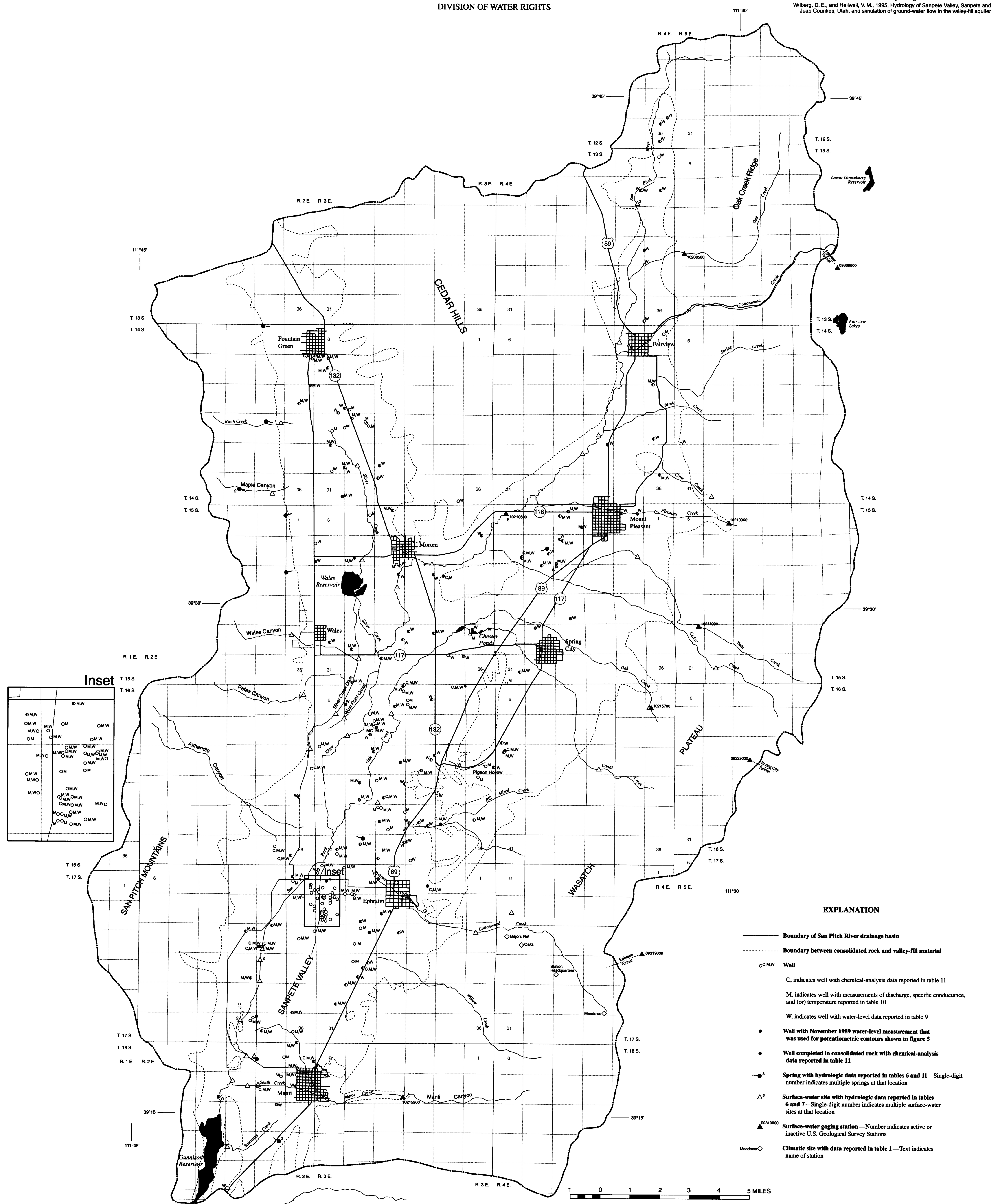
PREPARED BY THE U.S. GEOLOGICAL SURVEY
IN COOPERATION WITH THE
UTAH DEPARTMENT OF NATURAL RESOURCES,
DIVISION OF WATER RIGHTS

UTAH DEPARTMENT OF NATURAL RESOURCES
TECHNICAL PUBLICATION NO. 113
Location of hydrologic-data sites—PLATE 1
Wilberg, D. E., and Heilweil, V. M., 1995, Hydrology of Sanpete Valley, Sanpete and Juab Counties, Utah, and simulation of ground-water flow in the valley-fill aquifer



Base from U.S. Geological digital data, 1:100,000, 1981
Universal Transverse Mercator projection
Zone 12

MAP SHOWING LOCATION OF DATA-COLLECTION SITES, SANPETE VALLEY, UTAH

By
Dale E. Wilberg and Victor M. Heilweil
1995

STATE OF UTAH
DEPARTMENT OF NATURAL RESOURCES

Technical Publication No. 113

HYDROLOGY OF SANPETE VALLEY, SANPETE AND JUAB COUNTIES, UTAH, AND SIMULATION OF GROUND-WATER FLOW IN THE VALLEY-FILL AQUIFER

By D.E. Wilberg and V.M. Heilweil
U.S. Geological Survey

Prepared by the
United States Geological Survey,
in cooperation with the
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Division of Water Rights
1995

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[Plate is in pocket]

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CONVERSION FACTORS, VERTICAL DATUM, AND ABBREVIATED WATER-QUALITY UNITS

Multiply	By	To obtain
acre	0.4047	hectare
	4,047	square meter
acre-foot (acre-ft)	0.001233	cubic hectometer
	1,233	cubic meter
acre-foot per year (acre-ft/yr)	0.00003907	cubic meter per second
cubic foot per second (ft^3/s)	0.02832	cubic meter per second
foot (ft)	0.3048	meter
foot per day (ft/d)	0.3048	meter per day
foot per day per foot (ft/d/ft)	0.0929	meter squared per day
foot squared per day[1] (ft^2/d)	0.0929	meter squared per day
foot per year (ft/yr)	0.3048	meter per year
gallon per minute (gal/min)	0.06308	liter per second
gallon per day per foot (gal/d/ft)	0.01242	meter squared per day
inch (in.)	25.4	millimeter
	0.0254	meter
inch per year (in/yr)	25.4	millimeter per year
mile (mi)	1.609	kilometer
square mile (mi^2)	2.59	square kilometer

Following are several useful conversion factors used in the text. To convert gal/min to ft^3/s, divide gal/min by 448.8; to convert gal/min to acre-ft /yr, multiply gal/min by 1.614; to convert ft^3/s to acre-ft/yr, multiply ft^3/s by 724.5; and because 1 ft^3 of water equals 7.48 gal, to convert gal/d/ft to ft^2/d, divide gal/d/ft by 7.48.

Water temperature is reported in degrees Celsius (°C), which can be converted to degrees Fahrenheit (°F) by the following equation:

$$°F = 1.8\,(°C) + 32.$$

Sea level: In this report, "sea level" refers to the National Geodetic Vertical Datum of 1929—a geodetic datum derived from a general adjustment of the first–order level nets of the United States and Canada, formerly called Sea Level Datum of 1929.

Chemical concentration and water temperature are reported in metric units. Chemical concentration is reported in milligrams per liter (mg/L) or micrograms per liter (µg/L). Milligrams per liter is a unit expressing the solute per unit volume (liter) of water. One thousand micrograms per liter is equivalent to 1 milligram per liter. For concentrations less than 7,000 milligrams per liter, the numerical value is about the same as for concentrations in parts per million.

Chemical concentration in terms of ionic interacting values is reported in milliequivalents per liter (meq/L). Specific conductance is reported in microsiemens per centimeter (µS/cm) at 25 degrees Celsius.

[1]Expresses transmissivity. An alternative way of expressing transmissivity is cubic foot per day per square foot, times foot of aquifer thickness.

Hydrology of Sanpete Valley, Sanpete and Juab Counties, Utah, and Simulation of Ground-Water Flow in the Valley-Fill Aquifer

By D.E. Wilberg and V.M. Heilweil
U.S. Geological Survey

ABSTRACT

The surface- and ground-water hydrology of Sanpete Valley and the San Pitch River drainage basin, Sanpete and Juab Counties, Utah, was studied to define the current conditions of the hydrologic system, to detect causes for downstream changes in water quality in the San Pitch River and in areas of high concentration of dissolved solids in ground water, and to determine the possible effects of present changes in irrigation methods and possible future increased ground-water withdrawals from the valley-fill aquifer. Measurements of water levels in wells show responses to climatic variation. The dissolved-solids concentration of water from the San Pitch River increases downstream. Principal areas of ground water with high concentrations of dissolved solids occur downgradient from outcrops of rocks of Jurassic and Tertiary age. One local-scale ground-water flow system discharges small volumes of water with high concentrations of dissolved solids to the San Pitch River southwest of Ephraim.

Although ground water occurs in both valley-fill and consolidated-rock aquifers in the study area, more hydrologic information is available for the valley-fill aquifer. The valley-fill aquifer consists primarily of fine-grained silt and clay in the center of the valley and coarser deposits along the margin of the valley. Surface-water inflow to the valley is estimated to be about 152,000 acre-feet per year. Recharge to the valley-fill aquifer is estimated to be between 74,000 and 103,000 acre-feet per year. A three-dimensional, ground-water flow model was developed to better define present ground-water conditions and to determine possible effects of future changes in ground-water withdrawals from the valley-fill aquifer. Computer simulation results indicate the possibility of recharge to the valley-fill aquifer as subsurface inflow from consolidated-rock aquifers. Simulation of water-level changes during the late 1980's indicate that some of the declines could have been caused by conversion from flood irrigation to sprinkler irrigation. Predictive simulations using three times the average pumping rates indicate possible water-level declines of as much as 70 feet.

INTRODUCTION

Sanpete Valley includes about 240 mi^2 of unconsolidated valley-fill material in Sanpete and Juab Counties in central Utah (fig. 1). The area studied for this report is the 670-mi^2 San Pitch River drainage basin that drains into Gunnison Reservoir and includes Sanpete Valley. Most of Sanpete Valley is rural; more than 70 percent of the nearly 17,000 inhabitants live in small communities with populations less than 2,500. The economy of the valley is predominantly agricultural, with most income derived from the production of turkeys and sheep.

State of Utah water officials are concerned about how to optimize the use and development of available water resources in Sanpete Valley but minimize the effects on the hydrologic system. To address these concerns, the U.S. Geological Survey, in cooperation with the Utah Department of Natural Resources, Division of Water Rights, studied the hydrology of Sanpete Valley in the San Pitch River drainage basin during 1987-90. The objectives of this study were to (1) define the current conditions of the hydrologic system in Sanpete Valley, (2) detect causes for changes of water quality in a downstream direction in the San Pitch River and causes for areas of high concentrations of dissolved solids in ground water, and (3) estimate the hydrologic effects of present and possible future changes in irrigation methods and ground-water withdrawals from the valley-fill aquifer.

Purpose and Scope

This report describes the results of a hydrologic study of Sanpete Valley. Hydrologic data collected during this study and during previous studies by Robinson

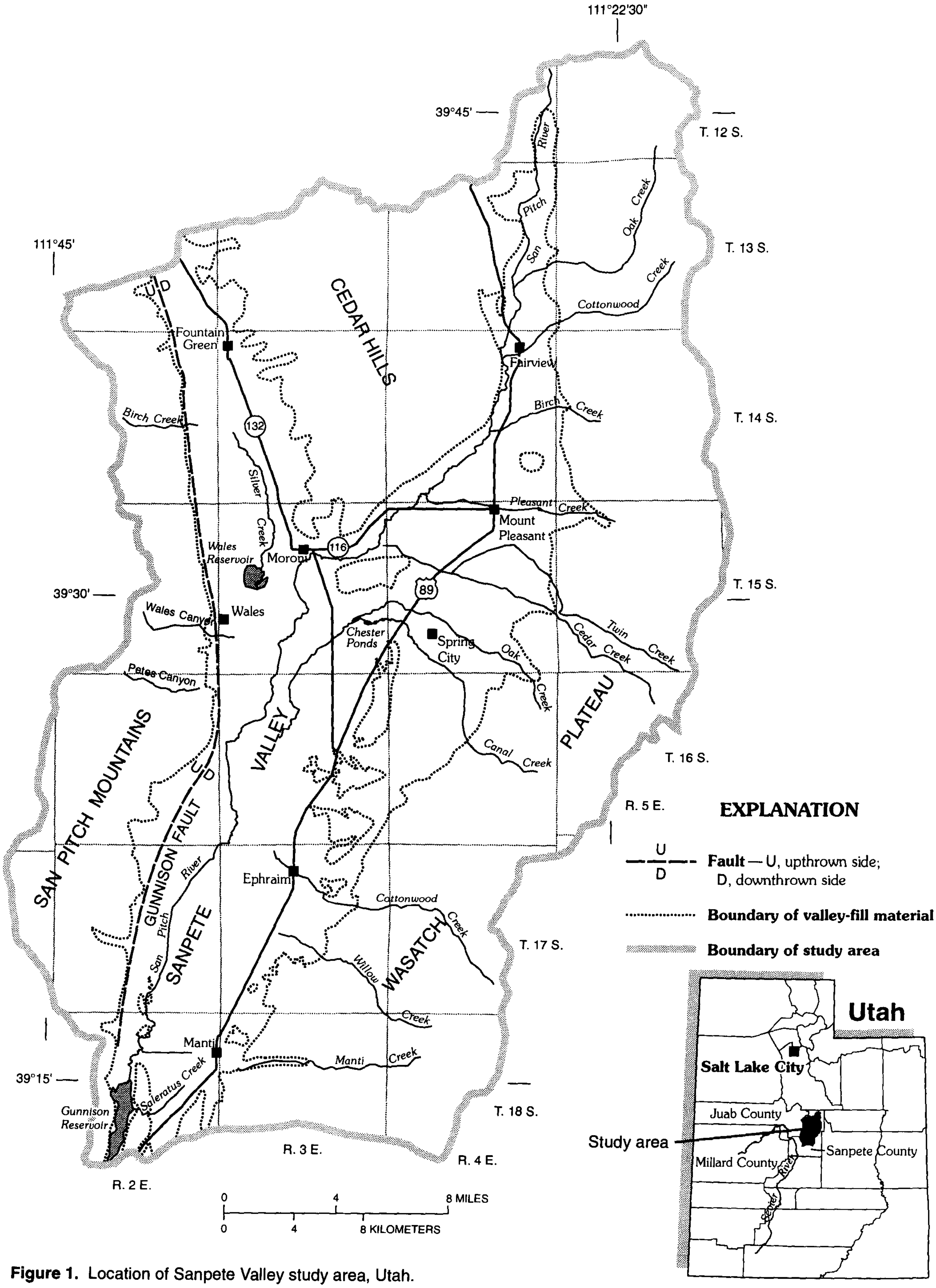

Figure 1. Location of Sanpete Valley study area, Utah.

(1968, 1971), along with other selected data, were used to interpret the surface- and ground-water hydrology of Sanpete Valley and to develop a digital computer model to simulate ground-water flow in Sanpete Valley. The model simulates ground-water flow in the unconsolidated valley-fill aquifer of Sanpete Valley and was used to estimate the effects of increased withdrawals from the valley-fill aquifer on the hydrologic system.

Methods of Investigation

Methods of investigation included measurements of water levels in wells, measurement of discharge at ground- and surface-water sites, and chemical analysis of water. Water levels in about 50 wells were measured, monthly or bimonthly, to monitor short-term changes. Water levels in about 130 wells were measured in May and November 1989 to monitor seasonal variability and were then compared with water levels that were measured in November and December 1966 to help detect any changes in ground-water occurrence and movement. A streamflow-gaging station was maintained on the San Pitch River west of Mount Pleasant during water year 1989 to record river stage. Streamflow measurements at selected sites on the San Pitch River in October 1988 provided estimates of the amounts and locations of seepage between ground water and surface water (Sandberg and Smith, 1995). Water-quality samples were collected for chemical analyses from 19 wells, 3 springs, and 5 surface-water sites. Miscellaneous water-quality data, which included measurements of flow, specific conductance, and temperature were collected from about 140 wells, 10 springs, and 15 surface-water sites. Data were compared with previously collected data to detect temporal or areal water-quality variation. Three shallow wells were drilled west of Ephraim to define the movement and quality of the shallow ground water and to determine reasons for changes in water quality in the nearby San Pitch River.

Numbering System for Hydrologic-Data Sites in Utah

The system of numbering wells, springs, and other hydrologic-data sites in Utah is based on the cadastral land-survey system of the U.S. Government. The number, in addition to designating the site, describes its position in the land net. Using the land-survey system, the State of Utah is divided into four quadrants by the Salt Lake Base Line and the Salt Lake Meridian. These quadrants are designated by the uppercase letters A, B, C, and D, which indicate, respectively, the northeast, northwest, southwest, and southeast quadrants. Numbers that designate the township and range (in that order) follow the quadrant letter, and the three are enclosed in parentheses. The number after the parentheses indicates the section and is followed by three letters that indicate the quarter section, the quarter-quarter section, and the quarter-quarter-quarter section—generally 10 acres for regular sections[1]; the lowercase letters a, b, c, and d indicate, respectively, the northeast, northwest, southwest, and southeast quarters of each subdivision. The number after the letters is the serial number of the wells or springs within the 10-acre plot. The letter 'S' preceding the serial number denotes a spring. Thus, (D-16-3)20bad-2 designates the second well constructed or visited in the SE^1/4 NE^1/4 NW^1/4 Sec. 20, T. 16 S., R. 3 E. The capital letter D indicates that the township is south of the Salt Lake Base Line and that the range is east of the Salt Lake Meridian. The numbering system is illustrated in figure 2.

Each streamflow-gaging station in Utah is assigned a unique 8-digit number that indicates the position of the station, in downstream order. The first two digits of the station number indicate the major drainage system; 09 indicates the Colorado River system and 10 indicates the Great Basin. The last six digits indicate the downstream order within the major drainage system.

Acknowledgments

The authors would like to thank all people who assisted with any part of this report, especially the landowners of Sanpete Valley who allowed access to their land to collect data related to this study. We also would like to thank personnel from the Manti office of the U.S. Department of Agriculture, Soil Conservation Service, for sharing their knowledge of irrigation practices, and personnel from the Ephraim office of the U.S. Department of Agriculture, Forest Service, Great Basin

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

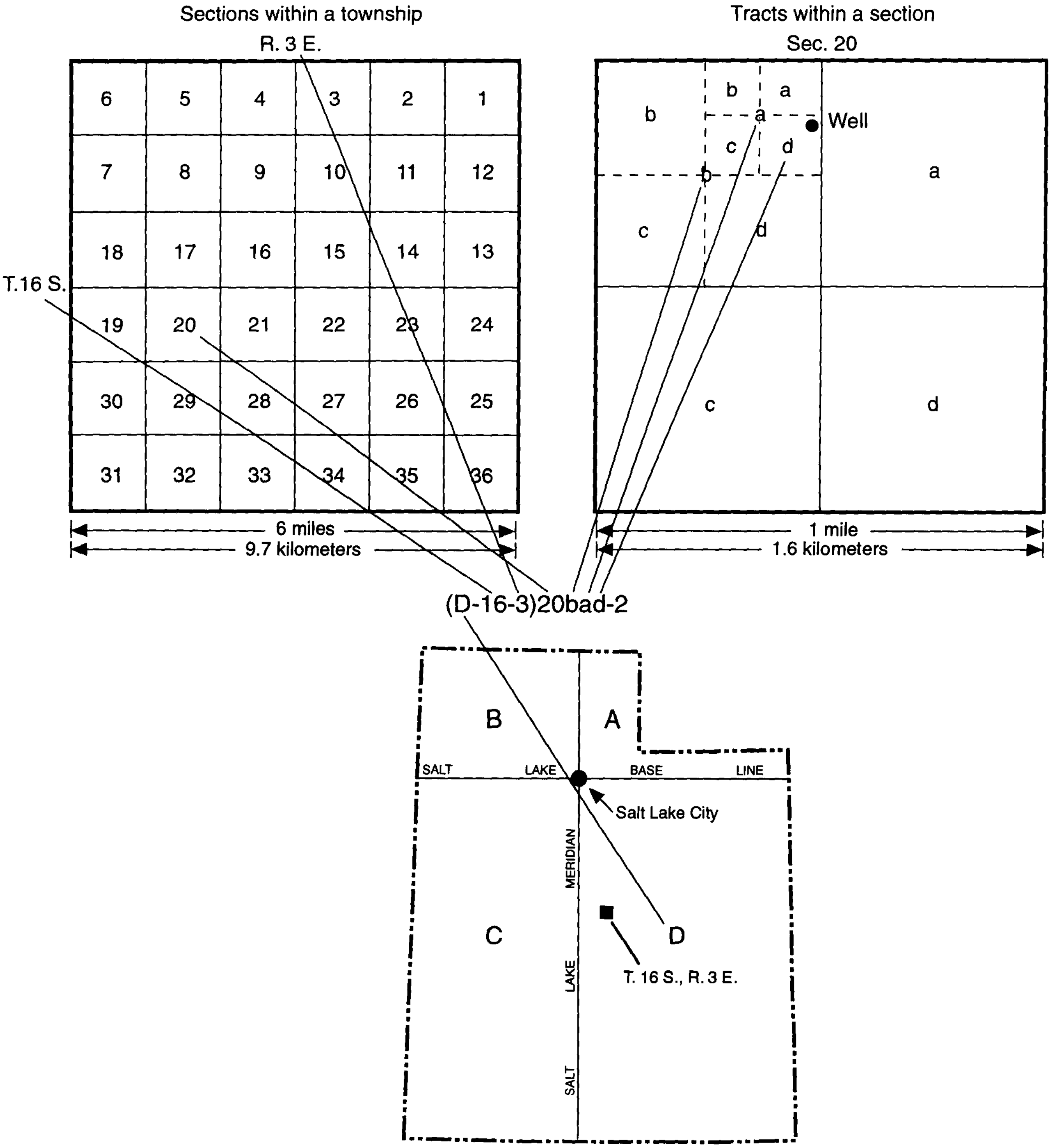

Figure 2. Numbering system for hydrologic-data sites in Utah.

Experimental Area, for climatic information collected from stations on the Wasatch Plateau.

Description of the Study Area

The 670-mi^2 study area is in central Utah and is defined by the San Pitch River drainage basin, which drains into Gunnison Reservoir (pl. 1). Sanpete Valley, for descriptive purposes, is shaped like a 'Y'. The Silver Creek drainage from Fountain Green to Moroni makes up the northwestern part of the valley, the San Pitch River from Fairview to Moroni makes up the northeastern part of the valley, and the San Pitch River from Moroni to Gunnison Reservoir makes up the southern or main part of the valley. Mountainous areas adjacent to Sanpete Valley are the San Pitch Mountains to the west, the Cedar Hills to the north, and the Wasatch Plateau to the east. The San Pitch River originates in the northern part of the Wasatch Plateau and exits the study area at the southwestern boundary through a structural and ground-water constriction at Gunnison Reservoir. Altitude in the southward-draining Sanpete Valley decreases from about 6,500 ft near Fairview and 6,300 ft near Fountain Green, to 5,500 ft near Moroni, to 5,380 ft near the outflow of Gunnison Reservoir. The highest points in the adjacent mountains are more than 11,000 ft along the crest of the Wasatch Plateau, nearly 10,000 ft in the San Pitch Mountains northwest of Fountain Green, and slightly more than 9,000 ft in the Cedar Hills north of Moroni. The relief between the valley and the adjacent mountains generally is greater than 3,000 ft. Maximum relief between the main valley and the crest of the Wasatch Plateau is greater than 5,550 ft.

Geology

The study area is in a geologic transition area between the more stable Colorado Plateau Physiographic Province to the east and the less stable Basin and Range Physiographic Province to the west (Stokes, 1986, p. 247). Episodes of folding, thrust faulting, and normal faulting have structurally deformed rocks of Jurassic age and younger in the study area. The structure of the San Pitch Mountains, composed of upper Mesozoic to lower Tertiary sedimentary rocks, is dominated by a southward-dipping syncline. A high-angle normal fault, which occurs near the site of the late Mesozoic Gunnison Thrust (Vivien and Kligfield, 1986), bounds the San Pitch Mountains on the east and displaces the valley downward relative to the mountains (fig. 1). Displacement of the normal fault in Sanpete Valley is greatest to the north near where the San Pitch Mountains are the highest. Weiss (1982, p. 50) estimated at least 3,600 ft of displacement at Maple Canyon near Manti but much less near Gunnison Reservoir. The normal fault is marked by tufa mounds along the base of the San Pitch Mountains from Big Springs southward to the mouth of Wales Canyon and by scarps in valley-fill material of Holocene age from Big Mountain southward to Maple Canyon near Manti.

The Wasatch Monocline was formed by uplift of the Colorado Plateau. Uplift began during the mid-Miocene Epoch, about 15 to 20 million years ago. Dip of the beds of Cretaceous and Tertiary age that are exposed in the monocline progressively increase from horizontal at the crest of the Wasatch Plateau to 25 to 40 degrees westward in the hogbacks at the canyon mouths (Baum and Fleming, 1989, p. C4). High-angled, north-trending, fractures and normal faults displace the bedrock and could provide a path for water to enter the bedrock.

Consolidated rock exposed in the study area represents a discontinuous record of geologic events that have occurred since the middle Jurassic Period. The oldest rocks are of middle Jurassic age and discontinuously crop out along the western margin of the valley. These gypsiferous and salt-bearing shale, siltstone, and limestone rocks, identified and mapped as the Arapien Shale by Spieker (1949, pl. 1), could affect localized ground-water quality to the east.

Conglomerates, siltstones, and sandstones of the Indianola Group of Cretaceous age are located along the western margin of the Silver Creek drainage area. These sedimentary rocks are the source of numerous springs near the contact with the valley-fill material.

The Flagstaff Limestone of Tertiary age crops out at several locations along the eastern and southern parts of Sanpete Valley. Its fractures yield water to a few springs in the southernmost part of the study area. It is deeply buried in the northern part of the main Sanpete Valley near Moroni; information from deep wells indicates that ground water in this formation is under very high hydraulic head.

Consolidated lacustrine and fluvial deposits of the Green River and Crazy Hollow Formations of Tertiary age crop out at isolated locations in Sanpete Valley near Gunnison Reservoir and along a discontinuous northward-trending, westward-dipping outcrop from east of Ephraim to southeast of Moroni (fig. 1). These rocks could affect localized ground-water quality, espeprecipitation (1931-60) for the entire study area is about 16 in/yr. Values were derived from areas, volumes, and rates calculated from digitized precipitation contours from the 1931-60 State of Utah precipitation map (U.S. Weather Bureau, 1963). A more recent precipitation map was unavailable.

Normal annual precipitation for 1951-80 and average annual precipitation for 1981–86 and 1987–89 at seven stations in the study area are listed in table 1. Average annual precipitation for six consecutive years (1981-86) was greater than normal annual precipitation (1951-80). In September 1982, the moisture from the waning stages of Hurricane Olivia combined with a cold front over Utah and produced record rainfall, which along with an El Niño-affected weather pattern, increased 1981-86 average annual precipitation. Except for the Ephraim station, average annual precipitation for 1987-89 was less than the normal annual precipitation (1951-80).

Seasonal variation of precipitation in the study area is strongly influenced by regional air masses, which control the winter and summer weather patterns. The generally perpendicular alignment of the Wasatch Plateau relative to the direction of advancing storms enhances snow accumulation. Most of the precipitation falls during the winter months, generally as snow, with the greatest accumulations on the Wasatch Plateau. Precipitation on the Wasatch Plateau is more significant to the agricultural practices in Sanpete Valley than precipitation on the valley floor because most of the water used to irrigate crops is diverted from surface-water runoff from the Wasatch Plateau when supplies are available. During years of less-than-normal snowpack when surface-water runoff is insufficient for irrigation, the agricultural requirements are met by ground-water withdrawals.

Vegetation

A land-cover survey was completed by the Utah Department of Natural Resources, Division of Water Resources, for Sanpete Valley in 1985. Data indicated that about 21,400 acres in Sanpete Valley were covered with phreatophytes (J. Ralls, Utah Department of Natural Resources, Division of Water Resources, written commun., 1989), which is less than the 45,200 acres of phreatophytes determined by Robinson (1971, p. 49). The large discrepancy is partly because of the difference in land-cover categories used by the Utah Division of Water Resources and by Robinson. For example, much of the area that was mapped by Robinson as phreatophytic was mapped as irrigated pasture and grass hay by the Utah Division of Water Resources (see "Evapotranspiration" section of this report). Much of the land mapped as irrigated pasture and grass hay is in the main part of the valley, south of Moroni, and could be irrigated when surplus water supplies are available. Also, the Robinson (1971) phreatophyte estimate included 7,200 acres of rabbitbrush and greasewood cover that were not mapped in the land-cover survey by the Utah Division of Water Resources. Land use did not change much between the mid-1960's and the mid-1980's.

About 60,000 acres in Sanpete Valley are estimated to be irrigated primarily with available surface water and supplemented by pumped ground water. Acreage estimates are from the land-cover survey done by the Utah Division of Water Resources (J. Ralls, Utah Department of Natural Resources, Division of Water Resources, written commun., 1989) and from information obtained from the Soil Conservation Service (L. Jorgensen and R. Mickelson, Soil Conservation Service, written commun., 1989). Most of the irrigated acreage is located on the well-drained areas of the alluvial slopes; the low-lying areas, especially in the main part of the valley, are used for pasture.

SURFACE-WATER HYDROLOGY

Surface-water gaging stations have been operated by the U.S. Geological Survey at various times at 13 transbasin diversions, 7 tributary creeks, 2 sites on the San Pitch River, and at the outflow of Gunnison Reservoir. At the beginning of the 1991 water year, the following gaging stations (station numbers in parentheses) were operated by the U.S. Geological Survey: Fairview Tunnel near Fairview (09309600), Ephraim Tunnel near Ephraim (09319000), Spring City Tunnel near Spring City (09323000), Oak Creek near Spring City (10215700), and Manti Creek near Manti (10215900). Gages were discontinued at the end of water year 1989 at Oak Creek near Fairview (10208500) and San Pitch River near Mount Pleasant (10210500). Records of irrigation diversions from the San Pitch River are incomplete; records of diversions from the tributaries are unavailable and probably nonexistent.

San Pitch River

The San Pitch River, which Woolley (1947, p. 10) reported as the largest tributary of the Sevier River, begins near Oak Creek Ridge on the northern Wasatch Plateau and flows westward and southward through Sanpete Valley (pl. 1). The San Pitch River flows out of the study area at the southwestern boundary. Normally perennial, westward-flowing tributaries are Oak Creek and Cottonwood Creek near Fairview, Spring Creek, Birch Creek, Cove Creek, Pleasant Creek, Twin Creek, Cedar Creek, Oak Creek near Spring City, Canal Creek, Ephraim Creek, Willow Creek, and Manti Creek. Normally perennial, eastward-flowing tributaries that begin in the San Pitch Mountains are Birch Creek near Fountain Green, and the creeks in Wales Canyon, Petes Canyon, and Axhandle Canyon (Robinson, 1971, p. 10). During this study, however, no surface water was observed in the channel of Axhandle Canyon, and flows much less than those reported by Robinson (1971) were measured at the other perennial streams. Tributary inflow from the San Pitch Mountains is less in volume than tributary inflow from the Wasatch Plateau because of the lower altitude, which results in a smaller snowpack and less runoff. Except during times of high runoff when the canals are flowing at capacity and during the off-season irrigation months from October to April, most of the flow in these tributaries is diverted for irrigation before it reaches the San Pitch River.

For the 1989 water year, average streamflow of the San Pitch River near Mount Pleasant (10210500) was 21.5 ft^3/s and ranged from 3.2 to 120 ft^3/s (ReMillard and others, 1990, p. 311). Average streamflow was influenced by upstream diversions during the growing season. For comparison, average streamflow at seven long-term representative gaging stations in Utah during 1989 averaged 60 percent of the average streamflow for water years 1944-88 (Carlson, 1990, p. 2). Streamflow at the San Pitch River near the Mount Pleasant gage probably also was less than the long-term average streamflow.

The San Pitch River exits the study area through a structural and ground-water constriction at the outlet of Gunnison Reservoir, which is 1,000 ft upstream from the confluence with Sixmile Creek and 6.8 mi upstream from the confluence with the Sevier River. Releases from Gunnison Reservoir are regulated. Average annual streamflow of the San Pitch River near Sterling (10216210), which is 100 ft downstream from the reservoir outlet gates, was 44.9 ft^3/s for 1965-80 (U.S. Geological Survey, 1981, p. 580).

Tributary Inflow

Inflow of water from ungaged tributary streams to Sanpete Valley was estimated using an equation developed from average annual streamflow and drainage area for five gaged streams in the Wasatch Plateau area. The resulting regression equation is:

$$\ln Q = 8.40 + 0.06\,(A), \qquad (1)$$

where Q = average annual streamflow, in acre-ft/yr,
$\ln Q$ = natural logarithm of average annual streamflow,
8.40 = y-axis intercept,
0.06 = slope of the regression line, and
A = drainage area, in mi^2.

The average annual streamflow (Q) for five gaging stations located on tributary creeks that originate in the Wasatch Plateau was multiplied by a constant, in this case the natural logarithm (ln), which improved the linearity of the regression relation, the normality of the regression residuals, and the symmetry of the prediction intervals. The numbers in the equation are constants and represent the y-axis intercept and the slope of the regression line, respectively. Tributary streamflow data were collected by the U.S. Geological Survey at the gaging stations for the water years indicated: (1) Oak Creek near Fairview (10208500), 1965-89; (2) Pleasant Creek near Mount Pleasant (10210000), 1955-75; (3) Twin Creek near Mount Pleasant (10211000), 1955-66; (4) Oak Creek near Spring City (10215700), 1965-74 and 1980-89, and (5) Manti Creek near Manti (10215900), 1965-74 and 1979-89. Periods of record range from 12 to 25 years; average annual streamflow ranges from 6,064 to 22,720 acre-ft/yr (natural logarithm 8.71 to 10.03, respectively); and drainage-basin areas, measured from the site of each station, range from 5.9 to 26.4 mi^2. No attempt was made to limit the streamflow data to similar periods of record; such limiting would have reduced the period of record and potentially could have biased the sample by arbitrarily eliminating data from wet or dry periods.

Although the coefficient of determination (R^2) is 98 percent, the standard error (s) is 0.0619, and the residuals are normally distributed, the regression equation is limited by the small sample size of five gaging stations. A prediction interval represents the range of values that an individual value of streamflow can be for a given drainage-basin area. At a 90-percent confidence level, the width of the prediction interval is about 0.33 natural-logarithm units, or about 1,035 acre-ft/yr on either side of the regression line at the smallest drainage-basin area and about 3,655 acre-ft/yr on either side of the regression line at the largest drainage-basin area. With repeated collection of streamflow data from other Wasatch Plateau tributaries in the study area, the frequency that new streamflow data would be outside the prediction interval is 1:10 or 10 percent.

From the regression equation, an estimate of the amount of water that enters Sanpete Valley was individually determined for each tributary basin area by plugging the drainage-basin area (A) for each tributary into the equation and calculating the streamflow (ln Q), which can be converted from natural-logarithm units to acre-ft/yr by multiplying by e^x. Drainage-basin areas were determined from the point where each tributary crossed the contact of the consolidated rock and the valley-fill material, and range from about 4.5 to 31.1 mi^2. The ungaged-tributary drainage-basin areas are slightly different from the range of areas for the five gaged stations used to develop the regression equation. Extrapolation errors associated with the use of slightly different range of basin areas are assumed to be minimal because of the close linear agreement between the five regression variables. Topographic, climatic, and geologic similarity of the gaged and ungaged drainage basins, however, supports the estimates of streamflow from ungaged tributary inflow derived from the regression equation (fig. 3).

Calculations that use the regression equation indicate that an estimated 137,000 acre-ft/yr flows into Sanpete Valley from the 16 major Wasatch Plateau tributaries, which include 13 perennial and 3 ephemeral or intermittent tributaries. For the three ephemeral or intermittent tributaries, 25 percent of the inflow estimated from the regression equation was used.

Ungaged inflow to Silver Creek and the San Pitch River from the four normally perennial and four ephemeral or intermittent tributaries that drain the San Pitch Mountains and Cedar Hills was assumed to be about 25 percent or less of the streamflow predicted by the regression equation for the Wasatch Plateau. This value is based on comparative base-flow measurements made in September 1989 on selected tributaries that drain the Wasatch Plateau and the San Pitch Mountains and includes allowances for topographic, climatic, and geologic variations. Tributary inflow from the San

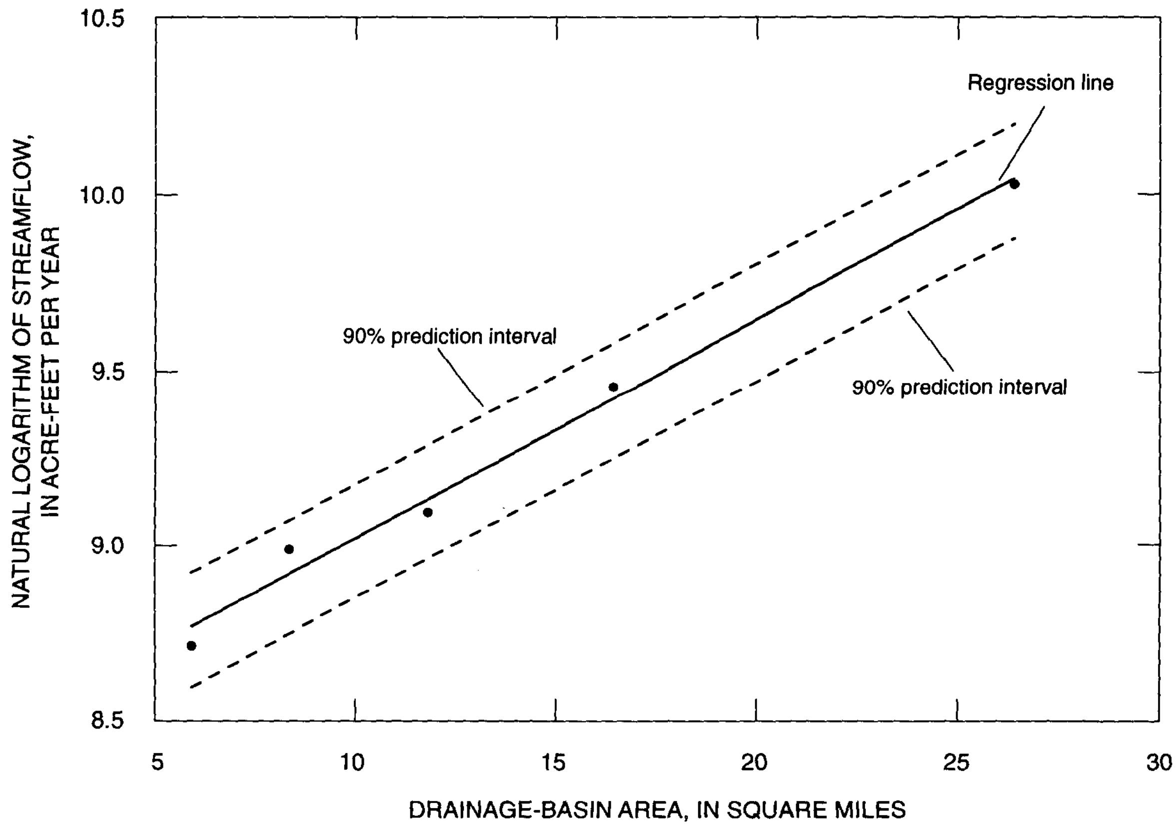

Figure 3. Relation of natural logarithm of average annual streamflow to five tributary drainage-basin areas, Sanpete Valley, Utah.

Pitch Mountains and Cedar Hills was estimated to be about 15,000 acre-ft/yr. Total estimated average annual tributary inflow to Sanpete Valley includes 137,000 acre-ft/yr from tributaries in the Wasatch Plateau and 15,000 acre-ft/yr from tributaries in the San Pitch Mountains and in the Cedar Hills for a total of about 152,000 acre-ft/yr.

Transbasin Diversions and Storage Facilities

Transbasin diversions from 13 tunnels and ditches that convey water from the Colorado River Basin to Sanpete Valley average about 11,000 acre-ft/yr (U.S. Geological Survey, 1960, 1963, 1970, 1974, 1971-90). Transbasin diversions are included in the average annual streamflow for three (Pleasant Creek, Twin Creek, and Oak Creek near Spring City) of the five gaging stations that were used to develop the regression equation. The amount of transbasin diversions represents less than 10 percent of the cumulative average annual streamflow at those three gaging stations and is not added as a separate component of the surface-water inflow to Sanpete Valley.

Storage facilities in the study area consist of small reservoirs built by local irrigation companies. The capacities of the storage facilities range from 550 acre-ft at Chester Ponds to 18,200 acre-ft at Gunnison Reservoir. Wales Reservoir, southwest of Moroni, has a storage capacity of 1,450 acre-ft. Fairview Lakes and Lower Gooseberry Reservoir provide water to users in Sanpete Valley through transbasin diversion tunnels, although the storage facilities are not in the study area.

Water Quality

Specific conductance of the San Pitch River generally increases downstream from the headwaters north of Fairview to the inflow at Gunnison Reservoir. Measurements of specific conductance during low-flow conditions in October 1988, in conjunction with a seepage study on the San Pitch River (Sandberg and Smith, 1995) show that values increase from about 700 µS/cm north of Fairview to 1,560 µS/cm or greater near the inflow to Gunnison Reservoir. Water from three separate river reaches northwest of Mount Pleasant, between Moroni to southwest of Chester, and southwest of Ephraim, had specific-conductance values in October 1988 that were higher than the range of values measured in water from other sites on the San Pitch River. High specific-conductance values of water sampled at river sites (D-14-4)22cda and 28ada (table 6) result from nearby flowing wells that discharge from consolidated rock (wells (D-14-4)22cdd-1 and 27daa-1)(Robinson, 1968, table 1). High specific-conductance values in water from sites (D-15-3)10ddc, 16dca, and 33bbb, and (D-16-3)8cbc (table 6) along the San Pitch River in the Moroni-Chester area likely result from seepage to the river of shallow ground water. The shallow ground water in this area is recharged in nearby outcrops of lacustrine and fluvial deposits of the Green River and Crazy Hollow Formations of Tertiary age. High specific-conductance values of water from site (D-16-3)8cbc (table 6) southwest of Chester were measured along a losing river reach and the water could have been partly concentrated by evaporation. The highest specific-conductance values were measured in water from a site (D-17-2)14cca along the San Pitch River upstream from Maple Canyon near Manti, along a gaining reach where flow in the river channel resulted from ground-water seepage from a local flow system that is recharged in nearby outcrops of Arapien Shale of Jurassic age. Specific-conductance values in water from this site, measured in October 1988 and July and September 1989, ranged from 21,500 to 33,400 µS/cm (table 6). A chemical analysis of water from this site is listed as San Pitch River upstream from Maple Canyon near Manti in table 7.

Specific-conductance values of water from tributaries that drain the Wasatch Plateau generally were 800 µS/cm or less (ReMillard and others, 1990, p. 353-354)(table 6). No inflow occurred from tributaries on the west in October 1988, but measurements of specific conductance and temperature for water from the tributaries at other times show that surface water from the San Pitch Mountains is of sufficient quality for most uses, with specific-conductance values less than 900 µS/cm (table 6).

Results of chemical analyses of water from four sample sites on the San Pitch River and one site on Saleratus Creek are listed in table 7. The sample sites are shown on plate 1. The percentage of predominant dissolved ions for those five surface-water sites are shown in figure 4. The low dissolved-solids concentration of two water samples collected from the San Pitch River near Fairview and near Mount Pleasant (both samples had a calcium-magnesium-bicarbonate composition) are of adequate quality for most uses, although an increase in the concentration of sulfate, potassium, and

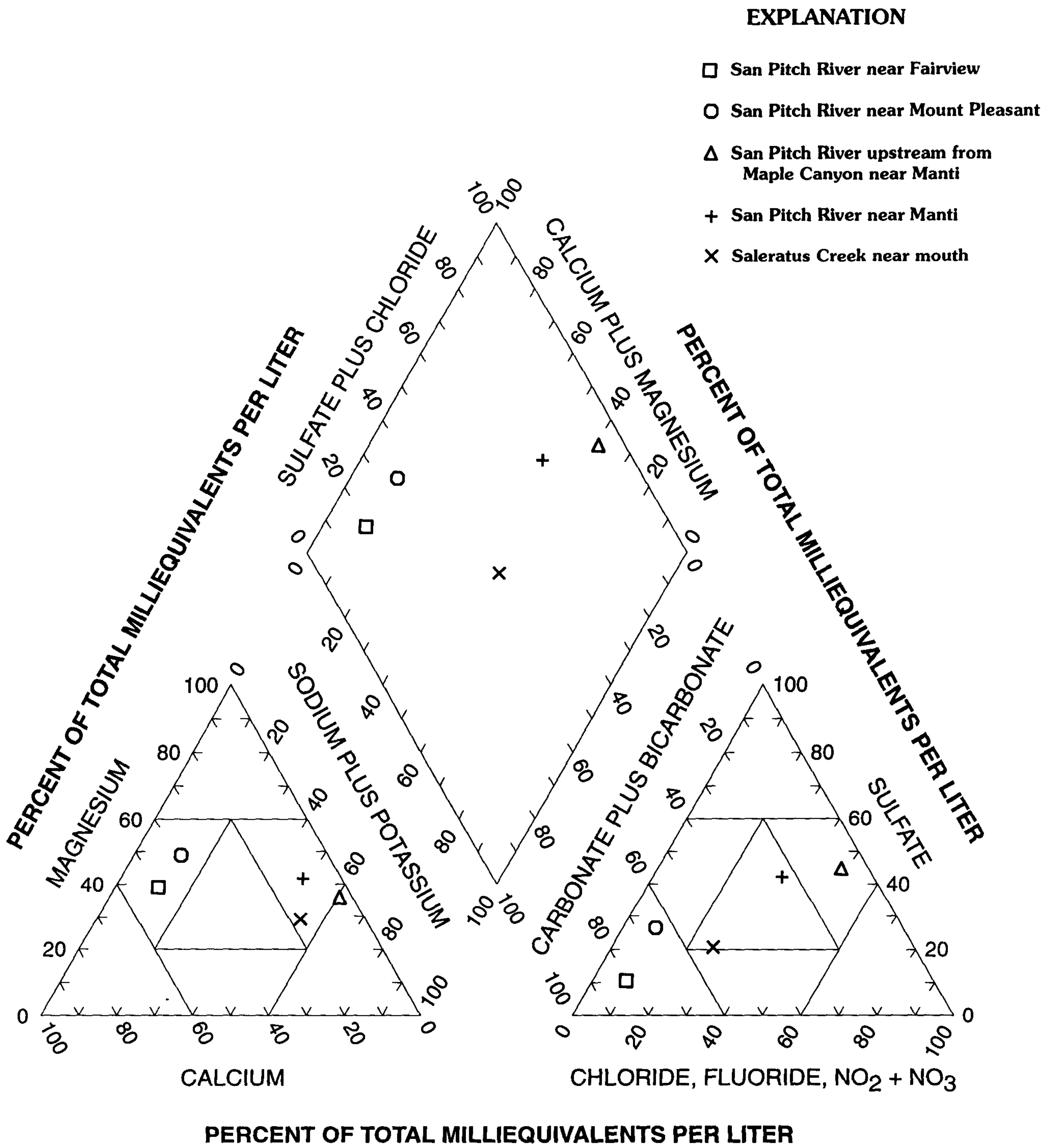

Figure 4. Percentage of predominant dissolved ions in water from five surface-water sites in Sanpete Valley, Utah.

dissolved solids was detected in the Mount Pleasant sample.

The water sample collected from the San Pitch River upstream from Maple Canyon near Manti contains high concentrations of sodium-magnesium cations and sulfate-chloride anions. This water is not of sufficient quality for most human and livestock use because of high dissolved-solids concentration. The cause of the high concentration of dissolved solids in the river water could result from shallow ground water that discharges into this reach of the river. Ground water in this local flow system is recharged along outcrops of Arapien Shale in the nearby San Pitch Mountains, flows eastward, and discharges to the San Pitch River (as discussed later in the "Water quality" section of the "Ground water" section of this report). An order-of-magnitude decrease in dissolved-solids concentration, determined by comparing the water analysis of the San Pitch River upstream from Maple Canyon near Manti with the water analysis of the San Pitch River near Manti, is the result of dilution by flowing-well inflow and irrigation-return flow that contains lower concentrations of dissolved solids. The San Pitch River near Manti, however, still has high concentrations of sodium, sulfate, and chloride.

The water sample from Saleratus Creek had a sodium-potassium-bicarbonate composition and a moderate dissolved-solids concentration (fig. 4, table 7). Saleratus Creek is located downgradient from a local ground-water flow system (that derives recharge from surface-water infiltration sources in Manti Creek) in the ground-water discharge area caused by the structural constriction at the south end of the Sanpete Valley.

GROUND-WATER HYDROLOGY

Ground water occurs in unconsolidated valley-fill material and consolidated rock of Tertiary age and older. The valley-fill aquifer provides most of the ground water used for agricultural, industrial, and municipal uses; therefore, more data are available for the valley-fill aquifer than are available for the consolidated-rock aquifers. Consolidated-rock aquifers, however, yield water to some springs in the Wasatch Plateau, the San Pitch Mountains, and to a few wells in Sanpete Valley.

Consolidated Rock

Ground-water in consolidated rock in and around Sanpete Valley is described by Robinson (1971, p. 24–25). Ground water occurs in consolidated rock of Tertiary age that underlies the valley. The consolidated-rock aquifers generally are assumed to be much less permeable than the valley-fill aquifer. Secondary faulting and dissolution of limestone formations could cause locally higher hydraulic conductivity.

Only a few wells are completed in consolidated-rock aquifers in Sanpete Valley. Robinson (1971, p. 25) discusses wells that might yield water from consolidated-rock aquifers near Fairview, Mount Pleasant, Moroni, Spring City, Chester, Pigeon Hollow, Ephraim, and Manti. Well (D-15-3)14bdb-1, about 2 mi southeast of Moroni, is perforated from 2,280 to 2,406 ft (table 8) beneath land surface in the Flagstaff Limestone and has the highest hydraulic head and discharge of any well perforated in the consolidated rock underlying Sanpete Valley. On May 5, 1980, the reported water level in well (D-15-3)14bdb-1 was 790 ft above land surface, and the reported initial discharge was about 1,350 gal/min (about 2,200 acre-ft/yr) (State of Utah Engineer's Office, written commun., 1980).

Consolidated-rock aquifers are the source of water that discharges from springs in the mountains and along the western and southern edges of Sanpete Valley. Robinson (1968, table 2) reported a discharge from 15 consolidated-rock springs along the western and southern edges of Sanpete Valley of about 12,000 acre-ft/yr of water, which includes only discharge from springs that flow directly into Sanpete Valley. Discharge from consolidated-rock springs that flow into tributary streams in the San Pitch Mountains, Cedar Hills, and Wasatch Plateau before reaching Sanpete Valley is considered to be part of surface-water tributary inflow (see "Tributary inflow" section of this report). The 15 consolidated-rock springs reported by Robinson (1968, table 2) are Big Springs, (D-14-2)2bab-S1; Birch Creek Springs, (D-14-2)23bda-S1; Bailey Spring, (D-14-2)26ddc-S1; Lauritz Tunnel Spring, (D-14-2)35aab-S1; Christensen Spring, (D-14-2)35aab-S2; Freedom Spring, (D-15-2)2ada-S1; Brewer's Spring, (D-15-2)13bbc-S1; Middle Spring, (D-15-2)13cdb-S1; South Spring, (D-15-2)24bda-S1; an unnamed spring, (D-15-2)24bdb-S1; Moroni Spring, (D-15-3)9acb-S1; Crystal Springs, (D-18-2)13cad-S1; Milt's Springs, (D-18-2)14cdb-S1; Saleratus Spring, (D-18-2)22cb-S1; and Stinking Springs, (D-18-2)23aac-S1.

Big Springs, (D-14-2)2bab-S1, northwest of Fountain Green, is the largest consolidated-rock spring that discharges water into Sanpete Valley, with measured discharge in 1989 that ranged from 3,320 to 4,170 gal/min (about 5,400 to 6,700 acre-ft/yr) (table 6). During the mid-1980's, when precipitation was greater than normal, discharge at Big Springs exceeded 12,500 gal/min (about 20,300 acre-ft/yr) (Utah Department of Wildlife Resources, Fountain Green Fish Hatchery, oral commun., 1989). Other measured discharge from consolidated-rock springs during this study includes Birch Creek Springs, (D-14-2)23bda-S1, with a discharge of 6.45 gal/min (about 10.4 acre-ft/yr) on April 24, 1989; Freedom Spring, (D-15-2)2ada-S1, with a discharge of 4.4 gal/min (about 7.1 acre-ft/yr) on April 25, 1989; and Brewer's Spring at (D-15-2)13bbc-S1, with a discharge of 27 gal/min (about 43.6 acre-ft/yr) on April 25, 1989 (table 6). The discharge of these springs measured during this study was considerably less than the discharge measured during the Robinson (1968, p. 23-26) study. The decrease could be because of less-than-normal annual precipitation in the late 1980's (table 1).

Although the consolidated-rock aquifers could locally be highly permeable because of fracturing and dissolution, it is assumed that these aquifers generally have very low hydraulic conductivity values. Also there is no direct evidence of a hydraulic connection with the overlying valley-fill aquifer. Without actual data confirming this hydraulic connection, the consolidated-rock aquifer is assumed to not contribute water to the valley-fill aquifer. This is consistent with the findings from the University of Arizona (1980, p. 4-25) overview of mountain-front recharge, where it is concluded that the hydraulic conductivity of material along a mountain front may be low because of cementation or poor sorting and could inhibit subsurface inflow. The high head (mentioned above) at well (D-15-3)14bdb-1 near Moroni could also indicate the presence of poorly permeable consolidated-rock layers between the Flagstaff Limestone and the valley-fill deposits.

Valley-Fill Aquifer

Depth to the ground-water table in Sanpete Valley ranges from about 10 ft in shallow wells in the center of the valley to 88 ft near the alluvial slopes at the base of the Wasatch Plateau northeast of Spring City at well (D-15-4)21cda-1 (table 9). Along the western side of the main valley and along the western side of the Cedar Hills depth to water generally is less than 50 ft.

Ground water in the valley-fill aquifer occurs under water-table (unconfined) and artesian (confined) conditions. Robinson (1971, p. 23-24) describes ground-water conditions in the valley-fill material in Sanpete Valley in detail. Ground water generally is under water-table conditions in the northeastern part of Sanpete Valley, although there are areas west of Mount Pleasant and in the vicinity of Spring City where wells completed in the valley-fill material flow at land surface, for example wells (D-15-4)7dad-1, 7dda-1, and 31dab-1 (table 9). In the Silver Creek part and the main part of Sanpete Valley, ground water is under water-table conditions along the margins of the valley. In the center of the valley, artesian conditions generally exist beneath the upper 50 ft of saturated valley-fill material because of the presence of fine-grained sediments and discontinuous clay confining units. Robinson (1971) also reported that a uniform artesian zone occurs in the center of the valley north of the midway point between Ephraim and Chester. South of this point, however, water levels in wells completed at various depths indicate that there are several discrete aquifer zones.

Recharge

The three known sources of recharge to the valley-fill aquifer are (1) seepage of water from tributaries and the San Pitch River, (2) infiltration of unconsumed irrigation water, and (3) infiltration of precipitation on the valley floor. Recharge to the valley-fill aquifer varies seasonally and yearly, but is estimated to average between 74,000 and 103,000 acre-ft/yr (table 2). Individual recharge components are discussed in more detail in the following sections.

Seepage from Tributaries and the San Pitch River

Most recharge to the valley-fill aquifer from seepage of water from streams occurs where the perennial tributaries to the San Pitch River, most of which originate in the Wasatch Plateau, flow across the coarser valley-fill material near the mountain fronts. Seepage losses were measured by Richardson (1907, p. 19) for reaches of three tributaries on the east side of Sanpete Valley. Twin Creek lost about 38 percent of its total flow in a 2.8-mi reach. Ephraim Creek lost about 10 percent of its total flow in a 0.6-mi reach downstream from the canyon mouth. Oak Creek near Spring City lost about 9 percent of its total flow in a 2.4-mi reach. Because these streams were measured in August

Table 2. Measured or estimated components of the ground-water budget for the valley-fill aquifer in Sanpete Valley, Utah

[values in acre-feet per year]

Recharge	
Seepage from tributaries	28,500–57,000[1]
Seepage from the San Pitch River	1,500[2]–1,800[3]
Infiltration of unconsumed irrigation water	29,000[1]
Infiltration of precipitation on the valley floor	15,000[1]
Total recharge (rounded)	74,000–103,000
Discharge	
Evapotranspiration	41,000–116,000[1]
Seepage to the San Pitch River	18,500[2]–80,300[3,4]
Withdrawals from wells	
Pumped wells	1,200–12,800[5]
Flowing wells	4,000[6]
Alluvial-spring discharge	11,000[7]
Total discharge (rounded)	76,000–224,000

[1]Estimated average conditions.
[2]Measured October 4-6, 1988.
[3]Measured April 4-5, 1966.
[4]Measured March 23-25, 1966.
[5]Well pumpage 1963-88.
[6]Discharge measurements 1965-67, 1989.
[7]Discharge measurements 1965-67.

and September, evapotranspiration could account for some of this water loss.

Tributaries along the west side of Sanpete Valley are either ephemeral or intermittent or have a small perennial base flow. Seepage information is not available for these tributaries. Assuming that seepage to the valley-fill aquifer is proportional to streamflow, these tributaries probably contribute much less recharge to the valley-fill aquifer than do the perennial tributaries that originate on the Wasatch Plateau.

Combining the estimated average annual tributary inflow of about 152,000 acre-ft/yr with estimated inflow from consolidated-rock springs of about 12,000 acre-ft/yr yields a total surface water inflow of about 164,000 acre-ft/yr to Sanpete Valley. Most of this inflow is diverted for irrigation after entering the valley. About 35 percent of the total inflow, or about 57,000 acre-ft/yr is estimated to remain undiverted in natural tributary channels (L. Young, Soil Conservation Service, oral commun., 1989). Diversion records are not available to quantify the water diverted for irrigation. The amount of water diverted is, in part, dependent on the time of year, the amount of snowpack and runoff, and the capacity of the diversion structures and canals. During spring snowmelt runoff and during wet years, a larger percentage of surface water is assumed to be undiverted because of capacity limitations for diversion structures and canals, whereas during the remainder of the irrigation season and during dry years, most of the surface water is diverted.

Between 50 and 100 percent of the undiverted surface water in tributaries, or about 28,500 acre-ft/yr to about 57,000 acre-ft/yr is estimated to recharge the valley-fill aquifer (table 2). The 50-percent value was estimated from stream seepage data of Richardson (1907). If the 10-percent loss along a 0.6-mi distance of Ephraim Creek, measured by Richardson in the summer of 1905, is assumed to occur along the entire 4-mi reach of the creek, then about 50 percent of the undiverted flow of this creek would recharge the valley-fill aquifer. This calculation assumes that the actual loss along each successive 0.6-mi reach decreases as tributary inflow decreases by the constant 10 percent in each successive reach. A 50-percent loss also was estimated for the 20-mi reach of Oak Creek near Spring City. The 100-percent value for recharge to the valley-fill aquifer from tributary seepage is based on observations of tributaries that flow into Sanpete Valley. Many tributaries in Sanpete Valley decrease to zero streamflow as they flow toward the center of the valley. The estimated 50- to 100-percent range of recharge to the valley-fill aquifer from tributary seepage loss assumes that all losses along the natural tributary channels will recharge the valley-fill aquifer. An unknown amount of water is lost to evapotranspiration, however, so actual recharge percentages could be smaller.

Seepage of water from losing sections of the San Pitch River is another source of recharge to the valley-fill aquifer. Recharge to the valley-fill aquifer from the river is estimated to be between about 1,500 (2.1 ft^3/s) and 1,800 acre-ft/yr (2.5 ft^3/s) (table 2). During October 4-6, 1988, an average total seepage loss of about 1,500 acre-ft/yr (2.1 ft^3/s) was measured for 5 of the 17 reaches of the San Pitch River. This average total seepage loss was determined by subtracting the average net seepage gain of about 17,000 acre-ft/yr (23.4 ft^3/s) from the average total seepage gain of about 18,500 acre-ft/yr (25.5 ft^3/s) (Sandberg and Smith, 1995, table 8). Actual recharge to the aquifer could be larger because during this period there were dry reaches of the river north of Fairview and from southeast of Wales to east of Ephraim that could be recharge areas when they are not dry. A total seepage loss of about 1,800 acre-ft/yr (2.5 ft^3/s) was measured along the San Pitch River between the bridge west of Ephraim (fig. 1) and the bridge west of Manti during seepage studies on April 4-5, 1966 (Robinson, 1971, table 9-10).

