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GROUND-WATER CONDITIONS IN CEDAR VALLEY, UTAH COUNTY, UTAH

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ABSTRACT

Cedar Valley is in north-central Utah about 20 miles west of Provo in Utah County. The valley is mostly a topographically closed basin, developed in a structural trough caused principally by faulting, and is bordered by mountains largely composed of Paleozoic sedimentary rock. The valley is filled with semiconsolidated to unconsolidated alluvial, colluvial, lacustrine, and eolian deposits of Tertiary and Quaternary age.

Ground water occurs under both water-table and artesian conditions, but most of the wells are developed in the artesian aquifer. The source of most recharge to the ground-water reservoir is in the Oquirrh Mountains in the northwest corner of the valley. After seeping into the ground, water moves directly from the bedrock in the valley fill, thence east and southeast across the valley. The estimated subsurface outflow along the east edge of the valley ranges from about 10,000 to 20,000 acre-feet per year.

Water levels and spring discharges generally fluctuate in response to variations of precipitation, but they have declined markedly in response to pumping at nearby irrigation wells. During 1965, about 1,900 acre-feet of water was pumped from eight irrigation wells in the valley.

The coefficient of transmissibility of the artesian aquifer in the north-central part of the valley, as determined by pumping and recovery tests at wells, ranges from about 5,000 to 26,000 gallons per day per foot. The specific capacities of irrigation wells in the center of the basin range from about 1 to 7 gallons per minute per foot of drawdown, but two wells at the west edge of the basin had specific capacities of 30 and 37 gallons per minute per foot of drawdown.

Most of the ground water in the north half and southwest corner of the valley is of good chemical quality, containing less than 500 parts per million of dissolved solids. In the southeast part of the valley, the water is of poor quality, containing more than 1,000 parts per million of dissolved solids.

INTRODUCTION

Purpose and Scope

This study of the ground-water conditions in Cedar Valley, Utah, was made by the U.S. Geological Survey in cooperation with the Utah State Engineer during the period July 1965-July 1966. The purposes of the study were to estimate the recharge to and the yield of the ground-water reservoir and to determine the direction of ground-water movement through Cedar Valley.

Water levels have been measured in observation wells in Cedar Valley from time to time since 1943. During the present investigation, water-level measurements were made in 38 observation wells, and 5 test wells were drilled to provide additional observation wells and also to provide information that would be helpful in understanding the subsurface geology of the valley. Geophysical logs were run in several wells and test wells to aid in interpreting the subsurface geology and to show the occurrence of ground-water aquifers. Tables 2-7 contain the basic data collected for the investigation and include: records of selected wells and springs, chemical analyses of water, water-level measurements, drillers' logs of wells, and logs of test wells. The locations of wells are shown in figure 4 and of springs in figure 7.

Location of the area

Cedar Valley is in the northwest corner of Utah County, Utah, about 20 miles west of Provo, and lies between 39°58′ and 40°29′ north latitude and between 111°55′ and 112°13′ west longitude (figure 1). The drainage basin for the valley includes about 300 square miles, but the valley proper includes only about 140 square miles. The valley has a maximum north-south length of about 25 miles and a maximum east-west width of about 8 miles. The valley is a topographically closed basin except at the extreme north end where the surface drainage is into northern Utah Valley. The valley is almost completely surrounded by mountains or low hills, and altitudes range from about 4,840 feet on the valley floor to 10,626 feet in the Oquirrh Mountains along the northwest edge of the valley. Mountains on the east side and south end of the valley reach altitudes of 7,647 and 7,828 feet.

Acknowledgments

Many thanks are owed to the residents and landowners of Cedar Valley who furnished or permitted the collection of hydrologic data and water samples from wells and springs and who gave permission to construct test holes for the collection of geologic and hydrologic data.

Well-numbering system used in Utah

The system of numbering wells in Utah is based on the cadastral land-survey system of the Federal Government. The well 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 and meridian, and these quadrants are designated by the capital letters A, B, C, and D. A is the northeast quadrant, B is the northwest, C is the southwest, and D is the southeast. Numbers designating the township and range follow the quadrant letter, and all 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 following the letters indicates the serial number of the well within the 10-acre tract. Thus, well (C-6-2)13caa-1 in Utah County is in the NE¼NE¼SW¼ sec. 13, T. 6 S., R. 2 W., and is the first well constructed or visited in that tract. Figure 2 shows the method of numbering wells as described above. In this report springs and sampling sites are also located by using this system, but the serial number within a 10-acre-tract is omitted.

GEOLOGY

Consolidated rocks of Paleozoic age

The mountains surrounding Cedar Valley contain mostly rocks of Paleozoic age that include limestone, dolomite, quartzite, conglomerate, sandstone, and shale (figure 3). Each rock type is generally present in each mountain range, but limestone and dolomite predomi-

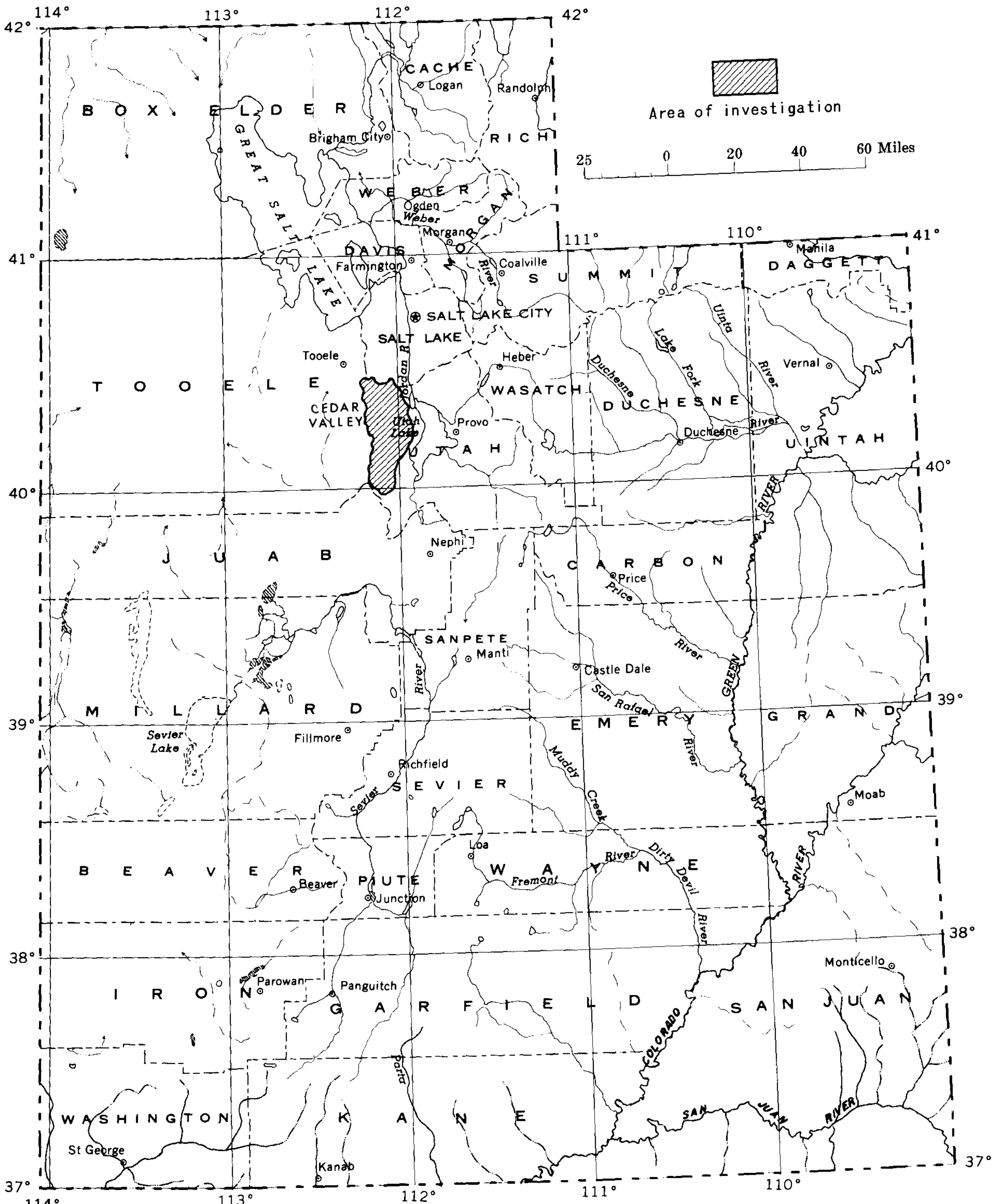

Figure 1. — Index map of Utah showing location of the Cedar Valley drainage basin.

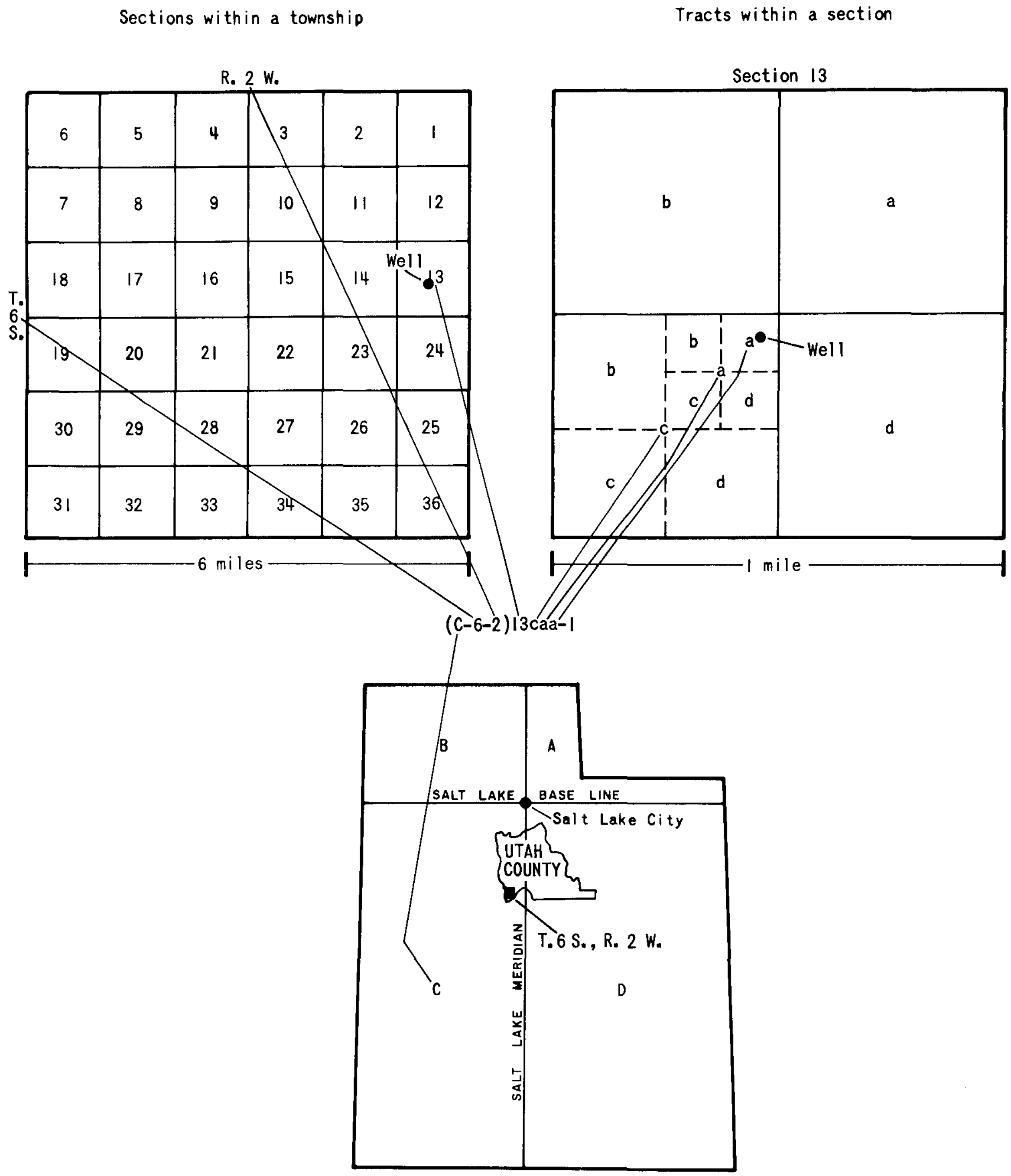

Figure 2. — Well-numbering system used in Utah.

nate. The age of the formations ranges from Devonian to Permian in the Lake Mountains, from Cambrian to Permian in the East Tintic Mountains, and from Mississippian to Permian in the Oquirrh and Traverse Mountains.

Sedimentary and igneous rocks of Tertiary age

Sedimentary rocks.—Scattered exposures of limestone and fresh and argillized tuff in the low hills southwest of the Lake Mountains is part of an unnamed sequence believed to be of early Tertiary—probably late or middle or early late Eocene—age (Morris and Lovering, 1961, p. 126). The limestone is fine to medium grained. The argillized tuff, where it has been mined, consists of halloysite and montmorillonite.

The Salt Lake Formation of Pliocene age probably occurs along the mountain fronts and in the subsurface of Cedar Valley, although it has not been mapped within the drainage basin of Cedar Valley by those who have described the geology of the surrounding mountains. The formation has been described by Morris and Lovering (1961, p. 126-127) in Rush and Tintic Valleys to the west and southwest of Cedar Valley as "* * * marly limestone, bentonitic tuff, sandy silt, and gravel * * *." In the Jordan Narrows, northeast of Cedar Valley, it is described by Hunt and others (1953, p. 13), as " * * * alternating dark-gray silt and white or light-gray, firm, ledge-forming beds that probably are cemented, reworked tuffs. The individual beds range from 2 to 20 feet in thickness; included with them are a few, very thin, clay partings. * * * These light-colored beds are overlain unconformably by a series of buff beds with a basal conglomerate * * *. The basal conglomerate is about 15 feet thick * * *. Above this is 50 feet of moderately consolidated buff sand and silt, which apparently is reworked crystal tuff partly cemented by lime carbonate."

The upper part of the Salt Lake Formation is not easily distinguished from younger alluvial deposits. Some of the partly indurated alluvium around the edges of the valley and in canyons of the mountains, that is mapped as unconsolidated Quaternary deposits in figure 3, may be Salt Lake Formation.

Igneous rocks.—Most of the igneous rocks around Cedar Valley crop out in the Traverse Mountains, northeast of the valley, and the East Tintic Mountains, in the southwest corner of the valley. Gilluly (1932, p. 41) described the extrusive igneous rocks in the Traverse Mountains as " * * * chiefly latite and quartz latite, with some minor flows of basalt, rhyolite obsidian, and nephelite basalt. Among the extrusive rocks, flows, although numerous, are quantitatively subordinate to breccias." The intrusive igneous rocks of the Traverse Mountains are several small rhyolite plugs.

Morris and Lovering (1961, p. 124) described the igneous rocks of the East Tintic Mountains as " * * * deeply eroded remnants of a large composite volcano * * *." These igneous rocks include intrusive bodies and thick lava flows as well as the bedded tuffs, breccias, agglomerates, and volcanic gravels that can be considered to be, in part at least, sedimentary deposits." The extrusive rocks are latite tuffs, flows, agglomerates, volcanic gravels, quartz latite, and basalt flows. The intrusive rocks consist of quartz monzonite, monzonite, monzonite porphyry, lamprophyre, andesite, and diabase.

Unconsolidated rocks of Quaternary age

The Quaternary deposits of the basin fill of Cedar Valley consist mostly of alluvial fans, lacustrine clay, silt, sand, and gravel, and eolian sand and silt.

The alluvial fans, composed largely of silt, sand, and gravel, extend from within the canyons of the mountains toward the center of the basin, where they interfinger with lake and eolian deposits. The fans range in age from early Pleistocene to Recent and in some areas may be lithologically similar to and indistinguishable from the upper part of the Salt Lake Formation of late Pliocene age. The individual fans coalesce along the mountain front to form a continuous undulating surface around the edge of the valley. The fans are generally very coarse grained and permeable near the mountains but become finer grained and less permeable toward the center of the valley. A large alluvial fan in the north end of Cedar Valley extends from the mouth of West Canyon southward to the latitude of Cedar Fort. It has overlapped the bedrock in the northeast corner of the valley, diverting the West Canyon drainage into Utah Valley.

Lakes have probably occupied Cedar Valley during the several periods of glaciation of the Pleistocene Epoch. The resultant lacustrine deposits are mostly impermeable, well-sorted, tabular beds of lake-bottom silt and clay, with some permeable lenticular beds of shoreline sand and gravel deposits. Few large deposits of sand and gravel are present, because no large perennial streams carried coarse debris into the lakes and because the sheltered nature of the valley prevented strong lake currents which could have deposited material on the lakeshore. Lake Bonneville was the last of the Pleistocene lakes that occupied the valley, and its shoreline can be seen etched in the alluvium around the basin.

Active sand dunes as much as 15 feet thick are present about 2 miles south of Fairfield. Goode (**in** Morris and Lovering, 1961, p. 137) reports that the dunes probably were formed during or immediately after the recession of Lake Bonneville and are now being reattacked by the wind. Blowouts in low stabilized dunes and in underlying lake beds are common across the floor of the valley and result in scattered, shifting masses of silt and sand.

Other Quaternary deposits in the valley include colluvium, talus, and landslide debris which occur along the edges of the valley and in the canyons of the mountains. Glacial moraines are at the heads of West Canyon and the Left Fork of West Canyon in the Oquirrh Mountains.

Structure

Cedar Valley is a basin similar in structure to the many basins of the Basin and Range physiographic province in Utah and Nevada. It is principally a graben produced by a system of faults that has uplifted and tilted the surrounding mountain blocks relative to the valley floor. A gravity map of Cedar Valley (Cook and Berg, 1961, pl. 13) shows the north-central part of the basin (T. 6 S., R. 2 W.) to be deepest. The fault system that produced the basins of western Utah is still active; therefore, Cedar Valley may still be in the process of development.

