HYDROGEOLOGY OF RECHARGE AREAS AND WATER QUALITY OF THE PRINCIPAL AQUIFERS ALONG THE WASATCH FRONT AND ADJACENT AREAS, UTAH

By P.B. Anderson, D.D. Susong, S.R. Wold, V.M. Heilweil, and R.L. Baskin

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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	0.001233	cubic hectometer
	1,233	cubic meter
cubic foot per second	0.02832	cubic meter per second
foot	0.3048	meter
foot per day	0.3048	meter per day
foot squared per day[1]	0.0929	meter squared per day
foot squared per second	0.0929	meter squared per second
gallon per minute	0.063	liter per second
inch	25.4	millimeter
	0.0254	meter
mile	1.609	kilometer
square mile	2.59	square kilometer

Water temperature is given 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. Specific conductance is reported in microsiemens per centimeter (µS/cm) at 25 degrees Celsius.

The decay rate of radionuclides is reported in picocuries (pCi). Radionuclide concentration is reported as picocuries per liter (pCi/L). Picocuries per liter is a unit expressing radioactive decay per unit volume (liter) of water. Tritium concentration is given in the tritium unit (TU) which is equivalent to 3.2 picocuries per liter.

[1]This unit is used to express transmissivity, the capacity of an aquifer to transmit water. Conceptually, transmissivity is cubic foot (of water) per day per square foot (of aquifer area) times foot (of aquifer thickness). In this report, the unit is reduced to its simplest form.

Hydrogeology of Recharge Areas and Water Quality of the Principal Aquifers along the Wasatch Front and Adjacent Areas, Utah

By P.B. Anderson, D.D. Susong, S.R. Wold, V.M. Heilweil, *and* R.L. Baskin

ABSTRACT

The principal basin-fill aquifers in Cache Valley, the lower Bear River area, and along the Wasatch Front provide ground water to about 84 percent of the population of Utah. Recharge areas for the principal aquifers were mapped to provide information needed for the implementation of ground-water quality regulations and a State ground-water protection plan. Water samples were collected and analyzed to provide baseline water-quality data for the principal aquifers.

The study area includes five subareas: Cache Valley, the lower Bear River area, the East Shore area, Salt Lake Valley, and Utah and Goshen Valleys. Basin-fill deposits in each subarea are lithologically heterogeneous. The principal aquifers in most of the subareas are composed of multiple discontinuous unconfined and confined aquifers and confining layers. Primary recharge areas generally are located along adjacent mountain fronts and extend into the valleys at the mouths of major drainages. Secondary recharge areas are located on the benches and uplands of the valleys. Ground-water flow generally is from these recharge areas to the discharge areas in the topographically low parts of the valleys. In general, dissolved-solids concentrations in ground water range from less than 500 mg/L to about 3,000 mg/L. Of 73 water samples, 5 contained inorganic constituents in concentrations that exceeded State of Utah water-quality standards. None of the samples contained concentrations of organic compounds that exceeded State standards.

INTRODUCTION

The principal basin-fill aquifers in Cache Valley, the lower Bear River area, the East Shore area, Salt Lake Valley, and Utah and Goshen Valleys provide ground water for multiple uses to 84 percent of the population of Utah. The identification of principal aquifers and their recharge areas is important for the protection of ground-water quality. The State of Utah is implementing ground-water-quality regulations and a ground-water protection plan. Data required to implement these regulations and this plan include descriptions of principal aquifers, the location of recharge areas for the principal aquifers, and the quality of water in the principal aquifers.

To provide some of the required data, the U.S. Geological Survey (USGS), in cooperation with the Utah Department of Environmental Quality (DEQ), Division of Water Quality, conducted a study to identify recharge and discharge areas and determine the general quality of water in the principal aquifers in basin-fill deposits, primarily along the Wasatch Front, Utah. The study area includes five subareas (fig. 1): Cache Valley, the lower Bear River area, the East Shore area, Salt Lake Valley, and Utah and Goshen Valleys. The subareas are ground-water basins and do not include the mountain surface-water drainages that might provide ground-water recharge to the basins.

Purpose and Scope

This report describes the recharge areas for the principal basin-fill aquifers in Cache Valley, the lower Bear River area, the East Shore area, Salt Lake Valley, and Utah and Goshen Valleys on the basis of well logs and water levels in wells and contains information on the general water quality of these aquifers. The report consists of two major sections. In the first section, the principal aquifers and confining layers are briefly described; ground-water flow, recharge and discharge areas, and dissolved-solids concentrations are described for each subarea. For the East Shore area and Salt Lake Valley, the directions of ground-water flow and the extent of the recharge areas were evaluated using existing digital ground-water models to simulate various ground-water pumping conditions. The recharge areas derived from the digital models were then compared with the recharge areas mapped in this study. The well locations and analytical results of 13 to

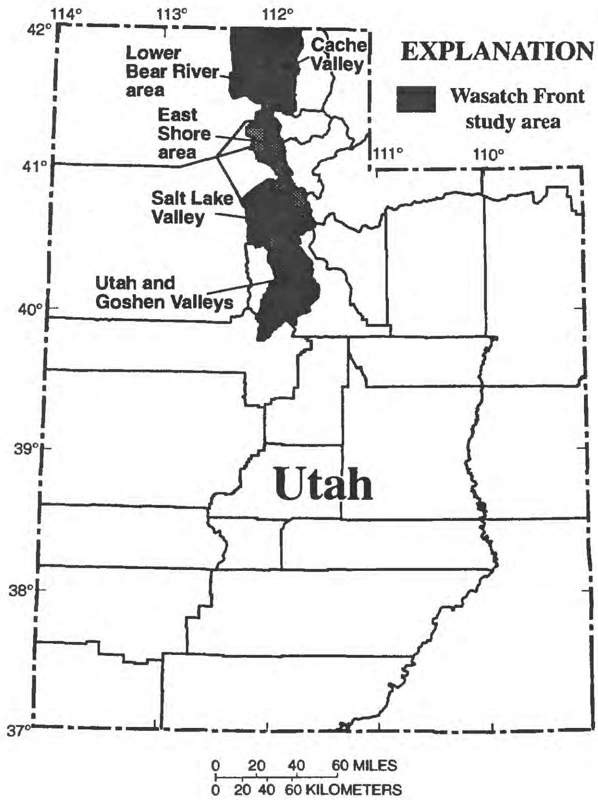

Figure 1. Location of study area and the five subareas, Utah.

15 water samples collected in each subarea are presented in the second section. Water samples were collected to provide baseline water-quality data for use in assessing existing conditions and to aid in classifying ground water for future protection. Samples collected and analyzed as part of this study represent the first attempt to gather baseline water-quality data for organic chemicals, trace elements, and radionuclide contaminants in water in the principal basin-fill aquifers.

Numbering System for Hydrologic-Data Sites

The system of numbering wells and springs in Utah is based on the cadastral land-survey system of the U.S. Government (fig. 2), and describes their position in the land net. The land-survey system divides the State into four quadrants separated by the Salt Lake Base Line and Meridian. These quadrants are designated by the uppercase letters A, B, C, and D, indicating the northeast, northwest, southwest, and southeast quadrants, respectively. Numbers designating the township and range, in that order, follow the quadrant letter, and all three are enclosed in parentheses. The number after the parentheses indicates the section and is followed by three letters indicating the quarter section, the quarter-quarter section, and the quarter-quarter-quarter section, generally 10 acres for regular sections. The letters a, b, c, and d indicate, respectively, the northeast, northwest, southwest, and southeast quarters of each subdivision. The number after the letters, if present, is the serial number of the well or spring within the 10-acre tract. The letter 'S' preceding the serial number designates a spring. Thus (A-9-1)9adb-1 designates the first well inventoried by the USGS in the NE1/4 SE1/4 NE1/4, section 9, T. 9 N., R. 1 E. (fig. 2), and (B-11-2)29dac-S1 designates the first spring inventoried by the USGS in the SE1/4 NE1/4 SW1/4, section 29, T. 11 N., R. 2 W. A number with no serial number at the end designates a site that has not been field checked by USGS personnel.

Acknowledgments

Special thanks are extended to James W. Hood, retired, U.S. Geological Survey, for his work in database management and his assistance in assembling lists of pertinent references, and to Tito J. Dardon, U.S. Geological Survey, for his work in data-base management and his assistance in sampling wells and springs.

Limitations and Methods of Investigation

The sources of data, assumptions, criteria, and methods used for classifying and describing the principal aquifers and confining layers, mapping directions of ground-water flow, mapping recharge areas, and mapping dissolved-solids concentrations, and sampling water from wells are described in this section. Criteria for selecting water-quality sampling sites also are described. Methods used in this study are described to insure that the reader understands the methods and the limitations of these methods, and to assist the reader in interpreting and utilizing the results.

Aquifers, Confining Layers, and Directions of Ground-Water Flow

Basin-fill aquifers were broadly classified into two types: shallow unconfined aquifers and principal aquifers (fig. 3). Shallow unconfined aquifers, also known as water-table aquifers, overlie the principal aquifers and consist of basin-fill deposits that do not contain fine-grained material (clay and silt) that form confining layers. Each principal aquifer includes the confined aquifer system (with one or more confined

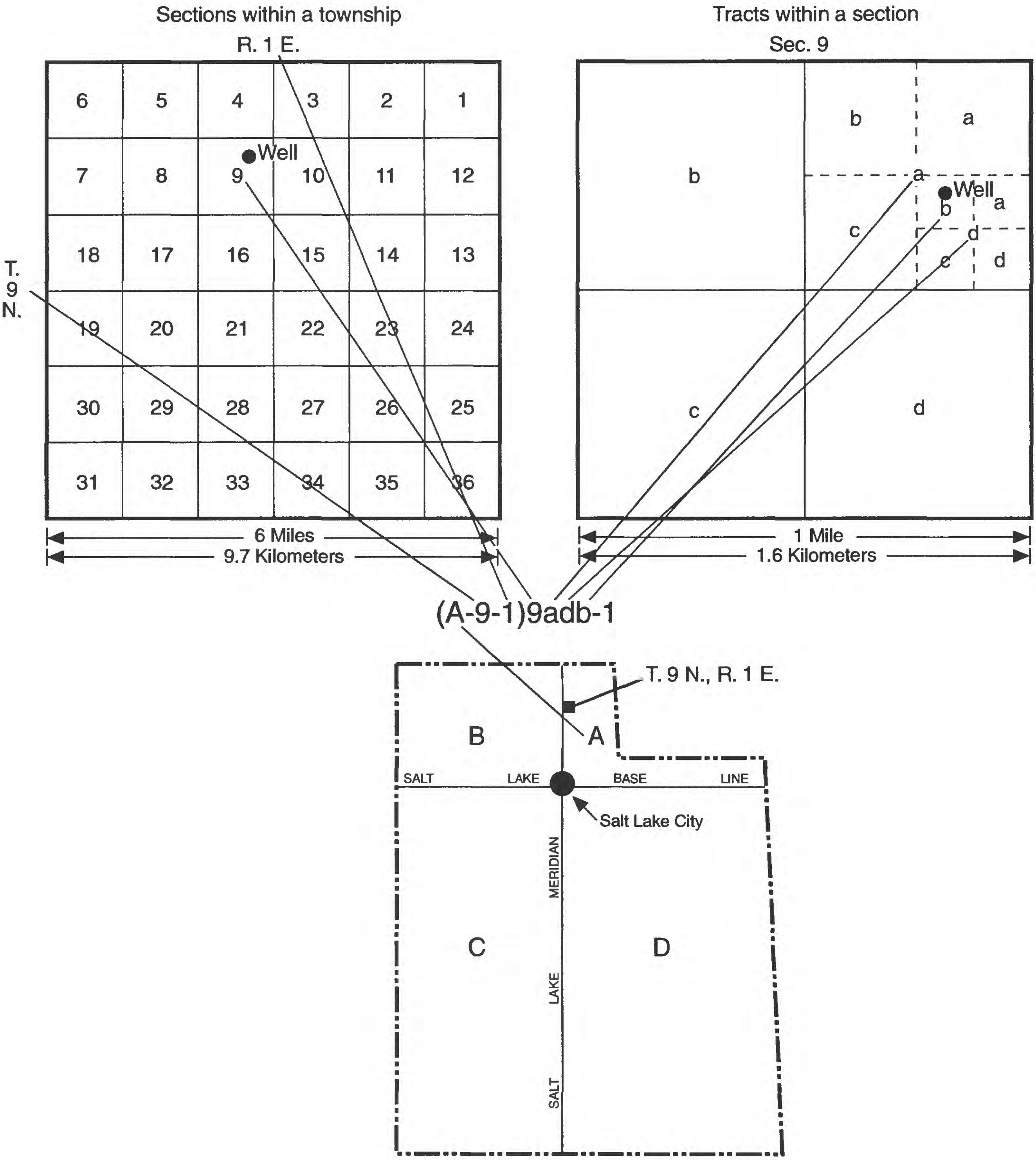

Figure 2. Numbering system for hydrologic-data sites in Utah.

aquifers) and the unconfined aquifer along the mountain front. Consolidated-rock formations in the study area are considered part of the principal aquifer when they are in direct contact with and have hydraulic connection with basin-fill deposits. The principal aquifer in each subarea supplies water to most of the wells.

Confining layers consist of fine-grained material that is distinctly less permeable than adjacent aquifers. Layers of clay, silt, sandy clay, or silt and clay more than 20 feet thick are called confining layers in this report. Fine-grained lithologies less than 20 feet thick are not recorded in the data base for this study because drillers' logs might not accurately define thinner confining layers. The term "confining layer" is used even though, in some cases, the water level in the underlying principal aquifer might be below the confining layer, and the aquifer is actually unconfined. The fine-grained sediments of confining layers are important for determining recharge areas because these layers inhibit the downward movement of water and contaminants.

The depth to the top and bottom of the first confining layer is included in tables 7 to 11. The thickness of the confining layer only includes the first confining layer and might not accurately reflect the actual thickness of the fine-grained material in an area. For example, if a 50-foot clay layer is the first confining layer noted in a well log, followed by a 5-foot gravel layer, with another 40-foot clay layer below, the data tables only show the first 50-foot clay layer. The first confining layer is usually the bottom of the shallow unconfined aquifer and the top of the principal aquifer.

Some lithologic logs describe thick zones of "clay and gravel," but rarely record the percentages of each material. These zones were not interpreted as confining layers on the basis of the definition used in this report; however, "clay and gravel" deposits can have small hydraulic conductivity values and are less permeable than adjacent aquifers. Basin-fill aquifer systems are extremely complex, and this simplistic classification is difficult to apply in all situations.

Naming conventions for, correlations between, and descriptions of aquifers and confining layers are summarized in the discussions of each subarea. No new work on defining or correlating aquifers was done as part of this study.

Ground water in the five subareas generally begins as precipitation in the mountains or on valley benches (the recharge areas), where it infiltrates through the soil and percolates downward through the basin-fill deposits to the principal basin-fill aquifer (fig. 3). Ground water in the basin-fill aquifer flows toward the center of the valleys and upward to discharge to springs, rivers, and lakes. Horizontal ground-water flow for each subarea was compiled from published potentiometric-surface maps. Flow-direction arrows are drawn at approximately 90 degrees to potentiometric contours and are shown in figures 5, 6, 7, 12, and 14. The references for the potentiometric maps used in developing the ground-water flow maps are summarized in the discussion of each subarea.

Mapping Recharge Areas

Recharge areas were mapped on the basis of hydrologic information, drillers' lithologic logs, and geophysical logs from wells. Water levels in wells were used to determine hydraulic gradients and directions of ground-water movement. Lithologic logs describe the basin-fill material and were used to delineate aquifers and confining layers.

Water-level data and the lithology of the basin fill, as described by the driller, were examined for each well. Water-level measurement dates for each well are listed in tables 7 to 11, showing the time difference between water-level measurements. In most cases, the most recent water-level data are listed.

Water-level hydrographs were used to determine the vertical hydraulic-gradient relation between aquifers over time. If water-level fluctuations over time in two aquifers were similar, the hydraulic gradient remained the same, and the area could be confidently classified as a particular recharge or discharge area. When temporal information on water levels was not available, areas were classified on the basis of the hydraulic-gradient relation reflected by available water levels. Hydraulic gradients determined from water levels that were measured years or decades apart might not reflect current hydrologic conditions and were used only when no other data were available.

Water-level data and drillers' logs from 2,828 wells in the USGS, Utah Division of Water Rights, and Utah Department of Health, Division of Environmental Health data bases were examined in the study. Data from 820 of these wells are presented in tables 7 to 11, at the back of the report, and the locations of these wells are shown on plates 1 to 5. The locations of many of these wells have not been checked in the field by USGS personnel. This subset of the entire well-data base was used to define recharge-area boundaries and illustrate hydrologic conditions near the wells. Borehole geophysical logs were examined when available. The log of every well within the recharge areas was given at least a cursory examination. Wells that were important in defining boundaries between recharge areas were examined in more detail than those clearly lying within a particular recharge or discharge area. Only the wells (820) that were used to define the recharge-area boundaries are included in tables 7 to 11.

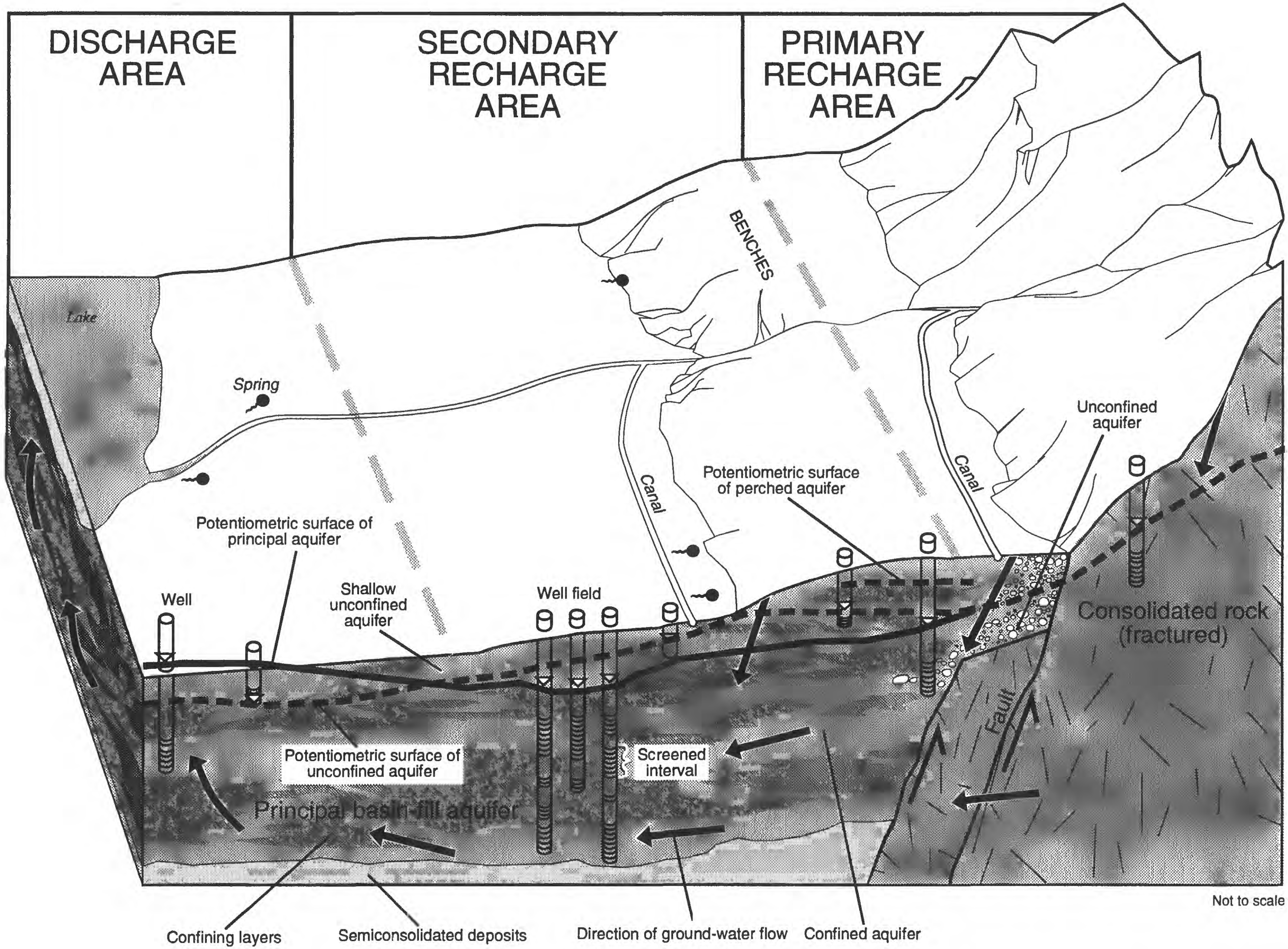

Figure 3. Generalized block diagram showing relation of recharge areas and the basin-fill aquifer system along the Wasatch Front, Utah.

The quality of lithologic descriptions varies considerably from driller to driller and log to log, requiring considerable interpretation. Most water-well drillers identify 20-foot-thick lithologic units in the logs. Thinner layers might be ignored or combined with other sediment types. On the State of Utah "Report of Well Driller" form, the driller is requested to indicate the material encountered by marking an "x" in the appropriate column describing the grain size. For the purposes of this investigation, sandy clay was included as a confining layer only if the driller marked both clay and sand with an "x" and had "sandy" written in the "Comments" column. This was interpreted to mean the driller was using "sandy" to modify the dominant grain size, clay.

The existence and depth of confining layers identified from the drillers' logs were checked with one or more geophysical logs where available. A full suite of good geophysical logs was available for only a few wells in the study area. Most of the other available geophysical logs were gamma-ray logs run by the USGS in the early 1960's to the early 1980's.

Ground-water recharge-area mapping delineated locations where surface contaminants could move down to the principal aquifer, but gives limited information about the travel time of contaminants to the principal aquifer. Areas where large quantities of water recharge the principal aquifer, typically at the mouths of canyons with perennial streams, are generally areas of faster ground-water flow. Contamination in these areas (or from surface water) can move rapidly down into the principal aquifer.

Classification of Recharge and Discharge Areas

Recharge areas were mapped as either primary or secondary using similar definitions to those proposed by Gates and Freethey (1989, p. 17). Classifications of recharge and discharge areas were qualitative, and no estimates of recharge or discharge quantity were made. In addition, recharge does not occur at all times in a recharge area, but only when enough water is present to move through the unsaturated zone to the water table. Recharge might not be occurring at any given time or location in areas mapped as recharge areas; however, the necessary hydrogeologic conditions exist so that there is the potential for recharge to occur.

Areas, shown diagrammatically in figure 3, are classified as primary recharge areas, secondary recharge areas, or discharge areas on the basis of the following definitions:

Primary Recharge Area—An area where the basin-fill deposits between the land surface and the water table consist of sediments that contain no confining layers thicker than about 20 feet.

Consolidated rock adjacent to basin-fill deposits is assumed to be part of the primary recharge area (fig. 3). This assumption is based on extensive fracturing in consolidated rock in most areas of northern Utah and thus, the potential for subsurface flow from the consolidated rock to the basin-fill aquifers. The upper (topographic) boundary for each primary recharge area in the consolidated rock is undefined.

Secondary Recharge Area—An area where a confining layer is present between the land surface and the principal aquifer. When a shallow unconfined aquifer is present above the first confining layer, the direction of ground-water movement between the shallow unconfined aquifer and the principal aquifer generally is downward.

As defined above, secondary recharge areas can include areas with perched aquifers (fig. 3). Small (less than 200 acres), isolated perched aquifers generally were not mapped as secondary recharge areas and were included in the primary recharge areas. One such area has been identified in the Utah and Goshen Valley subarea and is mapped as a secondary rather than a primary recharge area. In areas containing perched aquifer systems, only the areas with laterally continuous confining layers in a basinward direction were included in secondary recharge areas.

Shallow unconfined aquifers were either absent or could not be confirmed in many areas. In these areas, if the water level in the principal aquifer was below the first confining layer, indicating the potential for downward movement of ground water, the areas were mapped as secondary recharge areas.

Discharge Area—An area where the direction of ground-water movement is upward from the principal aquifer to the shallow unconfined aquifer. Discharge areas generally occur in the center or topographically lowest parts of the valleys.

Mapping Dissolved-Solids Concentration

Dissolved-solids concentrations are widely used to evaluate water quality and compare waters. The natural chemical quality of water is dependent on the chemical composition of rocks and sediments, the chemical quality of ground-water recharge, the length of time the water is in contact with rocks and sediments, and the chemical and biological reactions occurring along the ground-water flow path. The U.S. Environmental Protection Agency (EPA) has established a secondary drinking-water standard of 500 mg/L for dissolved-solids concentrations in drinking water (U.S. Environmental Protection Agency, 1990). This secondary standard was established to provide guidance in evaluating the aesthetic qualities of drinking water. The primary maximum contaminant level for dissolved-solids concentration in the State of Utah is 2,000 mg/L for community water systems (Utah Division of Environmental Health, 1989). This primary standard is for the protection of public health.

Maps of dissolved-solids concentrations in water in the principal aquifer in each subarea were compiled from existing USGS data; published dissolved-solids-concentration maps, and Utah Department of Health (DEH), Bureau of Drinking Water/Sanitation unpublished data (see pl. 1-5). Published dissolved-solids concentration contour maps from the following sources were used: Cache Valley, Bjorklund and McGreevy (1971, pl. 5); lower Bear River area, Bjorklund and McGreevy (1974, pl. 5); East Shore area, Bolke and Waddell (1972, pl. 3); and Utah and Goshen Valleys, Clark and Appel (1985, fig. 45) and Cordova (1970, pl. 4).

Maps of dissolved-solids concentration in ground water are a two-dimensional representation of a three-dimensional system, which can vary considerably with depth in some areas, and this variability cannot be accounted for on two-dimensional maps. Dissolved-solids-concentration data for water from wells with depths greater than 100 feet, with a few exceptions, were used to generate the maps in this study. This procedure eliminated data from the shallow unconfined aquifer overlying the principal aquifer. In most cases, wells were chosen that were completed in the principal aquifer, and no attempt was made to differentiate between the multiple confined aquifers within the principal aquifer.

Water-Quality Sampling

Water-quality sampling sites were selected from the USGS Ground Water Site Inventory (GWSI) data base and from sites recommended by local water municipalities. Sites were chosen to provide an areal distribution for each subarea and to represent water quality in the principal aquifers.

Geologic History

The five subareas along the Wasatch Front are at the eastern edge of the Basin and Range Physiographic Province and have similar post-Tertiary geologic histories. The deepest and oldest parts of the basin-fill deposits along the Wasatch Front are composed of sediments that were eroded from adjacent mountain ranges and have subsequently become semi-consolidated to consolidated by compaction and cementation. These basin-fill deposits of the Salt Lake Formation are of late Tertiary and Pleistocene age. The Salt Lake Formation includes units that are aquifers and confining layers. Confining layers generally are tuffaceous clay or claystone and cemented conglomerate. The shallower, younger basin-fill deposits consist of interbedded lacustrine and alluvial sediments associated with Pleistocene Lake Bonneville. These deposits are less compacted and cemented and generally more permeable than the older basin-fill deposits.

Mountain streams carried most of the sediment into the basins and Lake Bonneville. Gravel and sand carried by the streams were deposited near the mountain fronts where the streams enter the valley or the lake. Finer sediments, silt and clay, were transported by the streams or in the lake to the center of the basins. The coarse material, gravel and sand, deposited near the mountain fronts or lake shore form the principal basin-fill aquifers, and the finer sediments, silt and clay, form the confining layers in the basin-fill deposits. The coarse deposits at the mountain fronts are important primary recharge areas.

Temporal Changes in Recharge Areas

Seasonal and annual water-level fluctuations are caused by changes in the quantity and location of recharge or discharge. Water-level fluctuations are also caused by climatic fluctuations and by ground-water withdrawals from an aquifer. Water-level fluctuations can produce changes in hydraulic gradients between aquifers or within aquifers.

In each subarea, the boundary between the secondary recharge area and the discharge area can change with time. On plates 1 to 5, this boundary actually represents a narrow zone where the vertical hydraulic gradient between the shallow unconfined aquifer and the principal aquifer is zero. A small change in the potentiometric surface of either aquifer will result in a lateral shift in the boundary (fig. 3, note that the point where the potentiometric surface of the shallow unconfined aquifer crosses the potentiometric surface of the principal aquifer is the boundary of the secondary recharge area with the discharge area). The width of this zone (in the subareas) ranges from a few hundred feet to about a mile, and is dependent on the variation in the water levels of the shallow unconfined and principal aquifers through time.

Withdrawals from the principal aquifer can cause the potentiometric surface to decline and also cause local changes in the vertical hydraulic gradient between the shallow unconfined aquifer and the principal aquifer; therefore, withdrawals can produce a lateral shift in the boundary between the secondary recharge and discharge areas. Withdrawals from wells completed in discharge areas of the principal aquifer can create isolated areas of secondary recharge where the potentiometric surface is lowered around the pumped wells.

Examples of Basin-Fill Aquifer Complexity

Basin-fill aquifer systems are extremely complex because they consist of multiple aquifers and confining layers that are laterally discontinuous and internally heterogeneous. The simplified conceptualization of the basin-fill aquifer system shown in figure 3 is useful for large-scale hydrologic studies and recharge-area classification. The smaller scale complexity of the basin-fill aquifer systems is perhaps best illustrated with diagrammatic examples (fig. 4).

The situation depicted in case 1 of figure 4 was observed along the margins of the valleys. The consolidated-rock aquifer is confined along the mountain front by internal stratigraphy or structure. Lateral subsurface inflow probably occurs from the consolidated rock into the basin fill, indicating that this is a primary recharge area for the principal aquifer. Contamination in this case could move from the consolidated-rock aquifer to the principal aquifer.

In case 2 of figure 4, water levels in deeper wells are above land surface, and on a preliminary evaluation, might be designated as a discharge area. However, in the upper confined aquifer of the principal aquifer, water moves downward from the shallow unconfined aquifer to the upper confined aquifer because the water levels in wells in the shallow unconfined aquifer are higher than the water levels in wells in the upper confined aquifer. The hydraulic gradients indicate ground water moves toward the upper confined aquifer from above and below, which might result from ground-water withdrawals from the upper confined aquifer. The upper confined aquifer in the principal aquifer could be contaminated by water moving downward from the shallow unconfined aquifer.

The situation depicted in case 3 of figure 4 was observed less frequently and is more difficult to understand. This situation was limited to the East Shore area and Utah Valley. If the water levels in the wells in the lower confined aquifer of the principal aquifer and shallow unconfined aquifer were the only available data, the area would be mapped as a secondary recharge area because downward vertical movement of ground water was indicated. Data from the upper confined aquifer of the principal aquifer, however, indicated that the area is a discharge area because the vertical hydraulic gradient between the shallow unconfined and upper confined aquifers is upward. This relation generally exists near the boundary between the secondary and primary recharge areas.

The typical relation of multiple confined aquifers within the principal aquifer in a discharge area is illustrated in figure 4, case 4. Ground water moves upward between aquifers throughout the entire section, and the area is classified as a discharge area. In cases 3 and 4, water is moving upward from the principal aquifer to the shallow unconfined aquifer which generally protects the principal aquifer from contamination.

Contamination Potential of Recharge Areas

Primary recharge areas have the greatest potential for transmitting contamination to the principal aquifer because of the predominance of coarse-grained sediments and the absence of confining layers. These coarse-grained sediments typically have large hydraulic-conductivity values, and ground water commonly moves rapidly from the surface down to the principal aquifer. In secondary recharge areas, there is a greater potential for surface contamination near the boundary between the secondary and primary recharge areas than near the boundary between secondary recharge and discharge areas. Near the boundary between the secondary and primary recharge areas, confining layers in the basin fill are usually thinner, and the hydraulic gradient between the shallow unconfined and principal aquifers is greater than near the boundary between the secondary recharge and discharge areas. In discharge areas, water moves upward from the principal aquifer; thus, there is little or no potential for contamination.

The ratio of horizontal to vertical hydraulic conductivity in basin-fill aquifers is commonly greater than 100:1 (Freeze and Cherry, 1979, p. 34). This means that a contaminant would travel at a much faster rate in the horizontal direction than in the vertical if the hydraulic gradients were equal. Under these conditions, the farther upgradient (along a flow path) from a discharge area that a contaminant is introduced, the greater the potential is for downward migration of contaminants to the principal aquifer.

