greasewood, sagebrush, shadscale, and cheatgrass but are nowhere considered to be an important water-bearing unit; the deposits inhabit recharge in most places, but some recharge takes place through them above the 4,600-foot level where they are thin and overlie more permeable materials.
Lakeshore deposits	Shoreline deposits of Pleistocene Lake Bonneville; extensive throughout the Grassy Mountains between the altitudes of 4,600 and 5,200 feet and present locally in the Lakeside and Cedar Mountains; consist of sand and gravel composed chiefly of limestone in spits, bars, and terraces; deposits generally less than 50 feet thick.	Usually unsaturated and not considered as a source of ground water, but the extensive deposits in the Grassy Mountains enhance recharge by rapidly absorbing and transmitting snowmelt and rain to underlying rocks before the water can be consumed by evapotranspiration.
Older valley fill	Not exposed in the area but has been penetrated by wells; consists chiefly of thick layers of clay, clay and sand, and clay and gravel with interbedded strata of clean sand and gravel (table 7); maximum known aggregate thickness about 800 feet at well (B-1-9)16baa-1, but probably much greater except adjacent to mountains where fill pinches out; deposits are cemented and slightly indurated locally.	Forms the major ground-water reservoir in the project area; yields moderate to large quantities of water to properly constructed and located wells (table 6); water generally contains from 2,000 to about 5,000 mg/l of dissolved solids, however, depending on depth and location of aquifer; water from the deepest aquifers is highly saline (fig. 3); most favorable aquifers with respect to yield and quality of water are in alluvial fans near the mountains.

Table 3—continued:

Lithologic unit	Area of exposure and character of material	Water-bearing properties
Consolidated rocks	Form the bulk of the mountain masses that surround Sink Valley and extend beneath the valley fill; consist chiefly of limestone, dolomite, shale, sandstone, and quartzite; limestone and dolomite of the Oquirrh Formation (Pennsylvanian and Permian) underlie Grassy Mountains, north end of Cedar Mountains, and north and south ends of Lakeside Mountains; Cambrian to Mississippian limestone, quartzite, and shale underlie most of the Lakeside Mountains; all rocks have been folded and faulted and are highly fractured and brecciated in many places.	Unit as a whole is poorly permeable, but solution cavities and fault, fracture, and brecciated zones provide permeable channels for movement of water from areas of recharge in the mountains to the main zone of saturation; rocks yield water to only one small spring, and probably yield some water to well (B-1-9)16baa-1; some ground water that discharges from the lower end of Sink Valley may be channeled along faults, fracture zones, and bedding planes in the Lakeside Mountains toward Great Salt Lake.

WATER RESOURCES

The source of most of the water in Sink Valley is precipitation that falls within the drainage basin, but there may be some subsurface inflow from the Cedar Mountains. The sources of water in the north valley and west shore subareas are precipitation that falls in those subareas and subsurface inflow from Sink Valley. Water may also enter the west shore subarea as subsurface inflow from outside the project area; the source of this water is not known.

A discussion of the sources, amounts, and distribution of water in the Sink Valley area is given in the following sections.

Volume of precipitation

The normal annual precipitation in the Sink Valley area is less than 6 inches in the lowlands and about 12 inches on the highest mountain peaks. The total volume of precipitation that falls on the area annually was determined by making a planimeter survey of areas between the lines of equal precipitation (isohyets) on plate 1 and multiplying those areas (in acres) by the average values (in feet) of the bounding isohyets. (See table 4.) The average annual volume of precipitation was estimated to be about 115,000 acre-feet per year. Of the 115,000 acre-feet, about 54,000 acre-feet, or 47 percent, falls within the Sink Valley drainage basin, about 16,000, or 14 percent, falls in the north valley subarea, and about 45,000, or 39 percent, falls in the west shore subarea.

Surface water

Part of the precipitation that falls within the project area is carried from the mountains to the lowlands as streamflow. Much of the streamflow is lost by infiltration and by evapotranspiration. Some reaches the valley flats and the mudflats of Great Salt Lake where it evaporates from channels and ponds, but very little reaches Great Salt Lake except perhaps during cloudburst floods.

Table 4.—Estimated average annual precipitation and recharge from precipitation in the Sink Valley area

Precipitation (inches)	Area (acres)	Average precipitation (feet)	Volume of precipitation (acre-feet)	Percent recharge	Recharge (acre-feet)
		Sink Valley drainage basin			
>12	800	1.08	900	7.5	70
10-12	3,600	.92	3,300	7.5	250
8-10	5,200	.75	3,900	7.5	290
6-8 [1]	23,400	.58	13,600	2.5	340
6-8 [2]	39,300	.58	22,800	0	0
<6 [1]	3,600	.42	1,500	2.5	40
<6 [2]	20,000	.42	8,400	0	0
Totals (rounded)	96,000	-	54,000	-	1,000
		North valley subarea			
<6 [1]	10,000	0.42	4,200	2.5	100
<6 [2]	28,000	.42	11,800	0	0
Totals (rounded)	38,000	-	16,000	-	100
		West shore subarea			
>12	1,200	1.08	1,300	7.5	100
10-12	3,300	.92	3,000	7.5	220
8-10	2,000	.75	1,500	7.5	110
6-8 [1]	4,400	.58	2,600	2.5	60
6-8 [2]	58,000	.58	33,600	0	0
<6 [1]	8,000	.42	3,400	2.5	80
Totals (rounded)	77,000	-	45,000	-	600
Grand totals (rounded)	211,000	-	115,000	-	2,000

[1] Above an altitude of 4,600 feet (some recharge).

[2] Below an altitude of 4,600 feet (no recharge).

No measurements of streamflow have been made in the Sink Valley area, thus the volume of runoff is not known; however, it doubtless is small. Most of the precipitation falls in the mountains that surround Sink Valley, but according to a map showing estimated water yields in Utah (Bagley and others, 1964, p. 55)[1], the mean annual runoff in even the highest parts of the Lakeside and Grassy Mountains is less than 1 inch. Actually there is little or no runoff from areas below an altitude of 4,600 feet because the land is mostly flat, and nearly all the precipitation that falls on the valley flats is consumed in place by evapotranspiration. Therefore, the average annual runoff over the entire Sink Valley area has to be much less than 1 inch and is estimated to be about half an inch, or about 9,000 acre-feet a year.

Use of surface water in the Sink Valley area is limited to watering stock. During the winter and spring, the flow of some of the streams is impounded behind dams or is stored in small stock-watering ponds. The volume of runoff in streams is too small for irrigation or any other use that would require a perennial supply of water.

Ground water

General conditions

The older valley fill (table 3) that extends beneath Sink Valley and the north valley and west shore subareas contains the principal ground-water reservoirs in the project area. Records of eight of the wells in table 6 show discharges that range from 15 to 500 gpm (gallons per minute) and average about 190 gpm. Data reported for six of the wells indicate specific capacities ranging from 1 to 150 gpm per foot of drawdown. The ground water in almost the entire project area contains more than 2,000 mg/l (milligrams per liter) of dissolved solids and locally is highly saline (table 8). The poor quality is caused by the small amount of annual recharge and the slow movement of ground water through the ground-water reservoir. Most of the existing wells have been drilled high on the alluvial slopes of the Lakeside and Grassy Mountains where the ground water is least mineralized. In these areas the depth to water generally exceeds 200 feet.

