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HYDROLOGIC RECONNAISSANCE OF THE BLUE CREEK VALLEY AREA, BOX ELDER COUNTY, UTAH

by

E. L. Bolke and Don Price, Hydrologists
U. S. Geological Survey

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in cooperation with the
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ABSTRACT

The Blue Creek Valley area includes about 250 square miles in a semiarid, sparsely populated section of northwestern Utah. Normal annual precipitation in the area ranges from about 15 inches on the valley floor to slightly more than 20 inches in the mountains and totals about 184,000 acre-feet. Surface runoff is about 2,200 acre-feet per year.

Average annual ground-water recharge and discharge are estimated to be about 14,000 acre-feet each. The largest developed water supply in the area is from Blue Springs; the water is impounded in Blue Creek Reservoir and is used for irrigation. The discharge of Blue Springs is about 7,200 acre-feet per year.

The principal chemical types of water in the area are calcium magnesium chloride and sodium chloride. Concentrations of dissolved solids in the water range from less than 600 milligrams per liter in some wells and mountain springs to about 8,000 milligrams per liter in lower Blue Creek. Most of the water contains one or more dissolved constituents that exceed the recommended maximum allowable limits set by the U.S. Public Health Service for drinking water, but most of the water is acceptable for stock use. Water from Blue Springs is used for irrigation, although both the sodium hazard and salinity hazard are very high.

INTRODUCTION

Purpose and scope

This report is the tenth in a series of reports prepared by the U. S. Geological Survey in cooperation with the Utah Department of Natural Resources, Division of Water Rights, that describe the water resources of selected areas in northwestern Utah. The purpose of this report is to present available hydrologic data for the Blue Creek Valley area and to provide a quantitative evaluation of the potential water-resources development of the area.

The investigation on which this report is based was made during the period July-December 1970 and consisted largely of a study of previously collected hydrogeologic data. The writers checked geologic mapping, mapped phreatophytes, collected water samples for chemical analysis, measured ground-water levels and spring discharge, and determined ground-water pumpage during an 8-day reconnaissance in July-August 1970.

Description of the area

The Blue Creek Valley area is in northern Utah and lies north of Great Salt Lake between latitude 41°35′ and 42°00′ north and longitude 112°20′ and 112°35′ west (fig. 1 and pl. 1). The

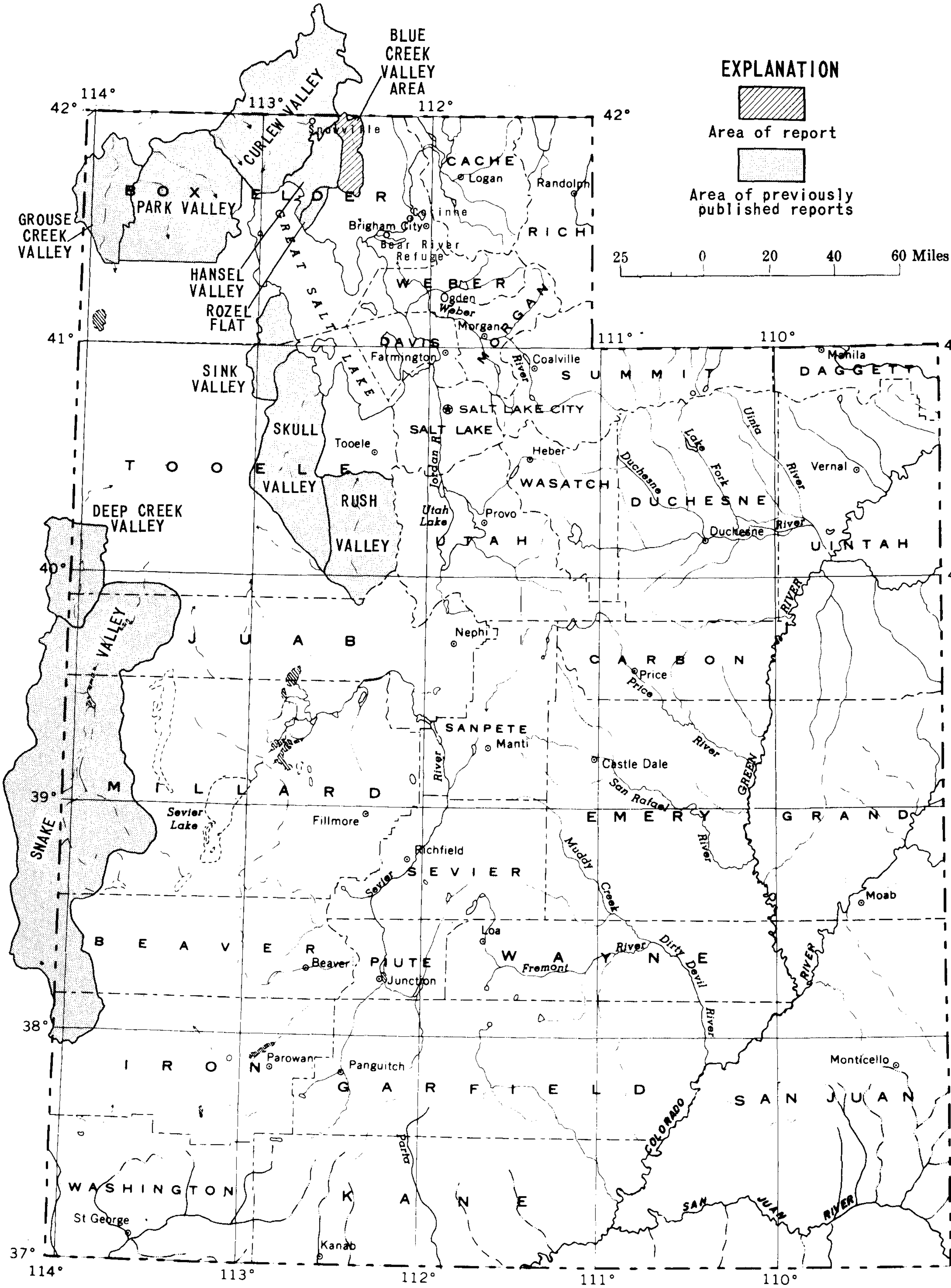

Figure 1.—Location of the Blue Creek Valley area and of other areas described in previously published reports in this reconnaissance series. (See list of technical publications at end of report.)

area includes all the drainage basin of Blue Creek north of T. 10 N. and the part of adjacent Pocatello Valley that is in Utah. The area is bounded on the west by the North Promontory Mountains and on the east by the Blue Spring Hills and the West Hills. Most of the area drains into Great Salt Lake.

The sparsely populated area covers about 250 square miles, about 220 of which lie within the Blue Creek Valley drainage basin. Most of the land is privately owned and is used chiefly for cultivation of dryland grain and for the grazing of livestock. Irrigation is limited to small areas near and below Blue Springs, where small grains, alfalfa, and pasture are the principal crops.

The only community center in the area is Howell, which had a population of about 200 in 1970. A chemical and rocket-motor plant of the Thiokol Chemical Corp. is located in the southern part of the area. Most of the plant employees commute from outside the area.

The total relief of the Blue Creek Valley area is about 3,000 feet. The lowest altitude is about 4,270 feet above mean sea level in the southern part of the area, and the highest is about 7,100 feet in the North Promontory Mountains.

The climate of the Blue Creek Valley area is semiarid; it is characterized by moderately cold winters and hot summers. The average annual air temperature and the average growing season in the valley are probably about the same as in Snowville, Utah. The average annual air temperature at Snowville is 45°F (7°C) (1899-1966), and the average growing season (number of days between last spring and first fall temperature of 28°F or -2°C) is 122 days (1950-66) (Bolke and Price, 1969, p. 9). Average annual precipitation ranges from about 15 inches on the valley floor to slightly more than 20 inches in the high mountain areas (pl. 1). Most of the precipitation occurs as snow during winter and spring and is the primary source of water supply in the area. Runoff from summer storms is usually local and of short duration. Potential evaporation from the area is about 42 inches per year (Kohler and others, 1959).

Acknowledgments and previous studies

The cooperation of landowners in the Blue Creek Valley area who permitted measurements at wells and springs and who provided general information about the area is gratefully acknowledged. The personnel of Thiokol Chemical Corp., Blue Creek Irrigation Co., and Utah Power and Light Co. were very helpful in providing records of water supply and power consumption in the area.

The Blue Creek Valley area was included in a reconnaissance of the ground-water resources of Tooele and Box Elder Counties, Utah (Carpenter, 1913). A watershed work plan for part of Blue Creek Valley was prepared by the Northern Utah Soil Conservation District, the town of Howell, and the Utah State Department of Fish and Game (U.S. Dept. Agriculture, Soil Conserv. Service, 1960). The general physical features, chemical quality, and discharge of Blue Springs have been briefly described by Milligan and others (1966) and by Mundorff (1970). Published sources of geologic data include a geologic map of Utah (Stokes, 1964), and a reconnaissance report of the Tertiary stratigraphy of western Utah (Heylmun, 1965).

GEOLOGY

The general geology of the Blue Creek Valley area is shown on plate 1. The age, general lithology, and general hydrologic properties of the principal units are summarized in table 1.

Blue Creek Valley is a structural trough formed by the deformation of rocks of Paleozoic and Tertiary age. The mountain ranges, which consist of rocks of Paleozoic age, were elevated in relation to rocks of the same age that underlie the valley fill by basin- and range-type faulting. Complex folding and faulting accompanied the major structural displacements. The Salt Lake Formation of Tertiary age, which overlies the Paleozoic rocks, was also involved in this structural deformation.

Rocks of Paleozoic and Tertiary age have considerable local relief beneath the valley fill, as indicated by outliers of those rocks (as in Andersons Hill) that protrude above the valley floor. The relief in the consolidated rock is attributed at least in part to faults concealed beneath the valley fill. Such faults are also inferred from (1) the presence of Blue Springs, a thermal spring area that discharges from highly fractured Paleozoic rocks (B. L. Bridges, Geologist, U. S. Soil Conserv. Service, oral commun., 1969) near the north end of Andersons Hill, (2) an apparent "subsurface dam" of upfaulted Paleozoic rocks near the lower end of the valley that impedes drainage from the valley, and (3) local anomalies in the chemical character of the ground water (p. 15). However, subsurface data are not adequate to accurately map any of these inferred faults.

Volcanic activity, which was widespread in adjacent parts of southern Idaho and northern Utah during the Tertiary Epoch, is evidenced in Blue Creek Valley by tuffaceous rocks of the Salt Lake Formation and by layered basaltic lava flows and associated deposits of tuff near the northwest margin of the valley. Lava is reported in logs of several wells drilled in that general area.

The valley fill, which forms the most permeable part of the valley ground-water reservoir, consists largely of detritus eroded from the mountains. Some of the fill was deposited in ancient Lake Bonneville and other pre-existing lakes and reworked by wave action. Shoreline features and deposits of Lake Bonneville are clearly visible at many places along the margins of the valley, especially near the highest level (about 5,200 feet) reached by that lake. Because of the high relief on the underlying rocks, the thickness of the valley fill varies considerably over short distances.

WATER RESOURCES

The quantitative estimates given in this section pertain only to the area within the Blue Creek Valley drainage basin above the narrows in sec. 17, T. 11 N., R. 5 W.

Volume of precipitation

The normal annual (1931-60) precipitation in the Blue Creek Valley drainage basin is shown by isohyets (lines of equal precipitation) on plate 1. The total volume of precipitation was estimated by determining the areas between isohyets, multiplying those areas by the mean value of precipitation between the isohyets and accumulating the total (table 2). The average annual volume of precipitation is about 184,000 acre-feet. Most of this precipitation is returned directly to the atmosphere by evapotranspiration at or near the point of fall; the remaining precipitation becomes runoff or ground-water recharge.

Table 1.—Principal lithologic units and their general hydrologic properties.

Age	Lithologic unit	General character of material	General hydrologic properties
Quaternary	Surficial alluvial deposits	Surficial deposits of predominantly clay and silt; some gravel on steeper slopes and in natural drainageways; scattered boulders near bedrock outcrops. Deposits are well drained and have a soil profile suitable for cultivation.	Are above the regional water table in most places and thus are not part of the valley ground-water reservoir; generally transmit water slowly; act as a recharge medium near the margins of the valley and in irrigated areas.
	Lake-bottom deposits	Mostly clay and silt and some very fine sand; probably contain some salt. Deposits exposed only locally, but apparently underlie alluvial surfaces in much of the lower part of the valley below the 4,800-foot level; exposed thickness in Sand Hollow exceeds 50 feet.	Poorly permeable and capable of yielding water only slowly to wells.
	Lakeshore deposits	Poorly to fairly well sorted deposits of sand and gravel in spits and bars and on terraces of ancient Lake Bonneville. The deposits commonly occur near the margins of the valley between the 4,800- and 5,200-foot levels and are generally less than 50 feet thick. Only the most extensive deposits are shown on plate 1.	Are above the regional water table and are not part of the ground-water reservoir; assumed to be moderately to highly permeable and to transmit water readily; act as an important recharge medium locally, especially in the northern half of the valley.
Tertiary and Quaternary	Valley-fill deposits	Not exposed at the surface, but have been penetrated by a number of wells within the valley. Drillers' logs of wells indicate that fill consists mostly of clay and gravel; clay mixed with sand, gravel, or boulders; and thin interbeds of sand and gravel. Total thickness varies considerably; maximum penetrated thickness exceeds 328 feet.	Contain the most permeable aquifers in the valley ground-water reservoir; most strata yield water slowly, but sand and gravel interbeds yield water readily; thick saturated sections are capable of yielding several hundred gallons per minute (gpm) of water to properly constructed wells. Well (B-13-5)29aaa-1, which taps these deposits, produced 290 gpm with 140 feet of drawdown on completion. Well (B-13-5)31daa-1, which yields about 350 gpm with a drawdown of 200 feet, is believed to tap these deposits.
Tertiary	Extrusive igneous rocks	Exposed only along part of the northwest margin of the project area, but may extend beneath valley-fill deposits in that general part of the valley. Consists of several layered basaltic lava flows with a maximum exposed thickness of more than 300 feet. Also include local deposits of volcanic tuff. Tops and bottoms of individual flow layers are moderately to highly vesicular. Columnar jointing is common in all flow layers.	Unit as a whole probably has low to moderate permeability, but interflow zones (vesicular and rubbly zones) appear to be highly permeable. The exposed section appears to be a highly effective recharge medium; the saturated section at depths probably transmits water readily, but may be too limited in extent to be a major aquifer.
	Salt Lake Formation	Exposed locally in the north-central part and along western margins of the valley and in a road cut (not mapped) on the divide east of Faust Valley; also present beneath unconsolidated valley fill. Exposures consist chiefly of tuffaceous sandstone, but formation also contains some conglomerate, limestone, and volcanic debris. Maximum exposed thickness exceeds 150 feet.	Formation as a whole has generally low permeability and yields water slowly to wells and springs; loosely cemented zones may transmit water readily. Well (B-13-6)1dbb-1, which yields 580 gpm with 192 feet of drawdown may tap this formation; but other wells that tap the formation generally yield less than 20 gpm.