HYDROGEOLOGY OF RECHARGE AREAS AND DISSOLVED-SOLIDS CONCENTRATIONS FOR EACH SUBAREA

Cache Valley

Bjorklund and McGreevy (1971) prepared the most recent report on the hydrology of the area, which includes a good summary of the geology taken chiefly

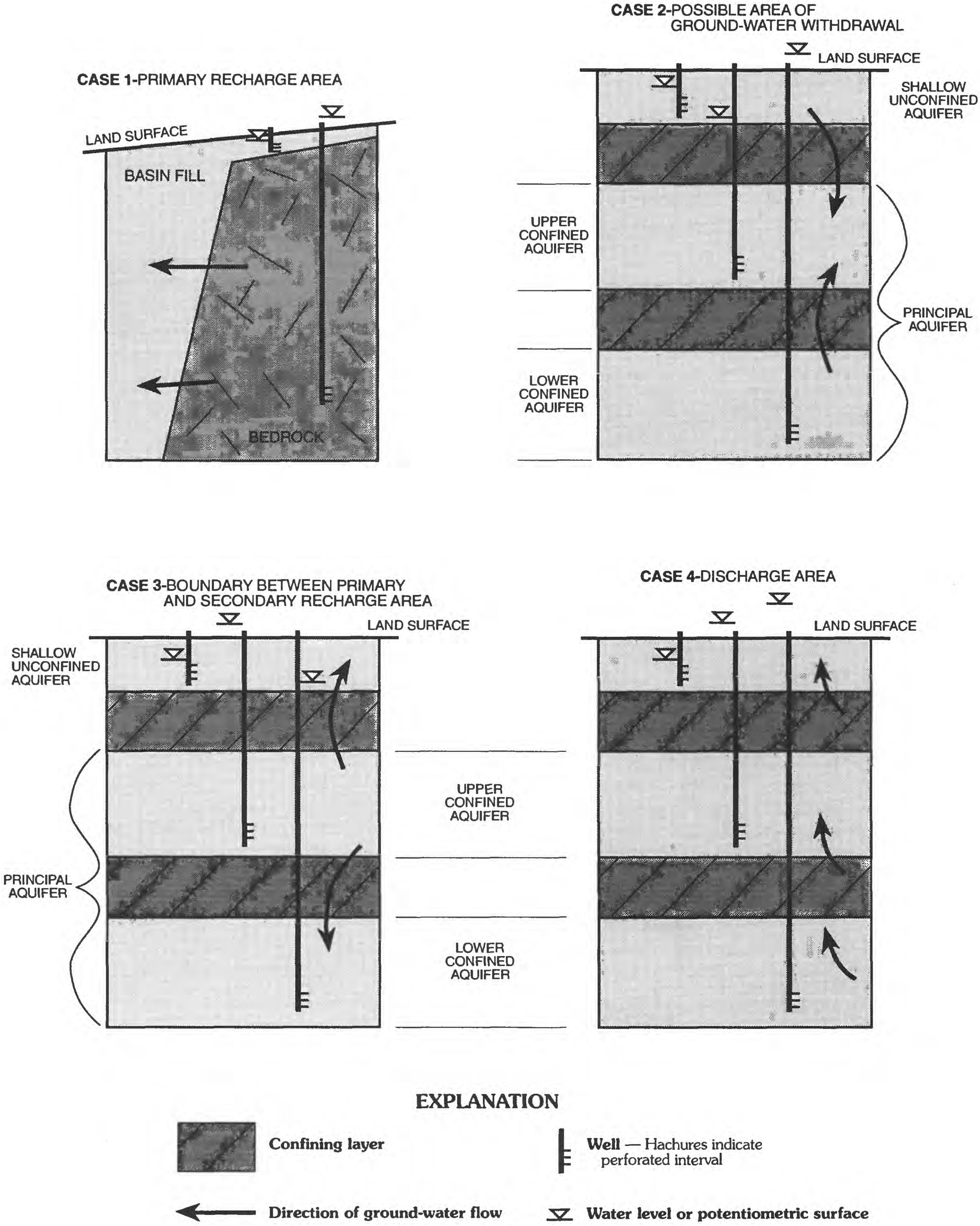

Figure 4. Four generalized cases of vertical hydraulic gradients and implied flow directions.

from Williams (1962). Hydrologic data on wells drilled prior to 1970 are summarized by McGreevy and Bjorklund (1970). McGreevy and Bjorklund (1971) constructed numerous cross sections through the valley, which are helpful in understanding the hydrogeology of the valley.

Principal Aquifers and Confining Layers

Bjorklund and McGreevy (1971, p. 21-22) describe the basin-fill aquifers in Cache Valley as shallow unconfined and perched aquifers (confined). The thickness of the shallow unconfined aquifer is 10 to 20 feet. Along the benches and near the mountains, layers of clay or silt commonly impede the downward flow of ground water, forming isolated discontinuous perched aquifers. These aquifers are small and commonly discharge as seeps and springs at the break in slope on the basin side of the benches. The principal aquifer is confined, except for a narrow band adjacent to the mountain ranges, where the aquifer is unconfined and water levels in wells are relatively deep. Water levels in wells completed in the principal aquifer are above land surface in most of the valley. Sediments that constitute the principal aquifer vary from fine sand to coarse, well-sorted gravel, with the most permeable aquifer material on the east side of the valley.

The confining layers in Cache Valley are generally rich in clay and increase in thickness and frequency basinward. Cache Valley has a greater percentage of clay in the unconsolidated basin-fill deposits than the other subareas. These clay layers exist throughout the vertical section and areally across the valley. Deep wells in the center of the valley encountered semi-consolidated to consolidated sediments that form confining layers that probably are part of the Salt Lake Formation. The Salt Lake Formation also crops out around the margins of the valley. It is generally considered a poor aquifer but many domestic wells are completed in this formation.

Directions of Ground-Water Flow

The potentiometric surface in Cache Valley (fig. 5) represents the unconfined and confined parts of the principal aquifer and is described as irregular, which may reflect mixing of data from unconfined and confined aquifers by Bjorklund and McGreevy (1971). Ground-water flow is generally from the mountainous areas toward the center of the valley (fig. 5) and then exiting the valley in the Bear River and through the Bear River alluvium.

Recharge Areas

Recharge areas in Cache Valley are adjacent to and generally coincide with the topographic break in slope between mountains and valley. The primary recharge area (pl. 1) includes areas of consolidated rock outcrop bounding the valley and a narrow band of basin fill along the mountain front. Secondary recharge areas are present on the east and west sides of the valley, with the exception of the southeastern and northwestern parts of the area. In the Avon-Paradise area (southern Cache Valley), secondary recharge areas are more extensive and surround discharge areas. In the northwest part of the valley, the secondary recharge area is absent near areas of consolidated rock extending into the valley.

On the basis of drillers' logs, Cache Valley contains more fine-grained sediments that form confining layers than the other subareas. Many of these confining layers extend to the edges of the basin-fill deposits, where they abut against consolidated rock or the Salt Lake Formation. Therefore, primary and secondary recharge areas are generally narrower in this valley than in the other subareas.

Salt Lake Formation

Much of Cache Valley is surrounded by outcrops of the Salt Lake Formation (Bjorklund and McGreevy, 1971, pl. 1). The consolidated to semiconsolidated deposits of the Salt Lake Formation have a lower hydraulic-conductivity value than unconsolidated basin-fill deposits. Locally, wells yield large quantities of water from the formation. Lacustrine sediments of Quaternary age overlie the Salt Lake Formation in many locations in the valley. Where these sediments contain fine-grained deposits that form confining layers, the areas are mapped as secondary recharge areas. Outcrops of the Salt Lake Formation and older consolidated rocks around the valley margins are mapped as primary recharge areas. Fracturing of the formations and some highly conductive areas provide paths for ground-water movement into the formations and subsequently into adjacent basin fill.

Outcrops of the Salt Lake Formation are absent between Green Canyon (pl. 1) on the north and Blacksmith Fork Canyon on the south, along the eastern edge of Cache Valley. As a result, the basin-fill sediments with large hydraulic-conductivity values are adjacent to the consolidated rock of the mountain front; therefore, this area is mapped as a primary recharge area.

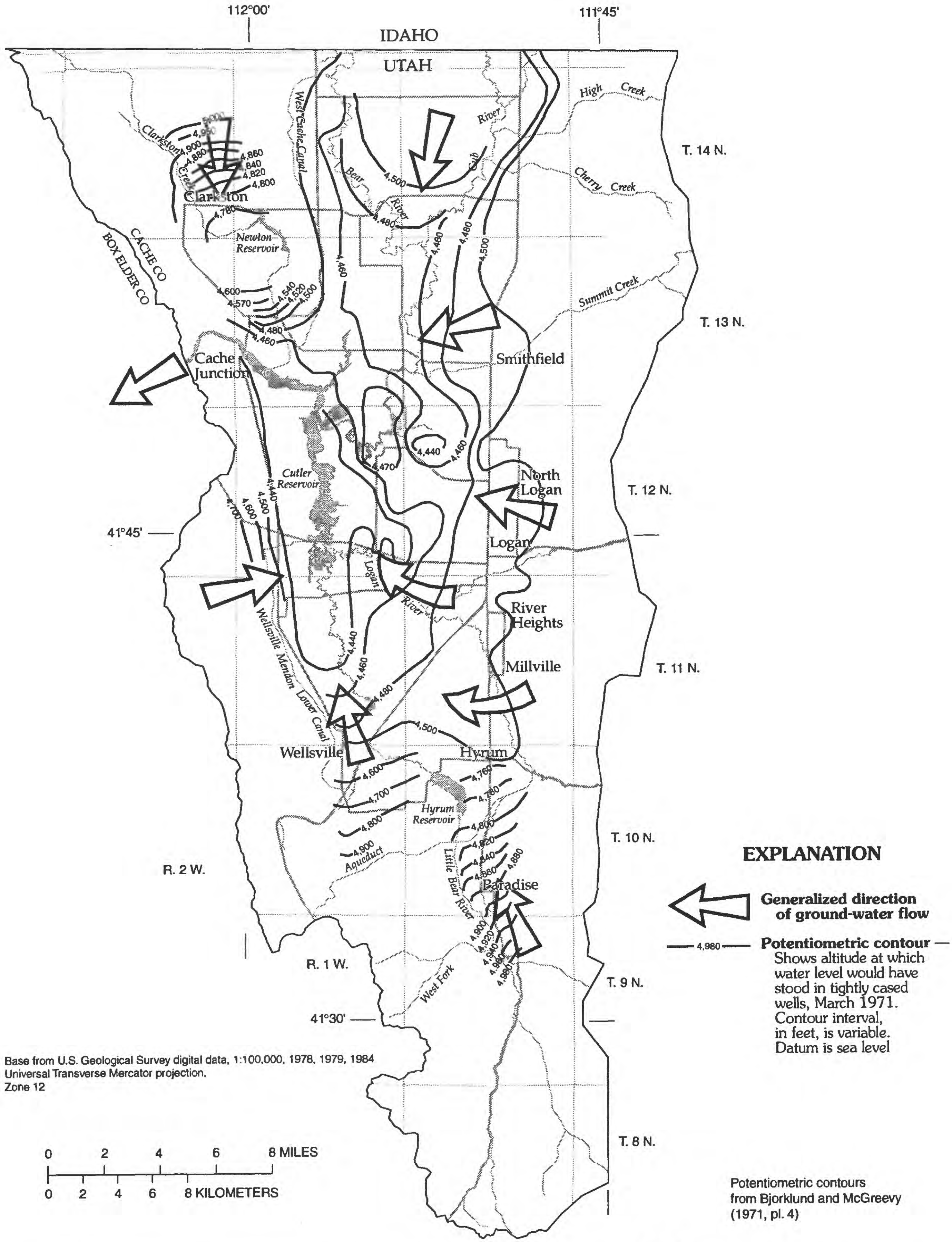

Figure 5. Generalized direction of ground-water flow and potentiometric surface of the principal aquifer, Cache Valley, Utah.

Hyrum-Avon Area

The Salt Lake Formation crops out near the town of Avon in southern Cache Valley. Water levels in wells completed in the Salt Lake Formation near the town of Avon and along the Little Bear River usually are above land surface. This area is mapped as a discharge area surrounded by a secondary recharge area (pl. 1).

Upward flow of water from the Salt Lake Formation into unconsolidated basin-fill deposits in the Hyrum-Avon area is indicated by data from well 10 (table 7, pl. 1). This well was drilled to 385 feet and completed in the Salt Lake Formation. The reported water level in 1964 was 2 feet below land surface, which is 100 to 300 feet higher than water levels in surrounding wells. Nearby, well 11 was drilled to a depth of 323 feet and completed in the basin fill. The description of deposits in well 11 by the driller did not indicate that the well penetrated the Salt Lake Formation. The water level in well 11 in 1974 was 293 feet below land surface. Water levels in wells 10 and 11 probably represent the aquifers they penetrate; thus, ground water moves upward, indicating ground-water discharge. However, water levels in wells 10 and 11 need to be measured at approximately the same time, to assess recent hydrologic conditions.

East of the Little Bear River, benches are partly covered with sediments containing confining layers. Water levels in several wells in this area show that the direction of ground-water movement is downward from the shallow unconfined aquifer, and thus, the area is mapped as a secondary recharge area. A perched aquifer above the principal aquifer was described by Bjorklund and McGreevy (1971, p. 22).

North Logan

The primary recharge area extends west into the valley near North Logan (pl. 1). Well 42 penetrated consolidated rock at 70 feet. No confining layers were described in the drillers' log; hence, the area is classified as a primary recharge area. Few wells have been drilled in the surrounding area to confirm and better define the subsurface geology.

Richmond-Cherry Creek Area

This area is mapped as a primary recharge area. The water level in well 71 completed in consolidated rock at the mouth of Cherry Creek is above land surface, which indicates that ground-water movement is from the consolidated rock to the basin fill. The situation identified in this well is similar to case 1 in figure 4, where the consolidated-rock aquifer is confined and water levels in wells completed in it are above land surface and the overlying and adjacent unconsolidated sediments are part of the primary recharge area for the principal aquifer.

Dissolved-Solids Concentrations

Dissolved-solids concentrations in ground water in Cache Valley (pl. 1) are generally less than 500 mg/L. Surface water that has small concentrations of dissolved solids is the primary source of ground-water recharge. However, in the northwestern part of the valley near the Bear River, dissolved-solids concentrations exceed 500 mg/L but generally are less than 1,000 mg/L. This is a ground-water discharge area, and dissolved-solids concentrations may be related to evapotranspiration.

Lower Bear River Area

The hydrology of lower Bear River area was described by Bjorklund and McGreevy (1974). Data for wells drilled prior to 1972 also were compiled by Bjorklund and McGreevy (1973).

Principal Aquifers and Confining Layers

Bjorklund and McGreevy (1974, p. 13-14) describe the aquifers in the lower Bear River area as follows:

> "Ground water in the lower Bear River drainage basin occurs (1) in a principal ground-water system, (2) in a shallow unconfined system in the central-plain area..., and (3) in perched systems. The principal ground-water system includes most of the ground water in all geologic units in the project area.... The principal system is complex and includes both confined and unconfined ground water. The shallow unconfined ground-water system exists in the central-plain area in materials near the land surface that are part of the interior deposits of Lake Bonneville basin. Unconfined ground water occurs in similar materials elsewhere in the valley, but the separation from the principal system is generally less distinct. Perched ground-water systems occur mostly in the marginal deposits of Lake Bonneville basin; in colluvium, alluvium, and undifferentiated deposits in the mountains; and in the Oquirrh Formation."

Aquifer materials in the lower Bear River subarea vary from silt, sand, and gravel to fractured consolidated rock. Reported transmissivity values of the principal aquifer range from 2,000 to 140,000 feet squared per day (Bjorklund and McGreevy, 1974).

Confining layers in the unconsolidated sediments are typically clay and silt. The percentage of clay and silt in the basin-fill deposits generally increases toward the center of the valley and Great Salt Lake.

Consolidated rock and the Salt Lake Formation do not yield large quantities of water to wells. However, in some areas, they are often the only source of usable ground water. The consolidated-rock aquifers tend to be developed chiefly in fracture zones.

The topographically lower part of the valley (south of Tremonton) has unconsolidated basin-fill deposits that consist of more than 600 feet of interbedded sand and clay. The principal aquifer yields small quantities of water.

Directions of Ground-Water Flow

Ground-water flow directions in the lower Bear River area (fig. 6) were derived from a potentiometric-surface map prepared by Bjorklund and McGreevy (1974, pl. 2). The direction of ground-water flow is generally from the mountainous areas in the east and west toward the Malad and Bear Rivers and then south toward Great Salt Lake.

Recharge Areas

The primary recharge areas in the lower Bear River area are along the mountain fronts (pl. 2) and include basin-fill deposits and consolidated rock. The Wellsville Mountains in the southeastern part of the study area do not have broad alluvial fans or wide benches at the mountain front, and fine-grained lake sediments were deposited near the mountain front creating numerous confining layers. The secondary recharge area is narrow or absent in this part of the study area.

In the northern part of the study area, the Bear and Malad Rivers have cut channels into the basin-fill deposits. These channels are the lowest part of the valley and are zones of ground-water discharge. The benches and upland terrain adjacent to the river channels are secondary recharge areas.

Deweyville Area

Many natural springs (not shown on pl. 2) discharge northeast of Deweyville. The area, however, has been mapped as a primary recharge area even though the local vertical hydraulic gradient indicates upward ground-water movement. Case 1 in figure 4 illustrates the probable hydrogeologic conditions in this area. Ground-water flow from consolidated rock recharges the basin-fill aquifer and is sufficient to maintain an upward hydraulic gradient in a small area of basin fill near the mountain front, thus recharging the basin fill.

West Hills and Blue Spring Hills Areas

Water levels in wells completed in basin-fill deposits and in consolidated rock at the south end of West Hills and along the Blue Spring Hills indicate that ground water moves downward from the basin-fill deposits to the consolidated rock. These unusual areas require more detailed investigations to accurately classify recharge areas. These areas are mapped as primary recharge areas because elsewhere in this study consolidated rocks are classified as primary recharge areas. Ground water near the southern end of Blue Spring Hills is not used because of small well yields and high dissolved-solids concentrations. Ground-water movement is probably toward Great Salt Lake, which is a discharge area.

Bothwell Pocket

Bothwell Pocket, on the west side of Point Lookout Mountain, is mapped as a secondary recharge area (pl. 2). No wells are completed in the shallow unconfined aquifer in this area, but fine-grained deposits that could be confining layers are present in the principal aquifer.

Collinston-Beaver Dam Area

A relatively thin layer of basin-fill deposits covers the Salt Lake Formation in the area between Collinston and Beaver Dam (Bjorklund and McGreevy, 1974, pl. 1). The thin layer does not contain fine-grained deposits that would form confining layers, and the underlying Salt Lake Formation appears to function as an aquifer, hence the area is mapped as a primary recharge area. However, many shale layers occur in the Salt Lake Formation that could impede the vertical movement of ground water, therefore, designation of the area as a primary recharge area is conservative in terms of ground-water protection.

Dissolved-Solids Concentrations

In the lower Bear River subarea, dissolved-solids concentrations in ground water along the east side of the valley and in its northern end are generally less than 500 mg/L (pl. 2) because the ground-water flow path from the recharge area to the discharge area is relatively short. Dissolved-solids concentrations are largest (14,000 mg/L) in the southwest part of the area near Great Salt Lake (pl. 2) because of evapotranspiration,

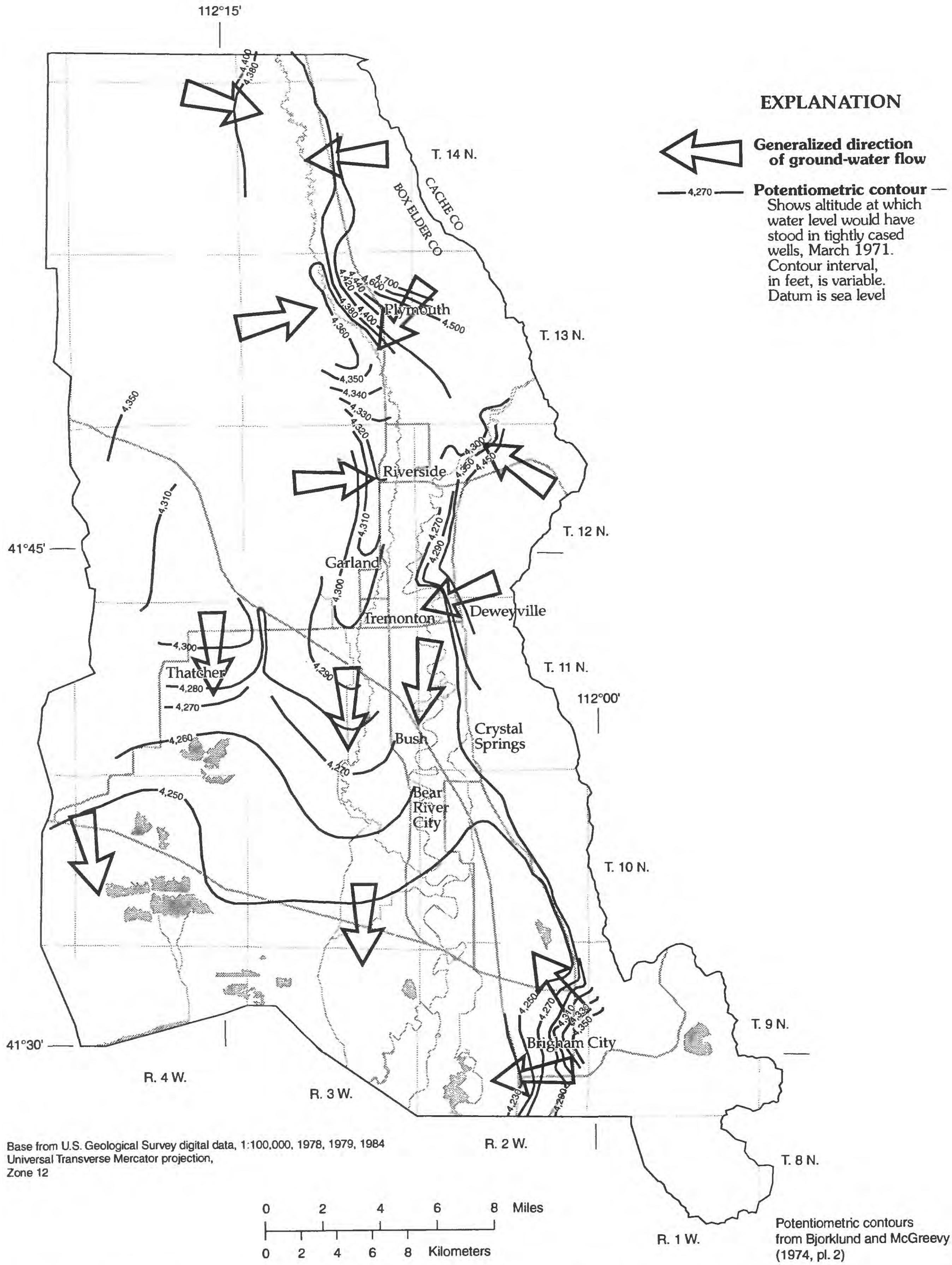

Figure 6. Generalized direction of ground-water flow and potentiometric surface of the principal aquifer, lower Bear River area, Utah.

the presence of saline lake sediments, and the long ground-water flow path from the recharge area to the discharge area.

East Shore Area

Thomas and Nelson (1948) discussed ground water in the Bountiful area, at the southern end of the East Shore area, and Dennis (1952) described recharge in the East Shore area. The work of Feth and others (1966) serves as the principal source of information on the hydrogeology of the area near the Weber River and its associated delta deposits. Bolke and Waddell (1972) described ground-water conditions in the East Shore area from 1960-69. Herbert and others (1987) provided quantitative information on recharge from canal seepage in the East Shore area. The hydrology of the East Shore area was discussed and a digital model was configured by Clark and others (1990). They classified the recharge areas as primary or secondary, although only general criteria are given for these designations. Basic data collected for this study were compiled by Plantz and others (1986).

Principal Aquifers and Confining Layers

According to Clark and others (1990, p. 21), the East Shore aquifer system includes multiple confined aquifers and their unconfined, laterally upgradient extensions, which are equivalent to the principal aquifer defined in this report. In the area from Kaysville north to Plain City, two confined aquifers, the Sunset and Delta aquifers (fig. 7) are included in the East Shore aquifer system of Clark and others (1990) and as part of the principal aquifer for this study.

The top of the Sunset aquifer is about 200 to 400 feet below the land surface. The aquifer is composed of unconsolidated basin-fill deposits and ranges from 50 to 200 feet thick. The top of Delta aquifer is 500 to 700 feet below the land surface. The aquifer is composed of deltaic deposits of the Weber River and is about 50 to 150 feet thick, but its base is poorly defined because few wells have penetrated the total thickness (Clark and others, 1990, p. 21). Basin-fill deposits in both aquifers become finer grained near Great Salt Lake. Each confined aquifer typically is separated from vertically adjacent aquifers by confining layers several feet to several hundred feet thick that can cause a substantial difference in the hydraulic head between aquifers.

Aquifers in the Bountiful area were classified as shallow artesian (60 to 250 feet below the land surface), intermediate artesian (250 to 500 feet below the land surface), and deep artesian (greater than 500 feet below the land surface) by Thomas and Nelson (1948, p. 167). Clark and others (1990) refer to all aquifers more than 100 feet below land surface as part of the East Shore aquifer system.

Transmissivity values determined from aquifer tests in the East Shore area range from 150 to 30,000 feet squared per day (Clark and others, 1990, table 5, p. 25). An average model-derived vertical hydraulic conductivity of 1×10^{-4} foot per day is reported by Clark and others (1990, p. 111).

Directions of Ground-Water Flow

Ground water generally moves through the principal aquifer from east to west toward Great Salt Lake (fig. 7), where it discharges by upward leakage to the shallow unconfined aquifer and as diffuse seepage to Great Salt Lake (Clark and others, 1990). The potentiometric surface map for the East Shore aquifer system, excluding the Sunset aquifer, for March 1985 is shown in figure 7. Although this potentiometric surface map shows hydrologic conditions in 1985, the general directions of ground-water flow probably do not vary substantially with time.

Recharge Areas

The primary recharge area in basin-fill deposits is along the base of the Wasatch Range (pl. 3). The primary recharge-area boundary extends westward at the mouths of the Weber and Ogden Rivers and just north of Farmington.

Secondary recharge areas include benches along the mountain front where Lake Bonneville deposits are at the land surface (Feth and others, 1966). A large secondary recharge area that consists of Weber River delta deposits lies between Kaysville and Ogden. At the northern and southern ends of the East Shore area, the secondary recharge areas are less than 1.5 miles wide or are not present. These narrow to nonexistent secondary recharge areas generally occur where Great Salt Lake is nearest to the Wasatch Range.

Area North of Roy

The boundary between the secondary recharge area and the discharge area generally follows the break in topographic slope at the base of benches in the area north of Roy. Water levels in wells completed in local shallow confined aquifers to the west of these benches are above land surface. Aquifers in the benches apparently are hydraulically connected and discharge to local shallow confined aquifers west of the benches. The area is mapped as a discharge area because water levels in the local shallow confined aquifers are above land

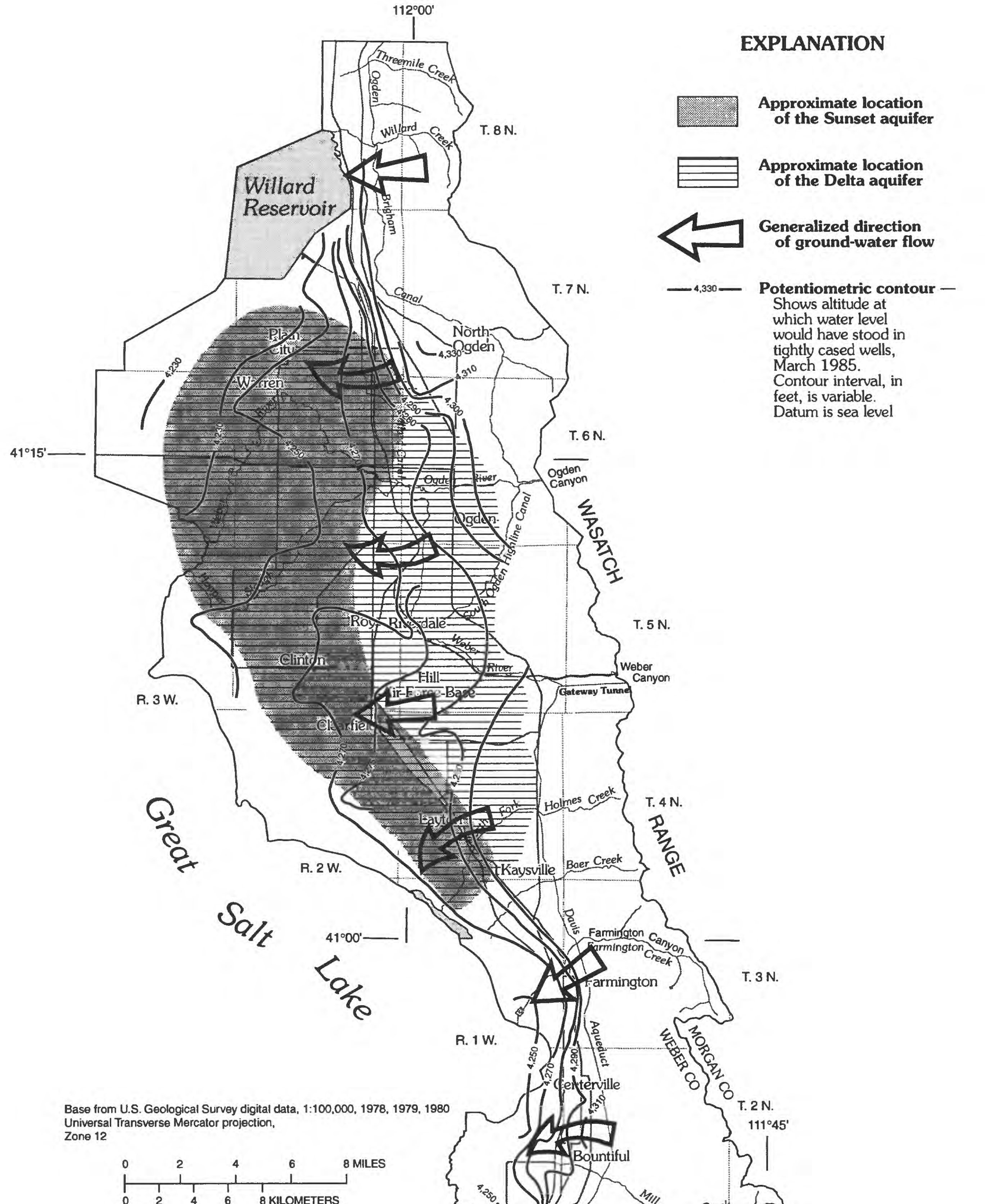

Figure 7. Approximate location of the Sunset and Delta aquifers, generalized direction of ground-water flow, and potentiometric surface of the East Shore aquifer system, excluding the Sunset aquifer, Utah.

surface. The upward hydraulic gradient in the local shallow confined aquifers might prevent contaminants from moving downward to the principal aquifer.

Woods Cross Area

The boundary of the secondary recharge area and the discharge area between North Salt Lake and Bountiful is drawn farther to the west than indicated by some water-level data. Historical data indicate that water levels in wells near the boundary vary considerably and this boundary appears to have moved westward through time. As mapped, the boundary represents a conservative interpretation.

Relative Flow Velocities, Flow Directions, and Potential Reversals of Flow Direction Between Aquifers

A modular three-dimensional finite-difference ground-water flow model (McDonald and Harbaugh, 1984) configured to the East Shore area by Clark and others (1990) was used in this study to investigate the susceptibility of the East Shore aquifer system to contamination. Results of model simulations were used to map areas of probable faster ground-water flow, horizontal and vertical ground-water flow directions, and possible reversals of ground-water flow. Clark and others (1990) based their model on hydrologic data collected from 1954 through 1985.

Horizontal Ground-Water Flow

Where ground-water flow velocities are large, contaminants can be transported more quickly downgradient. The average linear ground-water velocity is defined as the product of the hydraulic conductivity and hydraulic gradient divided by the effective porosity of the aquifer (Freeze and Cherry, 1979, p. 71). It was assumed for this study that the effective porosity of basin-fill deposits ranges from 5 to 30 percent. The hydraulic conductivity and hydraulic gradient, however, may also have large ranges. Areas with large hydraulic-conductivity values and/or hydraulic gradients can have much larger ground-water velocities than regions with smaller hydraulic-conductivity values and gradients. Transmissivity is defined as the product of hydraulic conductivity and aquifer thickness (Freeze and Cherry, 1979, p. 59). Therefore, regions with large values of transmissivity will have large values of hydraulic conductivity, if aquifer thickness is uniform or thins in these areas. Furthermore, if these areas of relatively large transmissivity correspond to regions of average or large hydraulic gradients, then ground-water flow velocities probably will be large.

A map of the estimated transmissivity of the deeper part of the East Shore aquifer system including the unconfined aquifer near the Wasatch Range (Clark and others, 1990) is shown in figure 8. Transmissivity values range from less than 2,500 feet squared per day near Willard Reservoir to 100,000 feet squared per day west of the mouth of Weber Canyon. Locally, transmissivity values are about 10,000 feet squared per day near the mouths of Ogden and Farmington Canyons.

Ground-water flow velocities at the mouths of Farmington Canyon, Weber Canyon, and Ogden Canyon are assumed to be larger than velocities farther west. This assumption is based on transmissivity values found in these areas and the assumption that aquifer thickness is smaller in these areas than farther west, resulting in large hydraulic-conductivity values and horizontal hydraulic gradients that are larger than or equal to the hydraulic gradients just west of these areas (Clark and others, 1990). Horizontal hydraulic gradients at the mouth of Farmington Canyon are actually larger than hydraulic gradients farther west. At the mouths of Weber and Ogden Canyons, the horizontal hydraulic gradients are similar to those in areas farther west.

Vertical Ground-Water Flow

The three-dimensional ground-water flow model developed for the East Shore area (Clark and others, 1990) consists of three layers that represent a shallow unconfined aquifer (layer 1) and two confined aquifers (layers 2 and 3). Layer 1 is used only to simulate a zone of discharge from the underlying confined aquifers. Layer 2 simulates the confined part of the principal aquifer system that is less than 400 feet deep, part of which has been identified as the Sunset aquifer by Feth and others (1966). Layer 3 simulates the deepest part of the principal aquifer system (greater than 400 feet deep) known as the Delta aquifer (Feth and others, 1966) and includes the shallow unconfined aquifer near the Wasatch Range (Clark and others, 1990).

In general, vertical flow is upward from layer 3 to layer 2 (fig. 9), except in three small areas. First, the area of downward flow southwest of Willard Reservoir is most likely caused by a large group of wells withdrawing water from layer 3. Likewise, the area surrounding Riverdale also has downward flow probably caused by ground-water withdrawals from layer 3. In contrast, downward flow in the third area near North Ogden is most likely due to natural recharge. Where ground water moves downward from layer 2 to layer 3, it probably also moves downward between layer 1 and layer 2, and these areas would, therefore, be susceptible to contamination.