Infiltration of Unconsumed Irrigation Water

Some of the more important factors that affect the amount of recharge from infiltration of unconsumed irrigation water for a particular field include irrigation rate, evapotranspiration rate, crop type, amount of precipitation during the growing season at that location, permeability of the soil, slope of the field, and irrigation method used. A general range of recharge was estimated because it was not possible to quantify these variables for all the irrigated land in Sanpete Valley. In general, changes in irrigated acreage are assumed to be minimal.

A recent change in irrigation practices has been the conversion from flood to sprinkler irrigation. Between 1975 and 1989, sprinkler irrigation is estimated to have increased from less than 10 percent to more than 50 percent for all irrigated land in Sanpete Valley (L. Young, Soil Conservation Service, oral commun., 1989). Thiros and Brothers (1993, p. 21) collected data from a sprinkler-irrigated field and a flood-irrigated field in Panguitch Valley, Utah, which is about 120 mi south-southwest of Sanpete Valley. In that study, water levels, soil moisture (determined with a neutron probe), and hydrologic properties of the soil (determined from drill cores) were analyzed. On the basis of water levels measured at the two test fields and a specific yield of 20 percent, they estimated that about 2.4 ft (24 percent) of the 10.0 ft of water applied as flood irrigation recharged the valley-fill aquifer, but little or no recharge was derived from water applied to the sprinkler-irrigated field.

The total amount of water applied as irrigation water to Sanpete Valley is estimated to be about 116,900 acre-ft/yr. This was determined by adding the 65 percent, or about 106,600 acre-ft/yr, of diverted tributary inflow (including spring discharge from consolidated rock) to the average well withdrawals of about 10,300 acre-ft/yr. About 25 percent, or about 29,000 acre-ft/yr, of the 116,900 acre-ft/yr of applied irrigation water is estimated to recharge the valley-fill aquifer (table 2). Dividing this estimated amount of unconsumed irrigation water by the approximately 60,000 irrigated acres in Sanpete Valley yields a recharge rate of about 0.48 ft/yr.

The 25 percent of applied irrigation water estimated to recharge the valley-fill aquifer is based on recharge estimates from other basin studies in Utah. Mower (1965, p. 49) estimated that 25 percent of applied irrigation water recharged the unconsolidated aquifer in Pahvant Valley, Utah, which is about 50 mi southwest of Sanpete Valley. Mower and Feltis (1968, p. 28) estimated that recharge from irrigation water exceeds 25 percent in the Sevier Desert, Utah, which is about 50 mi west of Sanpete Valley. A digital computer ground-water flow model for central Sevier Valley, about 50 mi south-southwest of Sanpete Valley, determined that about 28 percent of applied irrigation water recharged the valley-fill aquifer (Patrick Lambert, U.S. Geological Survey, written commun., 1990).

Infiltration of Precipitation

About 10 percent, or about 15,000 acre-ft/yr, of normal annual precipitation in Sanpete Valley is estimated to recharge the valley-fill aquifer (table 2). On the basis of studies of other valleys in Utah that receive from 8 to 16 in. of annual precipitation (Hood and Waddell, 1968, p. 24; Feth and others, 1966, p. 43), estimates of infiltration range from 6 to 25 percent of annual precipitation. Normal annual precipitation in Sanpete Valley is about 12 in. (see "Climate" section of this report).

The 6-percent estimate by Hood and Waddell for Skull Valley (1968, p. 22) is thought to be too low a percentage for Sanpete Valley because the altitude of Skull Valley is about 1,500 ft lower than the altitude of Sanpete Valley and because less precipitation is available for infiltration in Skull Valley because of the larger amount of evapotranspiration associated with the higher mean annual temperature. The 25-percent estimate by Feth and others for the Weber Delta (1966, p. 43) is thought to be too large for Sanpete Valley because of the higher hydraulic conductivity associated with the generally coarser sediments of the Weber Delta.

Movement

Potentiometric contours for the valley-fill aquifer in November 1989 are shown in figure 5. The direction of ground-water movement is downgradient and perpendicular to the potentiometric contours. Ground

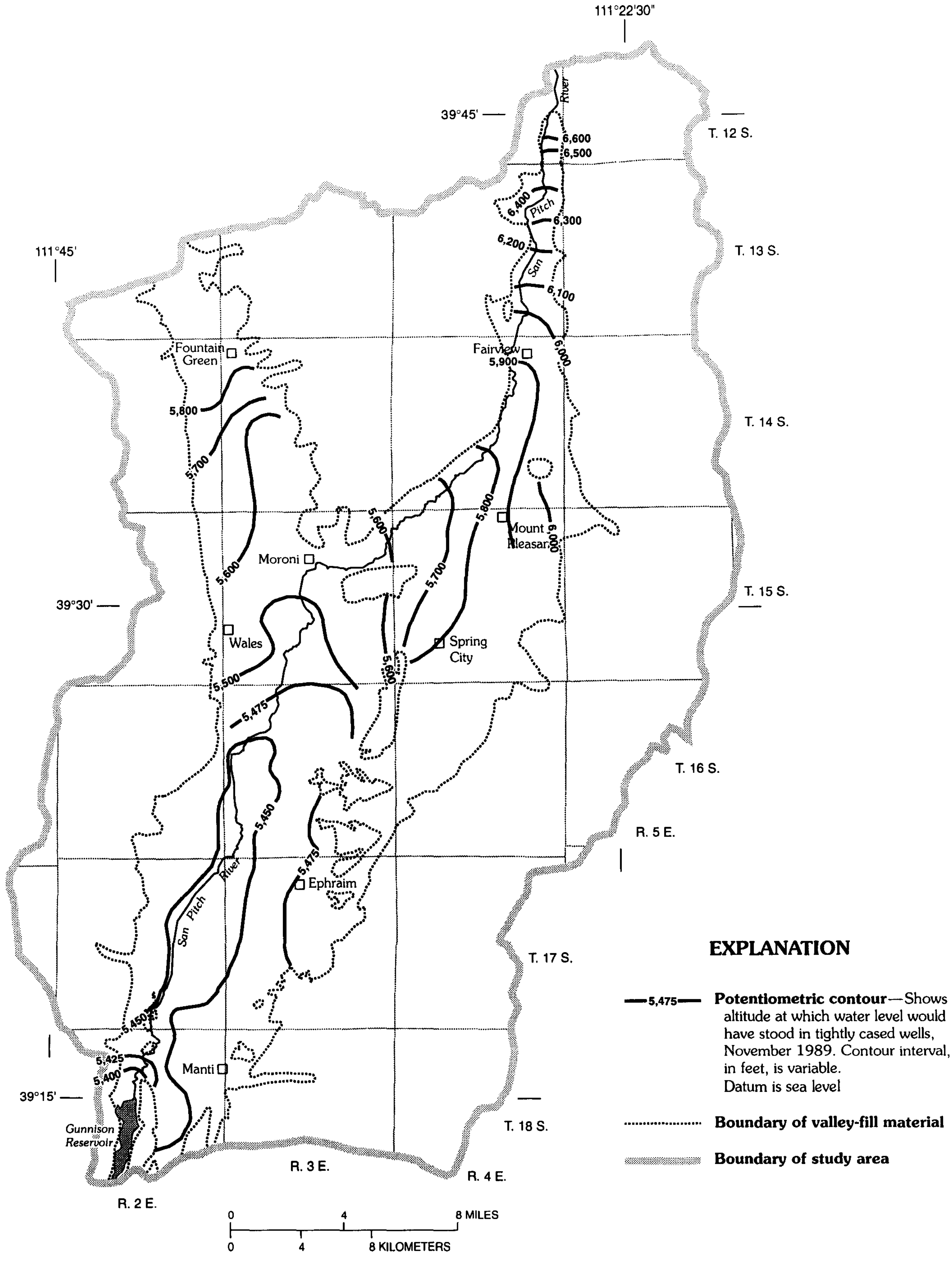

Figure 5. Potentiometric contours of water levels measured in the valley-fill aquifer, Sanpete Valley, Utah, November 1989.

water in the valley-fill aquifer generally moves horizontally from the high-altitude recharge areas along the edges of the valley to the discharge area in the center of the main Sanpete Valley (fig. 5). Recharge from tributaries, particularly along the east side of Sanpete Valley, creates an east-west component of ground-water flow from the edges to the center of the valley. The hydraulic gradient decreases toward the center of the valley and results in a nearly flat potentiometric surface. Areas of largest horizontal hydraulic gradient are in the northern parts of the Silver Creek and San Pitch River drainages. Potentiometric contours in the southern part of the valley indicate the potential for ground-water movement southward out of Sanpete Valley, although the amount is assumed to be minimal because of the limited thickness of saturated valley-fill material in this area.

Vertical ground-water movement generally is downward where recharge occurs along the edges of the valley and upward where discharge occurs in the center of the valley. The direction of movement is determined by comparing water levels in adjacent wells completed at different depths in the aquifer. In recharge areas, shallower wells have higher water levels than deeper wells and indicate a downward gradient. In discharge areas, deeper wells have higher water levels than nearby shallower wells and indicate an upward gradient. For example, on November 9, 1989, well (D-17-2)14ccb-1 near the San Pitch River southwest of Ephraim (open-ended at a depth of 183 ft) had a measured water level of 26.6 ft above land surface or about 5,447 ft above sea level, and well (D-17-2)14cca-1 (perforated at a depth of 54 to 64 ft) had a measured water level of 1.17 ft below land surface or about 5,422 ft above sea level (table 8 and 9). Upward gradients exist in flowing well areas and areas adjacent to flowing wells, where the gradient can still be upward, though not above the land surface. The flowing-well areas expand and contract with water-level fluctuations, which vary with climatic conditions. Comparison of November and December 1966 (Robinson, 1971, pl. 2) potentiometric contours with November 1989 potentiometric contours (fig. 5) shows minor variation in the shape and position of some contours but no major shifts that would indicate long-term changes in the ground-water system.

Discharge

Four principal sources of discharge from the valley-fill aquifer, ranked in order of decreasing amount, are (1) evapotranspiration, (2) seepage to the San Pitch River, (3) withdrawals from wells, and (4) alluvial-spring discharge. Total discharge from the valley-fill aquifer varies seasonally and yearly and is estimated to range from 76,000 to 224,000 acre-ft/yr (table 2).

Evapotranspiration

Ground-water discharge as evapotranspiration occurs throughout much of Sanpete Valley where the water table is at or near land surface. Robinson (1971, p. 45) states that four common types of phreatophytes are saltgrass, wiregrass, greasewood, and rabbitbrush. Saltgrass and wiregrass are found predominantly in the wet marshlands in the lower parts of Sanpete Valley; greasewood and rabbitbrush grow along the fringes of these wetlands where the water table is deeper beneath the land surface (Robinson, 1971, pl. 2). Robinson (1971, p. 49) estimated phreatophyte coverage during the mid-1960's to be 45,200 acres, including 38,000 acres of saltgrass and wiregrass and 7,200 acres of greasewood and rabbitbrush. A land survey completed by the Utah State Division of Water Resources in 1985 determined phreatophyte coverage to be 21,400 acres. The irrigated pasture and grass hay categories (20,500 acres and 4,100 acres, respectively) are considered to be generally phreatophytic, however, and are irrigated only when surplus water supplies are available. With the inclusion of irrigated pasture and grass hay, total phreatophytic acreage of the 1985 survey would be 46,000 acres. Most of the land categorized as irrigated pasture and grass hay is south of Moroni and could be flood-irrigated during spring runoff or when surplus water supplies are available. The water table, however, is very close to land surface in this area, and the vegetation generally is considered phreatophytic.

The amount of evapotranspiration from phreatophyte areas is estimated to range from 41,000 to 116,000 acre-ft/yr (56.6 to 160.1 ft^3/s) (table 2). The minimum value of 41,000 acre-ft/yr (56.6 ft^3/s) was calculated using evapotranspiration rates determined for the Milford area of southwestern Utah. White (1932, p. 86-87) determined evapotranspiration rates to be 1.0 ft/yr for saltgrass and 0.4 ft/yr for greasewood and wiregrass. The maximum value of 116,000 acre-ft/yr (160.1 ft^3/s) was reported by the U.S. Department of Agriculture (1969, p. 17-20) in a water-budget analysis of Sanpete Valley that used evapotranspiration rates from 1.2 to 3.0 ft/yr for saltgrass and 1.0 to 4.8 ft/yr for greasewood. Robinson (1971, p. 49) reported a value of 113,000 acre-ft/yr (155.9 ft^3/s), which was determined by multiplying 45,200 acres of phreatophytes by an evapotranspiration rate of 2.5 ft/yr and was based on evapotranspiration rates from Robinson (1958, p. 49-75). The minimum evapotranspiration estimate of 41,000 acre-ft/yr (using rates of 1.0 ft/yr for saltgrass and 0.4 ft/yr for greasewood and wiregrass) could be more realistic than the higher estimates because these evapotranspiration rates were based on actual growth conditions for a study area similar to Sanpete Valley.

Seepage to the San Pitch River

Discharge as seepage from the valley-fill aquifer into the San Pitch River is estimated to range from about 18,500 acre-ft/yr to about 80,300 acre-ft/yr (25.5 to 110.8 ft^3/s) (table 2). The minimum value of about 18,500 acre-ft/yr (25.5 ft^3/s) is the average total seepage gain of three seepage studies done during October 4-6, 1988. This average total seepage gain was determined by adding the individual gains from the 12 reaches in the Sandberg and Smith (1995) report. The October 1988 seepage studies included all reaches of the San Pitch River from Milburn to Gunnison Reservoir and were done during a period of less-than-normal precipitation (table 1) and streamflow. Most discharge as seepage to the San Pitch River occurred along the reach just south of Milburn to near Moroni. Two river reaches were dry during the seepage study; one was a short reach north of Fairview and the other was from near Chester to west of Ephraim.

The maximum value of about 80,300 acre-ft/yr (about 110.8 ft^3/s) is the combined total seepage gain from seepage studies done in March and April 1966 on two separate reaches of the San Pitch River (Robinson, 1971, tables 9 and 10). During March 23-25, 1966, the reach from north of Milburn to the bridge west of Ephraim showed average total seepage gains from ground water of about 58,900 acre-ft/yr (81.3 ft^3/s). During April 4-5, 1966, the reach from the bridge west of Ephraim to the bridge west of Manti showed average total seepage gains from ground water of about 21,400 acre-ft/yr (29.5 ft^3/s). The seepage studies were measured at a time when water levels in wells in Sanpete Valley were high because of greater-than-average precipitation during the preceding year. Discharge from the valley-fill aquifer probably is less than the maximum value of 80,300 acre-ft/yr.

Withdrawals from Wells

Well withdrawals from the valley-fill aquifer are from pumped and flowing wells. Nearly all of the water from well withdrawals is applied as irrigation water in Sanpete Valley. The average amount of well withdrawals for 1963 to 1988 was about 10,300 acre-ft/yr and includes about 6,300 acre-ft/yr of water from pumped wells and about 4,000 acre-ft/yr of water from flowing wells.

Withdrawals from 55 pumped wells ranged from 1,200 to 12,800 acre-ft/yr (1.7 to 17.7 ft^3/s) (table 2) from 1963 to 1989 (fig. 6). The average yearly withdrawal rate was about 6,300 acre-ft/yr (8.7 ft^3/s) for 1963-88. The relation of increased withdrawal by pumped wells with decreased precipitation at the Meadows climatic station, located on the Wasatch Plateau east of Ephraim at an altitude of 9,850 ft, is shown in figure 6. The relation corresponds to irrigation practices in Sanpete Valley. The primary source of water for irrigation is surface water. Ground water is pumped only when surface-water supplies are inadequate; therefore, the amount of pumped-well withdrawals is increased during dry years when snowpack in the surrounding mountains cannot supply an adequate amount of surface-water runoff. Two exceptions to the relation of increased withdrawals by pumped wells with decreased precipitation at Meadows climatic station occurred in 1969 and 1979. In 1969, both precipitation and pumped-well withdrawals increased from the previous year. In 1979, both precipitation and pumped-well withdrawals decreased from the previous year.

The discharge from flowing wells is estimated to be about 4,000 acre-ft/yr (about 5.5 ft^3/s)(table 2) on the basis of measured quantities that range from 1,300 to 4,500 acre-ft/yr (1.8 to 6.2 ft^3/s). A complete inventory of flowing wells was done by Robinson from 1965 to 1967. A total discharge of 4,500 acre-ft/yr (6.2 ft^3/s) was measured at 184 flowing wells completed in the valley-fill aquifer (Robinson, 1968, table 1). Robinson (1971, p. 44) assumed that discharge from these flowing wells was fairly constant. Discharge measured during August and September 1989 (after a period of less-than-normal precipitation) at 19 of the same flowing wells, however, was 28 percent of the 1965-67 amount. Some of the decrease in discharge could be caused by clogging of the wells or by the installation of other nearby flowing wells. The minimum estimated value of 1,300 acre-ft/yr (1.8 ft^3/s) for flowing-well discharge was estimated by applying the 28 percent to the total measured discharge of 4,500 acre-ft/yr. Because long-

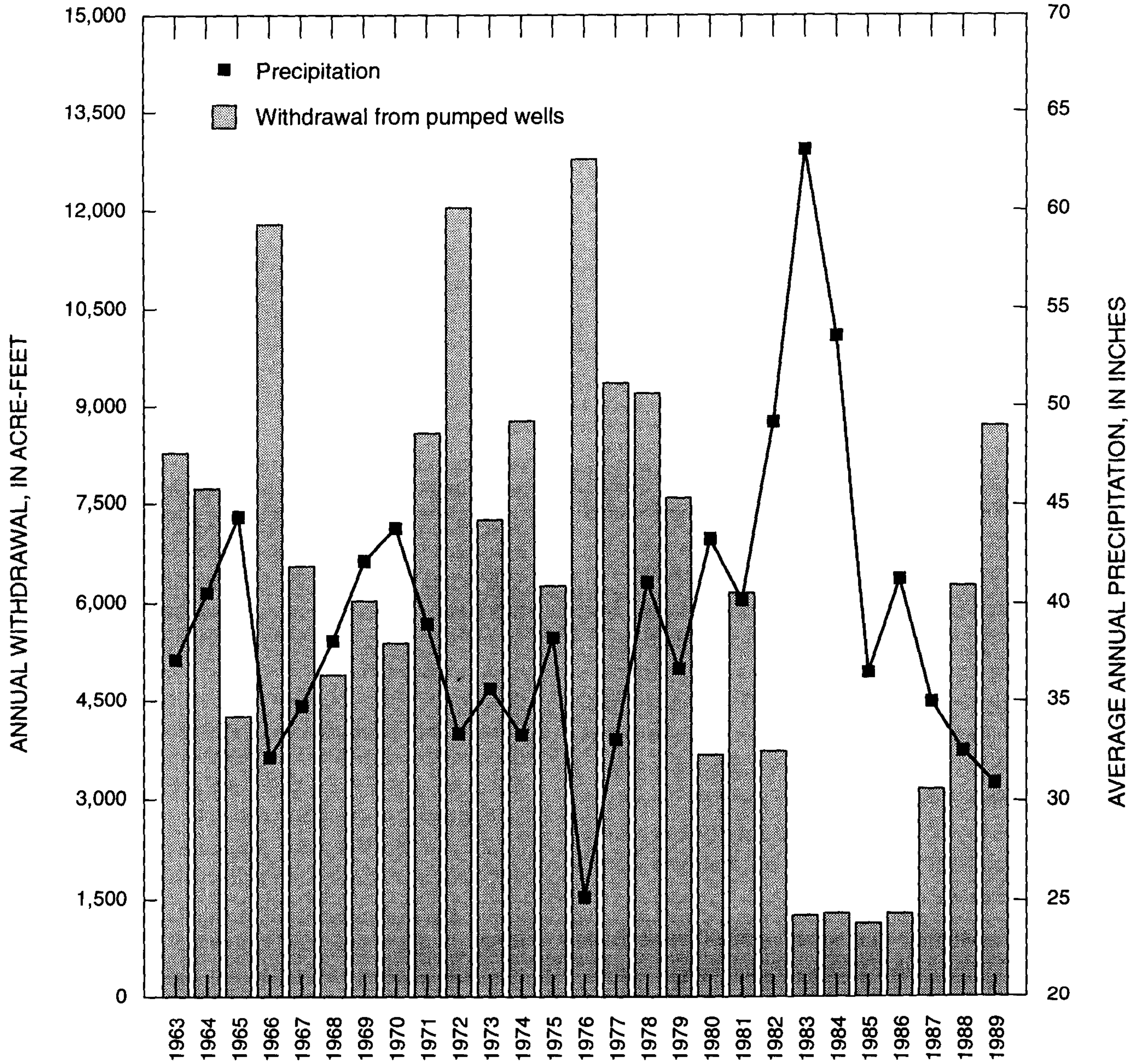

Figure 6. Annual ground-water withdrawals from pumped wells in Sanpete Valley and average annual precipitation at Meadows climatic station, Utah, calendar years, 1963-89.

term water levels have not changed appreciably since the U.S. Geological Survey began measuring water levels in Sanpete Valley in 1935 (see "Water-level fluctuations" of the "Ground-water hydrology" section of this report), overall discharge from flowing wells is assumed to have remained fairly constant.

Alluvial-Spring Discharge

Alluvial-spring discharge was estimated to be about 11,000 acre-ft/yr (15.2 ft^3/s)(table 2) (Robinson,1968, table 2). This was determined by adding the reported discharge from 15 springs that originate from alluvium of Quaternary age in Sanpete Valley. Springs not measured during 1965 to 1967 were not included. The smallest amount of alluvial-spring discharge was 27.4 acre-ft/yr (0.04 ft^3/s), measured at Squaw Spring, (D-14-2) 11ddb-S1 on January 14, 1966. The largest amount of alluvial-spring discharge was 3,019 acre-ft/yr (4.2 ft^3/s), measured at Lower Spring Creek, (D-14-4)11ad-S on January 25, 1966. Spring discharge reported in Robinson (1968, table 2) was usually measured in November and January 1965-67, months of typically low evapotranspiration. Because alluvial-spring discharge is assumed to be inversely proportional to evapotranspiration, total spring discharge should be less in the late spring and summer months. For example, discharge from the second largest alluvial-spring area in the study area, (D-15-3)4c-S1, increased from about 1,560 acre-ft/yr (about 2.2 ft^3/s) on August 9, 1966, to about 2,360 acre-ft/yr (about 3.3 ft^3/s) on November 7, 1966 (Robinson, 1968, table 2). Total annual alluvial-spring discharge would be an average of seasonal fluctuations and could be less than the estimated 11,000 acre-ft/yr (15.2 ft^3/s). Similarly, discharge for the spring area west of Moroni, (D-15-3)8dcb, when adjusted by subtracting out discharge in Silver Creek, (D-14-3)29cad, increased from 2,965 acre-ft/yr (1,838 gal/min) on July 25, 1989, to 3,949 acre-ft/yr (2,448 gal/min) on September 28, 1989 (table 6).

Two alluvial springs measured by Robinson in 1966 (1968, table 2) and again in 1989 are the Spring City Spring at (D-15-4)29dcb-S1 and a spring area west of Manti at (D-18-2)3add. The Spring City Spring had a measured discharge of 35.5 acre-ft/yr (22 gal/min) on November 15, 1966 (Robinson, 1968, table 2), and a measured discharge of 9.7 acre-ft/yr (6 gal/min) on April 4, 1989 (table 6). The spring area west of Manti had a measured discharge of 291 acre-ft/yr (180 gal/min) on August 3, 1966 (Robinson, 1968, table 2) and a measured discharge of 395 acre-ft/yr (245 gal/min) on August 24, 1989 (table 6). Because no other alluvial springs were measured during either study, and because the Spring City Spring was not measured during the same time of year during both studies, it is not possible to determine if there is any long-term change in total alluvial-spring discharge.

Hydrologic Properties

No aquifer tests were done to measure hydrologic properties during this study. Transmissivity values were determined by Robinson (1971, table 5) from 10 aquifer tests done in Sanpete Valley; however, no information on perforation intervals is available for 6 of these 10 wells. One of the remaining four wells is perforated partly in consolidated rock and was not used as a representative transmissivity value for the valley-fill aquifer. Aquifer-test analyses at two of the remaining four wells produced unreasonably large transmissivity values because early-time data was not used in the analyses. The raw data are not available for reanalysis. Thus, transmissivity values from aquifer tests at 1 of the 10 wells reported by Robinson were used in this study. Reported transmissivity values obtained from a multiple-well aquifer test at pumped well (D-16-2)36cbd-1, west of Ephraim, ranged from about 11,900 to 40,100 ft^2/d (89,000 to 300,000 gal/d/ft) (Robinson, 1971, table 5). Reanalysis of the aquifer-test data using the Hantush Modified Method, which modifies the theory of leaky confined aquifers by accounting for storage of water in the confining bed (Lohman, 1979, p. 32-34), indicated a transmissivity value of about 1,700 ft^2/d.

Transmissivity values estimated from specific-capacity values (Robinson, 1971, table 6) of 16 wells with known perforation intervals in the valley-fill material ranged from about 500 ft^2/d at well (D-15-4)21cda-1 north of Spring City to about 16,000 ft^2/d at well (D-18-2)1cdb-1 near Manti. Specific capacity and transmissivity values generally seem to decrease toward the edges of Sanpete Valley, however, no specific capacity information is available for the central portion of the valley. Because transmissivity is the product of hydraulic conductivity and aquifer thickness, smaller transmissivity values along the edges of the valley could be due to decreasing thickness of the valley-fill deposits and (or) to low hydraulic conductivity values of the poorly sorted sediments. In an overview of research findings on the topic of mountain-front recharge, University of Arizona researchers (1980, p. 4-1 to 4-44) referenced studies suggesting that, except at tributary mouths, transmissivity values of valley-fill material were smaller along the mountain fronts because of poorly sorted deposits. Huntley (1979)(University of Arizona, 1980, p. 4-23) found that low transmissivity values in wells along the mountain front in the San Luis Valley of Colorado were indicative of the poor degree of sorting near the mountain front. It is suggested that this poor degree of sorting near the mountain front was more important in decreasing hydraulic conductivity than was the finer grain size of sediments further from the mountains (University of Arizona, 1980, p. 4-23). Similarly, Cehrs (1979) (University of Arizona, 1980, p. 4-23) found transmissivity values and specific capacity values to be smaller on the upper parts of alluvial fans along the Sierra Nevada mountain front than further out in the middle or lower portions of the alluvial fans. The proposed explanation is that in areas of recurrent faulting, transmissivity values of the upper alluvial fan sediments will be small because coarse materials will be confined to the incised channel and fine materials will be deposited outside these channels due to flooding (University of Arizona, 1980, p. 4-23, 4-25).

Horizontal hydraulic conductivity is estimated by dividing transmissivity by aquifer thickness. The hydraulic conductivity value from a multiple-well aquifer-test at well (D-16-2)36cbd-1 was estimated to be 10 ft/d. This value was derived from a transmissivity of 1,700 ft^2/d and a perforated interval of 170 ft (128 to 298 ft)(table 8).

Hydraulic-conductivity values also were determined by dividing transmissivity values obtained from specific-capacity data (Robinson, 1971, table 5) by the perforated interval of the well casing. These hydraulic-conductivity values range from 6 ft/d at well (D-15-4)21cda-1 (with a transmissivity of 550 ft^2/d and a perforated interval of 89 ft) to 99 ft/d at well (D-14-3)17cca-1 (with a transmissivity of 9,400 ft^2/d and a perforated interval of 95 ft). Neither aquifer-test nor specific-capacity data were available to determine hydraulic conductivity in the upper 50 ft of saturated material of the valley-fill aquifer. Hydraulic-conductivity values in the shallow part of the valley-fill aquifer are estimated to be smaller than values for the deeper part of the aquifer because of the abundance of shallow clays noted in drillers' logs (Robinson, 1968, table 4). Hydraulic-conductivity values along the edges of Sanpete Valley also are estimated to be smaller than values for the center of the valley because sediments are assumed to be poorly sorted along the edges of the valley. This is consistent with the University of Arizona (1980, p. 4-25) synopsis of various studies indicating that "the presence of coarse materials along the mountain front does not necessarily imply the presence of high permeabilities... . Permeabilities here are often low due to the depositional systems operating in the past".

A vertical hydraulic-conductivity value of 0.06 ft/d was calculated using the Hantush Modified Method (Lohman, 1979, p. 32-34) for a multiple-well aquifer test at pumped well (D-16-2)36cbd-1 and assumes specific storage is 1×10^{-5}/ft. As discussed above, the estimated horizontal hydraulic-conductivity value at this well is 10 ft/d. The horizontal to vertical hydraulic-conductivity ratio is estimated to be 167 to 1. This large ratio could indicate the presence of clay layers that impede the vertical movement of ground water. Todd (1980, p. 81) reported that the ratio of horizontal to vertical hydraulic conductivity generally is less than 10 to 1 but can exceed 100 to 1 for unconsolidated material with clay layers.

Storage-coefficient values for the confined parts of the valley-fill aquifer were reported by Robinson (1971, table 4) and a storage-coefficient value was reanalyzed for one aquifer test during this study. Storage-coefficient values reported by Robinson (1971) ranged from 7.0×10^{-5} to 2.9×10^{-3} and were based on aquifer-test data. The reanalysis of aquifer-test data for pumped well (D-16-2)36cbd-1 indicates a storage-coefficient value of about 6.1×10^{-5}.

No values of specific yield for the unconfined parts of the valley-fill aquifer have been reported. A range of values, however, can be estimated from descriptions of materials in drillers' logs using a specific-yield table for unconsolidated materials. Drillers' logs indicate that material in the shallow unconfined part of the aquifer ranges from clay to gravel (Robinson, 1968, table 4), which has a corresponding range of estimated specific yield from 2 to 22 percent (Johnson, 1967, p. D1).

Water-Level Fluctuations

Monthly or bimonthly water levels were measured in 45 wells from November 1987 to March 1990 to determine seasonal and annual fluctuations. In addition, water levels were measured in about 130 wells during May and November 1989 to detect seasonal fluctuations and to compare with the water-level measurements of November 1966 (Robinson, 1968, table 3). Seven wells have been measured annually since the mid-1930's and are used to determine long-term water-level trends. Water levels in selected wells are listed in table 9.

Water levels in wells in Sanpete Valley fluctuate seasonally and generally peak in the spring during snowmelt runoff. Water levels gradually decline for the remainder of the year because of pumpage and declining quantities of recharge from snowmelt runoff. Hydrographs of wells (D-12-4)25dcd-1, (D-16-3)3daa-1, and (D-18-2)9dca-1, which are located in different parts of Sanpete Valley, are representative of seasonal or short-term water-level fluctuations (fig. 7).

Water levels steadily declined throughout most of Sanpete Valley during the late 1980's. The less-than-normal precipitation during the late 1980's (table 1) affected the amount of surface-water runoff, which limited the amount of ground-water recharge and produced an increased reliance on ground-water withdrawals to meet irrigation requirements. These factors contributed to the declining water-level trends shown in figure 7.

Annual water-level fluctuations in Sanpete Valley closely correspond to annual precipitation. The greater-than-normal precipitation of the mid-1980's caused water levels to rise in the valley-fill aquifer. The water level in well (D-15-4)21cda-1, which is on an alluvial slope in a ground-water recharge area northeast of Spring City, rose more than 32 ft from March 1982 to March 1985 (table 9). Well (D-16-2)35acd-1, which is on the west side of the valley on the alluvial-slope recharge area near the mouths of Axhandle and Rock Canyons, rose more than 11 ft during the same period (table 9). The difference in water-level rises in these two wells, which are both located on alluvial slopes in recharge areas near the mountain fronts but on opposite sides of the valley, probably is indicative of the relative difference in the amount of runoff that originates from the Wasatch Plateau and the San Pitch Mountains and resultant ground-water recharge.

Long-term water-level trends have not changed appreciably since the U.S. Geological Survey began measuring water levels in wells in Sanpete Valley in 1935. Variations in water levels closely follow climatic cycles. Long-term records of water-level measurements for three wells, (D-15-3)8cda-3, (D-15-4)4dda-1, and (D-17-3)9cbd-1, and cumulative departure from average annual precipitation at Meadows climatic station are shown in figure 8. Water levels in these wells respond to variations in precipitation, but do not show a long-term trend of water-level rises or declines. For example, the wet years of 1941, 1945-46, 1957, 1965, and the mid-1980's caused water levels in wells to rise; the dry years of the late 1930's, 1959-61, 1976-77, and the late 1980's caused water levels to decline. Water levels measured in wells during March 1989 approached water levels measured previously during the dry cycles of the 1930's, 1960's, and 1970's (table 9).

Water Quality

Interpretation of the field data and chemical analyses shows that two areas of the valley-fill aquifer in Sanpete Valley have water with high concentrations of dissolved solids. The field data include measurements of discharge, specific conductance, and (or) water temperature, at 144 pumped or flowing wells (table 10). In addition, water samples were collected from 19 wells and 3 springs for chemical analysis (table 11). Water sampled from 4 wells and 2 springs represents water from consolidated rock; water sampled from 15 wells and 2 springs represents water from valley-fill material. The sites are shown on plate 1.

Results of chemical analyses of water from four wells that are completed in consolidated rock and two springs that discharge water from consolidated rock (table 11) help to identify sources of water with elevated dissolved-solids concentrations at certain locations in the valley-fill aquifer. A trilinear diagram that shows the percentage of predominant dissolved ions in water sampled from the four wells and two springs in consolidated-rock aquifers is shown in figure 9. Dissolved-solids concentration and other chemical characteristics are affected by the type of source rock, length of flow path, and residence time.

Water from well (D-15-3)14bdb-1 is a mixed type composed of calcium, sodium, magnesium, and bicarbonate ions and has a low dissolved-solids concentration (479 mg/L). The source of water is the lacustrine Flagstaff Limestone of Tertiary age at a depth of 2,280 to 2,406 feet (State of Utah Engineer's Office, written commun., 1980). Wells (D-16-3)26cbd-1 and (D-17-3)3dbd-1 are oil-test wells and, on the basis of the predominance of sodium bicarbonate ions and higher dissolved-solids concentrations, tap strata in the lacustrine Green River Formation of Tertiary age. Water from well (D-16-4)18bac-2 is a mixed type composed of magnesium, calcium, chloride, and bicarbonate ions, and has a high dissolved-solids concentration (1,480 mg/L). Although well (D-16-4)18bac-2 also is completed in the Green River Formation, the water has a different chemistry than water from wells (D-16-3)26cbd-1 and (D-17-3)3dbd-1 and could indicate mix-

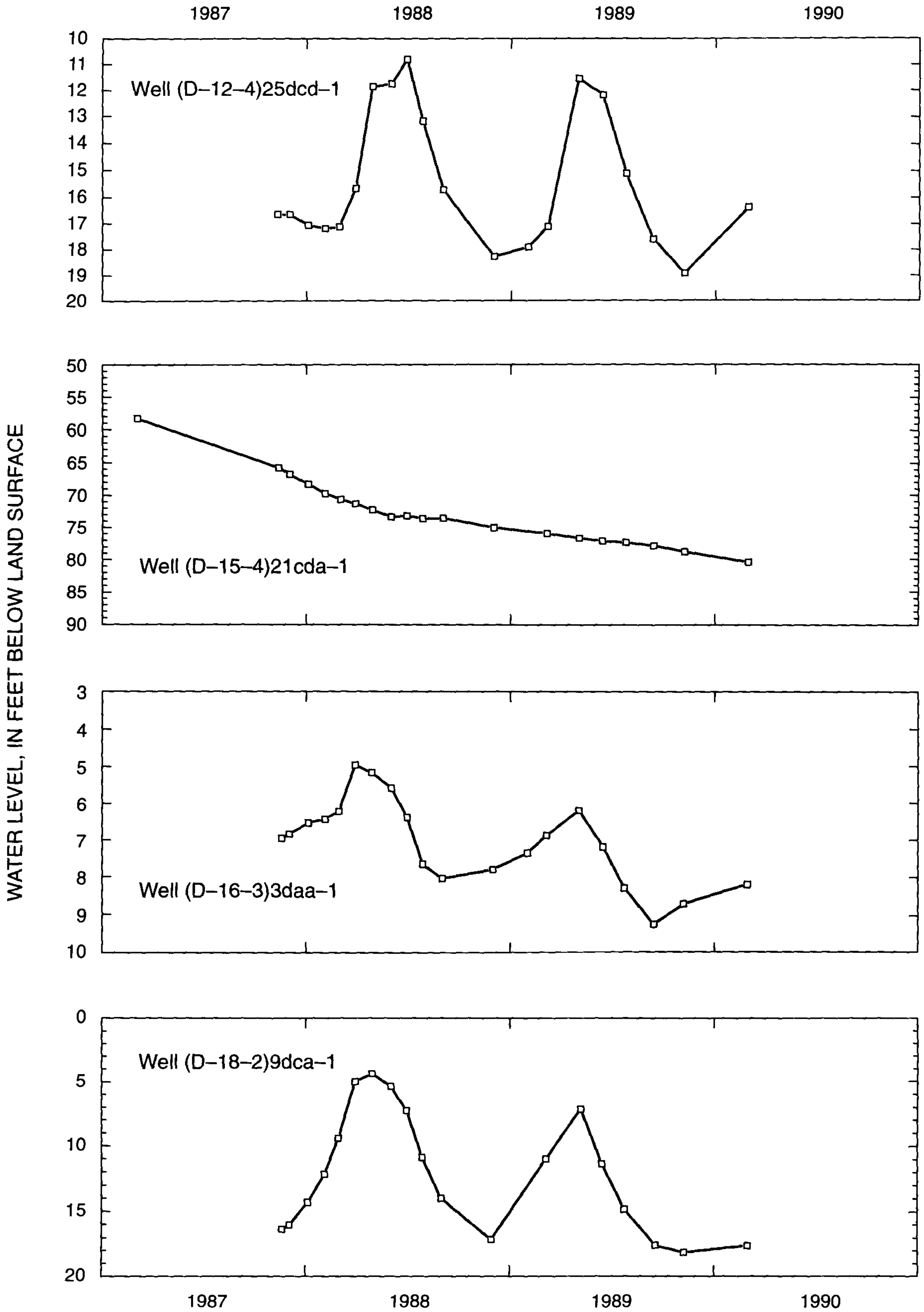

Figure 7. Short-term water-level fluctuations in four wells in Sanpete Valley, Utah, 1987-90.

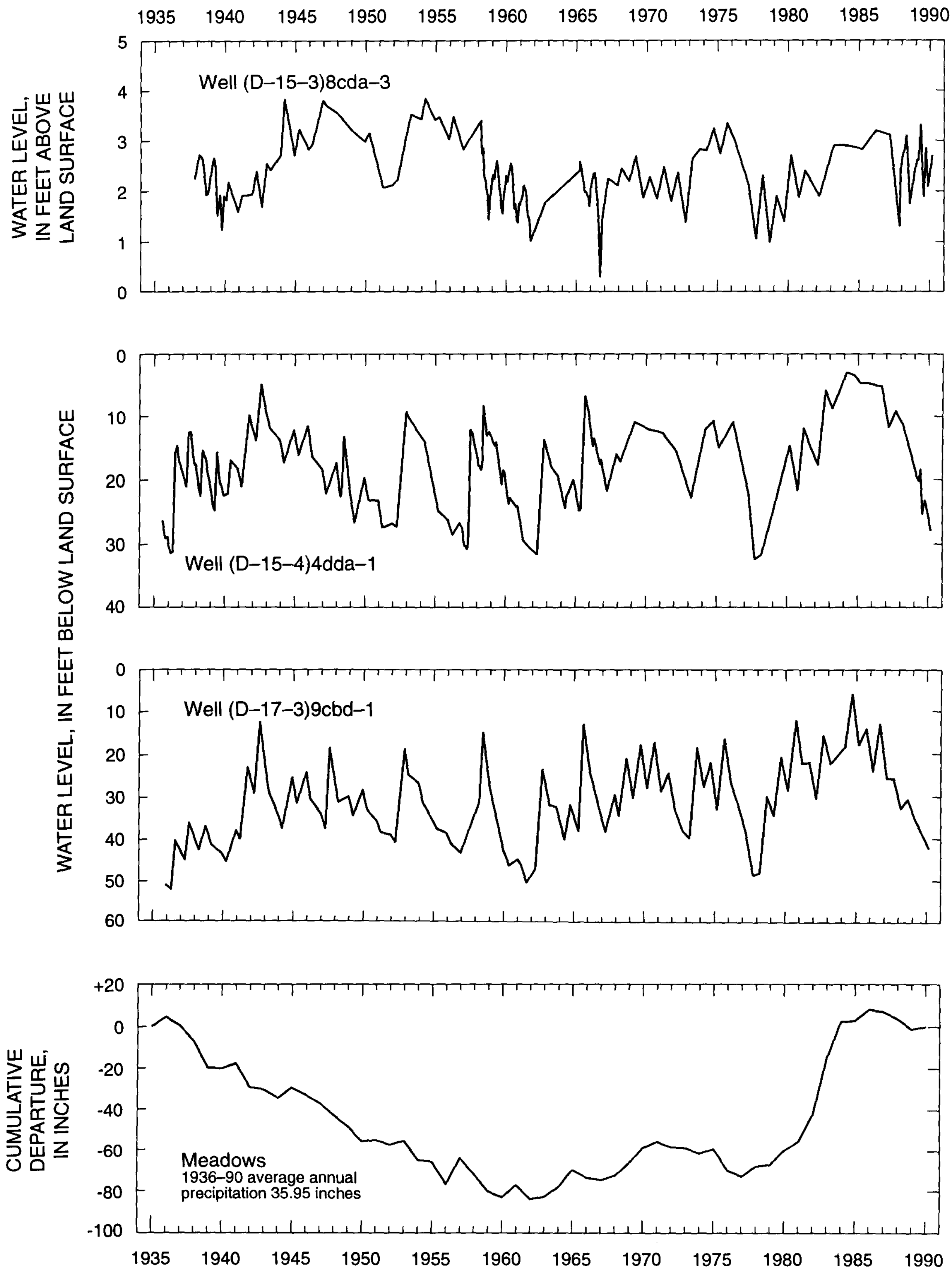

Figure 8. Relation of long-term water-level fluctuations in three wells in Sanpete Valley to cumulative departure from average annual precipitation at Meadows climatic station, Utah, 1935-90.

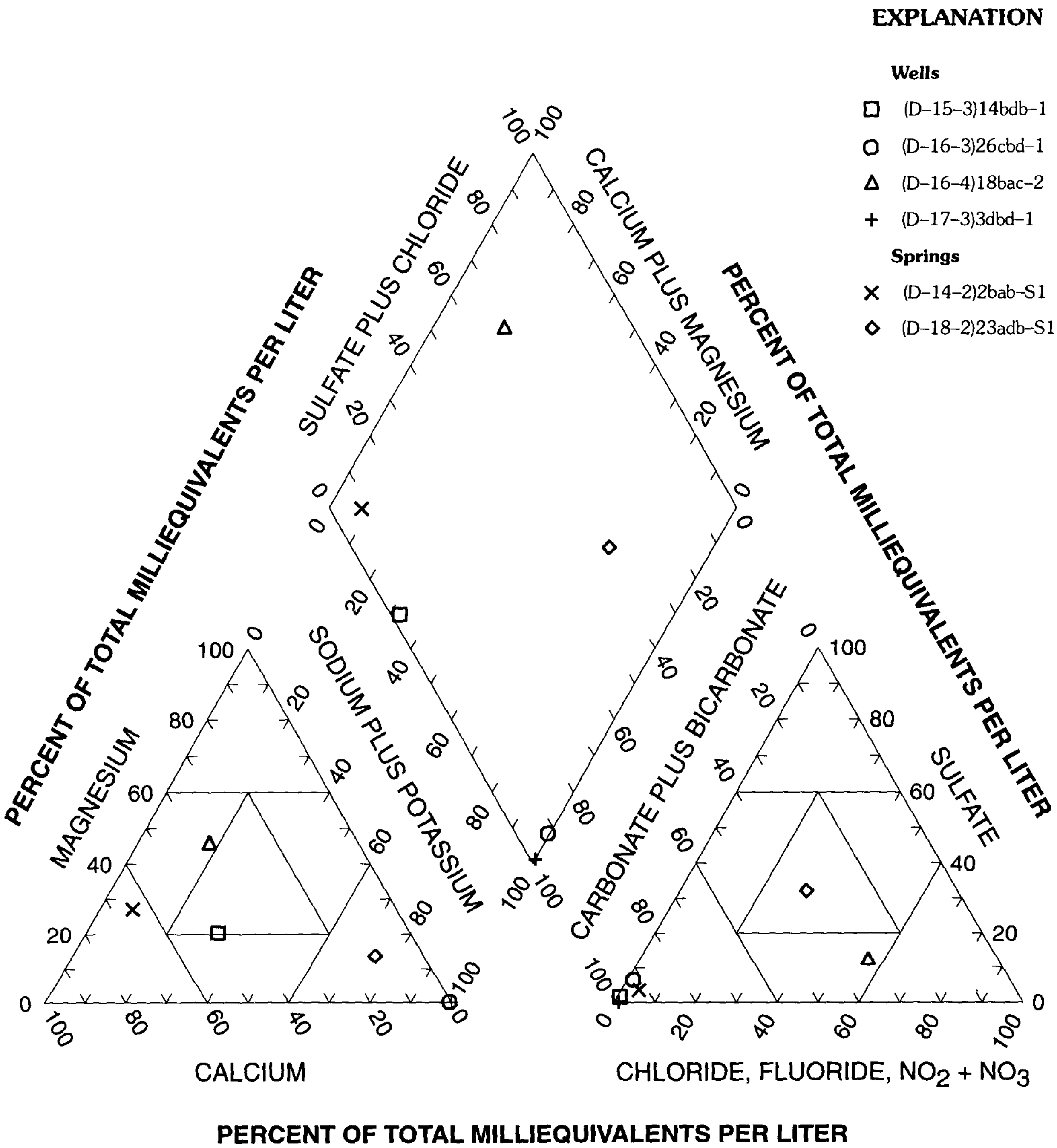

Figure 9. Percentage of predominant dissolved ions in water from four wells and two springs in consolidated-rock aquifers, Sanpete Valley, Utah.

ing with water from other sources (fig. 9). Water from wells (D-15-3)14bdb-1, (D-16-3)26cbd-1, and (D-16-4)18bac-2 is of sufficient quality for most uses, but the water from (D-17-3)3dbd-1 has a high concentration of alkalinity (7,550 mg/L) and a high pH (10.2)(table 11) and is suitable only for selected uses (table 11).

Water from Big Springs, located at (D-14-2)2bab-S1 west of Fountain Green, is a calcium bicarbonate type and has a low dissolved-solids concentration (245 mg/L)(fig. 9, table 11). The composition of water from this spring may be indicative of ground-water flow through the Indianola Group, which consists of conglomerates, sandstones, and siltstones. Robinson (1968, table 2) reported 11 springs that discharge from the Indianola Group in the northern San Pitch Mountains, all with measured specific-conductance values less than 600 µS/cm. These data indicate that certain formations in the Indianola Group could have locally high hydraulic-conductivity values. Short residence times and (or) lack of chemical reaction with the aquifer material in this formation could result in water with low dissolved-solids concentration. In contrast, water from spring (D-18-2)23adb-S1, which discharges along a fault zone southwest of Manti, is a mixed type composed of sodium bicarbonate, sulfate, and chloride ions and has a high dissolved-solids concentration (1,780 mg/L) (fig. 9, table 11). Although this spring does not flow directly from consolidated rock, sandstones and siltstones of Cretaceous age that outcrop nearby could be the source of the spring.

Water from 9 of the 16 wells completed in the valley-fill material has a dissolved-solids concentration less than 600 mg/L and specific-conductance value less than 1,000 µS/cm (table 11). This water is a mixed type composed of calcium, sodium, magnesium, and bicarbonate ions, which is typical of most of the ground water from the valley-fill aquifer in Sanpete Valley (fig. 10, table 11). Water from 124 of the 143 pumped or flowing wells with field measurements of specific conductance during 1987-90 had values less than 1,000 µS/cm (table 10). The values are generally lowest in wells near the boundary between the valley-fill material and mountain fronts of the Wasatch Plateau and San Pitch Mountains, where recharge from snowmelt runoff occurs, and increase downgradient, toward the center of Sanpete Valley.

Water with higher specific-conductance values primarily is concentrated in two areas of the valley. One area is in a local flow system that is downgradient of outcrops of lacustrine and fluvial deposits of the Green River and Crazy Hollow Formations of Tertiary age (Robinson, 1971, pl. 1) along the east side of the main valley from Chester to Pigeon Hollow. Wells in this area generally are less than 200 ft deep. The other area is in a local flow system that is downgradient from outcrops of evaporite deposits of the Arapien Shale of Jurassic age (Robinson, 1971, pl. 1) on the west side of the main valley from near Big Mountain southward to near the mouths of Axhandle and Rock Canyons.

Water from wells (D-16-3)1bbb-2, (D-16-3)4aaa-1, and (D-16-3)21cdb-2, which are completed in the valley-fill material in the Chester-Pigeon Hollow area on the east side of the main valley, has a higher dissolved-solids concentration than that in water from other wells in the study area (fig. 10, table 11). The higher dissolved-solids concentration and similar water composition might be typical of water from wells located downgradient from outcrops of Tertiary age on the east side of the main valley. Even though well (D-16-3)1bbb-2 is perforated from 95 to 105 ft below land surface in the valley-fill aquifer and located downgradient of outcrops of the Crazy Hollow Formation, water collected from it has chemical characteristics similar to those of water from well (D-16-4)18bac-2, which is perforated from 165 to 205 ft below land surface in the Green River Formation (figs. 9 and 10, tables 8 and 11). Water from wells (D-16-3)1bbb-2 and (D-16-4)18bac-2 also has at least twice the selenium concentration as water from other wells sampled in Sanpete Valley (table 11).

Chemical analyses of water in wells on the west side of Sanpete Valley show the limited extent of mixing of shallow ground water that has a higher dissolved-solids concentration, with deeper ground water that has a lower dissolved-solids concentration. Wells (D-17-2)14cca-1, 14cca-2, and 14ccb-1 are approximately aligned with the ground-water flow path of the local flow system and downgradient from the evaporite deposits of Jurassic age on the west side of the main valley. The perforation or open intervals for the sampled wells are 54 to 64 ft, 13.5 to 23.5 ft, and 183 ft, respectively (table 8). Water from shallow well (D-17-2)14cca-2 has a dissolved-solids concentration of 4,450 mg/L and contains magnesium-sodium cations and sulfate-chloride anions (fig. 10, table 11). Water from deeper wells (D-17-2)14cca-1 and 14ccb-1 both have a dissolved-solids concentration of 482 mg/L and contain magnesium-calcium-sodium cations and bicarbonate anions (fig. 10, table 11). The difference in water level is about 30 ft for adjacent wells (D-17-2)14cca-2 and 14ccb-1 (table 9). The upward head gradient in this area

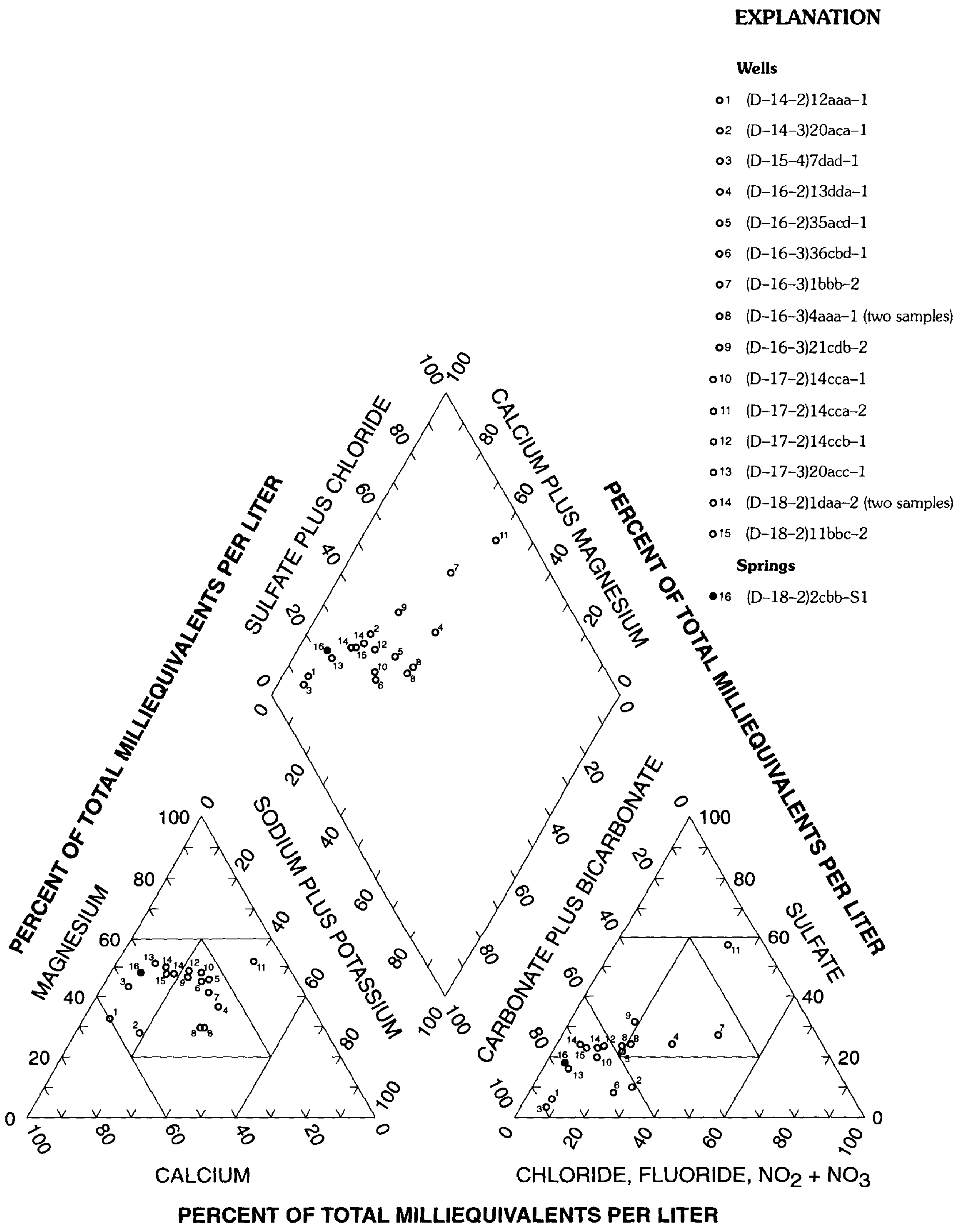

Figure 10. Percentage of predominant dissolved ions in water from 15 wells and 1 spring in the valley-fill aquifer, Sanpete Valley, Utah.

prevents downward infiltration of shallow ground water with higher dissolved-solids concentration and effectively limits mixing with the water with lower dissolved-solids concentration at depth.

Well (D-17-2)15aca-1, which is about 0.8 mi west of the three previously mentioned wells in a recharge area adjacent to the San Pitch Mountains, was drilled to a depth 22.5 ft and has a perforated interval from 15 to 20 ft (table 8). Specific conductance of water from this well was 26,800 μS/cm (table 10) on November 30, 1989, and is similar to the specific conductance of water from the San Pitch River upstream from Maple Canyon near Manti, which was 29,000 μS/cm on July 7, 1989 (table 7). The chemical analysis of the water sample collected from a gaining reach of the San Pitch River upstream from Maple Canyon near Manti is, therefore, assumed to be typical of water that discharges from the local shallow ground-water flow system.

Temperature of ground water in the valley-fill aquifer closely approximates the normal annual air temperature of the area (table 1) and generally ranges from 8.0 to 15.0 °C. Higher water temperatures typically were measured in summer months and show the influence of warmer summer air temperatures on shallow ground-water flow systems. Two wells completed in consolidated rock, (D-15-3)14bdb-1 and (D-17-3)3dbd-1, are considered to discharge thermal water because the temperature of the water (table 10) is much greater than the normal annual air temperature (table 1). Well (D-15-3)14bdb-1 is completed in limestone of Tertiary age at a depth of about 2,300 ft below land surface and the water temperature was 33.0 °C on July 5, 1989 (tables 8, 10). Well (D-17-3)3dbd-1 was drilled to 600 ft below land surface and the water temperature was 38.0 °C on July 24, 1989 (tables 8, 10), but the sample was collected from a stand pipe and probably doesn't accurately reflect the temperature at depth.

SIMULATION OF THE GROUND-WATER FLOW SYSTEM IN THE VALLEY-FILL AQUIFER

The modular, three-dimensional, finite-difference, ground-water flow model developed by McDonald and Harbaugh (1988) was used to simulate ground-water flow in the unconsolidated material that makes up the valley-fill aquifer in Sanpete Valley. Because the consolidated-rock aquifers are not assumed to be in hydrologic connection with the valley-fill aquifer, they were not simulated by the model. The ground-water flow model of the valley-fill aquifer was developed to improve the understanding of the ground-water system. Input arrays of budget components and aquifer properties were specified. The model was calibrated to steady-state and transient-state conditions. It provides a tool to analyze the ground-water system and the effects to the system caused by hypothetical increased ground-water withdrawals. The ability of the model to represent observed hydrologic conditions was evaluated by comparing measured and model-computed results. A discussion of the limitations of the model also is presented.

Modeling Approach

Average hydrologic conditions for Sanpete Valley were used to calibrate the model to steady-state conditions. Use of average conditions in the steady-state calibration is appropriate because:

1. Rises and declines of measured water levels in well hydrographs from 1935 to 1989 are attributed to factors associated with precipitation variability (fig. 8). There is no indication of any long-term water-level rises or declines that would infer a long-term change in ground-water storage.

2. Pumped-well withdrawals generally are less than 10 percent of the overall ground-water budget. The withdrawals are inversely related to the amount of precipitation that falls in the study area and do not show an increased or decreased trend with time (fig. 6).

3. Data are not available to refine ground-water budget components on a yearly basis.

The steady-state calibration incorporates estimates of infiltration from precipitation on the basis of the 30-year (1951-80) normal annual precipitation, average tributary inflow on the basis of several periods of record between 1955 and 1989, average well pumpage for 1963-88, and alluvial-spring discharge measurements for 1965-67 and 1987-89. Water levels from 1966 were used for the steady-state calibration because these water levels, measured by Robinson (1968, table 3), are the most complete data available, and they approximate long-term average water levels. Although annual precipitation in the study area was less than average in 1966, the lag effect of greater-than-average precipitation during 1965 resulted in approximately average 1966 water levels (fig. 8).

The final version of the steady-state calibration was used as initial conditions for the transient-state calibration. Calibration to transient-state conditions used yearly stress periods that represent 1967-89 fluctuations in recharge and discharge, and incorporated storage-coefficient values. The resulting model-computed water levels were compared with measured water-levels at selected wells. Results of the transient-state calibration were used to project the effects of increased well pumpage for 5- and 20-year periods.

Discretization

The valley-fill aquifer of Sanpete Valley was discretized into a three-dimensional grid of 80 rows, 40 columns, and 3 layers of cells. The location of the ground-water flow model with respect to the study-area and valley-fill boundaries is shown in figure 11. Layer 1 has 896 active cells, layer 2 has 697 active cells, and layer 3 has 307 active cells (figs. 12 to 14). Each cell has uniform dimensions of 0.5 mi on each side and encompasses an area of 0.25 mi^2.

Model layer 1 represents about the upper 50 ft of saturated valley-fill material, layer 2 represents saturated valley-fill material from about 50 to 150 ft deep, and layer 3 represents saturated valley-fill material deeper than about 150 ft. This subdivision of the aquifer is based on Robinson's (1971, p. 24) description of shallow fine-grained materials of low hydraulic conductivity (layer 1) that overlie and interfinger with more permeable sand and gravel layers (layers 2 and 3). It is difficult to determine an average thickness for layer 3 of the ground-water flow model because of the varying thickness of the valley-fill material, as described in the "Geology" section; however, if the total average depth of valley-fill material is estimated to be about 350 ft where layer 3 exists and the 150 ft combined vertical thickness of layers 1 and 2 is subtracted out, the average thickness of layer 3 would be about 200 ft.