Age	Lithologic unit	General character of material	General hydrologic properties
Mississippian to Permian	Sedimentary and metasedimentary rocks undivided	These rocks form Andersons Hill and the bulk of the mountains that bound Blue Creek Valley. The Oquirrh Formation (Pennsylvanian-Permian age), which consists chiefly of limestone and orthoquartzite with some sandstone, comprises more than 90 percent of the exposures. Manning Canyon Shale (mostly shale and sandstone of Mississippian and Pennsylvanian age) and Great Blue Limestone (mostly massive limestone of Mississippian age) are exposed only locally in Andersons Hill, along the lower slopes of Blue Spring Hills, and in the hills that protrude into the valley from the south. The oldest formation penetrated by oil test (B-11-5)18ddc-1 is reported to be the Laketown Dolomite of Silurian age. All the Paleozoic rocks have undergone considerable deformation and possible local metamorphism. Exposures display intense fracturing, and large solution cavities are evident in several places.	Water-bearing properties are highly variable. The unit as a whole has low permeability, but interconnected fracture zones and solution cavities are capable of transmitting water readily; the possibility of drilling a successful well at any given site is highly unpredictable. The rocks yield less than 10 gpm to most springs in the area; yields to wells range from about 10 to 450 gpm. These rocks probably are the source rocks for most of the flow of Blue Springs and several springs near the south end of Blue Spring Hills.

Table 2.—Estimated average annual volume of precipitation and ground-water recharge from precipitation in the Blue Creek Valley drainage basin

Average annual precipitation: Precipitation zone (inches)	Average annual precipitation: Weighted mean (feet)	Area over which precipitation occurs (acres)	Volume of precipitation (acre-feet)	Precentage of precipitation as recharge	Recharge (acre-feet)
Area where Quaternary and Tertiary sedimentary rocks are exposed					
12-16	1.25	95,770	119,710	5	5,990
16-20	1.50	5,710	8,560	10	860
Subtotals (rounded)		101,500	128,300		6,800
Area where Tertiary igneous rocks and Paleozoic rocks are exposed					
12-16	1.25	21,270	26,590	10	2,660
16-20	1.50	18,950	28,420	15	4,260
More than 20	1.90	440	840	20	170
Subtotals (rounded)		40,700	55,800		7,100
Totals (rounded)		142,000	184,000		14,000

Surface water

Blue Creek below Blue Springs is the only perennial stream in the drainage basin, and hence it is the only reliable surface-water supply in the basin. Some intermittent and ephemeral runoff is impounded in numerous small catchment basins throughout the drainage basin and in a sediment-control reservoir about one-eighth of a mile upstream from the head of Blue Springs.

Records from a partial-record gaging station on Blue Creek above Blue Springs at site (B-13-5)17cdc show that annual maximum flood peaks in the basin ranged from 9 to 1,820 cfs (cubic feet per second) during the 12 years of record. The annual flood-peak records are listed in the following table:

Annual peak discharge (cfs)	Date
282	Sept. 23, 1959
120	Apr. 28, 1960
36	Sept. 18, 1961
1,820	Feb. 12, 1962
9	Feb. 1, 1963
61	June 17, 1964
43	June 26, 1965
325	Mar. 14, 1966
55	June 13, 1967
56	July 10, 1968
490	Apr. 1, 1969
128	Sept. 5, 1970

The magnitude and frequency of annual peak discharges at the site are show in figure 2, a plot of a log-Pearson Type III (Beard, 1962) analysis of annual peak discharge and recurrence interval. The figure shows that at this site a peak discharge of 100 cfs will be equaled or exceeded on the average of once every 2 years; that is, a peak discharge of 100 cfs or more would have a 50 percent chance of occurrence during any year.

Blue Creek Dam was constructed in 1904, enlarged in 1920, and enlarged again in 1950; the capacity of the reservoir is about 2,000 acre-feet (U.S. Dept. Agriculture, Soil Conserv. Service, 1960, p. 3-4). Water from Blue Springs is stored in the reservoir during the winter months and used for irrigation during the growing season. As the average discharge from Blue Springs is about 10 cfs or about 7,200 acre-feet per year, 3 to 4 months are required to fill the reservoir with the water from the spring area. The water in the reservoir is distributed by canals owned by the Blue Creek Irrigation Co.

Blue Creek flows intermittently below Blue Creek Reservoir. Most of the flow occurs during the nonirrigation season or when the reservoir is filled to capacity. The average annual surface discharge from the valley, which is entirely through Blue Creek, is estimated to be between 1 and 5 cfs and is believed to average about 3 cfs or about 2,200 acre-feet. This estimate is based on miscellaneous streamflow measurements on Blue Creek at site (B-10-5)5bab. These measurements are listed in the following table. The measurements show that during the months from June to August little or no flow occurs in the channel at this location.

M, Measured by U.S. Geological Survey; F, flowing, but unmeasured (observed by Thiokol Chemical Corp.); E, estimated by U.S. Geological Survey.

Discharge (cfs)	Date
5.0M	Sept. 30, 1959
3.1M	Apr. 19, 1960
4.2M	Oct. 16, 1963
10E	Mar. 19, 1964
11.0M	Apr. 10, 1964
9.0M	Apr. 24, 1964
17.8M	May 7, 1964
2.5M	June 11, 1964
.1E	Sept. 15, 1964
F	Jan. 17, 1969-May 19, 1969
Dry	June 17, 1969
Dry	July 29, 1969
Dry	Aug. 15, 1969
Dry	Sept. 25, 1969
F	Oct. 21, 1969-Dec. 19, 1969
6.8M	Feb. 19, 1970
1.1M	Mar. 18, 1970
1.7M	Apr. 14, 1970
2.4M	May 14, 1970
.5E	July 15, 1970
.3E	Sept. 1, 1970
Dry	Sept. 21, 1970

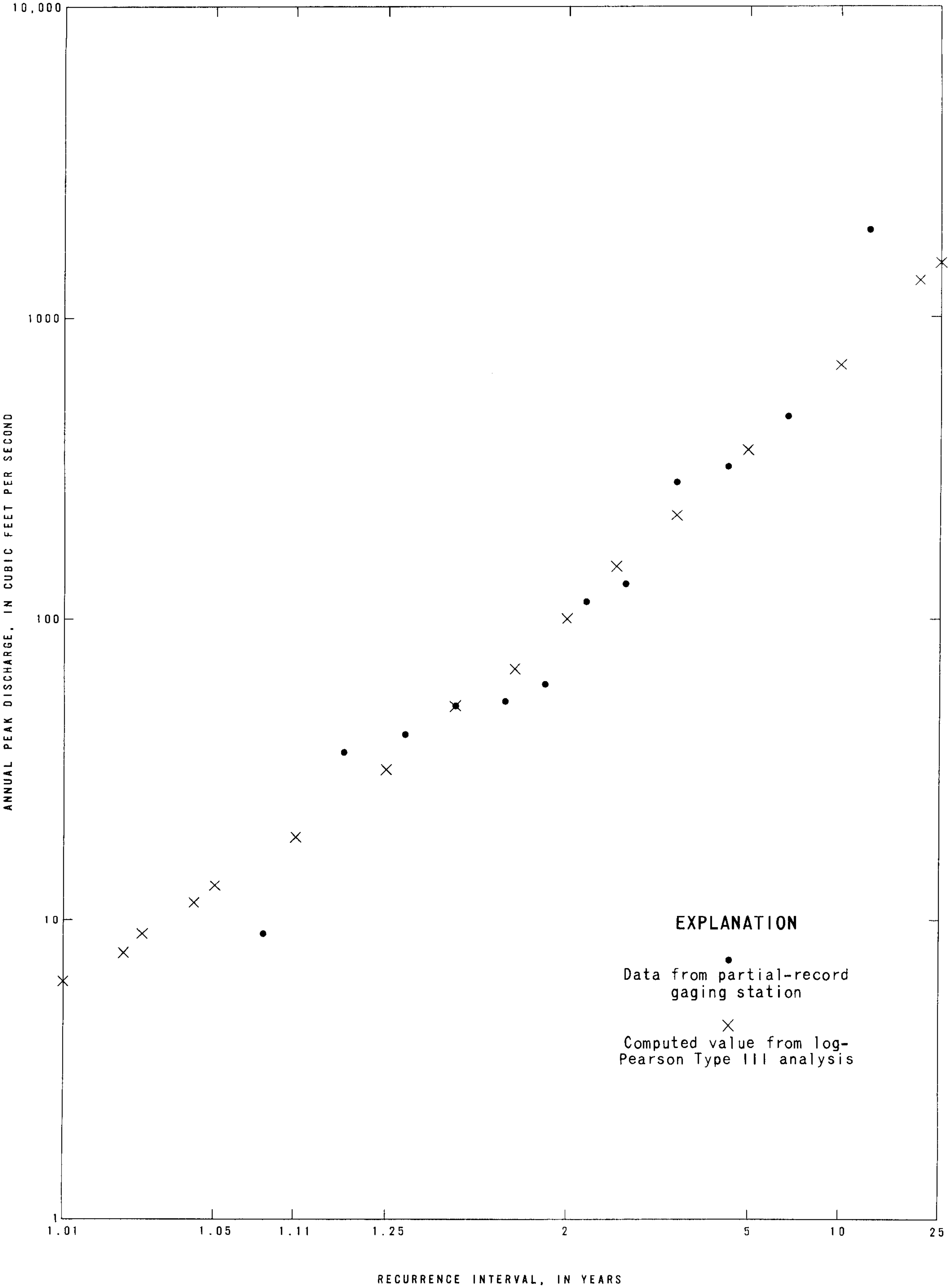

Figure 2.—Magnitude and frequency of annual peak discharges for Blue Creek.

Ground water

Recharge

The principal source of recharge to the ground-water reservoir in Blue Creek Valley is precipitation that falls on the drainage basin. The volume of recharge was estimated by a method described by Hood and Waddell (1968, p. 22). The estimated recharge is about 14,000 acre-feet annually (table 2) or about 8 percent of the estimated average annual volume of precipitation.

Thiokol Chemical Corp. imports about 150 acre-feet of water per year. About 90 percent of that water is either consumed or percolates into the ground-water reservoir; the remainder is discharged to Blue Creek as treated sewage effluent.

Shallow aquifers in the irrigated segment of the valley below Blue Springs receive some recharge from leaky canals and ditches and from flooded fields; this recharge is regarded as "recycled" ground water and does not add to the total recharge figure. Some additional ground water may enter the Blue Creek Valley area from outside the drainage basin along fault zones and solution cavities. However, data collected for this study were not adequate to confirm this means of recharge or to estimate its magnitude.

Occurence and movement

Ground water in the Blue Creek Valley area occurs under both confined (artesian) and unconfined (water table) conditions. In most of the ground-water reservoir beneath the valley, artesian conditions apparently exist in permeable water-bearing strata that underlie thick beds of clay or other material of poor permeability. Water-table conditions exist in shallow aquifers beneath the valley flat south of Blue Springs. Perched water-table conditions exist locally, especially near the margins of the valley where permeable lakeshore deposits overlie rocks of relatively low permeability. However, the perched aquifers probably are of limited extent and may not be a reliable perennial source of water.

Artesian conditions also exist in the consolidated rocks. These conditions are indicated by Blue Springs and Engineer Spring, which apparently rise along faults in the Paleozoic rocks; and also by the water level in well (B-11-5)5acd-1 (table 3), which taps Paleozoic rocks. Water-table conditions exist in some deep bedrock aquifers such as those tapped by wells (B-11-5)28bba-1 and (B-12-5)27bac-1.

The general direction of ground-water movement in the ground-water reservoir beneath the valley is shown by water-level contours and arrows on plate 1. Ground water moves generally from principal areas of natural recharge on the sides and upper reaches of the valley toward the axis of the valley; movement is then downvalley through the narrow gap near the south boundary of the project area to Great Salt Lake. The overall gradient along the main axis of the valley is slightly more than 500 feet in 25 miles or about 20 feet per mile. The flattening of the gradient near the center of the valley may be due in part to discharge of ground water by evapotranspiration and in part to a subsurface constriction in T. 11 N., R. 5 W., which impedes ground-water movement.

Movement of ground water in the consolidated rocks is controlled largely by geologic structures, such as fault and fracture zones, bedding planes, and solution cavities. Movement is from areas of natural recharge toward the valley fill or toward springs and seeps near the edge of the valley.

Deep circulation of water in major fault and fracture zones may result in increased temperature and mineral content of the water. Gulf Oil Corp. reported encountering salt water under extremely high pressure and temperature—about 240°F (116°C)—when they drilled a test well, (B-11-5)18ddc-1, to a depth of 8,950 feet. Such deep circulation may explain the relatively high temperature and large dissolved-solids content of water from Blue Springs and from wells such as (B-13-5)6aaa-2, (B-13-5)31daa-1, and (B-13-5)16ccc-1 (table 6).

Discharge

Ground water in Blue Creek Valley is discharged naturally by springs and seeps, by evapotranspiration, and by subsurface outflow. Ground water is also discharged by pumping from wells in the area. The total discharge from the ground-water reservoir (including water in the consolidated rocks) is estimated to be about 14,000 acre-feet per year.