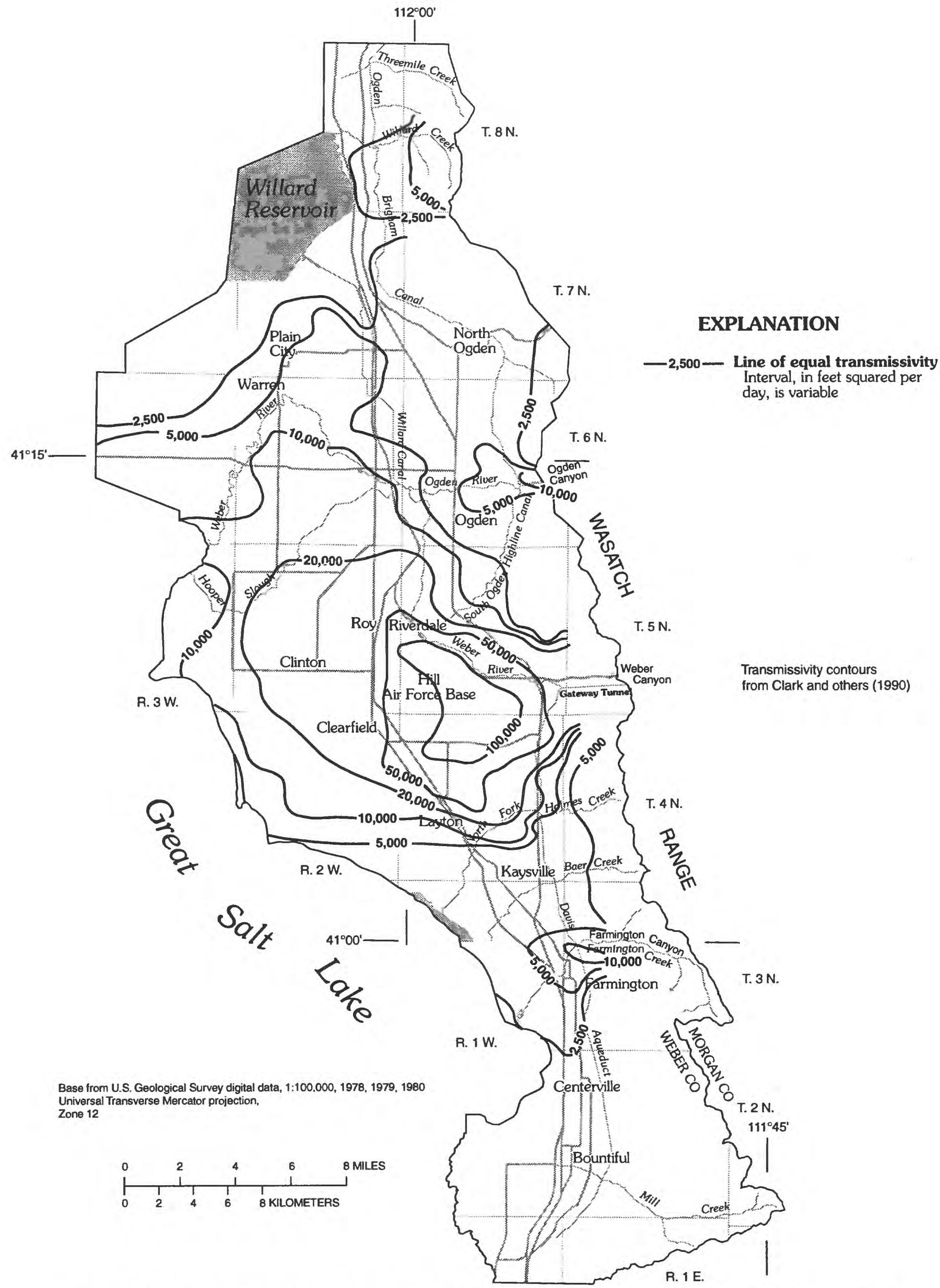

Figure 8. Estimated transmissivity of the deeper part of the East Shore aquifer system including the unconfined aquifer near the Wasatch Range, Utah.

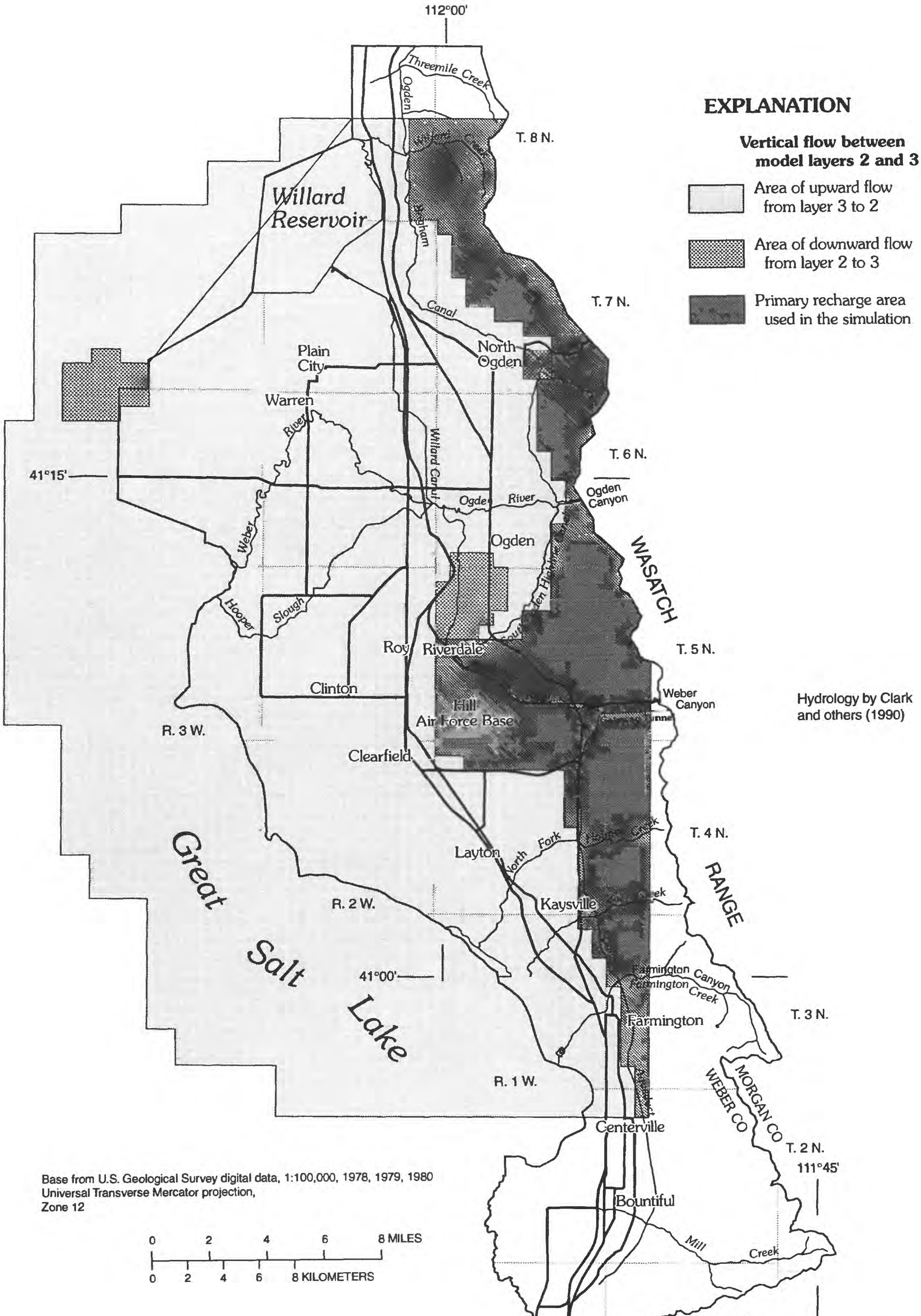

Figure 9. Computer-simulated ground-water flow between model layers 2 and 3, East Shore area, Utah, 1985.

The model primary recharge area (fig. 9) is the lateral extension of layer 3 adjacent to the mountain front and assumed to be under unconfined conditions. In this area, no major confining units exist, as simulated in the model by the absence of layers 1 and 2. Ground-water flow is assumed to be primarily downward because most ground-water recharge in this area occurs as water infiltrating from streamflow or as subsurface inflow from consolidated rock. This area of primary recharge in the model is similar to the area of primary recharge on plate 3, which is based on well-log analyses. A major difference between the simulated primary recharge area (fig. 9) and recharge areas shown on plate 3 occurs south of Ogden. A confining layer exists in this area; however, the model was simulated as unconfined (no layer 2) because the potentiometric surface was greater than 400 feet below land surface (Clark and others, 1990, p. 98).

Simulated Reversals of Vertical Ground-Water Flow

The model of the East Shore area was used to simulate the effects of possible future ground-water withdrawals on the direction of vertical ground-water flow between the shallow confined (layer 2) and deep confined (layer 3) parts of the principal aquifer. In particular, these simulations helped identify areas where future ground-water withdrawals from the deeper aquifer could cause ground-water flow to reverse from upward to downward between layers 2 and 3. These reversals generally would occur when the hydraulic head in the deeper confined part (layer 3) declined below the hydraulic head in the shallow confined part (layer 2) of the principal aquifer. Such reversals could increase the susceptibility of the deeper part of the principal aquifer to contamination if ground water moves downward from layer 1 (the shallow unconfined aquifer) to layer 2.

Two hypothetical situations were simulated for the 20-year period from 1985 through 2004. Both simulations used an average annual recharge rate of about 105,000 acre-feet (Clark and others, 1990, p. 138). The first simulation maintained the 1980-84 average annual withdrawal rates for 53 wells (Clark and others, 1990, p. 120), resulting in a constant annual withdrawal of about 23,400 acre-feet during the 20-year predictive simulation. Every five years, wells that had stopped flowing were manually removed from the model. Simulated reversals occurred only in the area west of Warren and Plain City near the shoreline of Great Salt Lake (fig. 10).

In the second simulation, 21 of the 53 pumped wells with discharges equal to or greater than 0.3 cubic foot per second were assigned pumping rates that gradually increased to twice their 1980-84 average annual rate. These wells are primarily located near Hill Air Force Base and south of Ogden with two exceptions. One well is located near the shore of Great Salt Lake, west of North Ogden, and the other well is in Farmington. The 32 wells with discharges less than 0.3 cubic foot per second continued to be pumped at the 1980-84 average annual rates as in the first simulation.

In the second simulation, total annual withdrawals from pumped wells were gradually increased from about 23,000 acre-feet to about 44,000 acre-feet during the 20-year predictive simulation. Similarly, flowing wells that stopped flowing were manually removed from the model every 5 years during the simulation. Areas where the vertical ground-water flow between layers 2 and 3 could be reversed with this two-fold increase in pumping are shown in figure 11. Reversals occurred in three new areas: near North Ogden, south and west of Ogden, and between Roy and Clinton. In addition, the area west of Warren and Plain City determined by the first simulation increased in size. The principal aquifer in these areas would be susceptible to the downward movement of contamination.

Dissolved-Solids Concentrations

In the East Shore area, dissolved-solids concentrations in ground water generally are less than 500 mg/L (pl. 3), because of the proximity to recharge from the Wasatch Range. Concentrations exceed 1,000 to 2,000 mg/L (pl. 3) within discharge areas in the northwest and southwest parts of the East Shore area and probably are partly related to evapotranspiration.

Salt Lake Valley

Hely and others (1971) and Marine and Price (1964) prepared comprehensive hydrogeologic studies of Salt Lake Valley. The shallow unconfined aquifer of the valley was discussed and well data summarized by Seiler and Waddell (1984). The most recent summary of data from shallow (unconfined) and deep wells was compiled by Seiler (1986). Seiler's hydrologic-data report is not comprehensive and earlier reports (referenced in Hely and others, 1971) were used in this study. Mower (1973, 1973a, 1973b, 1973c) and Mower and Van Horn (1973) as well as McGregor and others (1973) provide information on the hydrology of part of Salt Lake Valley. Seepage studies of Salt Lake Valley canals are described in a report by Herbert and others (1985). Waddell, Seiler, and others (1987) developed a ground-water model for Salt Lake Valley, and Waddell, Seiler, and Solomon (1987) discuss the chemical quality of ground water in Salt Lake Valley. Factors related to the potential for contamination of the principal aqui-

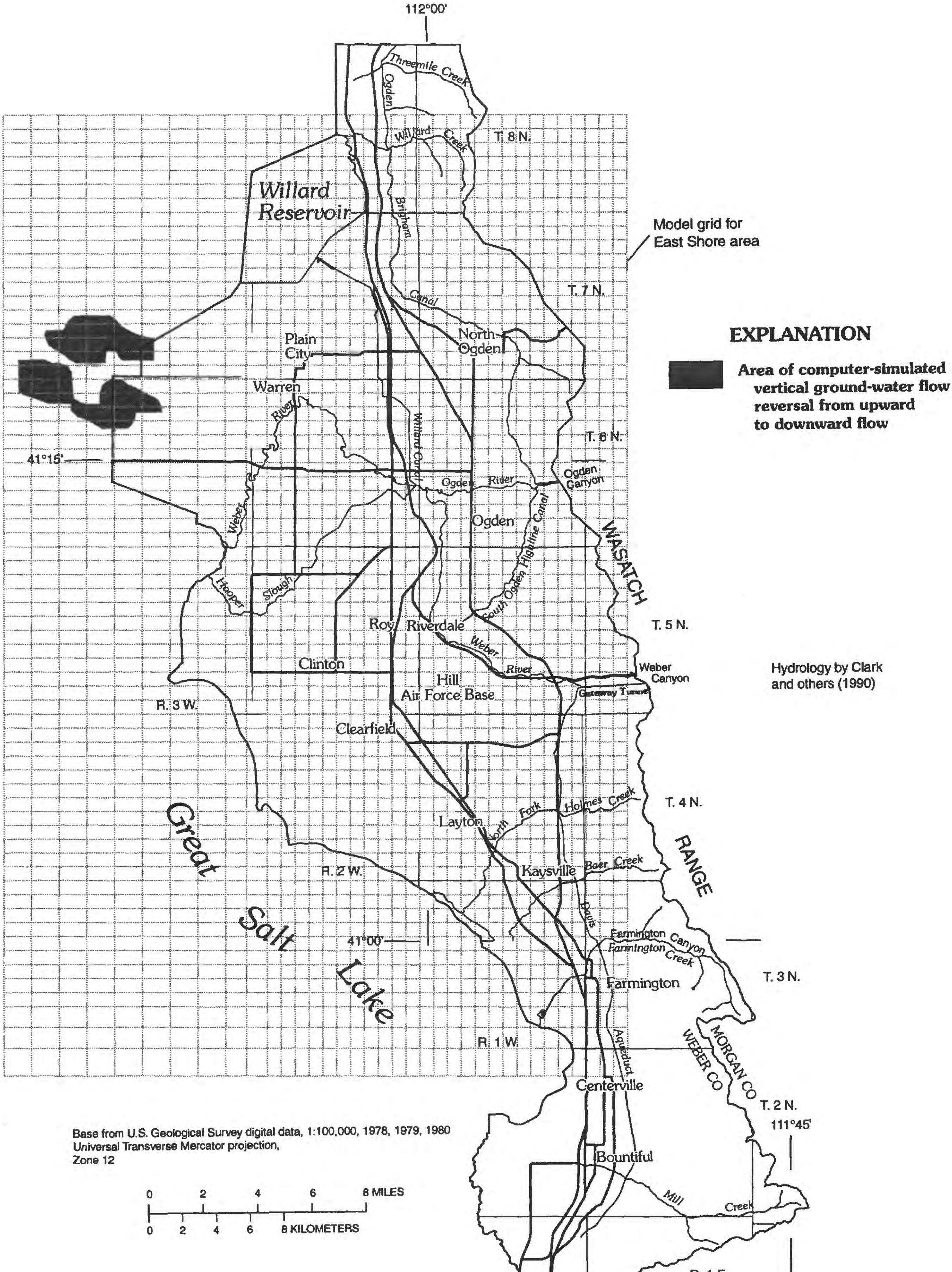

Figure 10. Computer-simulated reversals of vertical ground-water flow at 1980-84 average pumping rate through 2004, East Shore area, Utah.

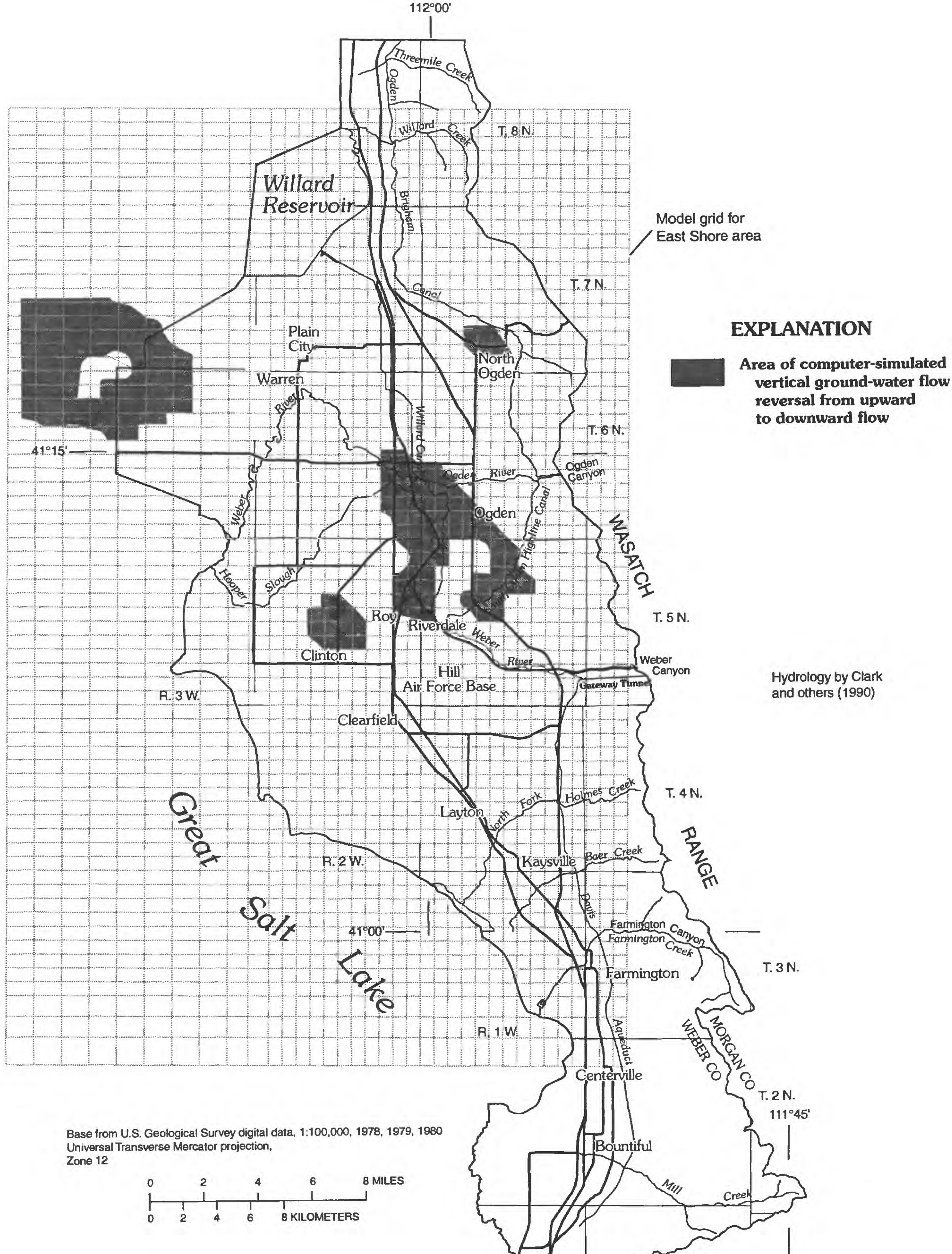

Figure 11. Computer-simulated reversals of vertical ground-water flow at twice the 1980-84 average pumping rate through 2004, East Shore area, Utah.

fer of Salt Lake Valley are the subject of a report by Baskin (1990), which is based on data derived from a digital model by Waddell, Seiler, and others (1987).

Principal Aquifers and Confining Layers

The stratigraphy of Salt Lake Valley basin-fill deposits was studied in detail by Marine and Price (1964). They concluded that the correlation of lithostratigraphic units in the basin-fill deposits was not possible and, hence, made no division of the aquifers beyond a shallow unconfined and principal confined.

Saturated basin-fill deposits in Salt Lake Valley are subdivided into a shallow unconfined aquifer and a principal aquifer. The base of the shallow unconfined aquifer is generally 10 to 20 feet below the land surface. The principal aquifer is usually unconfined near the mountain fronts but becomes confined basinward and underlies the shallow unconfined aquifer. Confining layers are absent or are discontinuous near the mountain fronts and thicken toward the center of the valley (fig. 3).

The principal aquifer is composed of coarse-grained clastics eroded from the Wasatch Range and Oquirrh Mountains. Most deep wells in Salt Lake Valley are completed in unconsolidated to semiconsolidated sediments at depths of less than 1,200 feet. In several areas around the perimeter of the valley, the unconsolidated sediments are thin and overlie Tertiary (semiconsolidated to consolidated) or older consolidated-rock formations. Faulted blocks of consolidated rock along the east side of the valley are capped with 100 to 200 feet of unconsolidated deposits. A faulted consolidated-rock bench extends out about a mile into the valley south of Emigration Canyon. In contrast, unconsolidated alluvial-fan deposits are as much as 700 feet thick near the mouth of Millcreek Canyon.

Hydraulic properties of the aquifers in Salt Lake Valley are discussed at length by Hely and others (1971). Vertical hydraulic conductivity between the shallow unconfined aquifer and the principal aquifer was estimated at three places in the valley: (1) near Great Salt Lake, 0.016 foot per day (Hely and others, 1971, p. 115); (2) between Holladay and Murray, 0.049 foot per day (Hely and others, 1971, p. 118); and (3) in the north-central part of the valley, 0.124 foot per day (Waddell, Seiler, and others, 1987, p. 30). The transmissivity in the principal aquifer ranges from 1,000 to as much as 50,000 feet squared per day, and transmissivity in the shallow unconfined aquifer ranges from 1,300 to 4,000 feet squared per day (Hely and others, 1971). Generally, the principal aquifer has larger transmissivity values on the east side of the valley than on the west side.

Directions of Ground-Water Flow

Ground-water flow directions in Salt Lake Valley are described by Baskin (1990) on the basis of earlier work by Waddell, Seiler, and others (1987). In general, flow is from the mountain fronts toward the Jordan River and subsequently to the northwest toward Great Salt Lake (fig. 12).

Recharge Areas

Recharge areas for basin-fill deposits in Salt Lake Valley are at the base of the Wasatch Range on the east side of the valley and at the base of the Oquirrh Mountains on the west side of the valley. The width of the primary recharge area varies from several miles in the southwest part of the valley to near zero at the north end of the Oquirrh Mountains and at the north end of the valley (T. 1 N., R. 1 W.; pl. 4). Secondary recharge areas are extensive in the southern part of Salt Lake Valley and can be attributed to the sediments deposited by Little and Big Cottonwood Creeks. A narrow discharge area exists along the Jordan River, which gradually widens to the north and northwest toward Great Salt Lake.

North Murray Area

The discharge area parallels the Jordan River in the southern part of the valley. The east boundary between the secondary recharge area and the discharge area curves to the east north of Murray (pl. 4). Water levels in wells in this area vary significantly due to pumping, and therefore recharge classification is difficult. Many water levels in wells in the area are above the land surface most of the time, therefore, the area is mapped as a discharge area. Variations in water levels in this area indicate that recharge-area boundaries are transient with time.

Southeast Valley Benches

Benches in the southeast part of the valley near the mouths of Big and Little Cottonwood Canyons consist of deltaic sand and gravel deposits and beach deposits. These thick, coarse-grained deposits with large transmissivity values and the deep water levels combine to form an important primary recharge area. In the areas downslope from the benches, clay and other fine-grained sediments that form confining layers are at depths from 100 to 300 feet below land surface. Water levels in wells located downslope from the benches are below these confining layers; hence, the area is mapped as secondary recharge.

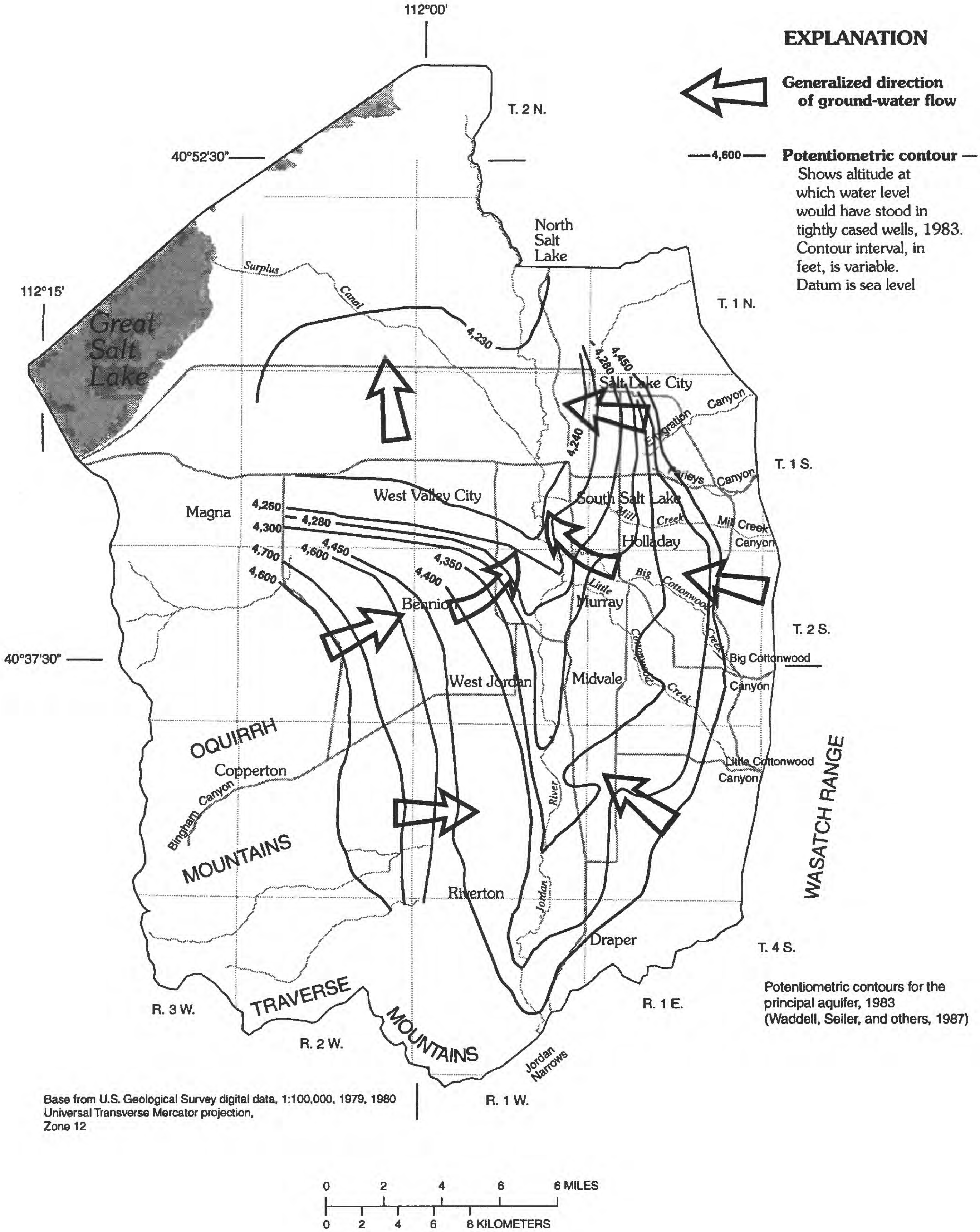

Figure 12. Generalized direction of ground-water flow and potentiometric surface of the principal aquifer, Salt Lake Valley, Utah.

Bennion Area

Confining layers in this area are less prevalent and deeper in the basin-fill deposits than typically found in other parts of the valley. For example, well 39 was drilled to a depth of 620 feet, and the driller did not report a confining layer. However, most drillers' logs for wells in the area report confining layers; therefore, the area is mapped as a secondary recharge area.

Riverton Area

Near Riverton, water levels are above land surface in wells completed at depths of less than 300 feet in the principal aquifer in benches on the west side of the river. However, water levels are below the land surface in wells completed at depths greater than 300 feet in the same area. The situation in this area is similar to case 3 (fig. 4), in which ground water moves upward from the upper confined aquifer toward the land surface. The area is mapped as a discharge area because water levels are above the land surface, and surface contaminants probably would not migrate to the deeper parts of the principal aquifer.

Recharge Areas in Salt Lake Valley Based on a Digital Model

Baskin (1990) investigated the susceptibility of the principal aquifer to contamination in Salt Lake Valley. Data arrays from an existing digital ground-water flow model (Waddell, Seiler, and others, 1987) were used to determine vertical ground-water flow directions between the shallow unconfined aquifer and the principal aquifer and to map the primary recharge areas for the principal aquifer.

Comparisons between the model-derived vertical ground-water flow directions (Waddell, Seiler, and others, 1987) and the recharge areas mapped in this study are shown in figure 13. A downward model-derived vertical flow direction indicates a recharge area, whereas an upward flow direction indicates a discharge area.

Most recharge areas indicated by the model are within the primary or secondary recharge areas mapped in this study (fig. 13). The exceptions probably result from block discretization for modeling purposes, which limits the precision of model boundaries. Several major inconsistencies between areas designated by the model and areas mapped in this study occur. First, southwest of North Salt Lake, an isolated block shows downward flow in the model area. This block probably results from a reversal of flow caused by ground-water pumping. Second, another large area of downward flow occurs near West Valley City and is mapped as a discharge area in this study. This area is complex and the model might not accurately represent the hydrologic conditions. Water-level records indicate that ground water moves upward in this area. The last area where the two studies do not agree occurs on the east side of the valley from Salt Lake City to southeast of Murray (fig. 13). The model simulation indicates that ground water moves upward in an area that is mapped as a secondary recharge area in this study. This difference is probably caused by the vertical discretization of the model. A large quantity of recharge moves into the second layer of the model beneath the confining layer, producing upward ground-water flow at the boundary of the confining layer.

Dissolved-Solids Concentrations

Dissolved-solids concentrations in Salt Lake Valley range from less than 500 mg/L to more than 10,000 mg/L (pl. 4). Concentrations are smallest near the primary recharge areas along the Wasatch Range and are highest in discharge areas near Great Salt Lake. Dissolved-solids concentrations generally increase along flow paths from recharge areas to discharge areas. Local variations are caused by seepage from different types of consolidated rock into the basin-fill deposits, and by discharge possibly from highly mineralized sources such as springs, mines, or seepage from tailings ponds (Hely and others, 1971, p. 159).

Water in the principal aquifer in the southeastern part of the valley has a dissolved-solids concentration of less than 500 mg/L. Big Cottonwood Creek, Little Cottonwood Creek, and other small streams with small dissolved-solids concentrations recharge the principal aquifer in this part of the valley. The northwestern part of the valley is a discharge area and ground water in the area has dissolved-solids concentrations greater than 1,000 mg/L.

Ground water downgradient from the mouths of Mill Creek, Parleys, and Emigration Canyons has higher dissolved-solids concentrations, ranging from 500 to 1,000 mg/L, than ground water near the mouths of Big and Little Cottonwood Canyons to the south. Geologic formations in the respective drainage basins have different soluble minerals, which may explain the difference in dissolved-solids concentrations in these areas. Consolidated rocks in the drainage basins of Mill Creek, Parleys, and Emigration Canyons are predominantly sandstone, siltstone, shale, and limestone; whereas, the most common consolidated rocks in Big and Little Cottonwood Canyons are quartzites and granitic intrusives.