Boundary Conditions

An accurate depiction of the hydrologic processes occurring between a ground-water flow system and its surrounding environment is perhaps the most critical part of the initial conceptualization that must occur prior to development of a mathematical model for that system. In a computer simulation these processes are called boundary conditions. They are specified mathematical representations of the hydrologic interactions taking place at the boundaries of a study area. Three types of boundary conditions were used in the model described herein; no-flow boundaries, head-dependent boundaries, and constant-flux boundaries.

No-Flow Boundaries

A no-flow boundary (shown with inactive cells on figs. 12 through 14) surrounds the active cells of the model in all three layers, except for a 5-cell-wide head-dependent flux boundary north of Fairview in layer 1. The no-flow boundary represents the contact between the more-permeable valley-fill material and the less-permeable consolidated rocks of the San Pitch Mountains, Cedar Hills, and Wasatch Plateau. A no-flow boundary underlying layer 3 represents the contact with underlying consolidated rocks. The no-flow boundaries are simulated with inactive cells through which water cannot enter or leave the active cells that represent the valley-fill aquifer.

Head-Dependent Flux Boundaries

Head-dependent flux boundaries simulate subsurface inflow from the valley-fill aquifer north of Fairview, ground-water discharge to and recharge from the San Pitch River, alluvial springs, and evapotranspiration. The General-Head Boundary Package (McDonald and Harbaugh, 1988, chap. 11) simulates subsurface inflow from the valley-fill aquifer north of Fairview in five cells in layer 1 (row 16, columns 30-34). Actual controlling heads and boundary-conductance values are described in the "Steady-state calibration" section of this report.

Ground-water discharge to, and recharge from, the San Pitch River are simulated with head-dependent flux cells of the River Package (McDonald and Harbaugh, 1988, chap. 6). Ground-water discharge from alluvial springs is simulated with head-dependent cells of the Drain Package (McDonald and Harbaugh, 1988, chap. 9). Ground-water discharge as evapotranspiration is simulated with head-dependent flux cells of the Evapotranspiration Package (McDonald and Harbaugh, 1988, chap. 10). Details of the calibration of the conductance values used for these three head-dependent boundaries are discussed under the "Steady-state calibration" section of this report.

Constant-Flux Boundaries

Constant-flux boundaries simulate both areal recharge and discharge from wells. The Recharge Package (McDonald and Harbaugh, 1988, chap. 7) simulates recharge to the upper surface of the valley-fill aquifer (layer 1). The Well Package (McDonald and Harbaugh, 1988, chap. 8) simulates discharge through pumping and flowing wells from the valley-fill aquifer.

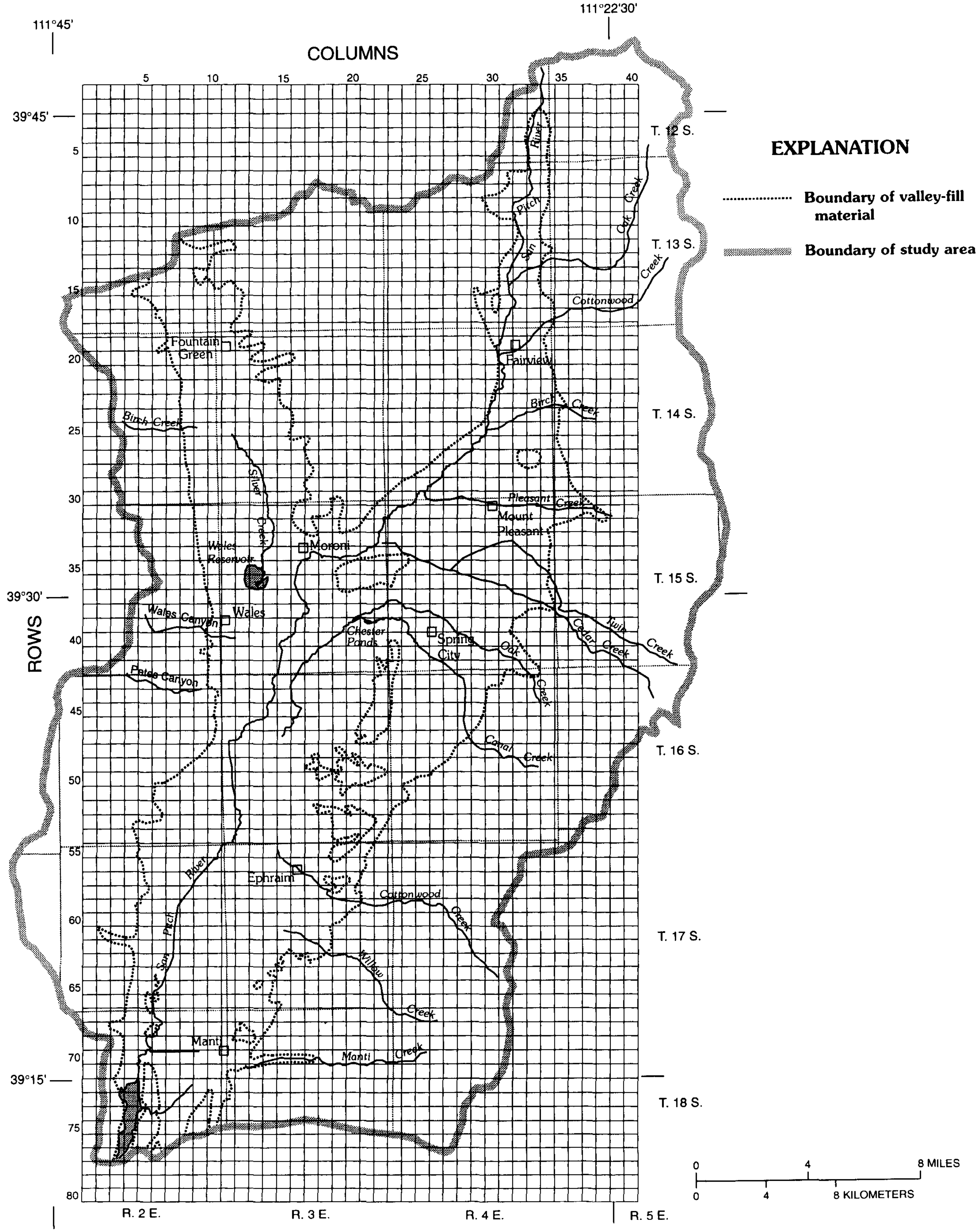

Figure 11. Location of the ground-water flow model in relation to the study area and valley-fill boundaries, Sanpete Valley, Utah.

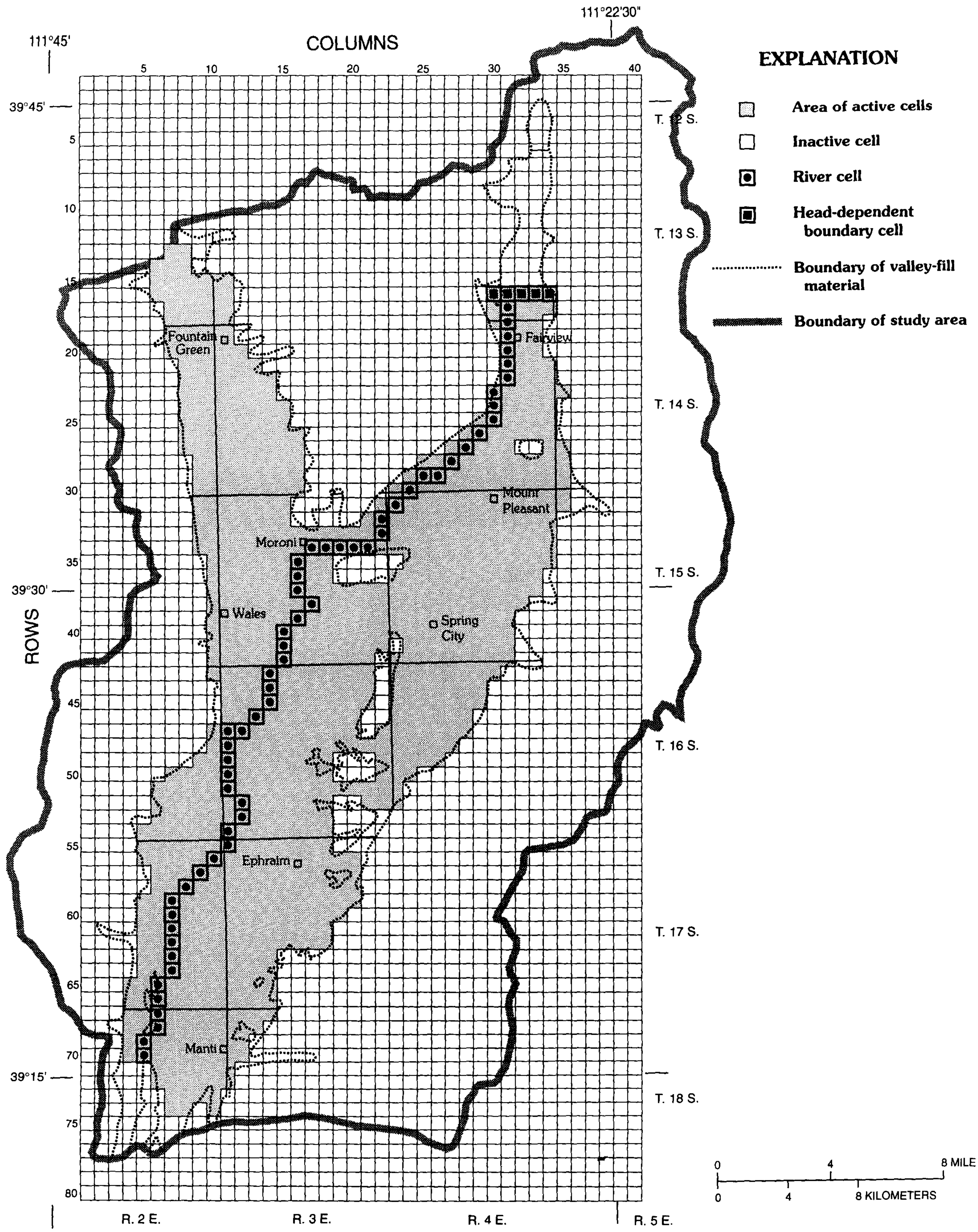

Figure 12. Location of active, inactive, river, and head-dependent boundary cells in layer 1 of the ground-water flow model of Sanpete Valley, Utah.

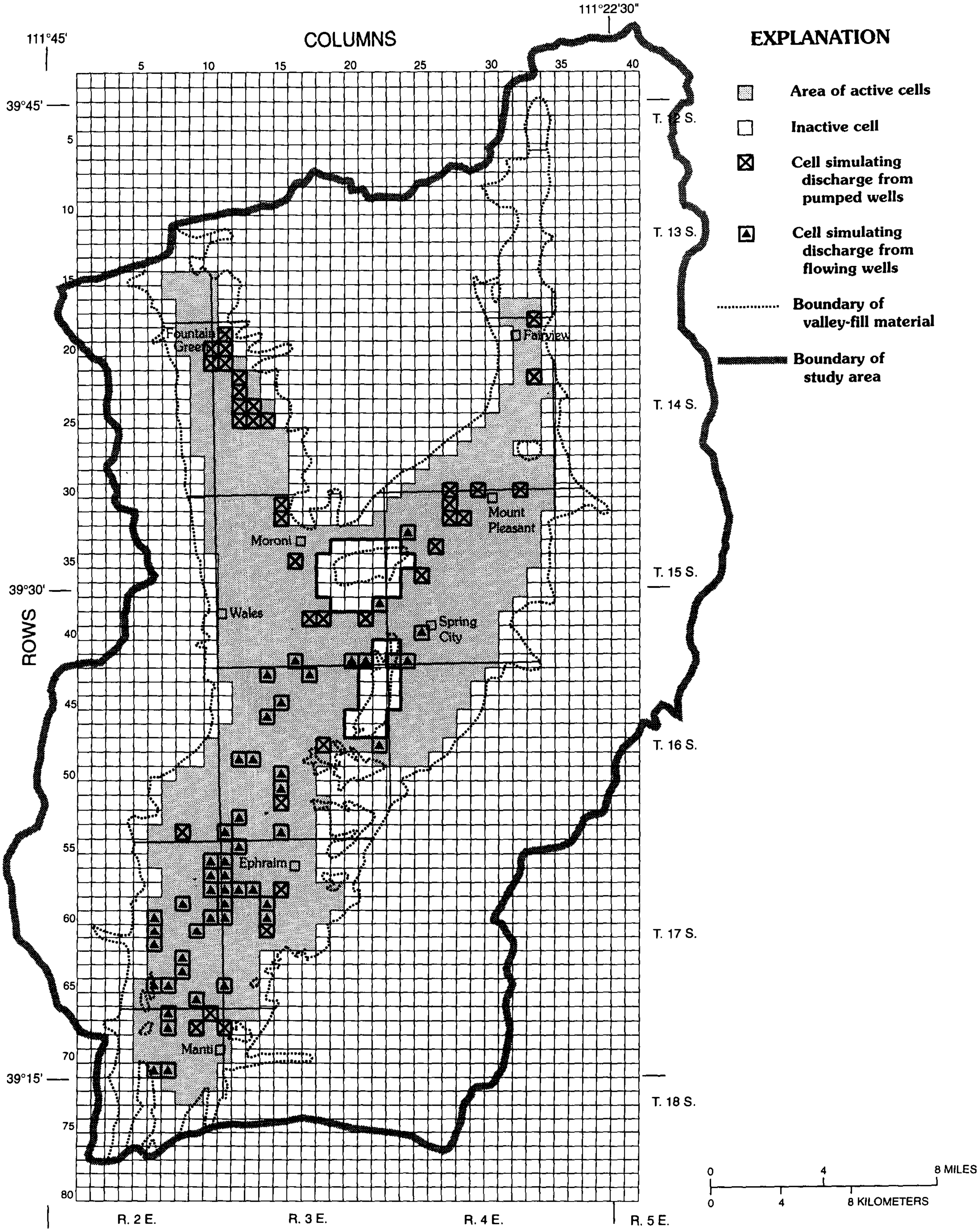

Figure 13. Location of active and inactive cells and cells that simulate discharge from pumped and flowing wells in layer 2 of the ground-water flow model of Sanpete Valley, Utah.

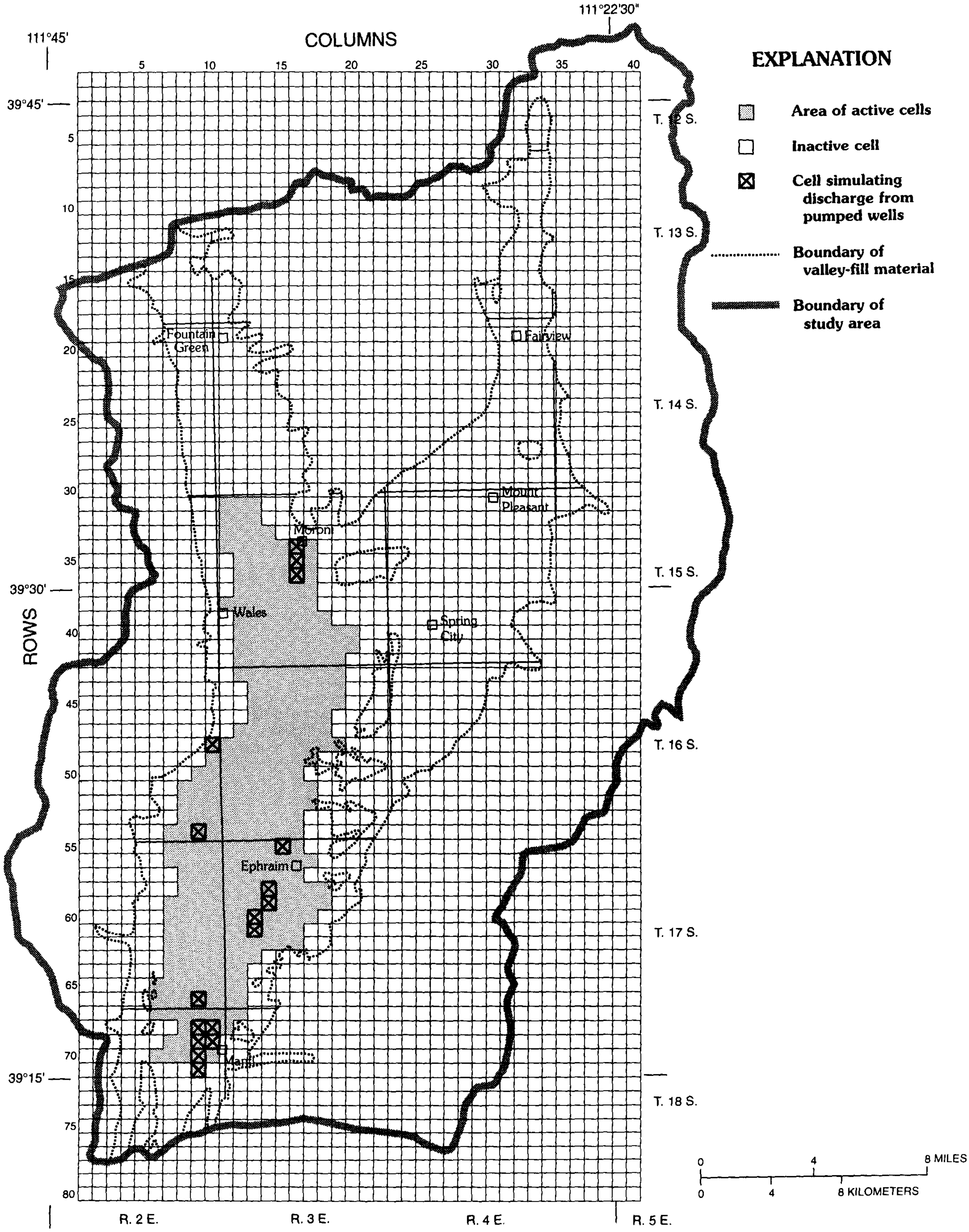

Figure 14. Location of active and inactive cells and cells that simulate discharge from pumped wells in layer 3 of the ground-water flow model of Sanpete Valley, Utah.

Both packages are discussed in the "Steady-state calibration" and "Transient-state calibration" sections of this report.

Distribution of Hydrologic Properties

Horizontal hydraulic-conductivity values were assigned to layer 1 and transmissivity values were assigned to layers 2 and 3. Because layer 1 represents water-table conditions where saturated thickness can vary, the model calculates transmissivity from the saturated thickness and the assigned hydraulic conductivity. Layers 2 and 3 represent confined aquifer conditions and transmissivity values are constant. Vertical flow between model layers is simulated with a vertical-leakance parameter (McDonald and Harbaugh, 1988, chap. 5). Specific-yield values are assigned to layer 1 and storage coefficients are assigned to layers 2 and 3 in the transient-state calibration. Hydrologic properties used in the model, when known, are based on actual data discussed previously in the "Hydrologic properties" section of this report.

Steady-State Calibration

Steady-state conditions were simulated by calibrating to measured or estimated components of the ground-water budget and to measured water levels. Measured budget components include San Pitch River seepage during March 1966, April 1966, and October 1988; average annual pumped-well withdrawals for 1963-88; flowing-well discharge for 1965-67 (Robinson, 1968, table 1); and alluvial-spring discharge for 1965-67 (Robinson, 1968, table 2). The amount of precipitation on the valley floor was estimated from normal annual precipitation records for 1931-60 and 1951-80 (U.S. Weather Bureau, 1963; and U.S. Department of Commerce, 1982).

Recharge to and discharge from the valley-fill aquifer are simulated with head-dependent and constant-flux boundaries. The simulated sources and quantities of recharge and discharge are based on estimations and measurements discussed previously in the "Recharge" and "Discharge" sections of the "Ground-water hydrology" section of this report. The comparison of measured or estimated with model-computed components of the ground-water budget for steady-state and transient-state calibrations is shown in table 3.

Recharge

The three largest known sources of recharge to the valley-fill aquifer are seepage from tributaries and the San Pitch River, infiltration of unconsumed irrigation water, and infiltration of precipitation on the valley floor. All are combined in the steady-state calibration as constant fluxes using the Recharge Package (McDonald and Harbaugh, 1988, chap. 7), except for recharge as seepage from the San Pitch River. The total amount of recharge applied through the steady-state Recharge Package is about 79,000 acre-ft/yr, with about 34,500 acre-ft/yr as seepage from tributaries, about 29,000 acre-ft/yr as infiltration of unconsumed irrigation water, and about 15,000 acre-ft/yr as direct infiltration of precipitation on the valley floor (table 3). Recharge to individual cells ranges from 14.5 to 833.0 acre-ft/yr (0.02 to 1.05 ft^3/s). The smallest rates are for cells where only recharge from infiltration of precipitation is simulated. The largest rates are for cells where all three sources of recharge are simulated. The cells that simulate recharge from (1) infiltration of precipitation, (2) infiltration of unconsumed irrigation water, and (3) seepage from tributaries are shown in figure 15. Recharge from infiltration of precipitation is uniformly simulated for all active cells of layer 1.

Total tributary inflow to Sanpete Valley, including spring discharge from consolidated rock, is estimated to be about 164,000 acre-ft/yr (see the "Seepage from tributaries and the San Pitch River" in the "Ground-water hydrology" section of this report). About 65 percent of the inflow (about 107,000 acre-ft/yr) is estimated to be diverted for irrigation near where the tributaries cross the valley-fill contact (L. Young, Soil Conservation Service, oral commun., 1989). The difference, about 57,000 acre-ft/yr, remains in the tributary channels. For the steady-state calibration, it is assumed that about 60 percent (or about 34,500 acre-ft/yr) of this undiverted water recharges the valley-fill aquifer (table 3) and the remaining 40 percent (or about 22,800 acre-ft/yr) either remains in tributary channels as surface water or is lost to evapotranspiration. Beginning with the 50- to 100-percent range discussed earlier in the "Seepage from tributaries and the San Pitch River" section of this report, the value of about 60 percent was determined to best match measured water levels and discharge rates. The amount of recharge simulated as seepage from tributaries was calculated by dividing the total amount of estimated recharge from each tributary by the number of cells along the tributary reach. Recharge as seepage from

Table 3. Measured or estimated and model-computed components of the ground-water budget for the valley-fill aquifer in Sanpete Valley, Utah

[values in acre-feet per year]

Component	Measured or estimated	Steady-state calibration	Transient-state calibration: Year of least simulated recharge (1989)	Transient-state calibration: Year of greatest simulated recharge (1983)
Recharge				
Seepage from tributaries	28,500–57,000	34,500	27,400	63,500
Seepage from the San Pitch River	1,500–1,800	400	700	200
Infiltration of unconsumed irrigation water	29,000	29,000	7,800	34,600
Infiltration of precipitation on the valley floor	15,000	15,000	11,900	27,500
Subsurface inflow from the valley-fill aquifer north of Fairview	unknown	200	200	200
Total recharge (rounded)	74,000–103,000	79,000	48,000	126,000
Discharge				
Evapotranspiration	41,000–116,000	48,000	43,400	53,900
Seepage to the San Pitch River	18,500–80,300	17,200	14,600	21,600
Withdrawals from wells				
Pumped wells	1,200–12,800	6,300	8,400	1,200
Flowing wells	4,000	4,000	4,000	4,000
Alluvial-spring discharge	11,000	3,600	3,200	4,400
Total discharge (rounded)	76,000–224,000	79,000	74,000	85,000
Change in storage (rounded)				
	unknown	0	-26,000	41,000

tributaries was applied to 124 cells (fig. 15), with steady-state quantities ranging from 65.2 to 746 acre-ft/yr per cell.

About 25 percent, or 29,000 acre-ft/yr, of water diverted for irrigation in Sanpete Valley is assumed to recharge the valley-fill aquifer as unconsumed irrigation water. The amount of water diverted for irrigation in Sanpete Valley is estimated to be 117,300 acre-ft/yr and is the sum of (1) 65 percent, or about 107,000 acre-ft/yr, of the total tributary inflow that includes spring discharge from consolidated rock estimated to be diverted for irrigation; and (2) the average pumped- and flowing-well withdrawals of about 10,300 acre-ft/yr. This 29,000 acre-ft/yr was not varied during steady-state calibration. On the basis of an estimate of about 60,000 irrigated acres in Sanpete Valley (discussed previously in the "Vegetation" section of this report), recharge from unconsumed irrigation water is simulated at 399 cells in layer 1 that represent the irrigated acreage of Sanpete Valley (fig. 15). The 29,000 acre-ft/yr of recharge from unconsumed irrigation water is evenly applied to these cells at a rate of about 73 acre-ft/yr per cell.

About 10 percent, or about 15,000 acre-ft/yr, of normal annual precipitation within Sanpete Valley is estimated to recharge the valley-fill aquifer (see the "Infiltration of precipitation" section in the "Ground-water hydrology" section of this report). For the steady-state calibration, recharge from precipitation was

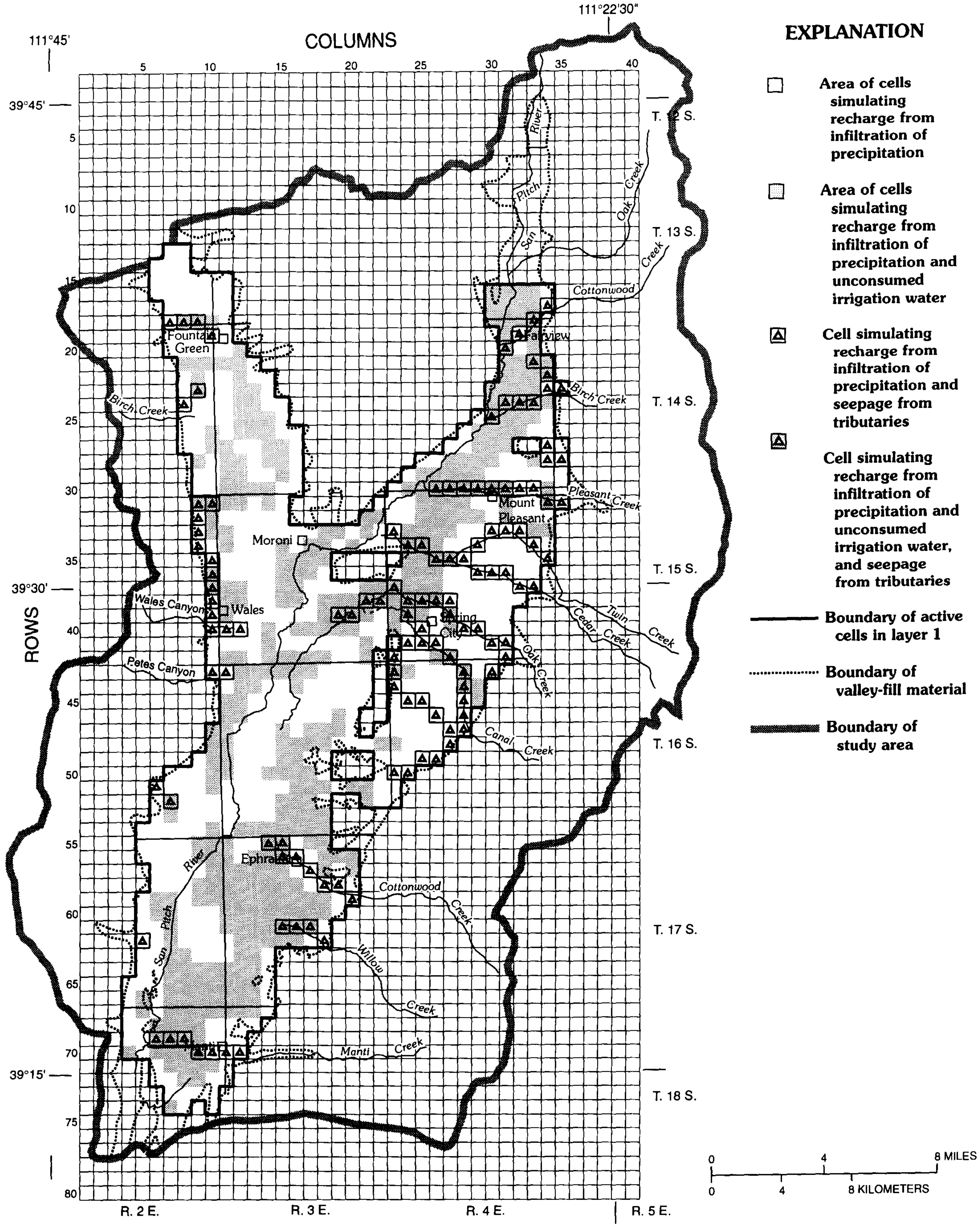

Figure 15. Location of cells that simulate recharge from infiltration of precipitation and unconsumed irrigation water and seepage from tributaries in layer 1 of the ground-water flow model of Sanpete Valley, Utah.

evenly distributed to the 896 active cells in layer 1 at a rate of about 17 acre-ft/yr per cell.

Head-dependent cells of the River Package (McDonald and Harbaugh, 1988, chap. 6) simulate the interconnection between the San Pitch River and layer 1 of the valley-fill aquifer. River cells simulate either removal of water from the aquifer or addition of water to the aquifer. The direction and amount of flow is determined by the difference between the specified altitude of the surface of the river and the model-computed water level at the corresponding cell, as well as the river-bed conductance. River-bed conductance is defined as the hydraulic conductivity of river-bed material multiplied by the area of the river bed and divided by the thickness of the river-bed material. If the water level in the aquifer is below the altitude of the river surface, then water from the river recharges the aquifer. Conversely, if the water level in the aquifer is above the altitude of the river surface, then water discharges from the aquifer to the river. Sixty river cells simulate seepage between the San Pitch River and layer 1 of the valley-fill aquifer (fig. 12).

To approximate San Pitch River seepage, a river-bed conductance of 1.73×10^4 ft^2/d produced the best match between simulated seepage and measured seepage. The river-bed altitudes were determined from topographic maps. River-stage elevations are designated to be 2 ft above river-bed altitudes. River-bed width is estimated to be about 20 ft; however, this width varies with location, time of year, and river stage. Simulated seepage to the valley-fill aquifer is about 400 acre-ft/yr.

The valley-fill aquifer north of Fairview was excluded from the modeled area because of its limited extent. Ground-water recharge from the unmodeled area was simulated as subsurface inflow using the General-Head Boundary Package (McDonald and Harbaugh, 1988, chap. 11) for five cells in layer 1 (fig. 12). The amount of recharge from this part of the aquifer was computed based on 1966 water levels from the potentiometric map of Robinson (1971, pl. 2). Initially, the flow rate was calculated across this boundary using constant-head nodes. This flow rate then was used to calibrate the conductance values that were assigned to the General-Head Boundary Package. The conductance values range from 5.0×10^{-4} to 1.0×10^{-3} ft/s. The 1966 potentiometric surface also was used in the General-Head Boundary Package for the assigned altitude of the boundary heads. Boundary head altitudes ranged from 6,100 to 6,350 ft. Simulated steady-state recharge as inflow from the valley-fill aquifer north of Fairview is 200 acre-ft/yr (table 3).

Discharge

Principal sources of discharge simulated in the ground-water flow model of the valley-fill aquifer are evapotranspiration, seepage to the San Pitch River, withdrawals from pumped and flowing wells, and alluvial-spring discharge. Evapotranspiration, seepage to the San Pitch River, and alluvial-spring discharge are all simulated with head-dependent boundaries. Well withdrawals (pumped and flowing) are specified in the model with a constant withdrawal rate. Location of cells that simulate discharge from pumped and flowing wells in layer 2 and pumped wells in layer 3 are shown in figures 13 and 14.

Evapotranspiration is simulated with the head-dependent Evapotranspiration Package (McDonald and Harbaugh, 1988, chap. 10). When the water table is at or above land surface, discharge occurs at the maximum specified evapotranspiration rate. As the water table drops below the land surface, evapotranspiration decreases linearly until the water table declines below a specified extinction depth, which is the depth at which evapotranspiration ceases. The phreatophyte map of Robinson (1971, pl. 2) was used to assign evapotranspiration areas to layer 1. Evapotranspiration is simulated at 324 cells, which correspond to an area of 81 mi^2 (fig. 16). Two different maximum evapotranspiration rates and extinction depths were used based on the division by Robinson (1971, pl. 2) of phreatophytes into two categories: (1) wiregrass and saltgrass, and (2) greasewood and rabbitbrush. Of the 324 cells with simulated evapotranspiration, 268 cells correspond to the wiregrass and saltgrass category and 56 cells correspond to the greasewood and rabbitbrush category.

The amount of simulated evapotranspiration was varied during steady-state calibration to best match measured shallow water levels, while keeping within the estimated budget range of 41,000 to 116,000 acre-ft/yr. During calibration, evapotranspiration rates for wiregrass and saltgrass areas were varied from 1.0 to 3.0 ft/yr and evapotranspiration rates for greasewood and rabbitbrush areas were varied from 0.4 to 1.2 ft/yr. These values are within the range of estimated values discussed in the "Evapotranspiration" section of the "Ground-water hydrology" section of this report. The final values were 1.8 ft/yr for wiregrass and saltgrass and 0.7 ft/yr for greasewood and rabbitbrush. The specified extinction depths were 5.0 ft for the wiregrass and

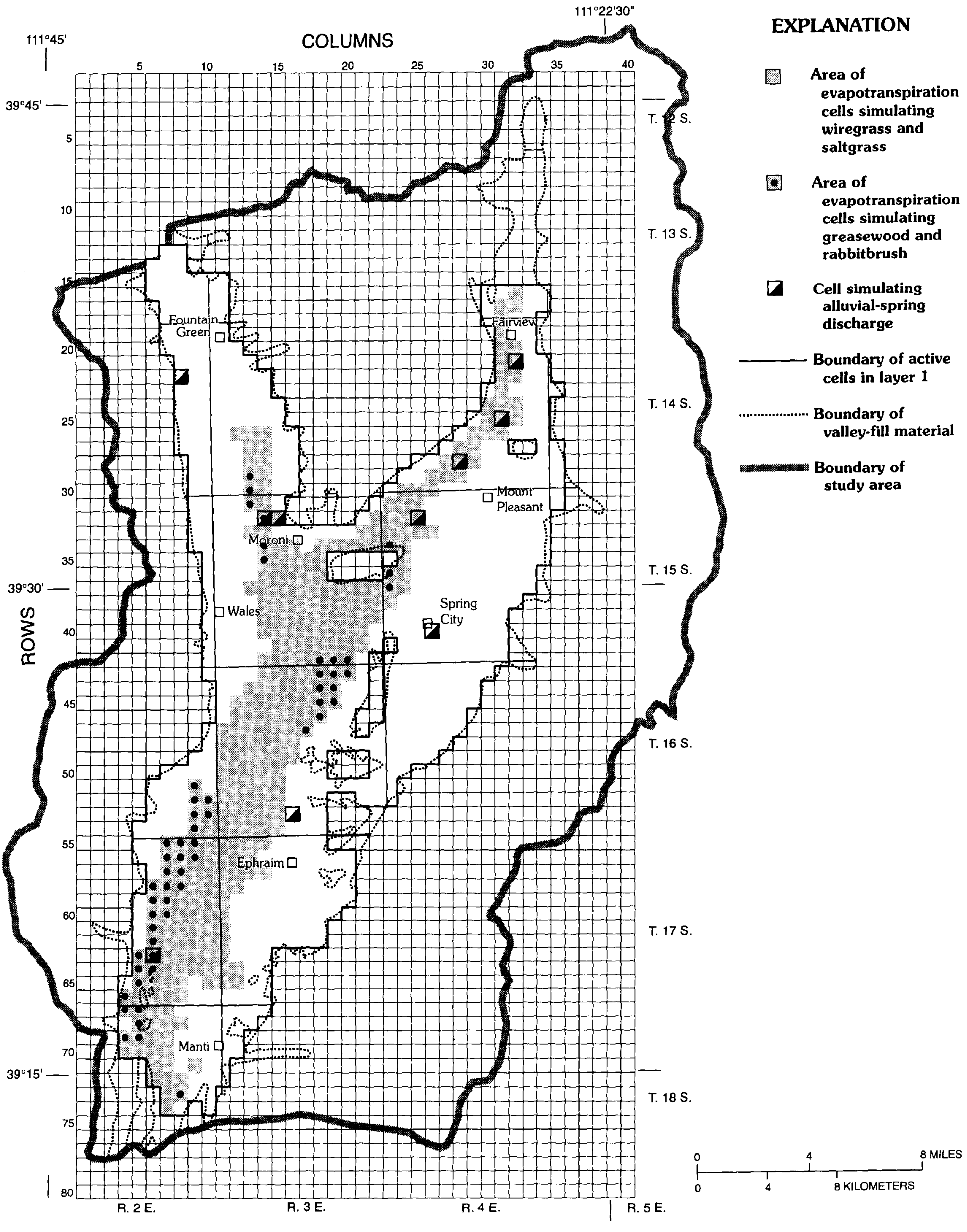

Figure 16. Location of evapotranspiration cells and cells simulating alluvial-spring discharge in layer 1 of the ground-water flow model of Sanpete Valley, Utah.

saltgrass areas and 10.0 ft for the greasewood and rabbitbrush areas. These extinction depths were determined on the basis of relations between vegetation types and maximum water-table depths given by Mower and Feltis (1968, p. 55-57).

As described previously in the "Recharge" section of this report, head-dependent cells of the River Package (McDonald and Harbaugh, 1988, chap. 6) simulate the interconnection between the San Pitch River and layer 1 of the valley-fill aquifer. Seepage data in table 2 indicate that most of the San Pitch River is a discharge area for the valley-fill aquifer. Simulated seepage to the San Pitch River is about 17,200 acre-ft/yr (table 3). The net simulated discharge (seepage from the valley-fill aquifer minus seepage to the valley-fill aquifer) is about 16,800 acre-ft/yr, which closely approximates the net discharge of 17,000 acre-ft/yr (23.4 ft^3/s) measured in October 1988 (Sandberg and Smith, 1995, table 8). Measured and model-computed discharge in the individual reaches generally are similar. Three of the 17 reaches, however, have simulated discharge from the aquifer where recharge to the aquifer from stream seepage was measured in October 1988. These reaches are near Fairview and along the river from west of Chester to west of Ephraim. The inability of the model to simulate these three losing reaches could be due to the changing nature of this head-dependent boundary. The October 1988 seepage study was conducted during abnormally dry conditions (fig. 6) and may not be representative of overall average or steady-state conditions. If average conditions were wetter than during October 1988, these three reaches could be gaining.

The Well Package (McDonald and Harbaugh, 1988, chap. 8) simulates pumping-well discharge at constant-flux boundaries where water is removed from a specified cell at a specified withdrawal rate. In the steady-state calibration, 6,300 acre-ft/yr of discharge is simulated at 53 cells that represent a total of 55 pumped wells in layers 2 and 3 (figs. 13 and 14). Individual discharge rates range from 1.4 to 366 acre-ft/yr and represent the average pumped-well withdrawals at each well for 1963 through 1988.

The Well Package (McDonald and Harbaugh, 1988, chap. 8) also simulates flowing-well discharge because yearly fluctuation of discharge with time is unknown. If data were collected to quantify fluctuation in discharge with time, a head-dependent package such as the Drain Package could simulate flowing-well discharge. Because discharge from flowing-wells represent only 5 percent of the overall steady-state discharge, the inability of the Well Package to simulate possible fluctuations in flowing-well discharge should not be important. Also, simulating flowing-well discharge with the Well Package simplifies the overall ground-water budget analyses.

A constant discharge of 4,000 acre-ft/yr is simulated for flowing wells, which are all in layer 2 (fig. 13). Of the 184 flowing wells inventoried by Robinson (1968, table 1), 60 wells with discharge rates greater than 10 gal/min (16 acre-ft/yr) were simulated in the model. This approximation was incorporated because these larger flowing wells accounted for about 90 percent of the total discharge (4,000 acre-ft/yr of the total 4,500 acre-ft/yr). Discharge rates for individual cells range from 15.9 to 469 acre-ft/yr.

Head-dependent cells of the Drain Package (McDonald and Harbaugh, 1988, chap. 9) simulate discharge from alluvial springs. Drain cells are similar to river cells, except that drain cells discharge water only from the aquifer and will dry up if the water level in the aquifer drops below the specified altitude of the spring. Spring altitudes were taken from Robinson (1968, table 2). The amount of discharge is calculated as the difference between the model-computed water level at the corresponding cell in the aquifer and the specified altitude of the spring, multiplied by the drain-conductance value. Drain conductance is based on the hydraulic conductivity between the aquifer and the drain.

Discharge from the 10 largest alluvial springs is simulated with the Drain Package (fig. 16). During steady-state calibration, it was not possible to closely approximate the alluvial-spring discharge of about 11,000 acre-ft/yr calculated from Robinson (1968, table 2). As mentioned previously in the "Alluvial-spring discharge" section of the "Ground-water hydrology" section of this report, total discharge from alluvial springs calculated from Robinson (1968, table 2) probably is too large because most measurements were made during November and January when evapotranspiration is at a minimum and alluvial-spring discharge is at a maximum. This could partly explain the difficulty in simulating the measured amount of discharge. During calibration, drain-conductance values of 8.64×10^4 to 8.64×10^7 ft^2/d were tested with the model. Dividing these conductance values by the 1/2-mi (2,640-ft) length of the drain in each cell yields simulated hydraulic-conductivity values of 33 to 33,000 ft/d for the drain-bed material. With the largest value of 8.64×10^7 ft^2/d, only 8,500 acre-ft/yr of drain discharge occurred. Large drain-conductance values, however, resulted in model instability. For adequate numerical stability, a drain-conductance value of 8.64 x 10^4 ft^2/d is used and results in simulated steady-state alluvial-spring discharge of 3,600 acre-ft/yr (table 3). Four of the largest spring areas, (D-14-4)11ad-S, (D-15-3)4c-S, (D-15-3)5d-S, and (D-15-3)5dba-S1, had a total measured discharge of 7,280 acre-ft/yr in January 1966 (Robinson, 1968, table 2). These alluvial springs discharge 1,500 acre-ft/yr in the steady-state calibration.

The difficulty in simulating measured alluvial-spring discharge could indicate the possibility of recharge to the valley-fill aquifer as subsurface inflow from consolidated rock. The larger amount of measured spring discharge (as compared with model-simulated spring discharge) is possible evidence for recharge as subsurface inflow from consolidated rock, a source that is not simulated by the computer model. Spring seepage areas (D-14-4)11ad-S, south of Fairview, (D-15-3)4c-S, (D-15-3)5d-S, and (D-15-3)5dba-S1, near Moroni (Robinson, 1968, table 2), are in areas where consolidated rock is at shallow depths.

Hydrologic Properties

Horizontal hydraulic-conductivity values and transmissivity values, and vertical hydraulic-conductivity values are used in the steady-state calibration to represent aquifer properties. These values were determined on the basis of measured aquifer properties or derived experimentally during steady-state calibration.

Horizontal Hydraulic Conductivity and Transmissivity

Initially, a uniform horizontal hydraulic-conductivity value for layer 1 of 50 ft/d was used. Horizontal hydraulic conductivity subsequently was refined to a non-uniform distribution of values ranging from 0.2 to 50 ft/d (fig. 17). The lowest model-computed value of 0.2 ft/d is less than the lowest value of 10 ft/d reported in the earlier “Hydrologic properties” section of the “Ground-water hydrology” section of this report. Data were not available, however, for wells exclusively completed in the shallow aquifer (layer 1). Values of hydraulic conductivity in the shallow aquifer zone and along the valley edges are assumed to be less than values for the deeper part of the aquifer and away from the valley edges. Generally, the lowest assigned hydraulic-conductivity values for layer 1 are along the edges of the valley, and the highest model-computed values are in the center of the valley.

The initial value of transmissivity used for layers 2 and 3 was 10,000 ft^2/d. Transmissivity values were modified to a non-uniform distribution of 100 to 10,000 ft^2/d for layer 2 and 2,000 to 20,000 ft^2/d for layer 3 (figs. 18 and 19) during calibration to more closely simulate measured water levels. The specified thickness of layer 2 is 100 ft; thus, the corresponding horizontal hydraulic-conductivity values are 1 to 100 ft/d. Layer 3 is assumed to have a variable thickness, estimated to be between 50 and 350 ft, so the corresponding horizontal hydraulic-conductivity values cannot be determined. Transmissivity values for both layers are smallest along the edges of the valley and largest toward the center of the valley, reflecting the increased thickness of sediment toward the center of the valley.

The simulated transmissivity value is in the same order of magnitude as the reported transmissivity at well (D-16-2)36cbd-1, perforated from 128 to 298 ft below land surface. The simulated transmissivity value at cells that represent this well is 3,000 ft^2/d (a combination of 1,000 ft^2/d in layer 2 and 2,000 ft^2/d in layer 3), whereas the calculated transmissivity value at this well is 1,700 ft^2/d. The simulated transmissivity values for cells that represent wells with transmissivity values determined from specific-capacity data also are generally within an order of magnitude of reported values. Emphasis was not placed on matching these values exactly, but rather on using the reported values to determine general areas of higher or lower transmissivity values. In general, the largest transmissivity and hydraulic-conductivity values specified for the model are in the center of the valley and the smallest transmissivity and hydraulic-conductivity values specified for the model are toward the edges of the valley (figs. 17-19).

Vertical Hydraulic Conductivity and Leakance

Vertical leakance simulates vertical flow between layers (McDonald and Harbaugh, 1988, chap. 5) and is defined for each cell as the vertical hydraulic-conductivity value divided by the vertical distance between the centers of model cells. In general, a vertical leakance value of 1.0 x10^{-4} ft/d/ft was specified between layers 1 and 2 and was determined iteratively by comparing simulated vertical head differences between layers 1 and 2 with measured water-level differences in nearby wells that were open at depths corresponding to either layer 1 or 2. In addition, model-computed discharge at cells that represent alluvial springs was compared to measured discharge from alluvial springs. In areas where alluvial-spring discharge is simulated (fig. 16), a vertical leakance of 1.0 x 10^{-3} ft/d/ft was specified

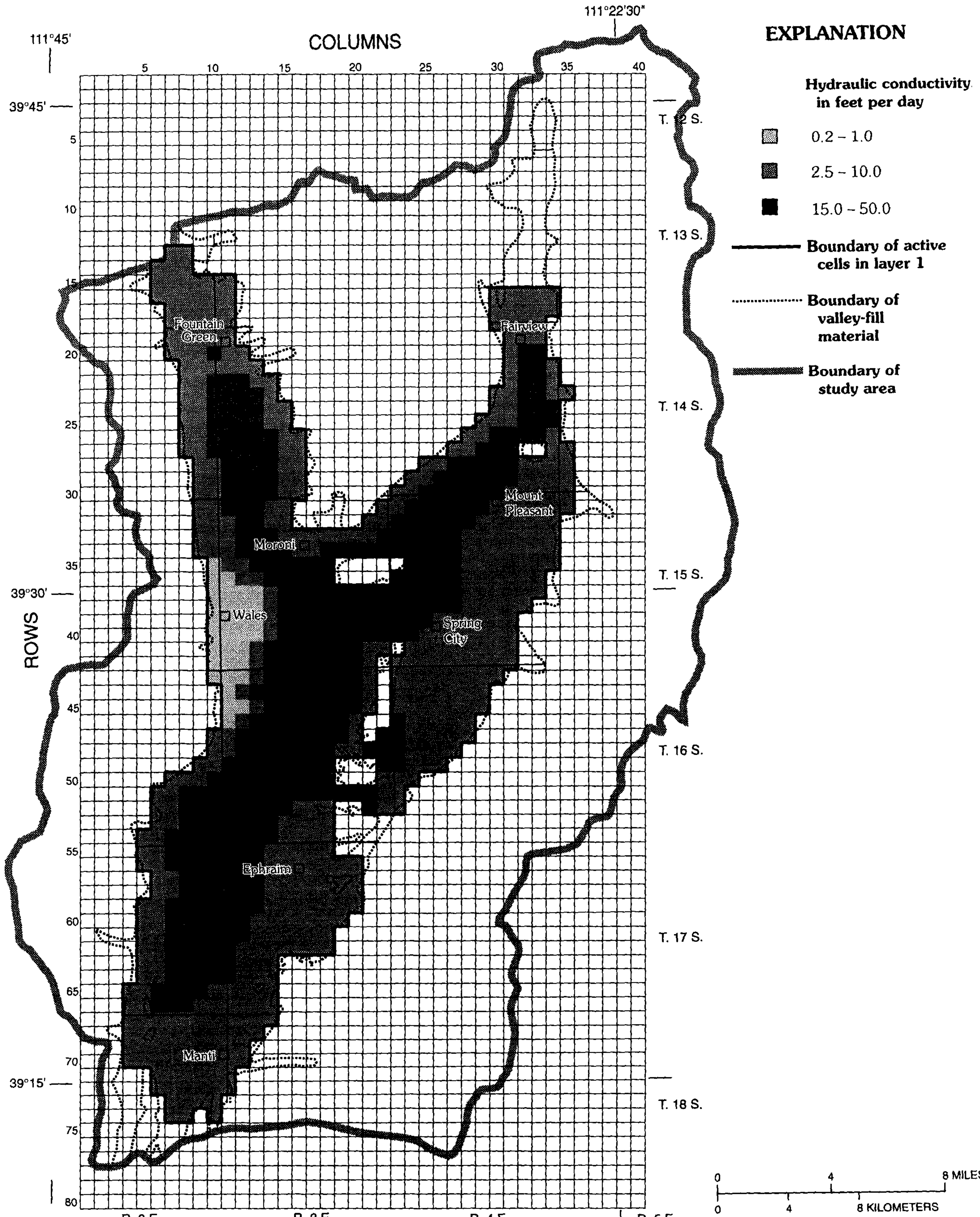

Figure 17. Final distribution of hydraulic-conductivity values used for layer 1 of the ground-water flow model of Sanpete Valley, Utah.

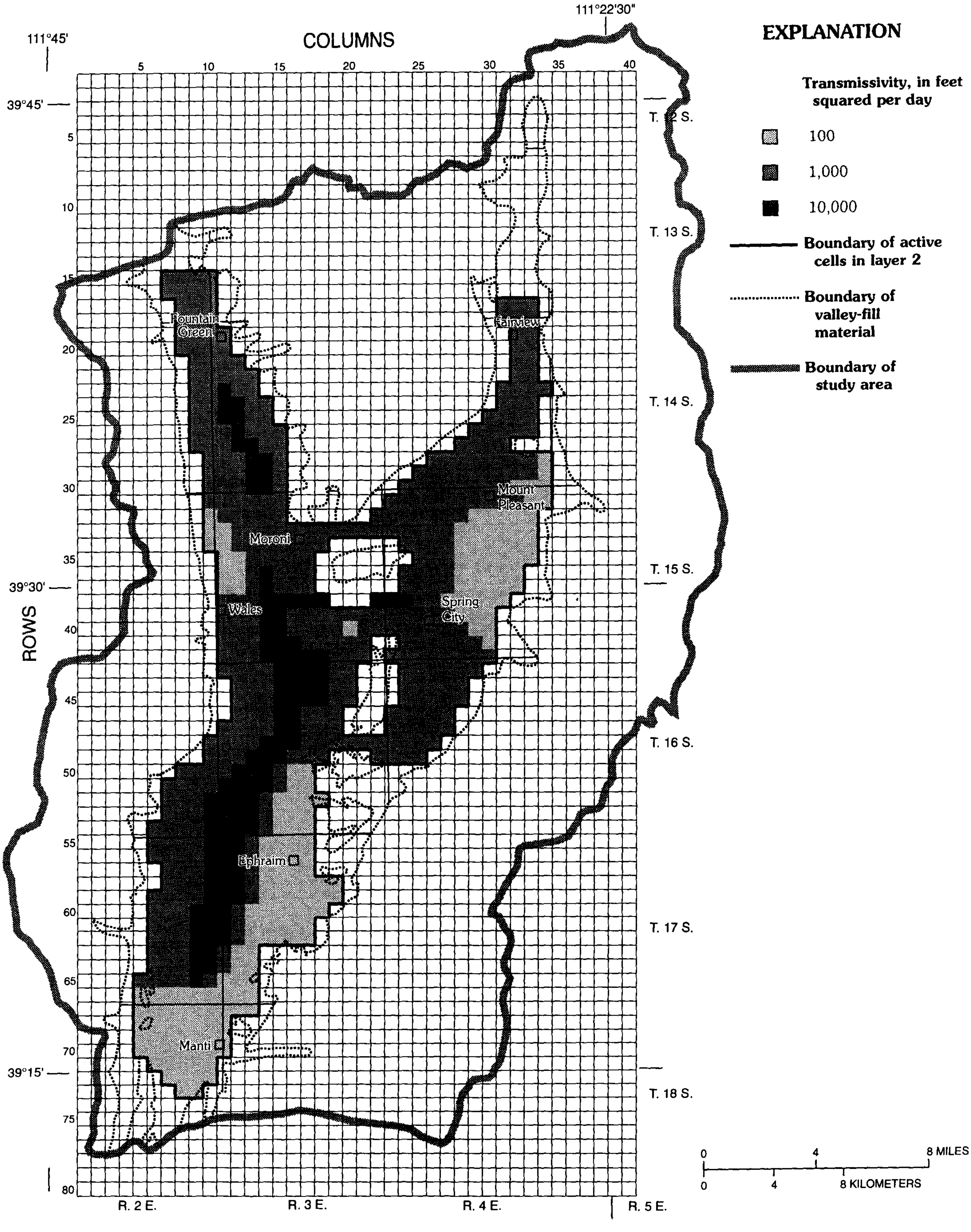

Figure 18. Final distribution of transmissivity values used for layer 2 of the ground-water flow model of Sanpete Valley, Utah.

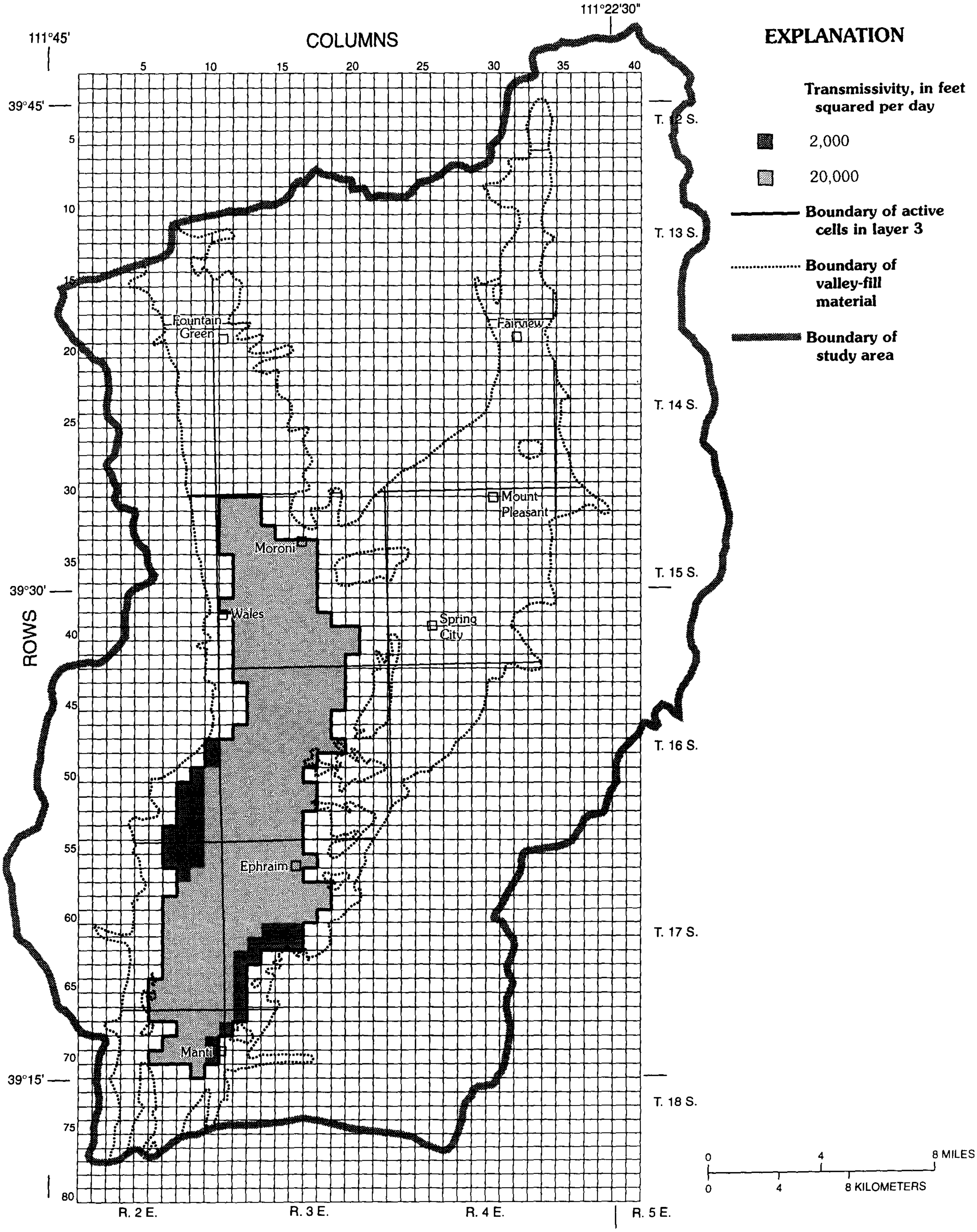

Figure 19. Final distribution of transmissivity values used for layer 3 of the ground-water flow model of Sanpete Valley, Utah.

between layers 2 and 3. The need for an increased vertical leakance could be the result of thin or missing shallow clay lenses in areas of alluvial springs. The simulated values of vertical leakance can be converted to vertical hydraulic-conductivity values by multiplying by the 75-ft vertical distance between the center of cells in layer 1 and layer 2. Simulated vertical hydraulic-conductivity values range from 7.5 x 10^{-3} to 7.5 x 10^{-2} ft/d and are similar to the value of 6.0 x 10^{-2} ft/d determined from a multiple-well aquifer test at well (D-16-2)36cbd-1.

Another option tested during steady-state calibration was to increase the vertical hydraulic-conductivity value between layers 1 and 2 along the sides of the valley. Vertical hydraulic conductivity was increased by two orders of magnitude along the sides of the valley, where the valley-fill aquifer is assumed to be unconfined. The boundary between the lower and higher vertical leakance values was based on the delineation of flowing-well and nonflowing-well areas by Robinson (1971, pl. 2). This option did not produce satisfactory matches between measured and model-computed water levels. The possible presence of fine-grained sediments and clay lenses along the edges of the valley could cause low vertical hydraulic-conductivity values. There have been no aquifer tests to quantify actual vertical hydraulic-conductivity values in these areas.

Division of the deeper aquifer zone into layers 2 and 3 is more arbitrary than the division of layers 1 and 2. Although well logs at some locations indicate a confining unit about 150 ft beneath the water table, it is not present everywhere. A vertical leakance value of 1.0 x 10^{-2} ft/d/ft was used to simulate the vertical hydraulic connection between layers 2 and 3, which is larger than the vertical leakance value of 1.0 x 10^{-4} ft/d/ft simulated between layers 1 and 2. Vertical leakance was determined iteratively by comparing measured and model-computed water levels in 133 wells that were open in either layer 2 or 3. Because the altitude of the bottom of layer 3 (the contact between valley-fill material and consolidated rock) varies and is not known in most locations, the vertical distance between the center of the cells in layers 2 and 3 is unknown; therefore, the vertical hydraulic-conductivity value that corresponds to vertical leakance cannot be accurately determined. If layer 3 is assumed to be between 50 and 200 ft thick, then the corresponding vertical hydraulic-conductivity value is between 0.5 and 2.0 ft/d or less. These values are larger than the vertical hydraulic-conductivity value of 6.0 x 10^{-2} ft/d determined from a multiple-well aquifer test at well (D-16-2)36cbd-1. Vertical hydraulic-conductivity values are assumed to vary throughout the study area and could be smaller at the aquifer-test location than elsewhere because of the presence of clay lenses of lower hydraulic conductivity.

Comparison of Measured and Model-Computed Water-Levels

The most complete set of measured water-level data available for the valley-fill aquifer in Sanpete Valley is from August to December 1966 (table 4). Water levels measured in 184 observation wells were compared with model-computed water levels: 51 wells correspond to layer 1; 103 wells correspond to layer 2; and 30 wells correspond to layer 3 (table 4). The mean difference between measured and model-computed water levels of the final steady-state calibration was -1.4 ft, and the standard deviation was 19.8 ft (table 4). The comparison of potentiometric contours generated from measured 1966 water levels (Robinson, 1971, pl. 2) with potentiometric contours generated from model-computed water levels is shown in figure 20.