Only one spring is known in the entire Sink Valley area. The spring, known as Craner Spring, is near the center of sec. 25, T. 2 N., R. 9 W., in the Lakeside Mountains (pl. 1). It flows intermittently and has a maximum yield of about ½ gallon per minute; the water is used for stock.

The locations of wells, water-level contours, areas of ground-water recharge and discharge, and general chemical quality of ground water are shown on plate 1. Records of wells, well logs, and chemical analyses of ground water are given in tables 6-8.

Ground water in Sink Valley

Recharge

The principal source of recharge to the ground-water reservoir in Sink Valley is precipitation that falls on the Lakeside, Cedar, and Grassy Mountains. The small amount of precipitation that is not lost by sublimation and evapotranspiration percolates directly, or through the channels of streams, into the underlying rocks and eventually to the ground-water reservoir.

[1] The map was compiled by using available data on precipitation, altitude, and topography to statistically analyze basins where runoff is gaged and then applying the derived parameters to ungaged basins such as Sink Valley.

A method derived by Hood and Waddell (1968, p. 22), from a method by Eakin and others (1951, p. 78-81), was used to estimate the volume of ground-water recharge in the Sink Valley area. When using this method, one assumes that a fixed percentage of the average annual precipitation for a specific area becomes ground-water recharge. The percentage depends mostly on geology, topography, and plant cover, but is generally greatest where precipitation is greatest at high altitudes.

In Sink Valley, no recharge is believed to take place below an altitude of 4,600 feet because the area below that level is underlain by fine-grained lakebed deposits. Above the 4,600-foot level, however, some recharge does take place because the lakebed deposits are thinner and more permeable and are capable of transmitting some precipitation to the underlying ground-water reservoir. The fractured and faulted bedrock in the mountains and the gravelly lakeshore deposits and colluvium that overlie the bedrock in many places are moderately to highly permeable and facilitate recharge locally. Based on these considerations, it is estimated that above the 4,600-foot altitude level about 2.5 percent of the precipitation that falls in the zones of less than 8 inches of average annual precipitation and about 7.5 percent of the precipitation that falls in the zones of greater than 8 inches of average annual precipitation becomes ground-water recharge. As table 4 shows, the total average annual recharge from precipitation in Sink Valley is about 1,000 acre-feet.

Some underflow from bedrock in the Cedar Mountains may also recharge the ground-water reservoir in Sink Valley. However, the amount, if any, is probably small because the figure for total volume of ground water moving downgradient through Sink Valley was found to be on the order of 1,000 acre-feet a year (see section on occurrence and movement in Sink Valley), which is the same order of magnitude as the estimated average annual recharge from precipitation.

Occurrence and movement

Ground water occurs in the older valley fill under both water-table (unconfined) and artesian (confined) conditions in Sink Valley. However, most wells tap aquifers in which the water is unconfined. For example, the water levels in the valley in all but well (B-3-10)13dad-1 (table 6) are at or near the same depth as the top of the aquifer, which indicates that there is no artesian pressure in the aquifer at those wells. The water level in well (B-3-10)13dad-1 is about 66 feet higher than the top of the aquifer (and the uppermost perforations in the well casing) and thus indicates confined conditions in the aquifer.

Water-level contours on plate 1 indicate that ground water in Sink Valley moves generally toward the axis of the valley from the surrounding mountains and thence northward to subsurface outlets north of the Tooele-Box Elder County line. Part of the water apparently enters the north valley subarea and continues generally northwestward toward the Great Salt Lake Desert, and part moves eastward into the west shore subarea and continues eastward toward Great Salt Lake.

An estimate of the volume of water that moves downgradient through the valley each year was made as a check against the figure for annual recharge from precipitation. The estimate was made by multiplying the average coefficient of transmissibility (estimated from specific capacities of wells to be about 12,000 gpd per ft (gallons per day per foot) and the average ground-water gradient (7 feet per mile) by the length of cross section through which the water moves (about 10 miles). The amount was found to be 840,000 gpd, or about 1,000 acre-feet per year. This figure compares favorably with the estimated volume of recharge from precipitation.

Storage

Ground-water storage, in this report, is considered to be only recoverable storage, that is, the volume of ground water that can be economically recovered from the valley fill by wells. It is equal to the product of the specific yield (defined as ratio of the volume of water that saturated rock materials will yield by gravity to the total volume of those rock materials) and the volume of the saturated materials.

The total volume of ground water stored in Sink Valley is not known because the total volume of the saturated valley fill is unknown. However, a rough approximation is given of the volume of ground water recoverable from the upper 40-60 feet of saturated valley fill, that is, above an altitude of 4,195 feet (the approximate level of Great Salt Lake at the time (1967) of this investigation. The volume of recoverable ground water in storage is estimated to be about 370,000 acre-feet, according to the following method:

Using well logs (table 7) as a guide, Sink Valley was subdivided into two subareas—a central area believed to be underlain chiefly by fine-grained deposits with an average specific yield of about 10 percent, and a marginal area believed to be underlain chiefly by sand and gravel deposits with an average specific yield of about 20 percent. Using the water-level map (pl. 1), the mean saturated thickness above the 4,195-foot level was determined, the two subareas were then planimetered, and the volume of saturated fill in each subarea was calculated. These volumes were then multiplied by the respective estimated average specific yields to determine the volume of recoverable ground water.

There undoubtedly are additional large quantities of recoverable ground water stored in the valley fill below the 4,195-foot level. However, the water below that level is believed to be too highly saline to merit inclusion in the estimated volume of available ground water.

Discharge

Ground water is withdrawn from six widely scattered stock wells in Sink Valley. According to the U. S. Bureau of Land Management, the water pumped from all six wells annually ranges from about 270,000 gallons during wet years to about 480,000 gallons during dry years, and averages about 380,000 gallons, or about 1.2 acre-feet.

There is no natural ground-water discharge from the valley through springs or by evaporation because the depth to the ground-water reservoir ranges from about 130 to about 300 feet and is well below the bottoms of stream channels and the roots of any phreatophytes that grow in the valley. Greasewood and rabbitbrush grow locally along some of the larger streams and in dune areas, but these phreatophytes owe their existence to soil moisture and small bodies of perched ground water and not to water from the main ground-water reservoir.

The only natural means of discharge from the ground-water reservoir is by subsurface outflow through outlets near the lower end of the valley. The volume of water discharged by subsurface outflow is roughly equal to the estimated average annual recharge from precipitation (p. 16) or volume of water that moves downgradient through the valley (p. 16)—that is, about 1,000 acre-feet a year.