Recharge from consolidated rock in the Oquirrh and Traverse Mountains is considerably less than recharge from the Wasatch Range, and the water con-

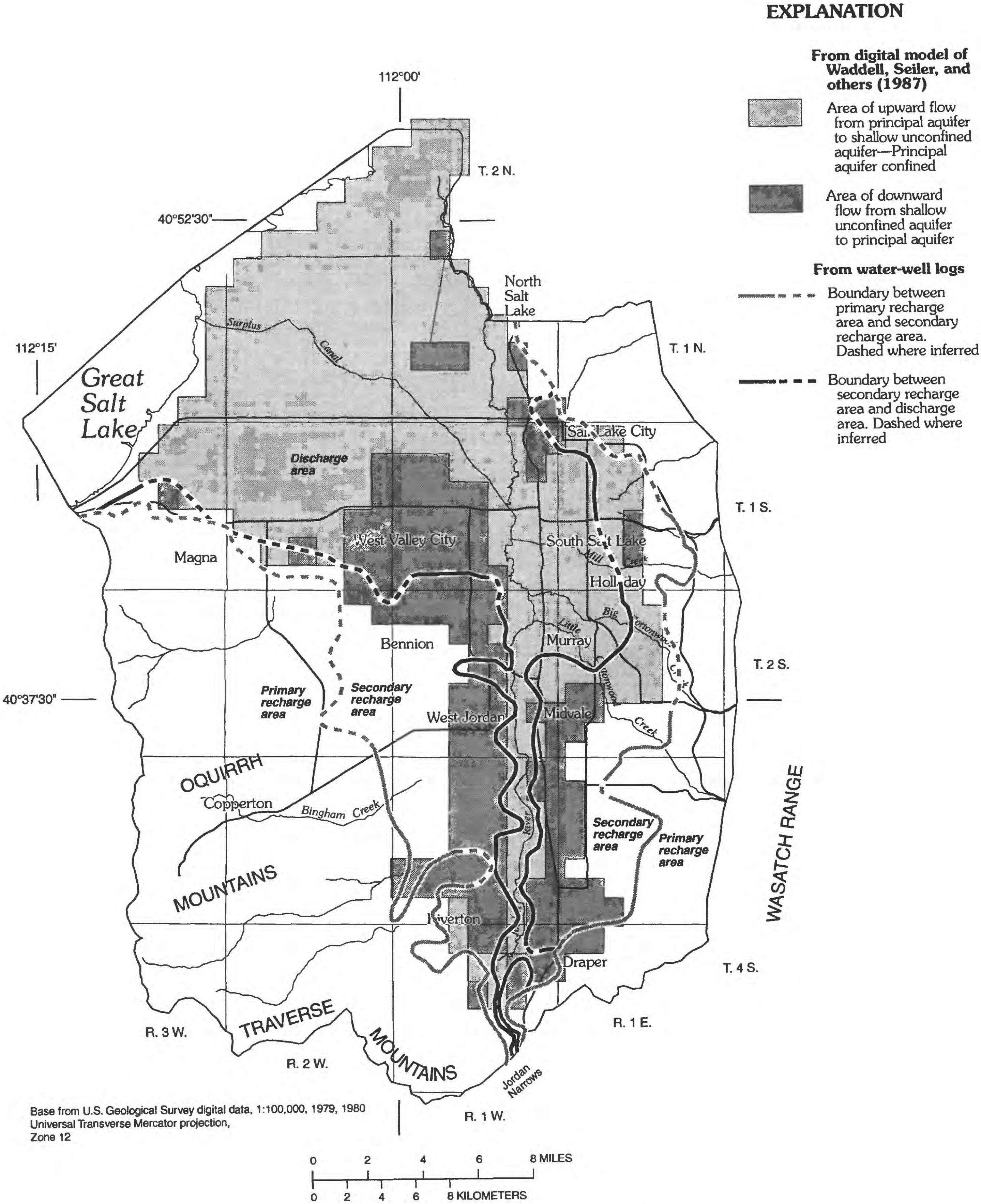

Figure 13. Areas of upward and downward flow between the principal aquifer and the shallow unconfined aquifer of Salt Lake Valley, Utah, determined from a digital model and water-well logs.

tains larger concentrations of dissolved solids (Hely and others, 1971, p. 120-121). As a result, water in the western and southwestern parts of the valley has larger concentrations of dissolved solids than water on the eastern side. The dissolved-solids concentrations in ground water exceed 2,000 mg/L in the southwestern part of the valley, from Copperton east to the Jordan River.

Utah and Goshen Valleys

Northern Utah Valley ground-water resources were investigated by Clark and Appel (1985), and a companion report described simulated effects of pumping ground-water aquifers using a digital model (Clark, 1984). Hydrologic data were compiled by Appel and others (1982). Much of the geology and aquifer nomenclature in Clark and Appel (1985) is based on earlier work by Hunt and others (1953). Cordova (1970) describes the general ground-water conditions in southern Utah Valley and Goshen Valley, based in part on previous geologic work by Bissell (1963). Hydrologic data for southern Utah Valley and Goshen Valley were compiled by Cordova (1969).

Principal Aquifers and Confining Layers

Four aquifers in the basin-fill deposits of northern Utah Valley were classified and described by Hunt and others (1953): a shallow unconfined aquifer; a shallow artesian aquifer and a deep artesian aquifer both in deposits of Pleistocene age; and an artesian aquifer in deposits of early Quaternary or Tertiary age. The three confined aquifers are part of the principal aquifer defined in this report. The four aquifers are difficult to distinguish in southern Utah Valley and are not distinguishable in Goshen Valley (L.E. Brooks, U.S. Geological Survey, oral commun., 1990). The division of the basin-fill deposits into four aquifers is practical only where there are well-defined, mappable confining layers, such as in northern Utah Valley. The principal aquifer for Utah and Goshen Valleys includes all of the confined basin-fill aquifers in the valley and the laterally equivalent unconfined basin-fill aquifers near the mountains.

Basin-fill aquifer material generally varies from sand to coarse gravel. Grain size of the aquifer material generally decreases with increasing distance from the mountains, but shows no trends related to depth. The deepest aquifer is often semiconsolidated to consolidated, but the small quantity of test data indicate that hydraulic conductivity does not decrease with depth. Hydraulic-conductivity values of aquifers in northern Utah Valley range from 80 to more than 500 feet per day, and one value of vertical hydraulic conductivity of 1×10^{-3} feet per day is reported by Clark and Appel (1985, p. 47). Aquifer tests in southern Utah Valley and Goshen Valley indicate the confined aquifers are leaky, which is indicative of discontinuous confining layers (L.E. Brooks, U.S. Geological Survey, oral commun., 1990) or confining layers with high conductivity when compared with the "tight" confining units.

A few wells are completed in consolidated rock underlying the basin-fill deposits in western Goshen Valley. Water levels in these wells are about the same as water levels in wells completed in the unconfined aquifer in the basin-fill deposits, indicating that the consolidated rock probably is in hydraulic connection with the basin-fill deposits. The principal aquifer in Goshen Valley is generally confined south of Utah Lake except near the surrounding mountains.

Directions of Ground-Water Flow

Ground-water flow directions in Utah and Goshen Valleys (fig. 14) were determined from a potentiometric-surface map of the deep confined part of the principal aquifer in northern Utah Valley prepared by Clark and Appel (1985, p. 54), and a potentiometric-surface map of the deep confined part of the principal aquifer in southern Utah Valley (Cordova, 1970, p. 44). Ground-water flow in Utah Valley is generally toward Utah Lake. In the northern parts of the valley the flow is toward the Jordan River or Utah Lake. Data are insufficient to determine the flow direction in the area west of Utah Lake, but it also probably is toward the lake. Ground-water flow in Goshen Valley is toward the center of the valley and toward Utah Lake.

Recharge Areas

The primary recharge areas in Utah and Goshen Valleys generally are limited to the perimeter of the valleys along the mountain fronts (pl. 5). The primary recharge area in northwestern Goshen Valley includes broad alluvial fans along the eastern flank of the East Tintic Mountains.

Secondary recharge areas in eastern Utah Valley range from 0 to about 6 miles wide. The secondary recharge area is absent between Provo and Springville. The width of the secondary recharge area is less than 1.5 miles in southern Utah Valley (from Salem south) and along the east side of West Mountain.

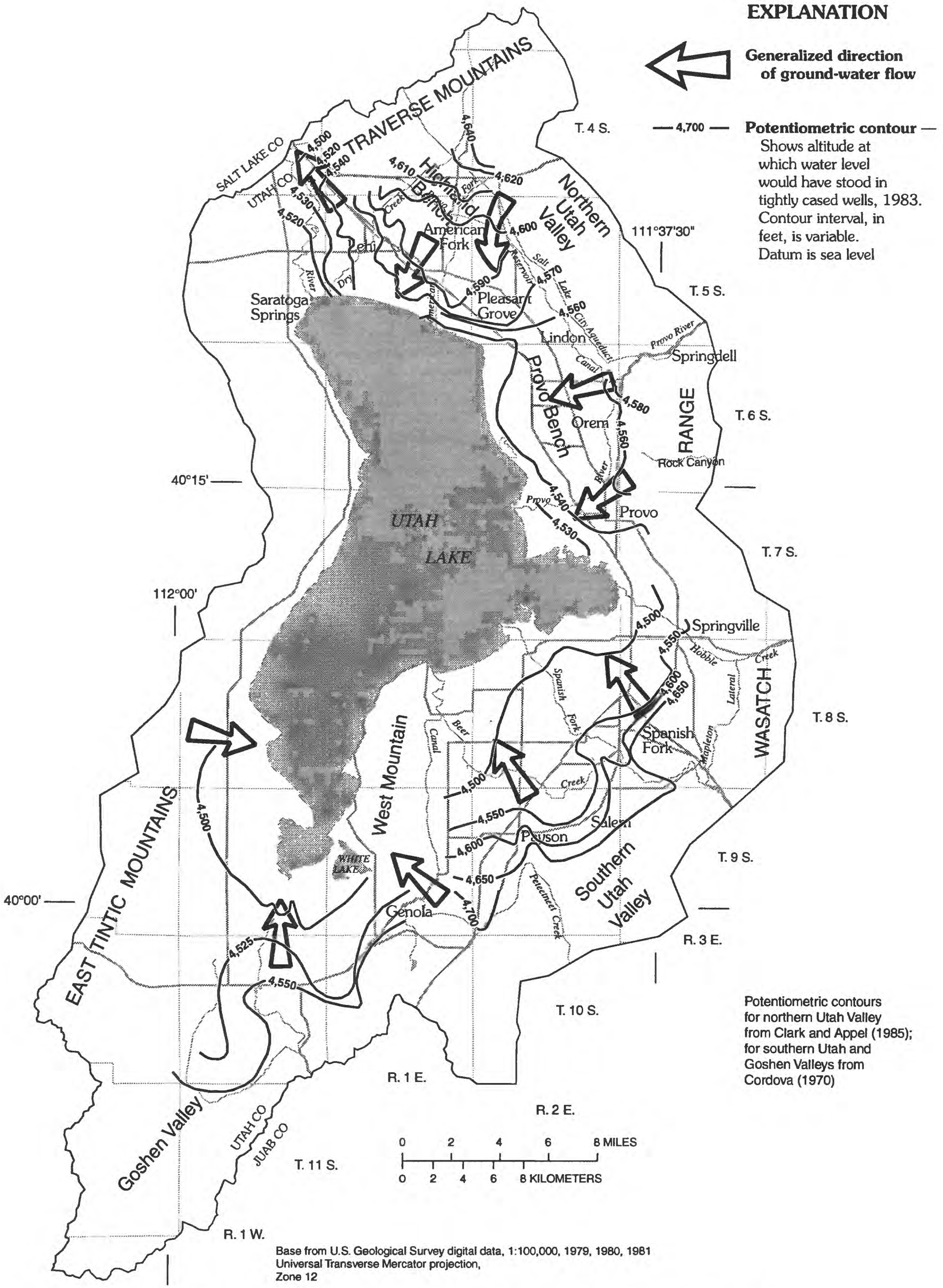

Figure 14. Generalized direction of ground-water flow and potentiometric surface of the principal aquifer, Utah and Goshen Valleys, Utah.

Jordan Narrows

Subsurface flow from the principal aquifer in northern Utah Valley to the principal aquifer in Salt Lake Valley was estimated to be 2,500 (Mower, 1970) and 2,000 acre-feet per year (Clark and Appel, 1985). The Jordan River probably does not recharge the principal aquifer through the Jordan Narrows because water levels in wells in this area are above the river, and the principal aquifer is discharging water to the river.

Secondary Recharge Areas Within Discharge Areas

Seasonal- and pumping-induced changes in vertical hydraulic gradient between the shallow unconfined aquifer and the principal aquifer can create secondary recharge areas within discharge areas. Many wells are completed in the upper confined part of the principal aquifer along the boundary between the secondary recharge and discharge areas between Lehi and American Fork. Water levels in these wells are above land surface most of the time. During late summer and times of drought, water levels in these wells can drop below water levels in wells in the shallow unconfined aquifer and the lower confined part of the principal aquifer. As a result, ground water from the shallow unconfined aquifer might recharge the upper confined part of the principal aquifer. These conditions are shown in case 2, figure 4, where ground water moves down from the shallow unconfined aquifer to the upper confined part of the principal aquifer, and ground water also moves up from the lower part of the principal confined aquifer to the upper confined part of the principal aquifer.

Near Lake Shore and Benjamin in southern Utah Valley, wells are completed in the shallow unconfined aquifer (10-60 feet deep) and in the upper (100-300 feet) and lower (below 300 feet) confined parts of the principal aquifer. Water levels in wells completed at depths of 100-300 feet are about the same as, although occasionally drop below, those in the shallow unconfined aquifer. If withdrawals of water from the principal aquifer in the 100- to 300-foot zone increase, the hydraulic gradient between the shallow unconfined aquifer and the principal aquifer could be reversed, creating a secondary recharge area. Water levels in wells completed in the principal aquifer at depths below 300 feet are above the land surface.

Provo Bench

The Provo Bench (pl. 5) is a thick sequence of Lake Bonneville and older sediments at the mouth of the Provo River. The lobate primary recharge area and the fan-like secondary recharge area are the result of the deposition of coarser sediments by the ancestral Provo River. The lobate extension of the primary recharge area to the south in the southeast quarter of T. 6 S., R. 2 E. (pl. 5) is inferred from data from wells 76 and 77 (table 11) because no confining layers were noted in the drillers' logs and water levels are about 190 feet below land surface.

Spanish Fork Area

The primary recharge area is limited to an unusually small area at the mouth of Spanish Fork Canyon. Spanish Fork has not deposited coarse-grained sediments such as those deposited by the Provo River and at several other locations along the Wasatch Front.

Subsurface inflow from consolidated rock apparently occurs just southwest of the mouth of Spanish Fork Canyon, as shown in figure 4, case 1. The water level in well 139 (completed in consolidated rock) is above that of a nearby well completed in the shallow unconfined (perhaps perched) aquifer in basin-fill deposits.

A secondary recharge area formed by an alluvial fan extends into the valley southwest of the town of Spanish Fork (T. 8 S., R. 2 E.). A few wells completed in the principal aquifer have water levels above land surface, but are included in the secondary recharge area. Most of the wells in this area indicate the presence of at least one confining layer and a downward vertical hydraulic gradient; thus, the area is mapped as a secondary recharge area.

Payson Area

An isolated primary recharge area occurs northwest of Payson (pl. 5). Consolidated rock was penetrated in well 178 at a depth of 30 feet, and a second well, 179 (pl. 5), was drilled to 310 feet without encountering consolidated rock. A small outcrop of consolidated rock and Salt Lake Formation was mapped by Bissell (1963, pl. 5) in this area. On the basis of this outcrop of consolidated rock, the area is mapped as a primary recharge area.

South of Payson, well 198 is completed in the Salt Lake Formation and had a water level above land surface in August 1989. However, other wells indicate that this is a secondary recharge area. Also, near Payson the primary recharge area extends into the valley at the mouth of Peteetneet Creek because coarse-grained sediments were deposited by the creek.

Southwestern Goshen Valley

A large secondary recharge area was mapped at the southwest end of Goshen Valley. Aquifer tests in topographically lower parts of the valley indicate leaky confined conditions in the principal aquifer (L.E. Brooks, U.S. Geological Survey, oral commun., 1990); thus, water may move through the confining layer. In the topographically higher parts of this secondary recharge area, water levels are below the base of the confining unit creating the potential for downward movement of water.

Dissolved-Solids Concentrations

In eastern Utah and Goshen Valleys, dissolved-solids concentrations are generally less than 500 mg/L between the Wasatch Range and Utah Lake (pl. 5), because of recharge along the Wasatch Range. In northern Utah Valley, concentrations exceed 500 mg/L south of the Traverse Mountains, at Saratoga Springs, and at the mouth of American Fork, where the river enters Utah Lake. In these areas, thermal springs discharge saline water that also may increase the dissolved-solids concentration in the principal aquifer (Clark and Appel, 1985, p. 88, 95-97) as the thermal waters move to the surface. In Goshen Valley, dissolved-solids concentrations exceed 1,000 mg/L near White Lake (an ephemeral lake) and Elberta.

Ground water from springs, mines, and tunnels contains the highest dissolved-solids concentrations in southern Utah Valley and Goshen Valley (Cordova, 1970, p. 61). Dissolved-solids concentration data are insufficient to contour in the area west of Utah Lake.

WATER-QUALITY ANALYSES

Prior to this study, water from the principal aquifer in most of the study areas had not been systematically sampled and analyzed for inorganic constituents, radionuclides, trace elements and metals, and organic chemicals. All wells of known depth and springs that were sampled in this study produce water from the principal aquifer, and water sampled from wells of unknown depth and springs was assumed to be from the principal aquifer. Of the total of 73 wells and springs sampled, the concentration of inorganic constituents in 5 samples exceeded State of Utah water-quality standards. In none of the samples did the concentration of organic compounds exceed State standards. The sampling sites are shown by subarea on plates 1 to 5 and are listed in table 1.

Samples from every site in the subareas could not be analyzed for the full set of constituents and properties because of the expense of organic chemical analyses. Analyses were selected to address State of Utah water-quality standards (Utah Division of Environmental Health, 1989). The full set of sample constituents was divided into three suites: A, B, and C. Suite A (tables 2 and 3) consists of physical properties and selected inorganic constituents, nutrients, trace elements, and radionuclides analyzed for all 73 sites. Suite B (tables 4 and 5) includes additional trace elements, radionuclides, and selected organic chemicals analyzed for 33 of the 73 sites. Suite C (table 6) includes additional organic chemicals analyzed for 13 of the 73 sites. Analyses of organic chemicals in suites B and C included tentative identification of any other related compounds, although the confidence level of the identification of other compounds is lower than for analyses explicitly requested.

Ground-water samples were collected at 15 sites in Cache Valley (pl. 1) and the East Shore area (pl. 2), and at 14 sites in the lower Bear River area (pl. 3) and Utah and Goshen Valleys (pl. 5). Samples in these subareas were analyzed for suite A constituents. Samples from five sites in each of these four subareas were analyzed for suite A and suite B constituents.

Samples collected at 13 Salt Lake Valley sites (pl. 4) were analyzed for suite A, B, and C constituents. Water samples from two additional Salt Lake Valley sites were analyzed for suite A constituents for a total of 15 samples in Salt Lake Valley.

Constituents of Suite A

Results of analyses, State water-quality standards, and exceedences for suite A constituents are listed in tables 2 and 3. Water from site 26, a thermal spring, exceeded State standards for pH, gross alpha, barium, cadmium, chromium, lead, and manganese (tables 2 and 3). The source of the spring water is unknown but might not be from the principal aquifer; however, it is not a potential source for public supply. Water from this spring has a high, naturally occurring dissolved-solids concentration that exceeds State standards.

Water samples from three sites (26, 28, and 46) exceeded gross alpha radiation standards (table 2). When gross alpha radiation in a water sample is exceeded, the State of Utah drinking-water standards require that radium-226 and radium-228 be analyzed to determine if their combined radioactivity exceeds 5 pCi/L. The radium-226 and radium-228 results indicate that water samples from sites 28 and 46 did not exceed a combined radioactivity of 5 pCi/L (table 4). Site 26 is not a potential source of water for public supply; therefore, it was not sampled for radium-226 and radium-228.

Table 1. Records of wells and springs where water-quality samples were collected in Cache Valley and along the Wasatch Front, Utah

[—, no data]

Site number: See plates 1 to 5 for location of water-quality sampling sites.

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

Sample suite/area: See text for explanation of suite analyses. Suite A, tables 2 and 3; suite B, tables 4 and 5; suite C, table 6; 0, discharge; 1, primary recharge; 2, secondary recharge.

Use of water (primary): P, public supply; I, irrigation; S, stock; H, domestic; F, fire; N, industrial; U, unused; R, recreation; C, commercial; –, no information.

Well description: Depth, in feet below land surface; S, spring. Finish and type: Total perforated interval, in feet below land surface; ?, unknown; P, gross perforations; S, screened interval, in feet below land surface; O, open end, depth for open-end completion, in feet below land surface.

Discharge: Yield: gal/min, gallons per minute; P, pumped; F, flowing.

Altitude of land surface: In feet above sea level.

Water level: Depth, in feet below or above (+) land surface.

Site number	Location	Sample suite/ area		Sample date	Use of water	Well description			Discharge			Altitude of land surface (feet)	Water level	
						Depth (feet)	Finish (feet)	Type	Yield (gal/min)		Date		Depth (feet)	Date
Cache Valley														
1	(B-14-1)17add-1	A	0	08-15-89	P	92	51-85	P	100	P	07-31-67	4,555	9.0	09-27-67
2	(A-14-1)22bab-1	A	0	08-11-89	I	126	—	—	111	P	—	4,469	+1.0	11-01-67
3	(A-14-1)26bcb-1	AB	0	09-05-89	I	77	52-63	P	116	P	—	4,548	+6.0	06-00-67
4	(A-13-1)33aca-1	AB	0	08-14-89	I	333	85-333	P	1,640	P	—	4,543	60.0	03-07-67
5	(A-12-1)6bcc-1	A	0	08-10-89	S	585	504-585	S	5.4	F	03-19-91	4,437	+28.0	06-12-68
6	(B-12-1)10cdd-1	A	0	08-10-89	H	710	—	—	30	F	08-01-79	4,418	+35.0	08-01-79
7	(A-12-1)17add-1	A	0	08-10-89	F	154	146-?	P	400	P	—	4,445	+43.0	06-06-68
8	(A-12-1)29acc-1	A	0	08-10-89	N	108	—	—	550	P	—	4,450	+31.0	08-23-67
9	(A-12-1)35bba-1	A	2	08-15-89	T	434	380-434	P	432	P	12-02-83	4,783	280	12-02-83
10	(A-11-1)6aab-1	A	0	08-15-89	H	230	—	—	25	F	08-05-85	4,430	—	—
11	(A-11-1)9aad-1	AB	0	08-02-89	N	385	336-368	P	150	P	—	4,495	3.0	06-18-68
12	(A-11-1)8ddc-1	AB	0	08-02-89	H	138	—	—	80	F	11-26-80	4,477	+15.0	11-28-80
13	(A-11-1)15ddb-1	A	2	08-14-89	P	385	269-369	P	440	P	09-06-73	4,680	180	09-06-73
14	(B-11-1)36abb-1	A	0	08-16-89	H	195	148-184	—	210	P	10-05-83	4,501	12.0	10-06-83
15	(A-11-1)32dbc-1	AB	0	08-17-89	S	139	—	—	25	P	03-14-80	4,590	95.0	03-14-80
Lower Bear River Area														
16	(B-14-3)5cdc-1	A	0	08-09-89	U	22	—	—	8	P	—	4,369	+7.0	05-01-70
17	(B-13-3)9aca-1	AB	2	07-27-89	U	100	—	—	—	—	—	4,410	50.0	07-01-70
18	(B-13-3)12adb-1	A	1	08-16-89	P	130	—	P	40	P	—	4,750	33.0	03-01-70
19	(B-12-3)11daa-3	A	2	08-09-89	-	—	—	—	—	—	—	4,360	—	—
20	(B-12-3)33add-1	AB	2	07-31-89	-	—	—	—	—	—	—	—	—	—
21	(B-12-4)34cca-1	A	2	07-31-89	I	292	—	—	1,100	P	—	4,424	120	03-01-70
22	(B-11-3)5bab-1	A	1	08-09-89	-	200	—	—	—	—	—	4,464	—	—
23	(B-11-2)29dac-S1	A	0	08-16-89	R	S	—	—	1,600	F	12-00-70	4,272	—	—
24	(B-10-3)1aca-1	AB	0	08-08-89	H	62	51-?	P	—	—	—	4,267	—	—
25	(B-10-4)6cda-S1	A	0	08-08-89	S	S	—	—	—	—	—	4,255	—	—
26	(B-10-3)30bbd-S1	A	0	08-01-89	U	S	—	—	25	F	05-24-66	4,261	—	—
27	(B-9-2)1cdd-1	A	0	08-17-89	H	67	—	—	140	P	07-18-87	4,244	+18.5	07-18-87
28	(B-9-2)15daa-1	AB	0	07-26-89	I	465	440-?	P	10	P	—	4,232	+26.0	07-01-70
29	(B-9-2)25ccb-1	AB	2	07-26-89	I	316	127-?	P	895	P	—	4,297	7.0	04-01-61

Table 1. Records of wells and springs where water-quality samples were collected in Cache Valley and along the Wasatch Front, Utah—Continued

Site number	Location	Sample suite/ area		Sample date	Use of water	Well description: Depth (feet)	Well description: Finish (feet)	Well description: Type	Discharge: Yield (gal/min)		Discharge: Date	Altitude of land surface (feet)	Water level: Depth (feet)	Water level: Date
							East Shore Area							
30	(B-8-2)11bcd-1	A	0	07-26-89	C	221	130-?	P	—	—	—	4,315	31.0	05-01-65
31	(B-8-2)26bca-3	A	0	07-03-89	I	327	280-?	P	1,000	P	—	4,288	—	—
32	(B-7-1)22dcb-S1	A	1	07-14-89	-	S	—	—	—	—	—	—	—	—
33	(B-7-2)34bbb-2	AB	0	07-20-89	H	517	507-?	P	20	P	—	4,238	+18.0	05-01-69
34	(B-5-2)3aab-1	A	0	07-21-89	P	340	266-?	S	2,400	P	—	4,273	10.0	11-01-65
35	(B-5-2)6bdd-4	A	0	07-03-89	I	303	285-303	P	70	P	—	4,220	+16.0	08-01-68
36	(B-5-2)14bdc-1	AB	2	07-18-89	P	1,000	953-993	S	1,550	P	08-27-65	4,510	240	03-07-85
37	(B-5-2)16dda-2	AB	0	07-18-89	P	890	247-790	P	—	—	—	4,298	27.0	03-19-85
38	(B-5-1)20ddd-2	AB	2	07-17-89	P	1,000	400-980	S	4,480	P	—	4,422	147	03-05-81
39	(A-5-1)31bcb-S1	A	1	07-17-89	-	S	—	—	—	—	—	5,600	—	—
40	(B-4-2)12bdc-1	A	2	07-20-89	P	875	659-768	P	1,000	P	12-31-42	4,434	175	03-06-85
41	(B-4-1)13abd-S1	A	1	09-01-89	-	S	—	—	—	—	—	5,360	—	—
42	(B-4-2)26aad-2	AB	0	07-19-89	H	795	783-?	P	24	P	—	4,262	+13.0	07-01-66
43	(A-2-1)6acb-1	A	2	06-30-89	H	593	430-593	—	2,500	P	10-20-86	4,300	9	10-20-86
44	(B-2-1)24bad-3	A	0	07-03-89	I	386	—	—	18	F	09-02-88	4,249	—	—
							Salt Lake Valley							
45	(B-1-1)9adb-1	A	0	05-25-89	I	255	251-255	P	4	F	08-06-70	4,210	+7.7	11-20-81
46	(B-1-2)36baa-1	ABC	0	05-25-89	S	464	—	O	—	—	—	4,224	+5.2	07-30-91
47	(A-1-1)31cac-1	ABC	2	06-19-89	P	464	162-420	P	8.9	P	07-16-43	4,401	134	07-27-43
48	(D-1-1)11aac-S1	ABC	1	06-13-89	P	S	—	—	—	—	—	5,000	—	—
49	(C-1-1)23bcb-1	ABC	0	07-13-89	P	840	145-804	S	2,150	P	09-02-90	4,227	+17.6	03-06-92
50	(D-1-1)21acc-2	ABC	2	06-28-89	P	576	175-560	P	—	—	—	4,445	54.0	04-09-65
51	(C-1-2)22cbb-1	ABC	0	06-01-89	S	110	—	—	—	—	—	4,232	+13.5	10-07-31
52	(C-1-1)25bdb-1	ABC	0	07-10-89	H	1,000	214-1,000	P	2,040	P	07-14-67	4,236	—	07-25-67
53	(C-1-1)27dda-8	ABC	0	07-10-89	P	775	670-760	P	1,160	P	09-30-89	4,237	—	—
54	(D-2-1)2cdc-S1	ABC	1	07-10-89	P	S	—	—	1,170	F	05-01-51	4,680	—	—
55	(C-2-1)20aad-1	ABC	2	07-10-89	P	658	240-355	P	1,080	P	05-06-79	4,515	126	03-04-92
56	(D-2-1)21dbc-1	ABC	2	06-07-89	P	740	210-728	P	2,500	P	09-20-61	4,453	82.3	12-13-61
57	(C-3-1)12ccb-1	ABC	0	06-06-89	S	118	—	—	—	—	—	4,322	+22.8	01-06-83
58	(C-4-2)1bbb-1	ABC	1	06-06-89	I	540	220-524	P	—	—	—	4,890	81.7	03-19-65
59	(C-4-1)23bac-1	A	1	06-02-89	H	260	160-254	—	1,350	P	01-26-68	4,590	145	01-26-68
							Utah and Goshen Valleys							
60	(D-5-1)19ccc-1	A	0	05-26-89	U	150	143-?	P	8	F	03-01-82	4,493	+23.3	03-06-81
61	(D-5-1)24ccd-1	AB	0	06-15-89	H	343	315-342	P	12	F	10-24-80	4,556	+35.0	10-24-80
62	(D-6-3)6adc-S1	A	1	07-12-89	-	S	—	—	—	—	—	5,000	—	—
63	(D-6-2)17dcc-1	AB	0	07-12-89	H	253	210-252	P	7.5	F	12-18-80	4,532	+17.7	12-18-80
64	(D-7-3)5dbb-S1	A	1	07-07-89	-	S	—	—	—	—	—	5,160	—	—
65	(D-7-2)4cbb-2	AB	0	06-15-89	H	144	136-144	P	286	F	10-12-81	4,490	+25.4	10-12-81
66	(D-7-3)33baa-6	A	0	06-09-89	H	138	—	O	4	F	12-19-89	4,560	+7.2	07-31-35
67	(D-8-2)2daa-1	A	0	06-09-89	S	346	—	O	1.4	F	01-23-90	4,515	+20.0	04-12-48
68	(C-8-1)20cdb-2	A	1	07-07-89	I	345	—	O	1,900	P	04-04-67	4,620	120	04-04-67
69	(D-8-2)34dda-1	AB	0	07-12-89	S	130	—	O	25	F	06-21-46	4,528	+22.0	06-21-46
70	(D-9-1)26aaa-1	A	2	07-05-89	I	380	100-380	P	—	—	—	4,705	53	06-26-73
71	(C-9-1)20dcc-1	AB	1	07-05-89	I	532	—	P	2,500	P	08-19-64	4,701	196	07-08-64
72	(C-9-1)26bda-3	A	0	07-07-89	S	56	—	O	1	F	12-20-89	4,496	+4.5	04-09-64
73	(C-10-1)9ccc-1	A	1	08-18-89	I	474	255-474	P	1,320	P	06-08-66	4,681	145	05-01-61

Constituents of Suite B

Suite B trace-element and radionuclide analyses are listed in table 4, and organic compounds, detection limits, and exceedences are listed in table 5. The selenium concentration in water from site 55 exceeded State of Utah standards (table 4).

The purgeable organic compounds are volatile hydrocarbons. These compounds have a wide range of uses, from solvent degreasing and fumigating to the pharmaceutical industry (Smith, 1988).

Trihalomethanes (THMs) are purgeable organic compounds. By halogenating methane with chloride and bromide (the halogens in most useful THMs) the four different THMs, listed in table 5, result. This group of halomethanes is termed total trihalomethanes (TTHM) and is regulated by the EPA in drinking water in the United States. The maximum permissible concentration set by the EPA is the same as the State standard, which is 100 μg/L for the sum of the concentrations of all four THMs making up the TTHMs.

Chloroform was once used as an anesthetic, but that practice has been abandoned due to its toxic effects. It is now used in many industrial and pharmaceutical applications, including the purification of penicillin. Chloroform is also widely distributed in the atmosphere and water, as well as in public drinking water, mostly as a result of water chlorination. Bromoform has pharmaceutical manufacturing and other industrial applications. Bromo-dichloromethane has applications in organic synthesis. Dibromo-chloromethane is used as a chemical intermediate in various manufacturing processes. It has been detected in drinking water in the United States and may be formed during water chlorination. It has the potential to remain in the aquatic environment because it resists degradation (Smith, 1988).

Chlorophenoxy acid herbicides are plant-growth regulators usually used to control broadleaf weeds. In warm, moist soil, most of these herbicides usually do not remain in their original form long because of degradation by microorganisms (Biggar, 1987).

Organochlorine insecticides and PCBs (polychlorinated biphenyls) are the most persistent (remain in their original form the longest) synthetic organic compounds analyzed for in this study. PCBs and PCNs (polychlorinated naphthalenes) vary in toxicity depending on the type of PCB or PCN. They are used in industrial applications because they are stable, thermoplastic, and nonflammable. PCBs have been used, for example, as plasticizers, hydraulic lubricants, and as dielectrics in capacitors and transformers (Smith, 1988). PCNs are used in such applications as the production of electric condensers and in the insulation of electric wires (Sittig, 1985).

For Cache Valley, the lower Bear River area, the East Shore area, and Utah and Goshen Valleys, the detection limit is 3.0 μg/L for all purgeable organic compounds and TTHMs except vinyl chloride, which has a 1.0 μg/L detection limit. The more sensitive detection limit of 0.2 μg/L was used for analyses of all the purgeable organic compounds and TTHMs in samples from Salt Lake Valley, where contamination was considered to be a greater problem. Two detection limits were specified for testing because of the high cost of organic chemical analyses. Tests for higher detection limits were less costly and allowed for more compounds to be analyzed.

Water from wells that exceeded detection limits for organic compounds in the East Shore area, Salt Lake Valley, and Utah and Goshen Valleys are listed in table 5. In Cache Valley and the lower Bear River area, organic compounds did not exceed detection limits. Analyses of compounds that were not requested but were tentatively identified from water samples include 1,4 dimethyl-benzene (or an isomer) at 0.09 μg/L for site 71 and 1,1,2-trichloro-1,2,2-trifluoroethane at 0.9 μg/L for site 56.

Constituents of Suite C

Suite C includes analyses of additional organic compounds (table 6) for water samples from 13 wells and springs in Salt Lake Valley. Analytical results for the Suite C organic chemicals did not exceed State of Utah ground-water-quality standards or laboratory detection limits. One compound not requested for analysis, sulfur 8 (3.00 μg/L at site 46), was tentatively identified from the water samples. Sulfur 8 usually is found in sediment samples and can occur naturally in water or come from a human source.

The methylene-chloride-extractable compounds (table 6) for which analyses were made as part of this study have a wide range of industrial uses and vary in their persistence. Both triazine herbicides and other nitrogen-containing herbicides are used for control of certain seedling broadleaf weeds and some grass weeds. Triazine herbicides have low toxicity to mammals, but can be persistent in the environment. Other nitrogen-containing herbicides vary in their persistence depending on chemical structure. Although dicamba is moderately persistent and picloram is persistent, both are used to control many annual and perennial broadleaf plants (Biggar, 1987).