Springs and seeps

Blue Springs is the largest source of ground-water discharge and the major source of water supply for irrigation in the valley. The annual discharge is about 7,200 acre-feet. The following table lists some miscellaneous measurements of the flow from Blue Springs:

Discharge (cfs)	Date
[1]7.6	Sept. 10, 1964
[2]8.4	Feb. 20, 1968
[3]11.6	Mar. 1, 1969
[3]9.3	Dec. 1, 1969
[2]10.6	July 8, 1970
[2]10.1	Sept. 21, 1970

[1]Measurement by Utah Water Research Lab., Utah State University.

[2]Current-meter measurement by U.S. Geological Survey.

[3]Weir measurement by Blue Creek Irrigation Co.

Thiokol Chemical Corp. utilizes water from a group of springs in secs. 21-23, T. 11 N., R. 5 W., known collectively as Railroad Springs, for drinking and culinary purposes. The combined flow of Railroad Springs averages about 22 gpm (gallons per minute) or about 35 acre-feet per year. All other springs and seeps in the study area combined probably discharge less than 35 acre-feet per year. The total discharge by springs and seeps within the drainage basin, therefore, is about 7,300 acre-feet per year.

Evapotranspiration

Phreatophytes, chiefly greasewood (*Sarcobatus vermiculatus*), rabbitbrush (*Chrysothamnum greenei (?)*), sedges (*Carex* sp.), other marsh grasses, and alfalfa (*Medicago sativa*) discharge ground water by evapotranspiration. Ground water probably was transpired by native vegetation in most of the area presently cultivated; when the land was cleared of native vegetation, evapotranspiration probably was reduced. Excluding the irrigated alfalfa fields, about 200 acres of land below Blue Creek Reservoir contain various amounts of phreatophytes (plant density about 50 percent). In this area the water table is less than 20 feet below land surface. Adjusting the plant density to 100 percent yields about 100 acres covered by phreatophytes. The rate of evapotranspiration is about 2 acre-feet per acre per year (Mower and Nace, 1957, p. 17-21), hence the total evapotranspiration by native phreatophytes is about 200 acre-feet per year.

There are at least 1,000 acres of well-established alfalfa under irrigation in the valley. This alfalfa probably consumes some ground water to supplement the water applied by irrigation. Assuming a ground-water consumption of 0.5 acre-foot per acre per year (J.W. Hood, U.S. Geol. Survey, oral commun., 1971), the evapotranspiration by alfalfa is about 500 acre-feet per year. Thus the total discharge of ground water by evapotranspiration is about 700 acre-feet per year.

Pumpage

Only two large-diameter (more than 6 inches) irrigation wells exist in Blue Creek Valley. In 1969, 256 acre-feet of water was discharged from well (B-13-6)1dbb-1 (estimated from power-consumption records), and about 50 acre-feet was discharged from well (B-13-5)31daa-1. About 30 small-diameter (6 inches or less) domestic and stock wells (pumped at the rate of 1-10 gpm) discharge about 200 acre-feet annually. The total pumpage is about 500 acre-feet annually.

Ground-water outflow

A direct determination of ground-water outflow was not made. The detailed study of the water-bearing properties of the aquifers needed for such a determination is beyond the scope of this investigation. Therefore, the ground-water outflow was estimated as the difference between the total annual recharge (14,000 acre-feet) and the annual discharge by springs, seeps, wells, and evapotranspiration (8,500 acre-feet). The difference is 5,500 acre-feet, which is assumed to be the ground-water outflow from Blue Creek Valley. Ground-water inflow to Blue Creek, unknown but probably small, is included in that amount.

Water-level fluctuations

Changes in ground-water storage resulting from changes in ground-water recharge and discharge are reflected by changes of water levels in wells. Under natural conditions, ground-water recharge and discharge are equal over the long term, and ground-water levels fluctuate in response to changes in precipitation. (See fig. 3.)

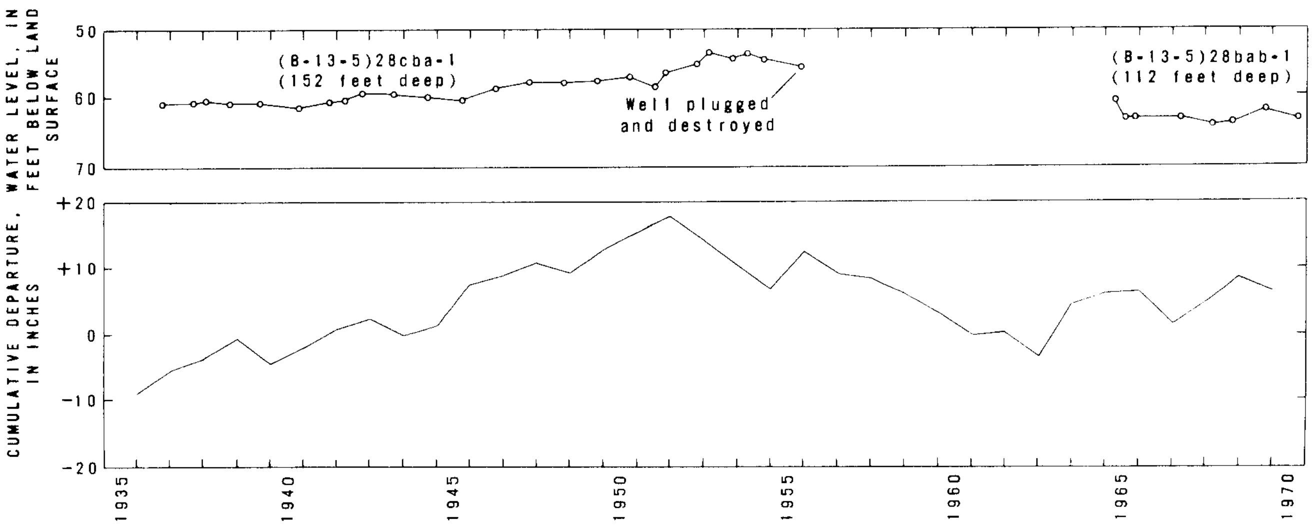

Figure 3.—Depth to water in selected wells in the Blue Creek Valley area and cumulative departure from normal annual (1931-60) precipitation at Malad, Idaho.

Historic water-level data for this study are insufficient for a detailed assessment of man's effect on ground-water levels and the natural recharge-discharge relations in Blue Creek Valley. In the irrigated area below Blue Creek Reservoir, water levels in the shallow aquifers probably fluctuate in response to recharge from irrigation as well as to changes in precipitation. Pumping of the two large-yield wells in the valley has local effects on water levels, but total pumpage probably has very little effect on the natural recharge-discharge relation. It should be noted, however, that any large-scale withdrawal of ground-water by wells in the valley could result in a general decline of water levels, interference between discharging wells, and possible local overdraft from the ground-water reservoir.

Storage

For this report, storage was estimated as the quantity of water, regardless of chemical quality, recoverable from the upper 100 feet of the saturated valley-fill deposits. It is the product of the volume and the specific yield (quantity of water yielded per unit of water-level decline) of the saturated section. In Blue Creek Valley, the volume of the upper 100 feet of saturated valley fill is about 8 million acre-feet. Because of the abundance of fine-grained sediments in this section, the specific yield is low and is estimated to range from less than 1 to about 5 percent. Assuming the average specific yield to be about 2.5 percent, the total recoverable storage in the upper 100 feet of saturated valley-fill deposits is about 200,000 acre-feet. Some of this water is saline (contains more than 1,000 milligrams per liter of dissolved solids) as shown in table 6.

A considerable amount of water is stored in the valley fill and in the consolidated rocks that surround and underlie the valley, but no estimate was made of the total amount. Much of this water is probably saline.

Budget

The estimated annual volumes of ground-water recharge and discharge in the Blue Creek Valley drainage basin are given in the following table:

	Acre-feet
Recharge:	
Precipitation (p. 4)	14,000
Total	14,000
Discharge:	
Springs and seeps (p. 11)	7,300
Withdrawal by wells (p. 12)	500
Evapotranspiration (p. 12)	700
Ground-water outflow (p. 12)	5,500
Total	14,000

Of the 8,500 acre-feet of water discharged by wells, springs, and evapotranspiration, about 8,000 acre-feet is used beneficially and about 500 acre-feet is regarded as salvageable.

Perennial yield

The perennial yield of a ground-water system is the maximum amount of water that can be withdrawn from the system each year indefinitely without causing a permanent and continuing depletion of ground water in storage or a deterioration of chemical quality of the ground water. The perennial yield is limited to the amount of natural discharge of water of suitable chemical quality that can economically be salvaged for beneficial use.

Assuming (1) that subsurface outflow is of suitable chemical quality and could be economically intercepted by wells and (2) that the evapotranspiration loss by nonbeneficial phreatophytes could be salvaged, then the perennial yield of the basin would approximate the discharge from the ground-water reservoir or about 14,000 acre-feet.

Chemical quality of water

Chemical analyses of selected water samples from the Blue Creek Valley area are given in table 6. Plate 1 shows diagrams of chemical quality of water. For some analyses, sulfate ion was not determined, and the sulfate values for the diagrams have been estimated by taking the difference (in milliequivalents per liter) of total cations and anions and assuming the difference to be sulfate ion. These estimated values do not appear in table 6.

The sodium calcium bicarbonate ground water in the upland areas of the valley appears to be related to the sedimentary rocks of Paleozoic age, whereas the calcium magnesium chloride ground water in the lowlands appears to be related to the igneous and sedimentary rocks of Tertiary age. Ground water in the lowlands, in addition to being of a different chemical type, contains more dissolved solids, which is probably due to slow circulation through the Tertiary rocks. The sodium chloride water in the lowest part of the valley is probably the result of leaching of the fine-grained sediments comprising the Quaternary lake-bottom deposits.

Concentrations of dissolved solids in water in the Blue Creek Valley area range from about 400 to nearly 800 mg/l (milligrams per liter). The areal distribution of dissolved-solids concentration is shown on plate 1. Water from small mountain springs contains the least amount of dissolved solids (generally less than 600 mg/l), but water from Blue Springs contains about 2,000 mg/l of dissolved solids. Water from shallow wells below Blue Creek Reservoir has large concentrations of dissolved solids (see wells (B-12-5)7ddc-1 and (B-12-5)20bbb-2, table 6). The large concentration of dissolved solids in the water in this area is partly due to leaching by applied irrigation water and partly to concentration by evapotranspiration. The water from well (B-13-5)16ccc-1, north of Blue Creek Reservoir, contains 4,860 mg/l of dissolved solids. The source of this large concentration is not known but it may be related to water moving along a concealed fault.

Wells (B-12-5)20bbb-2 and (B-12-5)7ddc-1 are shallow wells below Blue Springs and are located near the stream channel of Blue Creek. The water is similar to that from the springs, but it contains more dissolved solids than the spring water. The greater concentration of dissolved-solids in this water is due to a combination of return flow from irrigation and concentration by evapotranspiration.

Blue Creek at site (B-10-5)5bab contains the largest known concentration of dissolved solids (as much as 7,700 mg/l) of any water in the area. The quality of water at this site is affected by irrigation return flow, flood runoff, surplus flow from Blue Creek Reservoir, and effluent from the sewage treatment plant at Thiokol Chemical Corp.

The difference in type between water from Blue Springs and that from most surrounding wells, together with the difference in temperature and the proximity of Blue Springs to outcrops of Paleozoic rocks (pl. 1), suggest different sources of water for Blue Springs and for the surrounding wells. Well (B-15-6)34ccc-1 contains water similar to that of Blue Springs. This well taps consolidated rocks believed to be of Paleozoic age (see driller's log, table 5).

Chemical quality in relation to use

Water used for domestic and public supply should be clear, colorless, and free of objectionable tastes and odors. The U. S. Public Health Service (1962) has established quality standards for drinking water. The recommended maximum limits for some of the chemical constituents are listed below:

Constituent	Concentration (mg/l)
Nitrate (NO_3)	45
Chloride (Cl)	250
Sulfate (SO_4)	250
Dissolved solids	500

Most of the water in Blue Creek Valley exceeds these standards in one or more of the categories listed; exceptions are wells (B-13-6)1dbb-1, (B-14-6)3aaa-2, and (B-15-6)35bdb-1 and some mountain springs.

Little information is available concerning the rating of water for stock supplies. The State of Montana (McKee and Wolf, 1963, p. 113) rates water containing less than 2,500 mg/l of dissolved solids as good, 2,500-3,500 mg/l as fair, 3,500-4,000 mg/l as poor, and more than 4,500 mg/l as unfit for stock. Using these criteria, most of the ground-water sampled in Blue Creek Valley is rated as good for stock use.

The principal chemical quality characteristics that affect the usefulness of water for irrigation are: (1) total concentration of soluble salts, (2) relative proportion of sodium to other cations, (3) concentration of boron or other constituents that may be toxic to some plants, and (4) bicarbonate concentration in excess of the concentration of calcium plus magnesium. The U. S. Salinity Laboratory Staff (1954, p. 79-81) has devised a method for classifying water for irrigation use by plotting data on specific conductance (conductivity) versus sodium-absorption ratio (SAR) on a diagram (fig. 4). This method of classification is based on "average conditions" with respect to soil texture, infiltration rate, drainage, quantity of water used, climate, and salt tolerance of crops. Most of the water sampled in Blue Creek Valley has a low- sodium hazard and a high- to very high-salinity hazard (compare table 6 and fig. 4). Well (B-13-6)1dbb-1 (point 7 in fig. 4) is a large-diameter irrigation well; Blue Springs (point 5 in fig. 4) is the largest source of irrigation water in the valley. Crops are raised using water from Blue Springs, which has both a high SAR and a high mineral content.

SUMMARY OF WATER USE

Past and present development

Development of water in the Blue Creek Valley area began prior to 1900 when the first wells were constructed for domestic and stock supplies. The first recorded well in the area was constructed in 1898. However, most of the domestic and stock wells were constructed during the years 1910-20 and 1930-40. Many of those wells are now used only seasonally by the dryland grain farmers.

The water system for the town of Howell began operating in 1947 with the development and diversion of Hillside Spring (table 4). The system was enlarged about 1965 when well (B-12-6)24add-1 was drilled and put into operation. In 1970 the system served about 150 people.