The rocks in the mountains surrounding the basin generally have been folded into broad, north to northwest trending folds (figure 3). These broad folds and their subsidiary faults and folds were probably made during Cretaceous and early Tertiary time, prior to development of the Cedar Valley graben. The structural elements of the bedrock are of great importance to the hydrology of the valley because of their partial control of movement of ground water into and from Cedar Valley.

WATER RESOURCES

Volume of precipitation

The range in the normal annual precipitation in Cedar Valley and surrounding mountains is generally from 12 to 40 inches. The isohyetal lines of figure 4 show that the greatest precipitation is on the Oquirrh Mountains, from which most of the surface and ground water in Cedar Valley is derived.

Not all precipitation in the Cedar Valley drainage basin is available to recharge the ground-water reservoir. It is assumed that only areas above the 12-inch isohyetal line on the west side of the basin receive precipitation that is effective in recharging the reservoir. Precipitation directly on the valley floor is used by vegetation or evaporated back to the atmosphere, and water from precipitation on the Lake Mountains moves eastward away from Cedar Valley (see p. 12).

The normal annual precipitation that falls above the 12-inch isohyetal line in the Cedar Valley drainage basin is about 150,000 acre-feet (table 1). Of this amount about 80,000 acre-feet falls above the 16-inch isohyetal line in the Oquirrh Mountains.

Surface water

The only perennial stream in Cedar Valley is in West Canyon in the Oquirrh Mountains, and all the water is diverted in sec. 7, T. 5 S., R. 2 W., for irrigation near Cedar Fort. The discharge from West Canyon from July 1965 through June 1966, as determined at a gaging station in sec. 7, T. 5 S., R. 2 W., was 2,100 acre-feet of water. Although the stream channel crosses the north end of Cedar Valley and drains into northern Utah Valley, surface water leaves the valley only in flash floods or as runoff from local snowmelt.

Ground water

Recharge.—The principal recharge area of the ground-water reservoir in Cedar Valley is in the Oquirrh Mountains along the northwest edge of the valley, where snowmelt percolates directly into fractures and solution channels of the rock. The alignment of springs (C-4-3)20dba, (C-4-3)26cbd, (C-4-3)26dda, and (C-4-3)27bab, and springs (C-5-3)36cba, (C-6-2)6cad, and (C-6-3)1aad, along the strike of the bedrock, shows that some strata transmit water more readily than others. (See figures 3 and 7.) Some precipitation also enters the alluvial and glacial deposits in the mountain valleys. Most of the water in the basin fill throughout Cedar Valley entered the ground in the Oquirrh Mountains (figure 4).

Table 1. — Annual precipitation over the recharge area and estimated water available for recharge to the ground-water reservoir in Cedar Valley

Interval of annual precipitation (inches)	Area (acres)	Average annual precipitation (feet)	Quantity of water from precipitation (acre-feet, rounded)	Estimated percentage of precipitation as recharge	Estimated water available for recharge to ground-water reservoir (acre-feet, rounded)
12-16	60,500	1.17	70,800	5	3,500
16-20	16,400	1.50	24,600	15	3,700
20-25	7,600	1.88	14,300	20	2,900
25-30	6,000	2.29	13,700	27	3,700
30-40	6,500	2.92	19,000	35	6,600
More than 40	2,700	3.33	9,000	40	3,600
	Totals (rounded)		151,000		24,000

Other areas of recharge are the East Tintic Mountains, Topliff Hill, Thorpe Hills, and alluvial fans along the west side and north end of the valley above the 12-inch isohyetal line. At the north end of the valley, discharge from West Canyon is a source of recharge beginning near the mouth of the canyon, extending south along the West Canyon ditch, and ending in the irrigated land east of Cedar Fort.

The estimated water available for recharge to the ground-water reservoir from precipitation is about 24,000 acre-feet (table 1). The percentages used in the calculations are based on the method used by Eakin and Maxey (1951, p. 79-81) in which an increased percentage of water from precipitation becomes available for recharge as the total precipitation increases with an increase in altitude of a mountain mass (isohyetal intervals of figure 4). Of the 24,000 acre-feet of water available for recharge, about 20,500 acre-feet originates above the 16-inch isohyetal line in the Oquirrh Mountains.

The amount of recharge to the ground-water reservoir from West Canyon is probably less than 5 percent of the total recharge. The valley fill in the area crossed by the stream, the West Canyon ditch, and the irrigated fields consists of permeable alluvial-fan deposits, and it is estimated that 50 percent of the water is recharged to the ground-water reservoir. The recharge from streamflow in West Canyon for 1965-66 (See p. 11) amounts to about 1,000 acre-feet.

Occurrence.—Ground water in the unconsolidated deposits in Cedar Valley occurs under both water-table (unconfined) and artesian (confined) conditions. Water-table conditions predominate in the southern part of the valley, where stock wells have been hand dug to depths of more than 200 feet. In the central part of the basin, south and east of Fairfield, water in the shallow beds in unconfined, and these beds extend from the land surface to depths of about 100 feet. Water-table conditions occur around the edges of the basin fill as indicated by the water levels in wells (C-5-2)31dcd-1, (C-6-1)18dca-1, and (C-6-1)31dab-1.

Artesian aquifers are present in the valley fill opposite the drainages of Pole and Manning Canyons, and possibly in the alluvial fan of West Canyon. Permeable and impermeable beds in the lower parts of the alluvial fans in Pole and Manning Canyons form the aquifers and confining beds of the artesian system on the west side of the valley in secs. 17, 29, 32, and 33, T. 6 S., R. 2 W. Toward the center of the valley, as in secs. 13, 14, 15, and 26, T. 6 S., R. 2 W., fine-grained lake-bottom deposits overlap the alluvial deposits and act as the confining beds for the artesian system. The artesian aquifers between Cedar Fort and Fairfield, extending eastward across the basin, have had the greatest development as sources of ground water in Cedar Valley. In the town of Fairfield, wells flow from the artesian aquifer at depths ranging from 100 to 824 feet. Although the artesian system may extend across the central part of the basin, artesian pressures are not sufficient to cause wells in the center or topographically low parts of the basin to flow. The low artesian pressure may be due to the discharge of water from the basin fill into the bedrock along the east edge of the valley. Artesian conditions may occur at depths exceeding 200 feet in the southern part of the valley, but no substantiating data are available.

Movement of ground water.—The ground water in Cedar Valley moves generally from the west to the east side of the valley. Figure 4 shows contour lines connecting points of equal altitude on the water surface in March 1966. Because ground water moves from points of higher altitude to points of lower altitude, the contours indicate the direction of movement and the areas of ground-water recharge and discharge.

Altitudes of the water surface are highest near Fairfield and Cedar Fort, where water from the Oquirrh Mountains enters the basin fill. Nearly all the ground water in the central and southern parts of the valley has infiltrated along the Pole Canyon syncline (figure 3), and moved through fractures and solution channels in the rock, down the syncline, and into the valley fill.

The lowest altitudes of the water surface are along the east edge and southeast corner of the valley. Along the base of the Lake Mountains from about sec. 24, T. 5 S., R. 2 W., southward to sec. 8, T. 7 S., R. 1 W., the beds of the west limb of the Lake Mountains syncline (figure 3) dip toward the east and water leaves Cedar Valley along the bedding planes and through fractures and solution channels in the rocks. The water may discharge in springs and seeps on the east side of the Lake Mountains, in the bottom of Utah Lake, or to the alluvium northeast of the Lake Mountains on the west side of northern Utah Valley.

Ground water also leaves Cedar Valley through bedrock in the low pass between the Lake and Traverse Mountains. This movement is indicated by the difference of water levels in test wells (C-5-1)20ddc-1 and (C-5-2)24aab-1, which are completed in bedrock at the north end of the Lake Mountains.

The ground-water trough extending southwest of sec. 25, T. 5 S., R. 2 W. (figure 4), is probably caused by ground water draining from the basin in the northeast corner of the valley and by pumping irrigation wells in secs. 13, 14, and 15, T. 6 S., R. 2 W.

Ground water may also leave the southeast corner of Cedar Valley through the bedrock of the eastern East Tintic Mountains in Tps. 8 and 9 S., R. 2 W. This water may move into the alluvium on the west side of Goshen Valley.

Water in bedrock in the western East Tintic Mountains in Tps. 8 and 9 S., R. 3 W., probably moves to the west and east, controlled by the structure of the North Tintic anticline (figure 3). Water from the west limb of the anticline probably moves into Rush Valley, whereas water from the east limb moves into the valley fill in the southern end of Cedar Valley.

Water-level fluctuations.—Water levels in observation wells in Cedar Valley rise and fall in response to recharge to and discharge from the ground-water reservoir.

The hydrograph of well (C-6-2)29cac-1 (figure 5) shows three general water-level conditions: a relatively steady trend of high water levels from 1943 through 1952, a generally declining trend from 1953 to 1964, and rising water levels during 1965 and the spring of 1966. These trends generally follow the curve of the cumulative departure from the 1943-65 average annual precipitation at Fairfield (figure 5). Lines trending upward on the cumulative-departure curve indicate periods of above-average precipitation, when recharge to the ground-water reservoir is comparatively great; and lines trending downward indicate periods of below-average precipitation, when recharge is comparatively small.

Precipitation was above average for most of the period 1944 through 1952; but water levels in well (C-6-2)29cac-1 did not rise continuously because the discharge of nearby Fairfield Spring, (C-6-2)29ccc, had a damping effect.

From 1952 to 1962, however, the nearly continuous below-average precipitation resulted in a nearly continuous decline in water levels. This decline was accentuated in 1963-64 by the pumping of irrigation wells in secs. 17 and 32, T. 6 S., R. 2 W.

Water levels rose in 1965 and early in 1966 because of a combination of above-average precipitation from 1963 to 1965 and cessation of pumping at the irrigation wells in secs. 17 and 32, T. 6 S., R. 2 W.

The hydrographs of wells (C-6-2)14cba-1 and (C-6-2)16baa-1 (figure 5) show the decline of water levels from 1954 to 1966 in an area 3 miles northeast of Fairfield where irrigation wells have been pumped annually during the entire period of the hydrograph. Although water levels rose in 1965, they declined in the pumping season of 1966 to record lows at each observation well.

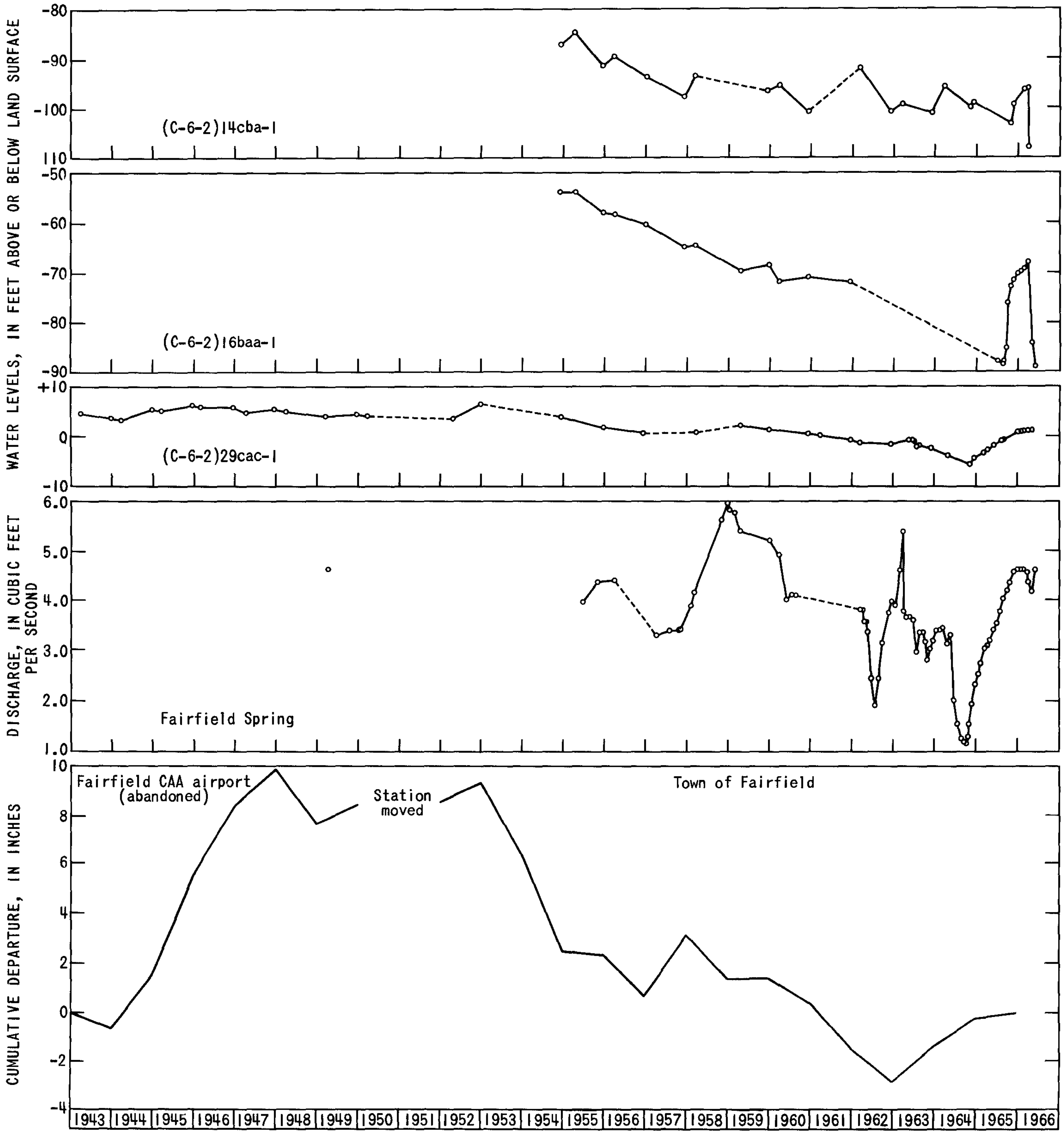

Figure 5. — Hydrographs of selected wells, discharge of Fairfield Spring, and cumulative departure from the 1943-65 average annual precipitation at Fairfield.

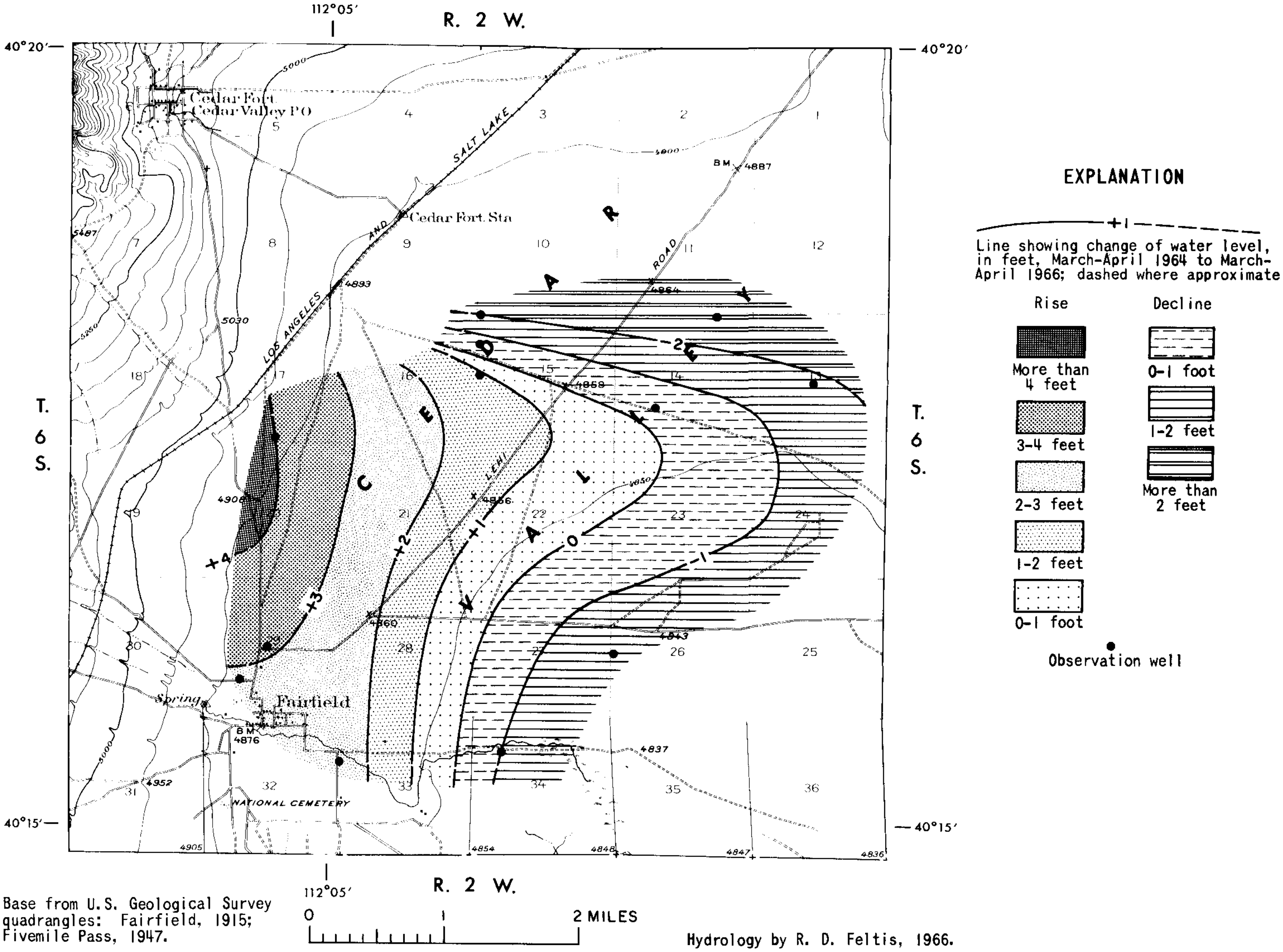

Figure 6. — Changes of water levels in the artesian aquifer, March-April 1964 to March-April 1966 in part of Cedar Valley.