Table 2. Suite A inorganic and radionuclide analyses of water from wells and springs in Cache Valley and along the

[μS/cm, microsiemens per centimeter at 25 degrees Celsius; °C, degrees Celsius; mg/L, milligrams per liter; μg/L, micrograms per liter; pCi/L,

Site number	Specific conductance (μS/cm)	pH (standard units)	Temperature, water (°C)	Alkalinity, lab (mg/L as $CaCO_3$)	Calcium, dissolved (mg/L as Ca)	Magnesium, dissolved (mg/L as Mg)	Sodium, dissolved (mg/L as Na)	Sulfate, dissolved (mg/L as SO_4)	Chloride, dissolved (mg/L as Cl)	Fluoride, dissolved (mg/L as F)
State ground-water quality standard:	—	6.5<pH<8.5	—	—	—	—	—	—	—	2.4
					Cache Valley					
1	3,350	7.2	17.0	319	130	44	420	150.	640	2.0
2	435	7.6	10.0	212	57	18	6.1	5.0	3.7	0.1
3	930	7.3	13.0	376	92	55	20	21	19	0.3
4	630	7.6	11.5	305	67	36	9.7	9.0	7.6	0.1
5	1,140	7.6	16.0	168	69	40	68	<1.0	250	0.3
6	870	7.7	21.0	307	55	17	95	<1.0	98	0.3
7	530	7.5	20.5	251	55	21	18	10	5.7	0.3
8	485	7.6	23.0	214	52	20	18	18	11	0.2
9	430	7.8	10.0	202	53	19	4.9	9.0	7.6	0.1
10	445	7.7	16.0	207	47	20	12	7.0	9.3	0.1
11	445	7.8	11.5	202	47	20	13	13	11	0.1
12	570	7.5	11.0	263	68	28	7.0	24	20	0.2
13	620	7.6	13.5	287	66	36	7.9	19	7.1	0.1
14	740	8.0	11.5	355	60	43	21	5.0	17	0.3
15	730	7.5	14.0	353	69	33	22	11	12	0.3
					Lower Bear River Area					
16	640	7.7	11.5	204	35	19	60	19	64	0.2
17	2,940	7.8	14.5	209	100	50	350	61	770	0.6
18	630	7.7	16.0	248	63	27	20	39	25	0.8
19	1,650	7.1	11.5	518	110	72	90	93	140	0.5
20	860	7.5	14.5	294	64	27	72	37	74	0.5
21	2,040	7.3	16.5	183	120	60	160	110	420	0.2
22	1,240	7.6	15.5	308	67	25	140	73	160	0.7
23	1,420	7.6	15.0	227	58	25	160	31	240	0.2
24	1,440	7.6	15.5	485	26	70	140	66	110	0.9
25	4,680	7.7	15.5	229	81	52	720	86	1,300	0.4
26	49,000	[1]6.3	42.5	342	820	320	10,000	94	19,000	1.0
27	350	7.5	14.5	133	32	14	14	20	10	0.1
28	640	[1]8.5	16.5	308	2.1	0.8	150	2.0	15	0.7
29	500	7.2	15.0	201	50	21	20	18	21	0.2
					East Shore Area					
30	880	7.4	16.5	268	67	52	28	160	29	0.2
31	200	7.4	15.0	74	6.5	3.9	26	9.0	7.9	0.1
32	310	7.8	10.5	132	39	12	4.0	13	4.1	0.1
33	1,770	7.7	18.5	164	90	28	180	<1.0	400	0.2
34	440	8.0	17.5	200	43	13	30	2.0	17	0.1
35	490	7.9	16.0	222	35	14	35	<1.0	16	0.2
36	560	7.6	20.0	201	65	16	19	32	23	0.1
37	425	7.7	17.5	171	52	13	15	20	16	0.1
38	560	7.5	15.0	204	67	16	18	24	22	0.1
39	130	8.3	10.5	46	15	2.6	6.7	10	4.0	<0.1

picocuries per liter; <, below detection limit; —, no State of Utah water-quality standard]

Silica, dissolved (mg/L as SiO_2)	Solids, dissolved, residue at 180 °C, (mg/L)	Nitrogen, NO_2+NO_3, total (mg/L as N)	Gross alpha, suspended (µg/L as U-nat)	Gross alpha, dissolved (µg/L as U-nat)	Gross beta, suspended (pCi/L as Cs-137)	Gross beta, dissolved (pCi/L as Cs-137)	Gross beta, suspended (pCi/L as Sr/Yt-90)	Gross beta, dissolved (pCi/L as Sr/Yt-90)	Gross alpha, suspended (pCi/L as Th-230)	Gross alpha, dissolved (pCi/L as Th-230)
—	—	—	—	—	—	—	—	—	**15**	**15**
Cache Valley										
32	1,730	<0.1	0.5	4.6	0.9	77	0.8	69	0.5	5.1
10	227	1.2	0.4	0.6	<0.4	57	<0.4	51	<0.4	0.7
43	535	8.9	0.8	1.9	<0.4	11	<0.4	8.7	0.8	2.1
17	289	4.9	<0.4	2.1	<0.4	5.2	<0.4	4.5	<0.4	2.3
16	574	<0.1	<0.4	1.8	<0.4	4.1	<0.4	3.6	<0.4	2.0
27	469	<0.1	<0.4	0.4	0.5	5.1	0.5	4.5	<0.4	0.5
28	293	1.7	<0.4	1.6	<0.4	9.9	<0.4	8.5	<0.4	1.7
20	261	0.9	<0.4	1.5	<0.4	7.4	<0.4	6.1	<0.4	1.6
7.4	174	0.4	<0.4	1.1	<0.4	3.4	<0.4	3.0	<0.4	1.2
11	187	0.3	<0.4	1.8	<0.4	3.0	<0.4	2.6	<0.4	2.0
11	229	1.2	<0.4	0.5	<0.4	2.5	<0.4	2.1	<0.4	0.5
10	276	1.4	<0.4	2.7	<0.4	2.5	<0.4	2.2	<0.4	2.9
13	304	3.8	<0.4	1.3	<0.4	3.7	<0.4	3.2	<0.4	1.4
17	355	<0.1	<0.4	1.7	<0.4	9.8	<0.4	8.7	<0.4	1.9
14	363	<0.1	1.0	1.9	6.3	9.7	5.4	8.2	1.0	2.1
Lower Bear River Area										
32	342	0.3	<0.4	2.6	<0.4	3.5	<0.4	3.3	<0.4	2.9
57	1,630	1.2	<0.4	3.7	<0.4	34	<0.4	29	<0.4	4.0
59	371	0.2	<0.4	4.2	<0.4	9.4	<0.4	8.5	<0.4	4.6
47	838	4.3	<0.4	5.0	<0.4	25	<0.4	22	<0.4	5.5
50	521	2.1	<0.4	7.8	<0.4	15	<0.4	14	<0.4	8.3
22	1,060	2.2	<0.4	8.8	0.8	19	0.9	15	<0.4	9.2
44	705	1.4	<0.4	5.4	<0.4	6.3	<0.4	5.6	<0.4	6.0
11	694	1.2	<0.4	9.8	<0.4	14	<0.4	12	<0.4	11
35	835	11.0	<0.4	6.0	<0.4	64	<0.4	56	<0.4	6.5
19	2,520	2.0	<0.4	10	<0.4	29	<0.4	26	<0.4	11
49	33,800	<0.1	<0.4	91	<0.4	270	<0.4	220	<0.4	[1]100
11	182	0.3	<0.4	1.5	<0.4	14	<0.4	12	<0.4	1.9
17	418	<0.1	<0.4	32	<0.4	15	<0.4	13	<0.4	[1]34
16	275	1.8	<0.4	2.5	<0.4	3.9	<0.4	3.3	<0.4	2.6
East Shore Area										
16	524	0.5	<0.4	6.6	0.5	19	0.5	15	<0.4	6.9
14	118	0.6	<0.4	1.1	<0.4	3.9	<0.4	3.1	<0.4	1.2
6.8	158	0.4	<0.4	2.1	0.5	3.3	0.5	2.6	<0.4	2.2
22	943	<0.1	<0.4	<0.4	<0.4	4.4	<0.4	3.9	<0.4	<0.4
18	242	<0.1	0.5	3.3	0.9	8.7	0.9	6.9	0.5	3.5
31	270	<0.1	0.9	3.3	<0.4	4.9	<0.4	3.9	0.9	3.6
12	293	0.8	<0.4	5.5	<0.4	2.1	<0.4	1.7	<0.4	5.8
15	229	0.7	<0.4	3.8	<0.4	3.4	<0.4	2.9	<0.4	4.0
13	242	1.2	<0.4	4.5	<0.4	2.8	<0.4	2.4	<0.4	4.8
9.1	76	0.3	<0.4	6.0	1.0	4.9	1.0	4.0	<0.4	6.3

Table 2. Suite A inorganic and radionuclide analyses water from wells and springs in Cache Valley and along the

Site number	Specific conductance (µS/cm)	pH (standard units)	Temperature, water (°C)	Alkalinity, lab (mg/L as $CaCO_3$)	Calcium, dissolved (mg/L as Ca)	Magnesium, dissolved (mg/L as Mg)	Sodium, dissolved (mg/L as Na)	Sulfate, dissolved (mg/L as SO_4)	Chloride, dissolved (mg/L as Cl)	Fluoride, dissolved (mg/L as F)
State ground-water quality standard:	—	6.5<pH<8.5	—	—	—	—	—	—	—	2.4
					East Shore Area—Continued					
40	490	7.7	13.0	207	61	14	18	17	15	0.1
41	145	7.5	10.5	53	17	2.9	7.0	9.0	3.9	0.1
42	285	8.1	17.0	123	28	7.6	18	3.0	4.1	0.1
43	215	7.8	14.0	76	12	6.4	20	15	9.1	0.1
44	520	7.7	16.0	174	34	7.8	59	27	30	0.2
					Salt Lake Valley					
45	4,520	6.9	18.5	322	170	53	630	<1.0	1,300	0.8
46	6,300	7.3	27.5	143	200	66	990	36	1,800	1.1
47	960	7.3	14.0	213	95	35	51	86	92	0.2
48	970	7.2	11.5	249	130	33	27	180	45	0.1
49	820	7.9	15.0	172	72	29	46	150	55	0.4
50	950	7.6	14.0	245	100	36	44	150	59	0.2
51	2,160	7.7	14.5	286	66	29	380	310	320	0.5
52	540	7.7	18.5	161	52	19	29	97	13	0.4
53	710	7.7	21.0	130	50	15	65	120	60	0.5
54	490	7.5	10.5	150	65	19	5.9	100	7.7	0.4
55	2,270	7.3	15.0	243	180	130	210	750	380	0.3
56	260	7.9	12.0	96	30	9.8	9.0	21	7.7	0.2
57	970	7.4	20.0	188	60	31	80	110	120	0.2
58	1,390	7.4	14.5	250	140	36	57	76	220	0.2
59	740	8.0	15.0	172	53	29	57	90	79	0.6
					Utah and Goshen Valleys					
60	230	7.9	13.5	105	26	10	8.0	8.0	6.8	0.2
61	470	7.7	12.0	160	52	22	6.4	61	6.5	0.2
62	370	7.6	12.5	175	47	16	6.0	12	4.1	0.1
63	330	7.9	19.0	159	29	11	23	4.0	4.7	0.3
64	495	7.8	12.0	148	39	30	16	75	18	0.5
65	570	7.6	13.0	228	63	23	17	47	11	0.2
66	560	7.2	13.0	234	70	22	13	41	11	0.1
67	480	7.8	15.0	227	52	21	15	17	9.1	0.2
68	1,340	7.7	26.0	235	76	37	130	100	210	0.6
69	660	7.6	19.0	329	53	31	35	3.0	19	0.4
70	660	7.4	11.5	277	74	27	18	29	19	0.2
71	1,090	7.9	18.0	127	56	19	110	69	150	0.3
72	2,320	7.4	12.5	259	81	48	270	100	530	0.4
73	1,960	7.4	18.0	142	160	70	120	370	310	0.1

[1]Exceeds or is lower than State of Utah ground-water quality standard.

Silica, dis-solved (mg/L as SiO_2)	Solids, dis-solved, residue at 180 °C, (mg/L)	Nitro-gen, NO_2+NO_3, total (mg/L as N)	Gross alpha, suspended (µg/L as U-nat)	Gross alpha, dis-solved (µg/L as U-nat)	Gross beta, suspended (pCi/L as Cs-137)	Gross beta, dis-solved (pCi/L as Cs-137)	Gross beta, suspended (pCi/L as Sr/Yt-90)	Gross beta, dis-solved (pCi/L as Sr/Yt-90)	Gross alpha, suspended (pCi/L as Th-230)	Gross alpha, dis-solved (pCi/L as Th-230)
—	—	—	—	—	—	—	—	—	15	15
				East Shore Area—Continued						
16	268	0.7	<0.4	3.1	<0.4	5.6	<0.4	4.4	<0.4	3.2
9.8	85	0.4	0.5	2.7	0.7	3.8	0.8	3.0	0.5	2.9
18	158	0.1	<0.4	0.8	<0.4	2.0	<0.4	1.6	<0.4	0.9
17	122	0.3	0.5	3.3	<0.4	5.3	<0.4	4.2	0.4	3.5
17	290	1.7	<0.4	3.8	<0.4	4.4	<0.4	3.5	<0.4	4.1
				Salt Lake Valley						
30	2,460	<0.1	1.9	8.5	1.3	45	1.1	40	2.1	9.0
49	3,620	<0.1	<0.4	21	<0.4	27	<0.4	24	<0.4	[1]19
20	588	1.3	<0.4	3.0	<0.4	5.1	<0.4	4.6	<0.4	3.3
15	627	0.6	<0.4	1.0	<0.4	1.3	<0.4	1.2	<0.4	1.1
22	422	<0.1	<0.4	<0.4	<0.4	6.8	<0.4	6.2	<0.4	<0.4
22	616	3.1	<0.4	3.2	<0.4	4.6	<0.4	4.2	<0.4	3.5
57	1,340	3.4	0.5	7.0	1.3	86	1.1	77	0.5	7.3
20	320	<0.1	<0.4	0.7	<0.4	2.2	<0.4	1.8	<0.4	0.8
25	416	<0.1	<0.4	1.0	0.6	3.7	0.6	3.2	<0.4	1.1
6.9	296	0.2	<0.4	2.5	<0.4	2.5	<0.4	2.0	<0.4	2.7
43	2,070	5.6	<0.4	8.5	<0.4	8.5	<0.4	7.7	<0.4	9.3
11	140	0.8	<0.4	2.2	0.7	3.4	0.7	2.7	<0.4	2.4
34	550	0.2	6.7	6.9	0.7	10	0.7	9.3	6.6	7.6
49	819	1.8	<0.4	11	1.2	14	1.1	13	<0.4	12
26	491	2.4	0.5	4.5	0.9	8.8	0.7	7.5	0.6	4.7
				Utah and Goshen Valleys						
11	132	<0.1	<0.4	1.6	0.8	1.5	0.6	1.2	<0.4	1.7
11	262	0.8	<0.4	2.1	<0.4	2.7	<0.4	2.2	<0.4	2.3
7.4	196	0.9	<0.4	2.8	0.6	3.1	0.6	2.5	<0.4	3.0
19	189	<0.1	<0.4	1.0	<0.4	1.4	<0.4	1.1	<0.4	1.1
8.5	283	1.6	<0.4	1.9	1.2	2.8	1.2	2.2	<0.4	2.1
19	317	<0.1	<0.4	1.1	<0.4	3.6	<0.4	3.1	<0.4	1.2
11	319	0.8	<0.4	2.2	0.6	<0.4	0.6	<0.4	<0.4	2.4
26	281	<0.1	<0.4	<0.4	<0.4	3.4	<0.4	2.7	<0.4	<0.4
20	767	2.0	<0.4	4.3	<0.4	16	<0.4	13	<0.4	4.7
30	367	<0.1	<0.4	1.5	<0.4	7.6	<0.4	6.5	<0.4	1.7
19	356	3.0	<0.4	1.9	<0.4	6.5	<0.4	5.1	<0.4	2.1
59	637	17.0	<0.4	<0.4	<0.4	12	<0.4	11	<0.4	<0.4
66	1,190	<0.1	<0.4	6.2	<0.4	49	<0.4	38	<0.4	6.9
61	1,320	17.0	<0.4	6.9	<0.4	17	<0.4	16	<0.4	7.7

Table 3. Suite A trace-element and metal analyses of water from wells and springs in Cache Valley and along the

[mg/L, micrograms per liter; <, below detection limit]

Site number	Barium, dissolved (µg/L as Ba)	Beryllium, dissolved (µg/L as Be)	Cadmium dissolved (µg/L as Cd)	Chromium, dissolved (µg/L as Cr)	Cobalt, dissolved (µg/L as Co)	Copper, dissolved (µg/L as Cu)	Iron, dissolved (µg/L as Fe)	Lead, dissolved (µg/L as Pb)
State ground-water quality standard:	**1,000**		**10**	**50**		**1,000**		**50**
				Cache Valley				
1	140	<2	<3	<20	<9	<30	2,200	<30
2	56	<0.5	<1	<5	<3	<10	5	<10
3	160	<0.5	<1	<1	<3	90	7	<10
4	98	<0.5	<1	<2	<3	<10	6	<10
5	270	<0.5	<1	<5	<3	<10	1,000	<10
6	350	<0.5	<1	<5	<3	<10	670	10
7	150	<0.5	<1	<5	<3	<10	7	<10
8	110	<0.5	<1	<5	<3	<10	8	<10
9	37	<0.5	1	<5	<3	<10	7	<10
10	56	<0.5	1	<5	<3	<10	9	<10
11	120	<0.5	<1	<3	<3	<10	7	<10
12	59	<0.5	<1	<2	<3	<10	10	10
13	170	<0.5	<1	<5	<3	<10	6	<10
14	200	<0.5	1	<5	<3	<10	940	<10
15	190	<0.5	1	<2	<3	<10	2,600	<10
				Lower Bear River Area				
16	79	<0.5	<1	<5	<3	<10	6	<10
17	180	<2	<3	<1	<9	<30	34	<30
18	110	<0.5	<1	<5	<3	<10	210	<10
19	100	<0.5	2	<5	<3	20	11	<10
20	100	<0.5	<1	<1	<3	<10	8	<10
21	84	<0.5	1	<5	<3	<10	8	<10
22	46	<0.5	<1	<5	<3	<10	13	<10
23	81	<0.5	1	<5	<3	<10	<3	<10
24	4	<0.5	<1	<2	<3	30	15	<10
25	81	<0.5	5	<5	<3	<10	9	<10
26	[1]4,500	<13	[1]63	[1]130	<80	<250	3,000	[1]<250
27	120	<0.5	<1	<5	<3	<10	48	<10
28	10	<0.5	<1	<2	<3	<10	410	<10
29	26	<0.5	<1	<1	<3	10	13	<10

Lithium, dissolved (µg/L as Li)	Manganese, dissolved (µg/L as Mn)	Molybdenum, dissolved (µg/L as Mo)	Nickel, dissolved (µg/L as Ni)	Silver, dissolved (µg/L as Ag)	Strontium, dissolved (µg/L as Sr)	Vanadium, dissolved (µg/L as V)	Zinc, dissolved (µg/L as Zn)
	50			50			5,000
			Cache Valley				
500	[1]130	<30	<30	<3.0	3,000	<18	<9
7	<1	10	<10	<1.0	140	<6	28
43	2	<10	10	<1.0	520	<6	9
27	<1	<10	<10	<1.0	500	<6	10
32	[1]64	10	<10	<1.0	540	<6	600
79	[1]94	<10	<10	<1.0	490	<6	4
47	<1	<10	<10	<1.0	1,500	<6	5
29	<1	10	<10	<1.0	620	<6	<3
7	<1	<10	<10	<1.0	110	<6	12
12	4	<10	<10	<1.0	210	<6	5
10	2	<10	<10	<1.0	220	<6	7
11	15	<10	<10	<1.0	200	<6	10
16	<1	<10	<10	<1.0	190	<6	38
25	[1]140	<10	<10	<1.0	210	<6	11
19	[1]170	<10	<10	<1.0	320	<6	10
			Lower Bear River Area				
29	<1	<10	<10	<1.0	250	<6	11
150	13	<30	<20	<1.0	880	<18	<9
46	29	<10	<10	<1.0	440	<6	29
120	8	<10	<10	1.0	1,100	9	32
66	<1	10	<10	<1.0	410	<6	45
62	<1	<10	<10	<1.0	2,600	<6	12
77	1	20	<10	<1.0	700	29	37
88	<1	<10	<10	<1.0	520	<6	5
170	7	10	<10	<1.0	46	<6	16
270	<1	<10	<10	2.0	2,000	<6	9
4,900	[1]110	<250	<250	28	25,000	<150	160
19	16	<10	<10	<1.0	130	<6	9
39	14	<10	<10	<1.0	9	13	6
25	<1	<10	<10	<1.0	320	<6	13

Table 3. Suite A trace-element and metal analyses of water from wells and springs in Cache Valley and along the

Site number	Barium, dissolved (µg/L as Ba)	Beryllium, dissolved (µg/L as Be)	Cadmium dissolved (µg/L as Cd)	Chromium, dissolved (µg/L as Cr)	Cobalt, dissolved (µg/L as Co)	Copper, dissolved (µg/L as Cu)	Iron, dissolved (µg/L as Fe)	Lead, dissolved (µg/L as Pb)
State ground-water quality standard:	1,000		10	50		1,000		50
				East Shore Area				
30	24	<0.5	<1	<5	<3	<10	29	10
31	28	<0.5	<1	<5	<3	<10	8	10
32	120	<0.5	<1	<5	<3	<10	13	<10
33	570	<0.5	<1	<1	<3	<10	790	<10
34	560	<0.5	<1	<5	<3	<10	210	<10
35	370	<0.5	<1	<5	<3	<10	250	<10
36	190	<0.5	1	<1	<3	<10	7	<10
37	200	<0.5	<1	<1	<3	<10	11	<10
38	220	<0.5	<1	<2	<3	<10	9	<10
39	<2	<0.5	<1	<5	<3	<10	21	<10
40	240	<0.5	<1	<5	<3	<10	7	<10
41	6	<0.5	2	<5	<3	<10	91	<10
42	230	<0.5	<1	<1	<3	<10	390	20
43	14	<0.5	2	<5	<3	<10	10	10
44	31	<0.5	<1	<5	<3	<10	15	10
				Salt Lake Valley				
45	[1]1,700	<2	<3	<20	<3	<30	250	<30
46	660	<3	<5	<1	<20	<50	560	<50
47	91	<0.5	2	<4	<3	<10	6	10
48	34	<0.5	<1	<2	<3	<10	4	<10
49	140	<0.5	<1	<1	<3	<10	290	<10
50	26	<0.5	<1	<2	<3	<10	6	20
51	81	<2	<3	<2	<3	<30	140	<30
52	32	<0.5	1	<2	<3	<10	69	<10
53	33	<0.5	<1	<1	<3	<10	21	10
54	82	<0.5	<1	<1	<3	<10	7	<10
55	21	<0.5	2	<5	<3	<10	13	<10
56	59	<0.5	<1	<1	<3	<10	<3	<10
57	39	<0.5	<1	<2	<3	<10	8	10
58	200	<0.5	2	<4	<3	<10	7	<10
59	54	<0.5	<1	<5	<3	<10	19	<10

Lithium dis-solved (µg/L as Li)	Manga-nese, dis-solved (µg/L as Mn)	Molyb-denum, dis-solved (µg/L as Mo)	Nickel, dis-solved (µg/L as Ni)	Silver, dis-solved (µg/L as Ag)	Stron-tium, dis-solved (µg/L as Sr)	Vana-dium, dis-solved (µg/L as V)	Zinc, dis-solved (µg/L as Zn)
	50			**50**			**5,000**
			East Shore Area				
39	3	<10	<10	2.0	360	<6	13
14	<1	<10	<10	1.0	44	<6	<3
5	<1	<10	<10	1.0	120	<6	29
230	[1]240	<10	<10	<1.0	1,000	<6	9
17	[1]90	<10	<10	<1.0	210	<6	5
42	[1]130	<10	<10	1.0	230	<6	<3
12	<1	<10	<10	<1.0	260	<6	29
10	<1	<10	<10	<1.0	240	<6	8
10	<1	<10	<10	<1.0	260	<6	18
<4	2	<10	<10	<1.0	33	<6	9
9	<1	<10	<10	<1.0	180	<6	<3
<4	15	<10	<10	<1.0	41	<6	4
6	[1]79	<10	<10	<1.0	150	<6	4
<4	2	<10	<10	<1.0	50	<6	6
10	10	<10	<10	<1.0	130	<6	<3
			Salt Lake Valley				
670	[1]290	<30	<30	<3.0	5,300	<18	11
420	[1]140	<50	<50	<1.0	6,600	<50	<15
26	<1	<10	<10	<1.0	560	<6	<3
19	<1	<10	<10	<1.0	1,800	<6	3
34	[1]120	<10	<10	<1.0	1,000	<6	4
40	<1	<10	<10	<1.0	1,400	<6	11
230	<3	<30	<30	<1.0	1,300	<18	21
18	[1]82	<10	<10	<1.0	790	<6	24
27	[1]64	<10	<10	<1.0	980	<6	5
10	<1	<10	<10	<1.0	670	<6	14
280	<1	<10	<10	<1.0	1,300	8	21
<4	<1	<10	<10	<1.0	180	<6	7
72	<1	<10	<10	<1.0	890	<6	8
38	<1	10	<10	<1.0	770	8	10
55	1	<10	<10	<1.0	660	<6	12

Table 3. Suite A trace-element and metal analyses of water from wells and springs in Cache Valley and along the

Site number	Barium, dissolved (µg/L as Ba)	Beryllium, dissolved (µg/L as Be)	Cadmium dissolved (µg/L as Cd)	Chromium, dissolved (µg/L as Cr)	Cobalt, dissolved (µg/L as Co)	Copper, dissolved (µg/L as Cu)	Iron, dissolved (µg/L as Fe)	Lead, dissolved (µg/L as Pb)
State ground-water quality standard:	1,000		10	50		1,000		50
				Utah/Goshen Valleys				
60	53	<0.5	<1	<5	<3	<10	18	10
61	70	<0.5	<1	<2	<3	<10	11	<10
62	45	<0.5	<1	<5	<3	<10	6	<10
63	110	<0.5	<1	<1	<3	<10	210	<10
64	43	<0.5	<1	6	<3	<10	6	<10
65	150	<0.5	<1	<1	<3	<10	780	<10
66	96	<0.5	<1	<5	<3	<10	6	<10
67	190	<0.5	<1	<5	<3	<10	210	20
67	69	0.5	<1	<5	<3	<10	7	<10
69	690	<0.5	<1	<1	<3	<10	650	<10
70	110	<0.5	<1	<5	<3	<10	8	<10
71	71	<0.5	1	<3	<3	<10	5	<10
72	39	<0.5	2	<5	<3	<10	75	20
73	43	<0.5	<1	<5	<3	<10	7	<10

[1] Exceeds State of Utah ground-water quality standard.

Carbamate and organophosphorus insecticides (table 6) have had increased use over the past 20 years. This is a result of their lack of persistence and lower toxicity to mammals compared to organochlorine insecticides, and their effectiveness against insects not specifically controlled by organochlorine insecticides (Smith, 1988).

Age Dating of Ground Water

The age of ground water is defined as the time during which ground water has been isolated from the atmosphere; generally the time since the water entered the ground-water system as recharge. Age dating of ground water commonly is done using the radionuclide tritium. Tritium occurs naturally in small amounts in the upper atmosphere and has been released into the lower atmosphere by atmospheric testing of nuclear weapons, which began in 1953 and ended in the early 1960s. Tritium has a half life of 12.3 years and thus is useful for dating water less than 50 years old. Tritium concentrations in water were analyzed in this study, but the detection limits were set to address State of Utah ground-water quality standards, not to date water. However, some general qualitative conclusions about the age of ground water and the type of recharge area can be drawn from the tritium data.

Tritium concentrations listed in table 4 range from less than the 26-pCi/L (about 8 TU) detection limit to 140 pCi/L (44 TU). High tritium concentrations (greater than 10 TU) are expected in ground water from recharge areas because the water has recently recharged the aquifer (post-nuclear testing), whereas low tritium concentrations (less than 10 TU) are expected in ground water from discharge areas where water entered the ground-water system prior to nuclear testing. Secondary recharge areas probably contain a mix of waters, and tritium concentrations are difficult to interpret.

Tritium concentrations for 14 of the 20 sites in primary recharge and discharge areas, excluding shallow wells (less than 100 ft deep) and springs, have the expected tritium concentrations of greater than or less

Wasatch Front, Utah—Continued

Lithium dissolved (µg/L as Li)	Manganese, dissolved (µg/L as Mn)	Molybdenum, dissolved (µg/L as Mo)	Nickel, dissolved (µg/L as Ni)	Silver, dissolved (µg/L as Ag)	Strontium, dissolved (µg/L as Sr)	Vanadium, dissolved (µg/L as V)	Zinc, dissolved (µg/L as Zn)
	50			50			5,000
			Utah/Goshen Valleys				
5	16	<10	10	2.0	240	<6	21
7	<1	<10	<10	<1.0	470	<6	9
5	<1	<10	<10	<1.0	200	<6	4
10	18	<10	<10	<1.0	430	<6	10
9	2	<10	<10	<1.0	210	<6	12
18	[1]75	<10	<10	<1.0	630	<6	4
11	<1	<10	<10	<1.0	260	<6	5
25	[1]110	<10	10	<1.0	440	<6	6
240	<1	<10	<10	2.0	1,000	<6	22
28	[1]53	<10	<10	<1.0	420	<6	4
10	<1	<10	<10	<1.0	240	<6	17
77	<1	<10	<10	<1.0	570	15	<3
310	[1]71	<10	<10	2.0	1,600	16	<3
81	<1	<10	<10	1.0	1,900	12	15

than 10 TU, respectively. The remaining six tritium concentrations were outside the expected values. Unexpectedly high tritium concentrations in ground water from five wells in discharge areas might be the result of relatively fast ground-water movement, or the flow path (point of recharge to point of discharge at the well) may be relatively short.

An unexpected, low tritium concentration in ground water from one well in a primary recharge area might be the result of relatively slow ground-water movement, or a relatively long flow path, or small quantities of ground-water recharge. In addition, atmospheric concentrations of tritium are decreasing because of radioactive decay, and low tritium concentrations in ground water in a primary recharge area could be caused by the water being recharged recently. Recent studies indicate that young water has extremely low tritium concentrations, similar to old water (M.J. Hendry, National Water Well Association, oral commun., 1990). Tritium concentrations generally confirm the mapping of sites as primary recharge areas and discharge areas.

SUMMARY

The U.S. Geological Survey (USGS), in cooperation with the Utah Department of Environmental Quality (DEQ), Division of Water Quality, conducted a study to identify recharge areas and determine the general quality of water in the principal aquifers in basin-fill deposits, primarily along the Wasatch Front, Utah. The principal aquifers and confining layers, ground-water flow directions, recharge and discharge areas, dissolved-solids concentrations, and ground-water quality are described for Cache Valley, the lower Bear River area, the East Shore area, Salt Lake Valley, and Utah and Goshen Valleys to provide information for implementing ground-water quality regulations and a ground-water protection plan.

The principal aquifer in Cache Valley is confined throughout much of the valley and is composed of fine sand to coarse well-sorted gravel. Ground-water flow directions are generally from the mountainous areas toward the center of the valley. Primary and secondary

Table 4. Suite B trace-element and radionuclide analyses of water from wells and springs in Cache Valley and along the Wasatch Front, Utah

[µg/L, micrograms per liter; pCi/L, picocuries per liter; TU, tritium units; <, below detection limit; —, no data]

Site number	Arsenic, dissolved (µg/L as As)	Mercury, dissolved (µg/L as Hg)	Selenium, dissolved (µg/L as Se)	Radium 226, dissolved radon method (pCi/L)	Radium 228, dissolved (pCi/L as Ra-228)	Sum of Ra-226 and Ra-228, dissolved (pCi/L)	Strontium 90, dissolved (pCi/L)	Tritium, total (pCi/L)	Tritium, total (TU)
State ground-water quality standard:	50	2	10	—	—	5	[1]8	[2]20,000	6,250
				Cache Valley					
3	10	<0.1	<1	0.05	3.6	3.65	<0.5	140	44
4	1	<0.1	<1	0.11	<1.0	<1.11	<0.5	120	38
11	1	<0.1	<1	0.12	<1.0	<1.12	<0.5	<26	<8.1
12	1	<0.1	<1	0.15	<1.0	<1.15	<0.5	70	22
15	10	<0.1	<1	0.34	—	—	<0.5	<26	8.1
				Lower Bear River Area					
17	9	<0.1	5	0.26	<1.0	<1.26	<0.5	<26	<8.1
20	9	<0.1	<1	0.09	1.0	1.09	<0.5	29	9.1
24	7	<0.1	<1	0.06	<1.0	<1.06	5.9	58	18
28	<1	<0.1	<1	0.14	1.3	1.44	<0.5	<26	<8.1
29	<1	<0.1	<1	0.12	<1.0	<1.12	<0.5	57	18
				East Shore Area					
33	14	<0.1	<1	0.79	1.1	1.89	<0.5	<26	<8.1
36	<1	0.1	<1	0.19	<1.0	<1.19	<0.5	<26	<8.1
37	2	<0.1	<1	0.16	<1.0	<1.16	<0.5	<26	<8.1
38	1	<0.1	<1	0.19	<1.0	<1.19	<0.5	130	41
42	4	<0.1	<1	0.15	<1.0	<1.15	<0.5	<26	<8.1
				Salt Lake Valley					
46	<1	0.6	<1	2.9	1.4	4.3	—	<26	<8.1
47	1	<0.1	1	0.13	<1.0	<1.13	<0.5	<26	<8.1
48	<1	<0.1	<1	0.12	<1.0	<1.12	<0.5	93	29
49	8	<0.1	<1	0.20	<1.0	<1.20	<0.5	29	9.1
50	<1	<0.1	1	0.07	<1.0	<1.07	<0.5	35	11
51	12	<0.1	1	0.03	<1.0	<1.03	<0.5	100	31
52	2	<0.1	<1	0.11	<1.0	<1.11	<0.5	<26	<8.1
53	5	<0.1	<1	0.08	<1.0	<1.08	<0.5	<26	<8.1
54	<1	<0.1	<1	0.51	<1.0	<1.51	<0.5	<26	<8.1
55	11	<0.1	[3]18	0.13	<1.0	<1.13	<0.5	<26	<8.1
56	1	<0.1	<1	0.09	<1.0	<1.09	<0.5	90	28
57	4	<0.1	1	0.12	<1.0	<1.12	<0.5	<26	<8.1
58	3	<0.1	2	0.16	<1.0	<1.16	<0.5	<26	<8.1
				Utah and Goshen Valleys					
61	<1	<0.1	1	0.09	<1.0	<1.09	<0.5	140	44
63	6	<0.1	<1	0.12	<1.0	<1.12	<0.5	<26	<8.1
65	2	<0.1	<1	0.10	<1.0	<1.10	<0.5	86	27
69	8	<0.1	<1	0.25	<1.0	<1.25	<0.5	<26	<8.1
71	16	<0.1	2	0.14	<1.0	<1.14	<0.5	80	25

[1]Bone marrow exposure.