Perennial yield

The perennial yield of a ground-water reservoir is the maximum amount of water of usable chemical quality that can be withdrawn each year for an indefinite period of years (Hood and Rush, 1965, p. 92); it generally cannot exceed the natural discharge from the reservoir. In Sink Valley, the perennial yield is equal to subsurface outflow from the valley or the annual volume of recharge, which is about 1,000 acre-feet of water a year. Any annual withdrawals in excess of this amount for long periods of time would cause a continual lowering of water levels to the point where the water pumped would become progressively more mineralized. It would also reduce the amount of underflow into the north valley and west shore subareas.

Ground water in the north valley subarea

Recharge

Ground water in the north valley subarea is derived from subsurface inflow from Sink Valley and deep percolation of precipitation that falls on the northern parts of the Lakeside and Grassy Mountains.

The volume of subsurface inflow from Sink Valley is estimated to be 100 acre-feet of water annually. This figure was arrived at by assuming that virtually all the inflow moves through about a 1-mile wide gap near the Tooele-Box Elder County line (see pl. 1) under a hydraulic gradient of about 7 feet per mile, and that the unconsolidated material underlying the gap has about the same coefficient of transmissibility as the fill in Sink Valley (12,000 gpd per ft). The volume of recharge from precipitation in the Lakeside and Grassy Mountains is also estimated to be 100 acre-feet as shown in table 4. The total volume of recharge from both sources, therefore, is only about 200 acre-feet a year.

Occurrence and movement

Ground water in the north valley subarea occurs in the older valley fill under both water-table and artesian conditions. Wells (B-4-10)13caa-1 and (B-4-10)25bcc-1 tap aquifers in which the water seems to be unconfined, whereas well (B-4-10)25bac-1 taps an aquifer where there is confinement. The ground water in the subarea moves generally downvalley (northwestward) to areas of natural discharge along the edge of the Great Salt Lake Desert.

Discharge

Wells (B-4-10)25bac-1 and (B-4-10)25bcc-1 are pumped for culinary supply and other uses at the Hill Range test facility. The wells are pumped alternately to avoid creating a deep cone of depression around either well because of poorer quality water at depth, and the water is demineralized before being diverted into the supply lines. According to Eugene M. Craner (oral commun., 1967), about 1 million gallons of water are pumped from the two wells each month. This amounts to about 37 acre-feet a year.

Ground water discharges naturally from the north valley subarea by evapotranspiration and possibly by subsurface outflow to the Great Salt Lake Desert. Discharge by evapotranspiration occurs in three areas of greasewood growth near the edge of the Great Salt Lake Desert (pl. 1). These areas of greasewood growth cover about 3,200 acres. The greasewood, which appears sparse and stunted, is estimated to consume about 0.05 acre-foot of water per acre each year. This rate amounts to about 160 acre-feet in all three areas. The volume of subsurface outflow from the north valley subarea is not known, but it is believed to be small, because the total volume of discharge by pumping and evapotranspiration nearly equals the estimated total volume of recharge. The theory that subsurface outflow is small seems reasonable because the northern end of the subarea is very near to the Great Salt Lake Desert where ground-water gradients are gentle and the water moves slowly. Also the material through which the water moves is generally fine grained and transmits the water slowly. A well (not included in this report) at Strongknob Siding near the northern end of the subarea reportedly penetrated mostly clay to a depth of 781 feet. (See Schreiber, 1954, p. 10.)

No estimates were made of the volume of water that could be withdrawn from storage by lowering water levels by pumping, because the north valley subarea is part of the larger ground-water system in the Great Salt Lake Desert and any estimate of storage or perennial yield for the subarea alone would be unrealistic. For example, large declines of ground-water levels in the subarea would cause a reversal of the ground-water gradient and thus induce additional inflow to the area from the ground-water system in the Great Salt Lake Desert. A more comprehensive study of the entire region is needed before inflow from the Great Salt Lake Desert can be evaluated.

Ground water to the west shore subarea

Recharge

The west shore subarea receives recharge from Sink Valley as subsurface inflow, from precipitation that falls on the east side of the Lakeside Mountains, and possibly by subsurface inflow from outside the project area. The estimated volume of recharge from Sink Valley is about 900 acre-feet per year (1,000 acre-feet of discharge from Sink Valley minus the 100 acre-feet that enters the north valley subarea). The estimated volume of recharge from precipitation is about 600 acre-feet (table 4). An imbalance between the estimated volume of recharge from the sources mentioned above (1,500 acre-feet) and the estimated volume of discharge by evapotranspiration (2,400 acre-feet, see section on discharge) indicates that about 900 acre-feet of ground water is moving into the subarea from other unknown sources.

Occurrence and movement

Ground water occurs under both water-table and artesian conditions in older valley-fill deposits in the west shore subarea. Of the two wells in the subarea for which records are available (table 6), well (B-5-9)22acd-1 taps an unconfined aquifer and well (B-3-8)31ccc-1 taps a confined aquifer. Ground water in the subarea moves generally eastward toward Great Salt Lake.

Discharge

Only well (B-3-8)31ccc-1 is pumped in the west shore subarea. According to the U. S. Bureau of Land Management, annual discharge from the well ranges from about 86,000 gallons during wet years to about 135,000 gallons during dry years, and averages about 115,000 gallons (0.35 acre-foot).

Ground water discharges naturally from the west shore subarea by evapotranspiration and subsurface outflow to the saltflats and Great Salt Lake. Discharge by evapotranspiration is chiefly in an area covering about 9,600 acres of stunted to fairly luxuriant greasewood growth. It is estimated that the greasewood annually consumes about 0.25 acre-foot of water per acre or a total of about 2,400 acre-feet. The volume of subsurface seepage to the saltflats and Great Salt Lake is not known, but the quantity is believed to be small compared to discharge by evapotranspiration, because ground-water gradients in the vicinity of the lake are gentle, and the material through which the water flows is believed to be fine grained and rather impermeable.

No estimate was made of the volume of ground water that could be drawn from storage by lowering water levels or of the perennial yield of the west shore subarea because the subarea is part of the larger ground-water system of adjacent Skull Valley. Any pumping withdrawals from the subarea in excess of natural discharge would result in declining water levels which would induce recharge from Skull Valley. It can be assumed, however, that the perennial yield for the subarea probably amounts to at least 2,400 acre-feet, the amount of water consumed annually by phreatophytes.

Ground-water budget

Table 5 gives the volumes, where known, of ground-water storage, recharge, and discharge for the Sink Valley area. The figures therein, which were derived in the foregoing sections, are only estimates but do indicate that the volumes are of a small order of magnitude.

Chemical quality of the ground water

Table 8 contains chemical analyses of 20 water samples collected from wells in the Sink Valley area. As these analyses show, ground water in the area contains moderate to large concentrations of dissolved solids and, in most cases, is unsuitable for irrigation, human consumption, or some other uses unless the water is properly treated.

The concentration of dissolved solids in ground water in the Sink Valley area ranged from 1,750 mg/l in the sample from well (B-1-10)21ddb-1 to 48,100 mg/l in the sample collected from a depth of 675-685 feet in well (B-4-10)25bac-1. Chloride and sodium were the principal constituents in most samples analyzed, but large concentrations of magnesium, calcium, sulfate, fluoride, and other constituents were found in the samples collected from deeper water-bearing zones tapped by well (B-4-10)25bac-1.