The effects of pumping an irrigation well, (C-6-2)26cbb-1, on two wells of different depths are indicated by water-level measurements in table 5. The water level in well (C-6-2)27ccc-1 declined 11.1 feet from April 7 to June 9, 1966, while the irrigation well was being pumped. The wells are about 1 mile apart, and both are 505 feet deep. During the same period, however, water levels in well (C-6-2)27ccc-2, which is 100 feet deep, did not decline but rose 0.2 foot.

Figure 6 shows the change of water levels in north-central Cedar Valley from March-April 1964 to March-April 1966. The rise of water levels in the western part of the valley reflects above-average precipitation in the recharge area from 1963 to 1965 and a cessation of pumping at the irrigation wells in secs. 17 and 32, T. 6 S., R. 2 W., in 1965. The decline of water levels in the central part of the basin is the result of continued withdrawal of water for irrigation in that area. (See well (C-6-2)14aba-1 in table 5.)

Water-bearing characteristics of the aquifers.—Information on the water-bearing characteristics of the aquifers in Cedar Valley is based on data obtained from a pumping test of well (C-6-2)14cac-1 and recovery tests of wells (C-6-2)13caa-1 and (C-6-2)26cbb-1 and calculations of specific capacities of wells in various sections of T. 6 S., R. 2 W.

Data from the pumping test were used to determine the coefficients of transmissibility[1] and storage[2] of the aquifer. Well (C-6-2)14cac-1 was pumped at an average rate of 600 gpm (gallons per minute) from March 28 to April 1, 1966, at the beginning of the irrigation season and prior to the pumping of other irrigation wells. Water-level fluctuations were observed in wells (C-6-2)14aba-1, (C-6-2)14cba-1, and (C-6-2)14dba-1. The coefficients of transmissibility and storage were computed using the nonequilibrium formula (Theis, 1935). The respective determined values for T at wells (C-6-2)14aba-1, (C-6-2)14cba-1, and (C-6-2)14dba-1 were 26,000, 12,000, and 8,000 gpd per ft (gallons per day per foot) and for S were 0.002, 0.001, and 0.0005.

At the end of the 1965 pumping season, recovery tests were made at wells (C-6-2)26cbb-1 and (C-6-2)13caa-1 on September 15 and 17, respectively. The coefficients of transmissibility were computed using the Theis recovery formula (Theis, 1935). The coefficient of transmissibility was 9,000 gpd per ft at well (C-6-2)26cbb-1 and 5,000 gpd per ft at well (C-6-2)13caa-1.

The specific capacities of irrigation wells in Cedar Valley range from 0.7 to 37 gpm per foot of drawdown (table 2). This wide range is due mostly to the variation in the composition of the aquifers. Wells (C-6-2)17dcc-1 and (C-6-2)17dcc-2, which have respective specific capacities of 30 and 37 gpm per foot of drawdown, are developed in coarse-grained aquifers of the alluvial fan of Pole Canyon. Wells in the central part of the basin, with specific capacities of 0.7 to 6.8 gpm per foot of drawdown, are developed in fine-grained lacustrine, eolian, and alluvial deposits. Some of the lower specific capacities can be attributed to caving around the well, and several wells have been abandoned because of caving.

Data from the pumping test, recovery tests, and specific capacities of wells indicate an increase in the coefficient of transmissibility from the center of the basin toward the north end and west side of the basin.

Discharge.—Water is discharged from the ground-water reservoir in Cedar Valley by springs, by wells, by evapotranspiration, and by subsurface outflow from the basin.

[1]The coefficient of transmissibility, T, is the rate of flow of water, in gallons per day, at the prevailing water temperature, through a vertical strip of the aquifer 1-foot wide extending the full saturated height of the aquifer under a hydraulic gradient of 100 percent.

[2]The coefficient of storage, S, of an aquifer is the volume of water released or taken into storage per unit surface area of the aquifer per unit change in the component of head normal to that surface.

Fairfield Spring, (C-6-2)29ccc, at the west edge of Fairfield, is the largest spring in Cedar Valley. It discharges water that is derived from precipitation on the Oquirrh Mountains. The permeable coarse-grained aquifers at the head of the alluvial fans of Manning and Pole Canyons readily transmit the water; but increasingly finer grained deposits toward the toe of the fan and in the lake beds in the center of the basin retard the flow, forcing some of the water to the surface. This discharges at the spring, which is at the break in slope of the alluvial fan with the valley floor.

Fairfield Spring generally discharges between 3 and 5 cfs (cubic feet per second), and the maximum discharge on record is 5.96 cfs (figure 5). A comparison of the spring hydrograph with the curve showing the cumulative departure from average annual precipitation at Fairfield (figure 5) shows the time lag between precipitation on the Oquirrh Mountains and discharge from the spring. For example, the above-average precipitation of 1957 resulted in a record high discharge of Fairfield Spring in late 1958. The sharp decrease in yield of the spring during the irrigation seasons of 1962-64 was due to pumping of irrigation wells in sec. 17, T. 6 S., R. 2 W., which tap the same or interconnected aquifers.

The water from Fairfield Spring is used mostly for irrigation near Fairfield in the summer and for irrigation of native pasture, from Fairfield southeast to the Sinks, during the winter. The upper part of the valley fill between Fairfeld and the Sinks consists of fine-grained lake beds with low permeability. Much of the water applied for irrigation, therefore, is discharged by evapotranspiration. Assuming an average discharge of 4 cfs from the spring, it is estimated that 70 percent of the water, or about 2.8 cfs (2,000 acre-feet per year), is consumed by evapotranspiration.

The total annual discharge of three springs west of Cedar Fort, based upon measurements made in October 1965, was about 800 acre-feet. About 50 percent of this water is returned to the ground-water reservoir; the remainder is consumed by evapotranspiration.

Numerous springs discharge in the mountains, but their yields are generally less than 15 gpm. They are used for stock watering.

During 1965, about 10 acre-feet of water was withdrawn from small-diameter wells for domestic and stock use, and about 1,900 acre-feet of water was pumped at 8 large-diameter irrigation wells in secs. 13 (1 well), 14 (3 wells), 15 (3 wells), and 26 (1 well), T. 6 S., R. 2 W. The yield of the wells ranged from 130 to 1,115 gpm. All the pumps are driven by electric motor, and the annual well discharge was computed from the amount of water discharged per 1,000 kilowatt hours of electricity used in 1965.

During 1964, about 3,800 acre-feet of water was pumped at 11 irrigation wells. These included the eight large-diameter irrigation wells mentioned above and three additional wells in secs. 17 (2 wells) and 32 (1 well), T. 6 S., R. 2 W. The two wells in sec. 17 reportedly yielded 2,000 and 3,600 gpm upon their completion in 1961-62. The three wells in secs. 17 and 32 produced 2,700 acre-feet of water in 1964 compared to 1,100 acre-feet from the 8 wells in secs. 13, 14, 15, and 26. The wells in secs. 17 and 32 tap more permeable, coarse-grained aquifers in alluvial fans along the west edge of the basin as compared to the fine-grained aquifers tapped by wells in secs. 13, 14, 15, and 26 in the center of the basin.

Evapotranspiration in secs. 13, 14, 15, 26, and 32, T. 6 S., R. 2 W., probably consumes 90 percent of the water pumped for irrigation because the low permeability of the surface deposits prevents rapid downward percolation. Thus in 1965, when the pumpage in these sections was about 1,900 acre-feet, approximately 1,700 acre-feet was consumed by evapotranspiration. The rate of evapotranspiration is probably lower in sec. 17, T. 6 S., R. 2 W., because the surface deposits consist of alluvial-fan sediments which permit a greater rate of infiltration.

Two methods were used to estimate the subsurface outflow of water along the east edge of the basin. The first method was based on transmissibility data obtained from aquifer tests and the hydraulic gradient of March 1966, determined from the water-table contour map (figure 4). The second method was a water budget for the ground-water reservoir.

In the first method, the parts of the ground-water reservoir to which the calculations apply are shown by the line of reference in figure 4. The transmissibility and hydraulic gradient along each section of the line were assumed to be uniform. The subsurface outflow beneath each segment of the line of reference was calculated using the formula:

$$Q = 0.00112\ T\ I\ W$$

where Q is the outflow, in acre-feet per year; 0.00112 is a factor that converts gallons per day to acre-feet per year; T is the coefficient of transmissibility, in gallons per day per foot; I is the hydraulic gradient, in feet per mile; and W is the length of the segment, in miles.

No aquifer test data are available for the southern part of Cedar Valley. The valley fill is relatively fine grained, however, and the coefficient of transmissibility along segment 1 is estimated to be about 7,000 gpd per ft. The hydraulic gradient is about 8 feet per mile.

Along segment 2, the hydraulic gradient is about 31 feet per mile. The coefficient of transmissibility based on data obtained during the recovery test at well (C-6-2)26cbb-1 is 9,000 gpd per ft.

Segment 3 is across an area where the depression of ground-water contours has been accentuated by pumping irrigation wells in secs. 13, 14, and 15, T. 6 S., R. 2 W. The transmissibility along this segment is based on the change in hydraulic gradient across the segment for an annual rate of discharge from wells of 1,500 acre-feet per year. The formula used to calculate the transmissibility of the segment is:

$$T = \frac{Q}{0.00112\ (I-I')W}$$

where T is the transmissibility, in gallons per day per foot; Q is the discharge of wells, 1,500 acre-feet per year; 0.00112 is a factor converting gallons per day to acre-feet per year; I is the average hydraulic gradient as determined from figure 4, 50 feet per mile; I' is the estimated average hydraulic gradient before pumping began, 33 feet per mile; and W is the length of the segment, 4.3 miles or

$$T = \frac{1,500}{0.00112\ (50-33)4.3} = 18,320, \text{ rounded to } 20,000 \text{ gpd per ft.}$$

Aquifer-test data are not available for the north end of Cedar Valley; however, the valley fill in this area consists of coarse-grained sediments of the West Canyon alluvial fan, which are assumed to be as permeable as the sediments of the Pole Canyon alluvial fan, which underlie the line of segment 3. The coefficient of transmissibility along segment 4, therefore, is assumed to be 20,000 gpd per ft. The hydraulic gradient is 73 feet per mile.

Underflow for the four segments is presented in the following table:

Segment (location shown in figure 4)	Coefficient of transmissibility (gallons per day per foot)	Hydraulic gradient (feet per mile)	Length of segment (miles)	Subsurface outflow past the segment (acre-feet per year)
1	7,000	8	6.1	400
2	9,000	31	8.4	2,600
3	20,000	33	4.3	3,200
4	20,000	73	2.2	3,600
		Total (rounded)		10,000

Thus the total subsurface outflow along the east edge of the basin is estimated to be 10,000 acre-feet per year.

The second method used to estimate subsurface outflow was a water budget of the ground-water reservoir in Cedar Valley. This budget is only an approximation of true conditions, however, because few data are available for rates of precipitation, evapotranspiration, and recharge in irrigated and nonirrigated areas.

It is assumed that all the water leaving the basin along the eastern margin (figure 4) is subsurface outflow from the basin and is a constant quantity. On this basis, the equation of the hydrologic budget is as follows: subsurface outflow (S) from the basin equals recharge from precipitation (Rp), minus evapotranspiration of surface water from West Canyon (Es), and of ground water from Fairfield Spring (Ef) and the three springs west of Cedar Fort (Ec), and of water pumped from wells (Ep), or

$$S = Rp - (Es + Ef + Ec + Ep)$$

Substituting values determined in previous sections of this report,

$$S = 24{,}000 - (1{,}000 + 2{,}000 + 400 + 1{,}700)$$

$$S = 19{,}000 \text{ acre-feet per year (rounded)}$$

Thus the subsurface outflow along the east edge of the basin is estimated by the budget method to be 19,000 acre-feet per year. Although this is almost twice as much as the outflow calculated by the first method, the two figures are of the same order of magnitude and they are a good indication of the magnitude of the actual quantity of outflow.

Test-well drilling.—Five test wells were drilled at four sites in Cedar Valley to construct water-level observation wells and to obtain additional data about the aquifers in parts of the valley. Descriptive data, water-level measurements, and logs for the test wells are given in tables 2, 5, and 7. Electric and gamma-ray logs for four of the wells are in the files of the U.S. Geological Survey in Salt Lake City.

Test wells (C-5-1)20ddc-1 and (C-5-2)24aab-1 were drilled in the pass between the Lake Mountains and the Traverse Mountains to determine the thickness of the alluvium, the depth to water, and whether or not water moves from Cedar Valley to Utah Valley through the alluvium. The alluvium was found to be 70 feet thick in well (C-5-1)20ddc-1 and 60 feet thick in well (C-5-2)24aab-1 (table 7). Water levels in the two test wells in May 1966 were 94 and 127 feet below the land surface, respectively. This indicates that the water does not leave Cedar Valley through the alluvium, but it does move through the bedrock.

Test well (C-6-2)1acc-1 was drilled to provide water-level data for the northeast corner of the valley and to define more closely the water-level contour lines of that area (figure 4). The test well was drilled entirely in unconsolidated valley-fill deposits, mostly sandy and clayey silt with occasional beds of fine to medium-grained sand or silty sand, ranging in thickness from 2 to 8 feet. The water level in the well was 175 feet below the land surface in March 1966.

Two test wells, about 15 feet apart, were drilled in sec. 27, T. 6 S., R. 2 W. Test well (C-6-2)27ccc-1 was drilled to a depth of 505 feet for observation of water levels in the deep artesian aquifer. It was drilled entirely in unconsolidated valley-fill deposits, mostly clayey and sandy silt with occasional beds of fine-grained sand or silty sand, ranging in thickness from 2 to 10 feet. Test well (C-6-2)27ccc-2 was drilled to a depth of 100 feet to provide water-level measurements in the shallow unconfined aquifer. A plug was installed in the annulus of the deep test well at a depth of 150 feet in an attempt to isolate the deep and shallow aquifers. Water levels in the shallow test well and the annulus of the deep test well were at the same level and almost 3 feet higher than the level within the deep test well itself during April 1966.

Chemical quality of water

The concentration of dissolved solids in the water in Cedar Valley ranges from 225 to 2,020 ppm (parts per million). Figure 7 shows the areal distribution of dissolved-solids concentrations and also illustrates the chemical composition of the water with lined diagrams. Differences in chemical composition are shown by the differences in the slope and length of lines comprising the diagrams.

The water from most of the wells and springs in the northern and south-western parts of the valley contains less than 500 ppm of dissolved solids, and the principal chemical constituents are calcium and bicarbonate. The springs in the principal recharge area (Oquirrh Mountain slopes, west and northwest of Cedar Fort) yield a calcium bicarbonate type of water chemically similar to that of ground water in the north-central part of the valley. The wells in the southeastern part of the valley yield water containing the highest concentration of dissolved solids, and the principal chemical constituents are sodium and sulfate.

Most of the water in the valley is very hard (more than 180 ppm), but generally the chemical constituents do not exceed the recommended maximum concentrations of the U.S. Public Health Service (1962, p. 7) as given below:

Constituent	Recommended maximum concentration (parts per million)
Dissolved solids	500
Chloride (Cl)	250
Sulfate (SO_4)	250
Nitrate (NO_3)	45

Thirty water samples from wells and springs in Cedar Valley were evaluated for suitability for irrigation by using a method devised by the U.S. Salinity Laboratory Staff (1954, p. 80). The water was classified in regard to salinity hazard and sodium hazard by plotting the specific conductance versus the sodium-adsorption ratio (figure 8). The interpretation of these quality-class ratings plotted in figure 8 are summarized by the U.S. Salinity Laboratory Staff (1954, p. 79-81) as follows:

"Medium-salinity water (C2) can be used if a moderate amount of leaching occurs. Plants with moderate salt tolerance can be grown in most cases without special practices for salinity control.

"High-salinity water (C3) cannot be used on soils with restricted drainage. Even with adequate drainage, special management for salinity control may be required and plants with good salt tolerance should be selected.

"Very high salinity water (C4) is not suitable for irrigation under ordinary conditions, but may be used occasionally under very special circumstances. The soils must be permeable, drainage must be adequate, irrigation water must be applied in excess to provide considerable leaching, and very salt-tolerant crops should be selected.

"Low-sodium water (S1) can be used for irrigation on almost all soils with little danger of the development of harmful levels of exchangeable sodium. However, sodium-sensitive crops such as stone-fruit trees and avocados may accumulate injurious concentrations of sodium.

"Medium-sodium water (S2) will present an appreciable sodium hazard in fine-textured soils having high cation-exchange-capacity, especially under low-leaching conditions, unless gypsum is present in the soil. This water may be used on coarse-textured or organic soils with good permeability.