Generally, water levels in the areas of steep hydraulic gradients are the most difficult to approximate. Steep hydraulic gradients generally correspond to the areas of greatest ground-water recharge from stream seepage along the eastern edge of Sanpete Valley and the northern parts of the Silver Creek and San Pitch River drainages. Other areas of steep hydraulic gradients are in erosional gaps formed in the north-trending consolidated-rock outcrops near the San Pitch River, Oak and Bill Allred Creeks, and Pigeon Hollow (pl. 1). Hydraulic-conductivity values in layer 1 and transmissivity values in layer 2 in the erosional gaps were adjusted during calibration.

Transient-State Calibration

After calibration to steady-state conditions, the ground-water flow model of Sanpete Valley was calibrated to transient conditions. Yearly stress periods from 1967 to 1989 are used in the transient calibration. For computational accuracy, each stress period was divided into three time steps with a time-step multiplier of 1.5. Splitting each stress period into more than three time steps did not substantially improve the numerical accuracy of the calibration. New data incorporated into the transient-state calibration included a yearly percentage of precipitation at 4 climatic stations on the

Table 4. Measured and model-computed water-level altitudes in selected wells, Sanpete Valley, Utah

Model grid location: See figure 11 for an explanation of the model grid-numbering system.

Well location: See figure 2 for an explanation of the numbering system for hydrologic-data sites.

Measured water-level altitude: From Robinson (1968, tables 1 and 3).

Location				Date	Measured water-level altitude (feet)	Model-computed water-level altitude (feet)	Difference (measured minus model-computed water level) (feet)
Model grid			Well				
Layer	Row	Column					
1	18	32	(D-13-4)35dda-1	09-30-66	5,981	6,044	-63
1	20	10	(D-14-3)7bbb-1	10-28-66	5,875	5,893	-18
1	21	11	(D-14-3)7acc-1	10-28-66	5,783	5,784	-1
1	23	12	(D-14-3)18adb-1	10-28-66	5,650	5,682	-32
1	23	13	(D-14-3)17bdc-1	08-19-66	5,644	5,674	-30
1	24	30	(D-14-4)15ddd-1	10-12-66	5,835	5,792	43
1	24	32	(D-14-4)24bbb-1	10-26-66	5,906	5,918	-12
1	24	34	(D-14-4)13ddc-1	10-11-66	5,923	5,942	-19
1	25	33	(D-14-4)24cdb-1	10-11-66	5,912	5,920	-8
1	25	34	(D-14-4)24dbd-1	10-11-66	5,941	5,937	4
1	26	29	(D-14-4)22cdd-2	10-13-66	5,764	5,760	4
1	26	30	(D-14-4)27aab-1	10-26-66	5,805	5,822	-17
1	28	12	(D-14-3)29ccb-3	08-26-66	5,584	5,604	-20
1	28	30	(D-14-4)34abd-1	10-14-66	5,825	5,829	-4
1	29	26	(D-14-4)33cbc-1	10-18-66	5,685	5,679	6
1	29	27	(D-14-4)33cbd-1	10-18-66	5,696	5,720	-24
1	29	29	(D-14-4)34bda-1	10-12-66	5,816	5,804	12
1	30	23	(D-15-4)6bac-1	10-19-66	5,634	5,626	8
1	30	26	(D-15-4)4bbc-1	10-18-66	5,700	5,702	-2
1	31	24	(D-15-4)6ada-1	10-19-66	5,640	5,644	-4
1	31	26	(D-15-4)5dbd-1	10-18-66	5,685	5,704	-19
1	32	21	(D-15-3)12abb-2	10-19-66	5,600	5,610	-10
1	32	22	(D-15-3)1ddc-2	10-19-66	5,593	5,592	1
1	32	26	(D-15-4)5dcd-1	10-18-66	5,681	5,702	-21
1	33	10	(D-15-2)12aad-1	10-26-66	5,644	5,626	18
1	33	20	(D-15-3)12bcc-2	10-19-66	5,579	5,565	14
1	33	26	(D-15-4)8acb-1	10-20-66	5,681	5,709	-28
1	33	27	(D-15-4)9bbd-1	10-20-66	5,716	5,732	-16
1	35	25	(D-15-4)17bad-2	11-09-66	5,695	5,718	-23
1	36	17	(D-15-3)15cac-1	10-26-66	5,517	5,512	5
1	36	24	(D-15-4)19abb-1	11-10-66	5,671	5,702	-31
1	37	13	(D-15-3)20bcc-1	11-22-66	5,527	5,496	31
1	38	12	(D-15-3)30aaa-1	11-21-66	5,535	5,521	14
1	38	19	(D-15-3)23cda-1	11-23-66	5,552	5,541	11
1	38	26	(D-15-4)20dcb-1	11-10-66	5,743	5,762	-19

Table 4. Measured and model-computed water level altitudes in selected wells, Sanpete Valley, Utah—Continued

Location: Model grid: Layer	Row	Column	Well	Date	Measured water-level altitude (feet)	Model-computed water-level altitude (feet)	Difference (measured minus model-computed water level) (feet)
1	39	27	(D-15-4)28cba-1	11-16-66	5,841	5,850	-9
1	40	13	(D-15-3)29cca-1	11-22-66	5,523	5,498	25
1	40	21	(D-15-3)36bbb-2	10-26-66	5,523	5,581	-58
1	41	12	(D-15-3)31aaa-1	10-28-66	5,496	5,498	-2
1	42	13	(D-15-3)32ccd-1	11-21-66	5,482	5,483	-1
1	46	23	(D-16-4) 7ccd-1	11-16-66	5,885	5,904	-19
1	47	23	(D-16-4)18bac-1	11-16-66	5,885	5,877	8
1	48	23	(D-16-3)13dda-1	11-03-66	5,821	5,859	-38
1	49	16	(D-16-3)21ada-1	12-10-66	5,459	5,456	3
1	49	18	(D-16-3)22abc-1	12-10-66	5,473	5,478	-5
1	50	9	(D-16-2)24cda-1	12-19-66	5,450	5,454	-4
1	50	23	(D-16-4)19ccc-1	12-14-66	5,910	5,875	35
1	52	21	(D-16-3)25cbd-1	12-14-66	5,760	5,755	5
1	53	17	(D-16-3)34bbc-1	12-14-66	5,483	5,516	-33
1	68	7	(D-18-2) 2cdb-1	11-02-66	5,462	5,451	11
1	74	7	(D-18-2)22add-1	11-02-66	5,436	5,432	4
2	20	11	(D-14-3) 7abb-1	10-28-66	5,796	5,843	-47
2	21	10	(D-14-2)12aad-1	10-28-66	5,867	5,807	60
2	22	10	(D-14-2)13aaa-1	10-28-66	5,812	5,745	67
2	22	33	(D-14-4)12cdc-1	10-26-66	5,911	5,930	-19
2	25	12	(D-14-3)20cbb-1	9-28-66	5,598	5,644	-46
2	26	11	(D-14-3)19ccd-1	8-25-66	5,657	5,640	17
2	27	12	(D-14-3)30abb-1	8-25-66	5,622	5,619	3
2	28	12	(D-14-3)29ccb-1	8-26-66	5,598	5,604	-6
2	28	14	(D-14-3)29ddc-1	8-26-66	5,572	5,591	-19
2	28	15	(D-14-3)28cbd-1	8-26-66	5,585	5,595	-10
2	29	14	(D-14-3)32adc-1	8-29-66	5,563	5,585	-22
2	29	15	(D-14-3)33bbc-1	8-29-66	5,571	5,585	-14
2	30	14	(D-14-3)32ddb-2	8-27-66	5,552	5,578	-26
2	31	14	(D-15-3) 5ada-2	10-28-66	5,548	5,550	-2
2	31	27	(D-15-4) 4bad-2	10-17-66	5,724	5,721	3
2	31	32	(D-15-4) 2adb-1	10-17-66	5,968	5,966	2
2	32	28	(D-15-4) 4dda-1	10-17-66	5,803	5,741	62
2	33	27	(D-15-4) 9bac-1	10-20-66	5,721	5,726	-5
2	34	13	(D-15-3) 8cda-3	10-26-66	5,512	5,518	-6
2	34	24	(D-15-4) 7dad-1	10-20-66	5,666	5,678	-12
2	34	26	(D-15-4)17abb-1	10-20-66	5,699	5,717	-18
2	34	27	(D-15-4) 9ccd-1	10-25-66	5,720	5,737	-17
2	35	14	(D-15-3)17adb-1	11-18-66	5,504	5,511	-7
2	35	17	(D-15-3)15bbc-3	10-26-66	5,506	5,507	-1

Table 4. Measured and model-computed water level altitudes in selected wells, Sanpete Valley, Utah—Continued

Location: Model grid: Layer	Row	Column	Well	Date	Measured water-level altitude (feet)	Model-computed water-level altitude (feet)	Difference (measured minus model-computed water level) (feet)
2	36	11	(D-15-3)18ccb-1	11-18-66	5,603	5,607	-4
2	36	24	(D-15-4)17ccb-1	10-26-66	5,683	5,714	-31
2	36	27	(D-15-4)16ccb-1	11-09-66	5,749	5,759	-10
2	37	14	(D-15-3)20adb-1	11-22-66	5,500	5,504	-4
2	37	15	(D-15-3)21bdd-2	11-22-66	5,495	5,503	-8
2	37	16	(D-15-3)22bcb-3	11-23-66	5,500	5,502	-2
2	37	28	(D-15-4)21cda-1	10-26-66	5,830	5,836	-6
2	38	14	(D-15-3)20dda-1	11-22-66	5,494	5,500	-6
2	38	16	(D-15-3)28aba-1	10-26-66	5,488	5,499	-11
2	38	18	(D-15-3)22dad-1	11-23-66	5,546	5,499	47
2	38	25	(D-15-4)29bac-1	10-26-66	5,753	5,733	20
2	39	17	(D-15-3)27bbc-1	10-26-66	5,493	5,495	-2
2	39	18	(D-15-3)27ada-1	10-26-66	5,514	5,495	19
2	39	19	(D-15-3)26bca-1	11-26-66	5,520	5,517	3
2	39	22	(D-15-3)25daa-1	11-26-66	5,658	5,654	4
2	39	23	(D-15-4)30cab-1	11-14-66	5,676	5,688	-12
2	40	16	(D-15-3)28daa-1	11-25-66	5,482	5,492	-10
2	40	19	(D-15-3)35baa-1	11-26-66	5,509	5,494	15
2	40	20	(D-15-3)35aaa-1	10-26-66	5,523	5,497	26
2	40	26	(D-15-4)29cad-2	11-16-66	5,793	5,829	-36
2	41	14	(D-15-3)32aac-1	11-22-66	5,476	5,490	-14
2	41	15	(D-15-3)33bba-1	11-25-66	5,483	5,489	-6
2	41	16	(D-15-3)33adc-1	11-25-66	5,478	5,488	-10
2	41	18	(D-15-3)34ada-1	11-28-66	5,498	5,490	8
2	41	21	(D-15-3)36bbc-1	11-26-66	5,524	5,536	-12
2	41	24	(D-15-4)31dab-1	10-26-66	5,819	5,826	-7
2	42	12	(D-15-3)31dbc-1	11-21-66	5,504	5,491	13
2	42	15	(D-15-3)33cdb-2	11-25-66	5,476	5,485	-9
2	42	16	(D-16-3) 4aaa-1	10-28-66	5,476	5,485	-9
2	42	18	(D-15-3)34ddc-1	11-26-66	5,478	5,485	-7
2	42	20	(D-16-3) 2abb-1	11-29-66	5,503	5,497	6
2	42	21	(D-16-3) 1bbb-2	11-29-66	5,571	5,516	55
2	43	18	(D-16-3) 3acd-1	11-29-66	5,463	5,483	-20
2	44	13	(D-16-3) 5cbc-1	12-05-66	5,472	5,478	-6
2	44	16	(D-16-3) 4dbd-2	12-06-66	5,470	5,478	-8
2	45	12	(D-16-3) 7abc-2	10-28-66	5,484	5,468	16
2	45	15	(D-16-3) 9bbb-1	10-28-66	5,468	5,474	-6
2	47	14	(D-16-3)17aad-1	12-09-66	5,455	5,466	-11
2	47	17	(D-16-3)16aad-2	12-09-66	5,456	5,473	-17
2	48	13	(D-16-3)17dac-2	12-09-66	5,450	5,462	-12

Table 4. Measured and model-computed water level altitudes in selected wells, Sanpete Valley, Utah—Continued

Location				Date	Measured water-level altitude (feet)	Model-computed water-level altitude (feet)	Difference (measured minus model-computed water level) (feet)
Model grid			Well				
Layer	Row	Column					
2	48	16	(D-16-3)16caa-1	12-09-66	5,452	5,468	-16
2	48	17	(D-16-3)15dcb-1	11-03-66	5,471	5,472	-1
2	49	10	(D-16-2)24baa-1	12-19-66	5,457	5,456	1
2	49	13	(D-16-3)20bad-2	12-12-66	5,448	5,460	-12
2	49	14	(D-16-3)20abc-1	12-12-66	5,448	5,462	-14
2	49	15	(D-16-3)21bbc-1	11-03-66	5,446	5,464	-18
2	50	15	(D-16-3)21cdb-2	11-03-66	5,460	5,461	-1
2	51	14	(D-16-3)29bad-1	12-12-66	5,448	5,458	-10
2	51	15	(D-16-3)28bbd-1	12-12-66	5,463	5,460	3
2	51	17	(D-16-3)28aad-1	11-03-66	5,471	5,463	8
2	52	10	(D-16-2)25dad-1	12-19-66	5,449	5,453	-4
2	52	17	(D-16-3)27cbc-1	11-03-66	5,499	5,464	35
2	52	18	(D-16-3)27caa-1	12-13-66	5,500	5,511	-11
2	53	8	(D-16-2)35acd-1	10-28-66	5,472	5,451	21
2	53	14	(D-16-3)32adb-2	12-14-66	5,458	5,458	0
2	53	15	(D-16-3)33bab-1	12-14-66	5,466	5,461	5
2	54	12	(D-16-3)31dcc-1	12-16-66	5,433	5,454	-21
2	54	15	(D-16-3)32dda-1	11-03-66	5,465	5,462	3
2	55	14	(D-16-3)32ddc-2	11-15-66	5,483	5,461	22
2	56	11	(D-17-3) 6cab-1	11-03-66	5,440	5,450	-10
2	56	15	(D-17-3) 5add-1	11-03-66	5,485	5,467	18
2	56	17	(D-17-3) 3cbb-1	11-03-66	5,504	5,473	31
2	57	13	(D-17-3) 8bab-1	11-03-66	5,457	5,456	1
2	58	14	(D-17-3) 8cdd-1	11-03-66	5,468	5,462	6
2	58	15	(D-17-3) 9cbd-1	11-03-66	5,487	5,468	19
2	61	14	(D-17-3)20bdd-1	11-03-66	5,474	5,466	8
2	62	13	(D-17-3)20cdb-1	11-03-66	5,479	5,457	22
2	62	14	(D-17-3)20acc-1	11-03-66	5,477	5,472	5
2	64	12	(D-17-3)30dbd-1	11-03-66	5,464	5,449	15
2	66	9	(D-17-2)36cba-1	11-04-66	5,467	5,448	19
2	67	7	(D-18-2)11bcc-2	11-02-66	5,456	5,447	9
2	67	10	(D-17-2)36cdc-2	11-02-66	5,473	5,451	22
2	68	9	(D-18-2) 2adc-1	11-02-66	5,467	5,455	12
2	68	10	(D-18-2) 1bdd-1	11-02-66	5,471	5,454	17
2	68	11	(D-18-2) 1daa-2	11-04-66	5,477	5,454	23
2	69	10	(D-18-2)12bab-1	11-02-66	5,475	5,466	9
2	70	9	(D-18-2)12cdb-1	11-02-66	5,475	5,466	9
2	70	10	(D-18-2)12bdc-1	11-02-66	5,472	5,477	-5
2	71	9	(D-18-2)14aac-1	11-02-66	5,468	5,469	-1
3	35	16	(D-15-3)16adb-1	10-26-66	5,513	5,507	6

Table 4. Measured and model-computed water level altitudes in selected wells, Sanpete Valley, Utah—Continued

Location				Date	Measured water-level altitude (feet)	Model-computed water-level altitude (feet)	Difference (measured minus model-computed water level) (feet)
Model grid			Well				
Layer	Row	Column					
3	38	11	(D-15-3)19cad-1	11-21-66	5,572	5,508	64
3	40	17	(D-15-3)27cca-3	11-25-66	5,487	5,492	-5
3	42	14	(D-15-3)32dca-1	11-21-66	5,475	5,487	-12
3	43	17	(D-16-3) 3bbc-1	11-29-66	5,477	5,482	-5
3	47	12	(D-16-3)18bad-1	12-08-66	5,443	5,462	-19
3	48	10	(D-16-2)13dda-1	10-28-66	5,455	5,457	-2
3	49	12	(D-16-3)19aca-1	12-12-66	5,448	5,458	-10
3	49	13	(D-16-3)20bbc-1	12-12-66	5,449	5,460	-11
3	50	10	(D-16-2)24ddd-1	12-19-66	5,450	5,455	-5
3	53	13	(D-16-3)32bbb-1	12-14-66	5,452	5,456	-4
3	53	16	(D-16-3)33acd-1	12-14-66	5,476	5,463	13
3	54	9	(D-16-2)36cbd-1	10-28-66	5,451	5,447	4
3	55	9	(D-17-2) 1bca-2	10-28-66	5,449	5,448	1
3	55	12	(D-17-3) 6aad-1	11-03-66	5,458	5,453	5
3	56	10	(D-17-2) 1dac-1	12-20-66	5,439	5,448	-9
3	56	13	(D-17-3) 6ddd-1	12-21-66	5,451	5,457	-6
3	57	9	(D-17-2)12bac-1	12-29-66	5,433	5,446	-13
3	57	10	(D-17-2) 1ddc-2	12-20-66	5,448	5,447	1
3	57	11	(D-17-3) 7bbb-1	12-29-66	5,442	5,449	-7
3	58	10	(D-17-2)12cda-1	12-30-66	5,428	5,447	-19
3	58	11	(D-17-3) 7cad-3	12-28-66	5,439	5,449	-10
3	58	14	(D-17-3) 8cda-2	11-03-66	5,467	5,462	5
3	59	8	(D-17-2)14baa-1	10-28-66	5,443	5,443	0
3	59	11	(D-17-2)13aad-1	12-30-66	5,437	5,448	-11
3	59	14	(D-17-3)17adb-1	11-13-66	5,482	5,462	20
3	60	10	(D-17-2)13bdd-1	12-30-66	5,432	5,446	-14
3	60	13	(D-17-3)17caa-1	11-03-66	5,474	5,456	18
3	63	13	(D-17-3)30aaa-1	11-03-66	5,471	5,456	15
3	64	8	(D-17-2)26dba-1	11-04-66	5,435	5,444	-9
						Arithmetic mean =	-1.4
						Standard deviation =	19.8

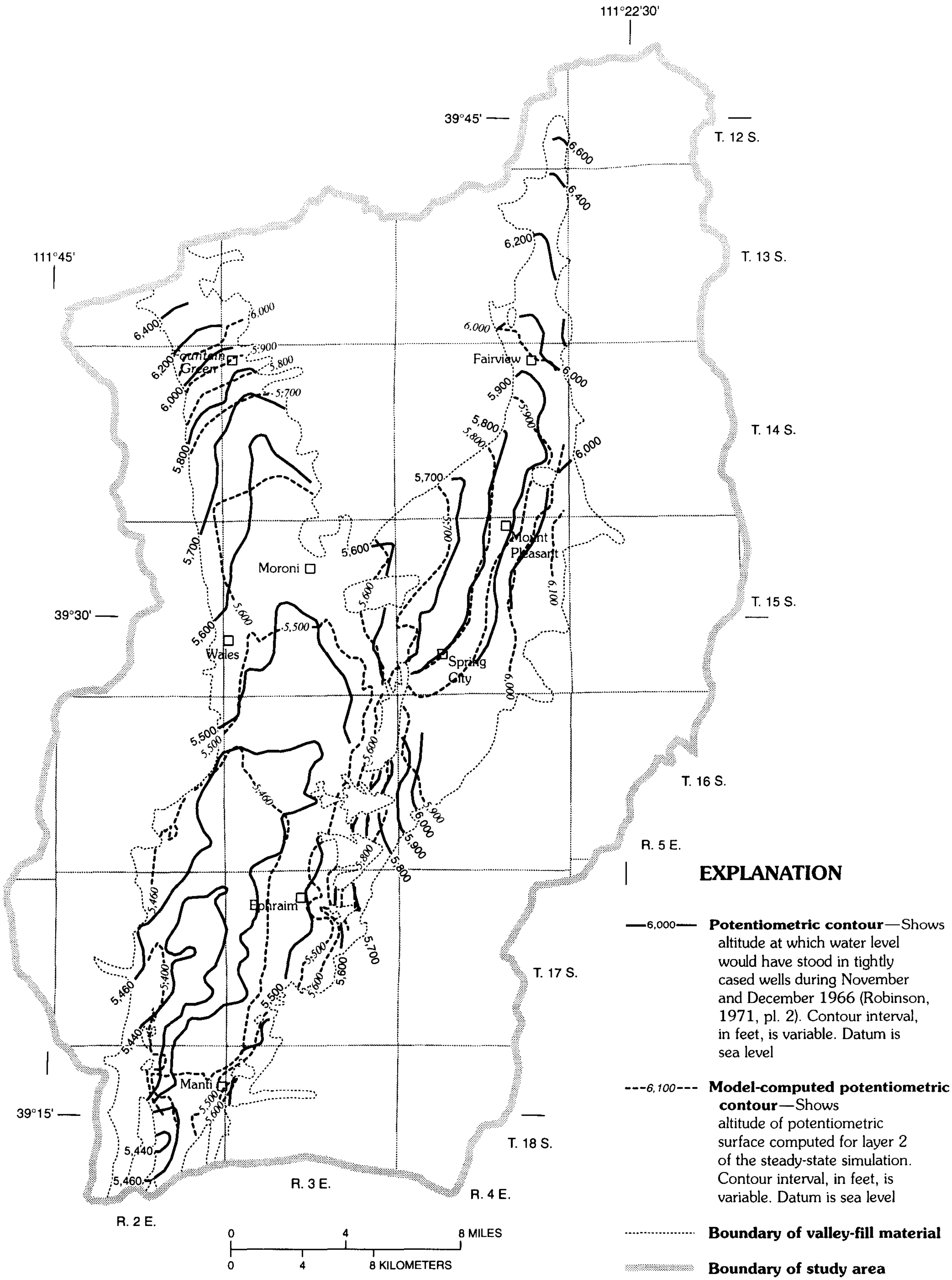

Figure 20. Potentiometric contours of measured and model-computed steady-state water levels for the valley-fill aquifer, Sanpete Valley, Utah.

Wasatch Plateau (G. Jorgensen, U.S. Forest Service, written commun., 1990), yearly measured water levels at 34 wells during 1967-80, yearly measured well-pumpage records during 1967-89, specific-yield values for layer 1, and storage-coefficient values for layers 2 and 3.

Recharge

The recharge rates simulated for each year of the transient-state calibration were determined by multiplying the steady-state recharge array by the ratio of annual precipitation divided by the normal annual precipitation for 1951-80. Various methods of determining the yearly ratio were tested that used the following data (1) normal annual precipitation (1951-80) for three climatic stations in Sanpete Valley (Ephraim, Manti, and Moroni); (2) the 23-year average discharge (1967-89) for Oak Creek near Fairview; (3) normal annual precipitation (1951-80) for four climatic stations on the Wasatch Plateau (with altitude ranging from about 7,100 to 9,850 ft); and (4) normal annual precipitation (1951-80) at the Meadows climatic station (altitude of about 9,850 ft). The transient-state recharge rates that produced the best match between measured and model-computed water-level changes were based on a yearly percentage of precipitation at the four climatic stations on the Wasatch Plateau. These rates produced the best match because most of the recharge to the valley-fill aquifer is from surface-water runoff derived from precipitation on the Wasatch Plateau.

The simulated components of the ground-water budget for the year of least simulated recharge (1989) and for the year of greatest simulated recharge (1983) are shown in table 3. Total model-computed recharge to the valley-fill aquifer ranged from 48,000 acre-ft/yr in 1989 to 126,000 acre-ft/yr in 1983. Recharge as seepage from tributaries ranged from 27,400 acre-ft/yr in 1989 to 63,500 acre-ft/yr in 1983. Recharge as infiltration of unconsumed irrigation water ranged from 7,800 acre-ft/yr in 1989 to 34,600 acre-ft/yr in 1983. Recharge as infiltration of precipitation on the valley floor ranged from 11,900 acre-ft/yr in 1989 to 27,500 acre-ft/yr in 1983. Recharge as seepage from the San Pitch River ranged from 200 acre-ft/yr in 1983 to 700 acre-ft/yr in 1989. Recharge as subsurface inflow from the valley-fill aquifer north of Fairview remained constant at 200 acre-ft/yr.

Discharge

For the transient-state calibration, the amount of pumped-well withdrawals varies and is based on yearly pumpage data collected by the U.S. Geological Survey. Pumped-well withdrawals ranged from 1,100 acre-ft/yr in 1985 to 12,700 acre-ft/yr in 1976 (fig. 6). Flowing-well discharge remained constant throughout the transient-state calibration at 4,000 acre-ft/yr.

Other head-dependent sources of discharge from the valley-fill aquifer that vary with water-level fluctuations in the transient-state calibration are evapotranspiration, seepage to the San Pitch River, and alluvial-spring discharge. Model-computed evapotranspiration ranged from about 43,400 acre-ft/yr in 1989 to 53,900 acre-ft/yr in 1983 (table 3). Model-computed seepage to the San Pitch River ranged from about 14,600 acre-ft/yr in 1989 to 21,600 acre-ft/yr in 1983. Alluvial-spring discharge ranged from about 3,100 acre-ft/yr in 1977 to 4,500 acre-ft/yr in 1984. Even though 1983 was the year of the greatest model-computed recharge, the response in alluvial-spring discharge did not occur until 1984. Total discharge ranged from 74,000 acre-ft/yr in 1989 to 85,000 acre-ft/yr in 1983. During transient-state calibration of 1989 conditions, about 26,000 acre-ft of water was removed from storage, and during transient-state calibration of 1983 conditions, about 41,000 acre-ft of water was added to storage.

Hydrologic Properties

Hydrologic properties specified for the transient-state calibration include specific-yield and storage-coefficient values. Initially, a uniform specific-yield value of 20 percent was specified for layer 1, which generally corresponds to sand and gravel sediments (Johnson, 1967, table 29). Specific-yield values for layer 1 were decreased in the area near Ephraim from 20 percent to 5 percent (fig. 21). By decreasing specific yield in this area, model-computed water-level changes in four wells, (D-16-3)21cdb-2, (D-17-2)1bca-2, (D-17-3)9cbd-1, and (D-17-3)20acc-1, more closely approximated measured water-level changes. The decrease in specific yield is based on evidence that this area has a higher percentage of fine clay and silt than other Sanpete Valley locations (Robinson, 1971, pl. 1). Even with the 5-percent specific-yield value, however, the water-level changes computed by the model are smaller than measured changes. This could be explained by the occurrence of clay lenses in the upper 50 ft of saturated material that could cause confined

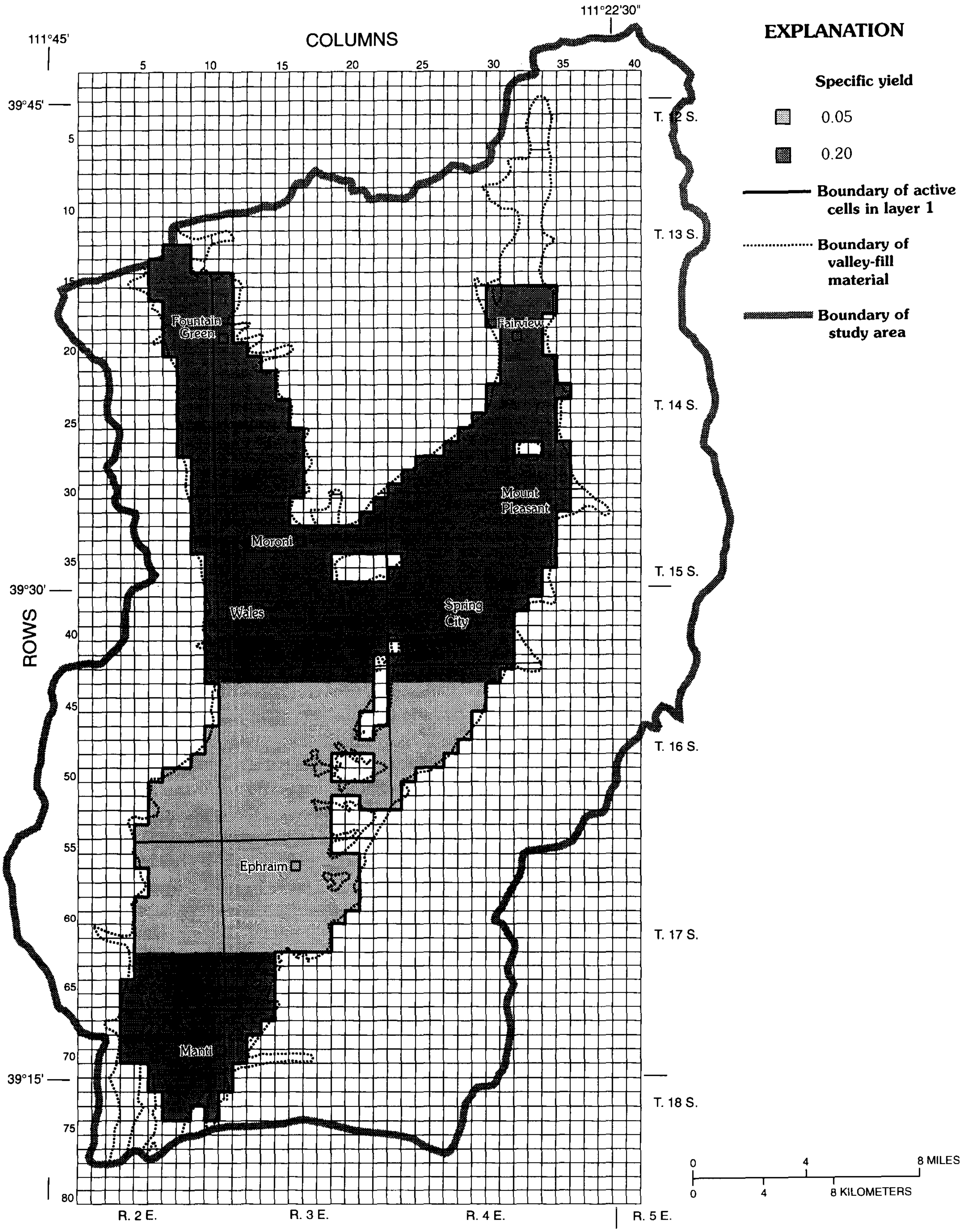

Figure 21. Final distribution of specific-yield values used for layer 1 of the ground-water flow model of Sanpete Valley, Utah.

conditions and result in smaller storage-coefficient values than were used in the model. Smaller specific-yield values generally cause larger fluctuations in water levels because less water is removed from or added to the aquifer material per unit change in head. A specific-yield value of 5 percent generally corresponds to silt and sandy clay (Johnson, 1967, table 29).

A uniform storage-coefficient value of 3.6×10^{-5} is used in layer 2 and a uniform storage-coefficient value of 7.2×10^{-5} is used in layer 3 throughout the transient-state calibration. These values are based on the results of an aquifer test at (D-16-2)36cbd-1 discussed previously in the "Hydrologic properties" section of this report which had a calculated storage coefficient of 6.1×10^{-5}. Dividing this value by the perforated interval of 170 ft at this well yields an approximate specific storage of 3.6×10^{-7} per foot of aquifer. Multiplying this specific storage by the 100-ft thickness of layer 2 results in the value 3.6×10^{-5} for storage coefficient. Similarly, multiplying the specific storage by the estimated 200-ft thickness of layer 3 results in the storage-coefficient value of 7.2×10^{-5}.

Comparison of Measured and Model-Computed Water-Level Changes

A determination of how well the results of the transient-state calibration represent the natural ground-water system is made by comparing measured water-level changes to model-computed water-level changes. A comparison of measured and model-computed water-level changes for 16 observation wells are shown in figure 22. To compare yearly trends rather than seasonal fluctuations, only water levels measured during March of each year were used. Comparison of measured and model-computed water-level changes began in 1968 because the model requires one stress period to equilibrate from steady-state to transient-state conditions.

The overall match between measured and model-computed water-level changes generally is good from the late 1960's to the early 1980's. An exception is at well (D-15-4)21cda-1, northeast of Spring City, where the model-computed water levels do not fluctuate as much as the measured water levels. A possible reason for the difference is the inability to accurately represent heterogeneities of the ground-water system because of lack of data. Two specified parameters that likely cause the dampened model-computed water-level fluctuations are storage coefficient and areal recharge.

The increased water levels caused by the greater-than-normal precipitation of the mid-1980's were the most difficult to approximate in the transient-state calibration. Seven wells (D-14-2)13aaa-1, (D-15-3)8cda-3, (D-15-4)4dda-1, (D-15-4)31dab-1, (D-16-3)13dda-1, (D-17-3)30dbd-1, and (D-18-2)1daa-2 had smaller measured water-level changes than were computed by the model, whereas five wells, (D-14-3)31dad-1, (D-15-4)21cda-1, (D-17-2)1bca-2, (D-17-3)9cbd-1, and (D-17-3)20acc-1, had larger measured water-level changes than were computed for these years (fig. 22). In the northern half of the valley, the distribution of these wells is random. In the southern half, the three wells near Ephraim, (D-17-2)1bca-2, (D-17-3)9cbd-1, and (D-17-3)20acc-1, had larger measured than model-computed water-level increases, and the two wells north of Manti, (D-17-3)30dbd-1 and (D-18-2)1daa-2, had smaller measured than model-computed water-level increases. This data may reflect the model's inability to accurately simulate local heterogeneities in aquifer properties and local recharge.

Matching measured with model-computed water levels for the mid-1980's was difficult because of the large volume of recharge during this period. Values assigned to simulate areal recharge are not exact and could result in overestimating or underestimating recharge in some locations. The quantities and exact locations of the two main components of recharge, seepage from tributaries and infiltration of unconsumed irrigation water, are not accurately known. A simplifying assumption that could cause an error in the transient-state calibration is the application of a yearly percentage of the steady-state recharge uniformly over the entire model. Local-scale deviations, such as time-dependent variations in irrigation diversions, are unknown and, therefore, could not be included in the transient-state calibration. This inherent error could be magnified during a period of greater-than-normal precipitation.

Simulation of water levels during the late 1980's indicates that water-level declines could be caused in part by the conversion from flood to sprinkler irrigation. During initial transient-state calibrations, measured water levels were less than model-computed water levels during stress periods that represent the late 1980's. About 50 percent of the irrigated acreage in Sanpete Valley is estimated to have been converted from flood to sprinkler irrigation by the late 1980's, as discussed in the "Infiltration of unconsumed irrigation water" section in the "Ground-water hydrology" section of this report. If little or no recharge from uncon-

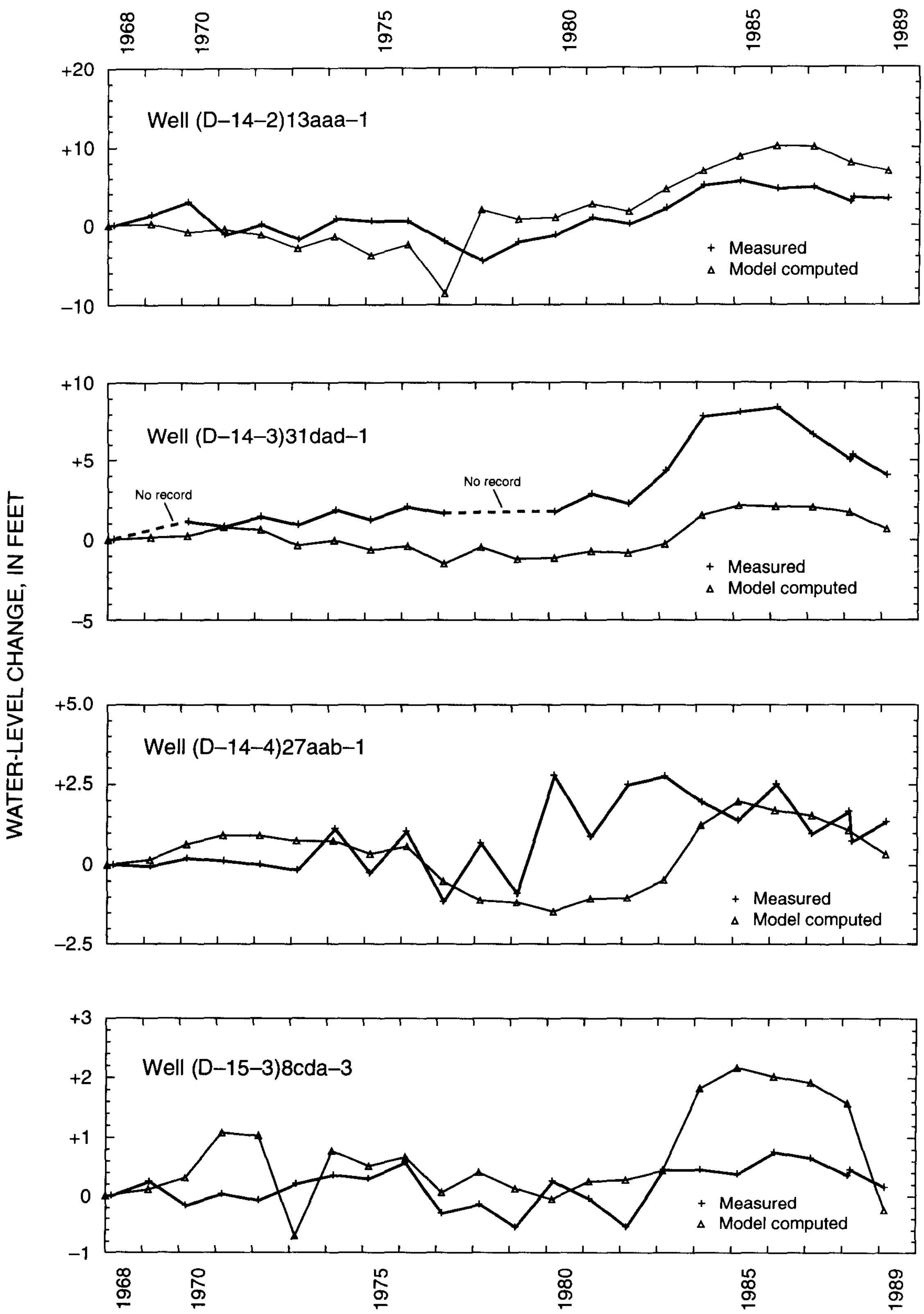

Figure 22. Measured and model-computed water-level changes in selected wells in Sanpete Valley, Utah, for the 1968-89 transient-state calibration.

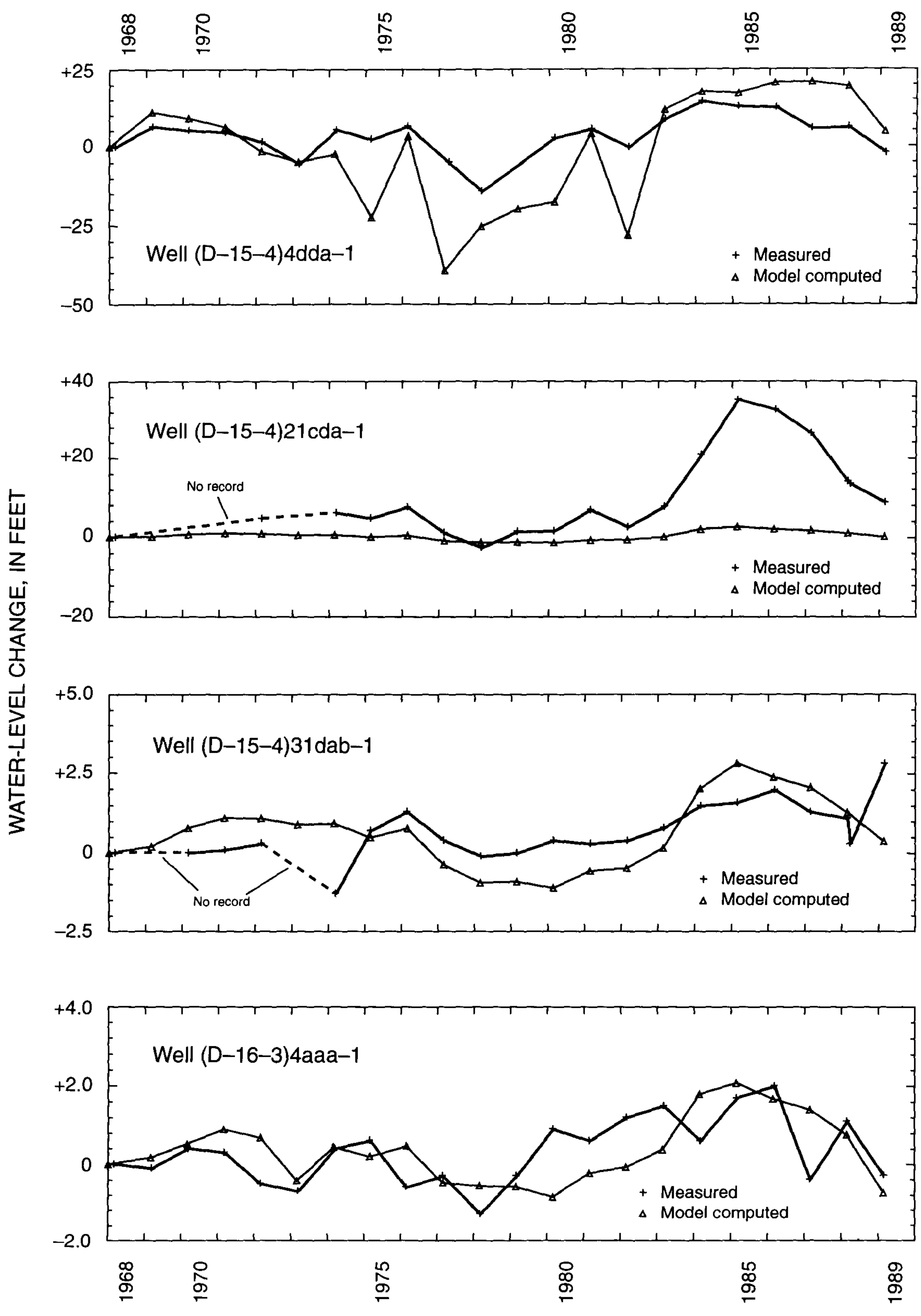

Figure 22. Measured and model-computed water-level changes in selected wells in Sanpete Valley, Utah, for the 1968-89 transient-state calibration—Continued.

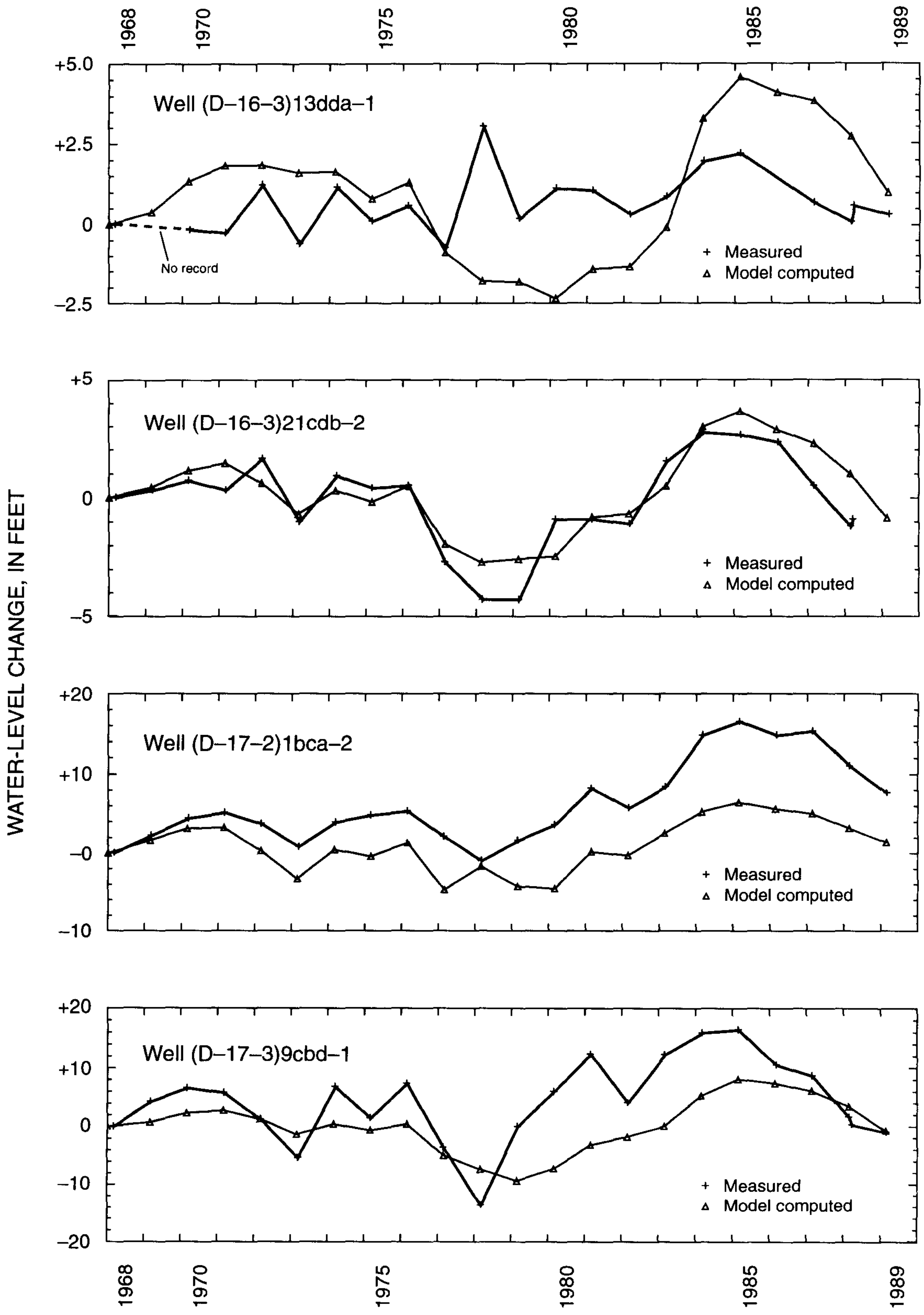

Figure 22. Measured and model-computed water-level changes in selected wells in Sanpete Valley, Utah, for the 1968-89 transient-state calibration—Continued.

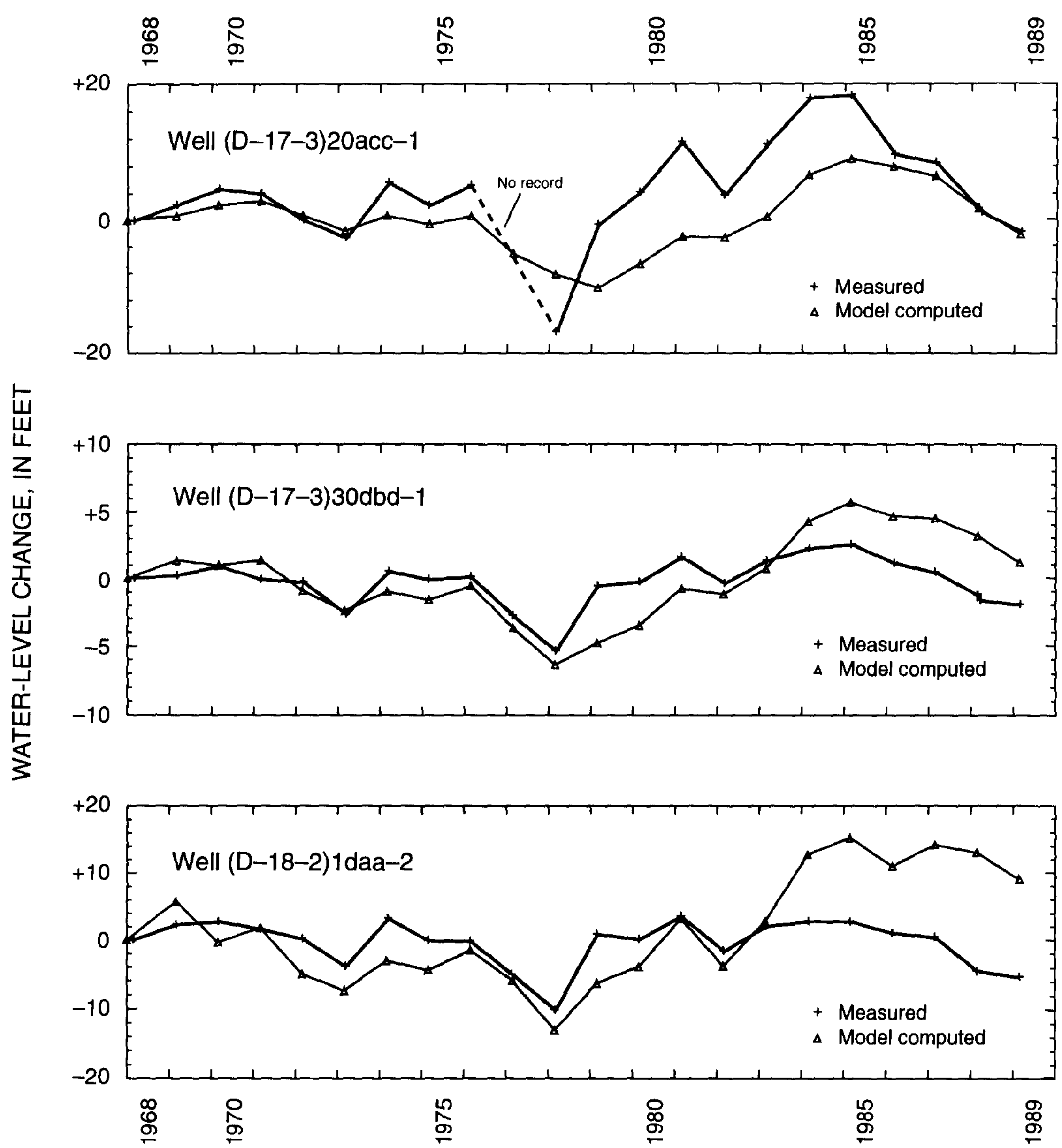

Figure 22. Measured and model-computed water-level changes in selected wells in Sanpete Valley, Utah, for the 1968-89 transient-state calibration—Continued.

sumed irrigation water is assumed to occur with sprinkler irrigation, then the decreased recharge could explain why measured water levels were less than model-computed water levels. To account for this conversion of irrigation methods that began in 1975, the proportion of total areal recharge that represents unconsumed irrigation water gradually was reduced. By 1989, the percentage of total areal recharge that represents unconsumed irrigation water was about half the percentage that was simulated in 1975. This change substantially improved the match between measured and model-computed water levels for the late 1980's. Although certain areas could be more affected than others, the conversion to sprinkler irrigation was fairly evenly distributed throughout the valley (L. Jorgensen and R. Mickelson, Soil Conservation Service, written commun., 1989); therefore, recharge from unconsumed irrigation water was decreased uniformly in the model.

Sensitivity Analysis

Sensitivity analysis was a continual process during calibration of the model to steady-state and transient-state conditions. Transmissivity values for layers 2 and 3 are fairly well constrained by aquifer-test and specific-capacity data, and ranges of estimates for these parameters are not large. No hydraulic-conductivity data were available for layer 1 and model-computed water levels and water budgets are very sensitive to changes in these values. Likewise, few data were available to define the vertical hydraulic connection between layers 1 and 2, and the model is very sensitive to order-of-magnitude changes for this parameter because of assumed low hydraulic conductivity at this boundary. Because a larger vertical hydraulic connection is assumed to exist between layers 2 and 3, water levels and water budgets are less sensitive to order-of-magnitude adjustments to this parameter.

Of the head-dependent recharge and discharge components, the model is most sensitive to adjustments of evapotranspiration rates and river-bed conductance values that represent the San Pitch River, and least sensitive to general-head boundary conductance and drain-conductance values. Widespread water-level rises resulted when the evapotranspiration rates and river-bed conductance values were decreased by one-half because of the large quantities of discharge simulated through these sources. Order-of-magnitude changes to the conductance of the general-head boundary, which represents inflow from the valley-fill material north of Fairview, caused large changes in the amount of inflow but had very little effect on overall model-computed water levels because of the relatively small importance of this source. Increasing drain-conductance values (representing alluvial springs) had little effect on the amount of discharge through drains and on model-computed water levels. The model, however, was sensitive to the assigned drain elevations. Decreasing the assigned elevations of the 10 drain cells each by 5 ft resulted in an increase in steady-state alluvial-spring discharge from 3,600 to 5,000 acre-ft/yr. Because these assigned elevations generally were interpolated from 10-ft contours on 1:24,000 topographic maps, modifying the assigned values was not considered. If field survey data for the spring elevations is collected in the future, the assigned elevations in the Drain Package could be modified.

During calibration of the model to transient-state conditions, storage-coefficient values for layers 2 and 3 were varied by an order of magnitude and had little effect on water levels or budget terms. The model was not sensitive to changes in storage-coefficient values because of the confined conditions of these model layers. Variation of specific-yield values in layer 1 by a factor of 2, however, caused substantial changes in simulated water levels.

Because of the uncertainty regarding the hydraulic connection between the valley-fill aquifer and consolidated rock, test simulations were designed in which recharge was increased to simulate subsurface inflow from consolidated rock. The Well Package was used to inject additional recharge (between about 40,000 to 80,000 acre-ft/yr) into 269 cells along the perimeter of model layers 2 and 3. Although there is no direct evidence of subsurface inflow from bedrock, the possibility exists that such a form of recharge could occur. This increase in recharge caused the water table and potentiometric surfaces in all three layers to rise to much higher levels than were measured. Attempts were made to lower the mean of the computed water levels back toward measured values. This included (1) increasing the discharge to alluvial springs and to the San Pitch River by increasing conductance values and lowering defined elevations; (2) reversing the assigned hydraulic conductivity values for layer 1 such that the largest values were along the edges of Sanpete Valley and the smallest values were along the center of the valley; and (3) increasing the assigned values for vertical conductance by an order of magnitude along the edges of the valley. None of these alternative simulations with simulated recharge as subsurface inflow yielded satisfactory approximations to measured water levels. If in the future, additional data were collected showing that subsurface inflow is an important component of recharge to the valley-fill aquifer, then users of the model should consider implementing other changes such as decreasing the amount of recharge added to layer 1 by the Recharge Package in order to better accommodate the addition of simulated subsurface inflow.

Limitations of the Model

The model that was developed to simulate ground-water flow in the valley-fill aquifer of Sanpete Valley represents one non-unique solution for the specified inputs and the geohydrologic discretization. Because the model is a simplification of a complex hydrologic system and because many of the values used in the model were estimated or determined during model calibration to steady-state and transient-state conditions, other combinations of budget quantities and hydrologic properties could produce similar results. Likewise, the incorporation of any data outside the specified range of recharge values, discharge values, and hydrologic properties could produce different results. Such changes need to be undertaken with caution. Major limitations of the Sanpete Valley ground-water model are (1) the consolidated-rock aquifer and/or subsurface inflow was not simulated by the model; and (2) the lack of measured data for certain recharge and discharge components of the ground-water budget and certain hydrologic properties.

Although there is no direct evidence or any means of quantifying recharge as subsurface inflow directly from consolidated rock to the valley-fill aquifer, indirect evidence indicates that such recharge could be occurring in certain areas of Sanpete Valley. Robinson (1971, p. 22-23) cites indirect evidence for subsurface inflow in the Silver Creek drainage of Sanpete Valley. Robinson noted that pumped wells in this area discharge more water than can be accounted for by recharge from tributaries. He also mentions that hydrographs of wells in this area do not exhibit an abrupt rise in water level during spring runoff as do most wells elsewhere in the valley. He concluded that if the primary source of recharge was from highly variable surface-water sources, then seasonal water-level fluctuations in wells would be greater.

Water levels in wells finished in consolidated rock also may indicate the possibility of recharge from consolidated rock. Pigeon Hollow well (D-16-4)18bac-1, which is open-ended at 90 ft in the valley-fill aquifer, had a measured water level of 66.83 ft below land surface or about 5,872 ft above sea level on November 9, 1989. Nearby well (D-16-4)18bac-2, which is perforated from 165 to 205 ft in the consolidated-rock aquifer, had a measured water level of 60.42 ft below land surface or about 5,884 ft above sea level (tables 8 and 9). These water levels indicate an upward vertical gradient of about 0.14 ft/ft. Water levels in two additional flowing wells open to consolidated rock also indicate a potential for recharge to the valley-fill aquifer. Well (D-14-4)1acb-1 in Fairview is cased in consolidated rock and was flowing at land surface during November 1989. The valley-fill aquifer at this location is assumed to be unconfined, which indicates that the vertical gradient is upward between the underlying consolidated-rock aquifer and the overlying valley-fill aquifer. Well (D-15-3)14bdb-1, southeast of Moroni, is located on an isolated, consolidated-rock outcrop in Sanpete Valley. The well is perforated in the Flagstaff Limestone at a depth of 2,280 to 2,406 ft below land surface and had a measured pressure head that equates to a water level of 790 ft above land surface in May 1980 (State of Utah Engineer's Office, written commun., 1980). However, the high water pressure in this consolidated-rock aquifer may also indicate that upward vertical flow is being prevented by a confining layer between it and the valley-fill aquifer. For recharge as subsurface inflow to occur, there must also be a hydraulic connection between the consolidated and valley-fill aquifers; such a connection has not been verified.

Errors could be introduced into the model in areas that could be influenced by recharge from consolidated rock and could affect the results of future predictive simulations. In areas where recharge of this type could occur, the drawdowns from increased stresses during predictive simulations could be dampened to some extent in the valley-fill aquifer. Interpretative discretion is advised for use of the model to determine probable effects of specified stresses for those areas near consolidated-rock contacts such as the Silver Creek drainage, Pigeon Hollow, and Fairview.

Important limitations to the accuracy of the computer model are a result of the paucity of data for certain ground-water budget components and hydrologic properties. Because the estimated range for overall recharge (74,000 to 103,000 acre-ft/yr) is smaller and perhaps better constrained than the estimated range for overall discharge (76,000 to 224,000 acre-ft/yr), the computer model was calibrated to reflect this smaller ground-water budget. However, seepage from the San Pitch River is the only measured recharge component. All the other recharge components are estimated and include infiltration of precipitation on the valley floor, seepage from tributaries, and infiltration of unconsumed irrigation water. Evapotranspiration, the major discharge component, is not accurately quantified. Other discharge components, including seepage to the San Pitch River, flowing-well discharge, and alluvial-spring discharge, were not measured seasonally or yearly; therefore, the steady-state and transient-state calibrations were based on estimated ranges of these budget components. Likewise, vertical and horizontal hydraulic-conductivity values in the shallow part of the aquifer are not well defined in the model because of the lack of aquifer-test data.

The difficulty in the approximation of measured water levels with the transient-state calibration during the mid-1980's could be caused by several simplifying assumptions, which include the uniform application of a yearly percentage of steady-state recharge and the distribution of hydrologic properties in the model. The model does not closely approximate actual heterogeneities in hydrologic properties, which control downward leakage of surface water to the valley-fill aquifer and lateral ground-water movement within the aquifer.

Another limitation of the transient-state calibration is the simplifying assumption of constant flowing-well discharge. To simplify the model-computed water-budget analysis and because the yearly fluctuation of flowing-well discharge is unknown, a constant amount is simulated with the Well Package (McDonald and Harbaugh, 1988, chap. 8). If data were collected to quantify this fluctuation, it could provide another refinement tool in the transient-state calibration by switching flowing wells to the head-dependent Drain Package (McDonald and Harbaugh, 1988, chap. 9). In the transient-state calibration, maximum drawdown in cells that represent flowing wells is not large enough to lower the water levels of these flowing wells below land surface; therefore, simulating flowing wells as a specified-flux boundary is an accurate approximation. However, if additional stresses are included during future predictive simulations (such as changes in the distribution and amount of well pumpage, drought conditions more severe than those simulated between 1967 and 1989, or additional changes in irrigation practices) that cause water-level declines of more than 10 ft in the flowing-well area, then the flowing wells would need to be simulated with the Drain Package so that a subsequent decrease in flowing-well discharge could be accurately simulated.