The Thiokol Chemical Corp. plant was constructed about 1957. About that time, Railroad Springs (table 4), which were formerly used for watering of livestock and for wildlife, were developed and diverted to the plant, chiefly for culinary use.

Irrigation in Blue Creek Valley began in 1904 using water from Blue Springs. In 1960 about 2,800 acres of land in the area was irrigated (U. S. Dept. Agriculture, Soil Conserv. Service, 1960, p. 4). Until 1962, Blue Springs was the only major source of irrigation water. An irrigation well was drilled in 1962 and another in 1968; about 300 acres of land is irrigated with water from these two wells.

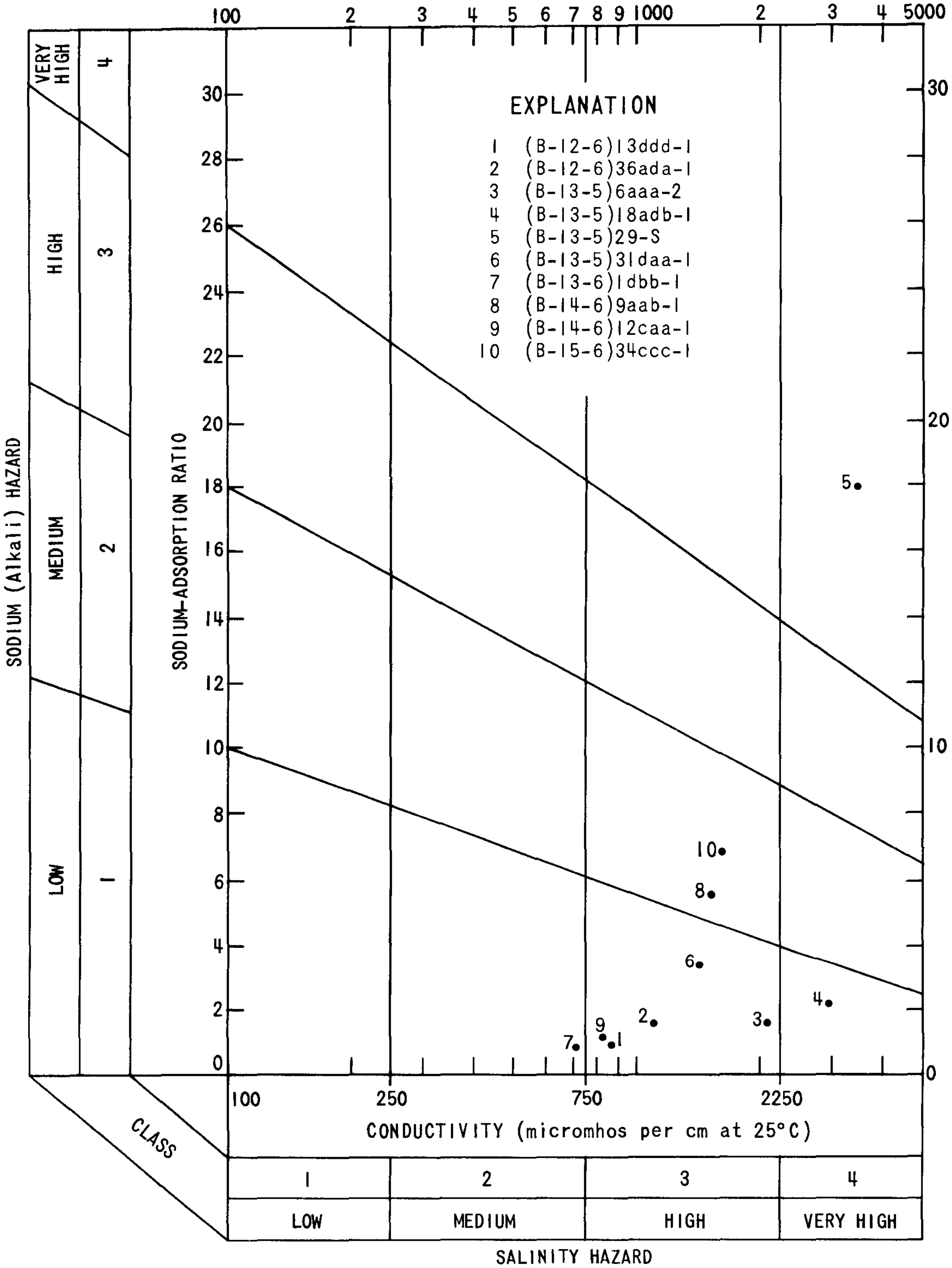

Figure 4.—Classification of water for irrigation.

Future Development

Because most of the land in Blue Creek Valley is cultivated, future development depends chiefly on additional water supplies to provide for increased irrigation. Blue Springs is fully appropriated for irrigation, and surface runoff in the valley is too meager or of too poor quality for irrigation; therefore, any additional irrigation supplies must be obtained from wells. Theoretically, the annual volume of ground water available for additional development is about 6,000 acre-feet—that is, the assumed perennial yield (about 14,000 acre-feet) less the quantity currently used beneficially (about 8,000 acre-feet). However, full development of the 6,000 acre-feet is not feasible because (1) some of the water is chemically unsuitable for irrigation, (2) the valley ground-water reservoir generally has low permeability and in most places yields water too slowly for large-scale irrigation, and (3) pumping may be too costly for irrigation in the upper part of the valley because water levels are several hundred feet below land surface. Therefore, the volume of ground water economically available probably is considerably less than 6,000 acre-feet a year.

PROPOSALS FOR FUTURE STUDIES

As the need for development of ground water in Blue Creek Valley arises, problems resulting from that development will also arise. Problems resulting from increased pumping might be declining water levels, well interference, decrease in flow of Blue Springs, and deterioration of the chemical quality of water. A detailed study of the basin and adjacent areas would help to better understand these problems and bring about a possible solution. Such a study should include:

1. Establishment of streamflow stations, particularly below Blue Springs and on Blue Creek near site (B-10-5)5bab.

2. Test drilling and gravity surveys to determine the subsurface geology and to delineate major aquifers.

3. Inventory of all wells and water sources, expansion of the observation-well network, and monitoring chemical quality of water at selected sites.

4. Aquifer performance tests to determine the water-bearing properties of the aquifers.

5. Collection of climatic records and detailed geologic mapping to more accurately estimate runoff and ground-water recharge.

6. Detailed mapping of phreatophytes.

REFERENCES CITED

Beard, L. R., 1962, Statistical methods in hydrology: U. S. Army Engineer Dist., Corps of Engineers, Sacramento, Calif., 74 p.

Bolke, E. L., and Price, Don, 1969, Hydrologic reconnaissance of Curlew Valley, Utah and Idaho: Utah Dept. Nat. Resources Tech. Pub. 25.

Carpenter, Everett, 1913, Ground water in Box Elder and Tooele Counties, Utah: U. S. Geol. Survey Water-Supply Paper 333.

Heylmun, E. B., 1965, Reconnaissance of the Tertiary sedimentary rocks in western Utah: Utah Geol. and Mineralog. Survey Bull. 75.

Hood, J. W., and Waddell, K. M., 1968, Hydrologic reconnaissance of Skull Valley, Tooele County, Utah: Utah Dept. Nat. Resources Tech. Pub. 18.

Kohler, M. A., Nordenson, T. J., and Baker, D. R., 1959, Evaporation maps of the United States: U. S. Weather Bur. Tech. Paper 37.

McKee, J. E., and Wolf, H. M., 1963, Water quality criteria, 2nd ed.: The Resources Agency of Calif., State Water Quality Control Board Pub. 3-A, 548 p.

Milligan, J. H., Marsell, R. E., and Bagley, J. M., 1966, Mineralized springs in Utah and their effect on manageable water supplies: Utah Water and Power Board Rept. WG23-6, p. 15.

Mower, R. W., and Nace, R. L., 1957, Water consumption by water-loving plants in the Malad Valley, Oneida County, Idaho: U. S. Geol. Survey Water-Supply Paper 1412.

Mundorff, J. C., 1970, Major thermal springs of Utah: Utah Geol. and Mineralog. Survey Water-Resources Bull. 13.

Stokes, W. L., ed., 1964, Geologic map of Utah: Utah Univ.

U.S. Department of Agriculture, Soil Conservation Service, 1960, Watershed Work Plan, Blue Creek-Howell Watershed Project, Box Elder County, Utah: Portland, Oregon, duplicated release, 73 p.

U. S. Public Health Service, 1962, Drinking water standards: Public Health Service Pub. 956.

U. S. Salinity Laboratory Staff, 1954, Diagnosis and improvement of saline and alkali soils: U. S. Dept. Agriculture Handb. 60.

U. S. Weather Bureau, 1963, Normal annual and May-September precipitation (1931-60) for the State of Utah: Map of Utah, scale 1:500,000.

APPENDIX

Well- and spring-numbering system

The system of numbering wells and springs in Utah is based on the cadastral land-survey system of the U.S. Government. The number, in addition to designating the well or spring, describes its position in the land net. By the land-survey system, the State is divided into four quadrants by the Salt Lake base line and meridian, and these quadrants are designated by the uppercase letters A, B, C, and D, indicating the northeast, northwest, southwest, and southeast quadrants, respectively. Numbers designating the township and range (in that order) follow the quadrant letter, and all three are enclosed in parentheses. The number after the parentheses indicates the section, and is followed by three letters indicating the quarter section, the quarter-quarter section, and the quarter-quarter-quarter section (generally 10 acres[1]); the letters a, b, c, and d indicate, respectively, the northeast, northwest, southwest, and southeast quarters of each subdivision. The number after the letters is the serial number of the well or spring within the 10-acre tract; the letter "S" preceding the serial number denotes a spring. 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. Thus (B-13-6)1dbb-1 designates the first well constructed or visited in the NW¼NW¼SE¼ sec. 1, T. 13 S., R. 6 W., and (B-13-6)1a-S designates a spring known only to be in the northeast quarter of the same section. Other sites where hydrologic data were collected are numbered in the same manner, but three letters are used after the section number and no serial number is used. The numbering system is illustrated in figure 5.

Use of metric units

The results of chemical analyses and temperature measurements are given in this report in metric units, rather than the more familiar English units. Temperatures are given in degrees Celsius, and concentrations are reported in milligrams per liter or milliequivalents per liter.

Degrees Celsius (°C) are the units used for reporting temperature in the metric system. One degree Celsius is equal to 9/5 degrees Fahrenheit, and the freezing point of water is 0° on the Celsius scale. The temperature-conversion table on the following page may be used to convert the temperature data given in this report to the more familiar Fahrenheit scale.

Milligrams per liter (mg/l) is the base unit for expressing the concentration of chemical constituents in solution, and it represents the weight of solute per unit volume of water. For concentrations of less than about 7,000 mg/l, this unit is numerically very nearly equal to the unit parts per million (ppm), which was formerly used by the U.S. Geological Survey.

Milliequivalents per liter (meq/l) is the base unit for expressing the concentration of chemical constituents in terms of the interacting values of the electrically charged particles, or ions, in solution. One meq/l of a positively charged ion can react with 1 meq/l of a negatively charged ion. Meq/l is numerically equal to the unit equivalents per million, which was formerly used by the U.S. Geological Survey. For comparison of water types and for graphical presentation, meq/l is a more convenient unit than mg/l.

[1] Although the basic land unit, the section, is theoretically a 1-mile square, many sections are irregular. Such sections are subdivided into 10-acre tracts, generally beginning at the southeast corner, and the surplus or shortage is taken up in the tracts along the north and west sides of the section.

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.

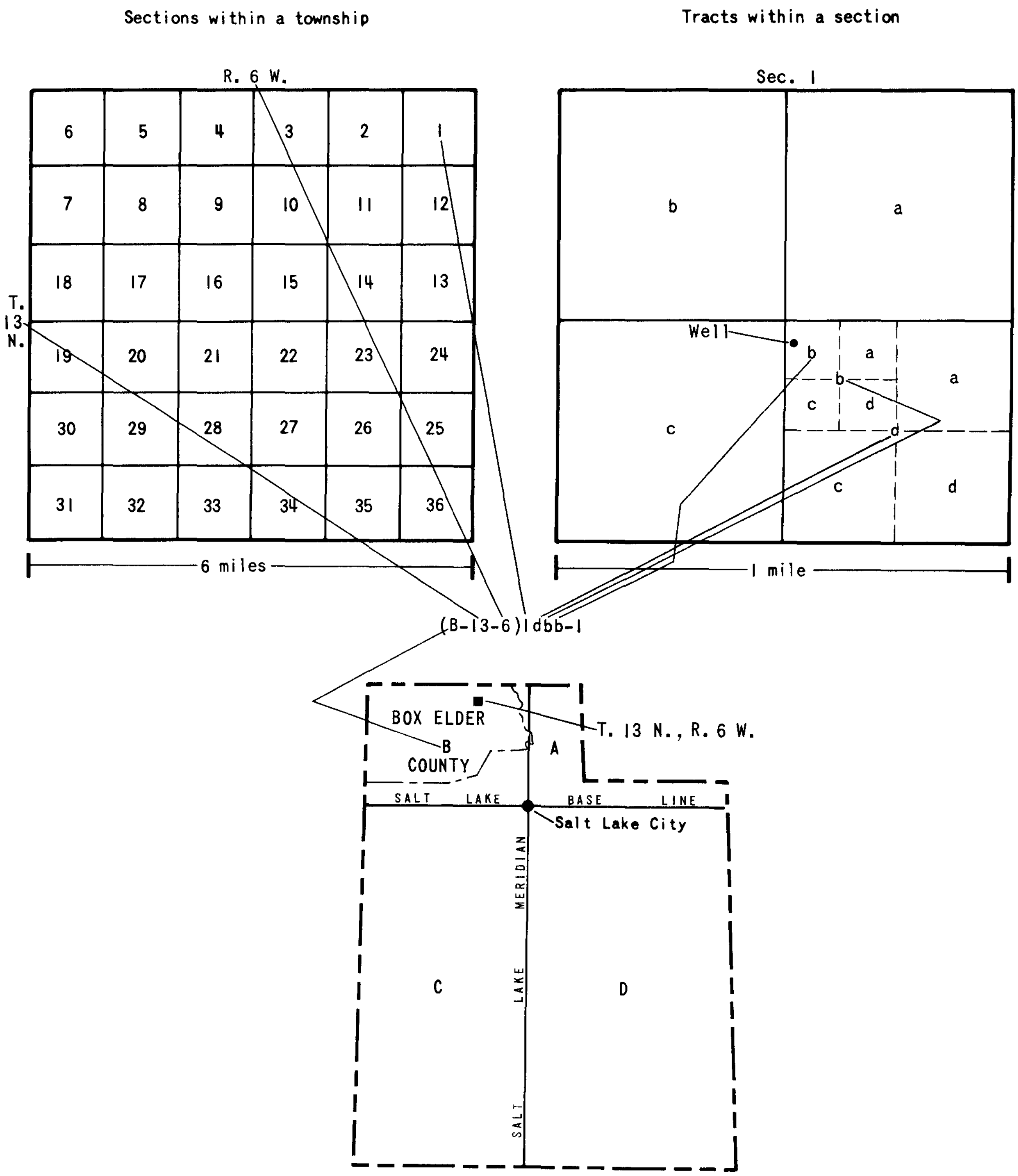

Figure 5.—Well- and spring-numbering system used in Utah.