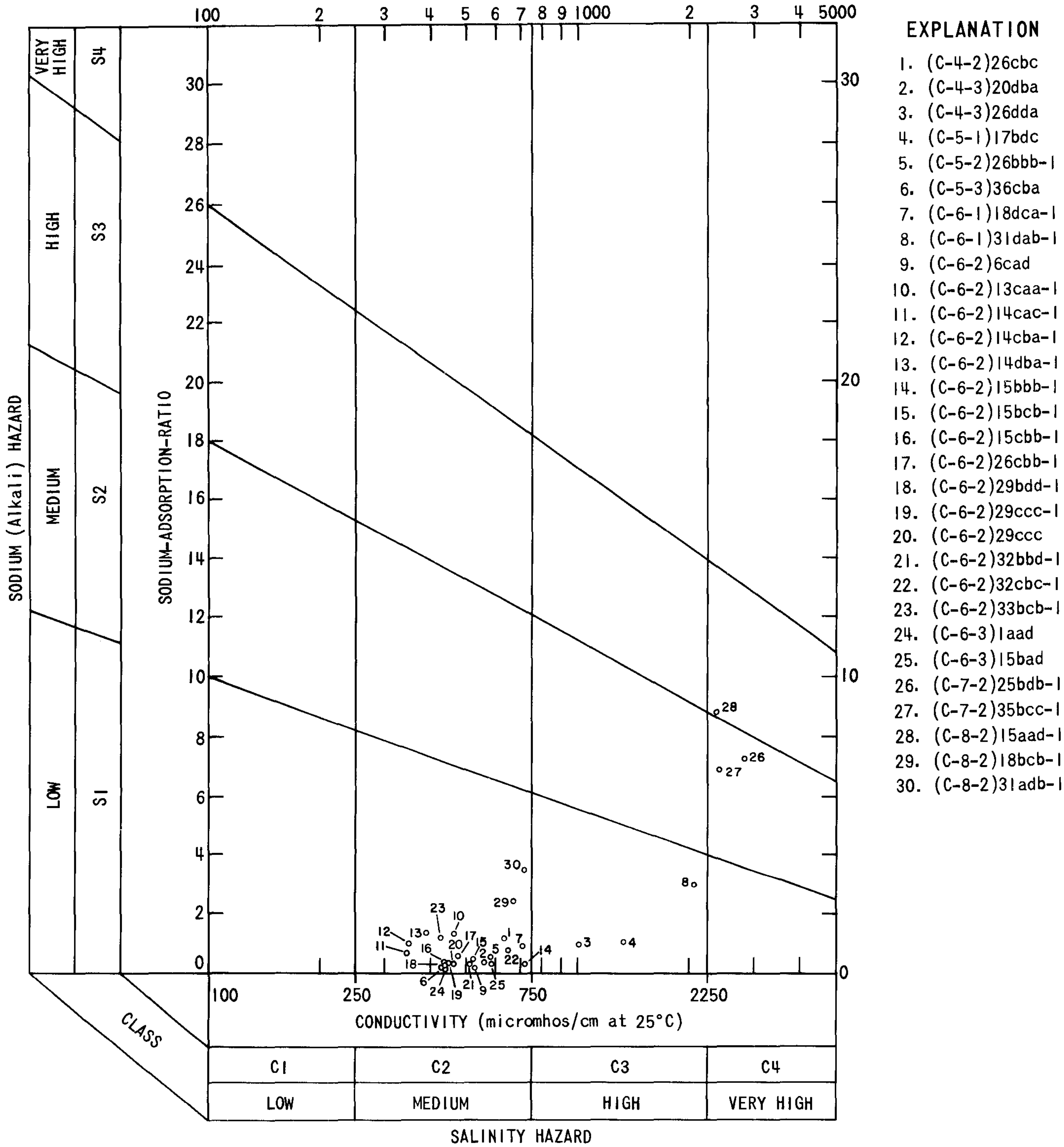

Figure 8. — Classification of water for irrigation in Cedar Valley (method of U.S. Salinity Lab. Staff, 1954, p. 80). Numbers refer to analyses in table 4.

"High-sodium water (S3) may produce harmful levels of exchangeable sodium in most soils and will require special soil management—good drainage, high leaching, and organic matter additions. Gypsiferous soils may not develop harmful levels of exchangeable sodium from such waters. Chemical amendments may be required for replacement of exchangeable sodium, except that amendments may not be feasible with waters of very high salinity."

Water from most of the wells and springs that were sampled in Cedar Valley has a low-sodium hazard and a medium-salinity hazard (figure 8). The analyses of water from the three wells that were sampled in the southern part of the valley, however, suggests that water in a large area southeast of Fairfield probably has a very high salinity hazard and medium to high-sodium hazard.

SUMMARY AND CONCLUSIONS

Most of the water in the ground-water reservoir of Cedar Valley is derived from precipitation on the Oquirrh Mountains northwest of the valley. After seeping into the ground, the water moves directly from the bedrock of the mountains into the aquifers of the valley fill, thence east and southeast across the valley.

Most of the wells in the valley tap artesian aquifers in the north-central part of the basin and yield water of good quality for domestic use and irrigation. Stock wells in the southeast part of the basin yield water of poor quality from aquifers under water-table conditions. In the southwest corner of the valley, where some recharge occurs at the base of the East Tintic Mountains, stock wells yield water of good quality.

During 1965, eight irrigation wells in secs. 13, 14, 15, and 26, T. 6 S., R. 2 W., discharged a total of 1,900 acre-feet of water. The yields of the wells ranged from 130 to 1,115 gpm, and specific capacities ranged from 0.7 to 6.8 gpm per ft of drawdown. During 1964, the eight wells discharged only 1,100 acre-feet of water, but three wells in secs. 17 and 32 discharged an additional 2,700 acre-feet of water. Two of the wells in sec. 17, reportedly yielded 2,000 and 3,600 gpm, with specific capacities of about 30 and 37 gpm per ft of drawdown upon their completion in 1961-62. The difference in well performance in the two areas is an indication of more permeable aquifers on the west edge of the basin.

Water levels in the valley generally fluctuate in response to variations of precipitation. In secs. 14 and 15, T. 6 S., R. 2 W., however, where nine irrigation wells were drilled during 1951-64, water levels have declined as much as 21 feet during the period 1954-66. Water levels in wells near Fairfield and the discharge of Fairfield Spring declined during the period 1962-64 when large irrigation wells in sec. 17, T. 6 S., R. 2 W., were pumped in the same or interconnected aquifers.

The estimated subsurface outflow of water from Cedar Valley along the east edge of the basin ranges from about 10,000 to 20,000 acre-feet per year. Some of this water could be recovered in the valley by an increased withdrawal of water from wells, principally along the west edge of the basin in T. 6 S., R. 2 W., where most of the recharge enters the valley fill from the bedrock in the Oquirrh Mountains. The aquifers in this area are the most permeable known in the basin; they are under artesian conditions, and the quality of the water is good. The altitude of the area would permit gravitational flow of the water to nearly any area now being irrigated. A long-term effect of pumping the wells, however, would be a decrease in the artesian pressure of the aquifers and a resultant decrease in or cessation of discharge from flowing wells and springs in the Fairfield area.

Another area of potential ground-water development is the alluvial fan of West Canyon. No well or water-level data are available for the large area north of Utah Highway 73, but permeable materials should be present in the fan which was built by the only perennial stream in the valley.

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Table 2. — Records of selected wells in Cedar Valley

Well number: See text for description of numbering system. Locations are shown in figure 4.
Type of well: Dr, drilled; Du, dug.
Altitude of land-surface datum: Surveyed altitudes from U.S. Geological Survey are given in feet and tenths; altitudes interpolated from topographic maps are given in feet.
Measuring point: Description - Ahp, access hole in pump; Apc, access pipe on casing; Bpb, bottom of pump base; Edp, end of discharge pipe; Hca, hole in casing; Hpb, hole in pump base; Hpc, hole in plate over casing; Tca, top of casing; Tcc, top of cap on casing; Tec, top of elbow on casing; Tfc, top of flange on casing; Tpc, top of pipe coupling; Trc, top of reducer on casing; Ttc, top of tee on casing.
Water level: Measured distances to water levels are given in feet and tenths; reported distances are given in feet.
Method of lift: Cy, cylinder pump; F, flowing well; N, no pump and well does not flow; T, turbine pump; Ts, submersible turbine pump.
Yield (gpm, gallons per minute): B, bailed; F, natural flow; P, pumped; e, estimated; m, measured; r, reported.
Specific capacity: gpm/ft, gallons per minute per foot of drawdown.
Use of water in 1965: D, domestic; I, irrigation; N, none; Nt, none, drilled as test well; S, stock.
Temperature: r, reported.
Remarks and other data available: C, chemical analysis (table 4); EGR, electrical and gamma-ray logs in files of U.S. Geological Survey, Salt Lake City; H, hydrograph (fig. 5); L, driller's log (table 6); perf., casing perforated; TW, test well; TWL, test-well log (table 7); W, water-level measurements (table 5).

Well number	Owner or user	Year drilled	Type of well	Depth of well (feet)	Diameter of well (inches)	Depth of casing (feet)	Altitude of land-surface datum (feet)	Measuring point		Water level		Method of lift	Yield		Drawdown		Specific capacity (gpm/ft)	Use of water in 1965	Temperature (°F)	Remarks and other data available
								Description	Above(+) or below(-) land-surface datum (feet)	Above(+) or below(-) surface (feet)	Date of measurement		Rate (gpm)	Date of measurement	Amount	Duration of test (days)				
(C-5-1)																				
19dbb-1		1963	Dr	105	10,6	105	4,900	-	-	Dry	8- 4-65	N	-	-	-	-	-	N	-	
20ddc-1	U.S. Geological Survey	1966	Dr	300	1	220	4,795	Tca	+0.5	-93.5	5- 3-66	N	-	-	-	-	-	Nt	-	TW 3. Perf. 60-70, 90-100, 210-220 ft. EGR, TWL, W.
(C-5-2)																				
24aab-1	do	1966	Dr	155	1	155	4,989.7	Tca	0	-127.3	5- 3-66	N	-	-	-	-	-	Nt	-	TW 2. Perf. 55-65, 145-155 ft. EGR, TWL, W.
26bbb-1	State of Utah	1916	Dr	448	8	448	5,082.9	-	-	-361	6-22-60	Cy	18Pr	6-22-60	-	-	-	S	53	C.
31dcd-1	G. S. Cook	1963	Dr	325	8	321	5,181.4	Tca	+1.4	-296.8	2-28-66	N	-	-	-	-	-	N	-	Bailer test April 1963; yield 12 gpm, no drawdown after 1 hr. Perf. 300-320 ft. L, W.
34dab-1	-	1943	Dr	280	6,4	280	4,962.2	Tca	+.9	-249.0	3-26-66	N	-	-	-	-	-	N	-	No perforations reported. Water level 250 ft in April 1943 reported by well driller. W.
(C-6-1)																				
18dca-1	Cooperative Security Corp.	1948	Dr	264	6	264	4,887.9	Tca	0	-230.0	3-14-66	Cy	12Pm	8-31-65	-	-	-	S	81	Perf. 235-264 ft. C, L, W.
31dab-1	do	1947	Dr	223	6	223	4,875	Tca	+1.1	-195.3	3-14-66	Cy	6Pm	7-21-65	-	-	-	S	61	Perf. 190-223 ft. C, W.
(C-6-2)																				
1acc-1	U.S. Geological Survey	1966	Dr	300	1	300	4,891.5	Tca	0	-174.6	3-30-66	N	-	-	-	-	-	Nt	-	TW 1. Perf. 200-210, 230-240, 280-290 ft. EGR, TWL, W.
5cad-1	-	193_	Dr	105	4	-	4,972.8	Tca	-3.3	-82.9	2-28-66	N	-	-	-	-	-	N	-	Local resident reported well drilled in early 1930's as drought relief well to depth of about 200 ft. Well was never used. W.
13caa-1	Cooperative Security Corp.	1962	Dr	525	10	339	4,856.6	Apc	+1.5	-119.8	3-28-66	T	400Pm	5- 3-66	72	(1)	5.5	I	61	Well was gravel packed 15-339 ft; perf. 0-339 ft; sealed 0-15 ft with bentonite in 20-inch surface casing. C, L, W.
14aba-1	do	1954	Dr	1,258	20,12	1,254	4,865.7	Tca	0	-121.7	3-28-66	N	90Pr	2- -54	-	-	-	N	-	Perf. 150-300, 306-1,254 ft. L, W.
14aca-1	do	1954	Dr	1,014	20,12	1,014	4,862.6	Tca	0	-109.7	2-28-66	N	-	-	-	-	-	N	-	Perf. 150-274, 280-1,014 ft. W.
14cac-1	do	1951	Dr	1,250	14,10	1,250	4,855.1	Edp	+14.4	-87.1	3-28-66	T	530Pm	5- 3-66	-	-	-	I	59	Perf. below 300 ft. C, W.
14cba-1	do	1954	Dr	1,007	16	1,007	4,856.7	Hca	-1.0	-99.2	3-28-66	T	330Pm	5- 3-66	-	-	-	D,I	59	Perf. 98-1,007 ft. C, H, W.
14dba-1	do	1964	Dr	810	20,12, 10	600	4,858.4	Bpb	+1.9	-97.3	3-28-66	T	130Pm	5- 3-66	174	(1)	.7	I	64	Casing: 20-inch from 0-556 ft, 12-inch from 0-350 ft, and 10-inch from 350 to 600 ft. Perf. 120-556 ft in 20-inch casing, 170-600 ft in 12- and 10-inch casing. Gravel packed between 20-inch and 12- and 10-inch casing 0-600 ft. C, W.
15abb-1	do	1961	Dr	2,366	16,10, 8	2,085	4,864.9	Tca	0	-120.4	3-27-66	N	470Pm	7- 1-63	-	-	-	N	-	Well deepened from 460 to 890 ft in 1959 and from 890 to 2,366 ft in 1961. Perf. 222-440, 985-995, 1,045-1,075, 1,440-1,485, 1,844-2,070 ft. L, W.
15bbb-1	do	1957	Dr	835	16	835	4,871.7	Apc	0	-118.9	2-28-66	T	515Pm	5- 3-66	134	33	3.8	I	53	Perf. below 185 ft. C, W.
15bcb-1	do	1959	Dr	955	16,10	955	4,864.6	Apc	+2.5	-88.9	3-24-66	T	390Pm	5- 3-66	140	(1)	2.8	I	53	Perf. 278-955 ft. C, W.
15cbb-1	do	1957	Dr	455	16	415	4,860.5	Apc	+1.5	-71.4	3-28-66	T	500Pm	5- 3-66	138	(1)	3.6	I	53	Perf. 190-340, 395-405 ft. C, W.
16baa-1	M. K. White	1951	Dr	505	10	505	4,876.5	Hpb	+1.3	-67.9	4- 1-66	T	335Pm	7-10-63	-	-	-	I	-	Perf. below 80 ft. H, W.
17dcc-1	do	1961	Dr	600	16	562	4,913.6	Ahp	+.5	-20.7	3-31-66	T	2,000Pr 2,890Pm	12-30-61 7- 1-64	67	2.6	30	I	-	Perf. 150-175, 237-246, 350-376, 422-432, 445-492, 525-555 ft. The south well of two wells. L, W.
17dcc-2	do	1962	Dr	595	16	595	4,920.9	Ahp	+.5	-27.9	3-31-66	T	3,600Pr 2,765Pm	2-24-62 7- 1-64	97	1	37	I	-	Perf. 170-174, 238-248, 325-350, 365-371, 410-440, 465-481, 488-493, 530-544, 550-574, 582-587 ft. The north well of two wells. W.
25cbc-1	Cooperative Security Corp.	-	Dr	-	-	-	4,838.8	Tca	+1.7	-68.9	3-30-66	Cy	-	-	-	-	-	S	-	W.
26cbb-1	do	1962	Dr	505	18	505	4,844.1	Apc	+3.3	-59.2	4- 7-66	T	1,115Pm	5- 3-66	164	26	6.8	I	53	Perf. 210-505 ft. C, L, W.
27cca-1	S. D. Nicholes	1953	Dr	80	6	80	4,842.8	Tcc	+.6	-34.6	4- 7-66	N	-	-	-	-	-	N	-	Perf. below 35 ft. W.
27ccc-1	U.S. Geological Survey	1966	Dr	505	1	505	4,843.2	Tca	0	-27.9	4- 7-66	N	-	-	-	-	-	Nt	-	TW 4. Perf. 265-275, 455-465, 485-495 ft. EGR, TWL, W.
27ccc-2	do	1966	Dr	100	1	100	4,843.2	Tca	0	-25.1	4- 7-66	N	-	-	-	-	-	Nt	-	TW 5. Perf. 90-100 ft. Located 15 ft from well (C-6-2)27ccc-1. W.
28bac-1	S. D. Nicholes	1953	Dr	80	6	80	4,858.1	Tcc	+.5	-20.0	3-11-66	N	-	-	-	-	-	N	-	Perf. below 20 ft. W.
29bdd-1	E. R. Carson	-	Dr	150	3	150	4,875.1	Trc	+1.2	+13.1	4- 7-66	F	1.8Fm	7-30-65	-	-	-	S	51	C, W.
29cac-1	L. N. Meinzer	-	Dr	350	4	350	4,888.4	Tca	0	+.9	4- 6-66	F	<1Fe	4- 6-66	-	-	-	S	50	C, H, W.
29cac-2	do	1953	Dr	220	4	220	4,888.7	Tca	+.5	-.4	4- 6-66	N	-	-	-	-	-	N	-	L, W.
29ccc-1	E. R. Carson	-	Dr	189	3	189	4,886.7	Ttc	+1.8	+2.8	3-11-66	F	1.7Fm	9- 9-65	-	-	-	I,S	52	C, W.
32bbd-1	M. K. White	1964	Dr	613	16	601	4,880	-	-	-	-	F T	42.8Fm 750Pr	9-10-65 3-14-64	- 145	- 1.3	- 5.2	I	-	Perf. at 14 intervals between 205 and 595 ft. C, L.