In general, the ground water with the lowest concentrations of dissolved solids occurs in and near areas of recharge near the south end of Sink Valley and the concentrations of chloride and dissolved solids in the water increases northward in the direction of ground-water flow (pl. 1). However, highly mineralized water probably occurs locally throughout the valley fill, where evaporites such as gypsum have accumulated in lakebed sediments. Several strata of clay with gypsum were penetrated by a well (not included in this report) at Strongknob Siding near the north end of the project area (see Schreiber, 1954, p. 10). Water from well (B-3-9)19bac-1 reportedly contained more than 14,000 mg/l of chloride (reported as sodium chloride), and samples from well (B-4-10)25bac-1 contained large amounts of calcium, magnesium, and sulfate presumably dissolved from evaporite deposits.

Table 5.—Ground-water budget for the Sink Valley area

	Sink Valley	North valley subarea	West shore subarea
Ground-water storage	370,000[1]	-	-
Annual recharge:			
From precipitation	1,000	100	600
Subsurface inflow	-	100	900[2]
Total (rounded)	1,000	200	-
Annual discharge:			
Subsurface outflow	1,000	-	-
Evapotranspiration	0	160	2,400
Pumpage	1	37	<1
Total (rounded)	1,000	-	-

[1] Computed only for the valley fill above an altitude of 4,195 feet (approximate level of Great Salt Lake in 1967); not computed for north valley and west shore subareas owing to inadequate data.

[2] From Sink Valley only.

In general, the water ranges from hard to very hard, according to the following table of hardness used by the U. S. Geological Survey:

Hardness range (mg/l)	**Adjective rating**
0- 60	Soft
61-120	Moderately hard
121-180	Hard
181+	Very hard

However, water from wells (B-1-10)21ddb-1 and (B-3-10)29dcd-1 was soft, which indicates that there is local ion exchange in some aquifers whereby calcium and magnesium ions are being replaced by sodium ions.

The mineral content of the ground water increases with depth as well as with distance from recharge areas. Figure 3 shows the relation between the depth of the water-bearing zones at well (B-4-10)25bac-1 and the concentrations of chloride and dissolved solids in water from those depth zones. The concentrations of chloride and dissolved solids increased markedly in waters between the depths of 225 and 685 feet. The concentrations of silica and bicarbonate generally decreased however (table 8).

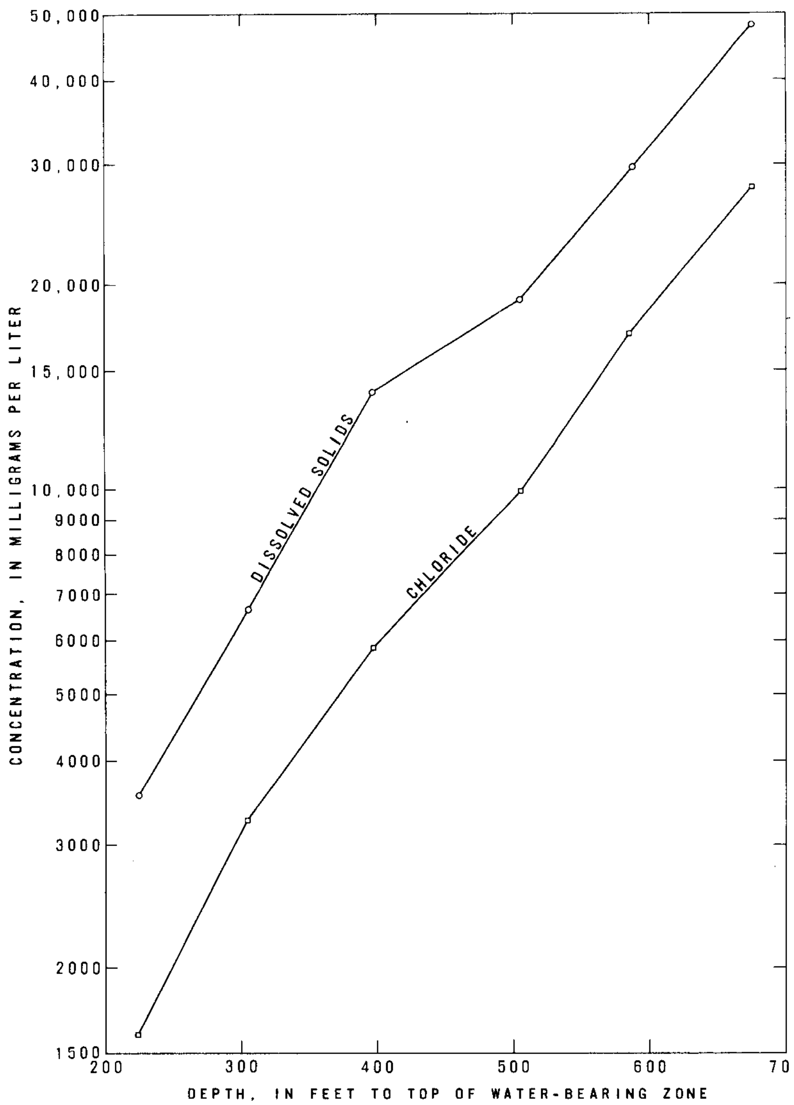

Figure 3.—Relation between depth of water-bearing zones and concentrations of chloride and dissolved solids in ground water at well (B-4-10)25bac-1 (see table 8 for dates of collection and other chemical constituents).

LAND UTILIZATION AND WATER DEVELOPMENT

Past and present

Almost all the land in the Sink Valley area is owned by the Federal Government. Most of the segment north of the Tooele-Box Elder County line and west of the Lakeside Mountains was withdrawn for military use prior to World War II. Most of the land in the remaining segments of the project area has been utilized as winter range for sheep since about 1930. Development of resources in the area other than pumpage of ground water includes some screening of gravel from the extensive lakeshore deposits and quarrying of limestone in the Lakeside Mountains.

Future

There are no foreseeable changes in land utilization and water development in the Sink Valley area. The ground water is chemically unsuitable for irrigation, and surface-water supplies for irrigation are lacking. Furthermore, soil conditions and climate in the area are generally unfavorable for raising crops. There is sufficient ground water locally to support some industrial development for which chemical quality of water is not a limiting factor. However, the ground water throughout the area is too highly mineralized for any industry which requires water with a concentration of dissolved solids of less than 2,000 mg/l. Water used for such industries or for domestic supplies would have to be hauled into the area as is done at Lakeside and Low, or would have to be pumped from ground-water sources and demineralized.