Additional information that could improve the accuracy of the model includes (1) seepage studies along the entire reach of each perennial tributary; (2) measurement of discharge from intermittent and ephemeral tributaries; (3) accurate diversion records for all water removed from natural stream channels for irrigation; (4) complete seasonal flowing-well inventories; (5) complete spring inventories during seasons of high and low evapotranspiration potential; (6) aquifer-test data to further refine simulated transmissivity values in model layers 2 and 3, as well as for the shallow part of the valley-fill aquifer (the upper 50 ft of saturated thickness beneath the water table) to further refine simulated hydraulic-conductivity values in layer 1; and (7) multiple-well aquifer tests to better define vertical hydraulic-conductivity values for the valley-fill aquifer and to explore the possibility of a hydraulic connection between the valley-fill and consolidated-rock aquifer.

Simulation of Increased Ground-Water Withdrawals

To determine possible effects of future increases in ground-water withdrawals in Sanpete Valley, three separate hypothetical stresses were simulated. The hypothetical stresses were (1) doubling the average 1963-88 pumped-well withdrawals from 6,300 acre-ft/yr to 12,600 acre-ft/yr for a 20-year period with average recharge; (2) tripling the average 1963-88 pumped-well withdrawals from 6,300 acre-ft/yr to 18,900 acre-ft/yr for a 20-year period with average recharge; and (3) tripling the average 1963-88 pumped-well withdrawals from 6,300 acre-ft/yr to 18,900 acre-ft/yr for a 5-year period with 75 percent of average recharge. The first two hypothetical stresses were developed to simulate the effects to the ground-water system of increased pumped-well withdrawals and average precipitation. These two simulations use the same Recharge Package as the steady-state calibration, which assumes the use of flood-irrigation methods. The Recharge Package could be altered to reflect sprinkler-irrigation methods for the predictive simulations by reducing the recharge component that represents infiltration of unconsumed irrigation water. The third hypothetical stress was developed to simulate the effects of increased pumped-well withdrawals during a 5-year period of less-than-average precipitation and associated reduced recharge. For all three stresses, the distribution of the 55 pumping wells remained the same as in the transient-state calibration. This distribution was based on the assumption that increased withdrawals would be in approximately the same areas as present pumping locations (J. Olds, Utah Department of Natural Resources, Division of Water Rights, written commun., 1990).

For the two 20-year simulations, one 20-year stress period was used with 1-year time steps. For the 5-year simulation, one 5-year stress period was used with 1-year time steps. A time-step multiplier of 1.0 was used for all three simulations. Model-computed water levels from the steady-state calibration were used as the starting heads for all three predictive simulations because the steady-state calibration is assumed to represent average hydrologic conditions. Water-level records (table 9) do not indicate any long-term trends of increasing or decreasing water levels in Sanpete Valley.

The distribution of water-level declines in layer 2 caused by doubling and tripling the well pumpage for a 20-year period occur in similar areas; however, the magnitude of the water-level decline is at least twice as large for the tripled pumping rates. Because the distribution of water-level declines in layer 2 for both simulations was similar, only the declines associated with tripling the well pumpage are shown (fig. 23). The largest water-level decline for both simulations occurs along the eastern edge of the Silver Creek drainage, near the town of Fountain Green; a decline of about 30 ft was caused by doubling the pumped-well withdrawals and about 70 ft by tripling the pumped-well withdrawals. The second largest water-level declines occur southwest of Mount Pleasant, with about 20 ft of water-level decline caused by doubling the pumped-well withdrawals and about 40 ft of water-level decline caused by tripling the pumped-well withdrawals. West of Manti, water-level declines of about 10 ft are caused by doubling the pumped-well withdrawals and of about 20 ft by tripling the pumped-well withdrawals.

The three areas of largest water-level declines have large pumped-well withdrawals (figs. 13 and 14) and low transmissivity values (figs. 18 and 19). The specified transmissivity value for the areas along the eastern edge of the Silver Creek drainage and southwest of Mount Pleasant is 1,000 ft^2/d. Similarly, simulated transmissivity values for the area west of Manti are about 2,000 ft^2/d. In contrast, the Moroni area has large pumped-well withdrawals but the total simulated transmissivity value for layers 2 and 3 is about 20,000 ft^2/d, which results in less than 10 ft of water-level decline caused by tripling the pumped-well withdrawals. Similarly, the area surrounding Ephraim has large pumped-well withdrawals and the simulated transmissivity values are approximately 20,000 ft^2/d, which result in less than 10 ft of water-level declines caused by tripling the pumped-well withdrawals.

The distribution of water-level declines in layer 2 caused by tripling the average 1963-88 pumped-well withdrawals for a 5-year drought with 75 percent of simulated steady-state recharge (fig. 24) is similar to the distribution of water-level declines caused by the 20-year hypothetical stresses with increased pumped-well withdrawals and average recharge. The magnitude of water-level declines is between the values reported previously for the doubled and tripled pumped-well withdrawal rates. Water-level declines along the eastern edge of the Silver Creek drainage are as much as 52 ft; water-level declines in the area southwest of Mount Pleasant are about 40 ft; and water-level declines west of Manti are about 20 ft. One difference in the drawdown distribution for this 5-year simulation of less-than-average recharge is a water-level decline up to 10 ft on the east side of the valley along the major tributaries near Fairview, south of Spring City, and near Manti. These declines are the direct result of decreased recharge because no large well withdrawals are simulated in these areas.

The model-computed water-level declines cause a decrease in head-dependent discharge and an increase in head-dependent recharge, such as seepage from the San Pitch River (table 5). Discharge by evapotranspiration decreases from 48,000 acre-ft/yr in the steady-state calibration to between 38,800 and 45,100 acre-ft/yr in the predictive simulations. Discharge as seepage to the San Pitch River decreases from 17,200 acre-ft/yr in the steady-state calibration to between 13,200 and 16,000 acre-ft/yr in the predictive simulations. Discharge from alluvial springs decreases from 3,600 acre-ft/yr in the steady-state calibration to between 2,400 and 3,100 acre-ft/yr in the predictive simulations. Recharge as seepage from the San Pitch River in the losing reaches increases from 400 acre-ft/yr in the steady-state calibration to between 500 and 1,000 acre-ft/yr in the predictive simulations.

An analysis of all three predictive simulations shows that increased well withdrawals do not lower water levels substantially in the flowing-well areas. Water-level declines at cells that represent flowing-well locations were compared with measured flowing-well water levels (above land surface). In both 20-year simulations, water-level declines are not large enough to stop any flowing-well discharge. In the 5-year simulation with reduced recharge, water-level declines would

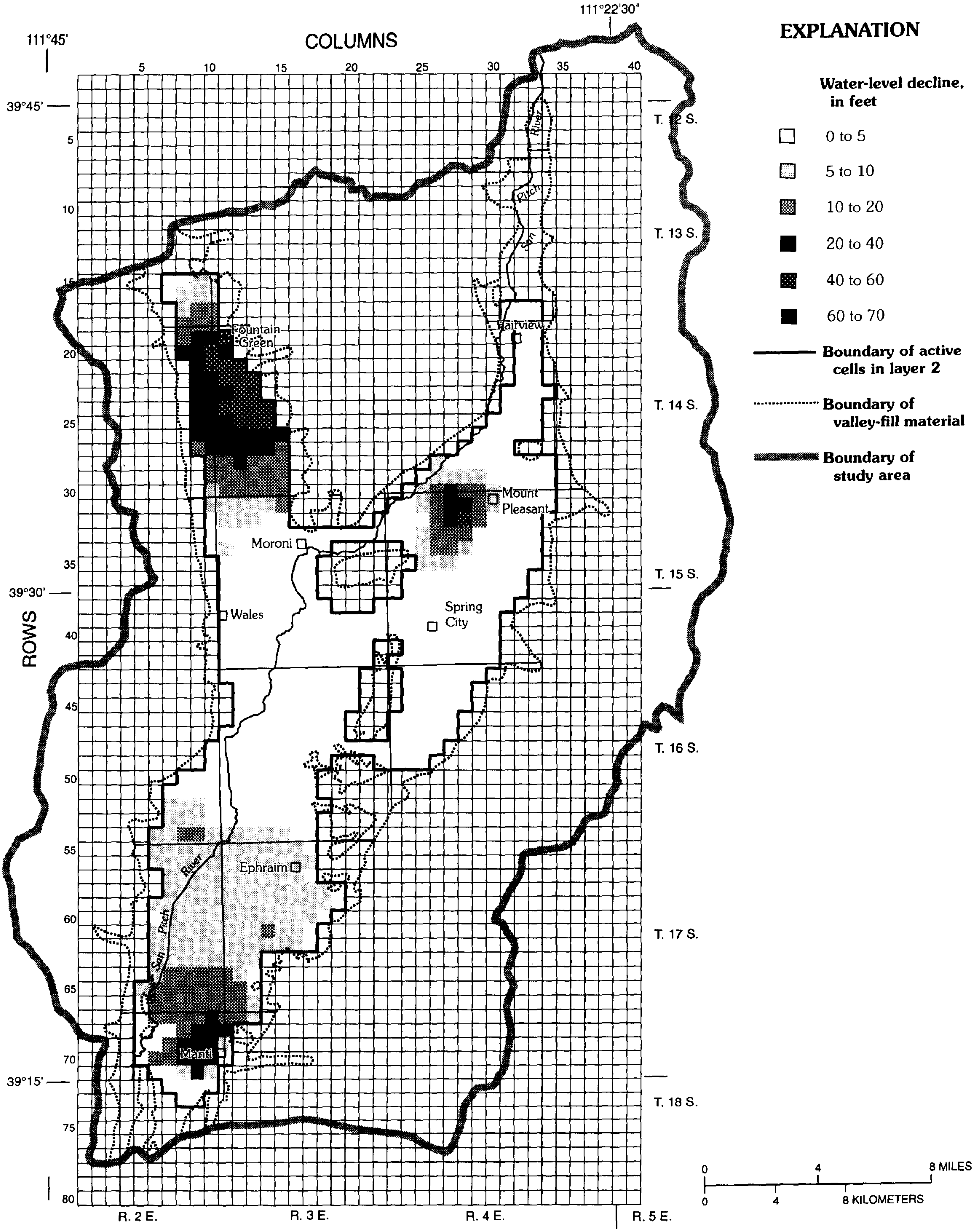

Figure 23. Model-computed water-level decline in layer 2 resulting from simulated pumping at triple the average 1963-88 rates for 20 years, Sanpete Valley, Utah.

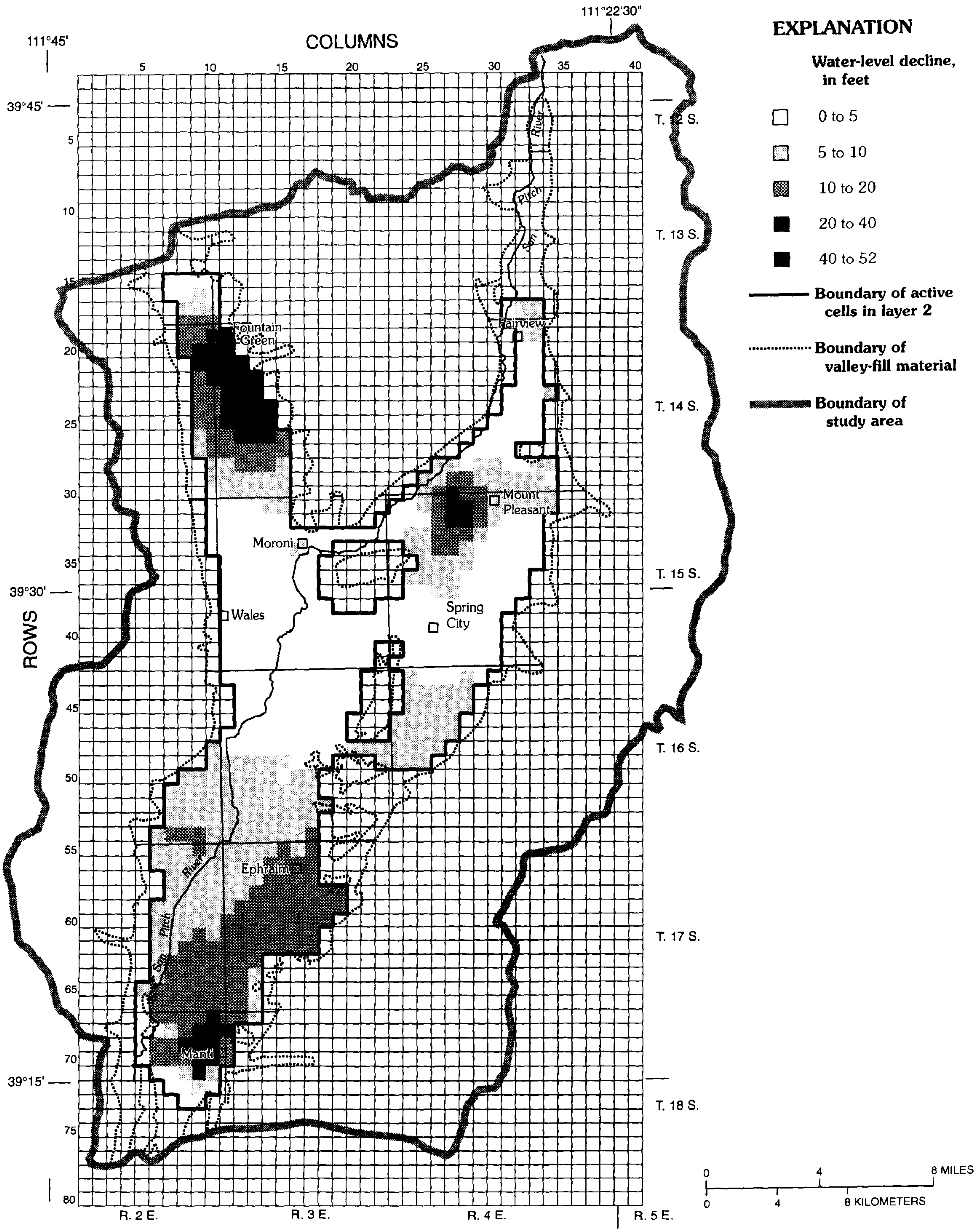

Figure 24. Model-computed water-level decline in layer 2 resulting from simulated pumping at triple the average 1963-88 rates for a 5-year drought with 75 percent of simulated steady-state recharge, Sanpete Valley, Utah.

have caused about a 7-percent decrease in flowing-well discharge. If additional predictive simulations cause larger water-level declines in the flowing-well areas and substantial drying up of flowing wells, the affected flowing wells should be removed from the Well Package or be simulated with the head-dependent Drain Package to accurately simulate this reduction of discharge from the valley-fill aquifer. Also, it should be noted that by simulating flowing wells with the Well Package, the results for the predictive simulation are conservative from a water management perspective. Drawdowns computed from the projected simulations may be larger in the flowing-well area than if the flowing wells had been simulated with the Drain Package.

If the model were altered in the future to simulate recharge as subsurface inflow from consolidated rock, then this additional recharge would offset the increased pumpage during the predictive simulations. Therefore, increasing recharge would most likely reduce the amount of drawdown projected during the predictive simulations.

SUMMARY

The 670-mi^2 study area in central Utah is defined by the San Pitch River drainage, which drains into Gunnison Reservoir. About 240 mi^2 of the study area consists of unconsolidated valley-fill material in Sanpete

Table 5. Model-computed components of the ground-water budget for the steady-state calibration and predictive simulations in the valley-fill aquifer, Sanpete Valley, Utah

[values in acre-feet per year]

Component	Steady-state calibration	20-year simulation at doubled pumping rates	20-year simulation at at tripled pumping rates	5-year simulation at tripled pumping rates with 75 percent of steady-state recharge
		Recharge		
Seepage from tributaries	34,500	34,500	34,500	25,900
Seepage from the San Pitch River	400	500	700	1,000
Infiltration of unconsumed irrigation water	29,000	29,000	29,000	21,800
Infiltration of precipitation on the valley floor	15,000	15,000	15,000	11,200
Subsurface inflow from the valley-fill aquifer north of Fairview	200	200	200	200
Total recharge (rounded)	79,000	79,000	79,000	60,000
		Discharge		
Evapotranspiration	48,000	45,100	41,500	38,800
Seepage to the San Pitch River	17,200	16,000	15,000	13,200
Withdrawals from wells				
Pumped wells	6,300	12,600	18,900	18,900
Flowing wells	4,000	4,000	4,000	4,000
Alluvial-spring discharge	3,600	3,100	2,800	2,400
Total discharge (rounded)	79,000	81,000	82,000	77,000
		Change in storage (rounded)		
	0	-2,000	-3,000	-17,000

Valley. The valley-fill material consists primarily of fine-grained silt and clay in the center of the valley and becomes progressively more coarse near the mountain fronts, especially near the mouths of tributaries. Thickness of the valley-fill material generally reaches a maximum of 300 to 500 ft.

Normal annual precipitation ranges from about 10 in/yr for valley areas south of Moroni to about 40 in/yr near the crest of the Wasatch Plateau. Normal annual precipitation for the entire study area is about 16 in/yr. Precipitation on the Wasatch Plateau is more significant to the agricultural practices in Sanpete Valley than precipitation on the valley floor because most of the water used to irrigate crops is diverted from surface-water runoff.

The San Pitch River begins near Oak Creek Ridge on the northern Wasatch Plateau and flows westward and southward through Sanpete Valley. The San Pitch River flows out of the study area at the southwestern boundary into Gunnison Reservoir. Most of the normally perennial tributaries in the study area originate in the Wasatch Plateau. Tributary inflow from the San Pitch Mountains is less in volume than tributary inflow from the Wasatch Plateau because of the lower altitude, which results in a smaller snowpack and less runoff.

Estimates of the amount of surface-water inflow are derived from data collected at five gaging stations located on tributaries to the San Pitch River. Perennial tributary inflow from the Wasatch Plateau was estimated from a regression equation that related drainage areas to average annual discharge for the five gaged tributaries. Estimated average annual inflow to Sanpete Valley was about 137,000 acre-ft/yr for tributaries that drain the Wasatch Plateau and about 15,000 acre-ft/yr for tributaries that drain the San Pitch Mountains and Cedar Hills.

Specific conductance of water in the San Pitch River generally increases downstream from about 700 μS/cm north of Fairview to 1,560 μS/cm or greater near the inflow to Gunnison Reservoir. Sources of water with high specific-conductance values that discharge to the river include flowing wells drilled into consolidated rock northwest of Mount Pleasant and seepage to the San Pitch River from shallow ground-water flow systems in the Moroni-Chester area and southwest of Ephraim.

Southwest of Ephraim, water in the San Pitch River upstream from Maple Canyon and in nearby shallow wells had high specific-conductance values. Water in this local ground-water flow system recharges along nearby Arapien Shale outcrops in the San Pitch Mountains and discharges to the San Pitch River. A decrease in the dissolved-solids concentration in the river from sites upstream from Maple Canyon to sites near Manti results from dilution by inflow from flowing wells and irrigation-return flows. These inflows to the river have a lower dissolved-solids concentration, though the San Pitch River near Manti still has high concentrations of sodium, sulfate, and chloride.

Of the 144 pumped or flowing wells with field measurements of specific conductance during 1987-90, water from 124 wells had specific-conductance values less than 1,000 μS/cm. The values are lowest in wells near the boundary between the valley-fill material and mountain fronts of the Wasatch Plateau and San Pitch Mountains and increase downgradient. Water with higher specific-conductance values primarily is concentrated in two areas of the valley. One area is downgradient from outcrops of lacustrine and fluvial deposits of the Green River and Crazy Hollow Formations of Tertiary age along the east side of the main valley from Chester to Pigeon Hollow. Wells in this area generally are less than 200 ft deep. The other area is downgradient from outcrops of evaporite deposits of the Arapien Shale of Jurassic age on the west side of the main valley from near Big Mountain southward to near the mouths of Axhandle and Rock Canyons.

In the study area, ground-water occurs in valley-fill material and in consolidated rock of Tertiary age and older. Depth to water in the valley-fill aquifer ranges from about 10 ft in shallow wells in the center of the valley to 88 ft along the alluvial slopes at the base of the Wasatch Plateau. Little is known about the underlying consolidated-rock aquifers and the hydraulic connection with the overlying valley-fill aquifer. Consolidated-rock aquifers supply locally large quantities of water to springs in the mountains and along the western edge of Sanpete Valley.

Total recharge to the valley-fill aquifer is estimated to average between 74,000 and 103,000 acre-ft/yr. Four possible sources of recharge to the valley-fill aquifer are (1) seepage from tributaries and the San Pitch River; (2) infiltration of unconsumed irrigation water; (3) infiltration of precipitation on the valley floor; and (4) subsurface inflow from consolidated rock. Recharge to valley-fill aquifer as seepage from tributaries is estimated to be between 28,500 and 57,000 acre-ft/yr. Also, a small amount of seepage (between 1,500 and 1,800 acre-ft/yr) from the San Pitch River was determined from seepage studies in 1966 and 1988. Recharge from infiltration of unconsumed irrigation water is estimated to be about 29,000 acre-ft/yr.

Recharge from infiltration of precipitation on the valley floor is estimated to be about 15,000 acre-ft/yr.

An upward vertical gradient of 0.14 ft/ft between the underlying consolidated rock and the valley-fill material at two wells in Pigeon Hollow indicate potential recharge from consolidated rock. To have actual inflow of ground water from consolidated rock, however, the hydraulic conductivity across the contact between consolidated rock and valley-fill material must be large enough to permit the flow of ground water. No information about this hydraulic connection has been obtained for this area; therefore, subsurface inflow from consolidated rock has not been quantified.

Total discharge from the valley-fill aquifer is estimated to average between 76,000 and 224,000 acre-ft/yr. The four principal sources of discharge are (1) evapotranspiration; (2) seepage to the San Pitch River; (3) withdrawals from wells; and (4) alluvial-spring discharge. The amount of discharge as evapotranspiration from the valley-fill aquifer is estimated to be between 41,000 and 116,000 acre-ft/yr. The amount of discharge as seepage to the San Pitch River is estimated to be between 18,500 and 80,300 acre-ft/yr. Withdrawal from pumped wells is between about 1,200 and 12,800 acre-ft/yr. Estimated discharge from flowing wells is about 4,000 acre-ft/yr. Alluvial-spring discharge is estimated to be as much as 11,000 acre-ft/yr.

Transmissivity and storage-coefficient data were determined during this study from the reanalysis of aquifer-test data from one well in the valley-fill aquifer, which indicated a transmissivity value of 1,700 ft^2/d and a storage-coefficient value of 6.1×10^{-5}. Transmissivity values determined from specific-capacity values from 16 wells in the valley-fill aquifer ranged from 500 to 16,000 ft^2/d. The horizontal hydraulic-conductivity value, determined from the aquifer-test transmissivity value was 10 ft^2/d. Horizontal hydraulic-conductivity values determined from specific-capacity data ranged from 6 to 99 ft/d. The vertical hydraulic-conductivity value was determined from aquifer-test data at one location to be 0.06 ft/d.

A three-dimensional ground-water flow model was used to simulate present ground-water conditions and the possible effects of additional withdrawals on the valley-fill aquifer in Sanpete Valley. The aquifer is assumed to be in a general steady-state condition because no long-term changes in water levels or storage have occurred; therefore, the model was calibrated to steady-state conditions that represent average hydrologic conditions. The model was then calibrated to transient-state conditions to simulate ground-water flow in the valley-fill aquifer from 1967 to 1989.

Steady-state conditions were simulated by calibrating to measured or estimated components of the ground-water budget and to measured water levels. Measured budget components include San Pitch River seepage, pumped- and flowing-well discharge, and alluvial-spring discharge. The mean difference between measured and model-computed water levels of the calibrated steady-state model was -1.4 ft, with a standard deviation of 19.8 ft for 184 observation wells. The largest differences between measured and model-computed water levels occur in the areas of steep hydraulic gradient along the eastern edge of Sanpete Valley and the northern parts of the Silver Creek and San Pitch River drainages.

Net simulated steady-state discharge from the valley-fill aquifer to the San Pitch River is about 16,800 acre-ft/yr, which closely approximates the net discharge measured during October 1988. The amount of alluvial-spring discharge simulated by the model is 3,600 acre-ft/yr, which is much less than the 11,000 acre-ft/yr of alluvial-spring discharge reported for 1965-67. One possibility for the lower-than-estimated amount of simulated alluvial-spring discharge is that springs south of Fairview and near Moroni are supplied by subsurface inflow from consolidated rock.

The model was calibrated to transient-state conditions to approximate measured water-level fluctuations at 16 observation wells throughout Sanpete Valley. Simulated recharge was varied on the basis of precipitation at four climatic stations on the Wasatch Plateau. To simulate measured water-level declines during the late 1980's, the amount of recharge from unconsumed irrigation water was reduced. This decrease is based on the assumption that the conversion from flood to sprinkler irrigation, which includes about 50 percent of all irrigated land, causes a reduction in recharge to the valley-fill aquifer.

Predictive simulations were used to determine possible effects of additional withdrawals in Sanpete Valley. Simulations included both doubling and tripling average pumped-well withdrawals for 20 years, as well as tripling average pumped-well withdrawals for a 5-year period with 75 percent of simulated steady-state recharge. The largest predicted simulated water-level declines are along the eastern edge of the Silver Creek drainage (about 30 to 70 ft of decline) and southwest of Mount Pleasant (about 20 to 40 ft of decline). These declines occurred because of large simulated withdrawals and relatively small simulated transmissivity values. The simulated water-level declines cause a decrease in head-dependent discharge (evapotranspiration, seepage to the San Pitch River, and alluvial-springs discharge), and an increase in head-dependent seepage from the San Pitch River.

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Table 6. Discharge, specific conductance, and temperature of water from selected surface-water sites and springs, Sanpete Valley, Utah

[—, no data]

Location: See figure 2 for an explanation of the numbering system for hydrologic-data sites; letter S following sequence number indicates a spring.
Discharge: gal/min, gallons per minute; (e), estimated.
Specific conductance: μS/cm, microsiemens per centimeter at 25 degrees Celsius, measured in field except where noted L, laboratory value.
Temperature: °C, degrees Celsius.
Remarks: Includes a description of the site or measuring point.

Location	Date	Discharge (gal/min)	Specific conductance (μS/cm)	Temperature (°C)	Remarks
(D-13-4)14aba	10-04-88	70	960	—	San Pitch River; inflow from the west.
	05-02-89	—	1,050	13.0	
(D-13-4)14aba	10-04-88	157	760	—	San Pitch River; measured at eastern culvert.
	05-02-89	—	760	10.0	
(D-14-2)2bab-S1	04-24-89	3,320	430	11.5	Big Springs, west of Fountain Green.
	06-06-89	4,170	460	12.0	Do.
	08-22-89	3,600	430	12.0	Sample collected; results of chemical analysis in table 11.
(D-14-2)23adb	04-24-89	80	540	12.0	Birch Creek.
	09-28-89	357	540	13.5	Do.
(D-14-2)23bda-S1	04-24-89	6.45	800	10.0	Birch Creek Springs.
(D-14-2)34dbb-S1	04-25-89	16.7	75	6.5	Westernmost spring at forks in Maple Canyon that discharges from 2-inch PVC pipe.
	09-28-89	4.6	110	8.0	Do.
(D-14-2)34dbb-S2	04-25-89	30	110	7.0	Northernmost spring at forks in Maple Canyon that discharges from 8-inch PVC pipe.
	09-28-89	dry	—	—	Do.
(D-14-2)35dac	04-25-89	224	140	11.0	Maple Canyon, at mouth.
	09-28-89	dry	—	—	Do.
(D-14-3)29cad	04-24-89	395	1,320	16.0	Silver Creek, upstream from spring area.
	06-06-89	167	1,220	23.0	Do.
	07-25-89	39	920	22.5	Do.
	09-28-89	45 (e)	980	23.0	Do.
(D-14-4)2cba	03-03-89	—	750	9.0	San Pitch River, near Fairview.
	07-24-89	817	770 L	14.0	Sample collected; results of chemical analyses in table 7.
(D-14-4)22cda	10-05-88	176	1,130	13.0	Inflow to San Pitch River.
(D-14-4)28ada	10-05-88	34	1,290	13.0	Inflow to San Pitch River.
(D-14-5)32c	09-29-89	705	395	14.5	Cove Creek, at headgate near mouth.
(D-15-2)2ada-S1	04-25-89	4.4	540	10.5	Freedom Spring.
(D-15-2)13bbc-S1	04-25-89	27	510	16.5	Brewers Spring.
	09-28-89	24	470	17.0	Do.

Table 6. Discharge, specific conductance, and temperature of water from selected surface-water sites and springs, Sanpete Valley, Utah—Continued

Location	Date	Discharge (gal/min)	Specific conductance (μS/cm)	Temperature (°C)	Remarks
(D-15-2)25bca	09-27-89	256	640	13.5	Wales Canyon, at mouth.
(D-15-3)8dcb	04-25-89	3,383	870	6.5	Silver Creek downstream from spring area; subtract discharge from Silver Creek upstream from spring area for indication of discharge from spring area west of Moroni. Discharge includes that from Prestwich and Duck Springs located to the west.
	06-06-89	1,942	750	23.0	No flow in Eliasons ditch.
	07-25-89	1,876	650	18.5	Discharge includes measured flow in Eliasons ditch.
	09-28-89	2,492	720	17.0	Do.
(D-15-3)10ddc	10-05-88	274	1,370	12.5	San Pitch River, east of Moroni.
(D-15-3)16dca	10-05-88	480	1,150	14.0	San Pitch River, south of Moroni.
(D-15-3)32baa	08-12-88	—	1,480	18.0	Silver Creek Ditch.
	06-07-89	2,830	1,390	16.0	Do.
(D-15-3)33bbb	08-12-88	—	1,360	22.0	San Pitch River, west of Chester.
	10-05-88	615	1,200	8.0	Do.
	06-07-89	—	1,480	12.0	Do.
	09-27-89	—	1,160	23.0	Do
(D-15-4)6bad (10210500)	08-12-88	—	990	20.5	San Pitch River, near Mount Pleasant at U.S. Geological Survey gage.
	03-08-89	—	820	6.0	
	07-25-89	5,441	1,000	24.0	Sample collected; results of chemical analysis in table 7.
(D-15-4)8acd-S1	05-03-89	144	750	11.5	Outflow from spring area in section 8; local residents say flow was nonexistent before the Mount Pleasant sewage ponds were built.
(D-15-4)11d	09-29-89	1,100 (e)	430	11.0	Twin Creek, on county road southeast of Mount Pleasant.
(D-15-4)29dcb-S1	04-04-89	6.0	620	10.0	Spring City Spring adjacent to service station.
(D-15-5)5d (10210000)	09-29-89	4,500 (e)	470	12.0	Pleasant Creek, at water-users gage; near former U.S. Geological Survey gage.
(D-16-2)1acb	08-12-88	—	860	16.0	Petes Canyon diversion at mouth.
	09-27-89	100	840	17.5	Do.
(D-16-2)13aab	08-12-88	109	3,020	15.5	Silver Creek Canal.
(D-16-3)4dcc	05-06-89	—	1,080	13.0	Oak Creek, southwest of Chester and upstream from inflow to the San Pitch River.
(D-16-3)6dcd	08-12-88	—	1,470	19.0	Silver Creek Ditch.
(D-16-3)7aaa	08-12-88	—	1,110	18.5	West Point Canal.

Table 6. Discharge, specific conductance, and temperature of water from selected surface-water sites and springs, Sanpete Valley, Utah—Continued

Location	Date	Discharge (gal/min)	Specific conductance (μS/cm)	Temperature (°C)	Remarks
(D16-3)8cbc	10-04-88	155	3,720	12.0	San Pitch River, southwest of Chester.
	10-05-88	171	3,800	10.5	
	10-06-88	160	3,550	11.0	
(D-16-3)21ccc	09-01-88	—	1,530	18.5	Oak Creek, southwest of Pigeon Hollow.
(D-16-3)32abb-S1	11-09-89	83	1,180	2.0	Johnson Spring outflow.
(D-16-4)1cdc (10215700)	09-29-89	3,869	445	6.5	Oak Creek, near Spring City at U.S. Geological Survey gage.
(D-16-4)15c	09-29-89	670 (e)	420	9.0	Canal Creek, downstream from confluence with Grizzly Gulch.
(D-17-2)14cca-1	10-04-88	18 (e)	31,900	—	San Pitch River, upstream from Maple Canyon near Manti.
	10-05-88	9 (e)	33,400	20.0	Do.
	10-06-88	6.3	32,300	16.5	Do.
	07-07-89	—	29,000	21.0	Sample collected; results of chemical analyses in table 7.
	09-27-89	225 (e)	21,500	17.5	San Pitch River, upstream from Maple Canyon near Manti.
(D-17-2)23bbc	10-05-88	12	540	—	Inflow to San Pitch River from the west.
(D-17-2)23bbc	10-05-88	—	8,650	—	San Pitch River just upstream of previous inflow.
(D-17-2)23ccc	10-05-88	—	5,430	—	
(D-17-2)34bad	10-05-88	—	730	15.5	Inflow to San Pitch River from the east.
(D-17-2)34bad	10-05-88	—	5,240	—	San Pitch River just upstream of inflow.
(D-17-3)13bdb	09-27-89	100 (e)	790	—	Cottonwood Creek inflow to Ephraim Canyon.
(D-17-4)7dbb	09-27-89	440 (e)	400	—	New Canyon tributary to Ephraim Canyon.
(D-18-2)2cbb-S1	09-26-89	225 (e)	820	13.5	Spring area west of Manti; southeasternmost source; sample collected; results of chemical analysis in table 11.
(D-18-2)3acd	08-12-88	—	2,200	14.0	San Pitch River near Manti.
	08-31-88	—	1,530	16.0	Do.
(D-18-2)3add	08-24-89	245	680	20.0	Measured at outflow of spring area west of Manti.
(D-18-2)10acd	08-31-88	—	830	13.0	South Creek west of Manti.
(D-18-2)10bca	08-31-88	—	1,580	18.0	San Pitch River near Manti and upstream from South Creek to divert water into ditch.
	06-08-89	—	2,880	16.0	
	07-26-89	.44	3,280	24.5	Recently constructed coffer dam immediately upstream from gage; sample collected; results of chemical analysis in table 7.
(D-18-2)11bcc	08-31-88	—	780	11.5	South Creek, west of Manti.

Table 6. Discharge, specific conductance, and temperature of water from selected surface-water sites and springs, Sanpete Valley, Utah—Continued

Location	Date	Discharge (gal/min)	Specific conductance (μS/cm)	Temperature (°C)	Remarks
(D-18-2)22cbb	04-25-89	682	1,700	13.5	Saleratus Creek, near inflow to Gunnison Reservoir.
	06-08-89	556	2,600	16.5	Do.
	07-26-89	366	1,610	14.0	Sample collected; results of chemical analysis in table 7.
	09-26-89	404	2,090	13.5	Saleratus Creek near inflow to Gunnison Reservoir.
(D-18-2)23adb-S1	09-26-89	7.25	3,020	15.5	Spring source downstream from canal and southeast of corral; sample collected; results of chemical analysis in table 11.
(D-18-2)23adb-S2	09-26-89	1 (e)	4,250	15.0	Spring source upstream from abandoned canal, slight sulfur smell.
(D-18-2)23adb-S3	09-26-89	.93	1,980	15.5	Spring area south of Manti; wooden collection box; sulfur smell.
(D-18-2)32abd	08-31-88	—	1,560	21.5	San Pitch River downstream from Gunnison Reservoir.
(10216210)	07-26-89	—	2,000	22.0	Gunnison Reservoir water level at 5,375.9 feet; near former U.S. Geological Survey gage.

Table 7. Results of chemical analyses of water from five selected surface-water sites, Sanpete Valley, Utah

[mg/L, milligrams per liter; μg/L, micrograms per liter; —, no data; <, less than]

Location: See figure 2 for explanation of numbering system for hydrologic-data sites.
Temperature: ^{o}C, degrees Celsius.
Specific conductance: μS/cm, microsiemens per centimeter at 25 degrees Celsius; measured in field except where noted L, laboratory value.

Location	Date of sample	Temperature (^{o}C)	Specific conductance (μS/cm)	pH (standard units)	Hardness, total (mg/L as $CaCO_3$)	Calcium, dissolved (mg/L as Ca)	Magnesium, dissolved (mg/L as Mg)
(D-14-4)2cba-1 San Pitch River near Fairview	07-24-89	14.0	770 L	7.6	390	88	42
(D-15-4)6bad-1 San Pitch River near Mount Pleasant (10210500)	07-25-89	24.0	1,000	8.3	520	91	70
(D-17-2)14cca-1 San Pitch River upstream from Maple Canyon near Manti	07-07-89	21.0	29,000	8.2	7,700	260	1,700
(D-18-2)10bca-1 San Pitch River near Manti	07-26-89	24.5	3,280	8.6	970	76	190
(D-18-2)22cbb-1 Saleratus Creek near mouth	07-26-89	14.0	1,610	7.7	400	59	61

Sodium, dis- solved (mg/L as Na)	Potas- sium, dis- solved (mg/L as K)	Alka- linity, lab (mg/L as $CaCO_3$)	Sulfate, dis- solved (mg/L as SO_4)	Chlo- ride, dis- solved (mg/L as Cl)	Fluo- ride, dis- solved (mg/L as F)	Silica, dis- solved, (mg/L as SiO_2)	Solids, sum of consti- tuents, dis- solved (mg/L)	Nitro- gen, NO_2 +NO_3, dis- solved (mg/L as N)	Boron, dis- solved (μg/L as B)	Sele- nium, dis- solved (μg/L as Se)
22	2.3	346	45	24	0.30	22	464	1.20	—	—
30	6.3	350	150	35	.20	25	638	.220	—	—
5,400	2.3	506	9,200	7,300	.30	5.6	24,800	<.100	2,300	<1
410	4.2	418	740	440	.50	10	2,130	<.100	—	—
210	5.0	448	170	160	.80	17	953	<.100	—	—

Table 8. Records of selected wells, Sanpete Valley, Utah

[—, no data; ?, unknown]

Location: See figure 2 explanation of the numbering system for hydrologic-data sites.

Owner or user: Refers to last known owner or user.

Year drilled: Reported from drillers' log.

Depth of hole: In feet below land surface.

Casing: Diameter reported from drillers' log or measured in the field; D indicates diameter of dug well (no casing); Depth, in feet below land surface; Type of opening: P, perforated; O, open end; Perforation interval: Upper and lower limits of perforations, in feet below land surface.

Other data available: W, water-level measurements (table 9); C, results of chemical analysis (table 11); M, field measurements of discharge, specific conductance, and temperature (table 10).

Location	Owner or user	Year drilled	Depth of hole (feet)	Altitude of land surface (feet)	Casing: Diameter (in.)	Casing: Depth (feet)	Casing: Type of openings (feet)	Casing: Perforation interval (feet)	Other data available
(D-12- 4) 25dcd-1	Paltreyman and Hatfield	1976	140	6,630	6	100	P	90-100	W
36abc-1	—	—	—	6,570	—	—	—		W
36cad-1	Nuttall, Verl	—	—	6,520	—	80	P	50-80	W
(D-13- 4) 1bda-1	Hamilton, L.E.	1920	98	6,449	D60	—	—		W
11adc-1	Terry, Lloyd	1918	40	6,261	D48	—	—		W
11adc-2	do.	—	—	6,261	—	66	—		W
12acc-1	Jenkins, L. Nora	—	23	6,360	D60	—	—		W
23ddd-1	Rigby, Cleon B.	1952	69	6,165	4	69	—		W
24bcc-1	Mower, Jared	1980	105	6,190	6	100	O		W
35dda-1	Cox, Andrew F.	1953	115	6,075	8	115	—		W
(D-14- 2) 12aaa-1	Fountain Green Irrigation Company	1976	—	5,885	—	98	—		C,M
12aad-1	Adobe Field Irrigation Company	1948	139	5,870	12	139	P	25-31	M,W
							P	112-122	
13aaa-1	Allred, Euray	1893	—	5,795	2	71	—		M,W
13cad-1	Maxfield, Edda	1964	80	5,820	4	80	O		M,W
(D-14- 3) 7abb-1	East Field Well Association	1956	300	5,834	12	300	P	58-71	M,W
							P	98-120	
							P	137-142	
							P	172-176	
							P	208-243	
							P	295-300	
7acc-1	Mikkelson, John	1951	81.5	5,790	10	81.5	P	8-10	M,W
							P	15-19	
							P	23-63	
7bbb- 1	Fountain Green Irrig. Company	1976	355	5,880	12	344	P	30-76	M,W
							P	106-120	
							P	138-160	
							P	265-280	
17cbb-1	—	1982	103	5,717	6	100	O		W
17cca-1	State Highway Well Association	1941	133	5,660	12	133	P	35-130	M
18ddd-1	Rasmussen, Robert M.	1940	81	5,653	6,4	81	P	65-81	W
19dbb-1	Oldroyd, T.J.	—	135	5,615	1.5	—	—		M
20abd-1	Mikkelson, Elmer	1935	—	5,665	10	125	P	50-124	M
20aca-1	do.	1934	125	5,655	10	125	P	50-124	C,M
20bba-1	Olsen, Jay L.	1934	151	5,564	10	151	P	40-150	M,W

Table 8. Records of selected wells—Continued

Location	Owner or user	Year drilled	Depth of hole (feet)	Altitude of land surface (feet)	Casing Diameter (in.)	Casing Depth (feet)	Casing Type of openings (feet)	Casing Perforation interval (feet)	Other data available
(D-14-3) 20cbb-1	Bailey, Earnest and Alan	1935	—	5,620	12	151	P	—	M
28cbd-1	Morley, Roy	1962	90.5	5,620	6	90	P	35-90	W
29ccb-1	Christensen, E.D.	1949	—	5,596	2	117	O		M,W
29ccb-3	do.	1955	50	5,596	4	50	O		M,W
30abb-1	Lund, Glade	1903	—	5,620	1.5	125	—		M,W
30dcc-1	Christensen and Sons, Inc.	1976	61	5,655	6	61	O		W
31dad-1	Christensen, Jay	1965	—	5,600	2	45	—		M,W
33bbb-1	Sowby, Rulon	1966	108	5,590	6	108	O		W
35ddb-1	Christensen, C.	1971	150	5,840	4	150	P	—	W
(D-14-4) 1acb-1	Bench, Kirby	1976	639	6,122	10	607	P	—	M
2dbb-2	Cheney	—	—	5,930	—	25	—		W
12cdc-1	Bench, Ralph	1955	265	5,968	16	265	P	82-105	M,W
							P	220-225	
24cdb-1	Seeley, J.B.	1941	90	5,960	6	88	O		W
27aab-1	Nelson, Murren	—	—	5,810	48	11	—		W
36abb-1	Smith, Melvin	1953	165	6,133	4	145	O		M,W
(D-14- 5) 19ccd-1	Prothero, Earl	1982	325	6,090	6	325	P	180-220	W
							P	260-325	
(D-15- 3) 4abc-1	Cook Turkey Farm	1985	145	5,638	6	145	O		M,W
5ada-2	Blackham, Mont	1960	143	5,546	10,8	143	P	123-143	M
7bcb-1	Moss, Ray	1971	105	5,632	4	105	P	85-105	W
7ccb-1	Lee, Kris	1986	45	5,640	6	42	O		W
8cda-3	Prestwich, Don	1905	75	5,511	1.5	75	O		M,W
9ddc-1	Moroni City Corporation	1978	340	5,522	12	340	P	120-340	M
12abb-3	LDS Church	1975	—	5,610	6	60	P	42-47	W
14bdb-1	Timms, Kelvin	1976	21,264	5,686	—	—	P	2,280-2,406	C,M
15ada-1	do.	1975	80	5,560	6	47	O		W
16aab-1	Moroni City Corporation	1956	340	5,520	12	340	P	60-134	W
do.	do.	1958	607	(deepened, no casing)					
16adb-1	Rock Dam Irrig. Company	1934	188	5,519	12	68	O		W
25bbd-1	Brown, Elmer	1983	97	5,600	6	42	O		W
25bca-1	Sunderland Dairy Farm	1970	293	5,610	12	293	P	70-290	M
27ada-1	Westenskow, Bruce	1949	310	5,521	16	150	P	100-150	M,W
27bbc-1	Christensen, Paul	1934	100	5,495	10	100	—		W
28daa-1	Dalton, Oliver	1934	151	5,486	12	150	P	70-100	W
							P	132-145	
29cca-1	Price, Lloyd	1953	31	5,518	4	31	O		M,W
30dbb-1	Olsen, M. and Rees, N.	1946	360	5,590	12	297	P	41-54	W
							P	63-77	
							P	98-115	
							P	127-149	
(D-15-3) 30dbb-1							P	249-253	
(D-15- 3) 32ccd-1	Thomas, N.M.	1952	40	5,495	4	40	—		M,W
33bba-1	Cloward, Lewis C.	1951	120	5,479	1.5	120	—		M,W
35aaa-1	Dyches, Delon	1954	87	5,533	2	87	O		W
35baa-1	Irving, Rodney	1943	90	5,517	4,3	90	P	58-90	W

Table 8. Records of selected wells—Continued

Location	Owner or user	Year drilled	Depth of hole (feet)	Altitude of land surface (feet)	Casing: Diameter (in.)	Casing: Depth (feet)	Casing: Type of openings (feet)	Casing: Perforation interval (feet)	Other data available
(D-15- 4) 2adb-1	City of Mount Pleasant	1952	297	6,109	12	297	P	170-180	W
							P	190-200	
							P	235-255	
							P	260-265	
							P	270-285	
							P	290-297	
2bdb-1	do.	1973	360	6,000	20,16	294	P	130-225	W
4bad-2	Sorensen, G.C.	1953	360	5,755	12	360	P	65-?	M,W
4bcd-1	Madsen	1948	353	5,740	12,10,8,6	353	P	40-180	M,W
4dda-1	Twin Creek Irrig. Company	1934	245	5,820	12	240	P	18-240	M,W
7dad-1	Nelson, Leslie	1892	52	5,660	1.5	52	—		C,M,W
7dda-1	Peel, David	—	—	5,660	—	—	—		M,W
8dac-1	—	—	—	5,702	—	—	—		W
9bac-1	Anderson, Lewis	1949	200	5,750	2	160	P	30-160	M,W
9bbd-1	do.	1946	60	5,738	4	57	0		W
9ccc-1	South Fields Irrig. Company	1977	255	5,745	12.75	205	P	40-205	M,W
16bbb-1	do.	1950	335	5,745	10,8	310.5	P	215-307	W
17abb-1	Peel, Paul R.	1949	200	5,716	12,10	192	P	25-125	M,W
21cda-1	Aiken, Terrance	1952	1,200	5,914	12	200	P	85-174	W
29bac-1	Jensen, Orin	1934	210	5,756	12.5	109	P	32-109	W
31dab-1	Olsen, Charles	1915	150	5,814	2	150	O		M,W
31dcc-1	Watson, Eva	1959	82	5,838	4	82	O		M
(D-16- 2) 13dda-1	Christensen, Dick	1935	324	5,465	12	324	P	212-320	C,M,W
24cda-1	Mortensen, Rulon	1965	86	5,490	4	84	O		W
35acd-1	Christensen, Ruel	1935	202	5,519	12	186	—		C,M,W
36cbd-1	Sanpitch Pump Company	1955	301	5,472	16	301	P	128-298	C,M,W
(D-16- 3) 1bbb-2	—	1965	107	5,560	4	107	P	95-105	C,M,W
3bbc-1	—	—	165	5,471	2	—	—		M,W
3cbb-1	Madsen Estate	1920	190	5,465	4	190	—		M
3cbc-1	—	—	—	5,461	—	—	—		M,W
3daa-1	Cunningham, Harry	1981	125	5,475	6	100	O		W
4aaa-1	Maxfield, Reed	1900	160	5,471	2	160	O		C,M,W
4aaa-2	do.	1902	140	5,471	2	140	O		M,W
4dbd-2	Bagnall, Lewis R.	1951	142	5,462	2	142	O		M,W
5cbc-1	Anderson, Kenneth	1944	131	5,480	4	130	O		W
5ddc-1	—	—	—	5,457	2	—	—		M,W
8aad-1	—	—	—	5,455	2	—	—		M,W
8add-1	Seeley, J.L.	1895	129	5,455	1.5	—	—		M,W
8daa-1	—	—	340	5,452	8	280	—		M
8dab-1	—	—	—	5,453	9.25	—	—		W
9bcb-1	Allred, R. and Blaine, J.	1900	500	5,455	3	—	O		M,W
9bcc-1	Seeley, J.L.	1900	300	5,455	4	300	O		M,W
13dbd-1	—	—	—	5,802	1	—	—		M
13dda-1	Hermansen, Lawrence	1890	71	5,862	48	71	P	51-71	W
14dca-1	Larsen, Christian	1935	275	5,641	10	275	P	—	W

Table 8. Records of selected wells—Continued

Location	Owner or user	Year drilled	Depth of hole (feet)	Altitude of land surface (feet)	Casing: Diameter (in.)	Casing: Depth (feet)	Casing: Type of openings (feet)	Casing: Perforation interval (feet)	Other data available
(D-16- 3) 15ada-1	Francks, Lavar	1966	130	5,524	4	—	—		W
15adc-1	do.	1938	250	5,520	12,8	143	P	—	W
15dcb-1	Bailey Brothers Farm	1955	200	5,485	16	200	P	50-55	M,W
							P	87-200	
16dab-1	—	—	—	5,450	2	—	—		M,W
17aad-1	Olsen, Rasmus	1913	150	5,450	1.5	—	—		M,W
18bba-1	Utah Emergency Relief	1934	385	5,445	6	62	O		M,W
20bad-2	Olsen, Nels I.	1950	120	5,443	2	120	—		M,W
20cda-1	—	—	—	5,437	2	—	—		M,W
21ada-1	—	—	—	5,459	4	30	—		W
21bbc-1	Olsen, Andrew	1958	152	5,442	2	152	O		M,W
21cdb-2	Olsen, Doug	1946	97	5,450	1.5	97	O		C,M,W
23cbc-1	Hanson, Aaron G.	1943	208	5,585	5	208	P		W
24aba-1	Hermansen, Lawrence	1959	172	5,820	3	172	O		M
25cab-1	Owens, Seth	—	—	5,800	6	—	—		M,W
26cbd-1	Peterson Estate	1915	800	5,637	6	240	O		C,M,W
27caa-1	Olsen, Clyde	1950	92	5,543	6,4	92	P	80-92	W
27cbc-1	Olsen, Steve	1963	300	5,520	16,12	300	P	100-133	W
							P	136-297	
27dbd-1	Garland, Glen	1982	85	5,582	6	80	O		W
28aad-1	Anderson, E.B.	1945	267	5,491	12,10	153	P	18-153	M
28bbd-1	Olsen, J.L.	1902	—	5,445	2	—	—		M
28bbd-2	—	—	—	5,445	2	—	—		M,W
28cba-1	Olsen, Wayne	—	—	5,460	—	—	—		M,W
28cda-1	Olsen, Steve	1927	104	5,470	12	104	P	8-104	M
31acd-1	—	—	—	5,430	—	—	—		M,W
31dbd-1	—	—	—	5,435	2	—	—		M,W
32bda-1	Allred, Charles	1949	256	5,445	2	255	O		M,W
33ada-1	—	—	—	5,485	4	—	—		W
33ccb-2	Olsen, Chris	1954	105	5,466	2	105	O		M,W
34bbc-1	Peterson, Clifford	1910	30	5,490	4	—	—		W
34ccd-1	Peterson, Ludeal	1975	75	5,510	6	67	O		W
(D-16- 4) 7ccd-1	Larsen, J.H.	—	150	5,940	5	60	P	40-60	W
18bac-1	Reynolds, Dennis	1950	185	5,939	6	90	O		M,W
18bac-2	do.	1988	205	5,945	4	205	P	165-205	C,M,W
(D-17- 2) 1bca-2	Reid, Roy F.	1931	225	5,444	2	225	O		M,W
1cba-1	Larson, Luttery	1920	—	5,438	4	330	O		M
1dac-1	—	1964	190	5,428	2	173	O		M,W
1dda-1	—	—	—	5,427	1	65	—		M,W
1ddb-1	—	—	—	5,427	2	—	—		M,W
1ddc-1	—	1912	—	5,428	4	290	—		M
12abb-1	—	—	—	5,425	2	—	—		M,W
12adb-1	—	—	—	5,424	2	—	—		M,W
12add-2	—	1962	232	5,423	2	232	O		M,W
12daa-1	—	—	225	5,424	2	—	—		M,W

Table 8. Records of selected wells—Continued

Location	Owner or user	Year drilled	Depth of hole (feet)	Altitude of land surface (feet)	Casing Diameter (in.)	Casing Depth (feet)	Casing Type of openings (feet)	Casing Perforation interval (feet)	Other data available
(D-17- 2) 13aad-1	—	1902	225	5,423	1.5	—	—		M,W
13bdd-1	—	1949	205	5,417	2	203	O		M,W
14baa-1	Larsen, Afton	1950	337	5,425	2	337	O		M,W
14cca-1	Bailey, Dick	1988	83	5,423	2	74	P	54-64	C,M,W
14cca-2	do.	1988	26	5,423	2	26	P	13.5-23.5	C,M,W
14ccb-1	do.	1962	185	5,420	2	183	O		C,M,W
14cdb-1	Thompson, Neils Albert	1946	158	5,421	2,1.5	158	O		M,W
15aca-1	Nielson, Richard	1988	22.5	5,447	2	22.5	P	15-20	M,W
22ddb-1	Maylett, Claude	1952	171	5,445	4	171	—		M,W
25ccd-1	—	—	—	5,440	2	—	—		M,W
34aad-1	—	—	—	5,423	1	—	—		M
34adb-1	Kjar Brothers	1890	200	5,423	3	200	—		M,W
35cba-1	Barton, Don	1971	220	5,440	4	220	O		M,W
36cba-1	Cox, Ray	1918	50	5,470	4	50	O		M,W
36cdc-2	Cox, David	1941	353	5,490	12	353	P	77-84	M,W
							P	94-98	
							P	118-123	
							P	140-146	
							P	152-171	
							P	185-288	
(D-17-3) 3dbd-1	Paulsen, John E.	1916	600	5,650	6	—	—		C,M,W
4bcc-2	Ditches 7 and 8 Pump Company	1935	396	5,487	12,8	392	P	30-63	M,W
							P	350-392	
5ccd-1	—	1900	212	5,454	3	200	O		M,W
6aad-1	Larsen, William A.	1918	325	5,440	4	260	O		M,W
6bba-1	Thompson	1918	222	5,428	4	—	O		M,W
6bbc-1	Thompson and others	1918	260	5,428	4	—	O		M,W
6cab-1	Anderson, Anthon	1900	160	5,434	1.5	141	O		M,W
6cca-1	Christensen and Thompson	—	—	5,431	4	250	—		M
6ccb-1	—	—	—	5,428	3	—	—		M,W
6ccc-1	—	—	—	5,429	2	—	—		M,W
6dca-1	Doke, O.C.	1912	167	5,446	1.5	67	—		M,W
6dcc-1	—	—	—	5,435	2	—	—		M,W
6ddd-1	—	—	200	5,445	2	—	—		M,W
7abb-1	—	1900	145	5,436	1.5	145	O		M,W
7abb-2	—	—	—	5,434	2	—	—		M,W
7abd-1	—	—	—	5,440	1.5	—	—		M,W
7baa-1	—	—	—	5,435	1.5	—	—		M,W
7baa-2	—	—	—	5,435	2	—	—		M,W
7bab-1	—	—	—	5,436	1.5	—	—		M,W
7bab-2	—	—	—	5,431	1.5	—	—		M,W
7bad-1	—	—	—	5,435	1.5	—	—		M,W
7bba-1	—	—	—	5,430	2	—	—		M,W
7bbb-1	Thompson	1931	400	5,428	4,2,1.25	397	O		M,W
7bbd-1	—	—	—	5,430	3	—	—		M,W

Table 8. Records of selected wells—Continued

Location	Owner or user	Year drilled	Depth of hole (feet)	Altitude of land surface (feet)	Casing: Diameter (in.)	Casing: Depth (feet)	Casing: Type of openings (feet)	Perforation interval (feet)	Other data available
(D-17-3) 7bca-1	—	—	—	5,429	4	—	—		M
7bda-1	—	—	—	5,434	1.5	—	—		M
7bdc-1	—	—	—	5,428	1.5	—	—		M,W
7cab-1	—	—	—	5,430	1.5	—	—		M,W
7cac-1	—	—	—	5,429	1.5	—	—		M,W
7cba-1	—	—	—	5,427	2	—	—		M,W
7cba-2	—	—	—	5,427	2	—	—		M,W
7cbd-1	—	—	—	5,428	1.5	—	—		M,W
7cca-1	—	1900	225	5,427	3	—	—		M,W
7cca-2	—	—	—	5,427	2	—	—		M
7cca-3	—	1900	180	5,428	1.5	—	—		M
7cca-4	—	—	—	5,427	2	—	—		M
7cda 1	—	—	—	5,438	4	—	—		M,W
7cdb-1	—	—	—	5,429	2	—	—		M,W
7cdc-1	—	—	—	5,430	2	—	—		M,W
7dbd-1	—	—	—	5,437	1	—	—		M,W
8bab-1	Andersen, J. Orrin	1900	186	5,454	1.5	112	O		M,W
8cdd-1	Larsen, Ronde	1956	278	5,488	12	278	P	160-273	W
9cbd-1	Willardson, Chris	1934	285	5,520	10	276	P	80-240	M,W
16adb-1	Ray, Gary N.	1978	200	5,610	6	200	P	160-200	W
17adb-1	Willow Creek Irrig. Company	1934	298	5,525	12.5	298	P	—	M,W
17bad-1	Nielson, Lawrence	1956	300	5,496	16	300	P	86-?	M
17cac-1	Nielsen, Vail	1955	453	5,495	12	430	P	91-162	M
							P	181-213	
							P	228-270	
							P	380-395	
							P	425-430	
20aca-1	—	—	—	5,555	4	—	—		W
20acc-1	Steck Pump Company	1956	436	5,548	12	416	P	100- ?	C,M,W
20bca-2	Keller-Hansen-Frischknect	1941	300	5,500	14,8	300	P	154-164	M
20cdb-1	Jensen, Halbert	1961	390	5,530	12	287	P	85-285	W
30aaa-1	McPherson, Dick	1950	230	5,490	12	199	—		M,W
30dbd-1	Olsen, David	1921	85	5,454	3	85	O		M,W
(D-18- 2) 1cdb-1	Manti Irrig. Company	1948	300	5,540	12,10	300	P	55-300	M,W
1daa-2	Cox, Grant	1960	233	5,556	14,12	233	P	100-215	C,M,W
2add-1	Barton, Alden	1951	154	5,497	12	148	P	30-148	M
9dca-1	—	—	—	5,395	6	—	—		W
11baa-1	—	1953	—	5,480	—	63	—		W
11bcc-2	Mackey, Glen	—	62	5,455	1.7	62	O		C,M,W
12bab-1	Manti Irrig. Company	1934	304	5,554	12	270	P	88-270	M,W
12bdc-1	do.	1948	305	5,565	12,10,8	305	P	—	W
14aba-1	—	—	—	5,510	4	—	—		W
27ccc-1	Anderson, Glen L.	1954	60	5,497	5	60	P	48-52	W

Table 9. Water levels in selected wells, Sanpete Valley, Utah

Location: See figure 2 for an explanation of the numbering system for hydrologic-data sites.
Water level: In feet above (-) or below land surface; S, influenced by nearby pumped well; R, reported.