Table 2. — Records of selected wells in Cedar Valley — Continued

Well number	Owner or user	Year drilled	Type of well	Depth of well (feet)	Diameter of well (inches)	Depth of casing (feet)	Altitude of land-surface datum (feet)	Measuring point		Water level		Method of lift	Yield		Drawdown		Specific capacity (gpm/ft)	Use of water in 1965	Temperature (°F)	Remarks and other data available
								Description	Above(+) or below(-) land-surface datum (feet)	Above(+) or below(-) surface (feet)	Date of measurement		Rate (gpm)	Date of measurement	Amount	Duration of test (days)				
(C-6-2)																				
32cbc-1	Utah State Parks and Recreation Comm.	-	Dr	64	4	64	4,890	-	-	-	-	T	6Pr	-	-	-	-	I	-	C.
33bcb-1	Rulon Carson	-	Dr	525	2	525	4,862.4	Tec	+2.0	+10.6	4- 7-66	F	<1Fe	4- 7-66	-	-	-	D,I	-	C, W.
34bac-1	S. D. Nicholes	1953	Dr	275	6	80	4,843.5	Tca	+1.7	-30.9	3-11-66	N	25Pr	8- -53	-	-	-	N	-	Well depth sounded at 55 ft below the top of casing in May 1963. Perf, below 30 ft. W.
(C-7-2)																				
5cbc-1	W. McKinney	-	Du	54	72x72	-	4,902	-	-	-45	-	N	-	-	-	-	-	S	-	Water level reported by Snyder (1963, p. 522).
23bcc-1	R. J. McKinney	1948	Dr	220	4	220	4,835	Hpc	0	-114.6	3-11-66	Cy	10Pr	7-22-48	-	-	-	S	58r	L, W.
25bdb-1	do	-	Du	200	-	200	4,846	-	-	-	-	Cy	-	-	-	-	-	S	54	Original dug well backfilled around 6-inch tile casing with 4-inch steel pump column. C.
29dbc-1	L. A. Fitzgerald	-	Du	198	-	-	4,860	Tfc	+.3	-169.0	3-11-66	Ts	-	-	-	-	-	S	-	Original dug well backfilled around 6-inch tile casing with 4-inch steel pump column. W.
35bcc-1	R. J. McKinney	1948	Dr	225	5	225	4,852	Tca	0	-180.4	3-11-66	Cy	10Br	7-14-48	-	-	-	S	60r	C, W.
(C-8-2)																				
15aad-1	J. H. Allen	-	Du	275	-	-	4,895	Tpc	+.6	-240.8	3-11-66	Cy	-	-	-	-	-	S	-	Original dug well backfilled around 6-inch tile casing with 4-inch steel pump column. C, W.
18bcb-1	do	-	Du	290	72x72	-	4,930	-	-	-	-	Cy	-	-	-	-	-	S	-	C.
31adb-1	do	-	Du	365	-	-	5,016	Tca	+.8	-343.0	3-11-66	Cy	-	-	-	-	-	S	-	Original dug well backfilled around 6-inch steel casing with 4-inch pump column. C, W.

1/ Well had been pumped for about 1 month since the beginning of the irrigation season.

Table 3. — Records of selected springs in Cedar Valley

Location: See figure 7.
Geologic source: Oquirrh Formation is of Pennsylvanian and Permian age.
Use of water: D, domestic, I, irrigation; S, stock.
Dependability: G, good; F, fair.
Yield (gpm, gallons per minute): e, estimated; m, measured.
Remarks and other data available: C, chemical analysis (table 4); H, hydrograph (fig. 5); K, specific conductance (table 4).

Location	Owner or user	Name	Geologic source: Formation or type of rock	Geologic source: Nature of openings	Use of water	Temperature (°F)	Dependability	Improvements	Yield (gpm) and date of measurement	Deposits	Remarks and other data available
(C-4-2)26cbc	-	Tickville Spring	Alluvium in contact with igneous rock of Tertiary age	Large seep area in stream channel	S	-	G	None	10e 4-7-66	None	C.
(C-4-3)20dba	-	-	Oquirrh Formation	Joints and solution channels in limestone	S	45	-	do	15m 11-3-65	do	C.
26cbd	-	Cottonwood Spring	do	do	S	51	G	Water trough	15e 11-3-65	Tufa	K.
26dda	-	-	do	do	S	49	G	do	15m 11-3-65	do	C.
27bab	-	-	do	do	S	48	G	None	17m 11-3-65	do	K.
(C-5-1)17bdc	-	-	Alluvium	Seep area in stream channel	S	-	F	Water trough	<1e 8-25-65	None	C.
(C-5-3)4cdc	-	-	Oquirrh Formation	Joints and solution channels in limestone	S	44	-	None	10e 11-2-65	do	K.
4dcd	-	-	Alluvium	Seep area in canyon fill	S	42	G	Pipeline and trough	5m 11-2-65	do	Water piped about half a mile to water trough. K.
36cba	Cedar Fort Irrigation Co.	-	Oquirrh Formation	Joints and solution channels in limestone	I,S	46	G	None	300e 7-22-65	Tufa	C.
(C-6-2)6cad	do	-	Alluvium overlying the Oquirrh Formation	-	D,I,S	50	G	Headhouse and pipeline	>124m 7-22-65	None	C.
29ccc	Fairfield Irrigation Co.	Fairfield Spring	Alluvial fan	Large seep and spring area at toe of alluvial fan	D,I,S	52	G	Headhouse, pipeline, and diversion system	2,070m 3-11-66	do	C, H.
(C-6-3)1aad	Cedar Fort Irrigation Co.	-	Oquirrh Formation	Joints and solution channels in limestone	D,I,S	47	G	Tunnel and pipeline	>88m 7-22-65	Tufa	C.
15bad	-	-	do	do	S	52	F	None	7m 6-21-65	None	C.
(C-9-2)29b and 32c	J. H. Allen	-	Alluvium	Seep area	D,S	-	G	Pipeline and tanks	-	-	Water piped about 4 miles from two spring sites to ranch house and several stock tanks. K.

Table 4. — Chemical analyses of water from wells and springs in Cedar Valley

Dissolved solids: Residue on evaporation at 180°C unless indicated otherwise.

Sampling site	Date of collection	Temperature (°F)	Parts per million: Silica (SiO_2)	Calcium (Ca)	Magnesium (Mg)	Na + K: Sodium (Na)	Na + K: Potassium (K)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Sulfate (SO_4)	Chloride (Cl)	Nitrate (NO_3)	Dissolved solids	Hardness as $CaCO_3$	Noncarbonate hardness as $CaCO_3$	Sodium-adsorption ratio (SAR)	Specific conductance (micromhos/cm at 25°C)	pH
(C-4-2) 26cbc	4- 7-66	-	48	77	10	41		220	0	33	76	0.8	431	234	54	1.2	634	7.7
(C-4-3) 20dba	11- 3-65	45	7.0	95	13	10		330	0	25	11	.3	323	290	19	.3	558	7.6
26cbd	11- 3-65	51	-	-	-	-		-	-	-	-	-	-	-	-	-	771	-
26dda	11- 3-65	49	12	130	28	47		447	0	58	80	.1	558	438	71	1.0	1,000	7.7
27bab	11- 3-65	48	-	-	-	-		-	-	-	-	-	-	-	-	-	670	-
(C-5-1) 17bdc	8-25-65	-	49	148	30	57		148	12	56	295	2.1	853	494	353	1.1	1,360	8.5
(C-5-2) 26bbb-1	6-30-65	53	19	80	14	21		262	0	37	34	1.1	337	257	42	.6	572	7.6
(C-5-3) 4cdc	11- 2-65	45	-	-	-	-		-	-	-	-	-	-	-	-	-	477	-
4dcd	11- 2-65	42	-	-	-	-		-	-	-	-	-	-	-	-	-	518	-
36cba	7-22-65	46	6.5	62	16	2.9		240	0	15	8.0	3.5	227	220	23	.1	424	7.6
(C-6-1) 18dca-1	7- 1-65	81	21	75	25	35		240	0	70	66	1.4	421	288	91	.9	706	7.7
31dab-1 1/	7- 1-65	61	46	82	116	179		324	0	291	355	.7	2/ 1,230	680	414	3.0	2,060	7.8
(C-6-2) 6cad	7-22-65	50	8.0	88	12	5.5		288	0	27	11	2.1	290	269	33	.1	520	7.7
13caa-1	7- 1-65	61	55	35	18	37		208	0	38	21	.4	300	160	0	1.3	461	8.0
14cac-1	6- 8-65	59	53	31	14	20		170	0	14	16	1.0	229	134	0	.7	344	8.0
14cba-1	6- 8-65	59	48	27	13	26		174	0	14	14	.2	225	120	0	1.0	346	7.6
14dba-1	6- 9-65	64	46	29	13	36		198	0	22	14	.0	253	126	0	1.4	393	8.1
15bbb-1	6- 8-65	53	40	80	32	14		263	0	36	78	.7	451	332	116	.3	709	7.7
15bcb-1	6- 8-65	53	38	55	26	16		248	0	37	26	.0	313	244	41	.4	512	8.1
15cbb-1	6- 8-65	53	40	46	20	8.6		194	6	23	17	2.1	273	200	41	.3	434	8.4
26cbb-1	7- 1-65	53	53	36	30	20		246	0	27	19	.2	298	212	10	.6	470	8.2
29bdd-1	7-30-65	51	11	58	17	5.9		228	0	17	15	2.7	235	215	28	.2	430	7.6
29cac-1	1- 3-66	50	-	-	-	-		-	-	-	17	-	-	-	-	-	421	-
29ccc-1	9- 9-65	52	11	57	18	9.2		232	0	18	17	1.4	262	214	24	.3	444	7.7
29ccc	6- 3-65	-	10	59	20	8.7		236	0	29	18	2.3	253	232	38	.3	457	8.1
32bbd-1	6-30-65	-	14	56	27	12		248	0	40	21	1.0	290	250	47	.3	507	8.1
32cbc-1	10- 4-65	-	19	67	30	31		325	0	49	29	.1	380	292	26	.8	647	7.9
33bcb-1	1- 3-66	-	15	32	16	33		193	0	34	16	.3	237	146	0	1.2	424	8.0
(C-6-3) 1aad	7-22-65	47	6.8	65	16	4.0		248	0	17	8.7	3.2	235	227	24	.1	436	8.2
15bad	6-21-65	52	6.9	67	29	12		303	0	38	20	.2	321	289	41	.3	586	7.7
(C-7-2) 25bdb-1 3/	3-31-66	54	32	28	135	426	54	518	0	941	140	.4	2/ 2,020	625	200	7.4	2,870	8.1
35bcc-1	3-29-66	-	23	42	114	383		487	0	842	94	.4	2/ 1,740	575	176	7.0	2,430	7.8
(C-8-2) 15aad-1	3- -66	-	52	30	92	439		764	0	638	84	.5	2/ 1,710	455	0	8.9	2,410	8.1
18bcb-1	3- -66	-	10	31	24	75		226	0	72	56	1.5	391	176	0	2.5	668	7.8
31adb-1	3- -66	-	38	26	19	101		228	0	64	79	.5	448	146	0	3.6	717	7.7
(C-9-2) 29b and 32c		-	-	-	-	-		-	-	-	-	-	-	-	-	-	581	-

1/ Analysis includes 2.2 ppm fluoride.
2/ Calculated from determined constituents.
3/ Analysis includes 0.00 ppm iron (at time of analysis), 4.0 ppm fluoride, and 1.3 ppm boron.

Table 5. — Water levels in observation wells in Cedar Valley

Water levels in feet below land-surface datum are designated by a minus (-) sign immediately before the first entry in each column in the table, those above land-surface datum are designated similarly by a plus (+) sign. The sign applied to any water level applies to all succeeding water levels until a change is indicated.

An asterisk (*) immediately after a measurement indicates that the measurement is from data supplied by the Office of the Utah State Engineer; a dagger (†) after a measurement indicates that the measurement is from data supplied by private consultant; all other measurements were made by the U.S. Geological Survey.

(C-5-1)20ddc-1. Records available 1966

Mar. 18, 1966	1/ - 49.7	Mar. 30, 1966	2/ - 88.1	May 3, 1966	3/ - 93.5
Mar. 21	1/ 60.0	Apr. 1	3/ 42.4	June 9	93.3
Mar. 26	1/ 80.8	Apr. 7	3/ 57.9		

(C-5-2)24aab-1. Records available 1966

Mar. 26, 1966	1/ - 67.0	Apr. 1, 1966	1/ -101.2	June 9, 1966	1/ -131.0
Mar. 30	1/ 96.7	May 3	1/ 127.3		

(C-5-2)31dcd-1. Records available 1965-66

Aug. 3, 1965	-299.9	Oct. 29, 1965	-298.6	Feb. 1, 1966	-297.1
Aug. 31	299.7	Nov. 30	297.9	Feb. 28	296.7
Oct. 4	299.0	Jan. 3, 1966	297.4		

(C-5-2)34dab-1. Records available 1966

May 26, 1966	-249.0

(C-6-1)18dca-1. Records available 1964-66

Apr. 28, 1964	-227.1	July 21, 1965	-229.9	Oct. 4, 1965	-229.9
Nov. 9	228.8	Aug. 3	229.7	Oct. 29	230.0
Mar. 9, 1965	229.6	Aug. 12	4/ 230.2	Mar. 14, 1966	230.0
Apr. 12	232.8	Sept. 3	229.9		

(C-6-1)31dab-1. Records available 1964-66

Apr. 28, 1964	-194.2	Aug. 12, 1965	-194.9	Nov. 30, 1965	-195.3
Dec. 16	194.7	Sept. 3	195.0	Jan. 4, 1966	195.3
Mar. 26, 1965	194.6	Oct. 4	195.1	Mar. 14	195.3
Aug. 3	194.9	Oct. 29	195.2		

(C-6-2)1acc-1. Records available 1966

Mar. 21, 1966	1/ -136.0	Mar. 30, 1966	-174.6	May 3, 1966	-174.8
Mar. 22	1/ 154.2	Apr. 1	174.5	June 9	174.6
Mar. 26	174.5	Apr. 7	174.5		

(C-6-2)5cad-1. Records available 1965-66

Aug. 17, 1965	- 85.6	Oct. 29, 1965	- 83.5	Feb. 1, 1966	- 82.8
Aug. 31	84.5	Nov. 30	83.4	Feb. 28	82.6
Oct. 4	83.7				

(C-6-2)13caa-1. Records available 1963-66

Mar. 29, 1963	-117.1*	Apr. 12, 1965	-119.5	Nov. 30, 1965	-122.8
Apr. 5	117.4*	Sept. 9	4/ 139.5	Jan. 3, 1966	121.4
June 6	4/ 156.6	Sept. 17	4/ 169.5	Feb. 1	120.6
July 10	4/ 133.1	Sept. 18	4/ 141.9	Mar. 14	120.0
Mar. 25, 1964	118.1	Sept. 19	4/ 136.6	Mar. 27	119.8
Oct. 10	122.3	Sept. 20	4/ 134.1	Mar. 28	119.8
Dec. 16	120.6	Oct. 4	127.4	May 3	5/ 192.1
Mar. 9, 1965	120.1	Oct. 29	124.6		
Mar. 26	4/ 124.6				

(C-6-2)14aba-1. Records available 1954-55, 1963-66

Dec. 9, 1954	-111.0	Mar. 25, 1964	-118.9	July 31, 1965	-139.3
Apr. 12, 1955	109.1	Oct. 1	129.6	Aug. 31	134.9
Mar. 23, 1963	119.9*	Nov. 10	123.7	Sept. 17	133.2
Mar. 29	122.4*	Dec. 16	122.3	Sept. 30	129.9
Apr. 5	127.0*	Dec. 31	122.0	Oct. 31	125.2
Apr. 30	129.5*	Jan. 31, 1965	121.6	Nov. 30	123.7
May 7	129.9*	Feb. 25	121.4	Dec. 31	122.8
May 11	130.7*	Mar. 1	121.2	Feb. 1, 1966	122.3
May 23	132.4*	Mar. 31	128.8	Mar. 1	121.9
June 6	133.1	Apr. 30	129.6	Mar. 28	121.7
June 15	132.1*	May 31	131.8	May 3	135.0
July 3	128.4*	June 30	136.7	June 9	136.3
July 20	132.6*				

(C-6-2)14aca-1. Records available 1954-55, 1963-66

Dec. 9, 1954	- 98.4	Mar. 25, 1964	-109.3	Oct. 4, 1965	-120.1
Apr. 12, 1955	95.7	Mar. 9, 1965	109.7	Oct. 29	114.7
Mar. 23, 1963	110.6*	July 1	145.4	Nov. 30	112.3
Mar. 29	120.1*	July 30	150.5	Jan. 3, 1966	111.1
Apr. 5	133.1*	Aug. 12	155.4	Feb. 1	110.2
Apr. 30	130.0*	Aug. 31	131.5	Mar. 1	109.7
June 6	139.2	Sept. 17	135.7		

(C-6-2)14cac-1. Records available 1951-55, 1964-66

May 17, 1951	- 76.8	Dec. 22, 1955	- 82.7	Oct. 29, 1965	- 92.7
June 6	76.7	Mar. 25, 1964	86.6	Nov. 30	89.7
Apr. 22, 1952	77.6	Oct. 2	100.8*	Jan. 3, 1966	88.6
Dec. 31	78.2	Oct. 22	92.3*	Feb. 1	87.8
Apr. 22, 1953	77.8	Nov. 10	91.1	Mar. 1	87.3
May 14	77.8	Dec. 16	89.2	Mar. 28	87.1
Dec. 9, 1954	79.2	Apr. 12, 1965	4/ 108.1		

(C-6-2)14cba-1. Records available 1954-60, 1962-66

Dec. 9, 1954	- 87.1	Mar. 13, 1959	4/ -110.2	Apr. 30, 1963	4/ -150.3*
Apr. 12, 1955	84.9	Dec. 24	96.4	Dec. 5	101.3
Dec. 22	91.6	Mar. 25, 1960	95.6	Mar. 25, 1964	96.7
Mar. 28, 1956	89.6	Dec. 7	100.8	Nov. 10	100.1
Jan. 2, 1957	93.8	Mar. 5, 1962	92.0	Dec. 16	99.0
Dec. 6	98.0	Dec. 4	100.8	Apr. 12, 1965	4/ 116.0
Mar. 14, 1958	93.5	Mar. 23, 1963	99.3*	July 1	4/ 161.6

(C-6-2)14cba-1 - Continued

Aug. 25, 1965	4/ -139.6	Sept. 19, 1965	4/ -130.7	Mar. 1, 1966	- 96.3
Aug. 31	4/ 123.8	Oct. 4	111.8	Mar. 28	96.1
Sept. 9	4/ 121.5	Oct. 29	103.2	Mar. 29	6/ 102.2
Sept. 16	5/ 218.4	Nov. 30	99.3	Mar. 30	6/ 104.6
Sept. 17	4/ 154.5	Jan. 3, 1966	98.3	Mar. 31	6/ 106.6
Sept. 18	4/ 143.3	Feb. 1	4/ 100.7	Apr. 1	6/ 107.9