[2]Total body exposure.

[3]Exceeds State of Utah ground-water quality standard.

Table 5. Suite B organic compounds, detection limits, and sampling sites where detection limits were exceeded in Cache Valley and along the Wasatch Front, Utah

[µg/L, micrograms per liter]

Organic chemical	Cache Valley, lower Bear River area, East Shore area, and Utah and Goshen Valleys[1] detection limit (µg/L)	Salt Lake Valley detection limit (µg/L)	State ground-water quality standard (µg/L)	Concentration (meets or exceeds detection limit) (µg/L)	Site number
	Industrial Organic Compounds: Purgeable				
Benzene, total	3.0	0.2	5		
Carbon tetrachloride, total	3.0	0.2	5		
Chlorobenzene, total	3.0	0.2			
Chloroethane, total	3.0	0.2			
2-Chloroethyl vinyl ether	3.0	0.2			
Chloromethane, total	3.0	0.2			
1,2-Dichlorobenzene, total	3.0	0.2			
1,3-Dichlorobenzene, total	3.0	0.2			
1,4-Dichlorobenzene, total	3.0	0.2	75		
Dichlorodifluoromethane, total	3.0	0.2			
1,1-Dichloroethane, total	3.0	0.2			
1,2-Dichloroethane, total	3.0	0.2	5		
1,1-Dichlorethylene, total	3.0	0.2	7		
1,2-trans-Dichloroethylene	3.0	0.2			
1,2-Dichloropropane, total	3.0	0.2			
1,3-Dichloropropene, total	3.0	0.2			
Ethylbenzene, total	3.0	0.2			
Methylbromide, total	3.0	0.2			
Methylene chloride, total	3.0	0.2		0.2	56
1,1,2,2-Tetrachloroethane, total	3.0	0.2			
Tetrachloroethylene, total	3.0	0.2		5.4	50
Toluene, total	3.0	0.2		0.2	58
1,1,1-Trichloroethane, total	3.0	0.2	200	0.3	56
1,1,2-Trichloroethane, total	3.0	0.2			
Trichloroethylene, total	3.0	0.2	5		
Trichlorofluoromethane, total	3.0	0.2			
Vinyl chloride, total	1.0	0.2	2		
1,2-Dibromoethane, total	3.0	0.2			
Cis-1,3-Dichloropropene	3.0	0.2			
Trans-1,3-Dichloropropene	3.0	0.2			
Styrene	3.0	0.2			
Xylene, total	3.0	0.2			
	Total Trihalomethanes (TTHM)[2]				
Bromoform, total	3.0	0.2	[2]100		
Bromodichloromethane, total	3.0	0.2	[2]100	10	36
				0.2	47
Chloroform, total	3.0	0.2	[2]100	19	36
				1.3	47
				0.4	50
Dibromochloromethane, total	3.0	0.2	[2]100	4.8	36
	Chlorophenoxy Acid Herbicides				
2,4-D, total (water)	0.01		100		
2,4-DP, total (water)	0.01				
Silvex, total (water)	0.01		10		
2,4,5-T total (water)	0.01				

Table 5. Suite B organic compounds, detection limits, and sampling sites where detection limits were exceeded in Cache Valley and along the Wasatch Front, Utah—Continued

Organic chemical	Cache Valley, lower Bear River area, East Shore area, and Utah and Goshen Valleys[1] detection limit (µg/L)	Salt Lake Valley detection limit (µg/L)	State ground-water quality standard (µg/L)	Concentration (meets or exceeds detection limit) (µg/L)	Site number
Organochlorine Insecticides with Gross Polychlorinated Biphenyls and Polychlorinated Naphthalenes					
Aldrin, total (water)	0.01				
Chlordane, total (water)[3]	0.1				
DDD, total (water)	0.01				
DDE, total (water)	0.01				
DDT, total (water)[3]	0.01				
Dieldrin, total (water)[3]	0.01				
Endosulfan I total[3]	0.01			0.03	71
Endrin, total (water)[3]	0.01		0.2	0.04	71
Gross polychlorinated biphenyls total (water)	0.1				
Gross polychlorinated naphthalenes total (water)[3]	0.10				
Heptachlor total (water)	0.01				
Heptachlor epoxide, total (water)[3]	0.01				
Lindane, total (water)[3]	0.01		4		
Methoxychlor total (water)[3]	0.01		100		
Mirex, total	0.01				
Perthane, total[3]	0.1				
Toxaphene, total (water)[3]	1		5		

[1]Site 71 has detection limits of 0.2 µg/L for all of the purgable organic compounds.
[2]The State of Utah ground-water quality standard is the sum of the TTHMs and cannot exceed 100 µg/L.
[3]No data for sites 57 and 58 due to laboratory error.

recharge areas are adjacent to and generally coincide with the topographic break in slope between mountains and valleys. Dissolved-solids concentrations in ground water in Cache Valley are generally less than 500 mg/L.

The aquifer materials in the lower Bear River area vary from silt, sand, and gravel to fractured consolidated rock. The direction of ground-water flow is generally from the mountainous areas to the Malad and Bear Rivers and then southward toward Great Salt Lake. The primary recharge areas in the lower Bear River area are along the mountain fronts and include basin-fill deposits and consolidated rock. Dissolved-solids concentrations range from less than 500 to as much as 14,000 mg/L.

The principal aquifer in the East Shore area is composed of multiple confined aquifers and their unconfined laterally upgradient extensions in unconsolidated basin-fill deposits. Ground water generally flows through the principal aquifers from east to west toward Great Salt Lake. The primary recharge area is along the base of the Wasatch Range and extends to the west at the mouths of the Weber and Ogden Rivers and just north of Farmington. Dissolved-solids concentrations range from less than 500 mg/L to 2,000 mg/L.

The principal aquifer in Salt Lake Valley is composed of coarse-grained clastic sediments eroded from the Wasatch Range and Oquirrh Mountains. Ground water flows from the mountain fronts toward the Jordan River and Great Salt Lake. Recharge areas in Salt Lake Valley are at the base of the Wasatch Range on the east side of the valley and at the base of the Oquirrh Mountains on the west side of the valley. Dissolved-solids concentrations in Salt Lake Valley range from less than 500 to more than 10,000 mg/L. They are smallest in the primary recharge areas along the Wasatch Range and largest in discharge areas near Great Salt Lake.

The principal aquifer in Utah and Goshen Valleys consists of multiple confined aquifers in the basin-fill deposits and their lateral unconfined equivalents. Ground-water flow directions are generally toward Utah Lake. The primary recharge areas in Utah and Goshen Valleys are limited to the perimeter of the valleys along the mountain fronts. Dissolved-solids concentrations in Utah and Goshen Valleys range from about 500 mg/L to greater than 1,000 mg/L.

Table 6. Suite C organic compounds and detection limits in Cache Valley and along the Wasatch Front, Utah

[μg/L, micrograms per liter]

Organic compound	Detection limit (μg/L)	Organic compound	Detection limit (μg/L)
Industrial Organic Compounds: Methylene Chloride Extractable (total)[1]			
Parachlorometa cresol	30	Chrysene	10
2-Chlorophenol	5	Dibenzanthracene	10
2,4-Dichlorophenol	5	Di-n-butyl phthalate	5
2,4,6-Trichlorophenol	20	Diethyl phthalate	5
2,4-Dimethylphenol	5	Dimethyl phthalate	5
Dinitromethylphenol	30	2,4-Dinitrotoluene	5
2,4-Dinitrophenol	20	2,6-Dinitrotoluene	5
2-Nitrophenol	5	Di-n-octylphthalate	10
4-Nitrophenol	30	2-Ethlyhexyl phthalate	5
Pentachlorophenol	30	Fluorene	5
Phenol	5	Fluoranthene	5
Acenaphthene	5	Hexachlorobenzene	5
Acenaphthylene	5	Hexachlorobutadiene	5
Anthracene	5	Hexachlorocyclopentadiene	5
Benzo(a)anthracene	10	Hexachloroethane	5
Benzo(b)fluoranthene	10	Indeno(1,2,3)pyrene	10
Benzo(k)fluoranthene	10	Isophorone	5
Benzo(a)pyrene	10	Naphthalene	5
Benzo(ghi)perylene	10	Nitrobenzene	5
Butyl benzyl phthalate	5	Nitrosodimethlyamine	5
2-Chloroethoxymethane	5	N-nitrosodiphenylamine	5
2-Chlorethyl ether	5	N-nitrosodi-n-propylamine	5
2-Chloroisopropyl ether	5	Phenanthrene	5
4-Bromophenyl phenyl ether	5	Pyrene	5
2-Chloronaphthalene	5	1,2,4-Trichlorobenzene	5
4-Chlorophenyl phenyl ether	5		
Triazine (and other nitrogen-containing) Herbicides with Dicamba and Picloram			
Prometryne, total	0.1	Ametryne, total	0.1
Atrazine, total	0.1	Alachlor	0.1
Prometone, total	0.1	Trifluralin	0.1
Simazine, total	0.1	Metribuzin	0.1
Simetryn, total	0.1	Metolachlor	0.1
Propazine, total	0.1	Picloram, total	0.01
Cyanazine, total	0.1	Dicamba, total	0.01
Carbamate Insecticides			
Carbaryl[1]	0.5	Aldicarb	0.5
Propham, total[1]	0.5	Aldicarb sulfoxide	0.5
Methomyl, total[1]	0.5	Aldicarb sulfone	0.5
Oxamyl	0.5	1-Naphthol	0.5
Carbofuran	0.5	3-Hydroxycarbofuran	0.5
Organophosphorus Insecticides			
Diazinon, total (water)	0.01	Methyltrithion, total	0.01
Ethion, total (water)	0.01	Parathion, total	0.01
Malathion, total (water)	0.01	Trithion, total	0.01
Methylparathion total	0.01		

[1] Water from Site 71 in Utah and Goshen Valleys was analyzed for the methylene chloride extractable compounds listed in table 6, as well as for carbaryl, propham, and methomyl, and all were below detection limits.

Water-quality samples were collected from 13 to 15 wells and springs in each subarea to document the background water quality in the principal aquifer. Of a total of 73 samples collected, concentration of inorganic constituents in five samples exceeded State of Utah water-quality standards. None of the samples contained concentrations of organic compounds that exceeded State standards.

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SUPPLEMENTAL INFORMATION

Recharge-Project Data Base

The well records in this section are a subset (29 percent) of all well records that were compiled into a recharge-project data base and used in mapping recharge areas. The recharge-project data base contains additional wells that were used to define the primary and secondary recharge areas and discharge areas, but are not included in tables 7 to 11 published here. Wells were selected from the recharge-project data base and their records included in tables 7 to 11 because of their utility in mapping the boundary between recharge areas. The entire recharge-project data base is available upon request at the U.S. Geological Survey, Water Resources Division, Salt Lake City, Utah.

Many of the wells listed in the recharge project data base have not been visited by USGS personnel to verify their location. Location information has been taken from the drillers' log and occasionally from the Utah Division of Water Rights computer data base.

The USGS maintains a computerized data base, Ground-Water Site Inventory (GWSI), of water wells in the State of Utah and surrounding areas. Most of these wells have been field checked, measured, and sampled by USGS personnel. Some well records in the USGS data base do not have an available drillers' log or geophysical log, but were included in the recharge-project data base. Well records without a drillers' log were typically in discharge areas and were used in this study because water levels were more important than lithology in mapping discharge areas.

Table 7. Records of selected wells, Cache Valley, Utah

[—, no data]

Site number: See plate 1 for well location.

Local well number: See text for explanation of numbering system for hydrologic-data sites.

Altitude: In feet above sea level.

Well depth: In feet below land surface.

Recharge area: Y, primary recharge area; 1, secondary recharge area—well completed in principal aquifer; 2, secondary recharge area—well completed in shallow unconfined aquifer; 3, secondary recharge area—one of a pair of wells completed in the shallow unconfined or principal aquifer used to determine vertical hydraulic gradients; N, discharge area.

Water level: In feet below land surface; values above (+) land surface; F, water level above land surface and well flowing.

Water-level source: L, drillers' log; G, U.S. Geological Survey data base.

Top of first confining layer: In feet below land surface.

Bottom of first confining layer: In feet below land surface.

Log types: e, indicates log was examined as part of this study; D, drillers' log; J, gamma log; K, fluid conductivity log; T, fluid temperature log; E, electric log; C, caliper log; Z, other logs.

Depth to consolidated rock: In feet below land surface; N, not encountered; Y, encountered, depth uncertain.

Top of perforated interval: In feet below land surface.

Bottom of perforated interval: In feet below land surface; MI, multiple perforated intervals within indicated interval.

Site number	Local well number	Year well drilled	Altitude of land surface (feet)	Well depth (feet)	Recharge area	Water level (feet)	Water-level source	Water-level date	Top of first confining layer	Bottom of first confining layer	Log types	Depth to consolidated rock (feet)	Top of perforated interval	Bottom of perforated interval
1	(A-9-1)9adb-1	1984	4,940	154	1	21	L	08-23-84	0	25	De	—	118	126
2	(A-9-1)3bca-1	1950	4,906	180	N	28	G	10-24-68	4	54	De	N	—	—
3	(A-9-1)10add-2	1934	5,010	595	N	—	—	—	14	250	De	N	—	—
4	(A-9-1)11ddc-1	1985	5,080	121	N	+39	L	11-05-85	0	77	De	N	113	119
5	(A-9-1)14cbb-1	1979	5,065	142	N	12	L	12-12-79	—	—	De	N	61	138 MI
6	(A-10-1)2bcc-1	1971	4,700	248	1	148	L	10-05-71	35	119	De	N	175	240
7	(A-10-1)4daa-1	1963	4,789	472	1	291	G	03-02-67	55	265	De	N	—	—
8	(A-10-1)5bcd-1	1961	4,675	195	1	152	G	03-28-69	50	120	De	N	—	—
9	(A-10-1)7bcc	1986	4,718	100	Y	18	L	09-01-86	—	—	D	—	50	80
10	(A-10-1)9aad-1	1964	4,805	385	N	2	L	07-11-64	—	—	De	—	336	368
11	(A-10-1)10bcc	1974	4,797	323	1	293	L	07-24-74	80	162	De	N	304	323
12	(A-10-1)15cac-1	1987	4,920	408	1	188	L	06-17-87	—	—	De	N	181	408
13	(A-10-1)18cdc	1978	4,858	375	Y	5	L	02-25-78	—	—	De	N	156	375
14	(A-10-1)20ddd	1978	4,740	220	1	60	L	04-00-78	36	120	De	N	125	135
15	(A-10-1)22dac	1989	5,152	220	1	112	L	04-11-89	63	82	De	N	127	192 MI
16	(A-10-1)26adb	1977	5,217	220	Y	100	L	11-30-77	—	—	De	N	110	147
17	(A-10-1)27dab	1980	5,160	192	Y	35	L	09-04-80	—	—	De	N	92	114
18	(A-10-1)27bca	1979	4,920	220	1	55	L	07-05-79	0	97	De	N	97	209 MI
19	(A-10-1)33bbd-2	1971	4,800	245	N	+2	L	03-31-71	18	92	De	N	210	215
20	(A-10-1)34bac-1	1963	4,993	402	1	50	G	08-14-63	0	63	De	—	—	—
21	(A-11-1)2caa-1	1977	4,630	191	Y	155	L	04-12-77	—	—	De	N	—	—
22	(A-11-1)2bcb-1	1963	4,620	301	1	123	G	10-24-67	15	141	De	N	—	—
23	(A-11-1)4daa-2	1962	4,500	310	N	12	G	11-01-68	10	90	DeJKTe	N	—	—
24	(A-11-1)10cab	1977	4,527	151	N	35	L	05-13-77	14	30	De	N	—	—
25	(A-11-1)14dad	1979	5,250	520	Y	350	L	07-15-78	—	—	De	502	320	460
26	(A-11-1)14dbb	1980	5,010	77	1	F	L	04-22-80	0	60	De	N	55	77
27	(A-11-1)16aaa-1	1965	4,489	200	N	+5	G	03-28-69	—	—	D	N	—	—
28	(A-11-1)20ada-1	1963	4,522	378	N	23	G	09-20-67	17	85	De	N	—	—
29	(A-11-1)23ccb-2	1977	4,460	293	1	166	L	01-15-77	23	48	De	N	185	290
30	(A-11-1)23ccd-1	1981	4,745	296	Y	239	L	04-06-81	—	—	De	N	170	202 MI

Table 7. Records of selected wells, Cache Valley, Utah—Continued

Site number	Local well number	Year well drilled	Altitude of land surface (feet)	Well depth (feet)	Re-charge area	Water level (feet)	Water-level source	Water-level date	Top of first confin-ing layer	Bottom of first confin-ing layer	Log types	Depth to consol-idated rock (feet)	Top of perfor-ated interval	Bottom of perfor-ated interval	
31	(A-11-1)27aca-1	1981	4,635	234	1	150	L	01-06-80	10	40	De	N	175	180	
32	(A-11-1)29bbb-1	1975	4,499	157	1	2	G	03-03-75	0	31	De	N	66	120	
33	(A-11-1)30bbc-1		4,490	200	N	1	G	11-08-67	—	—	—	—	—	—	
34	(A-11-1)32dcb-1	1968	4,610	355	N	109	G	04-01-67	35	89	DeJe	N	170	340	MI
35	(A-11-1)34dca-1	1968	4,655	186	1	158	G	08-06-68	32	69	DJe	N	—	—	
36	(A-11-1)35cab-1	1971	4,900	189	1	144	L	04-20-71	40	85	De	N	—	—	
37	(A-12-1)2bda-2	1988	4,740	104	Y	38	L	02-11-88	38	—	De	N	42	45	
38	(A-12-1)3dbd-1	1970	4,520	275	N	17	L	11-10-70	1	41	De	N	95	250	
39	(A-12-1)10acb-1		4,500	—	N	+3	G	06-11-68	—	—	—	—	—	—	
40	(A-12-1)11dac-1	1986	4,770	364	1	278	L	12-04-86	8	39	De	N	329	355	MI
41	(A-12-1)12cbc	1985	4,882	480	Y	384	L	08-30-86	—	—	De	190	474	480	
42	(A-12-1)14cba	1983	4,610	255	Y	90	L	07-30-83	—	—	De	70	119	199	MI
43	(A-12-1)15ddb-1	1986	4,560	124	N	11	L	09-09-86	3	31	De	N	43	119	MI
44	(A-12-1)15aca-1	1980	4,510	116	N	45	L	12-12-80	70	100	De	N	—	—	
45	(A-12-1)22ccc-2	1965	4,517	200	N	18	G	10-06-67	—	—	De	N	—	—	
46	(A-12-1)24bcc-1	1957	4,835	347	1	—	—	—	42	63	De	N	—	—	
47	(A-12-1)24adb-1	1980	5,018	105	Y	55	L	06-01-80	—	—	De	35	—	—	
48	(A-12-1)26baa-1	1961	4,665	147	1	—	—	—	54	133	DJe	N	—	—	
49	(A-12-1)27dcd-1	1962	4,625	470	N	148	G	02-28-67	—	—	D	—	—	—	
50	(A-12-1)34cca-1	1963	4,550	1,000	N	53		—	20	85	De	N	—	—	
51	(A-12-1)34dcd-1	1981	4,553	38	2	9	L	03-02-81	—	—	De	N	7	35	
52	(A-13-1)2bad	1980	—	659	N	—	L	06-01-79	10	473	De	N	473	503	
53	(A-13-1)3ccc	1966	—	305	N	+12	L	05-21-66	—	—	De	—	—	—	
54	(A-13-1)10ddb	1982	4,650	275	1	15	L	10-29-82	0	37	De	N	40	275	MI
55	(A-13-1)16bba-1	1937	4,475	132	N	+14	G	05-11-37	0	70	De	N	—	—	
56	(A-13-1)21bbb-1	1961	4,485	202	N	+7	G	09-16-68	0	32	DeJe	N	—	—	
57	(A-13-1)22bbc	1980	4,580	302	Y	104	L	07-02-80	75	0	De	N	120	302	MI
58	(A-13-1)21dcc-1	1977	4,545	158	N	52	L	02-15-77	0	18	De	N	100	158	
59	(A-13-1)27acd-1	1966	4,660	268	Y	170	L	11-01-66	—	—	De	N	150	246	
60	(A-13-1)33ccc-1	1981	4,470	215	N	+1	L	02-05-81	22	35	De	N	197	215	
61	(A-13-1)35bcd-1	1984	4,745	275	Y	220	L	06-28-84	—	—	De	110	235	255	
62	(A-14-1)2bab-1	1978	4,486	150	N	+1	L	10-16-78	2	48	De	N	137	150	
63	(A-14-1)10bcc-1	1947	4,503	200	N	25	G	-47	15	118	De	N	—	—	
64	(A-14-1)11dcc-1	1977	4,557	224	Y	94	L	12-10-77	—	—	De	N	127	224	
65	(A-14-1)14aac-1	1981	4,635	256	Y	168	L	02-26-82	—	—	De	—	200	250	
66	(A-14-1)14cbc-1	1978	4,537	195	1	6	L	08-16-78	41	93	De	N	100	195	MI
67	(A-14-1)15cdc-1	1939	4,472	106	N	+5	G	07-25-39	—	—	De	N	—	—	
68	(A-14-1)22bbc-1	1935	4,447	107	N	+26	G	09-05-67	10	95	De	N	—	—	
69	(A-14-1)22dda-1	1966	4,513	181	3	27	L	08-02-66	2	42	De	N	44	177	MI
70	(A-14-1)24baa-1	1986	4,921	385	Y	260	L	11-11-86	255	273	De	N	373	385	
71	(A-14-1)24dda-1	1979	5,185	511	1	F	L	06-20-79	67	185	De	273	273	335	
72	(A-14-1)26dad-2	1978	4,768	504	1	44	L	12-08-78	105	150	De	192	150	504	MI
73	(A-14-1)26bda-1	1958	4,605	616	1	27	G	11-01-67	—	—	JKTe	N	—	—	
74	(A-14-1)26bcb-1	1967	4,548	77	N	+6	G	06-00-67	1	53	De	N	52	63	
75	(A-14-1)27dcc-1	1981	4,525	160	N	+1	L	11-18-81	0	53	De	N	107	160	MI

Table 7. Records of selected wells, Cache Valley, Utah—Continued

Site number	Local well number	Year well drilled	Altitude of land surface (feet)	Well depth (feet)	Re-charge area	Water level (feet)	Water-level source	Water-level date	Top of first confin-ing layer	Bottom of first confin-ing layer	Log types	Depth to consol-idated rock (feet)	Top of perfor-ated interval	Bottom of perfor-ated interval	
76	(A-14-1)34cac-2	1961	4,495	220	N	+16	G	09-18-67	0	68	De	N	—	—	
77	(A-14-1)35dac-1	1977	4,890	180	Y	106	L	07-19-77	—	—	De	N	76	126	M
78	(B-10-1)1aaa-1	—	4,580	18	2	7	G	10-00-68	—	—	—	N	—	—	
79	(B-10-1)1dca-1	1979	4,618	504	N	+2	L	01-15-79	72	121	De	—	484	—	
80	(B-10-1)2add-1	1980	4,552	140	N	+2	L	05-21-80	2	60	De	N	110	126	
81	(B-10-1)10ddd-1	1972	4,695	135	1	30	L	05-02-72	30	60	De	100	—	—	
82	(B-10-1)11daa-1	1980	4,683	178	N	3	L	06-05-80	0	20	De	N	135	165	MI
83	(B-10-1)12ddd-1	1962	4,800	250	1	14	G	08-03-67	—	—	DJe	—	—	—	
84	(B-10-1)13bca-1	1981	4,805	480	1	30	L	04-16-81	3	243	De	N	350	480	
85	(B-10-1)15dcd-1	1978	4,870	250	1	163	L	10-31-78	34	67	De	166	188	250	
86	(B-10-1)15cdb-1	1984	4,797	202	Y	—	—	—	—	—	De	193	70	176	MI
87	(B-10-1)15bca-2	1975	4,790	157	1	—	—	—	0	35	De	—	95	157	
88	(B-10-1)22add-1	1979	4,872	253	Y	176	L	02-13-79	—	—	De	150	200	240	
89	(B-10-1)23cbc-1	1946	4,880	285	1	20	G	00-00-60	12	122	De	N	—	—	
90	(B-11-1)5ddb-1	—	4,470	120	N	+6	G	09-05-68	—	—	Je	N	—	—	
91	(B-11-1)5bad-1	1983	4,562	80	1	55	L	01-28-84	0	65	De	N	65	80	
92	(B-11-1)6ddd-1	1981	4,722	142	1	74	L	02-27-81	27	65	De	N	96	135	
93	(B-11-1)8dda-1	1963	4,438	184	N	+8	G	08-29-68	30	105	De	N	—	—	
94	(B-11-1)18add	1978	—	148	1	15	—	—	0	90	De	-	-	-	
95	(B-11-1)17ada-2	1977	4,473	127	N	3	L	07-11-77	12	57	De	N	93	127	
96	(B-11-1)21bab-1	1979	4,481	157	Y	30	L	03-14-79	49	68	De	N	135	157	
97	(B-11-1)21dcd-1	1979	4,540	180	1	90	L	06-01-79	40	95	De	N	120	160	
98	(B-11-1)21aab	1978	4,433	260	N	+14	L	01-10-78	0	200	D	N	—	—	
99	(B-11-1)25cda-1	1981	4,495	212	N	16	L	07-29-81	47	73	De	N	187	207	
100	(B-11-1)26cbd-1	—	4,470	141	N	+9	G	05-27-68	—	—	Je	N	—	—	
101	(B-11-1)27cdc-1	1972	4,600	194	1	77	L	11-27-72	64	145	De	—	—	—	
102	(B-11-1)34bac	1987	4,575	173	Y	74	L	03-26-87	—	—	De	N	—	—	
103	(B-11-1)35cca-1	1923	4,475	65	N	+10	G	05-00-66	—	—	—	—	—	—	
104	(B-11-1)36cac	1977	4,518	247	1	22	L	07-23-77	19	51	De	N	—	—	
105	(B-12-1)7ddd-1	1931	4,465	185	1	20	G	08-03-67	—	—	—	—	—	—	
106	(B-12-1)8cdb-2	1889	4,431	210	N	+7	G	03-06-36	—	—	—	—	—	—	
107	(B-12-1)19ddc-1	1984	4,543	180	Y	28	L	08-17-84	—	—	De	N	100	120	
108	(B-12-1)19ddd	1983	4,537	150	1	4	L	08-27-83	60	80	De	N	60	150	
109	(B-12-1)29cda	1978	4,499	200	Y	8	L	01-24-78	—	—	De	N	170	200	
110	(B-12-1)31dbc	1983	—	160	1	12	L	04-21-83	23	120	De	N	—	—	
111	(B-12-1)32abc-1	—	4,508	460	N	+4	G	10-03-68	85	109	Je	N	—	—	
112	(B-12-2)36cac-1	1972	5,130	183	1	96	L	10-25-72	2	50	De	N	115	183	
113	(B-13-1)5ada-1	1971	4,800	205	Y	25	L	09-09-71	—	—	De	N	148	190	
114	(B-13-1)7dbd-1	1934	4,615	350	N	+4	G	09-25-68	—	—	Je	133	—	—	
115	(B-13-1)10acb-1	1957	4,423	5,208	N	45	G	10-03-68	—	—	JeECZ	Y	—	—	
116	(B-13-1)15cdd-1	1957	4,422	132	N	+7	G	04-17-57	—	100	De	N	—	—	
117	(B-13-1)16cbd	1971	4,645	216	Y	32	L	09-04-71	0	67	De	N	—	—	
118	(B-13-1)19ddd-1	1979	4,441	90	N	+4	L	06-06-79	0	59	De	N	—	—	
119	(B-13-1)22cbc-1	1977	4,454	440	N	+32	L	09-11-77	0	80	De	N	435	440	
120	(B-13-1)28acb-1	1940	4,449	210	N	+13	G	09-06-67	0	30	De	N	—	—	

Table 7. Records of selected wells, Cache Valley, Utah—Continued

Site number	Local well number	Year well drilled	Altitude of land surface (feet)	Well depth (feet)	Re-charge area	Water level (feet)	Water-level source	Water-level date	Top of first confin-ing layer	Bottom of first confin-ing layer	Log types	Depth to consol-idated rock (feet)	Top of perfor-ated interval	Bottom of perfor-ated interval
121	(B-13-1)30cad	1984	4,443	194	N	+20	L	00-00-84	21	72	De	N	160	175
122	(B-13-1)30cbb-1	1978	4,512	287	Y	38	L	05-28-78	—	—	De	N	55	90
123	(B-13-1)31acc	1979	4,445	81	N	+9	L	10-18-79	10	53	De	N	—	—
124	(B-13-02)2bac-1	1958	4,803	115	N	—	G	—	—	—	—	—	—	—
125	(B-14-1)17add-1	1965	4,555	92	N	9	G	09-27-67	26	51	JeDe	N	51	85 MI
126	(B-14-1)28ccb	1979	4,635	215	Y	63	L	12-07-79	—	—	De	23	100	115
127	(B-15-1)34ccc-1	1961	4,510	410	3	8	G	11-06-67	80	115	DeJe	N	—	—
128	(B-14-02)26ddb-1	1970	4,803	100	N	+1	L	10-26-70	21	77	De	N	78	90

Table 8. Records of selected wells, lower Bear River area, Utah

[—, no data]

Site number: See plate 2 for well location.
Local well number: See text for explanation of numbering system for hydrologic-data sites.
Altitude: In feet above sea level.
Well depth: In feet below land surface.
Recharge area: Y, primary recharge area; 1, secondary recharge area—well completed in principal aquifer; 2, secondary recharge area—well completed in shallow unconfined aquifer; 3, secondary recharge area—one of a pair of wells completed in the shallow unconfined or principal aquifer used to determine vertical hydraulic gradients; N, discharge area.
Water level: In feet below land surface or above (+) land surface; F, water level above land surface and well flowing.
Water-level source: G, U.S. Geological Survey data base; L, drillers' log; B, published data report.
Top of first confining layer: In feet below land surface.
Bottom of first confining layer: In feet below land surface.
Log types: e, indicates log was examined as part of this study; D, drillers' log; J, gamma log.
Depth to consolidated rock: In feet below land surface; N, not encountered; Y, encountered, depth uncertain.
Top of perforated interval: In feet below land surface.
Bottom of perforated interval: In feet below land surface; MI, multiple perforated intervals within indicated interval.