Location	Altitude of land surface (feet)	Date	Water level (feet)
(D-12-4)25dcd-1	6,630	11-10-87	16.64
		12-02-87	16.65
		01-04-88	17.05
		02-03-88	17.19
		02-29-88	17.11
		03-29-88	15.66
		04-28-88	11.86
		06-01-88	11.75
		06-29-88	10.81
		07-27-88	13.18
		09-02-88	15.72
		12-02-88	18.27
		02-01-89	17.90
		03-08-89	17.10
		05-02-89	11.55
		06-14-89	12.19
		07-26-89	15.10
		09-12-89	17.59
		11-07-89	18.92
		03-01-90	16.37
(D-12-4)36abc-1	6,570	11-06-89	31.25
(D-12-4)36cad-1	6,520	11-07-89	50.31
(D-13-4)1bda-1	6,449	09-20-66	71.69
		05-02-89	83.69
(D-13-4)11adc-1	6,261	09-23-66	24.10
		05-02-89	25.57
		11-07-89	30.81
(D-13-4)11adc-2	6,261	05-02-89	28.13
(D-13-4)12acc-1	6,360	07-25-51	9.87
		03-18-53	17.22
		12-11-53	20.15
		03-27-54	21.10
		11-29-54	17.50
		03-23-55	20.90
		03-22-56	21.54
		12-05-56	21.50
		12-06-56	21.50
		03-12-58	18.68
		04-04-58	14.02
		05-07-58	9.73
		06-04-58	7.80
		07-03-58	6.90
		08-04-58	8.72
		09-02-58	11.83
		10-07-58	14.92
		11-06-58	16.29
		11-29-58	17.13
		01-02-59	19.07
		01-27-59	20.30
		02-25-59	20.68
		03-26-59	19.67
		04-29-59	18.53
		05-29-59	10.81
(D-13-4)12acc-1—Continued		06-24-59	8.54
		07-29-59	11.79
		08-25-59	15.31
		09-25-59	18.14
		10-29-59	19.69
		11-30-59	20.44
		12-30-59	20.93
		01-27-60	21.64
		03-25-60	23.27
		04-27-60	13.69
		05-25-60	7.86
		06-17-60	7.38
		07-27-60	13.80
		08-29-60	17.48
		09-30-60	19.12
		10-27-60	19.90
		11-30-60	21.03
		12-30-60	21.52
		01-30-61	23.25
		05-26-61	21.89
		07-06-61	16.38
		07-26-61	18.37
		08-24-61	21.32
		10-16-62	15.71
		03-29-65	18.61
		04-30-65	11.28
		06-29-65	5.43
		07-31-65	6.62
		09-03-65	8.70
		10-04-65	12.22
		10-28-65	13.40
		12-02-65	15.00
		01-06-66	17.10
		03-21-66	14.35
		04-22-66	11.97
		05-20-66	9.72
		06-17-66	9.61
		07-29-66	12.10
		09-14-66	16.25
		10-26-66	18.99
		03-24-67	17.71
		11-30-67	16.05
		03-05-68	17.35
		09-24-68	10.66
		09-23-69	12.64
		03-09-70	15.89
		09-14-70	11.07
		03-12-71	17.32
		09-15-71	12.10
		03-10-72	15.50
		09-26-72	18.14
		03-12-73	18.04
		09-25-73	10.04
		03-18-74	11.85
		09-13-74	11.14
		03-03-75	18.18
		09-04-75	7.19
		03-01-76	17.32
		09-21-76	13.30
(D-13-4)12acc-1—Continued		03-02-77	21.30
		09-22-77	21.35
		03-08-78	16.32
		03-06-79	18.28
		09-12-79	10.10
		03-06-80	12.93
		09-29-80	12.23
		03-06-81	15.98
		09-11-81	13.39
		03-10-82	13.44
		09-14-82	9.59
		03-08-83	12.93
		09-12-83	6.66
		03-09-84	12.42
		09-14-84	7.32
		03-05-85	14.05
		09-20-85	10.25
		03-07-86	4.26
		09-05-86	8.60
		03-05-87	16.69
		09-02-87	11.86
		11-09-87	15.22
		12-02-87	16.30
		01-04-88	18.02
		02-03-88	17.98
		03-02-88	16.18
		03-29-88	13.91
		04-28-88	13.84
		06-01-88	11.29
		06-29-88	9.30
		07-27-88	9.28
		09-02-88	12.90
		12-02-88	18.17
		02-01-89	19.80
		03-08-89	20.20
		05-02-89	16.62
		06-14-89	11.56
		07-26-89	11.99
		09-12-89	22.33
		11-07-89	17.99
		03-01-90	21.50
(D-13-4)23ddd-1	6,165	09-29-66	42.80
		05-02-89	34.04
(D-13-4)24bcc-1	6,190	11-10-87	26.12
		12-02-87	28.83
		02-03-88	29.94
		02-29-88	28.43
		03-29-88	26.57
		04-28-88	27.16
		06-01-88	13.39
		06-29-88	22.27
		07-27-88	26.95
		09-02-88	29.18
		12-02-88	29.84
		02-01-89	30.60
		03-08-89	30.16
		05-02-89	20.60

Table 9. Water levels in selected wells, Sanpete Valley, Utah—Continued

Location	Altitude of land surface (feet)	Date	Water level (feet)
(D-13-4)24bcc-1—Continued		06-14-89	20.10
		07-26-89	28.05
		09-13-89	29.52
		11-07-89	27.94
		03-01-90	29.85
(D-13-4)35dda-1	6,075	09-30-66	93.70
		05-02-89	96.81
		11-07-89	97.13
(D-14-2)12aad-1	5,870	10-28-66	3.40
		05-05-89	3.64
		11-06-89	3.02
(D-14-2)13aaa-1	5,795	08-01-35	-12.10
		09-03-35	-12.00
		10-09-35	-11.30
		11-20-35	-11.45
		12-13-35	-11.90
		01-25-36	-11.80
		03-02-36	-11.75
		05-01-36	-13.40
		06-19-36	-16.55
		08-07-36	-16.90
		10-02-36	-16.35
		11-29-36	-16.20
		02-05-37	-16.60
		04-11-37	-17.25
		06-10-37	-18.50
		08-01-37	-19.00
		09-24-37	-17.80
		11-03-37	-17.60
		12-21-37	-18.30
		02-24-38	-17.50
		04-07-38	-18.50
		06-03-38	-19.60
		08-30-38	-18.70
		10-09-38	-18.40
		12-22-38	-18.50
		03-03-39	-17.10
		04-15-39	-18.00
		06-18-39	-17.45
		08-24-39	-16.40
		10-14-39	-15.50
		12-02-39	-15.85
		02-06-40	-15.90
		03-27-40	-16.20
		06-03-40	-16.60
		12-04-40	-16.10
		03-19-41	-17.60
		12-06-41	-21.30
		03-26-42	-20.60
		08-11-42	-21.70
		12-19-42	-19.40
		03-24-43	-20.50
		12-17-43	-17.60
		03-20-44	-17.40
		12-04-44	-20.00
		04-04-45	-19.50
		12-05-45	-21.30
		03-20-46	-19.00
		12-19-46	-19.80
(D-14-2)13aaa-1—Continued		03-28-47	-19.20
		03-18-48	-19.20
		07-23-48	-19.40
		12-14-48	-18.40
		04-04-49	-18.20
		12-13-49	-18.00
		03-30-50	-18.50
		12-11-50	-16.50
		03-28-51	-17.20
		12-12-51	-16.70
		04-08-52	-17.80
		12-09-52	-24.80
		03-18-53	-22.40
		12-14-53	-21.10
		03-27-54	-22.30
		11-30-54	-17.20
		03-23-55	-17.70
		12-07-55	-16.30
		03-22-56	-17.10
		12-05-56	-15.60
		01-04-57	-16.30
		02-04-57	-16.70
		02-28-57	-16.80
		04-03-57	-16.70
		05-03-57	-16.60
		07-01-57	-18.70
		07-26-57	-18.80
		08-29-57	-18.40
		10-01-57	-18.30
		11-07-57	-19.40
		12-04-57	-18.70
		12-31-57	-20.50
		02-05-58	-18.70
		03-04-58	-19.00
		04-04-58	-18.70
		05-07-58	-19.90
		06-04-58	-21.50
		07-03-58	-22.00
		08-04-58	-22.30
		09-02-58	-20.10
		10-07-58	-19.40
		11-06-58	-20.00
		11-29-58	-21.50
		01-02-59	-20.00
		01-21-59	-19.00
		02-25-59	-20.60
		03-26-59	-20.50
		04-29-59	-20.00
		05-29-59	-21.00
		06-24-59	-20.30
		07-29-59	-19.70
		08-25-59	-19.00
		09-25-59	-18.25
		10-29-59	-18.60
		11-30-59	-18.60
		12-30-59	-17.70
		01-27-60	-17.80
		03-25-60	-17.50
		04-27-60	-18.20
		05-25-60	-17.50
		06-17-60	-16.70
		07-27-60	-16.10
(D-14-2)13aaa-1—Continued		08-29-60	-15.40
		09-30-60	-15.20
		10-27-60	-15.10
		11-30-60	-15.60
		12-30-60	-16.20
		01-30-61	-16.10
		02-27-61	-16.10
		03-31-61	-16.20
		04-24-61	-15.80
		05-26-61	-14.90
		07-06-61	-14.10
		07-26-61	-13.70
		08-24-61	-12.90
		09-29-61	-13.10
		04-05-62	-14.10
		09-28-62	-17.90
		04-11-63	-17.50
		09-25-63	-16.40
		04-01-64	-16.50
		07-02-64	-17.50
		08-03-64	-17.30
		08-28-64	-17.30
		09-29-64	-17.40
		10-30-64	-17.20
		12-14-64	-17.20
		02-12-65	-17.80
		03-26-65	-18.70
		04-30-65	-18.10
		06-29-65	-19.60
		07-31-65	-19.60
		09-03-65	-19.20
		10-04-65	-18.90
		10-28-65	-18.10
		12-02-65	-17.70
		01-05-66	-17.70
		03-18-66	-19.00
		04-22-66	-17.90
		05-20-66	-18.90
		06-17-66	-17.90
		07-28-66	-17.70
		09-15-66	-17.70
		10-28-66	-17.30
		03-24-67	-17.90
		11-29-67	-19.20
		03-05-68	-18.80
		09-25-68	-19.30
		03-14-69	-20.10
		09-25-69	-21.20
		03-12-70	-21.70
		09-16-70	-16.70
		03-11-71	-17.60
		09-17-71	-18.10
		03-08-72	-18.90
		09-28-72	-16.20
		03-16-73	-17.00
		09-25-73	-18.60
		03-21-74	-19.60
		09-18-74	-18.50
		03-05-75	-19.30
		09-05-75	-19.00
		03-01-76	-19.30
		09-22-76	-15.30

Table 9. Water levels in selected wells, Sanpete Valley, Utah—Continued

Location	Altitude of land surface (feet)	Date	Water level (feet)
(D-14-2)13aaa-1—Continued		03-02-77	-16.70
		03-13-78	-14.20
		09-02-78	-15.40
		03-06-79	-16.60
		09-12-79	-16.30
		03-06-80	-17.50
		09-29-80	-19.80
		03-05-81	-19.70
		09-12-81	-17.30
		03-09-82	-18.90
		09-14-82	-21.00
		03-11-83	-20.90
		09-12-83	-21.70
		03-10-84	-23.80
		09-14-84	-24.20
		03-08-85	-24.40
		09-20-85	-18.30
		03-13-86	-23.40
		09-05-86	-25.50
		03-03-87	-23.60
		09-01-87	-23.30
		11-10-87	-22.9
		12-02-87	-21.7
		01-04-88	-21.5
		02-03-88	-22.0
		03-02-88	-21.70
		03-29-88	-22.3
		04-28-88	-22.6
		06-01-88	-22.2
		06-29-88	-21.4
		07-27-88	-21.7
		08-29-88	-22.3
		12-19-88	-20.0
		01-30-89	-21.2
		03-06-89	-22.1
		05-05-89	-19.1
		07-24-89	-19.1
		09-20-89	-17.7
		11-06-89	-18.1
		03-01-90	-18.7
(D-14-2)13cad-1	5,820	08-25-66	62.50
		05-05-89	56.02
		11-06-89	58.66
(D-14-3)7abb-1	5,834	05-11-64	32.88
		09-29-64	36.66
		10-30-64	34.52
		12-14-64	31.02
		03-26-65	32.19
		09-03-65	30.82
		10-04-65	29.66
		10-28-65	26.81
		12-02-65	26.26
		01-05-66	27.30
		03-18-66	29.11
		10-28-66	37.52
		03-24-67	33.73
		03-05-68	29.52
		03-14-69	27.84
		03-12-70	28.14
		03-11-71	29.47
(D-14-3)7abb-1—Continued		03-08-72	29.64
		03-16-73	34.52
		03-21-74	26.16
		03-05-75	32.55
		03-01-76	27.88
		03-02-77	36.08
		03-10-78	42.20
		03-06-79	28.22
		03-06-80	27.62
		03-09-82	28.14
		03-11-83	25.35
		03-10-84	26.93
		03-04-85	26.82
		03-13-86	23.09
		03-03-87	26.35
		11-10-87	28.99
		12-02-87	27.92
		03-02-88	27.34
		03-29-88	27.33
		04-28-88	28.18
		06-01-88	29.80
		06-29-88	29.94
		07-27-88	30.43
		08-28-88	31.23
		08-29-88	31.23
		12-01-88	30.62
		01-30-89	27.78
		03-06-89	27.81
		05-05-89	28.66
		06-16-89	31.24
		07-24-89	32.51
		09-12-89	33.29
		11-06-89	33.58
		03-01-90	29.74
(D-14-3)7acc-1	5,790	07-08-64	4.83
		08-03-64	4.63
		08-28-64	5.70
		09-29-64	5.14
		10-30-64	4.39
		12-14-64	3.13
		02-12-65	2.12
		03-26-65	2.64
		04-30-65	3.32
		06-29-65	3.38
		07-31-65	3.49
		09-03-65	2.11
		10-04-65	1.05
		10-28-65	.04
		01-05-66	.50
		03-18-66	.97
		04-22-66	2.12
		06-17-66	5.64
		07-27-66	7.70
		09-15-66	9.70
		10-28-66	7.31
		03-24-67	4.44
		03-06-68	1.84
		03-14-69	1.67
		03-12-70	.47
		03-11-71	1.05
		03-08-72	1.60
(D-14-3)7acc-1—Continued		03-16-73	4.27
		03-21-74	-.90
		03-05-75	3.51
		03-01-76	-.32
		03-02-77	6.02
		03-10-78	11.47
		03-06-79	.89
		03-06-80	.19
		03-05-81	.78
		03-09-82	-.55
		03-02-88	-.78
		08-29-88	6.09
		03-08-89	-.30
		05-05-89	-.10
		09-12-89	4.28
		11-06-89	4.90
		03-01-90	1.62
(D-14-3)7bbb-1	5,880	12-14-48	2.12
		12-13-49	2.43
		03-30-50	1.19
		12-11-50	1.15
		03-28-51	2.03
		12-12-51	2.25
		04-08-52	-.10
		12-09-52	.56
		03-18-53	.99
		12-14-53	1.07
		03-27-54	.23
		11-30-54	1.97
		03-23-55	1.13
		12-07-55	2.20
		03-22-56	1.04
		12-05-56	2.14
		04-04-58	.31
		05-07-58	1.50
		10-07-58	2.51
		11-06-58	1.34
		11-29-58	.77
		01-02-59	1.04
		01-27-59	1.10
		02-25-59	.74
		03-26-59	1.36
		10-29-59	2.48
		11-30-59	1.46
		12-30-59	1.33
		01-27-60	1.57
		03-25-60	.53
		04-27-60	2.83
		10-27-60	2.26
		11-30-60	1.50
		12-30-60	1.75
		01-30-61	2.20
		02-27-61	2.21
		03-31-61	1.98
		04-24-61	1.73
		10-16-62	1.64
		12-14-64	1.68
		02-12-65	1.00
		03-26-65	1.84
		04-30-65	1.66
		09-03-65	1.48

Table 9. Water levels in selected wells, Sanpete Valley, Utah—Continued

Location	Altitude of land surface (feet)	Date	Water level (feet)
(D-14-3)7bbb-1—Continued		10-04-65	.43
		10-28-65	.29
		12-02-65	.19
		01-05-66	.29
		03-18-66	.71
		10-28-66	5.40
		03-24-67	.90
		03-05-68	.40
		03-11-71	1.02
		03-08-72	.97
		03-16-73	.60
		03-31-74	-.52
		03-05-75	.68
		03-01-76	.32
		03-02-77	.06
		03-10-78	1.88
		03-06-79	.41
		03-06-80	.90
		03-05-81	.40
		03-09-82	-.51
		03-11-83	-.70
		03-10-84	-.10
		03-04-85	.87
		03-13-86	.56
		03-03-87	1.42
		03-02-88	.90
		08-29-88	19.68S
		03-06-89	.93
		05-05-89	6.42
		09-12-89	4.30
		11-06-89	2.80
		03-01-90	1.23
(D-14-3)17cbb-1	5,717	05-05-89	40.72
		11-06-89	40.62
(D-14-3)18ddd-1	5,653	08-19-66	29.70
		05-05-89	24.05
		11-06-89	27.08
(D-14-3)20bba-1	5,564	03-18-66	26.90
		03-04-85	23.32
		03-03-87	24.09
		11-10-87	27.80
		12-02-87	26.38
		01-04-88	26.33
		02-03-88	26.31
		03-02-88	25.17
		03-29-88	24.02
		04-28-88	24.25
		06-01-88	27.17
		12-01-88	28.83
		01-30-89	28.87
		03-06-89	27.19
		07-24-89	32.13
		09-12-89	31.47
		11-06-89	30.50
		03-01-90	30.17
(D-14-3)28cbd-1	5,620	08-26-66	35.46
		05-06-89	33.46
		06-06-89	33.81
		11-06-89	34.65
(D-14-3)29ccb-1	5,596	08-26-66	-2.1
		05-06-89	-4.40
		06-06-89	-3.92
		11-06-89	-3.45
(D-14-3)29ccb-3	5,596	08-26-66	11.88
		05-06-89	11.20
		06-06-89	12.15
(D-14-3)30abb-1	5,620	08-25-66	-2.5
		11-07-89	-11.2
(D-14-3)30dcc-1	5,655	05-06-89	16.64
(D-14-3)31dad-1	5,600	03-15-65	-8.90
		04-30-65	-8.20
		06-25-65	-9.30
		07-31-65	-8.50
		09-03-65	-9.10
		10-04-65	-8.40
		10-28-65	-8.60
		12-02-65	-8.00
		01-05-66	-7.80
		03-18-66	-8.60
		04-22-66	-8.30
		05-20-66	-9.80
		06-17-66	-8.70
		07-26-66	-7.50
		09-15-66	-7.80
		03-24-67	-8.60
		03-05-68	-8.40
		03-19-70	-9.50
		03-11-71	-9.20
		03-07-72	-9.80
		03-16-73	-9.30
		03-21-74	-10.20
		03-05-75	-9.60
		03-01-76	-10.40
		03-02-77	-10.00
		03-06-80	-10.10
		03-05-81	-11.20
		03-09-82	-10.60
		03-11-83	-12.70
		03-10-84	-16.20
		03-12-85	-16.50
		03-13-86	-16.80
		03-03-87	-15.00
		11-10-87	-12.3
		12-02-87	-12.8
		01-04-88	-13.2
		02-03-88	-13.4
		03-02-88	-13.4
		03-29-88	-13.7
		04-28-88	-13.5
		06-01-88	-14.2
		06-29-88	-13.2
		07-27-88	-12.4
		08-29-88	-11.2
		12-19-88	-11.5
		01-30-89	-12.4
		03-06-89	-12.4
		06-16-89	-12.8
(D-14-3)31dad-1—Continued		07-24-89	-13.0
		09-12-89	-11.0
		11-07-89	-11.1
		03-01-90	-11.8
(D-14-3)33bbb-1	5,590	05-06-89	21.10
		06-06-89	22.05
		11-06-89	22.85
(D-14-3)35ddb-1	5,840	05-06-89	69.20
		11-07-89	69.75
(D-14-4)2dbb-2	5,930	03-12-71	16.22
		09-15-71	9.37
		03-07-72	14.62
		09-26-72	13.40
		03-14-73	16.85
		09-26-73	6.79
		03-19-74	14.53
		09-13-74	9.36
		03-03-75	16.77
		09-04-75	4.85
		03-01-76	15.48
		09-21-76	11.34
		03-02-77	17.55
		09-22-77	18.41
		03-08-78	16.50
		09-12-78	7.55
		03-06-79	15.86
		09-12-79	7.57
		03-06-80	14.35
		09-29-80	8.57
		03-06-81	16.08
		03-10-82	14.90
		09-14-82	7.01
		03-08-83	12.52
		03-09-84	14.18
		09-14-84	8.82
		03-05-85	16.02
		09-20-85	7.44
		03-07-86	13.49
		09-05-86	9.53
		03-05-87	16.39
		09-02-87	11.89
		11-09-87	15.36
		12-02-87	16.27
		01-04-88	16.83
		02-03-88	16.98
		03-02-88	16.77
		03-29-88	16.64
		04-28-88	15.44
		06-01-88	10.34
		06-29-88	8.92
		07-27-88	9.77
		09-02-88	11.96
		12-02-88	16.32
		02-01-89	17.42
		03-08-89	17.24
		05-02-89	13.60
		06-14-89	9.97
		07-26-89	11.12
		09-12-89	14.30

Table 9. Water levels in selected wells, Sanpete Valley, Utah, Sanpete Valley, Utah—Continued

Location	Altitude of land surface (feet)	Date	Water level (feet)
(D-14-4)2dbb-2—Continued		11-07-89	16.52
		03-01-90	17.17
(D-14-4)12cdc-1	5,968	05-11-64	58.22
		06-02-64	55.66
		08-31-64	47.35
		09-30-64	49.06
		11-03-64	51.02
		12-14-64	52.68
		02-17-65	55.14
		03-26-65	55.96
		04-30-65	56.49
		05-19-65	55.84
		06-29-65	42.26
		09-03-65	41.53
		10-04-65	43.79
		10-28-65	45.77
		12-02-65	47.26
		01-06-66	49.49
		03-21-66	51.46
		04-22-66	53.82
		09-14-66	57.10
		10-26-66	56.94
		03-24-67	58.02
		11-30-67	51.54
		03-05-68	64.09
		09-24-68	38.47
		03-11-69	51.47
		09-23-69	37.50
		03-09-70	51.30
		09-14-70	42.64
		03-12-71	53.29
		09-15-71	47.74
		03-07-72	55.05
		09-26-72	57.30
		03-14-73	59.29
		09-26-73	37.50
		03-21-74	51.01
		09-13-74	45.17
		03-03-75	54.45
		03-01-76	52.20
		09-21-76	54.91
		03-02-77	59.96
		09-22-77	66.02
		03-08-78	64.54
		03-06-79	51.86
		09-12-79	39.29
		03-06-80	52.74
		09-29-80	35.15
		03-06-81	49.44
		09-11-81	51.77
		03-10-82	52.57
		09-14-82	37.56
		03-08-83	50.05
		09-12-83	33.38
		03-09-84	46.13
		09-14-84	39.70
		03-05-85	48.57
		09-20-85	45.71
		03-07-86	50.67
		09-05-86	40.97
		03-05-87	52.44
(D-14-4)12cdc-1—Continued		09-02-87	52.76
		11-09-87	54.36
		12-02-87	55.32
		01-04-88	56.20
		02-03-88	56.94
		03-02-88	57.45
		03-29-88	57.57
		04-28-88	57.74
		06-01-88	52.29
		06-29-88	45.79
		07-27-88	48.69
		12-02-88	55.91
		02-01-89	58.28
		03-08-89	59.06
		05-02-89	59.02
		06-14-89	55.11
		07-26-89	56.63
		09-13-89	64.45
		11-07-89	59.30
		03-01-90	61.68
(D-14-4)24cdb-1	5,960	10-11-66	48.00
		12-04-87	30.74
		01-04-88	31.74
		02-03-88	32.58
		02-29-88	33.12
		03-29-88	33.39
		04-28-88	32.72
		06-01-88	32.32
		06-29-88	31.14
		07-27-88	29.67
		09-02-88	30.08
		12-02-88	33.50
		02-01-89	34.98
		03-08-89	35.58
		05-02-89	36.23
		06-14-89	34.98
		07-26-89	34.08
		11-07-89	37.19
		03-01-90	39.82
(D-14-4)27aab-1	5,810	03-16-65	4.58
		04-30-65	4.99
		06-29-65	2.30
		07-31-65	1.69
		09-03-65	4.64
		10-04-65	4.65
		10-28-65	4.43
		12-02-65	3.83
		01-06-66	3.64
		03-21-66	3.00
		04-22-66	3.58
		05-20-66	3.24
		06-17-66	3.66
		07-29-66	6.08
		09-14-66	6.55
		10-26-66	5.35
		03-24-67	3.94
		03-06-68	3.44
		03-11-69	3.49
		03-09-70	3.24
		03-12-71	3.32
(D-14-4)27aab-1—Continued		03-07-72	3.43
		03-14-73	3.61
		03-21-74	2.32
		03-03-75	3.70
		03-01-76	2.40
		03-03-77	4.59
		03-08-78	2.77
		03-06-79	4.34
		03-06-80	.68
		03-06-81	2.56
		03-10-82	.96
		03-08-83	.70
		03-09-84	1.50
		03-05-85	2.05
		03-18-86	.94
		03-05-87	2.47
		11-09-87	3.48
		12-02-87	3.74
		01-04-88	3.74
		02-03-88	3.56
		03-02-88	1.79
		03-29-88	2.71
		04-28-88	.85
		06-01-88	2.27
		06-29-88	3.27
		07-27-88	4.46
		09-02-88	5.27
		12-02-88	3.90
		02-01-89	3.62
		03-08-89	2.10
		05-02-89	3.71
		06-14-89	3.61
		07-26-89	5.26
		09-13-89	5.03
		11-07-89	6.05
		03-01-90	5.36
(D-14-4)36abb-1	6,133	05-28-50	125 R
		08-01-53	105 R
		05-03-89	119.60
		11-07-89	118.45
(D-14-5)19ccd-1	6,090	05-03-89	62.35
		11-07-89	66.32
(D-15-3)4abc-1	5,638	11-07-89	67.06
(D-15-3)7bcb-1	5,632	05-06-89	.86
(D-15-3)7ccb-1	5,640	11-11-87	15.45
		12-02-87	15.29
		01-04-88	14.99
		02-03-88	14.52
		02-29-88	14.29
		03-29-88	14.11
		04-28-88	14.30
		06-01-88	14.81
		06-29-88	15.19
		07-27-88	15.52
		08-29-88	15.86
		12-01-88	16.21
		01-30-89	15.60

Table 9. Water levels in selected wells, Sanpete Valley, Utah, Sanpete Valley, Utah—Continued

Location	Altitude of land surface (feet)	Date	Water level (feet)
(D-15-3)7ccb-1—Continued		03-06-89	15.20
		05-10-89	15.25
		06-16-89	15.78
		07-24-89	16.32
		09-12-89	16.80
		11-07-89	16.97
		03-01-90	16.09
(D-15-3)8cda-3	5,511	11-03-37	-2.25
		12-21-37	-2.47
		02-24-38	-2.72
		04-07-38	-2.70
		06-03-38	-2.60
		08-30-38	-1.93
		10-09-38	-1.95
		12-22-38	-2.32
		03-03-39	-2.65
		04-15-39	-2.58
		06-18-39	-1.53
		08-24-39	-1.92
		10-14-39	-1.25
		12-02-39	-1.90
		02-06-40	-1.82
		03-27-40	-2.18
		06-03-40	-2.02
		12-04-40	-1.60
		03-19-41	-1.91
		12-06-41	-1.94
		03-26-42	-2.40
		08-11-42	-1.70
		12-19-42	-2.55
		03-24-43	-2.43
		12-17-43	-2.72
		03-20-44	-3.83
		12-04-44	-2.72
		04-04-45	-3.23
		12-05-45	-2.83
		03-22-46	-2.95
		12-19-46	-3.80
		03-28-47	-3.70
		12-13-47	-3.55
		03-18-48	-3.48
		12-14-48	-3.22
		04-04-49	-3.15
		12-13-49	-2.98
		03-30-50	-3.16
		03-28-51	-2.08
		12-12-51	-2.13
		04-08-52	-2.24
		12-09-52	-3.17
		03-18-53	-3.52
		12-11-53	-3.43
		03-27-54	-3.84
		11-30-54	-3.42
		03-23-55	-3.47
		12-07-55	-3.03
		03-22-56	-3.48
		12-06-56	-2.83
		03-12-58	-3.40
		04-04-58	-2.75
		05-07-58	-2.85
		06-04-58	-2.30
(D-15-3)8cda-3—Continued		07-03-58	-2.23
		08-04-58	-2.06
		09-02-58	-1.90
		10-07-58	-1.44
		11-06-58	-1.90
		11-29-58	-1.98
		01-02-59	-2.25
		01-27-59	-2.33
		02-25-59	-2.25
		03-26-59	-2.45
		04-29-59	-2.60
		05-29-59	-2.42
		06-24-59	-2.16
		07-29-59	-1.94
		08-25-59	-1.65
		09-25-59	-1.55
		10-29-59	-1.93
		11-30-59	-2.08
		12-30-59	-2.30
		01-27-60	-2.20
		03-25-60	-2.42
		04-27-60	-2.55
		05-25-60	-2.45
		06-17-60	-2.28
		07-27-60	-1.65
		08-29-60	-1.75
		09-30-60	-1.43
		10-27-60	-1.38
		11-30-60	-1.75
		12-30-60	-1.72
		01-30-61	-1.85
		02-27-61	-1.92
		03-31-61	-2.12
		04-24-61	-2.08
		05-26-61	-2.00
		07-06-61	-1.52
		07-26-61	-1.49
		08-24-61	-1.47
		09-29-61	-1.02
		10-16-62	-1.78
		03-10-65	-2.40
		03-26-65	-2.58
		04-30-65	-2.43
		06-25-65	-2.20
		07-31-65	-2.00
		09-02-65	-2.00
		10-04-65	-1.92
		10-28-65	-1.89
		12-02-65	-1.70
		01-05-66	-2.10
		03-18-66	-2.35
		04-22-66	-2.35
		05-20-66	-2.10
		06-17-66	-1.90
		07-26-66	-1.40
		09-07-66	-.30
		10-26-66	-1.45
		03-24-67	-2.25
		11-29-67	-2.12
		03-05-68	-2.45
		09-25-68	-2.20
		03-14-69	-2.69
(D-15-3)8cda-3—Continued		09-25-69	-1.87
		03-12-70	-2.28
		09-16-70	-1.85
		03-09-71	-2.48
		09-17-71	-1.80
		03-07-72	-2.37
		09-28-72	-1.38
		03-16-73	-2.65
		09-27-73	-2.82
		03-21-74	-2.80
		09-18-74	-3.24
		03-05-75	-2.74
		09-05-75	-3.34
		03-01-76	-3.02
		03-02-77	-2.14
		09-23-77	-1.06
		03-10-78	-2.30
		09-12-78	-1.00
		03-06-79	-1.90
		09-12-79	-1.40
		03-06-80	-2.70
		09-29-80	-1.88
		03-05-81	-2.40
		03-09-82	-1.90
		03-11-83	-2.90
		03-09-84	-2.90
		03-12-85	-2.83
		03-13-86	-3.20
		03-03-87	-3.10
		11-10-87	-1.30
		12-02-87	-2.40
		01-04-88	-2.60
		02-03-88	-2.70
		03-02-88	-2.80
		03-29-88	-2.90
		04-28-88	-3.10
		06-01-88	-2.70
		06-29-88	-2.20
		08-03-88	-1.76
		08-29-88	-1.90
		12-01-88	-2.40
		01-30-89	-2.60
		03-06-89	-2.60
		05-06-89	-3.30
		06-16-89	-2.40
		07-24-89	-1.90
		09-12-89	-2.85
		11-07-89	-2.10
		03-01-90	-2.70
(D-15-3)12abb-3	5,610	11-18-87	12.77
		12-02-87	14.45
		01-04-88	16.86
		02-03-88	18.32
		02-29-88	19.35
		03-29-88	19.78
		04-28-88	18.83
		06-01-88	17.06
		06-29-88	11.47
		07-27-88	11.86
		09-02-88	10.67
		05-06-89	24.40S

Table 9. Water levels in selected wells, Sanpete Valley, Utah—Continued

Location	Altitude of land surface (feet)	Date	Water level (feet)
(D-15-3)12abb-3—Continued		06-16-89	13.37
		07-24-89	12.85
		11-07-89	15.99
		03-01-90	20.94
(D-15-3)15ada-1	5,560	05-06-89	24.98
		11-07-89	27.06
(D-15-3)16aab-1	5,520	06-25-64	4.37
		05-18-65	4.31
		05-05-89	2.35
		11-07-89	5.06
(D-15-3)16adb-1	5,519	05-06-64	4.11
		06-02-64	3.75
		06-25-64	3.79
		10-30-64	2.50
		12-11-64	2.95
		02-12-65	2.60
		03-26-65	3.49
		04-29-65	3.86
		05-18-65	4.35
		06-25-65	2.07
		07-22-65	3.66
		09-02-65	3.98
		10-04-65	2.95
		10-27-65	2.86
		12-02-65	2.40
		01-05-66	3.60
		03-18-66	3.92
		04-22-66	4.24
		05-23-66	3.48
		10-26-66	5.88
		03-24-67	3.93
		03-05-68	3.40
		03-19-70	4.54
		03-09-71	4.61
		03-07-72	4.72
		03-14-73	3.86
		03-21-74	3.88
		03-05-75	3.95
		03-01-76	4.81
		03-03-77	5.98
		03-10-78	6.52
		03-06-79	4.86
		03-05-80	3.17
		03-05-81	5.77
		03-09-82	4.39
		03-11-83	1.98
		03-10-84	4.24
		03-04-85	4.85
		03-13-86	4.14
		03-03-87	5.92
		11-10-87	4.89
		12-02-87	5.76
		01-04-88	5.60
		02-03-88	6.63
		03-02-88	5.42
		03-29-88	5.73
		04-28-88	4.40
		06-01-88	4.70
		06-29-88	5.34
(D-15-3)16adb-1—Continued		07-27-88	6.24
		09-01-88	6.82
		12-01-88	6.53
		01-30-89	5.91
		03-06-89	5.21
		06-16-89	6.06
		07-24-89	7.08
		09-12-89	7.92
		11-07-89	7.57
		03-01-90	6.54
(D-15-3)25bbd-1	5,600	11-18-87	5.29
		12-04-87	5.10
		01-04-88	4.86
		02-03-88	4.76
		02-29-88	4.42
		03-29-88	4.10
		04-28-88	4.23
		06-01-88	3.16
		06-29-88	4.24
		07-27-88	4.02
		09-01-88	9.05
		12-01-88	4.80
		02-01-89	4.27
		03-07-89	3.95
		05-04-89	4.62
		06-16-89	11.98
		07-24-89	15.46
		11-07-89	9.75
		03-01-90	5.30
(D-15-3)27ada-1	5,521	05-06-64	11.13
		06-02-64	7.28
		06-25-64	1.52
		08-03-64	2.62
		08-31-64	4.54
		09-29-64	6.17
		10-30-64	5.95
		12-11-64	7.30
		02-12-65	7.67
		03-25-65	7.90
		04-29-65	7.30
		06-25-65	.14
		07-30-65	-.70
		09-02-65	1.83
		10-04-65	2.87
		10-27-65	4.23
		12-02-65	4.58
		01-05-66	6.52
		03-18-66	8.85
		04-22-66	5.52
		05-23-66	2.37
		06-17-66	3.16
		09-14-66	10.97
		10-26-66	7.23
		03-24-67	8.46
		03-05-68	4.85
		03-14-69	7.14
		03-19-70	6.54
		03-11-71	9.03
		03-08-72	8.87
		03-14-73	3.17
(D-15-3)27ada-1—Continued		04-04-73	4.83
		03-19-74	3.05
		03-04-75	5.68
		03-01-76	7.17
		03-03-77	12.26
		03-18-86	10.59
		03-04-87	11.86
		11-11-87	4.35
		12-02-87	7.48
		01-04-88	9.95
		02-03-88	11.42
		03-02-88	12.00
		03-29-88	11.49
		04-28-88	9.45
		06-01-88	6.75
		06-29-88	7.48
		07-27-88	3.69
		09-01-88	8.55
		12-01-88	8.97
		02-01-89	12.12
		03-07-89	12.31
		05-04-89	9.09
		06-16-89	8.70
		07-24-89	10.50
		09-14-89	11.45
		11-07-89	8.07
		03-01-90	13.90
(D-15-3)27bbc-1	5,495	05-06-64	2.13
		06-02-64	2.24
		06-25-64	2.29
		08-03-64	3.74
		08-31-64	3.44
		09-29-64	3.07
		10-30-64	2.12
		05-18-65	1.85
		06-25-65	1.69
		10-27-65	1.83
		03-18-66	2.23
		10-26-66	2.22
		05-06-89	3.15
		11-07-89	4.31
(D-15-3)28daa-1	5,486	11-25-66	3.8
		05-06-89	3.82
		11-07-89	4.75
(D-15-3)29cca-1	5,518	11-22-66	-4.8
		05-06-89	2.14
		11-07-89	3.14
(D-15-3)30dbb-1	5,590	11-12-66	38.19
		03-23-81	31.82
		09-12-81	41.95
		03-09-82	33.06
		09-14-82	33.79
		03-11-83	29.06
		09-12-83	25.92
		03-09-84	24.87
		09-14-84	24.30
		03-04-85	26.38
		09-20-85	27.48

Location	Altitude of land surface (feet)	Date	Water level (feet)
(D-15-3)30dbb-1—Continued		03-13-86	27.22
		09-04-86	27.75
		03-03-87	26.35
		09-01-87	28.65
		11-11-87	29.05
		12-02-87	33.37
		01-04-88	29.00
		02-03-88	29.42
		03-02-88	27.77
		03-29-88	27.36
		04-28-88	27.84
		06-01-88	28.54
		06-29-88	29.32
		07-27-88	29.96
		09-01-88	30.53
		12-01-88	31.33
		02-01-89	30.30
		03-07-89	30.55
		05-10-89	29.34
		06-16-89	31.06
		07-24-89	31.69
		09-14-89	32.18
		11-07-89	32.41
		03-01-90	31.34
(D-15-3)32ccd-1	5,495	11-21-66	12.81
		05-06-89	4.67
		11-07-89	8.81
(D-15-3)33bba-1	5,479	11-25-66	-3.95
		05-06-89	-4.30
		11-07-89	-3.50
(D-15-3)35aaa-1	5,533	03-15-65	5.15
		04-30-65	4.28
		06-29-65	-.81
		07-31-65	-1.21
		09-03-65	.04
		10-04-65	-.09
		12-02-65	-.89
		01-05-66	-.70
		03-21-66	-.86
		04-22-66	-.18
		05-20-66	.60
		06-17-66	1.69
		07-28-66	5.74
		09-14-66	9.55
		10-26-66	10.20
		01-18-67	8.99
		03-24-67	5.36
		03-15-68	-2.10
		03-14-69	-2.32
		03-10-70	-.25
		03-09-71	.56
		03-09-72	-.75
		03-16-73	5.54
		04-04-73	-.27
		03-19-74	-2.22
		03-04-75	4.33
		03-01-76	-1.10
		03-03-77	10.33
		03-10-78	9.10
(D-15-3)35aaa-1—Continued		03-06-80	-3.01
		03-04-81	.22
		03-08-85	-.37
		03-18-86	-1.81
		03-04-87	-.90
		03-02-88	.15
		09-01-88	7.19
		03-07-89	1.39
		05-04-89	-.09
		09-14-89	10.34
		11-07-89	11.27
		03-01-90	7.52
(D-15-3)35baa-1	5,517	11-26-66	8.20
		05-06-89	13.96
(D-15-4)2adb-1	6,109	10-17-66	140.80
		05-03-89	140.58
		11-09-89	140.70
(D-15-4)2bdb-1	6,000	11-10-87	74.35
		12-02-87	75.60
		01-04-88	76.99
		02-03-88	78.57
		02-29-88	79.70
		03-29-88	80.82
		04-28-88	81.73
		06-01-88	81.71
		06-29-88	79.44
		07-27-88	78.34
		09-02-88	77.43
		12-02-88	81.01
		02-01-89	82.09
		03-07-89	83.02
		05-03-89	84.06
		06-14-89	84.99
		07-26-89	85.13
		11-08-89	87.16
		03-01-90	86.64
(D-15-4)4bad-2	5,755	05-11-64	33.48
		07-14-64	23.70
		09-30-64	29.67
		05-19-65	32.94
		06-29-65	23.17
		10-28-65	23.32
		03-21-66	29.27
		10-17-66	31.10
		12-02-88	30.32
		02-01-89	31.27
		03-07-89	31.95
		05-02-89	31.53
		06-14-89	29.18
		07-26-89	30.90
		11-08-89	33.46
		03-01-90	35.24
(D-15-4)4bcd-1	5,740	05-11-64	33.94
		09-30-64	30.45
		11-03-64	31.72
		12-14-64	32.03
		02-17-65	32.65
(D-15-4)4bcd-1—Continued		03-26-65	33.20
		04-30-65	33.68
		07-31-65	20.32
		10-04-65	22.68
		10-28-65	24.25
		12-02-65	25.41
		01-05-66	27.20
		03-21-66	29.83
		05-20-66	27.91
		06-17-66	27.29
		10-17-66	31.08
		03-24-67	31.18
		03-06-68	31.55
		03-11-69	28.15
		03-09-70	27.93
		03-09-71	28.69
		03-07-72	29.49
		03-14-73	30.02
		03-20-74	26.49
		03-03-75	30.23
		03-01-76	27.30
		03-03-77	32.23
		03-08-78	35.98
		03-06-79	32.89
		03-06-80	29.00
		03-05-81	26.67
		03-10-82	27.62
		03-08-83	26.46
		03-09-84	23.28
		03-05-85	25.09
		03-12-86	24.98
		03-05-87	27.08
		11-09-87	27.94
		12-02-87	23.30
		01-04-88	28.92
		02-03-88	29.58
		03-02-88	30.02
		03-29-88	30.18
		04-28-88	30.09
		06-01-88	27.63
		06-29-88	24.50
		07-27-88	28.67
		12-02-88	29.95
		02-01-89	31.01
		03-07-89	31.19
		05-03-89	29.81
		06-14-89	29.00
		09-13-89	34.07
		11-08-89	33.42
		03-01-90	35.62
(D-15-4)4dda-1	5,820	08-02-35	26.22
		09-03-35	27.42
		10-09-35	29.01
		11-21-35	28.97
		12-10-35	28.79
		01-10-36	30.15
		03-02-36	31.31
		04-24-36	31.10
		06-19-36	15.77
		08-07-36	14.68
		10-02-36	17.16

Table 9. Water levels in selected wells, Sanpete Valley, Utah—Continued

Location	Altitude of land surface (feet)	Date	Water level (feet)
(D-15-4)4dda-1—Continued		11-29-36	18.14
		02-05-37	19.65
		04-11-37	20.97
		06-10-37	12.58
		08-01-37	12.52
		09-24-37	15.85
		11-03-37	17.64
		12-11-37	17.62
		02-24-38	21.28
		04-07-38	22.44
		06-03-38	15.43
		08-30-38	16.77
		10-09-38	18.81
		12-22-38	20.96
		03-03-39	24.06
		04-14-39	24.70
		06-18-39	15.68
		08-24-39	20.38
		10-14-39	20.87
		12-02-39	22.44
		03-27-40	22.10
		06-03-40	16.95
		12-04-40	18.24
		03-19-41	21.06
		09-28-41	9.77
		12-06-41	11.48
		03-26-42	13.87
		08-11-42	4.82
		12-20-42	9.45
		03-24-43	11.92
		12-17-43	13.87
		03-20-44	17.32
		12-04-44	12.22
		04-04-45	16.12
		12-05-45	11.53
		03-22-46	16.32
		12-19-46	18.52
		03-28-47	22.05
		12-13-47	17.38
		12-31-47	18.32
		01-31-48	19.55
		02-28-48	21.17
		03-31-48	22.54
		04-30-48	22.08
		05-31-48	18.52
		06-30-48	13.28
		07-15-48	14.05
		12-13-48	22.21
		02-25-49	25.10
		04-04-49	26.53
		12-13-49	19.70
		03-30-50	23.10
		12-11-50	23.16
		03-28-51	27.35
		12-12-51	26.71
		04-08-52	27.23
		12-09-52	9.29
		03-18-53	10.59
		03-27-54	14.10
		03-23-55	24.78
		12-07-55	26.26
		03-22-56	28.48
(D-15-4)4dda-1—Continued		09-10-56	26.85
		09-28-56	26.81
		10-01-56	26.70
		12-05-56	27.38
		01-04-57	29.15
		02-04-57	30.18
		02-28-57	30.26
		04-03-57	30.75
		05-03-57	30.32
		06-03-57	25.40
		07-01-57	12.15
		08-29-57	12.65
		10-01-57	14.36
		11-07-57	14.98
		12-04-57	15.75
		12-31-57	16.61
		02-05-58	17.84
		03-04-58	17.80
		04-04-58	18.45
		05-07-58	17.86
		06-04-58	8.33
		09-02-58	13.10
		10-07-58	12.81
		11-06-58	12.50
		11-29-58	12.95
		01-02-59	13.27
		01-27-59	13.90
		02-26-59	14.39
		03-25-59	14.68
		04-29-59	14.13
		09-25-59	20.72
		10-29-59	18.55
		11-30-59	18.78
		12-30-59	19.84
		01-27-60	21.53
		03-25-60	23.69
		04-27-60	22.77
		09-30-60	24.14
		10-27-60	24.01
		11-30-60	24.43
		12-30-60	25.88
		01-30-61	26.59
		02-27-61	27.93
		03-31-61	29.23
		04-24-61	29.42
		09-29-61	30.58
		04-05-62	31.62
		09-28-62	13.75
		04-11-63	17.99
		09-25-63	19.42
		04-01-64	24.39
		05-11-64	22.60
		11-03-64	20.03
		12-14-64	21.09
		02-17-65	23.48
		03-26-65	24.74
		04-30-65	24.74
		05-19-65	23.42
		09-03-65	6.71
		10-04-65	7.73
		10-28-65	8.37
		12-02-65	9.28
(D-15-4)4dda-1—Continued		01-05-66	11.38
		03-21-66	14.78
		04-22-66	13.54
		09-14-66	17.55
		10-17-66	16.85
		03-24-67	21.76
		11-30-67	16.02
		03-06-68	17.21
		03-11-69	10.88
		03-09-70	12.09
		03-09-71	12.68
		03-07-72	15.76
		03-15-73	22.82
		03-20-74	12.05
		10-10-74	10.74
		03-03-75	15.03
		03-01-76	10.91
		04-05-77	22.02
		09-22-77	32.34
		03-08-78	31.66
		04-18-79	22.50
		03-06-80	14.68
		09-29-80	21.67
		03-05-81	11.90
		09-11-81	15.24
		03-10-82	17.71
		09-14-82	5.89
		03-08-83	8.71
		09-12-83	5.91
		03-09-84	2.99
		09-14-84	3.42
		03-05-85	4.68
		09-20-85	4.67
		03-12-86	4.96
		09-05-86	5.16
		03-05-87	11.75
		09-02-87	9.16
		03-02-88	11.32
		09-02-88	15.22
		03-08-89	19.60
		05-03-89	20.30
		06-08-89	18.50
		07-26-89	25.29
		09-29-89	23.24
		11-10-89	24.08
		03-02-90	27.90
(D-15-4)7dad-1	5,660	11-08-89	-7.0
(D-15-4)7dda-1	5,660	11-08-89	-3.9
(D-15-4)8dac-1	5,702	05-03-89	.32
		11-08-89	2.52
(D-15-4)9bac-1	5,750	05-11-64	32.81
		07-14-64	24.66
		09-30-64	29.08
		05-19-65	32.80
		06-29-65	25.80
		10-28-65	21.15
		03-21-66	26.23
		10-20-66	29.30

Table 9. Water levels in selected wells, Sanpete Valley, Utah—Continued

Location	Altitude of land surface (feet)	Date	Water level (feet)
(D-15-4)9bac-1—Continued		05-03-89	25.20
		11-08-89	29.93
(D-15-4)9bbd-1	5,738	10-20-66	22.00
		05-03-89	21.50
		11-08-89	24.76
(D-15-4)9ccc-1	5,745	03-05-85	8.63
		03-12-86	9.61
		03-05-87	14.01
		03-02-88	17.78
		09-02-88	20.03
		03-07-89	20.69
		05-03-89	22.89
		09-12-89	29.23
		11-08-89	27.67
		03-01-90	25.19
(D-15-4)16bbb-1	5,745	10-25-66	27.54
		05-03-89	23.30
		11-08-89	28.53
(D-15-4)17abb-1	5,716	05-11-64	19.90
		07-06-64	15.54
		08-03-64	18.18
		08-31-64	19.15
		11-03-64	19.83
		12-14-64	20.02
		02-17-65	19.52
		03-26-65	19.01
		04-30-65	19.19
		07-31-65	12.99
		09-03-65	12.76
		10-04-65	14.05
		10-28-65	14.34
		12-02-65	15.99
		01-05-66	15.58
		03-21-66	15.07
		04-22-66	15.61
		10-20-66	17.26
		03-24-67	16.78
		03-06-68	15.41
		03-11-69	14.43
		03-09-70	11.71
		03-09-71	12.10
		03-07-72	12.17
		03-14-73	15.09
		03-20-74	10.60
		03-03-75	13.53
		03-01-76	11.21
		03-03-77	17.66
		03-13-78	22.86
		03-06-79	21.22
		03-06-80	16.59
		03-05-81	12.98
		03-10-82	17.87
		03-08-83	12.64
		03-09-84	5.88
		03-05-85	12.17
		03-12-86	9.93
		03-05-87	12.46
		11-09-87	13.19
(D-15-4)17abb-1—Continued		12-02-87	13.22
		01-04-88	13.50
		02-03-88	13.80
		03-02-88	13.70
		03-29-88	12.85
		04-28-88	13.05
		06-01-88	12.17
		06-29-88	13.10
		07-27-88	15.40
		09-02-88	14.25
		12-02-88	15.14
		02-01-89	15.28
		03-07-89	14.99
		05-03-89	15.76
		06-14-89	17.69
		07-26-89	20.37
		09-14-89	18.38
		11-08-89	18.64
		03-01-90	17.49
(D-15-4)21cda-1	5,914	05-11-64	86.51
		07-06-64	82.62
		07-27-64	83.57
		09-29-64	84.10
		02-17-65	85.39
		03-24-65	85.99
		04-30-65	86.12
		06-29-65	81.70
		07-31-65	75.62
		09-03-65	76.39
		10-04-65	77.48
		10-28-65	77.57
		12-02-65	77.85
		01-05-66	78.83
		03-21-66	81.69
		04-22-66	82.57
		05-20-66	87.83
		06-17-66	86.82
		07-28-66	82.99
		09-14-66	83.10
		10-26-66	83.57
		03-24-67	85.43
		03-06-68	84.65
		03-07-72	80.13
		03-20-74	78.64
		03-03-75	79.97
		03-01-76	77.18
		03-03-77	83.54
		03-10-78	87.25
		03-06-79	83.22
		03-05-80	83.08
		03-04-81	77.83
		03-09-82	82.09
		03-08-83	76.97
		03-09-84	63.83
		03-05-85	49.61
		03-12-86	52.15
		03-04-87	58.33
		11-12-87	65.79
		12-02-87	66.78
		01-04-88	68.28
		02-03-88	69.72
(D-15-4)21cda-1—Continued		03-02-88	70.65
		03-29-88	71.33
		04-28-88	72.29
		06-01-88	73.37
		06-29-88	73.21
		07-27-88	73.63
		09-02-88	73.60
		12-02-88	75.05
		03-07-89	75.95
		05-04-89	76.70
		06-14-89	77.12
		07-26-89	77.37
		09-14-89	77.90
		11-08-89	78.80
		03-02-90	80.41
(D-15-4)29bac-1	5,756	11-12-87	1.79
		05-04-89	3.03
		11-08-89	5.67
(D-15-4)31dab-1	5,814	08-02-35	-3.80
		09-03-35	-3.70
		10-08-35	-3.70
		11-21-35	-3.50
		03-16-65	-4.80
		04-30-65	-4.80
		06-29-65	-5.40
		09-03-65	-5.40
		10-04-65	-5.20
		10-28-65	-5.20
		12-02-65	-5.00
		01-05-66	-4.80
		03-21-66	-4.70
		04-22-66	-4.70
		05-20-66	-4.90
		06-17-66	-4.90
		07-28-66	-4.80
		09-14-66	-4.80
		10-26-66	-4.60
		03-24-67	-4.50
		03-06-68	-4.90
		03-09-70	-4.90
		03-09-71	-5.00
		03-07-72	-5.20
		03-20-74	-3.60
		03-03-75	-5.60
		03-01-76	-6.20
		03-03-77	-5.30
		03-10-78	-4.80
		03-06-79	-4.90
		03-05-80	-5.30
		03-05-81	-5.20
		03-09-82	-5.30
		03-08-83	-5.70
		03-09-84	-6.40
		03-08-85	-6.50
		03-12-86	-6.90
		03-04-87	-6.20
		11-12-87	-5.90
		12-02-87	-4.90
		01-04-88	-5.90
		02-03-88	-5.60

Table 9. Water levels in selected wells, Sanpete Valley, Utah—Continued

Location	Altitude of land surface (feet)	Date	Water level (feet)
(D-15-4)31dab-1—Continued		03-02-88	-6.00
		03-29-88	-5.20
		04-28-88	-6.50
		06-01-88	-6.80
		06-29-88	-4.70
		07-27-88	-5.20
		09-02-88	-6.90
		12-01-88	-6.25
		02-01-89	-7.30
		03-07-89	-7.70
		05-04-89	-7.20
		06-14-89	-6.70
		07-27-89	-6.90
		09-14-89	-5.20
		11-09-89	-5.96
(D-16-2)13dda-1	5,465	05-04-64	5.99
		06-02-64	5.52
		06-24-64	5.25
		09-04-64	11.00
		09-29-64	9.22
		10-30-64	8.14
		12-11-64	7.17
		02-10-65	6.24
		03-25-65	6.00
		04-29-65	5.31
		05-18-65	5.29
		06-04-65	4.96
		06-25-65	4.55
		07-30-65	4.10
		09-02-65	3.86
		10-04-65	3.75
		10-27-65	3.59
		12-02-65	3.52
		01-05-66	3.34
		03-18-66	2.98
		04-27-66	2.78
		09-15-66	13.30
		10-28-66	10.40
		03-24-67	6.58
		03-06-68	3.85
		03-14-69	2.41
		03-19-70	.28
		03-09-71	.05
		03-08-72	1.36
		03-19-74	2.08
		03-05-75	2.09
		03-02-76	.99
		03-02-77	3.97
		03-09-78	7.66
		03-07-79	4.51
		03-05-80	4.86
		03-05-81	.14
		03-09-82	.35
		09-27-89	3.01
		03-01-90	.05
(D-16-2)24cda-1	5,490	12-19-66	40.40
		12-04-87	24.48
		01-05-88	24.67
		02-04-88	25.14
		02-29-88	25.21
(D-16-2)24cda-1—Continued		03-30-88	25.40
		04-29-88	25.71
		06-02-88	25.92
		06-30-88	26.21
		07-28-88	26.60
		08-30-88	26.90
		11-30-88	27.67
		01-31-89	27.86
		03-07-89	28.14
		05-08-89	28.37
		06-16-89	29.60
		07-25-89	29.60
		09-14-89	32.49
		11-09-89	32.73
		03-01-90	32.52
(D-16-2)35acd-1	5,519	05-04-64	45.62
		06-02-64	47.19
		09-29-64	49.14
		10-30-64	48.07
		12-11-64	47.29
		02-10-65	46.85
		03-25-65	46.50
		04-28-65	46.24
		05-18-65	46.12
		06-03-65	45.86
		06-23-65	45.78
		07-29-65	45.66
		08-30-65	44.63
		09-29-65	44.28
		10-26-65	43.91
		12-01-65	43.78
		01-03-66	43.65
		02-22-66	43.68
		03-17-66	43.76
		04-20-66	43.97
		09-15-66	48.70
		10-28-66	47.50
		03-23-67	45.72
		03-06-68	45.28
		03-19-70	34.77
		03-09-71	38.68
		03-08-72	39.86
		03-19-74	40.15
		03-05-75	39.41
		03-02-76	40.22
		03-02-77	42.81
		03-09-78	45.75
		03-07-79	43.12
		03-05-80	41.13
		03-04-81	35.65
		03-09-82	38.57
		03-11-83	34.30
		03-10-84	29.65
		03-04-85	27.35
		03-13-86	28.28
		03-03-87	26.07
		03-01-88	33.00
		08-30-88	36.32
		03-07-89	37.02
		09-27-89	39.59
		03-01-90	39.30
(D-16-2)36cbd-1	5,472	05-04-64	18.51
		06-02-64	21.46
		09-29-64	23.08
		10-30-64	21.34
		12-11-64	22.28
		02-10-65	19.32
		03-25-65	18.93
		04-28-65	18.78
		05-18-65	18.64
		06-03-65	18.38
		06-23-65	20.93
		07-29-65	17.70
		08-30-65	16.11
		09-29-65	15.50
		10-26-65	15.13
		12-01-65	14.95
		01-03-66	14.67
		02-22-66	14.51
		03-17-66	14.50
		04-20-66	14.51
		09-15-66	28.60
		10-28-66	21.10
		03-23-67	18.09
		03-06-68	17.20
		03-14-69	14.13
		03-19-70	10.38
		03-09-71	10.39
		03-08-72	13.07
		03-16-73	17.06
		03-19-74	12.93
		03-05-75	12.62
		03-02-76	11.84
		03-02-77	16.10
		03-09-78	19.77
		03-07-79	16.88
		03-05-80	16.19
		03-04-81	8.04
		03-09-82	11.09
		03-11-83	6.77
		11-12-87	1.35
		12-03-87	1.72
		01-05-88	2.07
		02-04-88	2.65
		03-01-88	2.83
		03-30-88	3.25
		04-29-88	3.76
		06-02-88	4.26
		06-30-88	4.68
		07-28-88	5.25
		08-30-88	4.03
		11-30-88	5.13
		01-31-89	4.90
		03-07-89	5.81
		05-08-89	6.51
		09-14-89	13.96
		11-09-89	10.83
		03-01-90	10.46
(D-16-3)1bbb-2	5,560	11-29-66	-10.6
		05-06-89	-13.3
		09-20-89	-11.9
		11-08-89	-9.2

Table 9. Water levels in selected wells, Sanpete Valley, Utah—Continued

Location	Altitude of land surface (feet)	Date	Water level (feet)
(D-16-3)3bbc-1	5.471	11-29-66	-6.1
		09-20-89	-5.1
(D-16-3)3cbc-1	5,461	09-08-89	-4.6
(D-16-3)3daa-1	5,475	11-18-87	6.96
		12-02-87	6.85
		01-05-88	6.54
		02-04-88	6.44
		02-29-88	6.23
		03-29-88	4.96
		04-28-88	5.17
		06-02-88	5.59
		06-30-88	6.39
		07-28-88	7.66
		09-01-88	8.04
		12-01-88	7.80
		02-01-89	7.36
		03-07-89	6.88
		05-04-89	6.20
		06-16-89	7.19
		07-24-89	8.29
		09-15-89	9.23
		11-07-89	8.70
		03-01-90	8.19
(D-16-3)4aaa-1	5,471	08-05-35	-2.30
		09-03-35	-2.15
		10-09-35	-2.06
		11-21-35	-4.05
		12-13-35	-4.42
		01-25-36	-4.80
		03-03-36	-5.10
		04-29-36	-5.70
		06-19-36	-5.55
		08-07-36	-5.30
		10-02-36	-5.00
		11-29-36	-5.60
		02-05-37	-6.40
		04-11-37	-7.60
		06-10-37	-6.65
		08-01-37	-3.98
		09-24-37	-3.06
		11-03-37	-5.80
		12-22-37	-6.30
		02-24-38	-6.20
		04-07-38	-6.55
		06-03-38	-5.55
		08-30-38	-3.28
		10-09-38	-4.80
		12-22-38	-5.40
		03-03-39	-5.70
		04-15-39	-5.65
		06-18-39	-3.55
		08-24-39	-2.78
		10-14-39	-4.40
		12-02-39	-5.50
		02-06-40	-6.00
		03-27-40	-6.10
		06-04-40	-4.70
		12-04-40	-5.90
		03-19-41	-6.20
(D-16-3)4aaa-1—Continued		12-06-41	-6.60
		03-27-42	-6.90
		08-11-42	-4.80
		12-20-42	-6.40
		03-24-43	-6.80
		12-17-43	-6.20
		03-20-44	-7.00
		12-04-44	-6.70
		04-04-45	-6.80
		12-05-45	-7.10
		03-22-46	-7.40
		12-19-46	-7.20
		03-28-47	-7.30
		12-13-47	-7.30
		03-18-48	-7.20
		12-13-48	-6.30
		04-04-49	-7.00
		12-13-49	-6.20
		03-30-50	-7.10
		12-11-50	-5.90
		03-28-51	-6.90
		12-12-51	-5.70
		04-08-52	-6.70
		12-09-52	-6.60
		03-18-53	-6.70
		12-14-53	-6.70
		03-27-54	-6.90
		11-30-54	-6.30
		03-23-55	-6.40
		12-07-55	-6.20
		03-22-56	-6.50
		12-05-56	-5.70
		03-12-58	-7.50
		04-04-58	-7.10
		05-07-58	-6.80
		06-04-58	-7.40
		07-03-58	-4.70
		08-04-58	-4.15
		09-02-58	-4.70
		10-07-58	-4.70
		11-06-58	-5.30
		11-29-58	-4.97
		01-02-59	-5.40
		01-27-59	-5.20
		02-25-59	-6.00
		03-26-59	-5.80
		04-29-59	-4.85
		05-29-59	-4.20
		06-24-59	-3.98
		07-29-59	-3.48
		08-25-59	-3.10
		09-25-59	-2.95
		10-29-59	-3.62
		11-30-59	-5.70
		12-30-59	-5.40
		01-27-60	-5.80
		03-25-60	-5.80
		04-27-60	-4.30
		05-25-60	-4.01
		06-17-60	-3.83
		07-27-60	-3.11
		08-29-60	-2.76
(D-16-3)4aaa-1—Continued		09-30-60	-2.78
		10-27-60	-3.03
		11-30-60	-5.00
		12-30-60	-5.50
		01-30-61	-5.35
		02-27-61	-5.50
		03-31-61	-5.90
		04-24-61	-4.90
		05-26-61	-3.66
		07-06-61	-2.83
		07-26-61	-2.46
		08-24-61	-2.25
		09-29-61	-2.50
		04-05-62	-4.80
		09-28-62	-3.55
		04-11-63	-4.20
		09-25-63	-2.91
		04-01-64	-4.00
		05-06-64	-3.80
		07-06-64	-4.00
		07-31-64	-3.21
		08-31-64	-2.96
		09-29-64	-3.16
		10-30-64	-3.60
		12-11-64	-5.80
		02-12-65	-6.25
		03-25-65	-6.21
		04-29-65	-4.12
		06-24-65	-4.50
		07-30-65	-4.80
		10-04-65	-4.40
		10-27-65	-6.30
		12-02-65	-6.50
		01-05-66	-6.60
		03-18-66	-6.50
		04-22-66	-6.35
		05-23-66	-5.80
		06-17-66	-3.90
		07-22-66	-5.00
		09-14-66	-2.95
		10-28-66	-4.70
		03-24-67	-6.03
		11-29-67	-5.80
		03-05-68	-5.90
		09-24-68	-4.00
		03-15-69	-5.80
		09-25-69	-4.00
		03-11-70	-6.30
		09-16-70	-3.90
		03-09-71	-6.20
		09-17-71	-4.40
		03-07-72	-5.40
		09-27-72	-4.50
		03-16-73	-5.20
		09-27-73	-4.30
		03-21-74	-6.30
		09-13-74	-4.00
		03-04-75	-6.50
		09-05-75	-3.40
		03-01-76	-5.30
		09-21-76	-5.00
		03-02-77	-5.60