BASIC DATA

Table 3.—Records of selected wells.

Well number: See appendix for well-numbering system.

Priority date: Year indicated from Utah State Engineer's records; C, indicates year when well was constructed.

Casing depth: Depth to bottom of casing or to first perforation in casing.

Casing finish: O, open end; P, perforate; W, shored; X, no casing.

Altitude of LSD: LSD, land-surface datum; altitudes interpolated from U.S. Geological Survey 7.5-minute topographic maps (20-foot contour interval).

Water level: Static level, in feet below land-surface datum; A, measured; D, driller's record; G, reported.

Water use: H, domestic; I, irrigation; P, public supply; S, stock; U, unused.

Log: D, driller's log, available in the files of the Utah Department of Natural Resources, Division of Water Rights or in the files of the U.S. Geological Survey; selected logs are given in table 5.

Other data available: P, chemical analysis or K, specific conductance given in table 6.

Well number	Owner	Priority date	Well depth (ft)	Casing Diameter (in.)	Casing Depth (ft)	Casing Finish	Altitude of LSD (ft)	Water level (ft)	Date of water-level measurement	Use of water	Log	Other data available
1/(B-11-5)5acd-1	Thiokol Chemical Corp.	1962C	610	10	400	P	4,445	153A	8-70	U	D	-
18ddc-1	Gulf Oil Co.	1963C	8,950	13	2,389	-	4,820	-	-	-	D	-
22ddc-1	Thiokol Chemical Corp.	-	370	20	-	-	5,100	177A	8-70	U	D	-
28bba-1	do	1956C	365	8	210	P	4,540	210D	9-56	U	D	-
2/29abb-1	do	1956C	216	8	150	P	4,410	142A	8-70	U	D	-
29cbd-1	Ray and Rex Adams	1955C	310	8	310	O	4,340	70D	12-55	-	D	-
31ddd-1	Ray Adams	1900	-	6	-	-	4,280	17A	9-70	S	-	-
(B-11-6)2bdc-1	S. J. Postma	1912	270	6	-	-	4,885	235A	7-70	H	-	P
8bcd-1	E. L. Rees	1912C	-	-	-	-	5,240	124A	8-70	H	-	-
10add-1	C. E. Petersen	1912	275	2	-	-	4,940	-	-	H	-	-
10dcd-1	do	1935	275	6	256	P	4,890	-	-	H	D	-
14bbb-1	R. T. Nish	1916	210	4	210	O	4,865	140G	3-36	H	-	P
16bcc-1	W. I. Sandall	1937C	292	5	145	O	5,040	140D	11-37	S	D	-
17cbb-1	D. B. Green	1934	300	6	-	-	5,215	105A	8-70	U	-	-
18daa-1	do	1930	180	6	-	-	5,310	-	-	H	-	-
(B-12-5)5cdb-1	L. S. Myers	1963C	-	12	-	-	4,555	2A	7-70	I	-	K
5d	Town of Howell	1913	92	-	-	-	4,580	-	-	-	-	P
5dcd-1	Latter-day Saints Church	1954	32	6	-	-	4,570	30A	7-70	U	-	-
7ccc-1	J. E. Nessen	1910	140	6	-	-	4,610	100D	1910	H	-	P
7ccc-2	do	1908	-	-	-	-	4,615	-	-	H	-	-
7dca-1	L. M. Olsen	1955	50	8	-	-	4,535	20A	7-70	S	-	-
7ddc-1	Orland Hess	1934	30	8	-	-	4,525	14A	7-70	S	-	P
9bac-1	V. F. Fonnesbeck	1910	-	-	-	-	4,630	-	-	U	-	-
10bca-1	H. C. Kotter	1957C	138	4	128	P	4,685	100D	7-57	H	-	P
18aba-1	E. L. Nessen	1930	40	-	-	-	4,535	25G	2-36	U	-	-
19aba-1	J. L. Payne	1931	35	6	-	-	4,518	15G	2-36	U	-	-
19ba	J. L. Baxter	1913	66	-	-	-	4,560	51G	1913	-	-	P
19baa-1	A. M. Shriber	1914	-	-	-	-	4,540	-	-	U	-	-
19dbb-1	J. C. Wood	1926	110	8	-	-	4,530	50G	2-36	U	-	-
20bbb-1	do	1916	180	6	172	P	4,502	30G	2-36	H	-	-
20bbb-2	do	1930	30	6	-	O	4,505	8A	7-70	I	-	P
20bbb-3	do	1930	30	-	-	-	4,500	-	-	S	-	K
22dab-1	Town of Howell	1957C	102	8	64	P	4,815	12D	11-57	P	D	-
3/22dbd-1	do	1962C	342	10	280	P	4,750	250D	6-62	P	D	-
27bac-1	L. P. Douglas	1954C	275	4	256	P	4,660	256D	4-54	S	-	-
31bbc-1	J. O. Munk	1928	180	4	-	O	4,605	144A	7-70	U	-	-
33baa-1	H. Fonnesbeck	1949	200	6	200	-	4,515	-	-	U	-	-
(B-12-6)12aad-1	Waldo Grant	1915	120	4	-	O	4,650	94A	7-70	S	-	-
13ddc-1	J. H. Forsgren	1937C	210	6	-	O	4,670	152D	9-37	H	D	-
13ddd-1	do	1912	-	-	-	-	4,630	-	-	H	-	P
14ddd-1	C. W. Forsgren	1913	250	8	-	-	4,885	218A	7-70	U	-	-
24add-1	Town of Howell	1965C	300	8	200	P	4,620	-	-	P	D	-
34acd-1	G. F. Rock	1939C	470	4	452	P	5,170	410D	10-39	U	D	-
36ada-1	O. M. Munk	1916	212	-	-	-	4,610	156G	9-69	H	-	P
36baa-1	P. F. Fonnesbeck	1912	270	6	-	-	4,705	240G	2-36	U	-	-
36bbb-1	do	1927	300	6	290	O	4,780	285G	2-36	U	-	-
(B-13-5)4ccc-1	V. C. Henrie	1910C	280	6	276	P	4,855	200G	2-36	U	-	-
5bcb-2	J. H. Reese	1956C	260	6	233	P	4,820	128D	9-57	H	D	P
6aaa-2	I. M. Turley	1968C	235	6	210	P	4,840	162D	9-68	H	D	P
7acc-1	C. A. Glenn	1947C	412	6	60	-	4,800	250D	7-47	-	D	-
8d	Louis Miller	1913C	180	-	-	-	4,780	80G	1913	-	-	P
8dbb-1	C. B. Nielsen	1920	-	-	-	O	4,785	-	-	U	-	-
9ccd-1	R. P. Nielsen	1925	212	2	20	O	4,805	178A	7-70	U	-	-
16ccc-1	E. L. Nielson	1918	-	-	-	-	4,725	-	-	-	-	P
17bca-1	R. A. Miller	1928	135	6	-	O	4,700	60A	7-70	H	-	-
17cac-1	M. S. Miller	1929	62	4	47	P	4,680	42G	2-36	U	D	-
18adb-1	Norman Johnson	1909	101	4	-	O	4,710	70G	3-36	H	-	P
18c	W. W. Roskelly	1913	113	-	-	-	4,780	53G	1913	-	-	P
22ccc-1	Thomas Roberts	1911	180	6	-	-	4,770	165G	3-36	S	-	P
28b	Fred Manning	1913	183	-	-	-	4,660	40G	1913	-	-	P
28bab-1	Aebischer Bros.	1906	112	4	-	O	4,665	63A	7-70	H	D	P
4/28cba-1	J. Aebischer	-	152	4	-	-	4,660	55A	11-54	-	-	-
5/29aaa-1	Thiokol Chemical Corp.	1958C	328	10	200	P	4,640	40A	8-70	U	D	-
30ada-1	D. H. Simpson	1910	65	1	-	O	4,635	45G	11-54	U	-	-
31cdd-1	S. E. Dejarnatt	1917	80	4	-	-	4,615	46G	2-36	U	-	-

Table 3.—Records of selected wells—continued

Well number	Owner	Priority date	Well depth (ft)	Casing: Diameter (in.)	Casing: Depth (ft)	Casing: Finish	Altitude of LSD (ft)	Water level (ft)	Date of water-level measurement	Use of water	Log	Other data available
6/(B-13-5)31daa-1	L. D. Nessen	1962C	405	16	20	P	4,610	27A	7-70	I	D	P
33acc-1	Lawrence Hawkes	1900	180	2	-	O	4,780	170G	3-40	H	-	P
(B-13-6)1bdb-1	R. W. Henrie	1904	195	6	-	-	4,870	175G	3-36	S	-	P
1bdb-2	J. E. Deakin	1929	200	4	-	-	4,875	175G	3-40	H	-	-
1cac-1	M. J. Hyde	1929C	200	4	-	-	4,845	150A	10-49	U	-	P
7/1dbb-1	R. W. Henrie	1968C	704	16	482	P	4,835	121A	9-70	I	D	P
2cab-1	D. B. Bradshaw	1941C	275	6	-	-	4,970	237A	7-70	U	-	-
2dab-1	J. E. Deakin	1906	175	6	-	-	4,885	150G	3-36	U	-	-
10dda-1	H. J. Anderson	1926	364	6	-	O	5,075	311A	7-70	U	-	-
12aba-1	R. W. Henrie	1958C	-	8	-	-	4,900	-	-	S	-	P
14bbc-1	O. P. Canfield	1949C	-	-	-	-	5,070	-	-	S	-	-
24add-1	C. H. Miller	1911	250	6	-	-	4,795	-	-	H	-	-
24dcd-1	W. T. Miller	1911	250	6	-	-	4,825	-	-	H	-	P
36acc-1	Alfred Manning	1911	300	6	-	-	4,800	200G	3-36	S	-	P
(B-14-5)4bab-1	Gerald Jessop	1914	185	6	-	O	5,070	160A	7-70	U	-	-
5aaa-1	L. G. Whitney	1922	150	6	-	-	5,065	130G	4-40	H	-	-
5aba-1	Gerald Jessop	1898	430	3	100	-	5,060	125G	8-36	U	-	-
5bab-1	L. G. Whitney	1932	190	4	-	O	5,070	50G	3-40	U	-	-
8dbc-1	Edward Jessop	1917	180	6	-	O	5,160	31A	7-70	S	-	-
8ddd-1	M. S. Jessop	1918	105	6	-	O	5,175	62A	7-70	H	-	P
17aaa-1	Seth Hammond	1915	125	6	113	P	5,175	70A	7-70	U	-	-
19ccc-1	H. M. Schumann	1934	-	-	-	-	4,920	174A	7-70	U	-	-
28cca-1	William Roberts	1935C	610	-	-	X	5,120	Dry	11-35	U	D	-
29abb-1	H. and L. Schumann	1917	340	42	-	W	5,040	297A	7-70	H	-	P
30cbd-1	James Roberts	1924	200	6	191	-	4,960	166G	3-40	U	-	-
31cdd-1	Edward Doutre	1912	160	4	-	-	4,820	96A	7-70	U	-	-
(B-14-6)3aaa-2	W. R. Bishop	1969C	390	6	348	O	5,115	340D	9-69	H	D	P
9aab-1	Deloris Stokes	1967C	409	6	-	-	5,150	390D	8-67	H	D	P
12add-1	W. E. Fridal	1934	462	6	455	O	5,045	287D	-	U	D	-
12caa-1	Coop Security	1933C	480	8	445	P	5,150	406A	7-70	H	-	P
23add-1	Ray Holdaway	1941C	336	4	-	-	5,050	309A	7-70	U	-	-
23ddd-1	Hyer and Turley	1915C	350	6	348	P	5,030	300G	3-40	H	-	K
24cbc-1	R. B. Hyer	1920	330	6	-	-	5,035	304A	7-70	H	-	P
36cba-1	A. H. Rock	1900	200	2	-	O	4,920	149A	7-70	U	-	-
(B-15-5)32cdd-1	L. G. Whitney	1915	200	8	-	-	5,055	50G	8-44	H	-	P
(B-15-6)34ccc-1	R. W. Tolman	1968C	555	6	-	O	5,230	461D	7-68	H	D	P
35bdb-1	Deloris Stokes	1920	-	-	-	-	5,085	-	-	S	-	P

1/ Reported yield and drawdown: 450 gpm and 20 feet, October, 1962.

2/ Reported yield and drawdown: 90 gpm and 32 feet, July, 1956.

3/ Reported yield and drawdown: 80 gpm and 50 feet, June, 1962.

4/ Well destroyed.

5/ Reported yield and drawdown: 290 gpm and 140 feet, April, 1958.

6/ Reported yield and drawdown: 350 gpm and 200 feet, December, 1962.

7/ Reported yield and drawdown: 580 gpm and 192 feet, October, 1968.

Table 4.—Records of selected springs.