Site number	Local well number	Year well drilled	Altitude of land surface (feet)	Well depth (feet)	Recharge area	Water level (feet)	Water-level source	Water-level date	Top of first confining layer	Bottom of first confining layer	Log types	Depth to consolidated rock (feet)	Top of perforated interval	Bottom of perforated interval
6	(B-9-1)19bcc-1	—	4,540	412	Y	175	G	—	—	—	—	N	—	—
6A	(B-9-1)18cab	1989	4,407	402	1	90	L	06-06-89	75	135	De	N	160	300 MI
6B	(B-9-2)12ccc-1	1915	4,298	350	N	10	B	03-31-53	—	—	—	—	30	350
7	(B-9-2)11cda-1	1963	4,245	626	N	+14	G	03-11-71	70	300	De	—	—	—
7A	(B-9-2)01bdd-1	1961	4,275	76	Y	7	G	03-18-71	—	—	D	—	—	—
7B	(B-9-2)01cdd-1	1987	4,257	70	N	+18	L	07-18-87	2	24	De	N	45	55
8	(B-9-2)23aab-1	1951	4,320	285	N	1	G	03-10-71	—	—	D	—	—	—
9	(B-9-2)23dac	1985	4,330	300	1	+33.5	L	09-28-85	69	90	De	—	140	270 MI
9A	(B-9-2)24ccc-1	—	4,350	50	2	37	B	03-10-71	—	—	—	—	—	—
10	(B-9-2)26aab-2	1961	4,310	330	N	20	B	08-28-70	—	—	De	—	220	315
10A	(B-9-2)26aab-3	—	4,310	33	N	29	B	03-10-71	—	—	—	—	—	—
11	(B-9-2)35abc-1	1959	4,272	190	N	+14	G	08-08-59	0	170	D	—	—	—
11A	(B-10-2)04dda-1	1961	4,525	366	Y	252	G	03-23-71	—	—	De	N	—	—
12	(B-10-2)15abc	1979	4,455	155	Y	50	L	07-20-79	—	—	De	N	140	152
13	(B-10-2)23bba-1	1978	4,390	203	Y	147	L	09-27-78	—	—	De	N	165	185
14	(B-10-2)26aad	1989	4,700	443	Y	92	L	03-22-89	—	—	De	225	—	—
15	(B-10-2)26baa-4	1985	4,255	66	2	19	L	05-25-85	—	—	De	—	50	60 —
16	(B-10-2)36bcc	1976	4,280	120	Y	90	L	09-14-76	70	90	De	—	—	—
17	(B-10-3)23	1980	—	700	N	—	—	—	—	—	De	—	—	—
18	(B-10-4)06cdd-1	1943	4,248	104	N	+3	G	03-11-71	18	93	DJe	N	—	—
19	(B-11-2)05dbb	1979	4,400	130	Y	35	L	08-09-79	—	—	De	—	117	127
20	(B-11-2)06ccc-1	1963	4,322	178	1	61	G	09-24-63	16	37	De	N	—	—
21	(B-11-2)07daa	1978	4,312	455	1	40	L	05-00-78	10	50	De	—	380	390
22	(B-11-2)21cdc	1977	4,390	188	Y	98	L	08-25-77	—	—	De	182	110	188 MI
23	(B-11-2)28abc-1	1957	4,550	315	Y	270	G	11-16-57	—	—	De	—	—	—
24	(B-11-2)33da	1980	4,460	290	1	100	L	02-26-80	100	235	De	240	277	287
25	(B-11-3)01dba	1988	4,330	35	1	9	L	01-25-88	—	—	De	—	—	—
26	(B-11-3)03ddd	1982	4,322	16	1	12	L	06-06-82	—	—	De	—	12	17
27	(B-11-3)04ccc	1973	4,320	175	1	31	L	04-12-73	2	125	De	—	165	175
28	(B-11-3)07ccd-1	1952	4,290	220	N	+2	L	05-25-52	2	135		N	—	—

Table 8. Records of selected wells, lower Bear River area, Utah—Continued

Site number	Local well number	Year well drilled	Altitude of land surface (feet)	Well depth (feet)	Re-charge area	Water level (feet)	Water-level source	Water-level date	Top of first confining layer	Bottom of first confining layer	Log types	Depth to consolidated rock (feet)	Top of perforated interval	Bottom of perforated interval
29	(B-11-3)05abb	1987	4,400	145	Y	95	L	07-23-87	—	—	De	—	—	—
30	(B-11-4)03ccc-1	1962	4,419	430	Y	113	G	03-23-71	—	—	De	N	—	—
30A	(B-11-4)10bba	1978	4,360	115	1	60	L	05-20-78	2	24	De	—	102	112
31	(B-11-4)12aba-1	1944	4,314	240	N	7	G	09-07-44	100	160	De	N	—	—
32	(B-11-4)12bcb-2		4,310	13	N	+3.4	G	03-24-71	—	—	—	—	—	—
33	(B-11-4)02bcc	1985	4,328	125	1	5	L	04-25-85	2	46	De	—	72	110
34	(B-11-4)16add-2	1955	4,338	75	Y	57	G	02-28-55	—	—	De	N	—	—
35	(B-11-4)28dda-1	1958	4,278	41	Y	30	G	05-18-58	0	6	De	38	—	—
36	(B-12-2)03bdb-1	1961	4,530	126	1	30	G	09-30-61	—	—	De	—	—	—
37	(B-12-2)06abc	1986	4,372	240	1	45	L	08-16-86	2	30	De	N	225	235
38	(B-12-2)09cad-1	1958	4,557	95	1	41	G	10-23-58	0	50	De	—	—	—
39	(B-12-2)11bdc-1	1973	4,700	140	1	0	L	—	0	30	De	N	120	140
40	(B-12-2)16baa	1979	4,642	275	Y	50	L	10-01-79	—	—	De	142	120	275
40A	(B-12-2)17aad	1982	4,456	300	1	7	L	11-17-82	23	92	De	128	115	275
41	(B-12-2)17dcc-1		4,435	36	2	34	G	03-25-71	—	—		N	—	—
41A	(B-12-2)17cac-1	1962	4,390	198	1	104	G	03-25-71	4	96	De	N	—	—
41B	(B-12-2)19aab-1	1939	4,242	280	N	+25	B	03-29-71	27	49	De	—	—	—
42	(B-12-2)20dbd	1979	4,518	280	Y	90	L	06-06-79	—	—	De	N	100	200
43	(B-12-2)31dda	1980	4,240	112	N	F	—	06-25-80	9	58	De	N	100	109
44	(B-12-2)32dba	1978	4,658	320	1	200	L	04-12-78	50	140	De	—	260	320
44A	(B-12-2)32bab-1	1973	4,520	260	Y	163	L	08-15-73	—	—	De	—	174	262
45	(B-12-3)02bbb-1	1985	4,408	140	Y	59	L	12-03-85	0	—	De	N	115	135
46	(B-12-3)11daa-2	1959	4,356	68	1	4	—	—	0	22	De	N	—	—
47	(B-12-3)14ccc	1986	4,368	85	1	19	L	12-02-86	25	72	De	N	74	81
48	(B-12-3)15cdc-1	1954	4,473	277	1	175	G	03-25-71	18	105	De	195	—	—
49	(B-12-3)22ddd-2	1984	4,350	128	1	13	L	11-26-84	2	100	De	N	114	125
50	(B-12-3)29dcc	1987	4,846	400	Y	100	L	10-23-87	—	—	De	N	205	225
51	(B-12-3)31abc	1978	5,040	500	Y	355	L	05-17-78	—	—	De	4	450	483
52	(B-12-3)33bbd	1983	4,488	104	1	7	L	10-15-83	12	64	De	N	94	104
53	(B-12-4)22aac-1	1971	4,529	680	1	222	G	04-01-71	2	22	De	307	—	—
54	(B-12-4)23bda	1979	4,538	665	Y	227	L	10-07-79	—	—	De	594	270	665
55	(B-12-4)26bdb-1	1983	4,475	280	Y	155	L	09-26-83	—	—	De	N	265	275
56	(B-12-4)26bbb-1	1981	4,465	240	1	170	L	10-01-81	12	50	De	N	212	240
57	(B-12-4)27dbd-1	1968	4,420	478	1	114	G	05-26-71	0	99	De	N	—	—
58	(B-12-4)27bdb-1	1969	4,496	500	1	189	G	03-22-71	—	—	De	427	—	—
59	(B-12-4)34bbd-1	1954	4,430	306	1	122	G	03-23-71	2	128	De	162	—	—
60	(B-12-4)34cbd-1	1955	4,424	292	1	118	G	03-23-71	12	65	De	Y	—	—
61	(B-12-4)35bbc-1	1968	4,376	668	1	70	G	03-22-71	0	58	De	N	—	—
62	(B-12-4)35aab-1	1973	4,390	667	Y	90	LG	06-11-73	—	—	De	N	265	640
63	(B-13-2)29aba-1	1971	4,500	95	1	26	L	04-03-71	20	55	De	N	—	—
64	(B-13-2)33add-1	1951	4,275	85	N	+15	G	05-31-51	—	—	D	Y	—	—
65	(B-13-3)02cbc	1986	4,570	228	1	140	L	12-19-86	35	145	De	—	180	228
66	(B-13-3)04cbb-1	1980	4,480	1,000	1	117	L	06-10-80	—	—	De	N	405	920
67	(B-13-3)09dbc-1	1980	4,480	80	1	61	L	04-28-80	0	60	De	N	65	75
68	(B-13-3)10dcd	1941	4,418	202	N	37	G	04-30-41	4	130	De	N	—	—

Table 8. Records of selected wells, lower Bear River area, Utah—Continued

Site number	Local well number	Year well drilled	Altitude of land surface (feet)	Well depth (feet)	Re-charge area	Water level (feet)	Water-level source	Water-level date	Top of first confin-ing layer	Bottom of first confin-ing layer	Log types	Depth to consol-idated rock (feet)	Top of perfor-ated interval	Bottom of perfor-ated interval
69	(B-13-3)10aaa-1	1981	4,490	185	1	105	L	—	5	70	De	N	100	185
70	(B-13-3)12cba-2	1978	4,584	93	Y	15	L	09-06-78	—	—	De	N	62	93
71	(B-13-3)26ccc-1	1962	4,403	131	1	60	G	07-04-62	0	32	De	N	—	—
72	(B-13-3)28ada-1	1916	4,580	245	Y	233	G	03-16-71	—	—	Je	102	—	—
73	(B-13-3)35dda-1	1963	4,371	237	3	41	G	03-09-71	2	27	De	N	—	—
74	(B-14-3)04cca-1	—	4,362	138	N	+13	G	03-16-71	0	113	Je	N	—	—
75	(B-14-3)05cdc-1	—	4,369	22	N	+7	G	03-16-71	—	—	—	—	—	—
76	(B-14-3)06cca-1	1960	4,490	135	1	113	G	03-08-71	0	20	De	—	—	—
77	(B-14-3)15bbc-1	—	4,375	85	N	+1	G	03-08-71	0	26	Je	—	—	—
78	(B-14-3)18ddd-1	1974	4,460	88	1	57	L	06-03-74	6	70	De	—	70	88
79	(B-14-3)17dca-1	1946	4,370	174	N	+3	G	12-12-46	—	—	D	—	—	—
80	(B-14-3)18dcb-1	1988	4,517	450	1	132	L	08-13-88	—	—	De	292	190	240
81	(B-14-3)34dbb-1	1980	4,448	320	Y	86	L	04-15-80	—	—	De	N	105	315
82	(B-14-3)35dbd-1	1979	4,940	408	Y	296	L	12-10-79	—	—	De	Y	302	402
83	(B-14-4)01aaa-1	1978	4,445	295	Y	180	L	03-03-78	—	—	De	12	200	280
84	(B-15-3)31ccc-1	1961	4,440	160	1	40	G	10-08-61	10	85	De	—	—	—

Table 9. Records of selected wells, East Shore area, Utah

[—, no data]

Site number: See plate 3 for well location.
Local well number: See text for explanation of numbering system for hydrologic-data sites.
Altitude: In feet above sea level.
Well depth: In feet below land surface.
Recharge area: Y, primary recharge area; 1, secondary recharge area—well completed in principal aquifer; 2, secondary recharge area—well completed in shallow unconfined aquifer; N, discharge area.
Water level: In feet below land surface; values above (+) land surface; F, water level above land surface and well flowing.
Water-level source: L, drillers' log; G, U.S. Geological Survey data base; B, published data report.
Top of first confining layer: In feet below land surface.
Bottom of first confining layer: In feet below land surface.
Log types: e, indicates log was examined as part of this study; D, drillers' log; J, gamma log; T, fluid temperature log; K, fluid conductivity log; E, electric log.
Depth to consolidated rock: In feet below land surface; N, not encountered; Y, encountered, depth uncertain.
Top of perforated interval: In feet below land surface.
Bottom of perforated interval: In feet below land surface; MI, multiple perforated intervals within indicated interval.

Site number	Local well number	Year well drilled	Altitude of land surface (feet)	Well depth (feet)	Re-charge area	Water level (feet)	Water-level source	Water-level date	Top of first confin-ing layer	Bottom of first confin-ing layer	Log types	Depth to consol-idated rock (feet)	Top of perfor-ated interval	Bottom of perfor-ated interval
1	(B-8-2)23cba	1978	4,308	241	N	+3	L	—	0	185	De	N	185	238 MI
2	(B-8-2)23dda-1	1962	4,525	460	Y	246	L	—	—	—	De	N	290	440 MI
3	(B-8-2)26ada-1	1981	4,565	330	Y	280	L	—	—	—	De	N	314	324
4	(B-8-2)26bca-3	1961	4,288	327	N	—	—	—	218	280	De	N	280	300
5	(B-8-2)35acb	1977	4,290	148	Y	8	L	—	—	—	De	145	101	146
6	(B-7-2)1cbb-1	1980	4,510	526	Y	158	L	—	—	—	De	N	185	525 MI
7	(B-7-2)2acb-2	1961	4,522	332	Y	30	L	—	—	—	De	—	95	315 MI
8	(B-7-2)2cad-1	1961	4,320	365	N	32	L	—	—	—	De	N	200	365
9	(B-7-2)11ddb	1974	4,410	114	Y	78	L	03-17-74	—	—	De	N	100	114
10	(B-7-2)11bdc	1979	4,295	477	N	14	L	10-12-79	42	82	De	N	400	465
11	(B-7-2)23acb-1	—	4,240	351	N	+12	G	—	—	—	D	N	—	—
12	(B-7-1)7cda-1	1980	5,340	180	Y	137	L	10-31-80	—	—	De	N	155	180
13	(B-7-1)17cdc-1	1973	5,100	90	Y	12	G	03-13-85	—	—	D	Y	70	90
14	(B-7-1)20ddb-1	1980	4,800	800	Y	78	G	09-07-84	20	50	De	55	240	800
15	(B-7-1)21bdb-1	1980	5,120	0	Y	153	B	03-22-85	—	—	—	—	—	—
16	(B-7-1)27cbc-1	1960	4,630	900	1	3	—	09-10-84	206	232	DeJe	781	295	900 MI
17	(B-7-1)28abb	1959	4,780	464	N	+14	L	08-06-59	30	127	De	N	—	0
18	(B-7-1)30dca-1	1916	4,321	180	N	+11	B	03-01-85	—	—	—	N	—	0
19	(B-7-1)33baa-5	1934	4,489	126	1	+21	G	03-22-85	—	—	—	N	—	—
20	(B-7-1)34caa-1	1967	4,680	192	Y	149	G	03-13-85	—	—	De	N	150	187
21	(B-7-1)34ccc-1	1970	4,560	154	1	29	G	06-05-70	21	142	De	N	144	154
22	(B-6-1)4aaa-1	—	4,480	55	N	+1	G	—	—	—	—	—	—	0
23	(B-6-1)4bda	—	4,384	165	N	+15	B	03-22-85	—	—	—	N	—	0
24	(B-6-1)9adb-2	1974	4,415	189	N	+3	—	03-13-85	21	138	De	138	—	—
25	(B-6-1)16dac-1	1960	4,445	458	N	+6	L	05-21-60	30	60	De	N	448	458
26	(B-6-1)21bcd-1	1954	4,306	16	2	14	L	09-05-54	0	—	De	N	—	0
27	(B-6-1)21add-1	—	4,340	270	1	55	L	—	—	135	De	N	126	270 MI
28	(B-6-1)28bcc-1	1952	4,293	195	1	60	L	06-05-52	31	187	De	N	188	195
29	(B-6-1)29abb	1939	4,293	464	N	+32	L	11-22-39	65	165	De	N	455	464
30	(B-6-1)32cdb-1	1955	4,315	21	2	10	L	06-25-55	21	—	De	N	14	21

Table 9. Records of selected wells, East Shore area, Utah—Continued

Site number	Local well number	Year well drilled	Altitude of land surface (feet)	Well depth (feet)	Recharge area	Water level (feet)	Water-level source	Water-level date	Top of first confining layer	Bottom of first confining layer	Log types	Depth to consolidated rock	Top of perforated interval	Bottom of perforated interval	
31	(B-6-1)32cdd-2	1948	4,317	567	1	7	L	08-18-48	12	160	De	N	536	567	
32	(B-6-1)35bcb-1	1965	4,861	510	1	340	L	01-23-65	35	75	TeDeJK	508	—	—	
33	(B-5-2) 1abb-2	1959	4,370	378	1	100	L	11-29-59	80	140	De	N	375	0	
34	(B-5-2) 1abb-1	1955	4,363	59	2	3	L	06-28-55	—	—	De	N	40	59	
35	(B-5-2) 2acc-1	1972	4,328	126	N	+9	L	05-20-72	2	38	De	N	112	122	
36	(B-5-2)10bad-3	—	4,300	118	N	+8	—	—	—	—	D	N	—	0	
37	(B-5-2)11bab	1971	4,368	430	1	100	L	06-02-71	2	34	De	N	390	400	
38	(B-5-2)12dab-1	1946	4,403	325	1	102	L	02-18-46	7	120	De	N	318	325	
39	(B-5-2)12daa-1	1955	4,404	22	2	4	L	04-05-55	—	—	De	N	—	0	
40	(B-5-2)15ddd-2	1963	4,389	278	1	128	B	03-07-85	75	145	De	N	255	275	
41	(B-5-2)21add-4	1960	4,300	74	N	+11	L	09-29-60	45	60	De	N	63	74	
42	(B-5-2)22aab-1	1960	4,370	104	N	+3	L	06-28-60	35	50	De	N	—	—	
43	(B-5-2)22ddd-1	1950	4,387	153	1	15	L	04-22-50	30	90	De	N	142	—	
44	(B-5-2)22ddd-2	1961	4,374	865	1	104	B	03-07-85	30	50	De	N	810	850	
45	(B-5-2)27bbc-2	1956	4,327	128	N	+6	L	08-20-56	55	97	De	N	107	—	
46	(B-5-2)33ddc-1	1935	4,343	808	N	78	B	03-01-85	20	60	De	N	786	808	
47	(B-5-2)34ccd-1	1960	4,372	865	1	102	B	03-01-85	35	106	De	N	802	840	
48	(B-5-2)34cdc-1	1967	4,377	315	1	100	L	04-04-67	44	120	De	N	273	282	
49	(B-5-1)6aba-1	1960	4,325	890	1	58	L	07-12-60	12	28	De	N	852	867	
50	(B-5-1)6abd-1	1950	4,322	357	1	35	L	01-02-50	50	75	De	N	350	357	
51	(B-5-1)15abb-10	1967	4,980	320	1	6	L	09-13-67	32	270	De	312	10	32	
52	(B-5-1)17aab	1950	4,610	39	2	36	L	04-05-50	29	—	De	N	35	39	
53	(B-5-1)17aab-1	1959	4,600	784	1	343	G	03-08-85	155	197	De	N	692	776	MI
54	(B-5-1)18bcc-1	1973	4,387	800	1	112	G	03-08-85	49	135	De	N	700	760	
55	(B-5-1)18bcd	1950	4,378	20	2	11	L	04-13-50	—	—	De	N	14	20	
56	(B-5-1)22acc-1	1946	4,805	20	2	15	L	08-15-46	20	—	De	N	15	20	
57	(B-5-1)22dbb-1	1978	4,803	404	1	370	L	08-10-78	125	167	De	N	390	400	
58	(B-5-1)23dbd-1	1965	4,815	601	1	425	L	08-13-65	26	130	De	N	583	601	
59	(B-5-1)26caa-1	1980	4,500	200	Y	70	L	09-09-80	—	—	De	N	100	110	
60	(B-5-1)26bbc-1	1979	4,512	800	Y	224	G	05-14-84	486	493	De	N	430	800	MI
61	(B-5-1)27dcc-1	1953	4,512	350	1	216	B	03-01-66	115	184	De	N	315	335	
62	(B-5-1)27dcc-2	1953	4,510	115	2	70	L	12-22-53	110	—	De	N	75	90	
63	(B-5-1)19dba	1984	4,405	56	2	6	L	11-26-84	55	—	De	N	45	56	
64	(B-5-1)19bdc	1980	4,530	379	1	290	L	12-04-80	25	90	De	N	367	377	
65	(B-5-1)33acc	1986	4,809	63	2	19	L	07-00-86	—	—	De	N	53	63	
66	(B-5-1)33cda-1	1943	4,796	730	1	499	B	03-16-62	205	495	De	N	584	716	MI
67	(B-5-1)36bbb-1	1952	4,528	217	Y	207	G	03-08-85	—	—	De	N	168	210	
68	(B-5-1)36cbd-1	1977	4,680	520	1	200	L	12-07-77	15	44	De	N	200	—	
69	(B-4-1)1bbd-1	1975	4,750	250	Y	75	L	08-04-75	—	—	De	197	135	250	
70	(B-4-1)3aad-1	1965	4,860	544	1	418	L	12-10-65	25	92	De	535	526	544	

Table 9. Records of selected wells, East Shore area, Utah—Continued

Site number	Local well number	Year well drilled	Altitude of land surface (feet)	Well depth (feet)	Re-charge area	Water level (feet)	Water-level source	Water-level date	Top of first confin-ing layer	Bottom of first confin-ing layer	Log types	Depth to consol-idated rock	Top of perfor-ated interval	Bottom of perfor-ated interval	
71	(B-4-1)3abc-1	1965	4,930	243	1	222	L	10-26-65	13	130	De	N	—	—	
72	(B-4-1)7baa-1	1961	4,585	1,005	1	290	D	—	2	56	DeEe	N	675	875	
73	(B-4-1)7bad-1	1968	4,550	28	2	11	G	11-19-68	—	—	De	N	13	24	
74	(B-4-1)11aac-1	1982	4,805	160	1	85	L	12-20-82	10	70	De	N	120	160	
75	(B-4-1)12bbd-1	1965	5,080	85	Y	45	L	06-10-65	—	—	De	N	60	80	
76	(B-4-1)13bbc-1	1952	4,860	127	Y	102	B	07-29-85	—	—	De	N	107	125	
77	(B-4-1)19daa	1946	4,352	622	1	58	L	06-12-46	145	175	De	N	472	616	MI
78	(B-4-1)24cac-1	1966	4,990	202	Y	61	L	01-15-66	—	—	De		53	53	—
79	(B-4-1)27ccb-1	1969	4,335	197	1	42	L	03-19-69	25	181	De	N	189	197	
80	(B-4-1)28ddd-1	1962	4,323	20	2	5	L	06-01-62	—	—	De	N	16	20	
81	(B-4-1)29dbb-1	1975	4,312	400	N	F	L	10-30-75	—	200	De	N	390	400	
82	(B-4-1)30bba-1	1915	4,301	525	N	27	B	01-03-85	—	—	—	—	—	—	
83	(B-4-1)32dca-1	1965	4,250	714	N	+31	L	11-22-65	45	170	De	N	704	714	
84	(B-4-1)34cbc-3	1930	4,296	350	N	18	B	03-01-85	0	—	—	—	—	—	
85	(B-4-1)34adc-2	1966	4,405	748	N	54	L	07-29-66	6	59	De	711	325	412	
86	(B-4-1)35bdd-1	1950	4,527	450	1	8	B	03-18-85	—	140	De	426	195	—	
87	(B-4-1)35aaa-2	1961	4,600	750	1	46	B	03-18-85	29	84	De	N	606	750	MI
88	(B-4-2)2cdc-1	1953	4,387	550	N	+25	L	09-24-53	80	100	De	N	540	—	
89	(B-4-2)10daa-1	1934	4,342	777	N	72	B	03-06-85	10	58	DeJe	N	642	684	
90	(B-4-2)12bdc-1	1942	4,434	875	1	175	B	03-06-85	70	390	De	N	659	768	MI
91	(B-4-2)15daa-2	1936	4,297	544	N	+8	L	10-26-36	2	34	De	N	539	544	
92	(B-4-2)22aaa-1	—	4,279	600	N	3	B	03-01-85	—	—	—	N	—	—	
93	(B-4-2)25dda	1980	4,251	455	N	F	L	09-16-80	0	225	De	N	445	455	
94	(B-4-2)26aaa-2	1952	4,272	597	N	—	B	03-01-85	—	—	—	—	—	—	
95	(B-3-1)1abc-1	1961	4,670	300	Y	123	B	03-18-85	—	—	—	N	—	—	
96	(B-3-1)1bbc-1	1952	4,555	300	1	162	B	03-01-85	12	152	De	N	195	288	
97	(B-3-1)2ddc-1	1956	4,420	50	2	8	L	07-10-56	1	20	De	N	42	—	
98	(B-3-1)2dcc-1	1954	4,397	386	1	56	L	07-31-54	23	64	De	N	380	—	
99	(B-3-1)4aba-3	1964	4,270	773	N	+13	L	09-16-64	15	146	De	N	763	773	
100	(B-3-1)11dbc-1	1954	4,285	556	N	+5	L	08-10-54	30	180	De	N	550	—	
101	(B-3-1)12baa-1	1968	4,560	301	1	128	L	11-10-68	27	63	De	N	147	300	
102	(B-3-1)12daa-1	1974	4,660	355	Y	44	B	04-02-85	—	—	De	35	185	—	
103	(B-3-1)13adc-1	1953	4,328	77	Y	50	L	05-02-53	—	—	De	N	—	—	
104	(B-3-1)13cda-7	1962	4,250	48	N	+11	L	08-09-62	2	10	De	N	38	48	
105	(A-3-1)18ccb-1	1963	4,316	223	Y	50	G	12-03-84	—	—	De	N	110	160	
106	(A-3-1)19bca-1	1973	4,293	435	1	32	L	07-06-73	5	47	De	—	260	406	MI
107	(A-3-1)19bcd-1	1956	4,294	35	2	2	L	09-04-56	—	—	De	N	30	—	
108	(A-3-1)19cdb-1	1964	4,305	63	N	+2	G	—	—	—	De	N	55	61	
109	(A-3-1)30caa-4	1964	4,325	165	Y	46	B	03-07-85	—	—	De	140	140	—	
110	(A-3-1)30cbd-2	1939	4,258	120	N	+14	L	08-14-39	20	60	De	N	115	120	
111	(A-3-1)31adc-1	1979	4,650	466	Y	263	G	03-14-85	—	—	De	42	360	442	
112	(A-3-1)31dcb-7	1970	4,320	150	1	108	L	01-10-70	4	71	De	N	141	147	
113	(A-3-1)31cba-1	1980	4,227	198	N	+20	L	01-15-80	8	40	De	N	170	175	
114	(A-2-1)6acb-1	1986	4,305	593	N	9	L	10-01-86	110	210	De	N	430	593	MI
115	(A-2-1)6dad-1	1970	4,380	332	1	89	G	12-04-84	59	87	De	N	230	322	MI

Table 9. Records of selected wells, East Shore area, Utah—Continued

Site number	Local well number	Year well drilled	Altitude of land surface (feet)	Well depth (feet)	Recharge area	Water level (feet)	Water-level source	Water-level date	Top of first confining layer	Bottom of first confining layer	Log types	Depth to consolidated rock	Top of perforated interval	Bottom of perforated interval	
116	(A-2-1)6ddd-1	1951	4,363	78	2	64	L	09-01-51	—	—	De	N	—	—	
117	(A-2-1)7aba-4	1930	4,280	450	N	+21	B	03-07-85	—	—	—	N	—	—	
118	(A-2-1)7ddd-1	1939	4,322	370	N	20	G	03-14-85	25	82	De	N	220	361	
119	(A-2-1)17cdd-1	1952	4,570	190	Y	50	L	06-10-52	158	175	De	175	—	—	
120	(A-2-1)17ccc-3	1961	4,375	500	N	67	G	10-11-84	2	70	De	N	140	498	
121	(A-2-1)20dda-2	1953	4,840	152	Y	40	L	10-29-53	—	—	De	N	60	113	MI
122	(A-2-1)28bca-1	1972	4,900	560	Y	215	G	03-19-85	—	—	De	94	128	428	
123	(A-2-1)30aba-1	1954	4,407	207	1	90	L	07-20-54	—	—	De	N	120	160	
124	(A-2-1)30ccd-1	1952	4,400	136	2	105	L	03-17-52	—	—	De	N	120	135	
125	(A-2-1)31bbd-1	1955	4,407	279	1	140	L	05-26-55	0	50	De	N	165	279	MI
126	(A-2-1)31cca-1	1934	4,498	209	1	119	B	03-01-85	0	35	De	N	177	207	
127	(A-2-1)31dbb-1	1946	4,555	294	Y	155	B	03-13-85	—	—	De	N	274	—	
128	(A-2-1)34cdb-1	1981	5,520	800	Y	16	G	09-13-81	—	—	Je	16	—	—	
129	(B-2-1)24ddb	1981	4,312	176	1	22	L	01-28-81	0	70	De	N	160	173	
130	(B-2-1)24ddd-2	1949	4,330	60	2	28	L	05-14-49	—	—	De	N	45	60	
131	(B-2-1)24aaa-7	1943	4,273	268	N	+20	L	11-29-43	2	30	De	N	266	—	
132	(B-2-1)24cdd-11	1953	4,274	607	N	+20	L	09-18-53	—	—	De	N	430	—	
133	(B-2-1)35dad-1	1954	4,272	222	N	+1	L	09-25-54	1	55	De	N	—	—	
134	(B-2-1)36cab-2	1952	4,295	540	1	5	L	08-30-52	0	55	De	N	150	160	
135	(B-2-1)36cac-1	1943	4,310	68	2	12	L	07-20-43	3	25	De	N	66	—	
136	(A-1-1)6abc-1	1955	4,780	410	1	230	L	03-08-55	35	92	De	—	225	384	MI
137	(A-1-1)6add-1	1977	5,038	830	Y	+3	L	08-07-77	—	—	DeEe	120	20	830	
138	(A-1-1)7cbb-1	1973	5,065	455	Y	18	L	12-00-72	9	59	De	78	200	411	MI
139	(B-1-1)10ac	1984	4,643	183	1	25	L	10-01-84	75	94	De	N	175	182	
140	(B-1-102baa	1961	4,235	549	N	F	L	09-15-61	5	36	De	N	400	544	
141	(B-1-1)10aac-1	1965	4,215	231	N	+11	G	03-01-85	12	120	De	N	221	231	
142	(B-1-1)11adc-2	1962	4,315	344	1	82	—	—	161	255	De	N	284	338	MI
143	(B-8-2)2abb-1	1954	4,342	334	Y	68	G	08-20-54	—	—	De	N	—	—	
144	(B-8-2)3dbd-8	1948	4,268	77	N	+10	G	03-09-71	4	24	De	—	—	—	
145	(B-8-2)10aaa	1981	4,320	206	N	+4	L	06-12-81	108	120	De	—	120	175	MI
146	(B-8-2)11bad	1974	4,378	298	Y	67	L	06-04-74	—	—	De	—	201	295	
147	(B-8-2)14bda-1	1959	4,315	332	Y	26	G	03-09-71	—	—	De	N	—	—	
148	(B-8-2)14cca-1	1920	4,283	85	N	+7	G	03-19-71	—	—	D	—	—	—	

Table 10. Records of selected wells, Salt Lake Valley, Utah

[—, no data]

Site number: See plate 4 for well location.
Local well number: See text for explanation of numbering system for hydrologic-data sites.
Altitude: In feet above sea level.
Well depth: In feet below land surface.
Recharge area: Y, primary recharge area; 1, secondary recharge area—well completed in principal aquifer; 2, secondary recharge area—well completed in shallow unconfined aquifer; 3, secondary recharge area—one of a pair of wells completed in the shallow unconfined or principal aquifer used to determine vertical hydraulic gradients; N, discharge area.
Water level: In feet below land surface; values above (+) land surface; F, water level above land surface and well flowing.
Water-level source: L, drillers' log; B, published data report; G, U.S. Geological Survey data base; K, Kennecott unpublished data.
Top of first confining layer: In feet below land surface.
Bottom of first confining layer: In feet below land surface.
Log types: e, indicates log was examined as part of this study; D, drillers' log; J, gamma log; K, fluid conductivity log; T, fluid temperature log; G, geologist's log; E, electric log.
Depth to consolidated rock: In feet below land surface; N, not encountered; Y, encountered, depth uncertain.
Top of perforated interval: In feet below land surface.
Bottom of perforated interval: In feet below land surface; MI, multiple perforated intervals within indicated interval.