Table 9. Water levels in selected wells, Sanpete Valley, Utah—Continued

Location	Altitude of land surface (feet)	Date	Water level (feet)
(D-16-3)4aaa-1—Continued		09-05-77	-4.10
		10-04-77	-2.55
		03-10-78	-4.60
		09-12-78	-4.60
		03-07-79	-5.60
		09-11-79	-4.11
		03-05-80	-6.80
		09-29-80	-4.70
		03-04-81	-6.50
		09-12-81	-4.00
		03-09-82	-7.10
		09-14-82	-4.90
		03-11-83	-7.40
		09-12-83	-7.70
		03-09-84	-6.50
		03-08-85	-7.60
		09-20-85	-5.00
		03-14-86	-7.90
		09-04-86	-5.60
		03-04-87	-5.50
		09-01-87	-5.90
		03-02-88	-7.00
		09-01-88	-5.00
		03-06-89	-5.60
		05-05-89	-5.40
		09-15-89	-3.30
		11-08-89	-4.40
		03-01-90	-6.00
(D-16-3)4aaa-2	5,471	10-28-66	-5.1
		05-05-89	-4.4
		11-08-89	-3.2
(D-16-3)4dbd-2	5,462	12-06-66	-8.4
		05-05-89	-7.9
		08-23-89	-8.2
		11-08-89	-8.4
(D-16-3)5cbc-1	5,480	12-05-66	7.7
		11-18-87	-.95
		12-02-87	-1.04
		01-04-88	-1.02
		02-03-88	-.92
		03-01-88	-.97
		03-29-88	-.90
		04-28-88	-.85
		06-01-88	-.76
		06-29-88	-.41
		07-27-88	-.03
		08-30-88	.14
		12-01-88	-.65
		02-01-89	.70
		03-07-89	.98
		05-06-89	1.26
		06-16-89	1.48
		07-24-89	1.82
		09-14-89	2.36
		11-07-89	2.49
		03-01-90	2.62
(D-16-3)5ddc-1	5,457	08-23-89	-8.1
(D-16-3)8aad-1	5,455	08-23-89	-3.05
(D-16-3)8add-1	5,455	08-23-89	-4.35
(D-16-3)8dab-1	5,453	05-05-89	.14
		11-08-89	.26
(D-16-3)9bcb-1	5,455	05-05-89	-10.8
		08-22-89	-8.3
(D-16-3)9bcc-1	5,455	05-05-89	-16.7
		08-22-89	-15.2
		11-08-89	-15.4
(D-16-3)13dda-1	5,862	03-08-65	42.76
		03-27-65	42.77
		04-29-65	42.89
		06-03-65	43.04
		06-24-65	43.20
		07-30-65	39.47
		09-01-65	28.29
		09-29-65	33.66
		10-27-65	34.59
		12-01-65	37.72
		01-03-66	38.95
		02-22-66	40.00
		03-17-66	40.31
		04-20-66	40.69
		05-17-66	41.08
		06-16-66	41.30
		07-21-66	40.70
		09-15-66	41.14
		11-03-66	41.47
		01-18-67	41.97
		01-18-67	42.00
		03-23-67	42.04
		03-06-68	42.01
		03-19-70	42.18
		03-09-71	42.28
		03-07-72	40.79
		03-16-73	42.62
		03-20-74	40.85
		03-03-75	41.91
		03-01-76	41.43
		03-02-77	42.75
		03-10-78	39.00
		03-06-79	41.83
		03-05-80	40.88
		03-04-81	40.95
		03-09-82	41.70
		03-08-83	41.14
		03-09-84	40.06
		03-05-85	39.82
		03-04-87	41.32
		11-12-87	40.94
		12-03-87	40.83
		01-05-88	41.02
		02-03-88	41.46
		03-01-88	41.93
		03-29-88	41.42
		12-02-88	41.16
		03-06-89	41.70
(D-16-3)13dda-1—Continued		05-04-89	41.35
		06-14-89	42.27
		07-26-89	39.43
		09-14-89	40.64
		11-09-89	41.93
(D-16-3)14dca-1	5,641	08-30-38	13.20
		10-09-38	13.02
		12-22-38	13.56
		03-03-39	14.94
		04-15-39	14.49
		06-17-39	14.49
		08-24-39	14.50
		10-14-39	14.51
		12-02-39	14.49
		02-07-40	14.47
		03-27-40	13.13
		08-01-40	13.42
		12-04-40	13.32
		03-19-41	13.21
		09-28-41	13.19
		12-06-41	13.10
		03-27-42	11.68
		08-11-42	12.35
		12-20-42	12.29
		03-24-43	12.21
		12-17-43	12.23
		03-20-44	12.21
		12-04-44	12.15
		04-04-45	12.14
		12-05-45	11.02
		03-22-46	11.08
		12-19-46	11.53
		03-28-47	11.48
		12-13-47	11.54
		03-18-48	11.25
		07-23-48	10.58
		12-13-48	11.20
		04-04-49	11.26
		12-13-49	11.62
		03-30-50	11.50
		12-11-50	11.87
		03-28-51	11.89
		12-13-51	12.29
		04-08-52	11.86
		12-09-52	11.71
		03-18-53	11.48
		12-11-53	11.57
		03-27-54	11.59
		03-23-55	11.91
		12-07-55	12.34
		03-22-56	12.30
		03-12-58	12.96
		04-04-58	12.98
		05-07-58	12.98
		06-04-58	11.52
		07-03-58	13.10
		08-04-58	13.04
		09-02-58	13.03
		10-07-58	12.07
		11-06-58	13.00
		11-29-58	12.98

Table 9. Water levels in selected wells, Sanpete Valley, Utah—Continued

Location	Altitude of land surface (feet)	Date	Water level (feet)
(D-16-3)14dca-1—Continued		01-02-59	13.05
		01-27-59	12.88
		02-25-59	12.86
		03-26-59	12.85
		04-29-59	12.86
		05-29-59	13.01
		06-24-59	13.88
		07-29-59	13.12
		08-25-59	13.13
		09-25-59	13.00
		10-29-59	12.94
		11-30-59	12.88
		12-30-59	12.91
		01-27-60	12.90
		03-25-60	12.92
		04-27-60	13.04
		05-25-60	13.24
		06-17-60	13.50
		07-27-60	13.97
		08-29-60	14.20
		09-30-60	14.17
		10-27-60	14.39
		11-30-60	13.62
		12-30-60	13.57
		01-30-61	13.55
		02-27-61	13.51
		03-31-61	13.51
		04-24-61	13.50
		05-26-61	13.80
		07-06-61	14.22
		07-26-61	14.59
		08-24-61	14.97
		09-29-61	14.53
		10-16-62	13.76
		02-10-65	14.15
		03-24-65	13.56
		04-29-65	13.46
		06-04-65	13.46
		06-24-65	13.58
		07-30-65	13.52
		09-01-65	13.39
		09-29-65	13.37
		10-27-65	13.25
		12-01-65	13.67
		01-03-66	13.37
		02-22-66	12.91
		03-17-66	13.19
		04-20-66	13.10
		05-17-66	12.97
		06-16-66	13.12
		07-21-66	14.03
		09-15-66	13.56
		11-03-66	13.45
		01-18-67	13.37
		03-23-67	13.28
		03-06-68	13.25
		03-12-69	13.13
		03-11-70	12.99
		09-15-70	13.49
		03-09-71	13.25
		03-07-72	13.29
		09-26-72	13.54
(D-16-3)14dca-1—Continued		03-16-73	13.39
		09-26-73	13.41
		03-20-74	13.36
		09-13-74	13.43
		03-03-75	13.26
		09-04-75	13.81
		03-01-76	13.38
		09-21-76	13.87
		03-02-77	13.32
		03-03-77	13.34
		09-22-77	14.72
		03-10-78	13.75
		09-12-78	15.13
		03-06-79	14.14
		09-11-79	14.37
		03-05-80	13.60
		09-29-80	13.84
		03-04-81	13.79
		09-11-81	14.85
		03-09-82	13.67
		09-14-82	13.44
		03-08-83	13.28
		09-12-83	12.59
		03-09-84	13.07
		09-14-84	13.01
		03-05-85	13.12
		09-19-85	12.97
		03-12-86	13.19
		09-04-86	13.15
		03-04-87	13.21
		09-02-87	13.19
		11-12-87	13.26
		03-01-88	13.15
		03-06-89	13.28
		05-03-89	13.32
		09-14-89	13.41
		11-09-89	13.37
		03-02-90	13.39
(D-16-3)15ada-1	5,524	05-05-89	54.97
		11-08-89	58.12
(D-16-3)15adc-1	5,520	08-28-56	53.3
		05-05-89	48.30
		11-08-89	51.75
(D-16-3)15dcb-1	5,485	05-06-64	19.65
		06-02-64	19.90
		06-25-64	16.80
		07-31-64	24.80
		09-29-64	20.55
		10-30-64	19.42
		12-11-64	19.05
		02-12-65	18.82
		03-25-65	18.43
		04-29-65	18.25
		05-18-65	18.56
		06-24-65	15.89
		09-01-65	11.44
		09-29-65	11.08
		10-27-65	11.21
		12-01-65	11.45
(D-16-3)15dcb-1—Continued		01-03-66	11.27
		02-22-66	11.39
		03-17-66	10.65
		04-27-66	11.09
		05-17-66	10.46
		07-22-66	14.13
		09-15-66	13.86
		11-03-66	14.29
		03-23-67	13.73
		03-08-68	13.17
		09-25-68	10.58
		03-14-69	11.19
		09-24-69	7.48
		03-10-70	8.55
		09-15-70	6.24
		03-09-71	8.21
		09-16-71	7.66
		03-07-72	8.77
		09-26-72	11.83
		03-13-73	13.12
		09-26-73	7.44
		03-21-74	7.46
		09-13-74	7.35
		03-03-75	10.99
		09-04-75	7.53
		03-02-76	11.06
		09-21-76	13.70
		03-03-77	16.26
		03-10-78	22.28
		09-12-78	18.12
		03-07-79	20.31
		09-11-79	15.18
		03-05-80	15.73
		09-29-80	9.39
		03-04-81	11.83
		09-12-81	12.27
		03-09-82	13.76
		09-14-82	8.17
		03-09-83	7.33
		09-12-83	3.68
		09-20-85	.24
		09-04-86	.66
		03-04-87	3.32
		09-02-87	4.95
		11-12-87	6.27
		12-03-87	6.64
		01-05-88	7.16
		02-04-88	7.74
		03-01-88	8.12
		03-29-88	8.14
		04-28-88	6.24
		06-02-88	6.07
		06-30-88	6.30
		07-28-88	7.77
		09-01-88	9.19
		12-01-88	11.27
		02-01-89	12.40
		03-07-89	12.66
		05-05-89	13.61
		06-16-89	13.16
		07-26-89	14.69
		09-14-89	17.71

Table 9. Water levels in selected wells, Sanpete Valley, Utah—Continued

Location	Altitude of land surface (feet)	Date	Water level (feet)
(D-16-3)15dcb-1—Continued		11-07-89	17.16
		03-02-90	18.69
(D-16-3)16dab-1	5,450	05-07-89	-6.4
		11-08-89	-4.5
(D-16-3)17aad-1	5,450	12-09-66	-5.4
		11-18-87	-4.8
		12-03-87	-5.3
		01-05-88	-5.0
		02-04-88	-5.9
		03-29-88	-5.3
		04-29-88	-5.9
		06-02-88	-4.9
		06-30-88	-5.2
		07-28-88	-3.7
		12-19-88	-3.6
		05-07-89	-6.2
		06-16-89	-5.0
		07-24-89	-4.4
		09-15-89	-3.8
		11-08-89	-3.9
		03-02-90	-4.2
(D-16-3)18bba-1	5,445	09-21-89	-10.0
(D-16-3)20bad-2	5,443	12-12-66	-5.1
		05-07-89	-7.9
		09-21-89	-6.5
		11-08-89	-5.7
(D-16-3)20cda-1	5,437	11-09-89	-5.7
(D-16-3)21ada-1	5,459	05-07-89	.80
		11-10-89	3.20
(D-16-3)21bbc-1	5,442	03-06-65	-4.20
		03-25-65	-4.15
		04-29-65	-4.05
		06-04-65	-4.30
		06-24-65	-4.50
		07-29-65	-4.60
		09-01-65	-5.00
		09-29-65	-4.50
		10-27-65	-4.90
		12-01-65	-4.40
		01-03-66	-4.40
		02-22-66	-4.40
		03-17-66	-4.80
		04-20-66	-4.05
		05-17-66	-4.05
		06-16-66	-4.00
		07-21-66	-3.90
		09-15-66	-4.40
		11-03-66	-4.50
		03-23-67	-5.10
		03-06-68	-5.35
		03-14-69	-4.90
		03-10-70	-6.00
		03-10-71	-5.80
		03-09-72	-5.70
		03-16-73	-5.50

Location	Altitude of land surface (feet)	Date	Water level (feet)
(D-16-3)21bbc-1—Continued		03-04-81	-6.10
		03-10-84	-6.70
		03-08-85	-6.80
		03-18-86	-6.60
		03-04-87	-6.30
		03-02-88	-6.20
		09-01-88	-5.50
		03-06-89	-6.10
		09-15-89	-4.80
		03-02-90	-6.10
(D-16-3)21cdb-2	5,450	03-06-65	-8.80
		03-25-65	-8.40
		04-29-65	-8.30
		06-04-65	-8.20
		06-24-65	-10.60
		07-29-65	-11.30
		09-01-65	-11.10
		09-29-65	-12.60
		10-27-65	-12.00
		12-01-65	-12.30
		01-03-66	-11.90
		02-22-66	-11.90
		03-17-66	-12.20
		04-20-66	-11.70
		05-17-66	-12.60
		06-16-66	-12.10
		07-21-66	-11.10
		09-15-66	-10.00
		11-03-66	-10.40
		03-23-67	-11.00
		03-15-68	-11.20
		03-14-69	-11.50
		03-10-70	-11.90
		03-10-71	-11.50
		03-09-72	-12.80
		03-16-73	-10.20
		03-21-74	-12.10
		03-04-75	-11.60
		03-03-76	-11.70
		03-02-77	-8.50
		03-10-78	-6.90
		03-07-79	-6.90
		03-05-80	-10.30
		03-04-81	-10.30
		03-09-82	-10.10
		03-09-83	-12.70
		03-10-84	-13.90
		03-11-85	-13.80
		03-14-86	-13.50
		03-04-87	-11.70
		11-12-87	-9.70
		12-03-87	-9.90
		01-05-88	-10.10
		02-04-88	-9.60
		03-02-88	-10.00
		03-29-88	-10.30
		04-29-88	-9.80
		06-02-88	-11.70
		06-30-88	-10.30
		07-28-88	-9.10
		09-01-88	-9.30

Location	Altitude of land surface (feet)	Date	Water level (feet)
(D-16-3)21cdb-2—Continued		12-19-88	-8.50
		02-01-89	-9.80
		05-07-89	-8.40
		06-16-89	-9.10
		07-24-89	-7.90
		09-15-89	-7.30
		11-08-89	-7.10
		03-02-90	-7.00
(D-16-3)23cbc-1	5,585	12-10-66	113.00
		05-06-89	112.10
		11-08-89	116.09
(D-16-3)25cab-1	5,800	05-04-89	47.54
		11-09-89	42.52
(D-16-3)26cbd-1	5,637	05-06-89	-11.7
		11-10-89	-12.6
(D-16-3)27caa-1	5,543	12-13-66	43.40
		05-04-89	42.28
		07-07-89	48.40
		11-07-89	51.92
(D-16-3)27cbc-1	5,520	05-06-64	30.27
		06-02-64	27.20
		06-25-64	21.68
		07-31-64	24.06
		09-03-64	25.69
		09-29-64	26.27
		10-30-64	26.76
		12-11-64	26.34
		02-10-65	27.43
		03-24-65	28.36
		04-29-65	28.79
		06-04-65	27.41
		06-24-65	19.10
		07-29-65	9.32
		09-01-65	8.21
		09-29-65	10.19
		10-27-65	11.32
		12-01-65	12.63
		01-03-66	13.28
		02-22-66	14.48
		03-17-66	14.84
		04-20-66	15.18
		05-17-66	15.45
		06-16-66	15.57
		07-21-66	18.06
		09-15-66	20.35
		11-03-66	21.30
		03-23-67	23.80
		03-06-68	20.59
		03-12-69	18.02
		09-24-69	8.40
		03-10-70	14.27
		09-15-70	6.74
		03-09-71	14.60
		09-15-71	12.85
		03-09-72	17.09
		09-26-72	23.05
		03-13-73	26.74

Table 9. Water levels in selected wells, Sanpete Valley, Utah—Continued

Location	Altitude of land surface (feet)	Date	Water level (feet)
(D-16-3)27cbc-1—Continued		09-26-73	10.95
		03-19-74	12.60
		09-13-74	11.75
		03-03-75	19.72
		09-04-75	9.85
		03-02-76	13.25
		09-21-76	22.66
		03-02-77	27.34
		12-01-88	21.90
		02-01-89	24.90
		03-06-89	26.79
		05-04-89	26.41
		06-16-89	23.63
		07-26-89	27.84
		09-12-89	32.67
		11-07-89	31.35
		03-02-90	34.98
(D-16-3)27dbd-1	5,582	05-01-85	40 R
		05-04-89	55.16
		11-07-89	57.48
(D-16-3)28bbd-2	5,445	09-21-89	-5.2
(D-16-3)28cba-1	5,460	11-08-89	-10.9
(D-16-3)31acd-1	5,430	05-07-89	-6.0
		11-09-89	-5.0
(D-16-3)31dbd-1	5,435	09-21-89	-2.79
(D-16-3)32bda-1	5,445	11-09-89	-32.7
(D-16-3)33ada-1	5,485	05-07-89	9.46
		11-09-89	11.96
(D-16-3)33ccb-2	5,466	03-04-81	-12.20
		03-09-82	-10.30
		03-09-83	-13.00
		03-10-84	-15.30
		03-08-85	-15.20
		03-14-86	-13.20
		03-04-87	-12.10
		11-12-87	-10.60
		12-03-87	-10.90
		01-05-88	-10.40
		02-04-88	-10.20
		03-02-88	-9.30
		03-30-88	-9.80
		04-29-88	-9.00
		06-02-88	-10.80
		06-30-88	-11.50
		07-28-88	-11.30
		09-01-88	-10.00
		12-19-88	-8.10
		01-31-89	-7.80
		03-06-89	-7.70
		05-07-89	-7.60
		06-16-89	-8.30
		07-24-89	-7.00
		09-15-89	-6.40
		11-09-89	-5.50
		03-02-90	-4.60
(D-16-3)34bbc-1	5,490	12-14-66	7.00
		05-07-89	12.47
		11-09-89	15.06
(D-16-3)34ccd-1	5,510	04-15-75	22 R
		05-07-89	19.47
(D-16-4)7ccd-1	5,940	11-16-66	54.85
		11-09-89	54.51
(D-16-4)18bac-1	5,939	11-16-66	53.87
		05-04-89	66.17
		11-09-89	66.83
(D-16-4)18bac-2	5,945	05-04-89	53.60
		07-06-89	54.98
		11-09-89	60.42
(D-17-2)1bca-2	5,444	04-08-38	-4.70
		06-03-38	-4.50
		08-25-38	-4.75
		10-08-38	-4.70
		12-22-38	-4.95
		03-03-39	-5.00
		04-17-39	-4.85
		06-17-39	-4.42
		08-23-39	-4.36
		10-14-39	-4.28
		12-04-39	-4.39
		02-07-40	-4.36
		03-26-40	-4.36
		06-04-40	-4.33
		12-04-40	-4.80
		03-19-41	-5.08
		12-06-41	-6.30
		03-27-42	-6.30
		08-11-42	-6.90
		12-20-42	-6.50
		03-24-43	-6.40
		12-17-43	-5.85
		12-05-44	-6.10
		04-03-45	-6.30
		12-06-45	-7.00
		03-22-46	-6.95
		12-18-46	-6.20
		03-27-47	-6.10
		12-13-47	-8.30
		03-17-48	-8.10
		12-13-48	-7.90
		04-04-49	-7.60
		12-13-49	-7.50
		03-30-50	-7.80
		12-10-50	-6.70
		03-27-51	-6.50
		12-11-51	-6.40
		12-09-52	-9.80
		03-17-53	-8.50
		12-14-53	-8.20
		03-27-54	-8.20
		11-30-54	-7.70
		03-23-55	-6.80
		12-06-55	-5.60
(D-17-2)1bca-2—Continued		03-22-56	-6.20
		03-12-58	-6.60
		04-04-58	-6.40
		05-07-58	-6.75
		06-04-58	-6.90
		07-03-58	-3.72
		08-04-58	2.00
		09-02-58	3.58
		10-07-58	-5.00
		11-06-58	-5.60
		11-29-58	-5.00
		01-02-59	-5.85
		01-27-59	-5.85
		02-25-59	-6.35
		03-26-59	-6.50
		04-29-59	-6.50
		05-29-59	.52
		06-24-59	4.72
		07-29-59	5.52
		08-25-59	2.84
		09-25-59	-3.15
		10-29-59	-4.75
		11-30-59	-5.20
		12-30-59	-5.10
		01-27-60	-5.00
		03-25-60	-5.40
		04-27-60	-5.70
		05-25-60	4.16
		06-17-60	6.05
		07-27-60	7.82
		08-29-60	1.88
		09-30-60	-2.84
		10-27-60	-3.45
		11-30-60	-4.03
		12-30-60	-4.42
		01-30-61	-4.50
		02-27-61	-4.61
		03-31-61	-4.69
		04-24-61	-4.72
		05-26-61	-1.68
		07-06-61	6.80
		07-26-61	8.18
		08-24-61	6.63
		09-29-61	-1.98
		04-05-62	-4.11
		09-28-62	-5.60
		04-11-63	-7.20
		09-25-63	-3.75
		04-01-64	-6.20
		05-04-64	-6.40
		06-24-64	5.17
		07-31-64	6.51
		09-03-64	6.52
		09-29-64	-3.50
		10-30-64	-4.60
		12-11-64	-5.60
		02-10-65	-6.05
		03-25-65	-6.20
		04-28-65	-5.90
		05-25-65	-6.00
		06-03-65	-5.95
		06-23-65	-3.50

Table 9. Water levels in selected wells, Sanpete Valley, Utah—Continued

Location	Altitude of land surface (feet)	Date	Water level (feet)
(D-17-2)1bca-2—Continued		07-29-65	-6.80
		08-30-65	-8.40
		09-29-65	-8.50
		10-26-65	-8.80
		12-01-65	-8.50
		01-03-66	-8.70
		02-22-66	-8.70
		03-17-66	-8.80
		04-20-66	-8.40
		05-17-66	1.36
		06-16-66	3.80
		07-21-66	4.97
		09-15-66	2.72
		10-28-66	-5.40
		03-23-67	-6.70
		11-29-67	-7.40
		03-08-68	-7.60
		09-24-68	-8.80
		03-14-69	-9.80
		09-24-69	-12.60
		03-19-70	-12.00
		09-15-70	-12.40
		03-09-71	-12.70
		09-15-71	-9.50
		03-08-72	-11.30
		09-26-72	-5.70
		03-16-73	-8.40
		09-26-73	-9.30
		03-19-74	-11.50
		09-13-74	-9.80
		03-04-75	-12.40
		09-05-75	-6.00
		03-02-76	-12.90
		09-22-76	-5.60
		03-02-77	-9.70
		03-09-78	-6.60
		09-12-78	-3.80
		03-07-79	-9.20
		09-01-79	-2.00
		03-05-80	-11.20
		09-29-80	-15.10
		03-04-81	-15.80
		09-12-81	-11.40
		03-09-82	-13.30
		09-14-82	-16.30
		03-09-83	-16.00
		09-12-83	-18.70
		03-10-84	-22.40
		09-14-84	-25.90
		03-08-85	-24.10
		09-19-85	-23.30
		03-13-86	-22.40
		09-04-86	-24.60
		03-03-87	-22.90
		09-01-87	-23.40
		03-01-88	-18.60
		08-30-88	-16.8
		03-07-89	-15.2
		05-09-89	-14.7
		11-09-89	-11.1
		03-01-90	-11.50
(D-17-2)1dac-1	5,428	12-20-66	-10.8
		08-29-89	-3.1
(D-17-2)1dda-1	5,427	08-29-89	-8.9
(D-17-2)1ddb-1	5,427	08-29-89	-9.8
(D-17-2)12abb-1	5,425	08-30-89	-10.0
(D-17-2)12adb-1	5,424	08-31-89	-11.6
(D-17-2)12add-2	5,423	08-30-89	-8.2
(D-17-2)12daa-1	5,424	08-31-89	-10.5
(D-17-2)13aad-1	5,423	09-06-66	-11.3
		12-30-66	-13.7
		09-06-89	-11.3
(D-17-2)13bdd-1	5,417	12-30-66	-14.8
		09-07-89	-16.8
(D-17-2)14baa-1	5,425	03-04-65	-19.5
		03-25-65	-20.3
		04-28-65	-20.1
		06-03-65	-19.1
		06-23-65	-19.3
		07-29-65	-19.9
		08-30-65	-20.1
		09-29-65	-20.5
		10-26-65	-20.3
		12-01-65	-20.5
		01-03-66	-19.9
		02-22-66	-19.8
		03-17-66	-22.1
		04-20-66	-20.1
		05-16-66	-21.5
		06-16-66	-20.6
		07-21-66	-19.4
		09-15-66	-17.2
		10-28-66	-17.9
		03-23-67	-19.8
		03-15-68	-17.8
		03-14-69	-19.6
		03-19-70	-21.5
		03-10-71	-24.1
		03-08-72	-23.8
		03-16-73	-20.4
		03-19-74	-21.0
		03-04-75	-24.7
		03-02-76	-25.0
		03-02-77	-21.5
		03-09-78	-18.9
		03-07-79	-19.3
		03-05-80	-20.1
		03-04-81	-22.9
		03-08-82	-19.7
		03-09-83	-26.3
		03-10-84	-26.9
		03-08-85	-32.6
		03-18-86	-30.0
		03-03-87	-31.7
(D-17-2)14baa-1—Continued		11-12-87	-28.1
		12-03-87	-25.0
		01-05-88	-24.9
		02-04-88	-25.6
		03-02-88	-23.9
		03-30-88	-23.8
		04-29-88	-25.1
		06-02-88	-23.2
		06-30-88	-25.7
		07-28-88	-20.5
		08-31-88	-19.7
		01-31-89	-22.8
		03-07-89	-20.2
		05-09-89	-27.3
		06-15-89	-19.5
		07-25-89	-21.9
		09-15-89	-21.2
		11-09-89	-19.4
		03-02-90	-24.9
(D-17-2)14cca-1	5,423	11-29-88	-.46
		03-07-89	-1.50
		05-09-89	-1.11
		06-15-89	-.40
		07-25-89	.53
		09-27-89	1.50
		11-09-89	1.17
		03-02-90	-.65
(D-17-2)14cca-2	5,423	11-29-88	2.94
		03-02-89	.45
		03-07-89	.45
		05-09-89	2.97
		06-15-89	4.42
		07-25-89	4.07
		09-27-89	4.17
		11-09-89	3.74
		03-02-90	2.66
(D-17-2)14ccb-1	5,420	05-09-89	-27.8
		07-25-89	-28.1
		09-26-89	-26.8
		11-09-89	-26.6
		03-02-90	-26.6
(D-17-2)14cdb-1	5,421	05-09-89	-11.3
		11-09-89	-7.2
(D-17-2)15aca-1	5,447	11-28-88	10.06
		03-07-89	9.48
		05-08-89	9.20
		06-15-89	9.66
		07-25-89	10.30
		09-26-89	11.02
		11-09-89	10.60
		03-02-90	10.89
(D-17-2)22ddb-1	5,445	12-04-87	-21.4
		01-05-88	-21.6
		02-04-88	-21.5
		02-29-88	-21.2
		03-30-88	-22.2

Table 9. Water levels in selected wells, Sanpete Valley, Utah—Continued

Location	Altitude of land surface (feet)	Date	Water level (feet)
(D-17-2)22ddb-1—Continued		04-29-88	-18.3
		06-02-88	-20.0
		06-30-88	-19.6
		07-28-88	-18.6
		08-31-88	-17.1
		11-29-88	-18.1
		01-31-89	-17.9
		03-07-89	-17.4
		05-08-89	-16.9
		06-15-89	-17.4
		07-25-89	-16.7
		09-18-89	-16.4
		11-09-89	-16.2
(D-17-2)25ccd-1	5,440	06-02-88	-12.0
		06-30-88	-13.1
		07-28-88	-11.6
		08-30-88	-11.0
		11-30-88	-10.7
		01-31-89	-9.9
		03-07-89	-10.3
		05-08-89	-10.3
		07-25-89	-9.5
		09-18-89	-8.6
		11-10-89	-8.5
		03-02-90	-8.8
(D-17-2)34adb-1	5,423	09-27-89	-9.8
(D-17-2)35cba-1	5,440	11-20-87	-15.9
		12-03-87	-16.2
		01-06-88	-16.1
		02-04-88	-16.7
		03-01-88	-16.0
		03-30-88	-15.5
		04-29-88	-15.2
		03-07-89	-14.5
		05-08-89	-11.6
		06-15-89	-12.6
		07-25-89	-11.8
		09-18-89	-10.2
		11-10-89	-12.1
		03-02-90	-11.1
(D-17-2)36cba-1	5,470	08-05-35	.72
		09-05-35	.95
		11-21-35	2.40
		12-12-35	2.65
		01-09-36	3.38
		06-18-36	-4.32
		08-06-36	-5.60
		10-01-36	-4.10
		11-30-36	-2.80
		04-10-37	1.28
		06-09-37	-4.03
		08-02-37	-6.15
		09-24-37	-4.05
		11-02-37	-2.85
		12-22-37	-1.22
		04-09-38	1.78
		06-03-38	-3.63
		08-25-38	-3.27
(D-17-2)36cba-1—Continued		10-08-38	-2.08
		12-21-38	-.20
		04-17-39	2.11
		06-17-39	-.34
		08-25-39	-.45
		10-15-39	.76
		12-05-39	1.80
		03-26-40	3.28
		06-04-40	-3.75
		12-05-40	-.15
		03-19-41	1.92
		12-05-41	-3.50
		03-18-42	.02
		08-10-42	-6.40
		12-20-42	-2.40
		03-25-43	.17
		12-17-43	1.12
		12-04-44	-2.56
		04-03-45	-.27
		12-06-45	-3.45
		03-21-46	-.88
		12-13-47	-3.80
		03-17-48	-.90
		12-13-48	-.70
		04-04-49	1.65
		03-30-50	.64
		12-10-50	1.38
		03-27-51	2.59
		12-08-52	-3.75
		03-17-53	-.73
		12-10-53	-.81
		03-26-54	.72
		12-06-55	4.62
		03-22-56	5.75
		03-12-58	-.27
		04-04-58	.29
		06-04-58	-3.65
		07-03-58	-5.20
		08-04-58	-4.75
		09-02-58	-2.36
		10-07-58	-2.15
		11-06-58	-1.84
		11-29-58	-1.50
		12-31-58	-.85
		01-27-59	-.60
		02-25-59	.12
		03-26-59	1.06
		04-29-59	1.50
		05-27-59	2.37
		06-24-59	4.03
		07-29-59	5.66
		08-25-59	6.36
		09-25-59	6.42
		10-29-59	6.10
		11-30-59	6.21
		12-30-59	6.24
		01-26-60	6.15
		02-26-60	6.74
		03-25-60	6.88
		04-27-60	6.81
		05-25-60	5.90
		06-17-60	2.93
(D-17-2)36cba-1—Continued		07-27-60	3.96
		08-29-60	5.55
		09-28-60	5.46
		10-27-60	5.18
		11-28-60	4.92
		12-30-60	5.05
		01-30-61	5.50
		02-27-61	5.99
		03-31-61	6.36
		04-24-61	6.53
		05-26-61	6.35
		07-06-61	6.19
		07-26-61	7.17
		08-24-61	7.61
		09-29-61	8.30
		10-16-62	-2.62
		03-01-65	2.23
		03-22-65	3.66
		04-27-65	3.84
		05-27-65	1.93
		06-22-65	-4.60
		07-28-65	-7.40
		08-30-65	-6.90
		09-28-65	-6.80
		10-25-65	-5.40
		11-30-65	-4.40
		12-30-65	-3.14
		01-29-66	-2.10
		03-16-66	-.70
		04-15-66	.30
		05-16-66	.24
		06-14-66	-.92
		07-19-66	.78
		09-19-66	3.59
		11-04-66	3.40
		03-21-67	4.10
		11-29-67	-.95
		03-05-68	1.26
		09-25-68	-4.40
		03-12-69	-.04
		09-24-69	-4.80
		03-11-70	.35
		09-15-70	-3.50
		03-10-71	.51
		09-16-71	-2.09
		03-08-72	1.44
		09-27-72	3.68
		03-15-73	3.73
		09-26-73	-4.10
		03-20-74	-.70
		09-13-74	-.94
		03-04-75	1.69
		09-04-75	-5.15
		03-02-76	2.33
		09-22-76	5.50
		03-02-77	4.80
		03-09-78	5.00
		09-12-78	-2.15
		09-11-79	1.70
		03-04-80	1.78
		09-29-80	-4.10
		03-08-82	2.54

Table 9. Water levels in selected wells, Sanpete Valley, Utah—Continued

Location	Altitude of land surface (feet)	Date	Water level (feet)
(D-17-2)36cba-1—Continued		09-14-82	-5.90
		03-08-85	.91
		09-19-85	-3.00
		03-18-86	1.24
		09-04-86	-4.70
		03-04-87	1.53
		09-02-87	-3.00
		11-13-87	1.49
		12-03-87	1.95
		01-06-88	1.83
		02-04-88	3.69
		03-01-88	4.10
		03-30-88	4.53
		04-29-88	4.63
		08-30-88	.10
		11-30-88	3.12
		03-07-89	4.78
		05-08-89	2.74
		06-15-89	1.13
		07-25-89	2.76
(D-17-2)36cdc-2	5,490	05-01-64	19.28
		06-02-64	16.53
		06-23-64	6.86
		09-28-64	10.28
		10-30-64	12.17
		12-10-64	13.22
		05-14-65	18.43
		06-23-65	3.55
		03-16-66	12.65
		07-19-66	17.10
		11-02-66	17.12
		05-08-89	21.06
		11-10-89	21.82
(D-17-3)3dbd-1	5,650	05-07-89	-2.8
		11-10-89	-2.07
(D-17-3)4bcc-2	5,487	12-13-35	17.7
		01-03-36	18.1
		03-03-36	19.35
		04-24-36	20.10
		08-06-36	11.65
		10-02-36	11.70
		11-29-36	12.23
		02-05-37	12.52
		03-12-37	13.10
		06-09-37	9.92
		08-02-37	9.74
		09-24-37	7.94
		10-26-37	8.55
		11-04-37	8.65
		12-22-37	9.02
		02-24-38	10.08
		03-07-38	10.84
		03-17-38	10.44
		03-25-38	11.20
		05-01-38	11.65
		05-15-38	12.30
		05-22-38	21.05
		05-29-38	9.66
		06-03-38	8.22
(D-17-3)4bcc-2—Continued		06-05-38	7.53
		06-12-38	6.25
		06-19-38	4.80
		06-26-38	8.18
		07-03-38	9.09
		07-06-38	50 S
		07-17-38	44 S
		08-01-38	54 S
		08-12-38	57 S
		08-14-38	7.35
		08-21-38	5.80
		08-30-38	5.70
		09-04-38	5.75
		09-12-38	6.70
		09-17-38	85.0S
		09-25-38	7.60
		10-02-38	7.10
		10-08-38	6.62
		10-15-38	6.60
		10-22-38	6.90
		10-29-38	6.65
		11-05-38	7.25
		11-14-38	6.80
		11-21-38	6.50
		11-28-38	6.70
		12-04-38	7.40
		12-10-38	7.20
		12-17-38	6.50
		12-31-38	7.10
		01-06-39	7.85
		01-21-39	7.10
		01-28-39	6.70
		02-04-39	6.00
		02-19-39	8.70
		02-25-39	9.20
		03-03-39	9.07
		03-11-39	9.50
		03-26-39	9.60
		04-02-39	10.40
		04-09-39	10.10
		04-14-39	9.63
		04-21-39	10.80
		05-11-39	14.80
		05-26-39	12.70
		06-17-39	53.02S
		08-27-39	10.10
		09-03-39	11.10
		09-10-39	11.40
		09-18-39	11.0
		09-24-39	10.10
		10-01-39	10.50
		10-08-39	10.90
		10-14-39	10.40
		10-22-39	11.00
		10-29-39	10.70
		11-05-39	10.00
		11-12-39	10.10
		12-04-39	10.92
		12-09-39	9.90
		12-16-39	10.20
		12-23-39	10.10
		12-30-39	11.00
(D-17-3)4bcc-2—Continued		01-06-40	11.00
		01-13-40	11.20
		01-20-40	11.60
		01-27-40	11.10
		02-03-40	10.30
		02-07-40	11.65
		02-10-40	11.90
		02-17-40	11.30
		02-24-40	11.60
		03-02-40	11.30
		03-10-40	10.80
		03-16-40	13.80
		03-23-40	11.70
		03-26-40	12.22
		04-06-40	12.10
		04-14-40	12.0
		05-19-40	10.08
		06-02-40	8.10
		06-04-40	7.30
		06-16-40	5.80
		08-04-40	6.11
		08-18-40	5.4
		09-01-40	6.60
		09-15-40	8.00
		09-21-40	8.00
		09-29-40	7.10
		10-06-40	8.10
		10-13-40	9.10
		10-20-40	9.0
		10-27-40	8.90
		11-03-40	8.90
		11-17-40	8.80
		11-24-40	8.1
		12-01-40	8.00
		12-04-40	8.45
		12-08-40	8.6
		12-15-40	8.60
		12-22-40	8.60
		12-31-40	8.90
		01-05-41	8.70
		01-14-41	8.7
		01-21-41	8.6
		01-28-41	8.5
		02-04-41	8.40
		02-12-41	8.2
		02-20-41	8.3
		02-28-41	8.1
		03-07-41	8.7
		03-19-41	7.92
		03-22-41	8.1
		03-29-41	8.70
		04-05-41	8.6
		05-11-41	9.1
		05-24-41	8.1
		06-01-41	7.0
		06-15-41	6.9
		08-05-41	8.6
		03-01-42	-1.0
		03-05-42	-1.0
		03-08-42	-1.0
		03-19-42	-1.0
		12-17-43	1.76

Table 9. Water levels in selected wells, Sanpete Valley, Utah—Continued

Location	Altitude of land surface (feet)	Date	Water level (feet)
(D-17-3)4bcc-2—Continued		01-03-44	3.5
		01-11-44	3.2
		01-21-44	4.0
		01-29-44	4.01
		02-07-44	5.00
		02-15-44	5.00
		02-23-44	5.90
		03-01-44	6.9
		03-08-44	7.2
		03-15-44	7.1
		03-25-44	5.9
		03-29-44	.71
		04-01-44	5.9
		04-09-44	5.9
		04-17-44	6.0
		04-20-44	4.00
		04-23-44	6.0
		05-02-44	6.2
		05-09-44	6.1
		05-16-44	6.1
		05-23-44	6.0
		05-31-44	5.9
		06-07-44	3.2
		06-14-44	2.2
		03-29-45	.71
		04-04-45	-1.0
		04-22-45	-.4
		04-29-45	.70
		05-05-45	.90
		05-14-45	.90
		05-23-45	.40
		12-19-46	1.51
		03-27-47	4.04
		05-04-64	6.76
		05-14-64	5.42
		06-24-64	1.64
		07-10-64	1.64
		09-28-64	2.28
		11-03-64	2.47
		05-07-89	6.29
		11-09-89	8.73
(D-17-3)5ccd-1	5,454	08-25-89	-14.9
(D-17-3)6aad-1	5,440	11-30-35	-12.7
		12-12-35	-13.0
		12-13-35	-12.8
		01-07-36	-13.1
		06-18-36	-13.8
		10-01-36	-16.6
		11-28-36	-16.7
		04-12-37	-16.8
		06-10-37	-15.3
		08-02-37	-18.1
		09-24-37	-18.8
		11-04-37	-18.1
		12-22-37	-19.0
		04-08-38	-19.0
		08-25-38	-18.5
		10-08-38	-18.2
		12-22-38	-20.4
		04-17-39	-17.0
(D-17-3)6aad-1—Continued		06-17-39	-15.8
		08-23-39	-16.4
		10-14-39	-16.7
		12-04-39	-16.7
		12-17-39	17.0
		03-26-40	-17.8
		06-04-40	-16.4
		12-04-40	-17.9
		03-03-65	-18.4
		03-25-65	-19.7
		06-03-65	-19.8
		06-23-65	-20.6
		07-29-65	-24.6
		09-01-65	-25.0
		09-29-65	-24.7
		10-26-65	-25.2
		12-01-65	-23.8
		12-03-65	19.8
		12-29-65	24.6
		01-03-66	-23.6
		02-22-66	-23.4
		03-17-66	-23.1
		04-20-66	-22.3
		05-17-66	-19.6
		06-16-66	-17.6
		07-21-66	-15.7
		09-15-66	-16.5
		11-03-66	-18.4
		12-17-66	-23.1
		12-22-66	-23.4
		03-23-67	-18.3
		03-08-68	-20.0
		03-14-69	-21.3
		03-19-70	-22.1
		03-09-72	-22.6
		03-15-73	-18.9
		03-21-74	-23.5
		09-22-89	-16.6
(D-17-3)6bba-1	5,428	09-22-89	-15.4
(D-17-3)6bbc-1	5,428	09-22-89	-16.4
(D-17-3)6cab-1	5,434	12-03-35	-7.2
		12-12-35	-6.30
		12-13-35	-7.3
		01-10-36	-7.0
		03-03-36	-6.6
		04-24-36	-4.5
		06-18-36	-6.0
		08-06-36	-6.6
		10-01-36	-6.3
		03-04-65	-6.3
		03-25-65	-6.4
		04-28-65	-6.2
		06-03-65	-6.2
		06-23-65	-6.8
		07-29-65	-9.2
		08-30-65	-9.4
		09-29-65	-9.2
		10-26-65	-9.2
		12-01-65	-8.6
(D-17-3)6cab-1—Continued		01-03-66	-8.7
		02-22-66	-8.2
		03-17-66	-8.1
		04-20-66	-7.6
		05-17-66	-6.9
		06-16-66	-6.6
		07-21-66	-6.6
		09-15-66	-6.3
		11-03-66	-6.6
		03-23-67	-6.3
		03-08-68	-6.8
		03-14-69	-7.9
		03-19-70	-8.2
		03-09-71	-8.5
		03-09-72	-7.7
		03-16-73	-6.3
		03-21-74	-7.6
		03-04-75	-8.1
		03-02-76	-9.1
		03-03-77	-6.9
		03-09-78	-5.9
		03-07-79	-6.6
		03-05-80	-8.2
		03-04-81	-9.7
		03-08-82	-8.5
		03-09-83	-9.9
		03-10-84	-11.1
		03-08-85	-11.6
		03-14-86	-10.3
		03-03-87	-9.9
		11-12-87	-8.9
		12-03-87	-8.7
		01-05-88	-9.0
		02-04-88	-9.3
		03-01-88	-9.5
		03-30-88	-8.3
		04-29-88	-7.9
		06-02-88	-8.9
		06-30-88	-8.3
		07-28-88	-8.3
		08-30-88	-8.7
		12-20-88	-8.0
		01-31-89	-8.2
		03-06-89	-8.1
		05-09-89	-7.5
		07-25-89	-6.5
		09-15-89	-7.1
		11-09-89	-6.4
		03-01-90	-6.8
(D-17-3)6ccb-1	5,428	08-29-89	-8.2
(D-17-3)6ccc-1	5,429	08-29-89	-6.4
(D-17-3)6dca-1	5,446	08-28-89	-4.8
(D-17-3)6dcc-1	5,435	08-28-89	-7.0
(D-17-3)6ddd-1	5,445	12-21-66	-6.1
		08-25-89	-5.3
(D-17-3)7abb-1	5,436	08-28-89	-5.8

Table 9. Water levels in selected wells, Sanpete Valley, Utah—Continued

Location	Altitude of land surface (feet)	Date	Water level (feet)
(D-17-3)7abb-2	5,434	08-28-89	-5.8
(D-17-3)7abd-1	5,440	08-29-89	-2.8
(D-17-3)7baa-1	5,435	08-25-89	-7.9
(D-17-3)7baa-2	5,435	08-25-89	-6.8
(D-17-3)7bab-1	5,436	08-28-89	-6.2
(D-17-3)7bab-2	5,431	08-30-89	-6.6
(D-17-3)7bad-1	5,435	08-28-89	-7.4
(D-17-3)7bba-1	5,430	08-30-89	-8.3
(D-17-3)7bbb-1	5,428	12-29-66	-13.5
		08-29-89	-7.4
(D-17-3)7bbd-1	5,430	09-28-89	-4.0
(D-17-3)7bdc-1	5,428	08-30-89	-8.0
(D-17-3)7cab-1	5,430	08-30-89	-6.7
(D-17-3)7cac-1	5,429	09-01-89	-5.2
(D-17-3)7cba-1	5,427	08-31-89	-12.8
(D-17-3)7cba-2	5,427	08-31-89	-9.4
(D-17-3)7cbd-1	5,428	08-31-89	-11.0
(D-17-3)7cca-1	5,427	09-06-89	-10.8
(D-17-3)7cda -1	5,438	09-06-89	-8.2
(D-17-3)7cdb-1	5,429	09-06-89	-7.2
(D-17-3)7cdc-1	5,430	09-06-89	-9.0
(D-17-3)7dbd-1	5,437	09-01-89	-3.15
(D-17-3)8bab-1	5,454	11-21-35	.32
		11-30-35	.16
		12-12-35	.02
		12-13-35	.06
		04-24-36	1.24
		06-18-36	-1.94
		08-07-36	-5.35
		10-01-36	-4.60
		11-28-36	-3.63
		04-12-37	-2.54
		06-09-37	-3.90
		08-02-37	-7.10
		09-24-37	-7.75
		11-04-37	-6.60
		12-22-37	-6.70
		04-08-38	-5.25
		06-03-38	-4.85
		08-25-38	-8.60
		10-08-38	-7.70
(D-17-3)8bab-1—Continued		12-22-38	-7.30
		04-17-39	-4.80
		06-17-39	-4.02
		08-23-39	-3.77
		10-14-39	-4.35
		12-04-39	4.26
		04-26-40	3.05
		06-04-40	5.80
		12-05-40	7.50
		03-03-65	-2.60
		03-24-65	-2.64
		04-28-65	-3.12
		06-03-65	-7.45
		06-23-65	-8.40
		07-29-65	-15.20
		08-30-65	-16.00
		09-28-65	-15.50
		10-26-65	-14.40
		12-01-65	-12.90
		01-03-66	-11.60
		02-22-66	-9.40
		03-17-66	-8.60
		04-20-66	-8.10
		05-17-66	-8.20
		06-16-66	-7.80
		07-20-66	-5.90
		09-15-66	-3.80
		11-03-66	-3.10
		03-23-67	-1.50
		03-08-68	2.80
		03-12-69	-4.40
		03-19-70	-5.40
		03-10-71	-4.40
		03-09-72	-2.80
		03-15-73	-1.40
		03-21-74	-5.00
		03-02-76	-5.38
		03-03-77	-.80
		03-07-79	-5.39
		03-05-80	-5.01
		03-04-81	-7.60
		03-08-82	-3.30
		03-09-83	-6.70
		03-10-84	-7.70
		03-08-85	-5.60
		03-18-86	-3.40
		03-03-87	-3.10
		11-12-87	-3.4
		12-03-87	-3.2
		01-05-88	-2.9
		02-04-88	-3.1
		03-01-88	-2.4
		03-30-88	-2.2
		04-29-88	-2.4
		06-02-88	-3.1
		06-30-88	-4.2
		07-28-88	-4.4
		08-30-88	-4.2
		12-20-88	-2.5
		01-31-89	-2.4
		03-06-89	-1.2
		05-09-89	-2.9
(D-17-3)8bab-1—Continued		06-16-89	-2.0
		07-25-89	-2.8
		09-15-89	-2.5
		11-09-89	-2.4
		03-02-90	-1.5
(D-17-3)8cdd-1	5,488	11-03-66	20.30
		05-08-89	17.06
		11-10-89	16.09
(D-17-3)9cbd-1	5,520	12-02-35	50.82
		12-12-35	50.72
		01-09-36	51.05
		01-24-36	51.27
		03-03-36	51.38
		04-24-36	51.87
		06-18-36	45.44
		08-07-36	40.19
		10-01-36	41.33
		11-28-36	42.60
		02-05-37	44.23
		04-12-37	44.80
		06-09-37	41.95
		08-02-37	36.00
		09-24-37	37.10
		11-02-37	38.72
		12-22-37	39.57
		02-24-38	41.10
		04-08-38	42.43
		06-03-38	41.27
		10-08-38	36.74
		12-21-38	37.67
		03-03-39	41.21
		04-17-39	42.62
		06-17-39	42.40
		10-14-39	42.60
		12-04-39	43.23
		03-26-40	45.22
		06-04-40	40.22
		12-05-40	37.81
		03-19-41	39.81
		09-28-41	22.82
		12-05-41	25.89
		03-18-42	28.94
		08-10-42	12.49
		12-20-42	23.23
		03-24-43	28.34
		12-17-43	34.41
		03-19-44	37.23
		12-04-44	25.29
		04-03-45	31.30
		12-06-45	24.08
		03-22-46	30.28
		12-19-46	33.90
		02-27-47	36.15
		03-27-47	37.03
		04-07-47	37.15
		04-16-47	37.32
		04-22-47	37.26
		05-11-47	36.70
		05-28-47	32.08
		06-07-47	27.99

Table 9. Water levels in selected wells, Sanpete Valley, Utah—Continued

Location	Altitude of land surface (feet)	Date	Water level (feet)
(D-17-3)9cbd-1—Continued		06-17-47	23.70
		07-03-47	19.21
		08-04-47	18.40
		09-05-47	19.16
		12-04-47	25.88
		12-13-47	26.50
		03-10-48	30.98
		07-22-48	29.50
		12-13-48	29.70
		04-04-49	34.30
		12-13-49	28.26
		03-30-50	32.87
		12-10-50	35.59
		03-27-51	38.29
		12-11-51	38.86
		04-08-52	40.67
		12-08-52	18.68
		03-17-53	24.73
		12-11-53	26.70
		03-26-54	31.26
		11-30-54	35.35
		03-22-55	37.45
		12-06-55	38.49
		03-22-56	40.85
		12-05-56	43.15
		03-12-58	29.60
		04-04-58	31.15
		05-07-58	31.50
		06-04-58	23.68
		07-03-58	14.92
		08-04-58	17.62
		09-02-58	20.28
		10-07-58	23.44
		11-06-58	24.38
		11-29-58	25.79
		01-02-59	27.61
		01-27-59	29.00
		02-25-59	30.37
		03-26-59	31.53
		04-29-59	33.05
		08-25-59	41.29
		09-25-59	41.11
		10-29-59	41.28
		11-30-59	42.32
		12-30-59	42.64
		01-27-60	43.15
		03-25-60	44.42
		05-25-60	46.14
		06-17-60	42.87
		07-27-60	43.56
		09-30-60	44.30
		10-27-60	44.16
		11-30-60	44.55
		12-30-60	44.75
		01-30-61	45.40
		02-27-61	45.78
		03-31-61	46.00
		04-24-61	45.83
		08-24-61	50.29
		09-29-61	48.72
		04-05-62	47.02
		09-28-62	23.39

Location	Altitude of land surface (feet)	Date	Water level (feet)
(D-17-3)9cbd-1—Continued		04-11-63	31.92
		09-25-63	32.20
		04-01-64	39.34
		05-01-64	40.03
		06-02-64	40.35
		06-24-64	33.27
		09-03-64	31.92
		09-28-64	31.81
		10-30-64	32.82
		12-11-64	34.35
		02-09-65	36.09
		03-24-65	37.17
		04-29-65	38.06
		05-14-65	37.99
		06-03-65	36.67
		06-23-65	28.05
		07-29-65	15.76
		08-30-65	12.98
		09-28-65	14.56
		10-26-65	17.50
		12-01-65	21.50
		02-22-66	24.16
		03-16-66	25.26
		04-20-66	26.99
		05-16-66	26.53
		06-16-66	25.70
		08-20-66	28.00
		09-16-66	31.35
		11-03-66	33.20
		03-23-67	38.17
		11-29-67	29.37
		03-08-68	34.31
		09-24-68	20.94
		03-12-69	30.07
		09-24-69	17.82
		03-10-70	27.78
		09-15-70	17.28
		03-10-71	28.58
		09-16-71	24.38
		03-09-72	33.16
		09-27-72	38.12
		03-16-73	39.75
		09-26-73	18.54
		03-20-74	27.55
		09-13-74	21.90
		03-03-75	32.89
		09-04-75	16.45
		03-02-76	27.01
		09-21-76	32.48
		03-03-77	37.98
		09-22-77	48.63
		03-09-78	48.05
		09-12-78	29.91
		03-07-79	34.33
		09-11-79	20.75
		03-04-80	28.36
		09-29-80	12.24
		03-03-81	22.08
		09-12-81	22.01
		03-08-82	30.29
		09-14-82	15.78
		03-09-83	22.17

Location	Altitude of land surface (feet)	Date	Water level (feet)
(D-17-3)9cbd-1—Continued		03-12-84	18.45
		09-14-84	5.90
		03-04-85	17.92
		09-19-85	14.16
		03-14-86	23.88
		09-04-86	12.98
		03-04-87	25.71
		09-02-87	25.66
		11-13-87	29.20
		12-03-87	30.03
		01-05-88	31.27
		02-04-88	32.16
		03-01-88	32.75
		03-30-88	34.05
		04-29-88	33.45
		06-02-88	30.61
		08-30-88	30.57
		11-30-88	33.83
		01-31-89	34.83
		03-06-89	35.41
		05-07-89	36.64
		07-25-89	37.00
		09-18-89	39.16
		11-10-89	40.12
		03-02-90	42.27
(D-17-3)16adb-1	5,610	05-07-89	109.58
		11-10-89	114.48
(D-17-3)17adb-1	5,525	04-09-38	50.91
		10-08-38	46.46
		12-21-38	48.65
		03-03-39	50.40
		08-23-39	51.44
		10-15-39	51.94
		12-04-39	52.62
		03-26-40	54.38
		06-04-40	49.78
		12-05-40	47.44
		03-19-41	49.36
		09-28-41	33.43
		12-05-41	36.55
		03-18-42	39.52
		08-10-42	24.14
		03-25-43	39.31
		12-17-43	44.46
		12-04-44	35.78
		04-03-45	41.73
		12-06-45	34.37
		12-19-46	44.35
		03-27-47	47.07
		12-13-47	37.00
		12-13-48	39.80
		04-04-49	44.01
		12-13-49	39.25
		03-30-50	42.98
		12-10-50	45.72
		03-27-51	47.67
		12-11-51	48.06
		04-07-52	49.95
		12-08-52	28.63
		03-17-53	34.50

Table 9. Water levels in selected wells, Sanpete Valley, Utah—Continued

Location	Altitude of land surface (feet)	Date	Water level (feet)
(D-17-3)17adb-1—Continued		12-11-53	36.57
		03-26-54	40.69
		11-30-54	43.49
		03-22-55	46.52
		12-06-55	48.14
		03-22-56	49.42
		03-12-58	38.78
		04-04-58	39.63
		05-07-58	39.95
		07-03-58	30.50
		08-04-58	31.34
		09-02-58	30.86
		10-07-58	32.95
		11-06-58	34.60
		11-29-58	35.87
		01-02-59	37.50
		01-27-59	38.73
		02-25-59	39.92
		03-26-59	40.98
		04-29-59	42.30
		09-25-59	50.92
		10-29-59	50.65
		11-30-59	51.85
		12-30-59	51.39
		01-27-60	51.95
		03-25-60	52.66
		05-25-60	64.23
		09-30-60	56.18
		10-27-60	53.38
		11-30-60	53.43
		12-30-60	53.53
		01-30-61	54.60
		02-27-61	56.63
		03-31-61	57.99
		04-24-61	56.18
		08-24-61	63.18
		09-29-61	56.74
		05-01-64	48.81
		06-23-64	41.94
		09-28-64	41.93
		02-09-65	45.32
		03-24-65	46.36
		04-28-65	47.16
		06-03-65	44.35
		06-23-65	35.77
		07-28-65	25.14
		08-30-65	23.95
		09-28-65	24.85
		10-26-65	26.55
		12-01-65	29.12
		01-03-66	31.15
		02-22-66	33.85
		03-16-66	34.85
		04-20-66	36.40
		05-16-66	36.42
		09-01-66	43.48
		09-16-66	41.93
		11-13-66	43.20
		03-21-67	47.11
		03-06-68	43.55
		03-12-69	39.67
		03-10-70	37.64
(D-17-3)17adb-1—Continued		03-10-71	38.28
		03-09-72	42.28
		03-15-73	48.44
		03-20-74	37.05
		03-03-75	40.54
		03-02-76	36.63
		03-02-77	43.07
		03-09-78	60.39
		03-07-79	43.88
		03-04-80	38.63
		03-03-81	32.45
		03-08-82	46.20
		03-11-83	32.04
		03-12-84	27.71
		03-04-85	27.83
		03-14-86	32.74
		03-04-87	34.70
		11-13-87	39.00
		12-03-87	39.45
		01-05-88	40.51
		02-04-88	41.55
		03-01-88	41.87
		03-30-88	42.33
		04-29-88	42.41
		06-02-88	43.34
		06-30-88	39.05
		07-28-88	38.19
		08-30-88	40.02
		11-30-88	42.90
		03-08-89	44.59
		06-15-89	49.12
		07-25-89	48.72
		09-18-89	50.29
		11-10-89	50.36
		03-02-90	51.48
(D-17-3)20aca-1	5,555	05-08-89	80.55
		11-10-89	85.20
(D-17-3)20acc-1	5,548	08-28-56	86.70
		09-28-56	80.09
		11-01-56	80.12
		01-04-57	78.59
		02-04-57	78.55
		04-03-57	78.93
		05-03-57	79.08
		06-03-57	77.04
		07-01-57	61.90
		07-26-57	54.85
		08-29-57	56.64
		10-01-57	57.24
		11-06-57	58.58
		12-04-57	60.55
		12-31-57	52.44
		02-05-58	53.73
		03-04-58	53.95
		04-04-58	65.57
		05-07-58	65.82
		06-04-58	60.48
		07-03-58	60.77
		09-02-58	61.22
		10-07-58	61.27
(D-17-3)20acc-1 —Continued		11-06-58	62.25
		11-29-58	63.18
		01-02-59	64.39
		01-27-59	65.55
		02-25-59	65.70
		03-26-59	66.32
		09-25-59	79.13
		10-29-59	78.38
		11-30-59	77.43
		12-30-59	77.26
		01-27-60	77.59
		03-25-60	78.10
		05-25-60	84.93
		09-30-60	82.30
		10-27-60	81.02
		11-30-60	80.45
		12-30-60	80.12
		01-30-61	79.95
		02-27-61	80.23
		03-31-61	80.31
		04-24-61	80.26
		08-24-61	93.44
		09-29-61	89.24
		10-16-62	63.27
		05-01-64	74.37
		06-02-64	74.69
		06-23-64	70.90
		09-03-64	73.24
		09-28-64	71.45
		10-30-64	73.72
		12-10-64	70.95
		02-09-65	71.64
		03-24-65	72.41
		04-28-65	73.08
		05-14-65	72.95
		06-03-65	71.35
		06-23-65	63.38
		07-28-65	54.66
		08-30-65	52.72
		09-28-65	54.22
		10-25-65	55.32
		12-01-65	56.57
		01-03-66	58.12
		01-29-66	59.84
		03-16-66	61.58
		04-20-66	62.67
		05-16-66	66.43
		09-16-66	71.58
		11-03-66	70.63
		03-21-67	74.07
		03-08-68	69.57
		03-12-69	67.30
		03-10-70	64.95
		03-10-71	65.60
		03-09-72	69.58
		03-15-73	72.30
		03-20-74	64.00
		03-03-75	67.39
		03-02-76	64.44
		04-05-77	75.21
		03-09-78	86.49
		03-07-79	70.36