PROPOSALS FOR ADDITIONAL STUDIES

No foreseeable significant increase in development of the water resources of the Sink Valley area merits an immediate detailed study. However, because of the water-quality problem, any development of additional supplies from ground-water sources in the area should be preceded by a detailed local study of the well site, which preferably should include drilling of at least one small-diameter test well. Data available for this investigation indicated that annual discharge from the west shore subarea exceeds accountable annual recharge by about 900 acre-feet. Therefore, should the need for further study arise, the following data should be collected:

1. Additional precipitation records to determine if there is more precipitation (and ground-water recharge from precipitation) in the west shore subarea than is indicated by the map showing normal annual precipitation in Utah for the period 1931-60.

2. More detailed mapping of the phreatophytes to determine more accurately the volume of water that is consumed by evapotranspiration.

3. Detailed geologic mapping to determine if, in fact, considerable water moves through bedrock in the Cedar and Lakeside Mountains to the west shore subarea.

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BASIC DATA

Table 6.--Records of selected wells in the Sink Valley area

Well number: See text for description of well-numbering system.
Owner or name: BLM, U.S. Bureau of Land Management.
Type of well: C, drilled by cable tool; H, drilled by hydraulic rotary.
Altitude: Altitude of land surface at well in feet above mean sea level determined by altimeter survey.
Water level: Measured depths given in feet and hundredths below land-surface datum; reported depths given in feet.
Type of pump: J, jet; N, none; P, piston; S, submersible; T, turbine.
Well performance: Yield and drawdown reported by driller; B, bailed yield.
Use of water: H, domestic, fire protection, and construction; N, industry; S, stock; U, unused.
Remarks and other data available: C, chemical analysis in table 8; L, driller's log of well in table 7; perf., casing perforated; log, casing depths, and other remarks regarding well reported by driller or owner.

Well No.	Owner or name	Utah State Engineer application No.	Year drilled	Type of well	Depth of well (feet)	Diameter of well (inches)	Water-bearing zone			Altitude above sea level (feet)	Water level		Type of pump	Well performance		Use of water	Remarks and other data available
							Depth to top (feet)	Thickness (feet)	Character of material		Below land-surface datum (feet)	Date of measurement		Yield (gpm)	Drawdown (feet)		
(B-1-9)																	
3ccc-1	Utah Marblehead Lime Co.	A-28500 A-29437	1957	C	543	8,6	390	75	Hard sand	4,600	370	6- 7-57	S	30B	-	N	In Skull Valley. Supplies water for quarry and lime production. Cased to 543 ft; perf. 395-? ft. C, L.
16baa-1	M. Morin and Son Co. Inc.	A-30015	1958	C	825	12	270 545	4 218	Sand Fine gravel	4,490	262	7-11-58	N	500	138	U	In Skull Valley. Originally used for highway construction. Cased to 808 ft; perf. 550-? ft. L.
(B-1-10)																	
3bbb-1	BLM, East Grassy Mountain well	A-20379	-	C	212	6	-	-	Gravel	4,430	170.00 174.05	6- 9-50 10-19-67	T	-	-	S	Cased to 212 ft. Clay to 95 ft, gravel 95-212 ft.
21ddb-1	BLM, South Puddle Valley well	A-13071	-	C	253	6	-	-	-	4,490	203.75 203.77 203.64 204.68 204.52 205.99 205.93	11- 5-46 12-27-49 12-11-50 12- 3-62 12- 4-63 12-16-65 10-19-67	P	-	-	S	C.
(B-2-9)																	
20acb-1	BLM, Skunk Ridge well	A-19598	1948	C	280	6,5	250	30	Sand and gravel	4,520	258.17 258.06 261.01 258.28 259.48	12- 3-62 12- 4-63 8- 3-65 12-12-65 9-12-66	P	15	-	S	Casing: 6 in. to 260 ft, 5 in. to 280 ft. Water quality reported to be good. L.
(B-2-10)																	
17dba-1	BLM, Government well 78	A-13071	1935	C	330	8,6	280	50	do	4,520	270.00 271.16	6- 9-50 10-19-67	T	-	-	S	Casing: 8 in. to 20 ft, 6 in. to 330 ft. C, L.
(B-3-8)																	
31ccc-1	BLM, Monarch well	A-12328	1936	C	127	8	75	52	Coarse gravel	4,260	54.78	10-19-67	J	300	20	S	Cased to 127 ft; perf. 75-127 ft. C, L.
(B-3-9)																	
19bac-1	BLM, California Knolls well	A-21624	1950	C	219	6	150	40	Sand	4,365	145	-	N	-	-	U	Abandoned; produced salty water. C, L.
30aaa-1	BLM, Richins well	A-22581	1950	C	245	6	210	-	Sand and gravel	4,450	215.20	8- 7-67	T	-	-	S	Cased to 243 ft, open end. C.
(B-3-10)																	
13dad-1	Stratton Bros. Construction Co.	A-35251	1963	H	410	8	200	210	do	4,350	134.33	10-19-67	N	-	-	U	Originally used for highway construction. Cased to 402 ft; perf. 200-402 ft. C, L.
29dcd-1	BLM, Bertagnole well	A-18028	1946	C	363	6	310	53	do	4,555	311.50 321	6- 9-50 10-19-67	P	20B	20	S	Cased to 360 ft, perf. 320-360 ft. C, L.
(B-4-10)																	
13caa-1	BLM, Kirk Homestead well	A-13758	1940	C	213	6	180	36	do	4,400	175	8-20-40	-	36	37	S	Originally drilled to 216 ft. Perf. 180-? ft. C, L.
25bac-1	U.S. Air Force	A-35226	1962	C	739	20,14	245	30	do	4,430	225	5- 7-62	-	300	50	H	Filled back to 704 ft. Cased to 723 ft; perf. 225-275 ft. C, L.
25bcc-1	do	A-35226	1963	C	302	12	112	50	Clay and gravel	4,410	190	6-14-63	-	300	2	H	Cased to 300 ft; perf. 112-162 ft. C, L.
(B-5-9)																	
22acd-1	-	A-18212	1946	C	260	6	210	50	Sand and gravel	4,420	210	10-14-46	-	-	-	U	Originally used for stock. Perf. 240-? ft. C, L.