Use of water: D, domestic, I, irrigation, P, public supply; S, stock.
Specific conductance: F, indicates field measurement.
Altitude at source: In feet above mean sea level; interpolated from U.S. Geological Survey 7.5 minute topographic maps (20-foot contour interval).
Other data available: P, chemical analysis, or K, specific conductance given in table 6.

Location	Owner or user	Name	Geologic source	Use of water	Specific conductance (micromhos per cm at 25°C)	Temperature (°C)	Yield (gpm)	Date measured	Altitude at source	Other data available
(B-11-5)3cac-S1	-	-	Oquirrh Formation	S	765	17.5	<1	July 1970	4,680	K
9adc-S1	U.S. Bureau of Land Management	Duchesneaux Spring	-	S	-	-	-	-	4,750	
12cca-S1	-	-	Oquirrh Formation	S	631	17.0	-	July 1970	5,100	K
15bcb-S1	Thiokol Chemical Corp.	Fanny Draper Spring	-	S	-	-	-	-	5,380	
21cda-S1	do	Railroad Spring No. 12	Oquirrh Formation	P	860F	14.0	6	Aug. 1970	4,740	P
1/22ada-S1	do	Railroad Spring No. 1	do	S	690F	15.0	6	Aug. 1970	5,360	
22cda-S1	do	Railroad Spring No. 11	do	P	690F	14.5	1-2	Aug. 1970	5,390	
22daa-S1	do	Railroad Spring No. 6	do	P	540F	13.0	1	Aug. 1970	5,260	
22daa-S2	do	Railroad Spring No. 7	do	P	530F	13.5	12	Aug. 1970	5,260	
22dac-S1	do	Railroad Spring No. 8	do	S	-	-	-	-	5,270	
22dac-S2	do	Railroad Spring No. 9	do	S	-	-	-	-	5,260	
22dac-S3	do	Railroad Spring No. 10	do	S	-	-	-	-	5,270	
23aac-S1	do	-	-	-	-	-	-	-	5,640	
23bcb-S1	do	Railroad Spring No. 2	Oquirrh Formation	S	-	-	-	-	5,420	
23bcb-S2	do	Railroad Spring No. 3	do	S	-	-	-	-	5,440	
23bcc-S1	do	Railroad Spring No. 4	do	S	-	-	-	-	5,400	
23bcc-S2	do	Railroad Spring No. 5	do	S	-	-	-	-	5,430	
(B-11-6)7abd-S1	-	-	Oquirrh Formation(?)	-	-	-	-	-	5,480	
19bcb-S1	W. I. Sandall	Hereford Spring	Oquirrh Formation	S	-	-	-	-	5,710	
24ddb-S1	John Adams	Engineer Spring	Great Blue Limestone(?)	D,S,I	1,010	-	-	Aug. 1970	4,795	P
(B-12-5)11cdd-S1	H. C. Kotter	-	Oquirrh Formation	S	858	11.5	<1	July 1970	4,940	K
14baa-S1	Dan Douglas	North Spring	do	S	900	17.0	<1	July 1970	5,065	P
14ccc-S1	do	-	do	S	798	18.0	<1	July 1970	4,930	K
22ccb-S1	F. L. Douglas	-	do	S	-	-	(2/)	-	4,810	
22dac-S1	Town of Howell	Hillside Spring	do	P	889	3/20.0	1	July 1970	4,820	K
34cdc-S1	L. P. Douglas	-	-	S	-	-	-	-	4,800	
(B-12-6)33dba-S1	-	-	Oquirrh Formation	S	751	4/20.5	<1	July 1970	5,480	P
5/(B-13-5)29-S1	Blue Creek Irrigation Co.	Blue Springs (spring area)	Oquirrh Formation(?)	I	3,410	28.0	6/4,680	July 1970	4,610	P

1/ Composite flow, temperature, and conductance from Railroad Springs Nos. 1, 2, 3, 4, 5, 8, 9, 10.

2/ Flows only during winter.

3/ Temperature measured from pipe orifice about 50 feet below source.

4/ Temperature measured from pipe orifice about 500 feet below source.

5/ Measured and sampled downstream from source at location (B-13-5)29ccc to obtain flow of entire spring area.

6/ See table in text for other discharge measurements.

Table 5.—Selected drillers' logs of wells.

Altitudes are in feet above sea level for land surface at well, interpolated from U.S. Geological Survey 7.5-minute topographic maps (20-foot contour interval).
Thickness in feet.
Depth in feet below land surface.

Material	Thickness	Depth
(B-11-5)5acd-1. Log by J. Hy Petersen and Sons. Alt. 4,445 ft.		
Topsoil	3	3
Clay, yellow	61	64
Clay, yellow, and gravel	31	95
Clay, sand, and gravel	49	144
Clay, yellow, and streaks of sandstone	20	164
Gravel, sand, and clay	32	196
Clay, sandy, yellow, and gravel	69	265
Gravel, sand, and hard clay	23	288
Gravel, cemented, hard, and sticky and sandy clay	81	369
Clay, yellow, and fine sandy gravel	29	398
Gravel, cemented	7	405
Gravel, hard, and clay	33	438
Gravel, hard, clay, and broken limestone boulders	7	445
Limestone, solid	94	539
Limestone, soft, black	13	552
Limestone, hard, broken	3	555
Limestone, soft, gray	10	565
Limestone, soft, broken	4	569
Limestone, hard, black	41	610
(B-11-5)28bba-1. Log by Melvin Church Drilling Co. Alt. 4,540 ft.		
Soil, rocky	2	2
Clay	3	5
Conglomerate	6	11
Rocks, large, and clay	183	194
Unlogged	1	195
Silt, yellow	5	200
Silt, red, and rocks	10	210
Silt and rocks; water seep	8	218
Limestone, broken	14	232
Shale, black	86	318
Rock; water seepage	6	324
Shale and limestone, lenticular	41	365
(B-11-5)29abb-1. Log by Melvin Church Drilling Co. Alt. 4,410 ft.		
Soil, rocky	4	4
Clay, gumbo	6	10
Conglomerate	26	36
Clay, gumbo	10	46
Conglomerate	37	83
Boulders and clay	4	87
Conglomerate	48	135
Clay, gumbo	6	141
Conglomerate	9	150
Gravel; water bearing	2	152
Clay	7	159
Gravel; water bearing	13	172
Clay	22	194
Gravel	2	196
Clay	4	200
Gravel; water bearing	14	214
Clay	2	216
(B-11-5)29cbd-1. Log by T. J. Burkhart. Alt. 4,340 ft.		
Soil	2	2
Clay, sandy	21	23
Gravel	7	30
Gravel and clay	15	45
Clay, sandy	15	60
Gravel	2	62
Clay, sandy	9	71
Gravel and clay	17	88
Sand, dirty	11	99
Gravel	8	107
Sand	8	115
Gravel	5	120
Clay	6	126
Sand and gravel	20	146
Clay	9	155
Gravel or sand	3	158
Gravel, dirty	26	184
Clay	8	192
Gravel with some clay	40	232
Gravel, loose	19	251
Gravel and boulders, dirty	53	304
Gravel and sand	6	310
(B-11-6)16bcc-1. Log by D. G. Musselman. Alt. 5,040 ft.		
Topsoil	3	3
Sandstone	17	20
Clay, blue	33	53
Clay, white	73	126
Clay, yellow, and gravel	10	136
Sandrock	156	292
(B-12-5)22dbd-1. Log by Robinson Drilling Co. Alt. 4,750 ft.		
Clay, silt, and cobbles	3	3
Sand and gravel	5	8
Clay, yellow, and boulders	7	15
Clay, red	5	20
Clay and boulders	10	30
Boulders	13	43
(B-12-5)22dbd-1 - Continued		
Limestone	18	61
Clay, red and yellow	4	65
Clay and rock	5	70
Limestone	10	80
Clay and rock	7	87
Boulders	6	93
Clay and rock	27	120
Shale, black	26	146
Limestone	53	199
Shale, black	52	251
Limestone, hard	32	283
Limestone, fractured	17	300
Limestone, hard	13	313
Shale, black	20	333
Limestone, hard	9	342
(B-12-6)24add-1.- Log by Waymon Yarbrough. Alt. 4,620 ft.		
Clay	6	6
Clay and boulders	17	23
Clay and sand	22	45
Gravel	50	95
Clay and sand	23	118
Limestone	1	119
Limestone and clay	26	145
Clay and sand	10	155
Sand, soft, tight	5	160
Limestone, hard	117	277
Sand, soft	2	279
Sand	12	291
Limestone, hard	2	293
Sand and clay	7	300
(B-12-6)34acd-1. Log by David Musselman. Alt. 5,170 ft.		
Clay, red	10	10
Rocks	4	14
Clay, red	236	250
"Hardpan"	10	260
Clay, red, and gravel	28	288
Clay, white, sandy	10	298
Clay, red, and gravel	54	352
"Hardpan"	10	362
Clay, red, and gravel	10	372
"Hardpan"	12	384
Clay, soft, red	8	392
Sand	46	438
Gravel and clay	20	458
Sand	8	466
Clay	4	470
(B-13-5)5bcb-2. Log by T. J. Burkhart. Alt. 4,820 ft.		
Soil	2	2
Clay, yellow	38	40
Clay, soft, sandy, yellow	12	52
Clay, hard, sandy, light gray	53	105
Clay, yellow, and gravel	82	187
Clay, dense, gray	45	232
Shale, sandy, hard and soft streaks, light gray	28	260
(B-13-5)6aaa-2. Log by R. J. Howell Drilling Co. Alt. 4,840 ft.		
Clay, brown	5	5
Clay, yellow, and sand	30	35
Gravel, dry	2	37
Clay, yellow	33	70
Clay, brown, and conglomerate	12	82
Clay, brown, and lava rock	4	86
Clay, brown, and sand	10	96
Clay, brown, and lava rock	4	100
Clay and gravel	15	115
Clay and boulders	15	130
Sandstone	20	150
Limestone	25	175
Clay, red	10	185
Limestone, hard	3	188
Sand, red, and gravel; water bearing	10	198
Sand and gravel	32	230
Limestone	5	235
(B-13-5)7acc-1. Log by Davis and Davis. Alt. 4,800 ft.		
Sand and shale	±120	±120
Sandstone, sand, and shale	278	398
Sand; water bearing	14	412
(B-13-5)28bab-1. Alt. 4,665 ft.		
Soil, black	1	1
Clay	110	111
Gravel	1	112
(B-13-5)29aaa-1. Log by T. J. Burkhart. Alt. 4,640.		
Soil	2	2
Clay, light gray	21	23
Clay, light brown, and gravel	15	38
Clay, light gray	16	54
(B-13-5)29aaa-1 - Continued		
Gravel and boulders	3	57
Clay, light brown, and gravel	63	120
Clay, sandy, light brown	31	151
Gravel and light brown clay	40	191
Gravel and boulders; some clay	5	196
Gravel and light brown clay	19	215
Boulders, gravel, and light brown clay	88	303
Sand, clay, and gravel	21	324
Gravel and clay	4	328
(B-13-5)31daa-1. Log by Waymon Yarbrough. Alt. 4,610 ft.		
Soil	7	7
Clay	35	42
Unlogged; water bearing	13	55
Clay, gray	23	78
Gravel, coarse, boulders, and sand	12	90
Clay, white	22	112
Shale, hard	3	115
Clay, blue	30	145
Shale, hard	5	150
Clay, white	50	200
Clay, blue green	20	220
Clay, green	50	270
Sandy (sandy streak)	5	275
Shale	5	280
Clay, white	25	305
Clay, soft, blue	10	315
Sandstone, hard	10	325
Sandy (sandy streak)	1	326
Sandstone	4	330
Sandy (sandy streak)	1	331
Shale	4	335
Clay, hard	10	345
Limestone	25	370
Sand, black	10	380
Clay	20	400
Clay, hard	5	405
(B-13-6)1dbb-1. Log by Robinson Drilling Co. Alt. 4,835 ft.		
Soil	9	9
Clay	28	37
Clay and gravel	77	114
Clay	29	143
Clay with lime seams	57	200
Clay	6	206
Clay with limestone seams	6	212
Clay and gravel	69	281
Clay	13	294
Gravel	2	296
Clay	53	349
Gravel	2	351
Clay and sand	23	374
Gravel	11	385
Clay	14	399
Gravel	4	403
Clay and gravel	78	481
Clay	3	484
Gravel	12	496
Clay	16	512
Gravel	7	519
Clay	13	532
Gravel	2	534
Clay and gravel	39	573
Gravel	61	634
Clay and gravel	6	640
Gravel	31	671
Clay	8	679
Gravel	18	697
Clay and gravel	7	704
(B-14-5)28cca-1. Log by Adam Inthurn and F. H. Hughes. Alt. 5,120 ft.		
Conglomerate	140	140
Clay	35	175
Rock	65	240
Conglomerate	80	320
Rock	35	355
Shale	39	394
Rock, black	12	406
Sand and sandstone	77	483
Rock, black	50	533
Conglomerate	10	543
Rock, black	25	568
Conglomerate	15	583
Rock, black	27	610
(B-14-6)3aaa-2. Log by R. H. Howell Drilling Co. (0-320 ft) and R. O. Denton (328-390 ft). Alt. 5,115 ft.		
Lime(stone), white	12	12
Sandstone, red, hard	10	22
Clay, red	28	50
Sandstone, red	18	68
Red rock or hardpan	4	72
Clay, red	15	87
Cobbles	5	92

Table 5.—Selected drillers' logs of wells—continued

Material	Thickness	Depth
(B-14-6)3aaa-2 - Continued		
Clay and boulders	8	100
Clay, brown	80	180
Conglomerate or lava rock	15	195
Gravel; crevice or air pocket	5	200
Clay, white	10	210
Sand	20	230
Lime(stone), white	18	248
Lava rock with crevice	3	251
Clay, white	9	260
Clay, brown	15	275
Gravel; water bearing	11	286
Clay, red, sticky	6	292
Lime(stone), white	13	305
Quartzite, hard	15	320
(B-14-6)3aaa-2 - Continued		
Unlogged	8	328
Clay and gravel	20	348
Gravel, loose, and boulders; water bearing	42	390
(B-14-6)12add-1. Log by W. W. Shuman and C. A. Holland. Alt. 5,045 ft.		
Loam, sandy	8	8
Shale (limy)	4	12
Clay, yellow, and gravel	58	70
Lime rock, sandy	55	125
Clay, yellow	60	185
Gravel	115	300
Gravel; some water (20 gpm per 2½ hr)	10	310
(B-14-6)12add-1 - Continued		
Gravel and sand; little water	15	325
Clay, gravel, and hard shale	35	360
Clay and gravel	96	456
Gravel; water	4	460
Clay	2	462
(B-15-6)34ccc-1. Log by T. J. Burkhart. Alt. 5,230 ft.		
Unknown	480	480
Lime(stone), hard, light gray	31	511
Lime(stone), hard, dark gray	30	541
Lime(stone), broken; some pink shale	5	546
Lime(stone), hard, dark gray	9	555

Table 6.—Chemical analyses of selected water samples.