(C-6-2)14dba-1. Records available 1964-66

Oct. 10, 1964	-101.9	Sept. 18, 1965	-148.8	Mar. 1, 1966	- 97.5
Dec. 16	105.3	Sept. 19	139.1	Mar. 28	97.3
Mar. 9, 1965	102.4	Sept. 20	133.3	Mar. 29	6/ 102.7
Apr. 12	120.2	Oct. 4	112.6	Mar. 30	6/ 105.9
July 1	169.7	Oct. 29	104.4	Mar. 31	6/ 108.5
Aug. 25	147.1	Nov. 30	100.6	Apr. 1	6/ 110.0
Aug. 31	128.6	Jan. 3, 1966	99.1	May 3	5/ 271.2
Sept. 17	195.8	Feb. 1	98.2		

(C-6-2)15abb-1. Records available 1964-66

Mar. 25, 1964	-123.9	Aug. 31, 1965	-136.3	Oct. 29, 1965	-123.9
Nov. 10	122.0	Sept. 16	135.3	Nov. 30	122.4
Dec. 16	121.2	Sept. 17	134.9	Jan. 3, 1966	121.6
Mar. 9, 1965	121.5	Sept. 18	134.3	Feb. 1	121.1
Apr. 12	124.9	Sept. 19	133.6	Feb. 28	120.7
July 1	136.1	Sept. 20	132.8	Mar. 27	120.4
July 30	137.3	Sept. 27	128.8	May 4	133.1
Aug. 12	138.5	Oct. 4	126.9		

(C-6-2)15bbb-1. Records available 1958-61, 1964-66

Mar. 14, 1958	-101.9	Nov. 6, 1964	-120.9*	Oct. 4, 1965	-127.4
Dec. 24, 1959	107.6	Nov. 10	120.4	Oct. 29	123.1
Mar. 25, 1960	6/ 123.7	Dec. 16	119.1	Nov. 30	121.4
Dec. 7	111.2	Apr. 12, 1965	124.1	Jan. 3, 1966	120.2
Mar. 22, 1961	118.1	Aug. 24	145.0	Feb. 1	119.4
Mar. 25, 1964	116.6	Sept. 9	5/ 240.2	Feb. 28	119.0
Oct. 2	126.0*	Sept. 16	165.8	Mar. 30	118.6
Oct. 22	122.0*	Sept. 20	141.9	May 3	5/ 252.1

(C-6-2)15bcb-1. Records available 1963-66

Mar. 23, 1963	- 96.5*	Dec. 16, 1964	- 90.1	Oct. 29, 1965	- 96.0
July 3	4/ 127.4	Mar. 9, 1965	96.8	Nov. 30	93.2
Mar. 25, 1964	88.4	Apr. 12	97.9	Jan. 3, 1966	92.2
Oct. 2	102.4*	Sept. 19	4/ 152.1	Feb. 1	90.0
Oct. 22	95.0*	Sept. 20	4/ 145.3	Mar. 1	89.2
Nov. 6	93.0*	Oct. 4	103.9	Mar. 30	88.8
Nov. 10	92.3				

(C-6-2)15cbb-1. Records available 1963-66

Mar. 23, 1963	6/ - 74.0*	Apr. 29, 1964	6/ - 78.8*	Sept. 18, 1965	4/ -124.8
Mar. 29	6/ 79.4*	Oct. 22	78.7*	Sept. 19	4/ 118.0
Apr. 5	6/ 93.0*	Nov. 6	76.6*	Sept. 20	4/ 113.2
Apr. 30	91.7*	Nov. 10	75.6	Oct. 4	86.9
May 7	6/ 98.5*	Dec. 16	73.6	Oct. 29	78.4
May 11	95.8*	Mar. 9, 1965	72.2	Nov. 30	75.2
June 6	94.2	Apr. 12	6/ 79.3	Jan. 3, 1966	73.4
June 15	6/ 102.2*	Sept. 9	4/ 114.4	Feb. 1	72.5
July 3	95.3*	Sept. 15	5/ 213.8	Mar. 1	71.7
July 20	6/ 117.2*	Sept. 16	4/ 140.8	Mar. 24	71.5
Mar. 25, 1964	72.8	Sept. 17	4/ 133.5	Mar. 28	71.4

(C-6-2)16baa-1. Records available 1954-61, 1965-66

Dec. 9, 1954	- 53.7	Dec. 7, 1960	- 70.6	Sept. 19, 1965	- 85.2
Apr. 12, 1955	53.8	Dec. 20, 1961	71.8	Oct. 4	75.9
Dec. 22	58.0	July 1, 1965	6/ 87.7	Oct. 29	72.7
Mar. 28, 1956	58.3	July 30	6/ 87.5	Nov. 30	71.2
Jan. 2, 1957	60.4	Aug. 12	6/ 88.5	Jan. 3, 1966	70.3
Dec. 6	64.7	Aug. 25	6/ 84.8	Feb. 1	69.7
Mar. 14, 1958	64.6	Aug. 31	6/ 87.7	Feb. 28	69.2
Apr. 13, 1959	69.6	Sept. 16	6/ 87.7	Apr. 1	67.9
Dec. 24	68.3	Sept. 17	87.0	May 3	84.2
Mar. 25, 1960	71.8	Sept. 18	86.3	June 9	88.9

(C-6-2)17dcc-1. Records available 1963-66

Mar. 2, 1963	- 23.6*	Nov. 1, 1964	- 29.4†	July 3, 1965	- 23.8†
Mar. 23	23.3*	Nov. 6	29.0*	July 10	23.6†
Mar. 29	23.3*	Nov. 7	28.9†	July 30	23.2
Apr. 5	23.3*	Nov. 13	28.8	Aug. 12	22.8
Apr. 30	23.2*	Dec. 17	27.6	Aug. 25	22.9
May 7	23.1*	Feb. 17, 1965	25.8*	Aug. 31	22.3
May 11	23.1*	Mar. 9	25.8	Oct. 4	21.5
May 23	23.2*	Apr. 2	25.2*	Oct. 29	21.2
June 3	23.6	Apr. 10	25.1*	Nov. 30	20.8
July 3	23.1*	Apr. 12	25.6	Jan. 3, 1966	20.7
July 20	23.2*	Apr. 17	25.2†	Feb. 2	20.8
Apr. 8, 1964	24.2	June 5	24.3†	Feb. 28	20.7
Apr. 29	24.0*	June 19	24.1†	Mar. 28	20.7
Oct. 31	29.7†	July 1	23.8	Mar. 31	20.7

(C-6-2)17dcc-2. Records available 1963-66

Mar. 2, 1963	- 30.7*	Apr. 5, 1963	- 30.5*	May 11, 1963	- 30.4*
Mar. 23	30.5*	Apr. 30	30.5*	May 23	30.5*
Mar. 29	30.6*	May 7	30.4*	June 3	31.0

Table 6. — Selected drillers' logs of wells in Cedar Valley

(Surveyed altitudes of land surface at the well by U.S. Geological Survey are given in feet and tenths; altitudes interpolated from topographic maps are given in feet.)

Thickness: Given in feet.
Depth: Given in feet below land surface.

	Thickness	Depth
(C-5-2)31dcd-1. Log by E. W. Hale. Alt. 5,181.4 ft.		
Boulders	15	15
Clay and sand	50	65
Boulders	2	67
Clay	9	76
Boulders	2	78
Clay	17	95
Hardpan	1	96
Clay and sand	22	118
Boulders	3	121
Clay	3	124
Boulders	2	126
Clay	10	136
Boulders	1	137
Clay and sand	27	164
Boulders	2	166
Clay	26	192
Boulders	1	193
Clay	26	219
Clay and sand	31	250
Boulders	2	252
Clay	24	276
Boulders	2	278
Clay	16	294
Boulders	2	296
Clay	4	300
Sand and gravel; water	25	325
(C-6-1)18dca-1. Log by L. E. Hale. Alt. 4,887.9 ft.		
Sand and clay	70	70
Clay with gravel	159	229
Gravel	5	234
Clay	4	238
Sand	5	243
Clay	7	250
Quicksand	2	252
Gravel	12	264
(C-6-2)13caa-1. Log by Robinson Drilling Co. Alt. 4,856.6 ft.		
Silt	2	2
Clay and hardpan	2	4
Clay, blue	41	45
Clay, yellow	50	95
Clay and sand	10	105
Clay, yellow	40	145
Clay, gray	3	148
Clay and gravel; small amount of water	2	150
Clay, gray	10	160
Clay, yellow	30	190
Clay, blue	15	205
Clay, yellow	47	252
Sand	16	268
Clay and sand	82	350
Clay and sand, hard and soft streaks	45	395
Clay and sand	40	435
Clay and gravel, mixed	8	443
Clay and sand	82	525
(C-6-2)14aba-1. Log by Roscoe Moss Drilling Co. Alt. 4,865.7 ft.		
Soil	4	4
Clay, gray	66	70
Clay, brown, sandy	147	217
Clay, brown	508	725
Sand, gravel, and clay	13	738
Clay, gray, hard, sandy	17	755
Clay, brown, soft	29	784
Clay, brown, hard, sandy	6	790
Clay, brown, soft, streaks of sand	20	810
Clay, blue, soft	15	825
Clay, brown, soft	15	840
Clay, brown, hard, sandy	20	860
Clay, brown, streaks of sand	27	887
Clay, light blue	15	902
Clay, gray, streaks of sand	101	1,003
Clay, brown, soft	102	1,105
Sand and gravel, streaks of clay	50	1,155
Sand and gravel, hard, clay streaks	71	1,226
Sand and gravel, hard	32	1,258
(C-6-2)15abb-1. Log by Robinson Drilling Co. Alt. 4,864.9 ft.		
Clay, yellow	42	42
Clay, blue	11	53
Clay, yellow	29	82
Gravel, dry	4	86
Clay, yellow	31	117
Sand, fine; making water	4	121
Clay and gravel, sandy, yellow	6	127
Sand, fine	10	137
Sand and gravel	9	146
Clay, yellow	56	202
Clay, sandy, yellow	22	224
Clay, sand, and gravel	20	244
Clay, yellow, and fine gravel	28	272
Clay, sticky	10	282
Clay, sandy	6	288
Clay, sticky	3	291
Clay and fine gravel	3	294
Clay, sticky	3	297
Clay and fine gravel	3	300
Clay, sticky, light brown	8	308
Clay, sandy, light brown	28	336
Clay and gravel	11	347
Clay, sticky, light brown	4	351
Gravel	9	360
Clay, sticky, light brown	5	365
Clay, sandy, light brown	37	402
Sand and cobbles	4	406
Clay, sandy, light brown	5	411
Sand and cobbles, hard	2	413
Clay, sticky, light brown	29	442
Clay, white, sandy	4	446
Clay, sticky, light brown	54	500
Clay, yellow	34	534
Clay, blue	4	538
Clay, yellow	22	560
Gravel and clay	5	565
Clay, yellow	15	580
Gravel and clay	10	590
Clay, yellow	12	602
Gravel and clay	4	606
Clay, yellow	29	635
Sand, hard	8	643
Clay, yellow	19	662
Clay, blue	4	666
Clay, yellow	109	775
Clay, yellow, with some fine gravel	40	815
Clay, yellow	15	830
Clay and gravel	8	838
Clay, brown	35	873
Sand, hard, brown	12	885
Clay, sticky, yellow	32	917
Clay, sticky, blue	69	986
Gravel and sand, 1-inch gravel	10	996
Clay, yellow	49	1,045
Clay, yellow, sandy	30	1,075
Clay, blue	27	1,102
Clay, yellow	13	1,115
Clay, sticky, brown	327	1,442
Sand, brown, and stands up	23	1,465
Clay, brown and white	5	1,470
Clay, white and red	5	1,475
Clay, sandy, yellow	10	1,485
Clay, sticky, brown	230	1,715
Clay, brown, and gravel mixed, 1/4-inch gravel	10	1,725
Clay, brown	10	1,735
Clay, brown, and fine gravel mixed, 1/4-inch gravel	10	1,745
Clay, brown	20	1,765
Clay, sandy, brown	10	1,775
Clay, brown	35	1,810
Clay, sticky, brown	15	1,825
Clay, sandy, brown	15	1,840
Clay, brown, mixed with fine gravel, 1/8-inch gravel	30	1,870
Clay, brown, with streaks of fine gravel, 1/2-inch gravel	10	1,880
Sand and fine gravel with some brown clay mixed	25	1,905
Sand, hard	8	1,913
Sand and fine gravel	12	1,925
Sand and gravel, 1/2-inch gravel	5	1,930
Clay, brown	5	1,935
Gravel	2	1,937
(C-6-2)15abb-1 - Continued		
Clay, brown	3	1,940
Sand and fine gravel, 1/2-inch gravel	15	1,955
Sand and gravel, 3/4-inch gravel	10	1,965
Sand and gravel, 1-inch gravel	35	2,000
Sand, hard	5	2,005
Sand and gravel, 1-inch gravel	20	2,025
Bentonite	5	2,030
Sand and gravel	5	2,035
Clay, sand, and gravel mixed	5	2,040
Sand and gravel	2	2,042
Gravel, clay, and sand	3	2,045
Clay, blue, and sand shells	5	2,050
Clay, blue	6	2,056
Sand, hard	4	2,060
Shale, blue, hard and sticky	5	2,065
Sand, hard, and gravel	5	2,070
Shale, blue, hard and sticky	5	2,075
Shale, blue, with hard sand shell	15	2,090
Limestone, gray, hard and sharp	38	2,128
Sand, hard and sharp	8	2,136
Lime, gray, hard	3	2,139
Sand, hard	9	2,148
Lime, gray, hard	53	2,201
Limestone, different colors, extra hard	3	2,204
Limestone, hard, brown	3	2,207
Limestone, gray	12	2,219
Limestone, gray, extra hard and sharp	36	2,255
Shale, gray, with lime shells	18	2,273
Limestone, gray, hard	18	2,291
Fault, fractured zone, gray limestone	18	2,309
Gravel, 3/4-inch diameter	1	2,310
Fault zone, limestone	5	2,315
Lime, gray	51	2,366
(C-6-2)17dcc-1. Log by J. S. Lee and Sons. Alt. 4,913.6 ft.		
Top soil	2	2
Clay	3	5
Gravel	5	10
Clay	50	60
Sand; surface water	5	65
Clay	82	147
Sand and gravel	8	155
Clay and gravel	20	175
Clay	35	210
Clay and gravel	15	225
Sand and gravel	10	235
Gravel, cemented	11	246
Clay	39	285
Gravel, cemented	10	295
Clay	20	315
Silt	30	345
Gravel	31	376
Clay	34	410
Clay and gravel	5	415
Conglomerate	10	425
Gravel	7	432
Clay and gravel	13	445
Gravel	16	461
Conglomerate	19	480
Gravel and boulders	12	492
Clay	29	521
Conglomerate	64	585
Clay	15	600
(C-6-2)26cbb-1. Log by Robinson Drilling Co. Alt. 4,844.1 ft.		
Clay, gray	30	30
Clay, yellow	25	55
Clay, gray	13	68
Sand and gravel; small amount of water	2	70
Clay, gray	10	80
Clay, yellow	30	110
Clay and sand	15	125
Clay, yellow	35	160
Clay, blue	15	175
Clay, yellow	35	210
Clay, blue, and sand	40	250
Clay, yellow	5	255

Table 5. — Water levels in observation wells in Cedar Valley — Continued

(C-6-2)17dcc-2 - Continued

July 3, 1963	- 30.4*	Jan. 16, 1965	- 33.6†	July 10, 1965	- 30.8†
July 20	30.5*	Feb. 13	33.1†	July 30	30.5
Mar. 24, 1964	32.0	Feb. 17	33.0*	Aug. 12	30.1
Apr. 8	31.5	Mar. 9	33.1	Aug. 25	30.1
Apr. 29	31.3*	Apr. 2	32.5*	Aug. 31	29.6
Oct. 31	36.9†	Apr. 3	32.6†	Oct. 4	28.7
Nov. 1	36.7†	Apr. 10	32.3*	Oct. 29	28.4
Nov. 6	36.3*	Apr. 12	32.9	Nov. 30	28.0
Nov. 7	36.2†	Apr. 17	32.5†	Jan. 3, 1966	27.9
Nov. 13	36.1	June 5	31.6†	Feb. 2	28.1
Nov. 14	35.7†	June 19	31.3†	Feb. 28	27.9
Nov. 21	35.3†	July 1	31.1	Mar. 28	28.0
Dec. 17	34.9	July 3	31.0†	Mar. 31	27.9
Dec. 26	34.0†				

(C-6-2)25cbc-1. Records available 1964-66

Dec. 17, 1964	- 67.8	Aug. 12, 1965	- 68.4	Jan. 4, 1966	- 68.9
Mar. 9, 1965	67.9	Aug. 31	68.2	Feb. 1	68.9
Apr. 20	68.7	Oct. 4	68.7	Mar. 11	68.9
July 1	68.0	Oct. 29	68.7	Mar. 30	68.9
July 30	68.0	Nov. 30	68.9		

(C-6-2)26cbb-1. Records available 1963-66

Mar. 2, 1963	- 53.1*	Apr. 12, 1965	- 58.1	Feb. 1, 1966	- 60.5
Apr. 30	4/ 62.7*	June 5	4/ 62.7†	Mar. 11	59.5
May 7	60.7*	Sept. 15	5/ 225.7	Mar. 28	59.2
Mar. 24, 1964	58.1	Sept. 16	4/ 107.2	Mar. 29	59.3
Apr. 29	57.8*	Sept. 18	4/ 97.1	Mar. 30	59.2
Oct. 2	68.3*	Sept. 19	4/ 92.4	Mar. 31	59.2
Oct. 22	63.6*	Sept. 20	4/ 88.4	Apr. 1	59.1
Nov. 6	62.0*	Oct. 4	74.0	Apr. 6	59.2
Nov. 10	61.6	Oct. 29	72.3	Apr. 7	59.2
Dec. 17	59.8	Nov. 30	63.9	May 3	5/ 222.8
Mar. 9, 1965	58.0	Jan. 4, 1966	61.5		