Table 7.--Drillers' logs of selected wells in the Sink Valley area

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

Material	Thickness	Depth
(B-1-9)3ccc-1. Composite log by Mac Exploration Co. to 410 ft and by Robinson Drilling Co. 410-543 ft. Alt. 4,600 ft.		
Sand with clay streaks	50	50
Boulders	10	60
Gravel, medium to fine	10	70
Gravel, fine, cemented, and clay streaks	130	200
Clay and gravel, stratified	210	410
Sand, hard; water bearing	55	465
Rocks, hard	1	466
Sand and gravel, some clay	9	475
Sand and gravel	15	490
Gravel and rocks	53	543
(B-1-9)16baa-1. Log by Robinson Drilling Co. Alt. 4,490 ft.		
Clay, sandy	10	10
Sand	110	120
Clay, yellow, sandy	25	145
Clay and gravel	125	270
Sand; water bearing	4	274
Clay, brown, sandy	106	380
Gravel, fine, and clay	165	545
Gravel, fine, and some clay	218	763
Clay, white	4	767
Conglomerate	34	801
Gravel, fine	5	806
Limestone, solid	19	825
(B-2-9)20acb-1. Log by L. E. Hale. Alt. 4,520 ft.		
Sand and gravel	30	30
Boulders	6	36
Clay with thin gravel strata	176	212
Boulders	4	216
Clay and gravel	34	250
Sand and gravel	30	280
(B-2-10)17dba-1. Log by H. H. Bell. Alt. 4,520 ft.		
Boulders, "quartz"	16	16
Quicksand and gravel	4	20
Boulders, quartzite	260	280
Sand and gravel; water bearing	50	330
(B-3-8)31ccc-1. Log by Robinson Drilling Co. Alt. 4,260 ft.		
Sand and clay	35	35
(B-3-8)31ccc-1 - Continued		
Clay, limy, and "burnt" rock	40	75
Gravel, coarse; water bearing	45	120
Gravel, fine	7	127
(B-3-9)19bac-1. Log by L. E. Hale. Alt. 4,365 ft.		
Topsoil	5	5
Sand	14	19
Clay	121	140
Sand and clay	10	150
Sand	40	190
Hardpan	3	193
Sand	7	200
Clay	19	219
(B-3-10)13dad-1. Log by Stratton Bros. Construction Co. Alt. 4,350 ft.		
Topsoil and clay	15	15
Silt and clay	15	30
Sand, silt, and clay	15	45
Sand	15	60
Clay and sand	30	90
Sand	15	105
Clay and sand	30	135
"Hard streaks"	15	150
Clay with hard streaks	15	165
Clay and sand, some gravel	15	180
Not recorded	15	195
Sand and gravel	30	225
Gravel, coarse	15	240
Clay, sand, and gravel	15	255
Clay and gravel	15	270
Sand and fine gravel	10	280
Sand and gravel	20	300
Sand and gravel with hard streaks	20	320
Gravel	20	340
Sand and gravel	40	380
Gravel with hard streaks	10	390
Gravel	20	410
(B-3-10)29ded-1. Log by L. E. Hale. Alt. 4,555 ft.		
Clay and some gravel	40	40
Boulders and sand	20	60
Clay with streaks of hardpan ½-2 ft thick	250	310
Sand and gravel; water bearing	53	363
(B-4-10)13caa-1. Log by L. E. Hale. Alt. 4,400 ft.		
Topsoil	3	3
Gravel, cemented	117	120
Clay and sand	15	135
Gravel, cemented	45	180
Sand and gravel; water bearing	36	216
(B-4-10)25bac-1. Log by Layne-Texas Co. Alt. 4,430 ft.		
Silt	35	35
Gravel	43	78
Clay and gravel	67	145
Clay and sand	25	170
Clay and gravel	75	245
Clay, sand, and gravel	30	275
Clay and gravel	113	388
Sand, fine	12	400
Sand and gravel	20	420
Sand, fine	45	465
Sand and gravel	80	545
Sand, gray	35	580
Sand and gravel	10	590
Sand, gray	32	622
Sand and gravel	15	637
Sand, fine	81	718
Sand, hard	21	739
(B-4-10)25bcc-1. Log by Intermountain Drilling Co. Alt. 4,410 ft.		
Clay	2	2
Clay, light, sandy	22	24
Clay, light, some gravel	8	32
Clay and gravel	14	46
Clay, gray, and gravel	47	93
Clay and gravel	85	178
Clay, brown, sandy, and gravel	32	210
Sand, brown, and gravel	2	212
Clay and gravel; water bearing	6	218
Clay and gravel	52	270
Clay and some gravel	32	302
(B-5-9)22acd-1. Log by Earl Hale. Alt. 4,420 ft.		
Clay	20	20
Limerock	25	45
Clay, sandy	165	210
Sand and gravel	50	260

Table 8.--Chemical analyses of water from wells in the Sink Valley area

[Analyses by U.S. Geological Survey unless otherwise noted in footnotes]

Temperature (°C): See text for discussion of metric units.
Sodium and potassium: Where no potassium value is shown, sodium plus potassium is calculated and reported as sodium.
Dissolved solids: Calculated from the sum of determined constituents.

Well No.	Depth of water-bearing zone (feet below land-surface datum)	Date of collection	Temperature (°C)	Milligrams per liter																	Percent sodium	Sodium-adsorption ratio	Specific conductance (micromhos/cm at 25°C)	pH
				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)	Boron (B)	Dissolved solids	Hardness as $CaCO_3$	Noncarbonate hardness as $CaCO_3$				
(B-1-9)																								
1/3ccc-1	390-465	8-7-67	-	39	-	-	104	71	853	20	136	0	80	1,520	1.0	7.2	0.22	2,760	550	438	76	16	4,900	7.5
(B-1-10)																								
21ddb-1	-	1-13-66	16	40	0.35	0.00	6.4	.5	653	26	381	0	113	710	1.2	8.5	.26	2/1,750	18	0	97	67	3,110	7.7
(B-2-10)																								
3/17dba-1	280-330	2- 2-35	-	31	-	-	-	-	-	-	414	-	806	1,120	-	-	-	2,530	-	-	-	-	-	-
(B-3-8)																								
31ccc-1	75-127	4-23-64	-	21	-	-	92	108	1,010	40	201	0	211	1,780	.5	11	.54	4/3,380	675	510	75	17	5,870	7.7
(B-3-9)																								
3/19bac-1	150-190	9- -50	-	-	-	-	-	-	-	-	-	-	-	5/>14,000	-	-	-	>14,000	-	-	-	-	-	-
(B-3-10)																								
13dad-1	200-402	8- 6-63	16	43	.06	.00	22	17	1,280	55	204	0	184	1,880	.8	25	1.20	3,610	122	0	94	50	6,520	7.8
29dcd-1	310-363	1-13-66	16	44	1.00	.04	4.4	3.2	932	34	400	4	347	900	1.8	9.0	.70	6/2,480	24	0	97	83	4,410	8.3
(B-4-10)																								
13caa-1	180-216	2- 9-62	14	34	.50	.00	22	12	807	17	268	0	86	1,090	.6	-	.91	2,230	104	0	93	35	3,980	8.0
		4- 2-62	-	38	.22	.00	26	15	741		258	0	100	1,000	1.0	8.4	-	2,060	125	0	93	29	3,710	8.2
25bac-1	225-275	3-23-62	15	39	.12	.05	18	29	1,310		578	0	245	1,600	1.6	24	-	3,550	164	0	95	44	6,140	8.0
	305-353	3-29-62	14	34	.19	.34	60	117	2,300		454	0	622	3,250	1.4	21	-	6,630	630	258	89	40	10,900	7.6
	399-400	4- 4-62	18	28	.02	.66	133.1	2,530	3,930		360	0	1,260	5,880	1.6	23	-	14,000	1,370	1,080	86	46	18,100	7.7
	505-515	4- 9-62	15	7.8	.34	1.30	509	557	5,520		252	0	1,260	9,940	1.6	24	-	18,000	3,560	3,350	77	40	27,300	7.0
	588-600	4-11-62	16	14	.09	2.30	1,170	924	8,890		216	0	1,810	17,000	1.6	21	-	29,900	6,720	6,540	74	47	42,300	6.9
	675-685	4-17-62	15	14	.04	3.60	1,470	1,370	14,900		152	0	2,350	27,800	11	35	-	48,100	9,320	9,200	78	66	62,700	7.5
	225-275	6- 5-62	15	31	.46	.10	53	62	1,930		486	0	456	2,620	1.3	20	-	5,410	386	0	92	43	9,200	8.1
		6- 8-62	15	47	-	-	128	169	2,950		408	0	879	4,360	1.4	19	-	8,750	1,010	677	-	-	14,200	7.8
		7- 8-63	17	40	1.90	-	80	174	2,730	86	432	0	772	3,970	1.4	17	1.70	8,280	915	561	85	-	13,400	8.0
25bcc-1	112-162	8-27-63	17	22	.00	-	27	55	1,540	52	348	6	457	2,060	2.3	55	1.40	7/4,500	292	0	90	-	7,580	8.3
(B-5-9)																								
22acd-1	210-260	4-23-64	-	40	-	-	164	163	2,270	91	130	0	415	4,040	1.0	14	.79	7,270	1,080	973	81	30	12,000	7.3