Sodium and potassium: An entry of C for potassium indicates that sodium and potassium are calculated and reported as sodium.
Agency making analysis: GS, U.S. Geological Survey; IN, Thiokol Chemical Corp.; SU, Utah State University.

Location	Date of collection	Temperature (°C)	Silica (SiO_2)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Boron (B)	Hardness as $CaCO_3$	Noncarbonate hardness	Dissolved solids: Determined	Dissolved solids: Calculated	Specific conductance (micromhos/cm at 25°C)	Sodium-adsorption ratio	pH	Agency making analysis
			Milligrams per liter																				
Wells																							
(B-11-6)2bdc-1	7-14-70	11.5	-	-	122	28	37	-	171	0	-	240	-	-	-	418	278	765	-	1,080	0.8	8.0	GS
14bbb-1	8-10-70	14.0	-	-	184	54	42	-	143	0	-	218	-	-	-	680	563	-	-	1,460	-	7.9	GS
(B-12-5)5cdb-1	7-14-70	9.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3,690	-	-	GS
5d	1913	-	-	-	1/80	-	160	C	310	0	40	155	-	-	-	205	-	570	-	-	4.9	-	GS
7ccc-1	7-13-70	12.0	-	-	131	98	69	-	192	0	-	460	-	-	-	732	575	1,020	-	1,830	1.1	7.8	GS
7ddc-1	7-13-70	9.5	-	-	418	180	1,520	-	539	0	-	2,580	-	-	-	1,780	1,340	6,080	-	9,280	16	7.8	GS
10bca-1	7-14-70	15.5	-	-	66	37	129	-	254	3	-	226	-	-	-	317	104	708	-	1,220	3.2	8.5	GS
19ba	1913	-	-	-	1/80	-	200	C	215	0	40	275	-	-	-	205	-	690	-	-	6.1	-	GS
20bbb-2	7-14-70	9.5	32	-	97	59	1,020	20	525	25	129	1,470	1.2	4.0	0.45	486	14	3,260	3,120	5,270	20	8.7	GS
20bbb-3	7-14-70	10.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	7,320	-	-	GS
(B-12-6)13ddd-1	7-13-70	12.5	44	-	61	47	38	3.0	179	0	33	173	.9	5.4	.01	347	200	526	493	885	.9	8.2	GS
36ada-1	7-14-70	16.5	42	-	77	49	67	7.7	183	0	54	230	.7	2.9	.05	391	241	644	620	1,100	1.5	8.2	GS
(B-13-5)5bcb-2	7- 8-70	14.5	53	-	98	40	61	6.9	173	0	20	267	.5	4.2	.03	410	268	717	636	1,140	1.3	8.1	GS
6aaa-2	7- 8-70	19.0	-	-	185	70	108	-	144	0	-	591	-	-	-	750	632	1,230	-	2,120	1.7	7.9	GS
8d	1913	-	-	-	1/80	-	180	C	220	0	40	275	-	-	-	205	-	700	-	-	5.5	-	GS
16ccc-1	7- 7-70	18.5	-	-	572	245	547	-	142	0	-	2,380	-	-	-	2,430	2,320	4,860	-	7,190	4.8	7.8	GS
18adb-1	7-13-70	-	-	-	152	226	176	-	224	0	-	520	-	-	-	1,310	1,130	1,980	-	2,980	2.1	8.0	GS
18c	1913	-	-	-	1/80	-	110	C	215	0	100	105	-	-	-	205	-	480	-	-	3.3	-	GS
22ccc-1	7- 8-70	16.5	-	-	65	24	78	-	269	0	-	128	-	-	-	260	40	501	-	860	2.1	8.2	GS
28b	1913	-	-	-	1/95	-	180	C	240	0	30	405	-	-	-	240	-	900	-	-	5.1	-	GS
28bab-1	7- 8-70	13.0	-	-	233	94	146	-	163	0	-	751	-	-	-	968	834	1,600	-	2,660	2.0	7.8	GS
31daa-1	7-13-70	20.5	-	-	89	41	153	-	343	4	-	274	-	-	-	391	103	1,010	-	1,440	3.4	8.4	GS
33acc-1	7-14-70	19.0	-	-	52	23	101	-	274	3	-	136	-	-	-	224	0	509	-	901	2.9	8.6	GS
(B-13-6)1bdb-1	7- 6-70	16.5	-	-	149	32	41	-	144	0	-	331	-	-	-	506	388	818	-	1,340	.8	7.8	GS
1cac-1	10-17-57	-	53	-	204	44	49	C	140	0	102	395	-	20	-	688	573	-	936	1,650	.8	7.5	GS
1dbb-1	7- 6-70	19.0	47	-	71	19	31	10	160	0	16	127	.4	6.1	.04	260	124	405	407	701	.8	8.2	GS
12aba-1	7- 7-70	16.5	-	-	325	77	62	-	150	0	-	551	-	-	-	1,130	1,000	1,700	-	2,470	.8	7.9	GS
24dcd-1	7-13-70	14.5	-	-	113	75	48	-	204	0	-	325	-	-	-	597	430	936	-	1,450	.9	7.9	GS
36acc-1	7-13-70	17.5	-	-	447	153	143	-	162	0	-	1,340	-	-	-	1,740	1,610	3,450	-	4,270	1.5	8.0	GS
(B-14-5)8ddd-1	7- 7-70	10.5	29	-	91	19	72	1.7	321	0	69	55	.2	7.6	.06	304	41	600	474	878	1.8	8.2	GS
29abb-1	7- 6-70	13.0	40	-	216	56	48	7.6	138	0	49	490	.3	3.9	.00	770	657	1,330	979	1,850	.8	8.1	GS
(B-14-6)3aaa-2	7- 7-70	12.0	29	-	56	22	59	4.5	187	0	26	131	.5	1.9	.05	231	78	440	422	739	1.7	7.6	GS
9aab-1	7- 7-70	20.5	-	-	67	25	213	-	2/258	0	-	341	-	-	-	270	58	870	-	1,530	5.6	8.3	GS
12caa-1	7- 7-70	12.0	26	-	87	17	41	10	143	0	44	176	.3	.0	.06	285	168	517	471	823	1.1	8.2	GS
23ddd-1	7- 8-70	10.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1,270	-	-	GS
24cbc-1	7- 8-70	10.0	-	-	121	30	33	-	183	-	-	230	-	-	-	428	278	773	-	1,080	.7	7.8	GS
(B-15-5)32cdd-1	7- 7-70	12.5	-	-	199	23	119	-	2/249	0	-	234	-	-	-	340	135	772	-	1,230	2.8	8.4	GS
(B-15-6)34ccc-1	7- 7-70	20.5	41	-	60	25	247	5.7	259	0	40	375	1.0	.3	.06	252	40	938	922	1,610	6.8	7.9	GS
35bdb-1	7- 7-70	18.5	-	-	88	16	16	-	258	0	-	64	-	-	-	284	73	417	-	634	.4	8.2	GS
Springs																							
(B-11-5)3cac-S1	7-14-70	17.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	765	-	-	GS
12cca-S1	7-14-70	17.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	631	-	-	GS
21-23-S3/	10- -62	-	13	-	36	5	47	-	-	-	22	75	-	-	0.06	112	-	382	-	-	1.9	8.1	IN
21-23-S3/	11- -62	-	17	-	53	11	73	-	-	-	42	119	-	-	.19	176	-	526	-	-	2.4	8.3	IN
(B-11-6)24ddb-S1	8-11-70	-	-	-	101	19	71	-	187	0	-	190	-	-	-	330	177	-		1,010	-	8.0	GS
(B-12-5)11cdd-S1	7-14-70	11.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	858	-	-	GS
14baa-S1	7-14-70	17.0	-	-	79	15	90	-	243	4	-	140	-	-	-	257	51	543	-	909	2.5	8.5	GS
14ccc-S1	7-14-70	18.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	798	-	-	GS
22dac-S1	7-14-70	20.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	889	-	-	GS
(B-12-6)33dba-S1	7-14-70	20.5	-	-	81	12	54	-	250	0	-	100	-	-	-	252	46	477	-	751	1.5	8.2	GS
(B-13-5)29-S	1913	-	-	-	1/75	-	630	C	240	0	40	840	-	-	-	185	-	1,600	-	-	20	-	GS
29-S	9-10-64	26.5	-	-	83	24	540	32	268	-	68	886	-	-	.2	306	-	-	1,923	3,580	13	8.0	SU
29-S	7- 7-70	28.0	19	-	56	24	636	22	329	0	84	895	0.4	1.0	.22	238	0	2,010	1,900	3,410	18	7.9	GS
Blue Creek [at location (B-10-5)5bab]																							
Discharge (cfs)																							
-	6-29-59	17.5	19	-	112	68	1,810	C	538	20	426	2,530	-	10	8.1	560	86	-	5,270	8,640	33	8.4	GS
5.0	9-30-59	12.0	26	0.04	98	36	941	34	350	16	202	1,380	2.0	1.7	.40	392	79	-	2,910	5,130	21	8.5	GS
3.1	4-19-60	12.0	26	.04	128	72	1,430	41	397	24	372	2,150	-	1.7	.55	615	250	-	4,440	7,710	25	8.5	GS
-	4- 6-61	6.0	21	.03	184	126	2,540	65	552	0	716	3,740	-	12	-	978	526	-	7,700	12,400	35	8.0	GS
4.2	10-16-63	15.0	-	-	-	-	-	-	-	-	350	2,200	-	-	-	510	-	4,220	-	7,170	-	-	GS
4/10	3-19-64	-	-	-	-	-	-	-	-	-	434	2,200	-	-	-	595	-	4,670	-	7,430	-	-	GS
11.0	4-10-64	7.0	-	-	-	-	-	-	-	-	354	1,950	-	-	-	510	-	3,850	-	6,400	-	-	GS
9.0	4-24-64	7.0	-	-	-	-	-	-	-	-	400	2,300	-	-	-	600	-	4,670	-	7,550	-	-	GS
17.8	5- 7-64	7.0	-	-	-	-	-	-	-	-	362	1,900	-	-	-	430	-	3,820	-	6,400	-	-	GS
2.5	6-11-64	13.5	26	-	136	96	2,330	-	628	-	612	3,290	-	4.7	-	735	220	6,740	-	10,800	-	8.1	GS
4/.1	9-15-64	-	-	-	-	-	-	-	-	-	395	2,440	-	-	-	454	-	4,920	-	8,140	-	-	GS
6.8	2-19-70	-	22	-	160	107	2,110	C	592	0	570	3,080	-	.6	-	840	355	6,540	6,340	10,100	32	7.8	GS
1.1	3-18-70	2.5	23	-	140	95	2,080	-	579	0	626	3,080	-	.2	-	740	265	6,560	6,330	10,100	33	8.1	GS
1.7	4-14-70	7.0	23	-	124	75	1,640	-	498	0	392	2,480	-	.0	-	620	212	5,140	4,980	8,330	29	8.1	GS
7.0	5-14-70	18.0	-	-	-	-	-	-	-	-	-	3,280	-	-	-	-	-	-	-	10,500	-	-	GS
4/.3	9- 1-70	18.5	-	-	-	-	-	-	-	-	-	2,350	-	-	-	-	-	-	-	7,980	-	-	GS

1/ Calcium plus magnesium. 2/ Some CO_3 included as HCO_3. 3/ Composite sample from 12 springs (Railroad Springs). 4/ Estimated.

REPORTS OF RECONNAISSANCE WATER-RESOURCES INVESTIGATIONS IN SELECTED BASINS OF WESTERN UTAH

Bolke, E. L., and Price, Don, 1969, Hydrologic reconnaissance of Curlew Valley, Utah and Idaho: Utah Dept. Nat. Resources Tech. Pub. 25.

Hood, J. W., 1971, Hydrologic reconnaissance of the Park Valley area, Box Elder County, Utah: Utah Dept. Nat. Resources Tech. Pub. 30.

....................1971, Hydrologic reconnaissance of Hansel Valley and northern Rozel Flat, Box Elder County, Utah: Utah Dept. Nat. Resources Tech. Pub 33.

Hood, J. W., and Price, Don, 1970, Hydrologic reconnaissance of Grouse Creek valley, Box Elder County, Utah: Utah Dept. Nat. Resources Tech. Pub. 29.

Hood, J. W., Price, Don, and Waddell, K. M., 1969, Hydrologic reconnaissance of Rush Valley, Tooele County, Utah: Utah Dept. Nat. Resources Tech. Pub. 23.

Hood, J. W., and Rush, E. F., 1965, Water-resources appraisal of the Snake Valley area, Utah and Nevada: Utah State Engineer Tech. Pub. 14.

Hood, J. W., and Waddell, K. M., 1968, Hydrologic reconnaissance of Skull Valley, Tooele County, Utah: Utah Dept. Nat. Resources Tech. Pub. 18.

...................1969, Hydrologic reconnaissance of Deep Creek valley, Tooele and Juab Counties, Utah, and Elko and White Pine Counties, Nevada: Utah Dept. Nat. Resources Tech. Pub. 24.

Price, Don, and Bolke, E. L., 1970, Hydrologic reconnaissance of the Sink Valley area, Tooele and Box Elder Counties, Utah: Utah Dept. Nat. Resources Tech. Pub. 26.