Table 9. Water levels in selected wells, Sanpete Valley, Utah—Continued

Location	Altitude of land surface (feet)	Date	Water level (feet)
(D-17-3)20acc-1 —Continued		03-04-80	65.47
		03-03-81	58.15
		03-03-82	65.93
		03-11-83	58.49
		03-12-84	51.78
		03-04-85	51.37
		03-14-86	60.01
		03-04-87	61.18
		11-13-87	65.89
		12-03-87	66.25
		01-05-88	66.88
		02-04-88	67.56
		03-01-88	67.91
		03-30-88	68.57
		04-29-88	66.01
		06-02-88	65.77
		06-30-88	64.32
		08-03-88	69.73
		11-29-88	69.89
		01-31-89	70.63
		03-08-89	71.59
		09-26-89	80.72
		11-10-89	77.05
		03-02-90	76.82
(D-17-3)20cdb-1	5,530	05-01-64	54.36
		06-24-64	52.65
		07-08-64	61.68
		09-04-64	69.03
		09-28-64	65.80
		10-30-64	52.33
		05-14-65	53.69
		10-26-65	37.76
		03-16-66	42.15
		09-01-66	54.60
		09-08-66	68.62
		11-03-66	51.40
		11-30-88	50.49
		01-30-89	50.80
		03-08-89	51.29
		05-08-89	51.92
		06-14-89	57.28
		07-25-89	60.11
		09-18-89	72.37
		11-10-89	57.53
		03-02-90	56.24
(D-17-3)30aaa-1	5,490	05-01-64	21.59
		05-14-64	20.88
		06-23-64	11.20
		09-28-64	20.00
		10-26-64	7.35
		03-16-66	11.66
		11-03-66	19.40
		11-30-88	20.01
		05-08-89	20.05
		09-18-89	29.03
		11-10-89	25.87
		03-02-90	24.97
(D-17-3)30dbd-1	5,454	10-08-38	-11.6
		12-21-38	-11.0
(D-17-3)30dbd-1—Continued		04-17-39	-10.0
		06-17-39	-11.4
		08-23-39	-10.3
		10-15-39	-10.0
		12-25-39	-9.7
		03-26-40	-9.3
		06-04-40	-10.8
		12-05-40	-11.2
		03-19-41	-10.6
		12-05-41	-13.5
		08-10-42	-14.8
		12-20-42	-13.7
		03-25-43	-12.3
		12-17-43	-11.2
		03-19-44	-10.1
		12-04-44	-13.2
		04-03-45	-12.2
		12-06-45	-13.9
		03-21-46	-13.4
		12-18-46	-12.0
		03-27-47	-10.7
		12-13-47	-13.3
		12-13-48	-12.1
		04-04-49	-10.8
		12-13-49	-11.8
		03-30-50	-11.0
		12-10-50	-9.6
		03-27-51	-9.3
		12-11-51	-9.9
		12-08-52	-14.1
		03-17-53	-13.3
		12-14-53	-11.6
		03-26-54	-11.5
		11-30-54	-10.3
		03-22-55	-10.7
		12-06-55	-8.7
		03-22-56	-9.1
		12-05-56	-8.2
		03-12-58	-11.8
		04-04-58	-11.4
		05-07-58	-11.5
		06-04-58	-12.0
		07-03-58	-13.8
		08-04-58	-13.1
		09-02-58	-11.7
		10-07-58	-11.5
		11-06-58	-11.2
		11-29-58	-9.8
		01-02-59	-11.0
		01-27-59	-8.8
		03-26-59	-10.2
		04-29-59	-9.5
		05-29-59	-11.5
		06-24-59	-10.5
		07-29-59	-9.4
		08-25-59	-9.0
		09-25-59	-8.7
		10-29-59	-8.7
		11-30-59	-7.7
		12-30-59	-8.0
		01-27-60	-7.8
		03-25-60	-7.6
(D-17-3)30dbd-1—Continued		04-27-60	-7.5
		05-25-60	-7.3
		06-17-60	-7.7
		07-27-60	-7.5
		08-29-60	-7.0
		09-28-60	-6.8
		10-27-60	-7.0
		11-30-60	-7.2
		12-30-60	-7.10
		01-30-61	-7.1
		02-27-61	-7.2
		03-31-61	-7.5
		04-24-61	-7.2
		05-26-61	-6.8
		07-06-61	-6.6
		07-26-61	-6.0
		08-24-61	-5.4
		09-29-61	-5.9
		10-16-62	-12.5
		03-01-65	-9.7
		03-24-65	-9.6
		04-28-65	-10.2
		06-03-65	-10.0
		06-23-65	-12.3
		07-28-65	-14.8
		08-30-65	-15.0
		09-28-65	-14.6
		10-25-65	-14.3
		12-01-65	-13.8
		01-03-66	-13.4
		01-29-66	-12.4
		03-16-66	-12.3
		04-20-66	-11.5
		05-16-66	-12.0
		06-16-66	-11.8
		07-20-66	-10.9
		09-16-66	-9.9
		11-03-66	-9.8
		03-21-67	-9.3
		03-08-68	-10.7
		03-12-69	-10.9
		03-11-70	-11.6
		03-10-71	-10.6
		03-09-72	-10.4
		03-15-73	-8.0
		03-20-74	-11.2
		03-03-75	-10.6
		03-02-76	-10.8
		03-02-77	-7.9
		04-05-77	-8.1
		03-09-78	-5.3
		03-07-79	-10.1
		03-04-80	-10.4
		03-03-81	-12.2
		03-08-82	-10.3
		03-09-83	-12.0
		03-12-84	-12.9
		03-08-85	-13.2
		03-14-86	-11.8
		03-04-87	-11.1
		11-13-87	-9.5
		12-03-87	-9.6

Table 9. Water levels in selected wells, Sanpete Valley, Utah—Continued

Location	Altitude of land surface (feet)	Date	Water level (feet)
(D-17-3)30dbd-1—Continued		01-05-88	-9.6
		02-04-88	-8.7
		03-01-88	-9.4
		03-30-88	-9.0
		04-29-88	-9.1
		06-02-88	-9.9
		06-30-88	-10.3
		07-28-88	-10.0
		08-30-88	-8.8
		12-20-88	-8.3
		03-07-89	-8.7
		05-08-89	-8.7
		06-15-89	-8.3
		07-25-89	-7.6
		09-18-89	-6.5
		11-10-89	-6.8
		03-02-90	-6.6
(D-18-2)1cdb-1	5,540	04-30-64	71.53
		06-02-64	67.36
		06-23-64	56.32
		07-09-64	67.16
		07-31-64	68.93
		09-01-64	71.90
		09-28-64	61.70
		10-30-64	63.50
		12-10-64	64.98
		05-14-65	70.99
		06-23-65	52.19
		07-28-65	43.25
		10-26-65	51.65
		03-16-66	64.99
		05-26-66	73.84
		07-19-66	76.60
		11-02-66	68.50
		04-29-88	73.06
		06-02-88	64.79
		07-01-88	59.33
		07-28-88	64.93
		08-30-88	68.32
		11-29-88	69.93
		01-31-89	71.53
		03-07-89	72.93
		05-08-89	72.89
		09-19-89	75.82
		11-09-89	75.20
		03-02-90	75.91
(D-18-2)1daa-2	5,556	05-25-60	83.57
		06-17-60	76.95
		07-27-60	89.59
		08-29-60	84.75
		09-28-60	81.76
		10-27-60	81.49
		11-28-60	81.21
		12-30-60	81.81
		01-30-61	83.37
		02-27-61	84.30
		03-31-61	84.88
		04-24-61	84.99
		05-26-61	84.70
		07-06-61	92.98
(D-18-2)1daa-2—Continued		09-29-61	83.84
		04-05-62	85.88
		09-28-62	64.90
		04-11-63	77.26
		09-25-63	74.73
		04-01-64	81.75
		05-01-64	81.93
		06-02-64	76.03
		06-24-64	66.40
		09-28-64	71.85
		10-30-64	73.74
		12-10-64	75.18
		02-09-65	78.60
		03-22-65	80.29
		04-27-65	81.32
		05-14-65	80.42
		05-27-65	77.49
		06-22-65	61.54
		07-28-65	53.36
		08-30-65	53.52
		09-28-65	57.50
		10-25-65	60.46
		11-30-65	65.00
		12-30-65	68.06
		01-29-66	70.84
		03-16-66	74.41
		04-15-66	75.75
		09-16-66	82.40
		11-04-66	78.60
		03-21-67	81.75
		11-29-67	72.30
		03-07-68	78.00
		09-25-68	64.10
		03-12-69	75.76
		09-24-69	62.08
		03-11-70	75.34
		09-15-70	65.51
		03-10-71	76.40
		09-16-71	69.46
		03-08-72	77.87
		09-27-72	80.93
		03-15-73	81.95
		09-26-73	65.45
		03-20-74	74.86
		09-13-74	74.07
		03-04-75	78.10
		03-02-76	78.17
		09-22-76	86.21
		03-02-77	83.09
		09-22-77	106.52S
		03-09-78	88.14
		03-07-79	77.16
		03-04-80	77.90
		09-29-80	63.76
		03-03-81	74.52
		09-12-81	74.90
		03-08-82	79.62
		09-14-82	63.20
		03-11-83	75.97
		09-02-83	53.51
		03-12-84	75.22
		09-14-84	59.02
(D-18-2)1daa-2—Continued		03-04-85	75.27
		09-19-85	68.48
		03-04-86	76.97
		09-04-86	63.55
		03-04-87	77.59
		09-02-87	73.30
		03-01-88	82.48
		08-30-88	78.25
		03-07-89	83.36
		05-08-89	83.10
		09-19-89	86.15
		11-09-89	84.94
(D-18-2)9dca-1	5,395	11-20-87	16.35
		12-03-87	16.03
		01-05-88	14.31
		02-04-88	12.16
		02-29-88	9.40
		03-30-88	5.01
		04-29-88	4.38
		06-02-88	5.37
		06-30-88	7.28
		07-28-88	10.86
		08-31-88	13.99
		11-29-88	17.13
		03-07-89	10.99
		05-08-89	7.16
		06-15-89	11.35
		07-25-89	14.80
		09-19-89	17.58
		11-09-89	18.14
		03-02-90	17.59
(D-18-2)11baa-1	5,480	05-13-89	9.01
		08-24-89	16.24
(D-18-2)11bcc-2	5,455	08-07-58	-6.65
		09-02-58	-5.35
		10-07-58	-4.95
		11-06-58	-4.85
		11-29-58	-4.40
		12-31-58	-3.83
		01-27-59	-3.38
		02-25-59	-2.95
		03-26-59	-2.52
		04-29-59	-2.36
		05-27-59	-2.66
		06-24-59	-2.23
		07-29-59	-1.08
		08-25-59	-.43
		09-25-59	-.05
		10-29-59	-.28
		11-30-59	-.25
		12-30-59	-.05
		10-16-62	-5.55
		03-01-65	-2.60
		03-22-65	-2.04
		04-27-65	-1.24
		05-27-65	-2.65
		06-22-65	-7.85
		07-28-65	-8.60
		08-27-65	-7.95

Table 9. Water levels in selected wells, Sanpete Valley, Utah—Continued

Location	Altitude of land surface (feet)	Date	Water level (feet)
(D-18-2)11bcc-2—Continued		09-28-65	-7.45
		10-25-65	-6.95
		11-30-65	-6.25
		12-30-65	-5.60
		01-29-66	-4.75
		03-15-66	-3.65
		04-15-66	-3.32
		05-12-66	-4.6
		06-14-66	-6.27
		07-18-66	-4.75
		09-19-66	-2.00
		11-02-66	-1.50
		03-21-67	-1.16
		03-08-68	-2.90
		03-12-69	-3.52
		03-11-70	-3.61
		03-10-71	-3.31
		03-08-72	-3.00
		03-15-73	-1.95
		03-19-74	-3.45
		03-04-75	-2.35
		03-02-76	-3.25
		03-09-78	-2.11
		03-04-80	-3.08
		03-03-81	-3.65
		03-08-82	-2.25
		03-04-87	-2.11
		11-13-87	-2.1
		12-03-87	-2.0
		01-06-88	-1.8
		02-04-88	-1.8
		03-01-88	-1.60
		03-30-88	-1.1
		04-29-88	-.8
		06-02-88	-3.4
		06-30-88	-4.2
		07-28-88	-3.3
		08-31-88	-2.25
		11-29-88	-1.2
		01-31-89	-1.0
		03-07-89	-.65
		05-08-89	-.07
		06-15-89	-2.1
		07-25-89	-.85
		09-19-89	.92
		11-10-89	.94
		03-02-90	.58
(D-18-2)12bab-1	5,554	08-03-35	70.86
		09-05-35	71.40
		10-10-35	75.66
		11-21-35	78.00
		11-04-36	68.60
		11-30-36	70.76
		02-05-37	75.56
		04-10-37	78.16
		06-10-37	65.94
		08-02-37	59.00
		10-25-37	68.75
		11-12-37	69.70
		12-12-37	72.93
		02-28-38	77.24
(D-18-2)12bab-1—Continued		04-09-38	79.02
		06-03-38	69.66
		01-06-39	75.87
		03-02-39	80.00
		04-17-39	79.54
		06-17-39	69.96
		10-15-39	75.39
		12-15-39	77.92
		02-07-40	80.28
		03-26-40	81.46
		06-04-40	63.55
		12-05-40	74.40
		03-19-41	78.48
		12-05-41	68.39
		03-18-42	75.72
		12-20-42	70.97
		03-25-43	76.32
		12-17-43	77.05
		03-19-44	80.05
		12-05-44	70.20
		04-03-45	80.89
		12-06-45	68.95
		03-21-46	75.72
		12-18-46	75.58
		03-27-47	78.15
		12-13-47	69.95
		03-17-48	78.21
		07-22-48	71.40
		12-13-48	73.86
		04-04-49	78.89
		12-13-49	78.24
		03-30-50	78.95
		12-10-50	77.59
		03-27-51	80.23
		12-11-51	79.35
		04-07-52	80.88
		12-08-52	66.47
		03-17-53	75.59
		12-10-53	71.59
		03-26-54	77.05
		11-30-54	78.56
		03-22-55	82.09
		03-22-56	83.06
		12-05-56	82.63
		03-12-58	74.41
		06-04-58	66.10
		11-06-58	70.15
		11-29-58	71.20
		12-31-58	78.54
		01-27-59	76.80
		02-25-59	77.10
		03-26-59	79.27
		04-29-59	80.22
		11-30-59	83.23
		12-30-59	82.25
		01-26-60	84.75
		02-26-60	85.53
		03-25-60	85.85
		04-27-60	85.46
		05-25-60	86.80
		11-28-60	83.90
		12-30-60	84.92
(D-18-2)12bab-1—Continued		01-30-61	84.30
		02-27-61	85.18
		03-31-61	85.65
		04-24-61	87.12
		05-26-61	86.18
		09-29-61	94.41
		04-30-64	86.13
		06-23-64	66.40
		07-27-64	80.57
		09-28-64	68.75
		12-11-64	75.33
		02-09-65	79.03
		03-22-65	80.97
		04-27-65	82.49
		05-14-65	82.10
		05-27-65	78.24
		06-22-65	61.08
		07-20-65	67.72
		08-27-65	68.36
		09-28-65	57.40
		10-25-65	61.33
		11-30-65	65.74
		12-30-65	68.98
		01-29-66	71.83
		03-16-66	75.50
		04-15-66	77.53
		05-16-66	76.04
		11-02-66	79.48
		03-21-67	82.26
		03-06-68	78.58
		03-10-71	77.56
		03-08-72	77.98
		03-15-73	82.04
		03-20-74	75.79
		03-04-75	80.14
		03-02-76	78.82
		03-02-77	84.18
		03-09-78	89.07
		03-07-79	89.13
		03-04-80	78.10
		03-03-81	76.03
		03-12-84	75.94
		03-12-85	76.82
		03-14-86	77.89
		03-04-87	78.80
		11-13-87	77.88
		12-03-87	78.86
		01-06-88	80.02
		02-04-88	80.87
		03-01-88	81.20
		03-08-89	83.40
(D-18-2)12bdc-1	5,565	04-30-64	102.50
		06-23-64	80.90
		09-28-64	90.48
		05-14-65	103.55
		06-23-65	78.28
		07-28-65	67.90
		10-26-65	81.01
		03-16-66	96.34
		11-02-66	92.90
		05-08-89	98.98
		11-10-89	101.23

Table 9. Water levels in selected wells, Sanpete Valley, Utah—Continued

Location	Altitude of land surface (feet)	Date	Water level (feet)
(D-18-2)14aba-1	5,510	12-04-87	46.63
		01-06-88	45.04
		02-04-88	45.77
		02-29-88	46.12
		03-30-88	46.55
		04-29-88	48.08
		06-02-88	39.66
		06-30-88	39.98
		07-27-88	42.61
		08-31-88	46.01
		11-29-88	48.71
		01-31-89	49.47
		03-07-89	49.66
		05-08-89	49.92
		06-15-89	45.34
		07-25-89	47.70
		09-19-89	50.56
		11-09-89	51.51
		03-02-90	51.97
(D-18-2)27ccc-1	5,497	07-29-58	22.52
		09-03-58	23.10
		10-03-58	23.73
		11-06-58	24.80
		11-29-58	25.92
		12-31-58	27.12
		01-27-59	28.40
		02-25-59	29.15
		03-26-59	30.17
		04-29-59	31.20
		05-27-59	30.51
		06-24-59	29.19
		06-24-59	29.19
		07-29-59	28.76
		08-25-59	29.27
		09-25-59	30.73
		10-29-59	31.94
		11-27-59	32.80
		12-30-59	33.95
		01-26-60	34.89
		02-29-60	35.92
		03-25-60	36.10
		04-27-60	37.10
		05-25-60	35.53
		06-17-60	30.42
		07-26-60	28.27
		08-31-60	29.39
		09-28-60	30.56
		10-27-60	30.97
		11-28-60	31.63
		12-30-60	32.56
		10-16-62	23.79
		02-24-65	30.82
		03-22-65	31.77
		04-27-65	32.16
		05-27-65	30.98
		06-22-65	22.66
		07-27-65	20.88
		08-27-65	20.96
		09-28-65	21.76
		10-25-65	23.17
		11-30-65	24.47
(D-18-2)27ccc-1—Continued		12-30-65	25.59
		01-29-66	26.88
		03-15-66	27.93
		04-15-66	28.56
		05-16-66	27.05
		06-14-66	24.30
		07-18-66	23.98
		09-19-66	25.90
		11-02-66	27.60
		03-21-67	31.61
		03-07-68	28.91
		03-12-69	28.33
		03-11-70	28.88
		03-08-71	29.75
		03-06-72	29.23
		03-15-73	31.45
		03-19-74	29.33
		03-04-75	29.42
		03-02-76	29.43
		03-02-77	32.88
		03-09-78	36.48
		03-07-79	34.41
		03-04-80	36.66
		03-03-81	33.31
		03-08-82	36.91
		03-09-83	31.19
		03-12-84	30.05
		03-04-85	29.60
		03-12-86	33.92
		03-04-87	35.53
		03-01-88	37.26
		08-31-88	34.35
		03-07-89	40.60
		09-19-89	42.73
		11-10-89	43.51
		03-02-90	45.86

Table 10. Discharge, specific conductance, and temperature of water from selected flowing and pumped wells, Sanpete Valley, Utah

[—, no data]

Location: See figure 2 for an explanation of the numbering system for hydrologic-data sites.
Discharge: gal/min, gallons per minute; measured with a current meter or volumetrically, with a bucket and stopwatch.
Specific conductance: μS/cm, microsiemens per centimeter at 25 degrees Celsius; A indicates additional water-quality data reported in table 11.
Temperature: °C, degrees Celsius.

Location	Date	Discharge (gal/min)	Specific conductance (μS/cm)	Temperature (°C)
(D-14-2)12aaa-1	08-29-88	—	570 A	10.5
(D-14-2)12aad-1	08-22-89	—	455	11.0
(D-14-2)13aaa-1	03-01-76	—	420	9.0
	11-10-87	.3	460	10.0
	03-02-88	.3	455	9.0
	08-29-88	.3	500	12.0
	12-19-88	.3	450	10.0
	01-30-89	.4	—	7.5
	03-06-89	.3	440	9.5
	05-05-89	.3	490	11.0
	06-16-89	.3	480	12.5
	07-24-89	.3	470	12.0
	09-20-89	.3	450	11.0
	11-06-89	.3	480	10.0
	03-01-90	.3	460	8.0
(D-14-2)13cad-1	03-20-64	—	840	12.0
	05-05-89	—	1,050	14.0
(D-14-3)7abb-1	07-31-75	—	530	10.5
	08-12-76	300	580	11.5
	08-10-77	—	600	11.0
(D-14-3)7acc-1	08-07-79	—	600	11.0
	06-23-81	—	670	11.5
(D-14-3)7bbb-1	08-07-81	—	530	11.0
(D-14-3)17cca-1	07-27-66	—	610	10.0
	08-08-79	—	620	11.0
	07-17-86	—	630	10.5
	05-05-89	—	660	11.5
(D-14-3)19dbb-1	11-06-89	.3	490	10.5
(D-14-3)20abd-1	05-05-89	—	850	13.5
(D-14-3)20aca-1	08-08-89	—	900 A	10.5
(D-14-3)20bba-1	07-27-66	—	590	10.0
	08-22-78	—	560	10.5
	08-20-85	—	520	9.0
	05-05-89	—	680	11.0
	08-08-89	—	690	10.0
(D-14-3)20cbb-1	05-18-65	—	740	10.0
	07-28-66	—	740	10.0
	08-12-76	—	600	10.0
	08-22-78	—	700	10.0
	08-08-79	—	700	11.0

Table 10. Discharge, specific conductance, and temperature of water from selected flowing and pumped wells, Sanpete Valley, Utah—Continued

Location	Date	Discharge (gal/min)	Specific conductance (μS/cm)	Temperature (°C)
(D-14-3)20cbb-1—Continued	06-23-81	—	710	10.5
	05-05-89	—	790	11.5
(D-14-3)29ccb-1	06-06-89	.1	700	13.0
	11-06-89	—	620	10.5
(D-14-3)29ccb-3	11-06-89	.1	—	—
(D-14-3)30abb-1	05-06-89	.8	540	12.0
	11-07-89	.8	690	10.5
(D-14-3)31dad-1	03-01-76	—	410	10.5
	11-10-87	1.7	455	12.0
	12-02-87	1.4	450	12.0
	01-04-88	1.5	425	10.5
	03-02-88	1.6	465	11.5
	06-29-88	1.4	450	12.5
	08-29-88	2.9	470	13.0
	12-19-88	.6	455	9.0
	01-30-89	1.4	—	9.5
	03-06-89	1.4	405	12.0
	05-06-89	1.5	450	13.5
	06-16-89	.6	475	13.5
	07-24-89	1.9	450	13.5
	09-12-89	1.6	470	13.0
	11-07-89	1.3	460	12.0
	03-01-90	1.3	460	11.5
(D-14-4)1acb-1	09-02-88	—	590	14.0
	03-08-89	6.0	550	14.5
	05-02-89	12	590	14.5
	09-12-89	7.5	560	15.0
	11-07-89	7.5	550	14.5
(D-14-4)12cdc-1	07-21-65	—	520	10.0
(D-14-4)36abb-1	10-14-66	—	870	10.0
(D-15-3)4abc-1	11-07-89	—	790	13.0
(D-15-3)5ada-2	08-08-89	—	690	11.5
(D-15-3)8cda-3	04-30-65	—	500	10.5
	03-01-76	—	470	10.0
	11-10-87	.8	500	10.0
	03-02-88	1.3	480	10.5
	08-29-88	.5	500	14.0
	12-01-88	.7	—	10.0
	01-30-89	.8	—	8.5
	03-06-89	.9	470	10.5
	05-06-89	1.2	—	13.5
	06-16-89	.9	500	13.0
	07-24-89	.6	510	14.5
	09-12-89	.4	485	12.0
	11-07-89	.6	500	10.5

Table 10. Discharge, specific conductance, and temperature of water from selected flowing and pumped wells, Sanpete Valley, Utah—Continued

Location	Date	Discharge (gal/min)	Specific conductance (μS/cm)	Temperature (°C)
(D-15-3)8cda-3—Continued	03-01-90	0.9	502	10.5
(D-15-3)9ddc-1	06-07-89	—	1,150	12.0
(D-15-3)14bdb-1	07-05-89	—	405 A	33.0
(D-15-3)25bca-1	06-07-89	—	950	13.0
(D-15-3)27ada-1	08-12-76	—	900	11.0
(D-15-3)29cca-1	11-22-66	2.4	780	10.0
(D-15-3)32ccd-1	11-21-66	—	1,890	10.5
(D-15-3)33bba-1	11-25-66	2.0	520	10.5
	05-06-89	1.3	580	10.5
	11-07-89	1.1	560	11.0
(D-15-4)4bad-2	08-10-76	—	540	12.0
	08-21-78	—	640	10.0
	08-13-79	—	600	12.0
(D-15-4)4bcd-1	08-10-76	—	520	11.0
	08-09-79	—	610	10.5
	08-13-80	—	590	10.5
	09-02-88	—	620	10.0
(D-15-4)4dda-1	06-29-65	—	640	10.0
	08-23-89	—	680	11.0
(D-15-4)7dad-1	10-20-66	10	580	10.0
	05-10-89	8.6	650	10.0
	07-27-89	7.9	690 A	10.5
	11-08-89	9.0	520	10.5
(D-15-4)7dda-1	05-10-89	8.6	650	10.0
	11-08-89	10	580	10.5
(D-15-4)9bac-1	07-29-66	—	540	10.0
	08-11-76	—	520	11.0
	08-21-78	—	570	10.5
	08-09-79	—	570	11.0
(D-15-4)9ccc-1	08-21-78	—	560	11.0
	08-09-79	—	430	11.5
	06-23-81	—	490	14.0
(D-15-4)17abb-1	06-23-81	—	550	11.0
	08-09-89	—	730	9.5
(D-15-4)31dab-1	03-16-65	4.0	—	11.0
	04-30-65	—	680	—
	11-12-87	3.0	670	11.0
	12-02-87	3.2	640	11.0
	01-04-88	3.2	640	11.0
	03-02-88	3.2	660	11.5
	06-29-88	2.9	670	10.5
	09-02-88	3.8	670	11.0
	12-01-88	4.3	—	11.5
	03-07-89	6.0	640	10.0
	05-04-89	2.4	680	11.0

Table 10. Discharge, specific conductance, and temperature of water from selected flowing and pumped wells, Sanpete Valley, Utah—Continued

Location	Date	Discharge (gal/min)	Specific conductance (µS/cm)	Temperature (°C)
(D-15-4)31dab-1—Continued	06-14-89	4.0	680	12.0
	07-27-89	3.6	690	11.5
	09-14-89	7.5	670	12.0
	11-09-89	8.6	620	11.5
(D-15-4)31dcc-1	04-29-65	—	640	10.0
	09-20-89	6.2	700	11.0
(D-16-2)13dda-1	06-24-81	—	940	14.0
	08-30-88	—	1,100 A	14.0
	03-07-89	7.5	1,100	13.5
(D-16-2)35acd-1	07-21-66	—	1,140	14.0
	08-09-79	—	1,200	15.0
	08-08-89	—	1,280 A	14.0
(D-16-2)36cbd-1	06-05-65	—	580	13.0
	08-21-78	—	640	14.0
	08-09-79	—	600	14.0
	06-24-81	—	630	14.0
	08-08-89	—	730 A	14.0
(D-16-3)1bbb-2	11-29-66	22	710	11.0
	05-06-89	4.6	2,120	11.0
	06-07-89	—	2,200 A	12.0
	09-20-89	—	2,070	12.0
	11-08-89	9.2	2,190	10.0
(D-16-3)3bbc-1	11-29-66	15	—	—
	09-20-89	.5	1,260	11.5
(D-16-3)3cbb-1	09-14-66	168	960	12.0
	09-08-89	77	1,100	13.0
(D-16-3)3cbc-1	09-08-89	3.9	1,100	11.5
(D-16-3)4aaa-1	10-28-66	—	1,100	10.5
	03-01-76	—	1,050	11.0
	09-14-82	—	1,140 A	10.5
	03-04-87	—	1,130 A	11.0
	09-01-87	—	1,100	11.0
	09-01-88	2.6	1,120	11.0
	03-06-89	3.5	1,130	11.0
	05-05-89	3.3	1,140	11.0
	09-15-89	1.9	1,110	12.0
	11-08-89	2.0	1,080	10.5
	03-01-90	3.3	1,120	11.0
(D-16-3)4aaa-2	10-28-66	—	1,230	10.5
	05-05-89	—	1,160	10.5
	11-08-89	—	1,110	10.0
(D-16-3)4dbd-2	05-05-89	.9	600	10.5
	08-23-89	.7	570	11.0
	11-08-89	.8	560	10.5
(D-16-3)5ddc-1	08-23-89	13	560	10.5

Table 10. Discharge, specific conductance, and temperature of water from selected flowing and pumped wells, Sanpete Valley, Utah—Continued

Location	Date	Discharge (gal/min)	Specific conductance (μS/cm)	Temperature (°C)
(D-16-3)8aad-1	08-23-89	0.8	580	11.0
(D-16-3)8add-1	08-23-89	—	600	17.5
(D-16-3)8daa-1	05-05-89	4.0	760	12.5
	11-08-89	5.2	710	12.5
(D-16-3)9bcb-1	10-09-35	13	—	—
	03-08-65	12	—	—
	05-05-89	7.5	—	12.5
	08-22-89	—	800	13.0
(D-16-3)9bcc-1	05-05-89	48	900	13.0
	08-22-89	52	880	13.5
	11-08-89	48	910	13.0
(D-16-3)13dbd-1	05-06-89	.9	870	11.5
	11-09-89	.4	860	9.0
(D-16-3)15dcb-1	06-04-65	—	1,420	11.5
(D-16-3)16dab-1	05-07-89	1.7	1,120	12.0
	11-08-89	.6	1,180	10.0
(D-16-3)17aad-1	09-01-88	—	650	10.5
	12-19-88	—	610	5.0
	03-07-89	.3	620	13.0
	03-07-89	—	600	9.0
	05-07-89	.3	620	13.0
	06-16-89	—	620	11.0
	07-24-89	—	620	12.0
	09-15-89	—	630	11.0
	11-08-89	—	650	9.5
	03-02-90	.2	630	10.5
(D-16-3)18bba-1	09-21-89	.6	730	13.5
(D-16-3)20bad-2	12-12-66	10	520	—
	05-07-89	12	610	16.5
	09-21-89	9.9	640	16.0
	11-08-89	9.8	620	15.0
(D-16-3)20cda-1	11-09-89	6.0	600	14.5
(D-16-3)21bbc-1	03-03-76	—	500	7.0
	09-01-88	.3	560	11.5
	03-06-89	.3	560	11.0
	09-15-89	.3	550	12.0
	03-02-90	.3	570	11.0
(D-16-3)21cdb-2	11-12-87	3.2	1,150	11.5
	12-03-87	2.7	1,100	11.5
	01-05-88	2.8	1,080	11.5
	03-02-88	2.7	1,210	11.0
	06-30-88	3.2	1,160	11.5
	09-01-88	2.6	1,210 A	11.5
	12-19-88	2.5	1,240	10.0
	02-01-89	2.5	—	9.5
	03-06-89	2.5	1,180	11.5
	05-07-89	2.2	1,180	13.0

Table 10. Discharge, specific conductance, and temperature of water from selected flowing and pumped wells, Sanpete Valley, Utah—Continued

Location	Date	Discharge (gal/min)	Specific conductance (μS/cm)	Temperature (°C)
(D-16-3)21cdb-2—Continued	06-16-89	2.7	1,130	12.0
	07-24-89	2.4	1,150	12.5
	09-15-89	—	1,150	12.0
	11-08-89	1.9	1,180	11.5
	03-02-90	1.9	1,190	12.0
(D-16-3)24aba-1	07-30-65	60	810	12.0
	09-21-89	14	870	14.0
(D-16-3)25cab-1	05-04-89	—	650	10.5
(D-16-3)26cbd-1	04-26-89	1.8	980	15.5
	05-06-89	1.6	980	16.5
	07-06-89	—	950 A	17.0
	11-09-89	1.5	930	16.5
(D-16-3)28aad-1	08-23-89	—	990	25.0
(D-16-3)28bbd-1	12-12-66	60	1,020	12.0
	09-21-89	30	1,100	13.0
(D-16-3)28bbd-2	09-21-89	.1	840	15.0
(D-16-3)28cba-1	05-07-89	—	1,100	13.5
	11-08-89	.4	1,160	11.0
(D-16-3)28cda-1	08-21-78	—	1,300	13.0
	08-08-89	—	950	14.0
(D-16-3)31acd-1	05-07-89	—	580	15.0
	11-09-89	1.2	560	11.5
(D-16-3)31dbd-1	09-21-89	1.1	480	11.5
(D-16-3)32bda-1	11-09-89	.8	1,000	11.0
(D-16-3)33ccb-2	11-12-87	.6	415	10.0
	03-02-88	.5	405	9.0
	06-30-88	.5	405	11.0
	09-01-88	.5	415	9.5
	12-19-88	.5	430	7.0
	03-06-89	.7	440	9.0
	05-07-89	.3	400	10.5
	06-16-89	.3	420	11.0
	07-24-89	.3	405	11.0
	09-15-89	—	400	12.0
	11-09-89	.3	430	9.0
	03-02-90	.2	420	9.0
(D-16-4)18bac-1	11-16-66	—	820	—
(D-16-4)18bac-2	07-05-89	—	2,230 A	13.0
(D-17-2)1bca-2	03-02-76	—	440	10.0
	08-30-88	.6	475	13.0
	03-07-89	.5	480	11.0
	09-15-89	.3	450	12.0
	03-01-90	.3	465	10.5
(D-17-2)1cba-1	12-20-66	5.0	470	13.0
	09-22-89	4.6	510	13.5

Table 10. Discharge, specific conductance, and temperature of water from selected flowing and pumped wells, Sanpete Valley, Utah—Continued

Location	Date	Discharge (gal/min)	Specific conductance (μS/cm)	Temperature (°C)
(D-17-2)1dac-1	12-20-66	4.0	500	11.0
	08-29-89	.1	540	13.0
(D-17-2)1dda-1	08-29-89	8.6	620	12.0
(D-17-2)1ddb-1	08-29-89	2.1	560	12.0
(D-17-2)1ddc-1	12-20-66	265	480	11.0
	08-29-89	5.0	550	12.0
(D-17-2)12abb-1	08-30-89	8.8	540	11.0
(D-17-2)12adb-1	08-31-89	1.9	620	11.0
(D-17-2)12add-2	08-30-89	.9	700	11.0
(D-17-2)12daa-1	08-31-89	6.0	680	11.0
(D-17-2)13aad-1	12-30-66	5.4	670	10.0
	09-06-89	2.8	750	11.0
(D-17-2)13bdd-1	12-30-66	12	590	10.0
	09-07-89	10	670	11.0
(D-17-2)14baa-1	03-02-76	—	450	9.0
	11-12-87	1.4	560	10.5
	12-03-87	—	530	11.0
	01-05-88	.7	470	10.5
	03-02-88	.7	455	10.5
	06-30-88	.6	500	10.5
	08-31-88	.6	490	12.0
	11-28-88	.6	495	10.5
	03-07-89	.6	500	11.0
	05-09-89	.6	495	11.5
	06-15-89	.5	600	12.5
	07-25-89	.5	465	12.5
	09-15-89	.5	490	12.0
	11-09-89	.5	475	11.0
	03-02-90	.5	485	10.0
(D-17-2)14cca-1	11-30-88	—	780 A	9.0
(D-17-2)14cca-2	11-30-88	—	5,990 A	9.0
(D-17-2)14ccb-1	05-09-89	.2	870	11.5
	06-07-89	.2	870 A	11.0
	07-25-89	.2	830	12.0
	09-26-89	.2	850	11.0
	11-09-89	.2	840	11.0
	03-02-90	.2	840	10.0
(D-17-2)14cdb-1	05-09-89	.6	860	11.5
	11-09-89	.4	830	11.0
(D-17-2)15aca-1	11-30-88	—	26,800	10.5
(D-17-2)22ddb-1	06-30-88	4.1	920	13.5
	08-31-88	—	920	—
	03-07-89	—	1,000	13.0
	05-08-89	3.9	970	13.0
	06-15-89	4.6	930	14.0

Table 10. Discharge, specific conductance, and temperature of water from selected flowing and pumped wells, Sanpete Valley, Utah—Continued

Location	Date	Discharge (gal/min)	Specific conductance (μS/cm)	Temperature (°C)
(D-17-2)22ddb-1—Continued	07-25-89	5.0	870	14.5
	09-18-89	1.3	920	14.0
	11-09-89	3.8	940	12.0
(D-17-2)25ccd-1	06-30-88	—	680	10.5
	08-30-88	1.4	730	10.5
	03-07-89	1.7	770	9.5
	05-08-89	1.6	720	10.0
	06-15-89	1.8	690	11.0
	07-25-89	1.3	700	11.0
	09-18-89	1.3	720	10.5
	11-10-89	1.2	730	9.5
	03-02-90	1.2	730	9.5
(D-17-2)34aad-1	09-27-89	15	630	10.5
(D-17-2)34adb-1	01-07-67	10	500	10.5
	09-27-89	21	500	10.5
(D-17-2)35cba-1	11-20-87	1.8	440	11.5
	08-30-88	1.6	840	10.0
	03-07-89	1.4	495	11.0
	05-08-89	1.4	380	12.5
	06-15-89	1.3	470	13.5
	07-25-89	1.3	440	13.5
	09-18-89	1.1	470	12.5
	11-10-89	1.1	450	11.0
	03-02-90	1.0	480	11.0
(D-17-2)36cba-1	08-30-88	1.6	840	10.0
(D-17-2)36cdc-2	08-12-76	—	500	11.0
	08-24-89	—	830	11.0
(D-17-3)3dbd-1	07-24-89	—	12,200 A	38.0
(D-17-3)4bcc-2	08-22-78	—	710	11.0
	08-08-89	—	830	10.5
(D-17-3)5ccd-1	08-25-89	9.4	570	11.0
(D-17-3)6aad-1	03-03-65	10	—	13.0
	04-28-65	—	660	13.0
	09-22-89	5.4	660	13.0
(D-17-3)6bba-1	12-20-66	—	480	11.5
	09-22-89	3.4	570	12.0
(D-17-3)6bbc-1	09-22-89	—	530	11.0
(D-17-3)6cab-1	03-02-76	—	680	10.0
	11-12-87	.5	720	10.5
	06-30-88	1.4	700	10.5
	08-30-88	1.4	720	11.0
	12-20-88	.6	660	9.5
	03-06-89	1.2	750	11.0
	05-09-89	1.1	720	10.5
	06-15-89	.5	690	12.0

Table 10. Discharge, specific conductance, and temperature of water from selected flowing and pumped wells, Sanpete Valley, Utah—Continued

Location	Date	Discharge (gal/min)	Specific conductance (µS/cm)	Temperature (°C)
(D-17-3)6cab-1—Continued	07-25-89	1.1	660	12.5
	09-15-89	—	700	11.0
	11-09-89	1.1	770	11.5
	03-01-90	1.0	680	11.0
(D-17-3)6cca-1	08-25-89	43	560	11.5
(D-17-3)6ccb-1	08-29-89	12	600	11.5
(D-17-3)6ccc-1	08-29-89	1.7	620	11.5
(D-17-3)6dca-1	08-28-89	.5	630	11.0
(D-17-3)6dcc-1	08-28-89	6.7	640	11.0
(D-17-3)6ddd-1	12-21-66	4.0	600	10.0
	08-25-89	.9	620	10.5
(D-17-3)7abb-1	08-28-89	2.5	690	11.0
(D-17-3)7abb-2	08-28-89	.5	680	11.5
(D-17-3)7abd-1	08-29-89	1.0	710	11.0
(D-17-3)7baa-1	08-25-89	3.5	750	11.0
(D-17-3)7baa-2	08-25-89	3.2	650	11.0
(D-17-3)7bab-1	08-28-89	.3	630	11.0
(D-17-3)7bab-2	08-30-89	1.9	730	11.5
(D-17-3)7bad-1	08-28-89	3.0	740	11.5
(D-17-3)7bba-1	08-30-89	3.0	880	11.5
(D-17-3)7bbb-1	12-29-66	6.0	540	11.0
	08-29-89	8.6	730	11.0
(D-17-3)7bbd-1	08-29-89	.5	780	11.5
(D-17-3)7bca-1	08-30-89	16	720	12.0
(D-17-3)7bda-1	08-28-89	1.0	750	11.0
(D-17-3)7bdc-1	08-30-89	3.5	750	11.0
(D-17-3)7cab-1	08-30-89	4.0	770	10.5
(D-17-3)7cac-1	09-01-89	6.0	790	11.0
(D-17-3)7cba-1	08-31-89	3.8	740	11.0
(D-17-3)7cba-2	08-31-89	1.4	790	10.5
(D-17-3)7cbd-1	08-31-89	2.4	830	11.0
(D-17-3)7cca-1	12-28-66	40	610	11.0
	09-06-89	9.0	690	11.5
(D-17-3)7cca-2	09-06-89	.7	860	11.0
(D-17-3)7cca-3	12-28-66	20	830	10.0
	09-06-89	13	920	11.0
(D-17-3)7cca-4	09-06-89	.8	850	11.0
(D-17-3)7cda -1	09-06-89	7.5	730	12.0
(D-17-3)7cdb-1	09-06-89	7.5	660	11.0
(D-17-3)7cdc-1	09-06-89	7.1	870	11.0
(D-17-3)7dbd-1	09-01-89	5.0	820	10.
(D-17-3)8bab-1	03-02-76	—	600	10.0
	11-12-87	1.1	640	9.5
	06-30-88	1.4	630	10.5
	08-30-88	1.4	660	10.0

Table 10. Discharge, specific conductance, and temperature of water from selected flowing and pumped wells, Sanpete Valley, Utah—Continued

Location	Date	Discharge (gal/min)	Specific conductance (μS/cm)	Temperature (°C)
(D-17-3)8bab-1—Continued	12-20-88	0.9	610	8.0
	03-06-89	.8	600	10.0
	05-09-89	.6	660	9.5
	06-16-89	.6	600	10.0
	07-25-89	.9	610	11.0
	09-15-89	—	650	10.5
	11-09-89	.8	620	10.0
	03-02-90	.6	650	9.5
(D-17-3)9cbd-1	08-22-78	—	670	11.0
	06-24-81	—	740	11.0
	08-09-89	—	810	10.5
(D-17-3)17adb-1	08-22-78	—	800	11.5
	08-15-79	—	740	11.0
	06-24-81	—	920	11.5
	08-09-89	—	850	11.0
(D-17-3)17bad-1	05-08-89	—	800	10.5
(D-17-3)17cac-1	08-22-78	—	720	12.0
	08-14-79	—	700	11.0
	06-16-88	—	650	11.0
(D-17-3)20acc-1	08-19-85	—	680	11.0
	08-30-88	—	790 A	11.5
	06-15-89	—	770	12.0
	07-25-89	—	800	12.0
(D-17-3)20bca-2	08-09-89	—	800	11.0
(D-17-3)30aaa-1	06-15-89	—	870	12.0
(D-17-3)30dbd-1	03-02-76	—	540	11.0
	11-13-87	3.3	580	11.0
	12-03-87	3.2	560	11.0
	01-05-88	3.2	570	11.0
	03-01-88	3.0	580	11.0
	06-30-88	3.3	580	11.0
	08-30-88	2.9	600	12.0
	12-20-88	2.9	570	10.0
	03-07-89	2.7	630	11.0
	05-08-89	2.7	600	10.5
	06-15-89	2.6	560	11.0
	07-25-89	2.3	640	11.5
	09-18-89	1.9	580	11.5
	11-10-89	2.1	560	11.5
	03-02-90	2.1	590	11.0
(D-18-2)1cdb-1	08-06-76	—	790	10.5
	08-22-78	—	740	11.5
	08-14-79	—	800	11.0
	08-19-85	—	790	11.0
	06-15-89	—	820	12.0

Table 10. Discharge, specific conductance, and temperature of water from selected flowing and pumped wells, Sanpete Valley, Utah—Continued

Location	Date	Discharge (gal/min)	Specific conductance (µS/cm)	Temperature (°C)
(D-18-2)1cdb-1—Continued	07-25-89	—	840	12.5
(D-18-2)1daa-2	08-06-75	—	830	11.0
	08-11-76	—	860	11.0
	08-10-77	—	860	10.0
	08-22-78	—	910	11.5
	08-23-82	—	940 A	11.5
	08-19-85	—	880	11.0
	08-09-89	—	990 A	11.0
(D-18-2)2add-1	08-22-78	—	880	11.0
	08-14-79	—	850	10.5
	08-19-85	—	800	11.0
	08-09-89	—	850	11.0
(D-18-2)11bcc-2	03-02-76	—	680	9.5
	11-13-87	1.5	740	9.5
	12-03-87	2.0	700	12.0
	01-06-88	1.7	700	10.0
	03-01-88	2.2	760	10.5
	06-30-88	5.7	760	11.0
	07-28-88	3.3	750 A	11.0
	08-31-88	—	790	11.0
	03-07-89	.4	820	10.0
	06-15-89	3.5	730	11.5
	07-25-89	.8	740	12.5
(D-18-2)12bab-1	07-20-65	—	810	10.5
	08-12-76	—	690	12.0
	08-22-78	—	770	12.5

Table 11. Results of chemical analyses of water from selected wells and springs, Sanpete Valley, Utah

[mg/L, milligrams per liter; µg/L; micrograms per liter; —, no data; < less than value shown]

Location: See figure 2 for an explanation of the numbering system for hydrologic-data sites. Letter S following serial number indicates a
Temperature: °C, degrees Celsius.
Specific conductance: µS/cm, microsiemens per centimeter at 25 degrees Celsius.

Location	Date of sample	Temperature (°C)	Specific conductance (µS/cm)	pH, (standard units)	Hardness, total (mg/L as $CaCO_3$)	Calcium, dissolved (mg/L as Ca)	Magnesium, dissolved (mg/L as Mg)	Sodium, dissolved (mg/L as Na)
(D-14-2)2bab-S1	08-22-89	12.0	430	—	220	63	16	8.5
(D-14-2)12aaa-1	08-29-88	10.5	570	7.6	280	73	24	9.8
(D-14-3)20aca-1	08-08-89	10.5	900	7.1	370	98	31	36
[1](D-15-3)14bdb-1	07-05-89	33.0	405	7.6	150	42	11	26
(D-15-4)7dad-1	07-27-89	10.5	690	7.4	340	73	39	12
(D-16-2)13dda-1	08-30-88	14.0	1,100	7.8	350	59	49	91
(D-16-2)35acd-1	08-08-89	14.0	1,280	—	480	67	75	89
(D-16-2)36cbd-1	08-08-89	14.0	730	7.9	260	39	39	44
(D-16-3)1bbb-2	06-07-89	12.0	2,200	7.8	820	130	120	170
(D-16-3)4aaa-1	09-14-82	10.5	1,140	7.2	400	86	45	99
	03-04-87	11.0	1,130	7.3	390	85	44	94
(D-16-3)21cdb-2	09-01-88	11.5	1,210	7.4	510	81	75	68
[1](D-16-3)26cbd-1	07-06-89	17.0	950	9.4	3	.71	.18	210
[1](D-16-4)18bac-2	07-05-89	13.0	2,230	7.6	960	170	130	92
(D-17-2)14cca-1	11-30-88	9.0	780	7.9	340	48	54	54
(D-17-2)14cca-2	11-30-88	9.0	5,990	7.6	2,200	130	450	640
(D-17-2)14ccb-1	06-07-89	11.0	870	7.8	350	53	53	45
[1](D-17-3)3dbd-1	07-24-89	38.0	12,200	10.2	2	.60	.1	3,600
(D-17-3)20acc-1	08-30-88	11.5	790	7.4	410	69	57	23
(D-18-2)1daa-2	08-23-82	11.5	940	7.4	440	72	62	35
	08-09-89	11.0	990	7.3	440	73	62	43
(D-18-2)2cbb-S1	09-26-89	13.5	820	—	390	74	50	16
(D-18-2)11bcc-2	07-28-88	11.0	750	7.5	360	62	51	32
(D-18-2)23adb-S1	09-26-89	15.5	3,020	—	380	71	49	500

[1] Completed in consolidated rock.

spring.

Potassium, dissolved (mg/L as K)	Alkalinity, lab (mg/L as $CaCO_3$)	Sulfate, dissolved (mg/L as SO_4)	Chloride, dissolved (mg/L as Cl)	Fluoride, dissolved (mg/L as F)	Silica, dissolved (mg/L as SiO_2)	Solids, sum of constituents, dissolved (mg/L)	Nitrogen, NO_2+NO_3, dis solved (mg/L as N)	Boron, dissolved (μg/L as B)	Selenium, dissolved (μg/L as Se)
0.80	223	8.0	6.7	0.10	7.1	245	0.250	—	—
1.1	229	18	9.9	.10	12	322	2.80	20	2
4.2	280	43	54	.10	35	536	15.0	—	—
12	216	9.0	1.1	.70	22	479	<.100	80	<1
1.2	329	14	11	.10	9.1	371	3.00	—	—
3.1	203	130	130	.50	26	633	<.100	100	<1
2.2	409	150	89	.30	23	754	3.10	—	—
1.1	242	28	60	.30	18	376	.240	—	—
4.2	356	300	360	.50	29	1,330	4.10	170	12
8.5	332	140	88	.20	54	725	1.10	160	—
8.6	357	140	80	.20	54	725	1.20	160	—
2.4	267	200	78	.30	21	739	3.40	150	5
.70	423	65	9.9	.70	10	888	<.100	560	<1
2.4	170	180	570	.10	31	1,480	6.30	80	15
1.7	298	86	42	.40	17	482	<.100	90	<1
3.8	365	2,100	870	.50	23	4,450	<.100	450	1
1.2	303	100	41	.30	17	482	.730	70	5
77	7,550	12	21	18	15	8,280	<.100	—	—
1.3	336	71	14	.30	16	478	3.60	40	2
2.1	330	110	21	.30	17	520	.600	120	—
2.0	356	120	29	.30	18	593	7.20	130	—
1.3	335	76	8.3	.30	9.9	450	2.90	—	—
1.5	254	83	13	.30	11	424	4.00	70	<1
10	560	470	330	1.8	13	1,780	<.100	—	—

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cially in the area from Chester to Pigeon Hollow. Erosional gaps formed in these north-trending outcrops by the San Pitch River, Oak and Bill Allred Creeks, and the creek in Pigeon Hollow (pl. 1) provide a path for ground-water movement through the thin, unconsolidated stream-channel deposits. Depth to consolidated rock in the erosional gaps generally is less than 100 ft. Smaller areas of isolated consolidated rocks crop out north of Manti, northeast of Mount Pleasant, and northwest of Fairview. Consolidated rock outcrops south of Fountain Green are too small to be shown on plate 1 and figure 1.

Unconsolidated deposits consist of loosely arranged, uncemented sediment and are referred to in this report as valley-fill material. Valley-fill material, outlined in figure 1 and on plate 1, occupies about 240 mi^2 in Sanpete Valley and is in contact on all sides and beneath by consolidated rock. Analysis of drillers' logs and Robinson's geologic cross sections (1971, pl. 1) indicates that there are few clear trends in the type and location of unconsolidated deposits within Sanpete Valley. Contrary to the classical view of basin-fill deposits as being coarse grained along the edges and grading into finer sediments toward the center of the valley, such trends are not apparent in Sanpete Valley. Coarser deposits, where they exist along the mountain front, appear to be poorly sorted and intermixed with silts and clays, except near the mouths of tributaries. This poor sorting could be a result of mass-wasting processes, as Robinson shows various Quaternary landslide deposits along the perimeter of the valley (1971, pl. 1). Fine sediments adjacent to the mountain front were also reported by investigators in southeastern Arizona, along the Sierra Nevada Mountains of California, and San Luis Valley of Colorado, as reported in a summary of findings related to mountain front recharge (University of Arizona, 1980, p. 4-1 to 4-44). Studies by Davidson (1961)(University of Arizona, 1980, p. 4-18) of basin-fill deposits in Safford Basin, Arizona, found fine sediments adjacent to the consolidated rocks of the mountain front, with coarser sediments extending out only from places where tributaries entered the basin. When coarse gravels are present along the mountain front, they were often clay-rich or thin and graded abruptly into silts and fine sands. A study of aquifer characteristics in alluvial fans along the Sierra Nevada mountain front by Cehrs (1979)(University of Arizona, 1980, p. 4-22) noted a substantial amount of fine-grained silts and clays in the upper parts of the alluvial fans, closest to the mountain front. Huntley (1979) (University of Arizona, 1980, p. 4-14, 4-23) suggested that low transmissivity values from wells along the mountain front in San Luis Valley, Colorado, could be due to the poor degree of sorting and the presence of clays and silts near the mountain front.

One trend that is apparent at most locations in Sanpete Valley is a shallow layer of clays and silts overlying coarser deposits. These fine-grained shallow sediments could have been deposited as lacustrine sediments at a time when Sanpete Valley was covered by a shallow lake.

Thickness of the valley-fill material, as determined from drillers' logs, generally reaches a maximum of 300 to 500 ft along the west side of the main valley from west of Moroni to west of Ephraim and probably is associated with displacement of the Gunnison Fault. Another depositional center of valley-fill material is near the eastern margin of the valley, midway between Ephraim and Manti, where well (D-17-3)20acc-1 was drilled to 404 ft before consolidated rock was encountered. Thickness of valley-fill material ranges from 200 to 350 ft near the alluvial fan near Manti (pl. 1) but thins to 100 ft or less at the structural and ground-water constriction near the southern boundary of the study area. Valley-fill material is 300 ft or greater in the vicinity of Mount Pleasant but thins southward toward Spring City and northward toward Fairview and could represent erosion and subsequent fill by tributary drainages in the area. North of Milburn, the thickness of valley-fill material could be as much as 100 ft and is associated with fluvial deposits of the San Pitch River. Thickness of the valley-fill material near Silver Creek approaches 300 ft, but isolated outcrops of consolidated rock are exposed south of Fountain Green. Around Moroni, the thickness of the valley-fill material ranges from 50 to 250 ft.

The contact between consolidated rock and the overlying valley-fill material, as evidenced from the irregular thickness of valley-fill material, could result from a variety of processes. These processes could include erosion by ancestral tributary streams that carved channels in the paleotopography. The channels were later covered by valley-fill deposits, and (or) deposition on unevenly tilted and displaced fault blocks. In general, the valley-fill material is thinner along the margins of the valley near the mountain fronts and thicker toward the valley center. Conceptually, the shape could resemble a spoon that is aligned slightly off north, with the tapered end representing the structural constriction near Gunnison Reservoir and the bowl end representing Sanpete Valley south of Moroni.

Climate

Climatic zones in the study area range from semi-arid or steppe in Sanpete Valley to undifferentiated highland in the higher parts of the Wasatch Plateau. Steppe climatic zones, defined where mean annual precipitation is less than potential evapotranspiration, occur at the lowest altitudes of Sanpete Valley. Mid-latitude, undifferentiated highland climatic zones, defined where mean annual precipitation exceeds potential evapotranspiration, are generally considered humid regions with severely cold winters and cool to cold summers (Murphy, 1981, p. 55), and occur in the adjacent mountains. Estimates of potential evapotranspiration range from 24 to 26.9 in/yr in Sanpete Valley to less than 18 to 23.9 in/yr in the adjacent mountains (Richardson and others, 1981, p. 65). The steppe-highland climatic boundary in the Wasatch Plateau is near the altitude of the Oaks climate station (pl. 1), which is at an altitude of 7,600 ft and has a normal annual precipitation of 22.05 in. (table 1). Mean annual precipitation is the same as average annual precipitation and is defined as the average for an entire period of record or for a specified period. Normal annual precipitation is the average annual precipitation for any three consecutive decades.

Altitude greatly influences the temperature, freeze-free period, and precipitation (table 1). With increasing altitude, precipitation increases, and maximum temperature generally decreases. The influence of lower altitude and cold-air drainage, which tends to pool cold air in the lower parts of the valley, is shown by comparing the minimum and mean temperatures and the freeze-free period at Moroni with those at Ephraim and Manti.

Normal annual precipitation (1931-60) ranges from about 10 in/yr for valley areas south of Moroni to about 40 in/yr near the crest of the Wasatch Plateau (U.S. Weather Bureau, 1963). A 1.39-in/yr difference between the normal annual precipitation (1951-80) at Moroni and Ephraim (table 1) is, in part, the result of the mountain-shadow effect cast on Moroni by the San Pitch Mountains and perhaps by Mount Nebo. Normal annual precipitation (1931-60) for Sanpete Valley, which is defined as the area within the valley-fill boundary (pl. 1, fig. 1), is about 12 in/yr. Normal annual precipitation (1931-60) for the remainder of the study area, which is defined as the area of outcropping consolidated-rock, is more than 18.5 in/yr; normal annual

Table 1. Selected data for seven climatic stations in the Sanpete Valley study area, Utah

[—, no data. Data from U.S. Department of Commerce, 1982; Stevens and others, 1983; and G. Jorgensen, U.S. Forest Service, Great Basin Experimental Area, written commun., 1990]

Climatic station	Altitude (feet)	Normal annual temperature (1951-80) (degrees Fahrenheit)			Freeze-free period (days)	Normal annual[1] precipitation (1951-80) (inches)	Average annual[2] precipitation (1981-86) (inches)	Average annual[2] precipitation (1987-89) (inches)
		Maximum	Minimum	Mean				
Ephraim	5,580	60.8	33.1	47.0	123	10.65	15.42	10.84
Major's Flat	7,100	—	—	—	—	18.14	24.52	16.22
Manti	5,740	62.0	33.2	47.6	128	12.53	17.19	12.15
Meadows	9,850	—	—	—	—	35.81	47.29	32.78
Moroni	5,525	63.0	29.7	46.3	112	9.26	13.47	9.11
Oaks	7,600	—	—	—	—	22.05	28.43	19.67
Station Headquarters	8,850	—	—	—	—	30.90	39.68	28.15

[1] Normal annual is an average annual for a specified 3-decade index period.
[2] Average annual is the average for an entire period of record or for a specified period.