1/ Sample collected from storage tank.
2/ Trace constituents, in milligrams per liter, are copper (Cu), 0.00; lead (Pb),0.05; zinc (Zn), 0.03; lithium (Li), 0.20; strontium (Sr), 0.04; phosphate (PO_4), 0.16.
3/ Analysis reported by U.S. Bureau of Land Management.
4/ Trace constituents, in milligrams per liter, are copper (Cu), 0.00; lead (Pb), 0.07; lithium (Li), 0.50; bromide (Br), 1.0; iodide (I), 0.02; phosphate (PO_4), 0.38.
5/ Reported as sodium chloride (NaCl).
6/ Trace constituents, in milligrams per liter, are copper (Cu), 0.02; lead (Pb), 0.02; zinc (Zn), 0.34; lithium (Li), 0.20; strontium (Sr), 0.08; phosphate (PO_4), 0.86.
7/ Trace constituents, in milligrams per liter, are copper (Cu), 0.01; lead (Pb), 0.11; lithium (Li), 0.80; bromide (Br), 2.0; iodide (I), 0.05.

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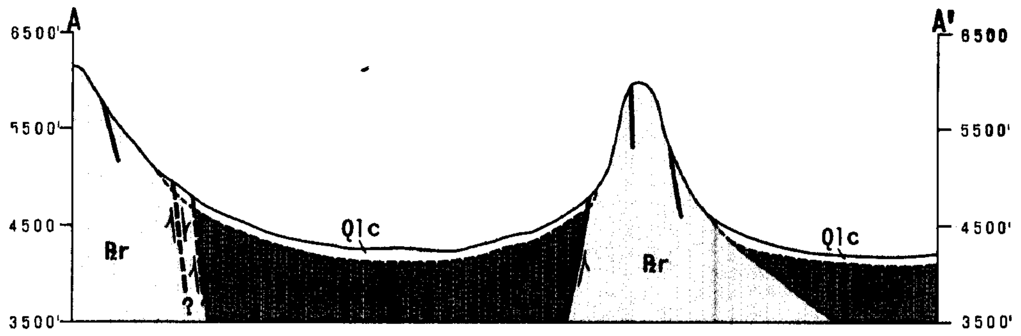


DIAGRAMMATIC SECTION
VERTICAL EXAGGERATION X 10.6

EXPLANATION

GEOLOGY

QUATERNARY

Qds Dune sand
Fine-grained siliceous sand, moderately permeable but too limited in extent to contain important aquifers

Qag Alluvium and colluvium
Mostly sand and gravel, too limited in extent to contain important aquifers; acts as a local recharge medium

Qlc Lakebed deposits
Clay and silt having moderate to large salt content; generally poorly to moderately permeable; contain no important aquifers and inhibits recharge in most places

Qlsg Lakeshore deposits
Mostly sand and gravel, moderately to highly permeable; generally unsaturated and not considered as a source of ground water, but are an important recharge medium

TERTIARY and QUATERNARY

Older valley fill
Interbedded strata of clay, sand, and gravel; locally partly consolidated; forms the major ground-water reservoir in the area; yields moderate to large quantities of water to wells

CAMBRIAN to PERMIAN

Rr Consolidated rocks
Mostly limestone and dolomite, some shale, sandstone, and quartzite; generally poorly permeable as a whole, but transmit water readily locally, particularly along zones of faulting, fracturing, and solution cavities

Approximate geologic contact

Fault
Dashed where inferred

General dip and strike of beds

A——A'
Line of diagrammatic section

HYDROLOGY

Observation well

4210
Water-level contour
Shows altitude of water level. Dashed where inferred. Contour interval 10 feet. Datum is mean sea level. Arrows indicate general direction of ground-water movement