(C-6-2)27cca-1. Records available 1963-66

May 7, 1963	- 31.2*	Apr. 29, 1964	- 32.9*	July 30, 1965	- 34.6
May 11	31.2*	Oct. 2	34.2*	Aug. 12	34.7
May 22	31.3*	Oct. 10	34.3*	Aug. 31	34.9
June 3	31.8	Oct. 22	34.4*	Oct. 4	35.2
June 5	31.6	Nov. 6	34.5*	Oct. 29	35.4
June 15	31.6*	Nov. 10	34.5	Nov. 30	35.4
July 3	31.8*	Dec. 17	34.6	Jan. 4	35.2
July 9	30.4	Mar. 9, 1965	34.1	Feb. 2	35.0
July 20	32.1*	Apr. 12	34.0	Mar. 11	34.8
Aug. 21	32.5	Apr. 15	33.9	Apr. 7	34.6
Mar. 24, 1964	33.2	July 1	33.9		

(C-6-2)27ccc-1. Records available 1966

Mar. 31, 1966	- 27.7	Apr. 6, 1966	- 27.9	May 3, 1966	- 34.1
Apr. 1	27.9	Apr. 7	27.9	June 9	39.0

(C-6-2)27ccc-2. Records available 1966

Mar. 31, 1966	- 25.2	Apr. 6, 1966	- 25.1	May 3, 1966	- 24.9
Apr. 1	25.1	Apr. 7	25.1	June 9	24.9

(C-6-2)28bac-1. Records available 1963-66

May 11, 1963	- 19.7*	Apr. 29, 1964	- 20.3*	Aug. 12, 1965	- 19.4
May 23	19.7*	Nov. 6	20.4*	Aug. 31	19.5
June 3	19.5	Nov. 10	20.4	Oct. 4	19.0
June 15	19.4*	Dec. 17	20.4	Oct. 29	19.6
July 3	19.7*	Mar. 9, 1965	20.3	Nov. 30	19.9
July 20	19.0*	Apr. 12	20.0	Jan. 3, 1966	20.1
Aug. 21	20.5	July 1	19.2	Feb. 2	20.1
Mar. 24, 1964	20.8	July 30	19.7	Mar. 11	20.0

(C-6-2)29bdd-1. Records available 1963-66

June 5, 1963	+ 11.0	Apr. 12, 1965	+ 8.9	Nov. 30, 1965	+ 12.9
July 9	11.0	July 1	10.3	Jan. 3, 1966	13.1
Aug. 21	9.5	Aug. 12	10.9	Feb. 2	13.0
Mar. 24, 1964	9.8	Aug. 31	11.5	Feb. 28	13.2
Nov. 10	6.3	Oct. 4	12.4	Apr. 7	13.1
Dec. 14	7.6	Oct. 29	12.8	May 3	13.1
Mar. 9, 1965	8.6				

(C-6-2)29cac-1. Records available 1943-50, 1952, 1954-56, 1958-66

Mar. 31, 1943	+ 4.7	Mar. 29, 1948	+ 5.0	Apr. 13, 1959	+ 2.1
Dec. 28	3.9	Mar. 15, 1949	3.9	Dec. 24	1.3
Mar. 24, 1944	3.4	Dec. 15	4.3	Dec. 7, 1960	.4
Dec. 28	5.5	Mar. 21, 1950	4.0	Mar. 22, 1961	+ .1
Mar. 13, 1945	5.0	Apr. 22, 1952	3.6	Dec. 20	- .9
Dec. 18	6.2	Dec. 31	6.4	Mar. 5, 1962	1.2
Mar. 6, 1946	5.9	Dec. 9, 1954	3.9	Dec. 4	1.6
Dec. 16	5.9	Dec. 20, 1955	1.7	May 23, 1963	1.0*
Apr. 8, 1947	4.7	Dec. 13, 1956	.6	June 5	.9
Dec. 16	5.5	Mar. 14, 1958	.7	June 15	1.0*

(C-6-2)29cac-1 - Continued

July 3, 1963	- 1.0*	Nov. 9, 1964	- 5.8	Aug. 31, 1965	- 0.7
July 9	1.0	Dec. 16	4.4	Jan. 3, 1966	+ .8
July 27	1.8*	Mar. 9, 1965	3.3	Feb. 2	.8
July 29	2.2*	Apr. 12	3.0	Feb. 28	.9
Aug. 21	2.0	June 9	2.0	Apr. 6	1.0
Dec. 5	2.6	Aug. 12	1.0	May 3	1.1
Apr. 29, 1964	4.4*				

(C-6-2)29cac-2. Records available 1954, 1958, 1960-66

Oct. 9, 1954	+ 2.0	Sept. 14, 1964	- 7.9†	Feb. 17, 1965	- 4.3*
Mar. 14, 1958	.0	Sept. 19	8.0†	Mar. 9	4.1
Mar. 25, 1960	+ .1	Sept. 26	8.1†	Apr. 2	3.9*
Dec. 7	- .1	Oct. 2	8.1*	Apr. 10	3.7*
Mar. 22, 1961	.4	Oct. 3	8.2†	Apr. 12	3.7
Dec. 20	1.5	Oct. 10	8.1*	June 9	2.8
Mar. 5, 1962	1.9	Oct. 17	8.3†	June 30	2.6
Dec. 4	2.2	Oct. 18	8.2†	July 21	2.3
Mar. 8, 1963	1.8	Oct. 20	8.0†	July 30	2.2
May 23	1.7*	Oct. 22	7.8*	Aug. 12	2.0
June 5	1.6	Oct. 23	8.3†	Aug. 31	1.7
June 15	1.6*	Oct. 29	7.4*	Oct. 4	.8
July 3	1.7*	Oct. 31	8.4†	Oct. 29	.6
July 9	1.7	Nov. 1	7.2†	Nov. 30	.5
July 20	1.7*	Nov. 6	6.7*	Jan. 3, 1966	.5
July 27	2.5*	Nov. 7	6.7†	Jan. 3	7/ .2
July 29	2.7	Nov. 9	6.5	Jan. 4	.6
Aug. 21	2.5	Nov. 14	6.2†	Feb. 1	.6
Dec. 5	3.1	Nov. 21	6.0†	Mar. 27	.6
Mar. 24, 1964	2.5	Dec. 5	5.6†	Apr. 6	.5
Apr. 29	2.3*	Dec. 16	5.2	Apr. 6	7/ .4
Aug. 13	7.2*	Dec. 26	4.9†	May 3	.4
Sept. 5	7.9†	Jan. 16, 1965	4.6†	May 3	7/ .3
Sept. 12	8.0†	Feb. 13	4.3†	June 9	.3

(C-6-2)29ccc-1. Records available 1965-66

Sept. 9, 1965	+ 1.7	Nov. 30, 1965	+ 2.9	Feb. 2, 1966	+ 2.8
Oct. 4	2.3	Jan. 4, 1966	2.9	Mar. 11	2.8

(C-6-2)33bcb-1. Records available 1950-51, 1954-56, 1958-66

Aug. 17, 1950	+ 14.9	Mar. 22, 1961	+ 9.7	July 1, 1965	+ 6.7
Dec. 5	14.4	Dec. 20	9.1	July 30	8.1
Mar. 30, 1951	15.6	Mar. 5, 1962	10.4	Aug. 12	8.2
Dec. 9, 1954	15.1	Dec. 4	9.1	Aug. 31	8.6
Apr. 12, 1955	13.2	Mar. 8, 1963	7.7	Oct. 4	9.0
Dec. 20	13.3	June 6	9.9	Oct. 29	9.6
Mar. 28, 1956	13.6	July 9	10.0	Nov. 30	9.8
Dec. 13	12.6	Aug. 21	8.7	Jan. 3, 1966	10.3
Mar. 14, 1958	11.8	Dec. 5	6.9	Feb. 2	10.4
Apr. 13, 1959	13.4	Mar. 24, 1964	7.9	Feb. 28	10.2
Dec. 24	12.3	Nov. 9	3.0	Apr. 7	10.6
Mar. 25, 1960	12.6	Dec. 17	5.1	May 3	11.1
Dec. 7	11.3	Mar. 9, 1965	6.4		

(C-6-2)34bac-1. Records available 1963-66

May 7, 1963	- 28.4*	Mar. 24, 1964	- 29.9	July 30, 1965	- 31.5
May 11	28.4*	Apr. 29	29.6*	Aug. 12	31.8
May 22	28.5*	Oct. 10	31.3*	Aug. 31	31.9
June 5	28.7	Nov. 6	31.5*	Oct. 4	31.7
June 15	28.8*	Nov. 10	31.5	Oct. 29	31.8
July 3	29.2*	Dec. 17	30.0	Nov. 30	31.8
July 20	29.5*	Mar. 9, 1965	30.8	Jan. 4, 1966	31.6
July 27	29.5*	Apr. 20	30.3	Feb. 2	30.3
Aug. 21	29.5	July 1	30.7	Mar. 11	30.9

(C-7-2)23bcc-1. Records available 1964-66

Apr. 28, 1964	-114.3	Aug. 3, 1965	-114.6	Nov. 30, 1965	-114.8
Mar. 26, 1965	114.5	Aug. 31	114.7	Jan. 4, 1966	114.7
Apr. 12	114.5	Oct. 5	114.7	Mar. 11	114.6
July 21	114.6	Oct. 29	114.8		

(C-7-2)29dbc-1. Records available 1965-66

Nov. 30, 1965	-170.1	Mar. 11, 1966	-169.4

(C-7-2)35bcc-1. Records available 1965-66

Oct. 19, 1965	-180.4	Nov. 30, 1965	-180.4	Mar. 11, 1966	-180.4
Oct. 29	180.5	Jan. 4, 1966	180.2		

(C-8-2)15aad-1. Records available 1965-66

Sept. 10, 1965	-240.6	Nov. 30, 1965	-241.2	Feb. 1, 1966	-241.4
Oct. 5	240.6	Jan. 4, 1966	241.3	Mar. 11	241.4
Oct. 29	240.7				

(C-8-2)31adb-1. Records available 1965-66

Aug. 3, 1965	-343.6	Oct. 29, 1965	-343.7	Feb. 1, 1966	-343.7
Aug. 31	343.7	Nov. 30	343.7	Mar. 11	343.8
Oct. 5	343.7	Jan. 4, 1966	343.7		

1/ Water levels declining after completion of drilling and flushing observation well.
2/ Water level prior to flushing well of detergent solution.
3/ Water level declining after flushing observation well.
4/ Well recently pumped.
5/ Well was being pumped.
6/ Nearby well was being pumped.
7/ Nearby flowing well shut-in for 30 minutes.

Table 6. — Selected drillers' logs of wells in Cedar Valley — Continued

	Thickness	Depth
(C-6-2)26cbb-1 - Continued		
Clay, blue, and sand.	17	272
Sand.	6	278
Clay, blue, and sand.	27	305
Clay, yellow.	25	330
Gravel.	5	335
Clay, yellow.	35	370
Sand, hard.	10	380
Gravel.	22	402
Clay, blue.	8	410
Clay, yellow.	10	420
Clay, yellow, and sand. . . .	38	458
Sand, hard.	20	478
Clay, yellow.	7	485
Clay, yellow, and sand. . . .	15	500
Clay, yellow.	5	505
(C-6-2)29cac-2. Log by L. N. Meinzer. Alt. 4,888.7 ft.		
Clay and hardpan layers . . .	110	110
Gravel, black, 1/4 to 1 inch.	6	116
Clay.	44	160
Hardpan on sandstone.	1	161

	Thickness	Depth
(C-6-2)29cac-2 - Continued		
Clay	47	208
Gravel, black, 1/4 to 1 inch . .	10	218
Hardpan.	2	220
Quicksand.	-	-
(C-6-2)32bbd-1. Log by J. S. Lee and Sons. Alt. 4,880 ft.		
Clay, brown.	60	60
Sand	1	61
Clay, brown.	62	123
Clay and gravel.	7	130
Clay, brown.	75	205
Gravel	3	208
Clay, sand, and gravel	45	253
Conglomerate	7	260
Clay, sand, and gravel	37	297
Gravel	2	299
Clay and gravel.	31	330
Gravel	3	333
Clay and gravel.	21	354
Conglomerate	10	364
Clay and gravel.	68	432

	Thickness	Depth
(C-6-2)32bbd-1 - Continued		
Conglomerate.	13	445
Clay, brown	7	452
Gravel.	11	463
Clay and gravel	22	485
Conglomerate.	2	487
Clay, brown	3	490
Conglomerate.	16	506
Clay.	4	510
Conglomerate.	25	535
Clay and gravel	13	548
Conglomerate.	4	552
Gravel.	7	559
Conglomerate.	16	575
Clay, sand, and gravel.	11	586
Gravel.	9	595
Clay and gravel	10	605
Clay, yellow.	8	613
(C-7-2)23bcc-1. Log by J. P. Feighny. Alt. 4,835 ft.		
Clay.	180	180
Clay, soft, with water.	15	195
Clay.	25	220

Table 7. — Logs of test wells in Cedar Valley

(Logs by U.S. Geological Survey. Surveyed altitudes of land surface at the well by U.S. Geological Survey are given in feet and tenths; altitudes interpolated from topographic maps are given in feet.)

Thickness: Given in feet.
Depth: Given in feet below land surface.

	Thickness	Depth
(C-5-1)20ddc-1. Alt. 4,795 ft.		
Recent and Pleistocene deposits:		
Sand, very fine to very coarse, and very fine gravel, silty. Gravel is subrounded to rounded. Composed of sedimentary and igneous rocks	12	12
Gravel, very fine to very coarse, and small cobbles, angular to rounded. Composed of sedimentary and igneous rocks. Slight caving.	2	14
Silt, brown and light gray, sandy and clayey. Contains some very fine to medium gravel, angular to subrounded. Composed of sedimentary and igneous rocks.	29	43
Gravel, very fine to very coarse, and small cobbles, angular to rounded. Composed of sedimentary and igneous rocks. Interval contains brown sandy silt matrix from 43 to 58 feet and yellow-brown clayey silt from 58 to 60 feet. Lost circulation between 45 and 55 feet.	17	60
Cobbles, small, and coarse gravel, mostly quartzite but some limestone and igneous rocks. Slight loss of circulation. .	10	70
Manning Canyon Shale of Pennsylvanian and Mississippian age:		
Claystone, gray, gray-brown, and olive, and gray silty clay.	21	91
Shale, rust-brown, fissile. Lost circulation while drilling.	5	96
Claystone, gray to dark gray, gray-brown, olive, and black, and gray to gray-brown sand, clay	46	142
Clay and claystone, dark gray to black. Formation changed color of drilling mud from brown to black	63	205
Shale, black	95	300
(C-5-2)24aab-1. Alt. 4,989.7 ft.		
Recent and Pleistocene deposits:		
Silt, brown and tan, sandy and clayey.	39	39
Sand, very fine to very coarse, and very fine to coarse gravel. Gravel is angular to rounded and composed of sedimentary and igneous rocks. Lost circulation while drilling.	4	43
Silt, brown, clayey and sandy.	7	50
Gravel, very fine to very coarse, angular to rounded. Composed of sedimentary and igneous rocks.	2	52
Silt, brown, sandy and clayey, as a matrix in very fine to coarse gravel. Interval is about 50 percent silt and 50 percent gravel. Gravel is angular to subrounded and composed of sedimentary and igneous rocks.	8	60
Igneous rock of Tertiary age. Probably lower Tertiary andesite-trachyte-latite flows (Stokes, 1963).	87	147
Limestone of Paleozoic age. Probably Oquirrh Formation of Permian and Pennsylvanian age.	8	155
(C-6-2)1acc-1. Alt. 4,891.5 ft.		
Recent and Pleistocene deposits:		
Silt and clay, tan and light gray.	8	8
Silt and very fine to medium sand, tan and gray.	14	22
Silt and clay, tan and light gray.	13	35

	Thickness	Depth
(C-6-2)1acc-1 - Continued.		
Recent and Pleistocene deposits - Continued:		
Silt and very fine to medium sand, tan	14	49
Sand, very fine to medium, silty, tan.	7	56
Silt, clayey and sandy, tan.	7	63
Silt and very fine to medium sand, brown. Contains fine gravel, angular to rounded, composed of quartzite and limestone from 70 to 71 feet.	10	73
Silt and clay, brown	13	86
Silt and very fine to coarse sand, light brown to brown. . .	12	98
Silt and clay, brown	8	106
Silt and very fine to medium sand, brown, slightly clayey. .	9	115
Silt and clay, brown	4	119
Silt and very fine to medium sand, brown. Contains very fine to medium gravel, angular to subrounded, composed of quartzite and limestone from 131 to 132 feet. Slightly clayey from 132 to 135 feet	22	141
Silt and clay, brown	3	144
Gravel, fine to coarse, angular to subrounded, composed of quartzite and limestone. Contains brown silt	4	148
Silt, brown, clayey and occasionally sandy	54	202
Sand, very fine to medium. Silty from 202 to 208 feet. . . .	11	213
Silt, brown, clayey. Sandy from 220 to 222 feet	18	231
Sand, very fine to coarse, silty	7	238
Silt, brown, clayey.	12	250
Sand, very fine to medium, silty	5	255
Silt, brown, clayey.	10	265
Sand, very fine to medium, silty	2	267
Silt, brown, clayey from 275 to 288 feet and sandy from 288 to 291 feet	33	300
(C-6-2)27ccc-1. Alt. 4,843.2 ft.		
Recent and Pleistocene deposits:		
Clay, light gray, silty.	51	51
Clay, dark gray to blue-gray, silty.	39	90
Silt, light gray and light to dark brown, sandy and clayey .	35	125
Clay, gray, silty.	23	148
Silt, brown, sandy and clayey. Color grades to gray-brown at 165 to 170 feet.	37	185
Clay, gray, silty. Contains thin, less than 1 foot, beds of white clay.	41	226
Silt, tan and brown, sandy and clayey.	38	264
Sand, very fine to medium, silty	8	272
Silt, tan and brown, sandy and clayey interbedded with 2 to 6 foot beds of silty sand	40	312
Sand, very fine to medium, silty	10	322
Silt, gray, sandy and clayey. Contains 2 to 6 foot thick beds of silty sand.	86	408
Silt, gray-brown, sandy and clayey. Contains 2 to 10 foot thick beds of silty sand.	56	464
Silt, gray and blue gray, sandy and clayey	41	505

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(*) — Out of Print

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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.