PUBLICATIONS OF THE UTAH DEPARTMENT OF NATURAL RESOURCES, DIVISION OF WATER RIGHTS

(*)—Out of Print

TECHNICAL PUBLICATIONS

No. 1. Underground leakage from artesian wells in the Flowell area, near Fillmore, Utah, by Penn Livingston and G. B. Maxey, U. S. Geological Survey, 1944.

No. 2. The Ogden Valley artesian reservoir, Weber County, Utah, by H. E. Thomas, U. S. Geological Survey, 1945.

*No. 3. Ground water in Pavant Valley, Millard County, Utah, by P. E. Dennis, G. B. Maxey, and H. E. Thomas, U. S. Geological Survey, 1946.

*No. 4. Ground water in Tooele Valley, Tooele County, Utah, by H. E. Thomas, U. S. Geological Survey, in Utah State Eng. 25th Bienn. Rept., p. 91-238, pls. 1-6, 1946.

*No. 5. Ground water in the East Shore area, Utah: Part I, Bountiful District, Davis County, Utah, by H. E. Thomas and W. B. Nelson, U. S. Geological Survey, in Utah State Eng. 26th Bienn. Rept., p. 53-206, pls. 1-2, 1948.

*No. 6. Ground water in the Escalante Valley, Beaver, Iron, and Washington Counties, Utah, by P. F. Fix, W. B. Nelson, B. E. Lofgren, and R. G. Butler, U. S. Geological Survey, in Utah State Eng. 27th Bienn. Rept., p. 107-210, pls. 1-10, 1950.

No. 7. Status of development of selected ground-water basins in Utah, by H. E. Thomas, W. B. Nelson, B. E. Lofgren, and R. G. Butler, U. S. Geological Survey, 1952.

*No. 8. Consumptive use of water and irrigation requirements of crops in Utah, by C. O. Roskelly and Wayne D. Criddle, 1952.

No. 8. (Revised) Consumptive use and water requirements for Utah, by W. D. Criddle, K. Harris, and L. S. Willardson, 1962.

No. 9. Progress report on selected ground water basins in Utah, by H. A. Waite, W. B. Nelson, and others, U. S. Geological Survey, 1954.

*No. 10. A compilation of chemical quality data for ground and surface waters in Utah, by J. G. Connor, C. G. Mitchell, and others, U. S. Geological Survey, 1958.

*No. 11. Ground water in northern Utah Valley, Utah: A progress report for the period 1948-63, by R. M. Cordova and Seymour Subitzky, U. S. Geological Survey, 1965.

No. 12. Reevaluation of the ground-water resources of Tooele Valley, Utah, by Joseph S. Gates, U. S. Geological Survey, 1965.

*No. 13. Ground-water resources of selected basins in southwestern Utah, by G. W. Sandberg, U. S. Geological Survey, 1966.

*No. 14. Water-resources appraisal of the Snake Valley area, Utah and Nevada, by J. W. Hood and F. E. Rush, U. S. Geological Survey, 1966.

*No. 15. Water from bedrock in the Colorado Plateau of Utah, by R. D. Feltis, U. S. Geological Survey, 1966.

No. 16. Ground-water conditions in Cedar Valley, Utah County, Utah, by R. D. Feltis, U. S. Geological Survey, 1967.

*No. 17. Ground-water resources of northern Juab Valley, Utah, by L. J. Bjorklund, U. S. Geological Survey, 1968.

No. 18. Hydrologic reconnaissance of Skull Valley, Tooele County, Utah, by J. W. Hood and K. M. Waddell, U. S. Geological Survey, 1968.

No. 19. An appraisal of the quality of surface water in the Sevier Lake basin, Utah, by D. C. Hahl and J. C. Mundorff, U. S. Geological Survey, 1968.

No. 20. Extensions of streamflow records in Utah, by J. K. Reid, L. E. Carroon, and G. E. Pyper, U. S. Geological Survey, 1969.

No. 21. Summary of maximum discharges in Utah streams, by G. L. Whitaker, U. S. Geological Survey, 1969.

No. 22. Reconnaissance of the ground-water resources of the upper Fremont River valley, Wayne County, Utah, by L. J. Bjorklund, U. S. Geological Survey, 1969.

No. 23. Hydrologic reconnaissance of Rush Valley, Tooele County, Utah, by J. W. Hood, Don Price, and K. M. Waddell, U. S. Geological Survey, 1969.

No. 24. Hydrologic reconnaissance of Deep Creek valley, Tooele and Juab Counties, Utah, and Elko and White Pine Counties, Nevada, by J. W. Hood and K. M. Waddell, U. S. Geological Survey, 1969.

No. 25. Hydrologic reconnaissance of Curlew Valley, Utah and Idaho, by E. L. Bolke and Don Price, U. S. Geological Survey, 1969.

No. 26. Hydrologic reconnaissance of the Sink Valley area, Tooele and Box Elder Counties, Utah, by Don Price and E. L. Bolke, U. S. Geological Survey, 1969.

No. 27. Water resources of the Heber-Kamas-Park City area, north-central Utah, by C. H. Baker, Jr., U. S. Geological Survey, 1970.

No. 28. Ground-water conditions in southern Utah Valley and Goshen Valley, Utah, by R.M. Cordova, U.S. Geological Survey, 1970.

No. 29. Hydrologic reconnaissance of Grouse Creek valley, Box Elder County, Utah, by J.W. Hood and Don Price, U.S. Geological Survey, 1970.

No. 30. Hydrologic reconnaissance of the Park Valley area, Box Elder County, Utah, by J. W. Hood, U. S. Geological Survey, 1971.

No. 31. Water resources of Salt Lake County, Utah, by Allen G. Hely, R.W. Mower, and C. Albert Harr, U.S. Geological Survey, 1971.

No. 32. Geology and water resources of the Spanish Valley area, Grand and San Juan Counties, Utah, by C.T. Sumsion, U.S. Geological Survey, 1971.

No. 33. Hydrologic reconnaissance of Hansel Valley and northern Rozel Flat, Box Elder County, Utah, by J.W. Hood, U.S. Geological Survey, 1971.

No. 34. Summary of water resources of Salt Lake County, Utah, by Allen G. Hely, R.W. Mower, and C. Albert Harr, U.S. Geological Survey, 1971.

No. 35. Ground-water conditions in the East Shore area, Box Elder, Davis, and Weber Counties, Utah, 1960-69, by E.L. Bolke and K.M. Waddell, U.S. Geological Survey, 1972.

No. 36. Ground-water resources of Cache Valley, Utah and Idaho, by L.J. Bjorklund and L.J. McGreevy, U.S. Geological Survey, 1971.

WATER CIRCULARS

No. 1. Ground water in the Jordan Valley, Salt Lake County, Utah, by Ted Arnow, U. S. Geological Survey, 1965.

No. 2. Ground water in Tooele Valley, Utah, by J. S. Gates and O. A. Keller, U. S. Geological Survey, 1970.

BASIC-DATA REPORTS

*No. 1. Records and water-level measurements of selected wells and chemical analyses of ground water, East Shore area, Davis, Weber, and Box Elder Counties, Utah, by R. E. Smith, U. S. Geological Survey, 1961.

*No. 2. Records of selected wells and springs, selected drillers' logs of wells, and chemical analyses of ground and surface waters, northern Utah Valley, Utah County, Utah, by Seymour Subitzky, U. S. Geological Survey, 1962.

*No. 3. Ground water data, central Sevier Valley, parts of Sanpete, Sevier, and Piute Counties, Utah, by C. H. Carpenter and R. A. Young, U. S. Geological Survey, 1963.

*No. 4. Selected hydrologic data, Jordan Valley, Salt Lake County, Utah, by I. W. Marine and Don Price, U. S. Geological Survey, 1963.

*No. 5. Selected hydrologic data, Pavant Valley, Millard County, Utah, by R. W. Mower, U. S. Geological Survey, 1963.

*No. 6. Ground-water data, parts of Washington, Iron, Beaver, and Millard Counties, Utah, by G. W. Sandberg, U. S. Geological Survey, 1963.

No. 7. Selected hydrologic data, Tooele Valley, Tooele County, Utah, by J. S. Gates, U. S. Geological Survey, 1963.

No. 8. Selected hydrologic data, upper Sevier River basin, Utah, by C. H. Carpenter, G. B. Robinson, Jr., and L. J. Bjorklund, U. S. Geological Survey, 1964.

No. 9. Ground-water data, Sevier Desert, Utah, by R. W. Mower and R. D. Feltis, U. S. Geological Survey, 1964.

*No. 10. Quality of surface water in the Sevier Lake basin, Utah, by D. C. Hahl and R. E. Cabell, U. S. Geological Survey, 1965.

*No. 11. Hydrologic and climatologic data, collected through 1964, Salt Lake County, Utah by W. V. Iorns, R. W. Mower, and C. A. Horr, U. S. Geological Survey, 1966.

No. 12. Hydrologic and climatologic data, 1965, Salt Lake County, Utah, by W. V. Iorns, R. W. Mower, and C. A. Horr, U. S. Geological Survey, 1966.

No. 13. Hydrologic and climatologic data, 1966, Salt Lake County, Utah, by A. G. Hely, R. W. Mower, and C. A. Horr, U. S. Geological Survey, 1967.

No. 14. Selected hydrologic data, San Pitch River drainage basin, Utah, by G. B. Robinson, Jr., U. S. Geological Survey, 1968.

No. 15. Hydrologic and climatologic data, 1967, Salt Lake County, Utah, by A. G. Hely, R. W. Mower, and C. A. Horr, U. S. Geological Survey, 1968.

No. 16. Selected hydrologic data, southern Utah and Goshen Valleys, Utah, by R. M. Cordova, U. S. Geological Survey, 1969.

No. 17. Hydrologic and climatologic data, 1968, Salt Lake County, Utah, by A. G. Hely, R. W. Mower, and C. A. Horr, U. S. Geological Survey, 1969.

No. 18. Quality of surface water in the Bear River basin, Utah, Wyoming, and Idaho, by K. M. Waddell, U. S. Geological Survey, 1970.

No. 19. Daily water-temperature records for Utah streams, 1944-68, by G. L. Whitaker, U. S. Geological Survey, 1970.

No. 20. Water quality data for the Flaming Gorge area, Utah and Wyoming, R.J. Madison, U.S. Geological Survey, 1970.

No. 21. Selected hydrologic data, Cache Valley, Utah and Idaho, L.J. McGreevy and L.J. Bjorklund, U.S. Geological Survey, 1970.

INFORMATION BULLETINS

*No. 1. Plan of work for the Sevier River Basin (Sec. 6, P. L. 566), U. S. Department of Agriculture, 1960.

*No. 2. Water production from oil wells in Utah, by Jerry Tuttle, Utah State Engineer's Office, 1960.

*No. 3. Ground-water areas and well logs, central Sevier Valley, Utah, by R. A. Young, U. S. Geological Survey, 1960.

*No. 4. Ground-water investigations in Utah in 1960 and reports published by the U. S. Geological Survey or the Utah State Engineer prior to 1960, by H. D. Goode, U. S. Geological Survey, 1960.

*No. 5. Developing ground water in the central Sevier Valley, Utah, by R. A. Young and C. H. Carpenter, U. S. Geological Survey, 1961.

*No. 6. Work outline and report outline for Sevier River basin survey, (Sec. 6, P.L. 566), U. S. Department of Agriculture, 1961.

No. 7. Relation of the deep and shallow artesian aquifers near Lynndyl, Utah, by R. W. Mower, U. S. Geological Survey, 1961.

*No. 8. Projected 1975 municipal water-use requirements, Davis County, Utah, by Utah State Engineer's Office, 1962.

No. 9. Projected 1975 municipal water-use requirements, Weber County, Utah, by Utah State Engineer's Office, 1962.

*No. 10. Effects on the shallow artesian aquifer of withdrawing water from the deep artesian aquifer near Sugarville, Millard County, Utah, by R. W. Mower, U. S. Geological Survey, 1963.

No. 11. Amendments to plan of work and work outline for the Sevier River basin (Sec. 6, P.L. 566), U. S. Department of Agriculture, 1964.

*No. 12. Test drilling in the upper Sevier River drainage basin, Garfield and Piute Counties, Utah, by R. D. Feltis and G. B. Robinson, Jr., U. S. Geological Survey, 1963.

*No. 13. Water requirements of lower Jordan River, Utah, by Karl Harris, Irrigation Engineer, Agricultural Research Service, Phoenix, Arizona, prepared under informal cooperation approved by Mr. William W. Donnan, Chief, Southwest Branch (Riverside, California) Soil and Water Conservation Research Division, Agricultural Research Service, U.S.D.A., and by Wayne D. Criddle, State Engineer, State of Utah, Salt Lake City, Utah, 1964.

*No. 14. Consumptive use of water by native vegetation and irrigated crops in the Virgin River area of Utah, by Wayne D. Criddle, Jay M. Bagley, R. Keith Higginson, and David W. Hendricks, through cooperation of Utah Agricultural Experiment Station, Agricultural Research Service, Soil and Water Conservation Branch, Western Soil and Water Management Section, Utah Water and Power Board, and Utah State Engineer, Salt Lake City, Utah, 1964.

*No. 15. Ground-water conditions and related water-administration problems in Cedar City Valley, Iron County, Utah, February, 1966, by Jack A. Barnett and Francis T. Mayo, Utah State Engineer's Office.

*No. 16. Summary of water well drilling activities in Utah, 1960 through 1965, compiled by Utah State Engineer's Office, 1966.

No. 17. Bibliography of U. S. Geological Survey Water Resources Reports for Utah, compiled by Olive A. Keller, U. S. Geological Survey, 1966.

No. 18. The effect of pumping large-discharge wells on the ground-water reservoir in southern Utah Valley, Utah County, Utah, by R. M. Cordova and R. W. Mower, U. S. Geological Survey 1967.

No. 19. Ground-water hydrology of southern Cache Valley, Utah, by L. P. Beer, 1967.

No. 20. Fluvial sediment in Utah, 1905-65, A data compilation by J. C. Mundorff, U. S. Geological Survey, 1968.

No. 21. Hydrogeology of the eastern portion of the south slopes of the Uinta Mountains, Utah, by L.G. Moore and D.A. Barker, U.S. Bureau of Reclamation, and James D. Maxwell and Bob L. Bridges, Soil Conservation Service, 1971.