Principal areas of ground-water recharge

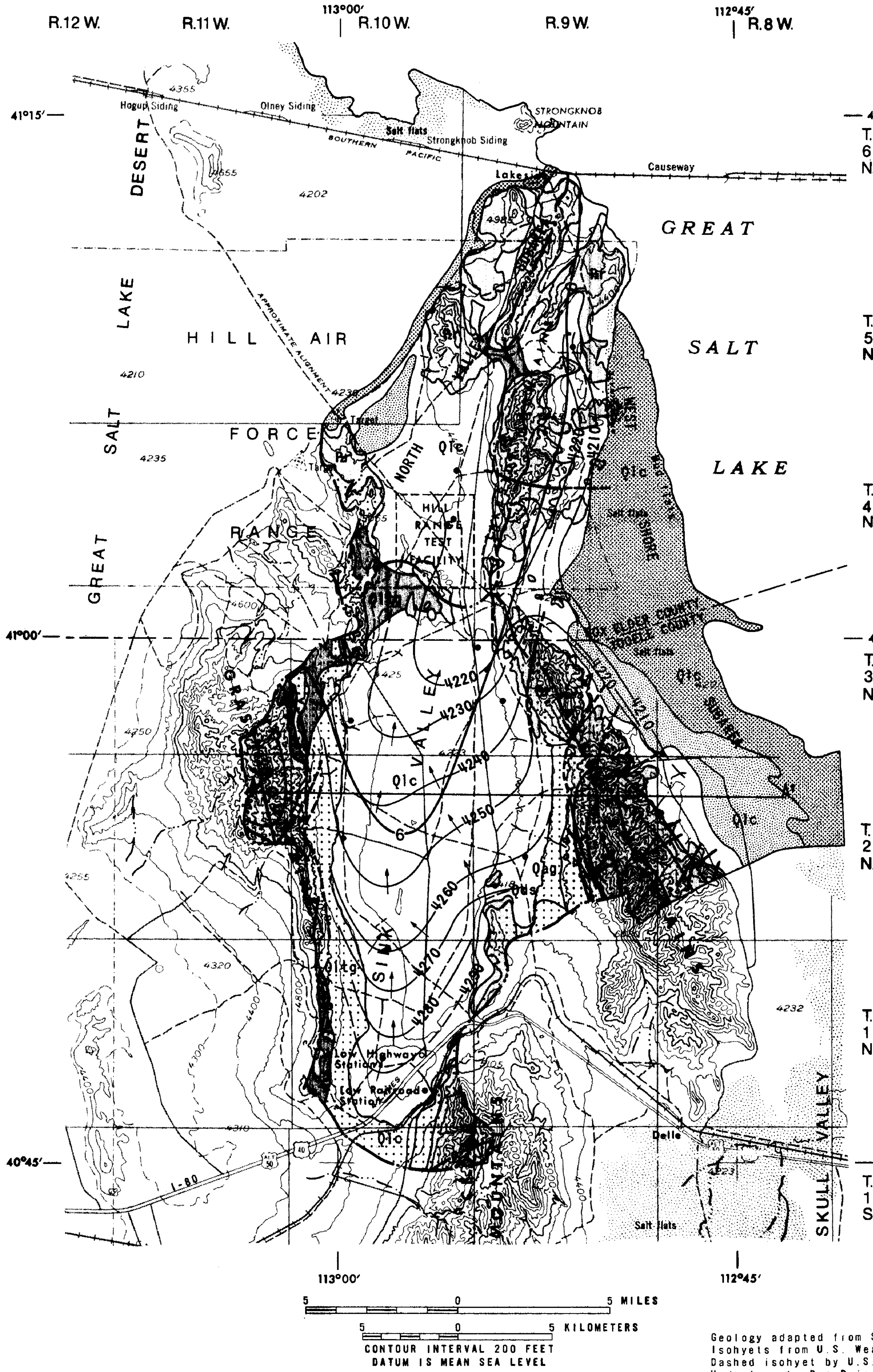
Areas of natural ground-water discharge

By evaporation

By evapotranspiration (greasewood)

12
Isohyet
Shows normal annual precipitation, 1931-60; interval 2 inches

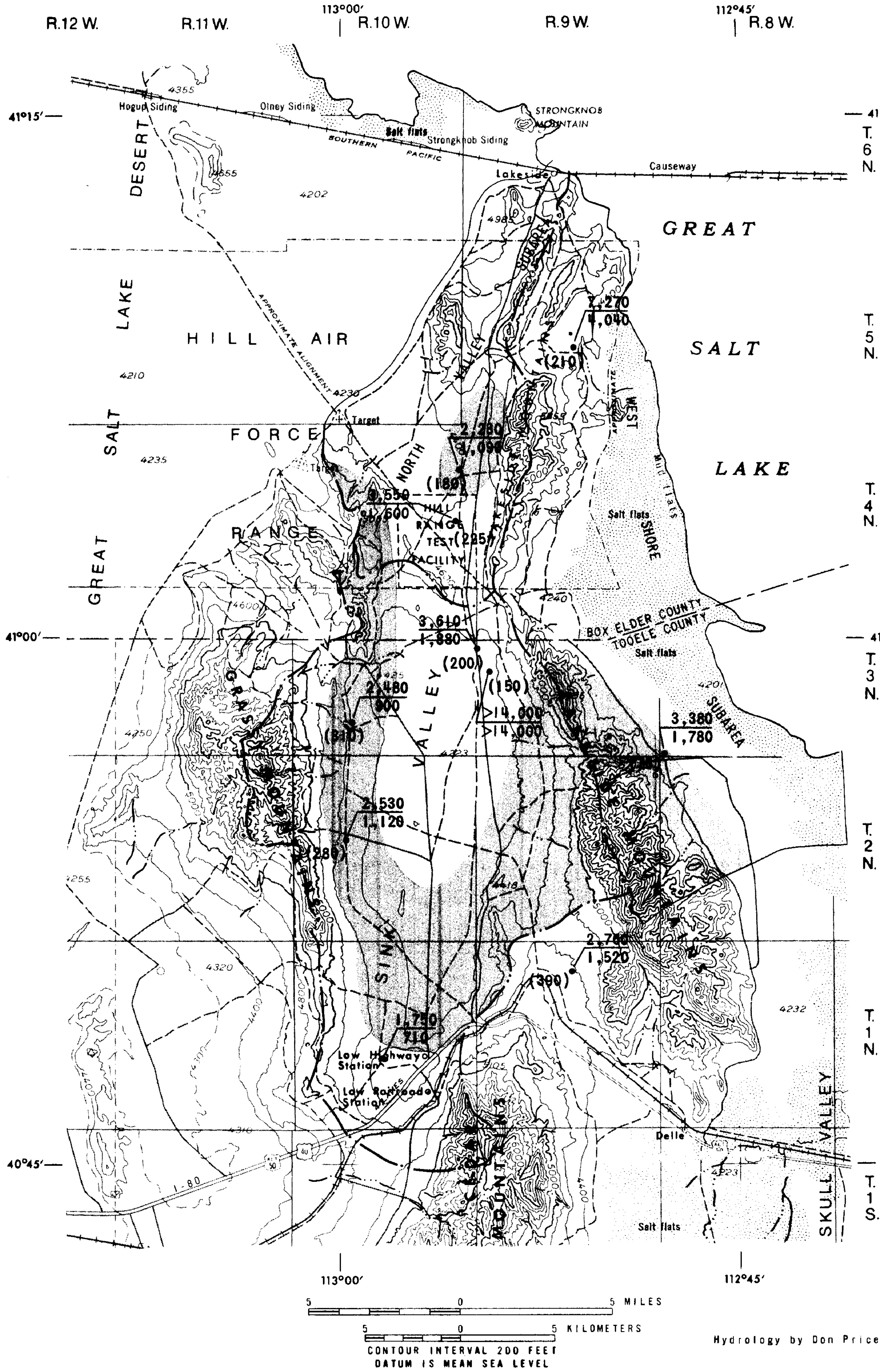
Drainage divide



Base from U.S. Geological Survey 1:250,000 series: Tooele, Utah (1962), and Brigham City, Utah-Idaho (1962)

Geology and hydrology

Geology adapted from Stokes (1964).
Isohyets from U.S. Weather Bureau (1963a).
Dashed isohyet by U.S. Geological Survey.
Hydrology by Don Price and E. L. Bolke



Hydrology by Don Price and E. L. Bolke

Chemical quality of ground water

EXPLANATION

CHEMICAL QUALITY OF WATER

(310) Well 2,480 / 900

Upper number indicates concentration of dissolved solids, in milligrams per liter; lower number indicates concentration of chloride, in milligrams per liter; number in parentheses is depth, in feet, to top of aquifer

Concentration of dissolved solids, in milligrams per liter, of water in shallowest water-bearing zones

Less than 2,000

2,000-3,000

More than 3,000

Drainage divide

GENERALIZED HYDROGEOLOGIC MAPS OF THE SINK VALLEY AREA, TOOELE AND BOX ELDER COUNTIES, UTAH