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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 1948-1963, by R. M. Cordova and Seymour Subitzky, U.S. Geological Survey, 1965.

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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.

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BASIC-DATA REPORTS

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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.

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

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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.

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INFORMATION BULLETINS

*No. 1. Plan of work for the Sevier River Basin (Sec. 6, P.L. 566), United States 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, United States Geological Survey, 1960.

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

No. 7. Relation of the deep and shallow artesian aquifers near Lynndyl, Utah, by R. W. Mower, United States 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, United States Geological Survey, 1963.

No. 11. Amendments to plan of work and work outline for the Sevier River basin (Sec. 6, P.L. 566), United States 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., United States 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.

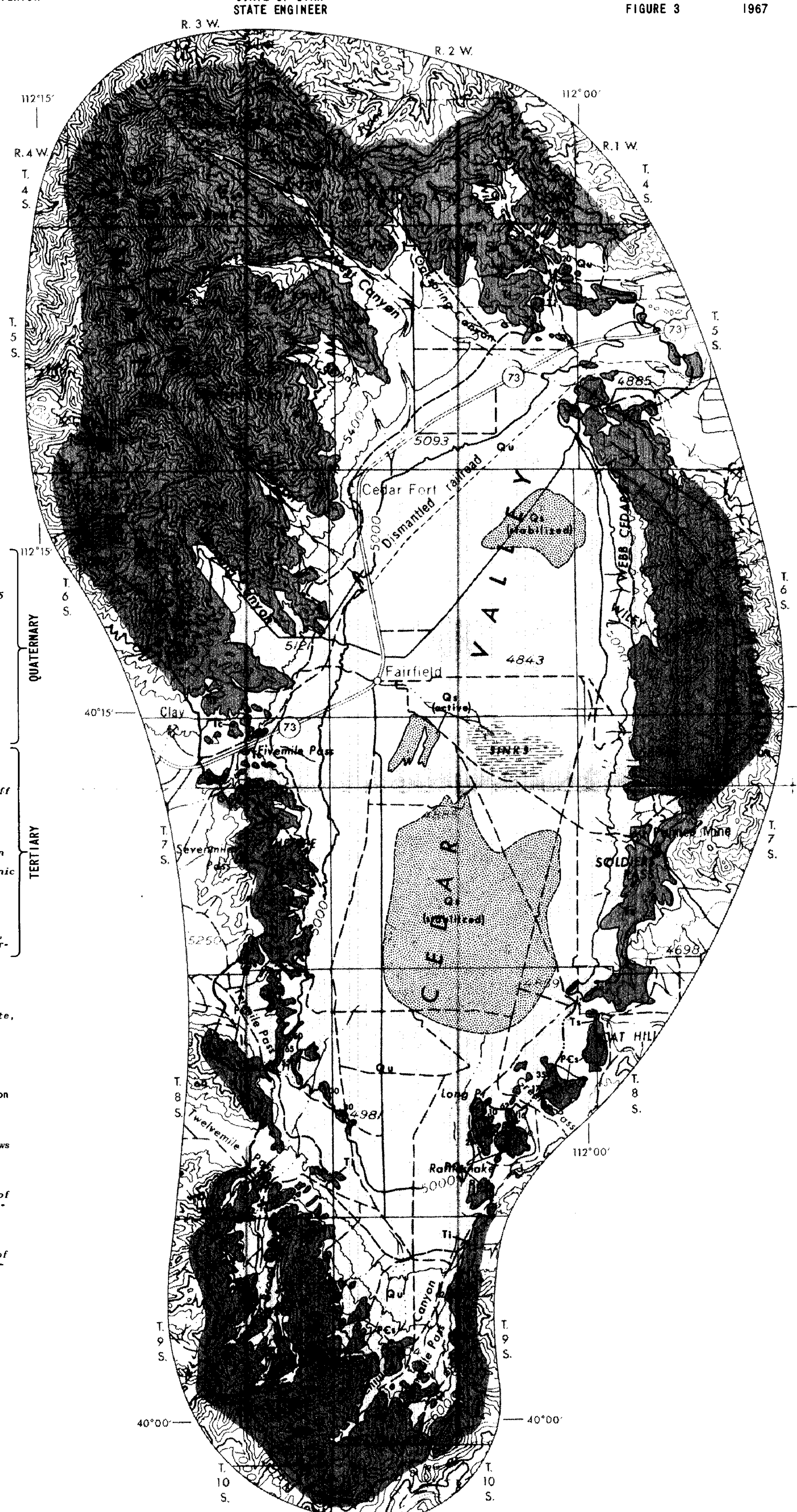
No. 16. Summary of water well drilling activities in Utah, 1960 through 1965, compiled by Utah State Engineer's Office, 1966.

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

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

STATE OF UTAH
STATE ENGINEER

TECHNICAL PUBLICATION NO. 16
FIGURE 3 1967



EXPLANATION

QUATERNARY

Pleistocene and Recent

Qs — Sand dunes
Active dunes with maximum height of 15 feet and low stabilized dunes and shifting sand

Glacial moraine deposits of probable Wisconsin age

Qu — Unconsolidated deposits
Alluvial-fan debris, colluvium, Lake Bonneville Group, and pre-Lake Bonneville valley-fill deposits

TERTIARY

Eocene(?)

Ts — Sedimentary rocks and tuffs
Limestone and fresh and argillized tuff

Eocene

Conglomerate
Poorly sorted boulders of limestone, sandstone, and quartzite embedded in a matrix of red-orange weathering clay; grades upward into gray volcanic agglomerate (Disbrow, 1957)

Igneous rocks
Includes intrusive bodies, lava flows, bedded tuffs, breccias, and agglomerates

Permian through Cambrian sedimentary rocks
Includes limestone, dolomite, quartzite, conglomerate, sandstone, and shale

Contact
Dashed where approximate

Highest shoreline of Lake Bonneville on alluvial deposits

Strike-slip fault
Dashed to indicate continuation. Arrows show relative movement

Anticline
Showing trace of plane and direction of plunge of axis. Dashed where approximately located

Syncline
Showing trace of plane and direction of plunge of axis. Dashed where approximately located

25 — Strike and dip of beds

75 — Strike and dip of overturned beds

90 — Strike of vertical beds

Boundary of surface drainage basin

STRUCTURAL FEATURES

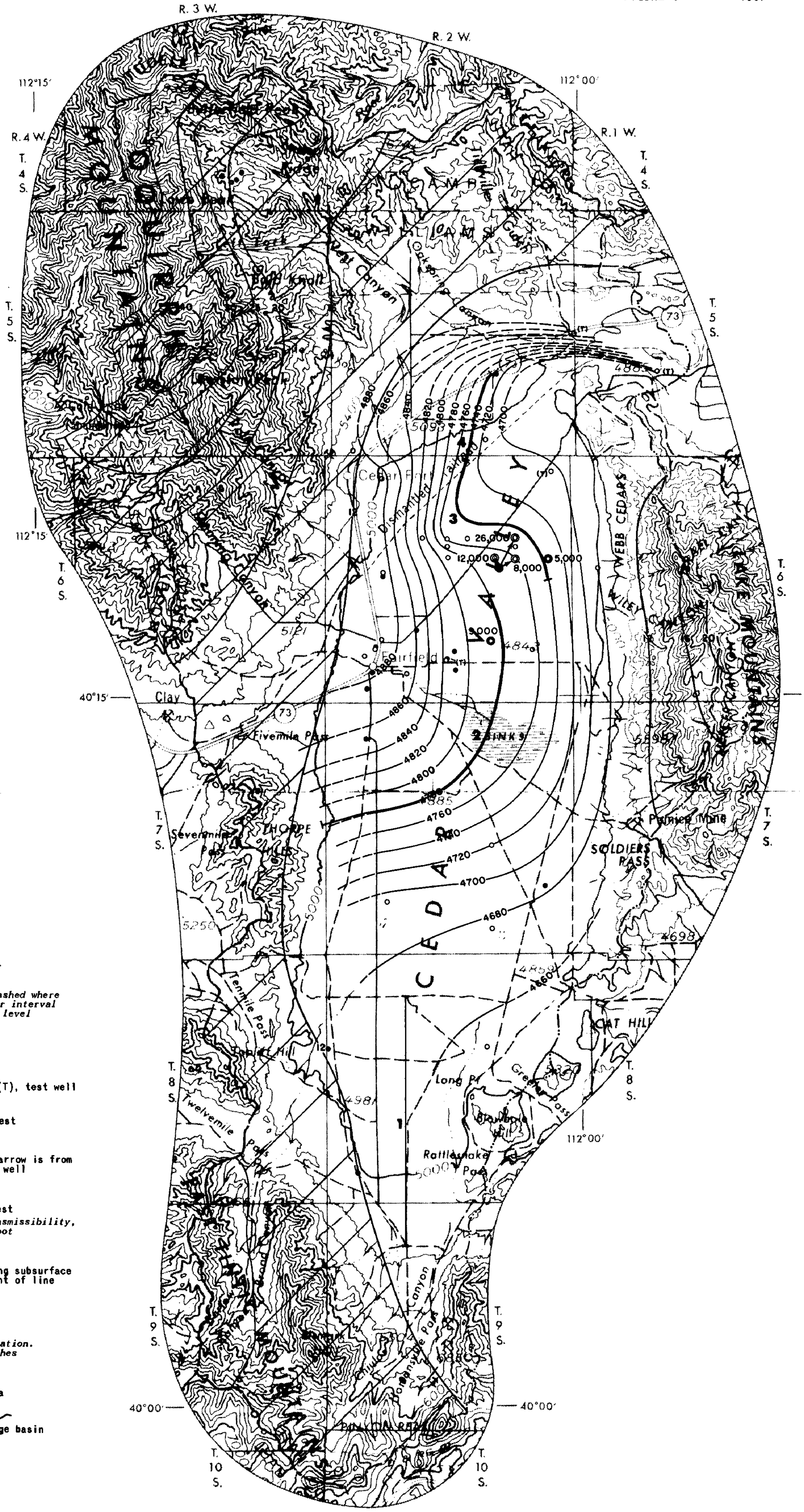
1. Ophir anticline
2. Pole Canyon syncline
3. Long Ridge anticline
4. Bingham syncline
5. Lake Mountain syncline
6. North Tintic anticline

Base from Army Map Service 1:250,000 series: Salt Lake City, Utah-Wyo., 1958; Tooele, 1958; Delta, 1958. Limited revision by U.S. Geological Survey.

0 1 2 3 4 5 6 MILES

Geology of Tertiary and Paleozoic rock by Bissell (1963), Bullock (1951), Disbrow (1957, 1961), Gilluly (1932), Morris (1964), Proctor (1956), and Stokes (1963). Glacial moraines mapped by Gilluly (1932). Quaternary geology by R. D. Feltis, 1965.

GENERALIZED GEOLOGIC MAP OF CEDAR VALLEY



EXPLANATION

——4800———
Water-table contour
Shows altitude of water table; dashed where approximate or doubtful. Contour interval 20 feet. Datum is mean sea level

•
Well

o(T)
Observation well for water levels; (T), test well

Well pumped for aquifer test

→◎ 8,000
Observation well for aquifer test; arrow is from pumped well to observation well

O 5,000
Well used for recovery test
Number indicates coefficient of transmissibility, in gallons per day per foot

3
Line of reference used in calculating subsurface flow. Number refers to segment of line

20
Isohyet
Shows normal annual precipitation. Interval 4, 5, and 10 inches

Approximate recharge area

Boundary of the surface drainage basin

Base from Army Map Service 1:250,000 series: Salt Lake City, Utah-Wyo., 1958; Tooele, 1958; Delta, 1958. Limited revision by U.S. Geological Survey.

0 1 2 3 4 5 6 MILES

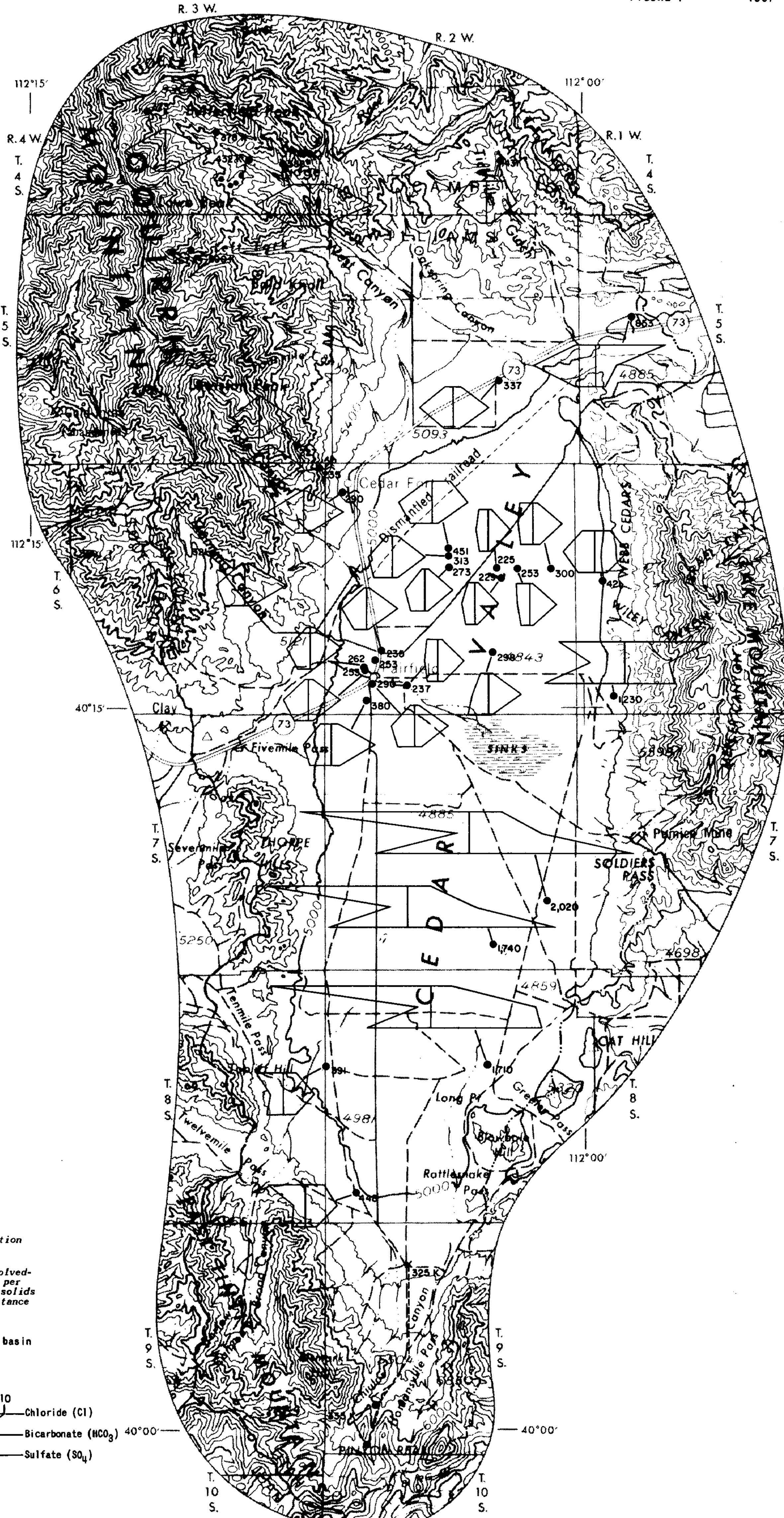
Contours of precipitation by Water Supply Forecast Unit and Office of State Climatologist, U.S. Weather Bureau, Salt Lake City, Utah, 1963. Hydrology by R. D. Feltis, 1966.

MAP OF CEDAR VALLEY SHOWING NORMAL ANNUAL PRECIPITATION FOR THE PERIOD 1931-60, APPROXIMATE RECHARGE AREA, WATER-TABLE CONTOURS OF MARCH 1966, THE LINE OF REFERENCE USED IN CALCULATING SUBSURFACE OUTFLOW, AND LOCATIONS OF WELLS

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

STATE OF UTAH
STATE ENGINEER

TECHNICAL PUBLICATION NO. 16
FIGURE 7 1967



EXPLANATION

Sampling site

298
Well

323
Spring

325K
Pipeline
Dashed line is approximate location of pipeline

Number by sampling site is dissolved-solids concentration, in parts per million. K indicates dissolved-solids calculated from specific conductance

Boundary of the surface drainage basin

Chemical constituents, in equivalents per million

Sodium (Na) + potassium (K) — 10 0 10 — Chloride (Cl)
Calcium (Ca) — Bicarbonate (HCO_3)
Magnesium (Mg) — Sulfate (SO_4)

Base from Army Map Service 1:250,000 series: Salt Lake City, Utah-Wyo., 1958; Tooele, 1958; Delta, 1958. Limited revision by U.S. Geological Survey.

0 1 2 3 4 5 6 MILES

By R. D. Feltis, 1966

MAP SHOWING THE CHEMICAL COMPOSITION AND THE DISSOLVED-SOLIDS CONCENTRATION OF WATER IN CEDAR VALLEY