Site number	Local well number	Year well drilled	Altitude of land surface (feet)	Well depth (feet)	Recharge area	Water level (feet)	Water-level source	Water-level date	Top of first confining layer	Bottom of first confining layer	Log types	Depth to consolidated rock (feet)	Top of perforated interval	Bottom of perforated interval
1	(B-1-1)15bcc-1	1966	4,209	150	N	F	L	04-28-66	—	20	De	N	146	149
2	(B-1-1)27acc-1	1978	4,213	650	N	+2	L	05-26-78	25	315	De	N	465	475
3	(B-1-1)25dcc	1986	4,239	145	N	+12	L	05-23-86	104	115	De	N	140	145
4	(B-1-1)36bac-29	1950	4,225	400	1	5		—	3	75	De	N	—	—
5	(B-1-1)36bad	1988	4,236	19	2	14	L	09-17-88	—	—	De	N	10	—
6	(B-1-1)34dcb	1980	4,222	1,063	N	+2	L	08-00-80	34	73	De	N	665	1,063
7	(A-1-1)31cac-1	1943	4,400	464	Y	143	B	02-16-83	—	—	De	N	162	420 MI
8	(A-1-1)31ccc-4	1965	4,335	705	1	107		—	90	120	DeJe	N	415	592
9	(C-1-1)2dca-2	1982	4,222	20	2	8	G	07-21-82	—	—		—	8	20
10	(C-1-1)2dca-1	1978	4,230	320	1	43	B	02-09-83	20	90	De	N	—	—
11	(C-1-1)3bda	1968	4,225	310	N	+2	L	06-02-68	10	60	De	N	295	299
12	(C-1-1)11aad	1969	4,224	1,580	N	2	L	11-01-69	147	178	De	N	1,491	1,576
13	(C-1-1)31bdb-1	1942	4,260	170	N	+10	G	04-21-83	—	—	—	—	100	—
14	(C-1-1)33dbc-2	—	4,263	18	2	5	B	03-28-84	—	—	—	—	—	—
15	(C-1-1)33dbc-1	1980	4,263	380	1	9	B	03-28-84	27	81	De	—	93	103
16	(C-1-1)28dad	1980	4,240	196	N	+4	L	11-14-80	40	80	De	N	120	186 MI
17	(C-1-1)35dbc	1983	4,260	570	N	F	L	12-24-83	—	70	De	N	420	527 MI
18	(C-1-2)36bbb	1978	4,305	230	N	+2	L	05-08-78	2	23	De	N	115	200
19	(C-1-2)35bad-1	1972	4,320	170	1	32	L	05-25-72	46	82	De	N	—	—
20	(C-1-2)34cda	1982	4,468	410	Y	126	L	09-29-82	—	—	De	N	170	380
21	(C-1-2)34bdc	1988	4,417	230	1	138	L	01-14-88	141	168	De	206	206	230
22	(C-1-2)22dcc	1980	4,240	184	N	F	L	03-19-80	—	40	De	N	96	172 MI
23	(C-1-2)21bcd	1977	4,228	148	N	+20	L	06-06-77	95	120	De	N	125	145
24	(C-1-2)31aaa	1976	4,440	215	Y	170	L	07-25-76	—	—	De	178	170	215
25	(C-1-3)15cbb-02	1966	4,224	575	1	30	L	10-01-66	5	25	JKTe	N	350	570 MI
26	(C-1-3)15bad	1986	4,230	11	2	2	L	04-10-86	—	—	De	N	1	10
27	(C-1-3)17bca-1	1966	4,200	485	N	2	L	12-01-66	113	205	Je	N	—	—
28	(C-2-1)2baa	1989	4,240	364	N	F	L	06-15-89	17	48	De	N	112	356
29	(C-2-1)3bdd-1	1982	4,283	721	1	21	L	03-05-82	66	96	Je	N	325	700
30	(C-2-1)3dba-1	1975	4,270	22	2	7	B	05-06-83	—	—	De	N	16	22

Table 10. Records of selected wells, Salt Lake Valley, Utah—Continued

Site number	Local well number	Year well drilled	Altitude of land surface (feet)	Well depth (feet)	Re-charge area	Water level (feet)	Water-level source	Water-level date	Top of first confining layer	Bottom of first confining layer	Log types	Depth to consolidated rock (feet)	Top of perforated interval	Bottom of perforated interval	
31	(C-2-1)10aad	1978	4,282	627	1	38	L	06-06-78	2	68	De	N	470	555	MI
32	(C-2-1)10daa	1978	4,307	125	2	25	L	04-16-78	—	—	De	N	40	120	
33	(C-2-1)11ccd-1	1976	4,260	657	N	F	L	—	143	175	De	N	192	308	MI
34	(C-2-1)13dba	1971	4,320	445	1	33	L	06-18-71	—	—	Je	—	—	—	
35	(C-2-1)13dad-02	1975	4,330	175	2	19	L	07-15-75	—	46	De	N	59	65	
36	(C-2-1)14cab-1	1979	4,272	584	1	50	L	09-08-79	250	275	De	N	120	295	
37	(C-2-1)15aca	1985	4,336	288	1	75	L	07-17-85	10	80	De	—	205	270	MI
38	(C-2-1)15abc-1	1982	4,331	20	N	7	B	05-10-84	—	—		—	8	20	
39	(C-2-1)15dac-1	1981	4,304	620	N	+34	B	09-07-84	—	—	De	N	404	417	
40	(C-2-1)16adc	1982	4,438	194	1	72	L	12-01-82	2	28	De	N	180	190	
41	(C-2-1)16dcb	1982	4,493	275	N	+4	L	03-30-82	—	100	De	N	—	—	
42	(C-2-1)21aad-1	1979	4,473	275	Y	103	L	08-29-79	—	—	De	N	205	275	
43	(C-2-1)22bdb-1	1981	4,459	691	1	92	B	09-27-85	155	190	Je	N	653	668	
44	(C-2-1)23dad-1	1972	4,283	391	N	F	L	03-15-72	—	—	De	N	140	380	MI
45	(C-2-1)24adc-1	1895	4,344	127	1	41	B	02-09-83	—	—		—	—	—	
46	(C-2-1)26abb	1982	4,278	20	2	2	B	02-09-84	—	—		—	1	13	
47	(C-2-1)26bbc	1944	4,335	212	1	63	K	08-12-44	—	—		—	—	—	
48	(C-2-1)34aab-1	1977	4,340	103	N	+1	L	07-16-77	—	—	De	N	82	92	
49	(C-2-1)33aaa	1982	4,410	39	2	30	G	10-15-82	—	—		—	29	39	
50	(C-2-1)34bcd	—	4,400	1,300	11	35	K	03-01-36	—	—		—	110	893	
51	(C-2-1)35cdd-1	1982	4,346	180	N	50	L	08-27-82	0	30	De	N	—	—	
52	(C-2-1)35dcc-1	1982	4,294	21	N	7	G	09-21-82	—	—	—	—	3	12	
53	(C-2-1)36bac	1982	4,360	20	2	11	G	07-20-82	—	—	—	—	1	12	
54	(C-2-1)36bcd	1967	4,347	303	1	51	L	03-04-67	95	148	De	N	202	300	MI
55	(C-2-2)1aab-1	1978	4,413	260	N	O	B	02-04-84	—	—	De	N	—	—	
56	(C-2-2)3bbc-1	1985	4,605	176	Y	157	L	12-18-85	—	—	De	N	161	176	
57	(C-2-2)10aca-1	1988	4,855	202	Y	173	L	01-28-88	—	—	De	N	169	202	
58	(C-2-2)11adc	1972	4,720	300	1	51	B	02-06-85	0	30	De	N	265	280	
59	(C-2-2)14bbc-1	1965	4,920	402	1	221	B	09-27-85	40	67	DeJe	N	270	287	
60	(C-2-2)24bbb	1974	4,820	1,107	1	185	L	05-22-75	108	132	DeJKT	N	750	1,107	
61	(C-2-2)25bbb-1	1976	4,820	308	1	158	G	12-21-76	15	55	De	N	—	—	
62	(C-2-2)22cdc	1987	5,170	1,000	Y	360	L	00-00-87	—	—	De	N	300	960	
63	(C-2-2)35acd-1	1977	4,835	280	Y	227	L	08-03-77	—	—	De	N	237	257	
64	(C-2-2)25cca-1	1977	4,780	280	1	100	L	04-20-77	5	56	De	N	216	280	
65	(C-2-2)25cdc-1	1985	4,759	575	1	135	L	05-08-85	20	73	De	N	535	575	
66	(C-2-2)27bcd-1	1980	5,070	270	1	207	L	08-18-80	20	40	De	N	224	260	
68	(C-2-2)27ccc	1975	4,950	1,008	Y	185	L	01-09-75	488	548	JKTeDe	N	240	440	
69	(C-3-1)2abc	1980	4,340	271	1	57	L	12-27-80	1	29	De	N	246	248	
70	(C-3-1)2cab-1	1965	4,357	12	2	9	G	09-08-65	—	—	—	—	10	12	
71	(C-3-1)5ddd-1	1986	4,554	400	1	129	K	08-28-86	—	—	—	N	360	380	
72	(C-3-1)7cbb-2	1976	4,800	700	1	190	G	03-13-76	20	52	Je	N	242	256	
73	(C-3-1)11cbc-1	1977	4,397	170	N	+7	L	04-29-77	15	60	De	N	80	160	
74	(C-3-1)12ccb-1	—	4,322	118	N	+23	B	09-27-85	—	—	—	—	—	—	
75	(C-3-1)13bac-1	1968	4,377	125	1	52	L	04-29-68	2	44	De	N	100	115	
76	(C-3-1)13acd	1985	4,385	11	2	5	L	00-00-85	—	—	De	N	4	11	

Table 10. Records of selected wells, Salt Lake Valley, Utah—Continued

Site number	Local well number	Year well drilled	Altitude of land surface (feet)	Well depth (feet)	Recharge area	Water level (feet)	Water-level source	Water-level date	Top of first confining layer	Bottom of first confining layer	Log types	Depth to consolidated rock (feet)	Top of perforated interval	Bottom of perforated interval	
77	(C-3-1)14acc	1982	4,389	20	2	7	G	08-17-82	—	—	—	—	8	20	
78	(C-3-1)14bbc	1977	4,432	395	1	60	L	04-22-77	40	97	De	N	270	395	
79	(C-3-1)15dda-1	—	4,394	360	1	+31	B	09-20-85	—	—	—	—	—	—	
80	(C-3-1)15cbc-2	1986	4,475	390	1	49	K	04-28-87	—	—	—	—	365	380	
81	(C-3-1)15cbc-1	1986	4,475	135	1	45	K	04-28-87	—	—	—	—	115	135	
83	(C-3-1)19aaa-2	1986	4,757	387	1	152	K	04-28-87	215	320	De	N	335	355	
84	(C-3-1)20ddb-1	1963	4,570	346	Y	136	B	02-16-84	—	—	De	N	170	320	
85	(C-3-1)22cdb	1983	4,450	165	Y	18	L	08-15-83	—	—	De	N	—	—	
86	(C-3-1)22dda	1979	4,402	232	N	+1	L	02-26-79	4	25	De	N	192	232	
87	(C-3-1)25cab	1962	4,405	191	1	49	L	05-14-62	29	118	De	N	143	185	
88	(C-3-1)25cac-1	1982	4,409	19	2	7	B	05-10-84	—	—	—	—	7	19	
89	(C-3-1)27acb	1977	4,428	180	1	30	L	04-17-77	0	32	De	N	—	—	
90	(C-3-1)28ada-1	1982	4,465	96	Y	32	L	10-10-82	—	—	De	N	90	95	
91	(C-3-1)29ddb-1	1977	4,568	205	1	120	L	05-04-77	32	54	De	N	—	—	
92	(C-3-1)30dcd	1980	4,682	205	Y	60	L	03-31-80	—	—	De	N	180	200	
93	(C-3-1)30acd-1	1957	4,690	420	N	24	B	02-06-85	—	—	De	N	50	—	
94	(C-3-1)30acc-1	1986	4,684	60	Y	22	K	04-28-87	—	—	—	—	40	60	
95	(C-3-1)31cbb-1	1959	4,765	400	1	95	L	04-03-59	10	42	De	N	98	—	
96	(C-3-1)31dcd-03	1954	4,692	625	Y	132	L	02-11-54	—	—	De	N	138	615	MI
97	(C-3-1)32baa-1	1975	4,620	120	Y	35	L	02-26-75	—	—	De	N	—	—	
98	(C-3-1)32dba-1	1982	4,582	150	1	10	L	10-17-82	0	70	De	N	—	—	
99	(C-3-1)35caa	1988	4,412	170	1	44	L	11-14-88	1	122	De	N	—	—	
100	(C-3-1)36bba-1	1973	4,407	701	1	73	L	07-04-73	—	—	De	N	200	545	
101	(C-3-2)2abc-2	1989	4,880	620	Y	199	L	04-18-89	—	—	De	N	330	544	MI
102	(C-3-2)1ccc	1986	4,878	610	Y	184	L	02-10-86	—	—	De	N	380	590	MI
103	(C-3-2)12dbc-1	1964	4,862	360	Y	190	L	07-20-64	—	—	De	N	200	280	
104	(C-3-2)36ddd-1	1975	4,800	190	Y	140	L	06-07-75	—	—	De	N	140	187	
105	(C-4-1)2bca	1963	4,363	250	N	+1	L	04-13-63	—	—	—	N	230	250	
106	(C-4-1)3cdd	1977	4,447	115	1	50	L	02-24-77	15	59	De	N	—	—	
107	(C-4-1)4cba	1975	4,540	203	1	88	L	11-01-75	96	118	De	N	174	199	
108	(C-4-1)5caa	1963	4,610	278	Y	163	L	01-12-63	—	—	De	N	235	273	
109	(C-4-1)6dad	1985	4,670	220	1	98	L	03-26-85	122	154	De	N	180	200	
110	(C-4-1)6adc-1	1955	4,690	355	Y	111	G	09-08-66	—	—	De	N	125	320	
111	(C-4-1)8acd-1	1975	4,660	230	1	145	L	11-28-75	2	35	De	N	177	230	
112	(C-4-1)9abb-1	1975	4,500	200	Y	84	L	08-08-75	—	—	De	N	125	200	
113	(C-4-1)10cda-1	1974	4,520	205	Y	120	B	10-22-74	—	—	De	N	—	—	
114	(C-4-1)10ddc-1	1980	4,414	520	N	15	L	08-14-80	20	100	De	N	140	490	
115	(C-4-1)11dab-1	1975	4,440	290	1	41	L	12-03-75	0	127	De	—	140	275	MI
116	(C-4-1)12bcb-1	1979	4,467	410	N	+7	L	11-19-79	5	45	De	45	—	—	
117	(C-4-1)12dda-1	1977	4,647	800	N	F	L	08-13-77	—	—	De	123	140	880	MI
118	(C-4-1)13bab-1	1974	4,640	140	N	27	L	04-05-74	—	—	De	38	100	120	
119	(C-4-1)14ada	1982	4,545	250	Y	124	L	11-16-82	—	—	De	N	180	220	
120	(C-4-1)14abd-1	1963	4,502	218	1	68	B	09-27-85	70	145	DeJKTe	N	—	—	
121	(C-4-1)15bdc-2	1963	4,590	607	1	144	B	02-16-83	85	137	De	N	180	522	
122	(C-4-1)15bcb	1983	4,618	361	Y	200	L	09-02-83	—	—	De	N	221	361	

Table 10. Records of selected wells, Salt Lake Valley, Utah—Continued

Site number	Local well number	Year well drilled	Altitude of land surface (feet)	Well depth (feet)	Re-charge area	Water level (feet)	Water-level source	Water-level date	Top of first confining layer	Bottom of first confining layer	Log types	Depth to consolidated rock (feet)	Top of perforated interval	Bottom of perforated interval	
123	(C-4-1)22dbd-1	1963	4,600	188	Y	80	B	02-10-83	—	—	De	N	102	188	
124	(C-4-1)23bac-1	1968	4,591	260	Y	145	L	01-26-68	—	—	DJTe	N	160	254	MI
125	(C-4-1)23dbd-1	1964	4,495	152	1	45	B	09-27-85	0	50	GJe	Y	74	—	
126	(C-4-1)26baa-1	1989	4,482	252	1	15	L	04-11-89	25	48	De	N	160	250	
127	(C-4-1)27aad	1987	4,655	260	Y	20	L	03-28-87	—	—	De	N	100	150	
128	(D-4-1)5aba	1987	4,528	222	Y	70	L	05-14-87	174	222	De	N	143	174	
129	(D-4-1)6caa-1	1974	4,460	210	Y	53	L	12-31-74	—	—	De	5	—	—	
130	(D-4-1)6bbc-1	1963	4,426	190	1	55	B	08-04-64	15	48	De	N	—	—	
131	(D-4-1)7bbb-1	1974	4,520	167	Y	85	L	06-18-74	—	—	De	N	120	164	MI
132	(D-3-1)32bdd-2	1985	4,483	236	1	65	L	05-15-85	121	142	De	N	230	235	
133	(D-3-1)32cda	1982	4,487	13	2	7	G	12-06-82	—	—	—	—	—	—	
134	(D-3-1)33cad	1986	4,572	317	1	123	L	07-01-86	207	224	De	N	162	299	MI
135	(D-3-1)33cab	1977	4,543	200	2	93	L	09-07-77	—	—	De	N	—	—	
136	(D-3-1)27bbd-1	1976	4,715	600	Y	290	L	04-22-76	—	—	De	N	335	527	
137	(D-3-1)28cca	1934	4,548	455	1	122	L	09-27-34	26	103	De	N	155	365	
138	(D-3-1)21dbc-1	1974	4,720	307	1	235	—	—	75	165	De	N	250	255	
139	(D-3-1)22bcb-1	1954	4,760	667	Y	387	L	10-04-65	—	—	DJKTe	N	—	—	
140	(D-3-1)21aaa	1988	4,802	497	1	385	L	08-02-88	156	182	De	N	420	480	
141	(D-3-1)15adc-1	1955	4,810	606	1	320	L	07-08-55	104	198	De	Y	198	605	MI
142	(D-3-1)14bbd	1980	4,875	90	Y	80	L	06-23-80	—	—	De	N	80	90	
143	(D-3-1)8aba-1	1954	4,620	531	Y	280	B	02-16-82	—	—	—	—	243	—	
144	(D-3-1)8bcb-1	1976	4,520	1,110	1	198	L	05-23-79	98	134	DJKTe	N	—	—	
145	(D-3-1)5cdb-1	1980	4,560	14	2	8	B	02-07-84	—	—	—	—	—	—	
146	(D-3-1)4bbb-1	1967	4,670	904	1	322	L	10-11-67	164	191	DeJKTe	N	406	—	
147	(D-2-1)33dda	1980	4,700	724	Y	330	L	09-01-77	—	—	De	N	396	715	MI
148	(D-2-1)33add-3	1956	4,632	301	1	291	B	02-22-78	20	46	De	N	264	300	
149	(D-2-1)34ada-2	1978	4,760	128	2	98	L	12-09-78	—	—	De	N	98	108	
150	(D-2-1)34ada-1	1972	4,760	385	1	370	L	08-15-72	170	280	De	N	—	—	
151	(D-2-1)35bbb-1	1972	4,889	238	Y	216		—	—	—	D	—	—	—	
152	(D-2-1)26bda	1979	4,848	425	Y	—	L	—	—	—	De	N	—	—	
153	(D-2-1)14ccd-2	1959	4,598	576	3	207	G	02-17-65	87	131	De	N	267	558	MI
154	(D-2-1)14bbb-1	1981	4,448	157	1	92	L	03-28-81	25	111	De	N	112	156	MI
155	(D-2-1)10cdb-6	1966	4,400	300	1	32	L	04-29-66	47	67	DeJe	N	245	295	
156	(D-2-1)3bda	1977	4,530	118	2	35	L	09-19-77	—	—	De	N	—	—	
157	(D-2-1)3abc-1	1957	4,560	220	1	175	L	06-25-57	0	21	De	N	200	220	
158	(D-2-1)2bbb-3	1950	4,655	332	Y	293	G	10-02-81	—	—	De	N	301	332	MI
159	(D-2-1)5aba-2	1950	4,310	247	N	+5	G	06-02-64	0	52	De	N	242	247	
160	(D-2-1)8abd	1980	4,320	185	N	—	B	10-13-83	0	84	De	N	—	—	
161	(D-2-1)16bba-2	1956	4,350	604	N	F	L	01-27-66	43	170	DeJKTe	N	253	585	
162	(D-2-1)16dbc-1	1961	4,400	—	1	41	B	12-03-68	—	—	—	—	—	—	
163	(D-2-1)16dcb	1970	4,410	30	2	8	L	00-00-70	—	—	De	N	5	25	
164	(D-2-1)17caa-1	1982	4,362	30	N	11	G	08-10-82	—	—	—	—	—	—	
165	(D-2-1)17cda-38	1954	4,356	455	N	3	L	07-19-88	20	40	JKTeDe	N	402	437	
166	(D-2-1)18dcd	1977	4,360	65	2	10	L	00-00-77	14	35	De	N	—	—	
167	(D-2-1)19aaa-1	—	4,380	121	1	38	L	09-25-85	—	—	—	—	—	—	

Table 10. Records of selected wells, Salt Lake Valley, Utah—Continued

Site number	Local well number	Year well drilled	Altitude of land surface (feet)	Well depth (feet)	Re-charge area	Water level (feet)	Water-level source	Water-level date	Top of first confin-ing layer	Bottom of first confin-ing layer	Log types	Depth to consol-idated rock (feet)	Top of perfor-ated interval	Bottom of perfor-ated interval	
168	(D-1-1)34dcb	1959	4,575	487	Y	268	L	03-17-59	—	—	De	N	275	—	
169	(D-1-1)35cdd-1	1965	4,790	580	Y	370	L	02-03-65	—	—	DeEJTe	N	382	577	
170	(D-1-1)35dbc	1969	4,860	700	1	440	L	05-14-69	23	60	De	N	500	700	
171	(D-1-1)25ccb-2	1956	4,920	546	Y	120	L	04-23-56	158	235	De	N	—	—	
172	(D-1-1)26ddc-4	1953	4,880	600	1	250	B	05-05-65	7	59	DeJ	—	190	—	
173	(D-1-1)26bbc-1	1960	4,720	470	1	310	L	11-30-60	6	57	DJKTe	N	314	470	MI
174	(D-1-1)15bdc	1957	4,610	230	1	73	G	04-04-58	42	172	De	226	185	204	
175	(D-1-1)10cac-1	1934	4,695	240	Y	143	—	07-23-65	61	72	JKTe	—	155	238	
176	(D-1-1)9aca-1	—	—	486	1	150	—	—	65	96	JKTe	—	—	—	
177	(D-1-1)9bab-1	1955	4,630	470	Y	140	G	—	0	140	D	—	175	463	MI
178	(D-1-1)6dbd	1981	4,276	310	1	60	L	06-20-81	35	85	De	N	10	60	
179	(D-1-1)7aca	1977	4,253	160	N	+25	L	06-03-77	2	58	De	N	106	155	
180	(D-1-1)18aaa-3	1900	4,265	300	N	+18	G	03-02-32	—	—	—	—	—	—	
181	(D-1-1)20ddd-2	1977	4,417	502	1	47	L	08-19-77	140	160	De	N	160	490	MI
182	(D-1-1)29dba-1	1966	4,362	480	N	+8	L	06-18-66	43	76	DeJTe	N	400	480	
183	(D-1-1)34cbc-1	1959	4,523	234	1	146	L	07-11-59	83	128	De	N	160	—	
184	(D-1-1)33ddd-1	1964	4,490	664	1	122	L	08-08-64	52	72	Je	N	295	650	MI
185	(D-1-1)22cad-1	1966	4,520	606	3	150	L	08-10-66	140	170	DeJe	N	160	570	MI

Table 11. Records of selected wells, Utah and Goshen Valleys, Utah

[—, no data]

Site number: See plate 5 for well location.

Local well number: See text for explanation of numbering system for hydrologic-data sites.

Altitude: In feet above sea level.

Well depth: In feet below land surface.

Recharge area: Y, primary recharge area; 1, secondary recharge area—well completed in principal aquifer; 2, secondary recharge area—well completed in shallow unconfined aquifer; 3, secondary recharge area—one of a pair of wells completed in the shallow unconfined or principal aquifer used to determine vertical hydraulic gradients; N, discharge area.

Water level: In feet below land surface; values above (+) land surface; F, water level above land surface and well flowing.

Water-level source: B, published data report; L, drillers' log; G, U.S. Geological Survey data base.

Top of first confining layer: In feet below land surface.

Bottom of first confining layer: In feet below land surface.

Log types: e, indicates log was examined as part of this study; D, drillers' log; E, electric log; G, geologist's log; J, gamma log; K, fluid conductivity log; T, fluid temperature log.

Depth to consolidated rock: In feet below land surface; N, not encountered; Y, encountered, depth uncertain.

Top of perforated interval: In feet below land surface.

Bottom of perforated interval: In feet below land surface; MI, multiple perforated intervals within indicated interval.

Site number	Local well number	Year well drilled	Altitude of land surface (feet)	Well depth (feet)	Re-charge area	Water level (feet)	Water-level source	Water-level date	Top of first confining layer	Bottom of first confining layer	Log types	Depth to consolidated rock (feet)	Top of perforated interval	Bottom of perforated interval
1	(D-4-1)31bbd	1977	4,700	341	Y	143	B	06-29-82	—	—	De	—	190	340
2	(D-4-1)31bcb	1980	4,730	480	1	60	L	01-19-80	0	55	De	—	150	300
3	(D-4-1)32bbc	1978	4,685	405	1	125	L	08-01-78	2	40	De	—	181	397 MI
4	(D-4-1)33acd	1981	4,797	316	1	220	L	03-22-81	53	122	De	N	—	—
5	(D-4-1)34bdc-1	1973	4,820	355	Y	213	G	10-08-80	—	—	De	N	320	330
6	(D-4-1)34cbc	1969	4,790	302	1	195	L	06-14-69	62	111	De	N	275	290
7	(D-4-1)35bcd-1	—	4,840	26	2	21	G	04-03-58	—	—	—	—	—	—
8	(D-4-1)26aac-1	1965	4,917	+615	Y	330	L	07-18-65	—	—	De	605	465	615
9	Site number not used.													
10	Site number not used.													
11	(D-4-1)36adc-1	1977	4,940	577	Y	325	G	05-5-82	0	325	De	552	380	574
12	(D-4-1)36cdd-1	1971	4,887	555	1	286	G	03-31-81	152	206	De	N	330	546
13	(D-5-1)01aaa-1	1961	4,895	522	Y	285	B	07-15-82	—	—	De	N	340	500
14	(D-5-1)01daa-1	—	4,860	600	Y	358	G	01-15-76	—	—	D	452	240	589 MI
15	(D-5-1)01dba-1	—	4,860	201	1	131	G	04-22-78	43	87	De	N	101	173
16	(D-5-1)06baa-1	1977	4,565	225	1	38	G	11-04-80	2	30	De	N	170	221 MI
17	(D-5-1)06bcd-1	1981	4,537	294	N	1	B	06-29-82	0	80	EGJe	N	—	—
18	(D-5-1)05bdb-1	1946	4,660	22	2	12	G	04-17-58	—	—	—	—	—	—
19	(D-5-1)05daa-1	1972	4,630	168	1	51	G	11-02-80	60	95	De	N	150	165
20	(D-5-1)06ddd-1	1968	4,557	168	1	9	G	12-12-80	5	95	De	N	160	186
21	(D-5-1)07acc-1	1969	4,524	197	N	+17	G	10-22-80	—	65	De	N	188	196
22	(D-5-1)08aaa-3	1956	4,600	709	1	11	B	04-13-82	129	144	De	N	305	—
23	(D-5-1)08daa-1	1953	4,580	310	N	+10	B	04-13-82	17	82	De	N	—	—
24	(D-5-1)10bdd-1	—	4,680	21	2	7	G	12-09-80	—	—	—	—	—	—
25	(D-5-1)10caa	1989	4,679	239	1	98	L	06-23-89	73	138	De	N	—	—
26	(D-5-1)15abb	1986	4,587	198	N	F	L	05-25-86	2	31	De	N	—	—
27	(D-5-1)14adb-1	1934	4,655	350	1	88	B	03-30-81	—	—	—	—	84	345
28	(D-5-1)14bdc-1	1968	4,585	910	N	12	G	03-30-81	98	123	Je	N	424	850 MI
29	(D-5-1)23abc-1	1975	4,584	269	N	+7	G	10-24-80	24	63	De	N	—	—
30	(D-5-1)24ddd-4	1946	4,548	106	N	+11	B	06-18-82	14	80	De	N	—	—

Table 11. Records of selected wells, Utah and Goshen Valleys, Utah—Continued

Site number	Local well number	Year well drilled	Altitude of land surface (feet)	Well depth (feet)	Recharge area	Water level (feet)	Water-level source	Water-level date	Top of first confining layer	Bottom of first confining layer	Log types	Depth to consolidated rock (feet)	Top of perforated interval	Bottom of perforated interval	
31	(D-5-1)24aaa-3	1962	4,600	105	1	41	G	11-19-80	35	87	De	N	97	105	
32	(D-5-1)24aad-1	1944	4,598	42	2	19	L	08-17-44	—	—	De	N	—	—	
33	(D-5-2)07aad-1	1955	4,830	415	Y	160	G	11-18-80	165	195	De	N	195	410	MI
34	(D-5-2)07aac-1	1954	4,788	363	1	185	L	09-17-54	85	125	De	N	233	363	MI
35	(D-5-2)07ddc-1	—	4,730	15	2	5	B	03-2-82	—	—	—	—	—	—	
36	(D-5-2)18aba-1	1972	4,746	315	1	168	B	06-29-82	83	103	De	N	—	—	
37	(D-5-2)17abc-1	1977	4,725	212	1	141	G	09-29-80	30	105	De	N	186	197	MI
38	(D-5-2)16cdc-1	1965	4,820	285	1	240	L	12-18-65	18	77	De	N	265	280	
39	(D-5-2)19abc-1	—	4,581	27	2	16	B	03-08-82	—	—	—	—	—	—	
40	(D-5-2)19abd-1	1971	4,570	309	N	+19	G	07-08-80	3	44	De	N	280	300	
41	(D-5-2)20bbc-1	1968	4,582	118	1	24	G	07-08-80	3	40	De	N	—	—	
42	(D-5-2)20cba-4	1934	4,552	265	N	+31	B	03-08-82	—	—	—	—	—	—	
43	(D-5-2)21ddb-1	1954	4,820	532	1	254	G	03-18-81	28	48	De	N	309	530	MI
44	(D-5-2)22bcc-1	1982	4,965	600	Y	415	L	04-07-82	—	—	De	410	300	535	MI
45	(D-5-2)29acb-1	1935	4,545	100	N	+14	G	10-26-81	3	84	De	N	94	—	
46	(D-5-2)27baa-1	1976	5,042	580	Y	495	G	03-28-81	—	—	De	452	529	570	
47	(D-5-2)27cca-1	1968	4,780	478	1	218	G	03-28-81	36	99	De	N	295	468	MI
48	(D-5-2)29dbd-12	1955	4,540	120	N	+17	G	03-09-81	1	65	De	N	73	—	
49	(D-5-2)33bbd-1	1947	4,575	415	N	8	G	03-17-81	—	—	—	—	150	200	
50	(D-5-2)33acd-1	1962	4,640	431	1	185	L	09-29-62	43	199	De	N	355	430	
51	(D-6-2)5ddb-1	1961	4,552	1,098	N	5	L	05-10-61	—	—	De	N	800	1,060	MI
52	(D-6-2)8acb-1	1950	4,543	1,190	N	+8	B	03-29-82	40	116	De	N	786	1,158	MI
53	(D-6-2)9bcb-1	1977	4,580	480	Y	41	G	08-25-77	—	—	De	N	360	480	
54	(D-6-2)9ccc-1	1981	4,575	467	1	30	B	09-09-82	64	140	DeJe	N	—	—	
55	(D-6-2)10adc-1	—	4,652	25	2	17	G	04-16-58	—	—	D	N	—	—	
56	(D-6-2)11bcc-1	1946	4,782	469	1	218	L	04-15-46	—	—	De	—	409	—	
57	(D-6-2)12bdb-1	1961	4,853	923	1	306	B	06-30-82	178	204	De	Y	370	880	MI
58	(D-6-2)11cdd-1	1961	4,805	545	1	260	L	07-21-61	156	185	De	N	463	539	
59	(D-6-2)17acb-1	1923	4,538	328	N	+15	G	04-16-58	—	—	—	—	—	—	
60	(D-6-2)16bbd-1	1963	4,580	382	1	48	L	09-06-63	—	—	De	N	145	382	MI
61	(D-6-2)16bda-1	1936	4,615	15	2	1	G	04-16-58	—	—	—	—	—	—	
62	(D-6-2)16ccc-2	1977	4,540	150	N	+15	G	12-24-77	0	20	De	N	—	—	
63	(D-6-2)15ccd-1	1963	4,746	145	1	12	L	06-24-63	87	116	De	N	116	145	
64	(D-6-2)15add-1	1959	4,767	299	Y	222	L	05-21-59	—	—	De	N	285	—	
65	(D-6-2)13cdd-1	1960	4,750	259	Y	201	L	08-25-60	—	—	De	N	231	252	
66	(D-6-2)24aaa-1	1978	4,720	233	Y	170	G	09-30-80	—	—	De	N	—	—	
67	(D-6-2)24aab-1	1976	4,720	180	1	145	G	03-26-76	15	132	De	N	—	—	
68	(D-6-2)23bad	1960	4,757	366	1	220	L	03-10-60	160	285	De	N	298	365	
69	(D-6-2)22dbd-2	1978	4,715	244	1	170	G	12-16-80	—	185	De	N	—	—	
70	(D-6-2)22dbd-1	1975	4,720	45	2	21	L	04-10-75	—	—	De	N	10	23	
71	(D-6-2)22ccb	1976	4,618	550	1	56	L	04-21-76	5	194	De	N	309	525	
72	(D-6-2)21cdc-2	1940	4,535	249	N	+4	B	03-07-78	3	96	De	N	—	—	
73	(D-6-2)27bcc-1	1974	4,560	132	1	14	G	12-16-80	40	102	De	N	—	—	
74	(D-6-2)28ddd-2	1935	4,528	270	N	+18	B	06-30-82	3	37	—	—	—	—	
75	(D-6-2)27cdd	1984	4,558	184	1	18	L	07-15-84	38	83	De	N	130	181	

Table 11. Records of selected wells, Utah and Goshen Valleys, Utah—Continued

Site number	Local well number	Year well drilled	Altitude of land surface (feet)	Well depth (feet)	Re-charge area	Water level (feet)	Water-level source	Water-level date	Top of first confin-ing layer	Bottom of first confin-ing layer	Log types	Depth to consol-idated rock (feet)	Top of perfor-ated interval	Bottom of perfor-ated interval	
76	(D-6-2)26cca-1	1976	4,730	338	Y	188	G	07-31-80	—	—	De	N	320	326	
77	(D-6-2)26cdd-1	1974	4,720	340	Y	190	G	07-31-80	—	—	De	N	320	340	
78	(D-6-2)25bcb-1	1955	4,747	700	1	196	G	03-30-81	98	274	De	N	447	684	
79	(D-6-2)34caa-6	1976	4,535	275	N	+8	G	03-19-81	225	260	De	N	—	—	
80	(D-6-2)36bcd-1	1956	4,588	186	1	33	L	01-16-56	14	106	De	N	152	—	
81	(D-6-3)18dcc-1	1974	4,880	305	Y	275	B	06-30-82	—	—	De	300	—	—	
82	(D-6-3)19cba-1	1965	4,718	562	1	169	G	03-24-81	58	145	DeJKTe	N	230	515	MI
83	(D-6-3)19cab-1	1989	4,778	30	2	8	L	04-13-89	25	—	De	N	10	30	
84	(D-6-3)30aac-1	1979	4,900	550	1	442	L	10-17-79	—	65	De	N	—	—	
85	(D-6-3)30caa-1	—	4,760	264	1	228	L	02-28-78	100	198	De	N	—	—	
86	(D-6-3)30ddc-1	1968	4,830	545		284	L	09-24-68	—	—	De	N	370	539	MI
87	(D-6-3)31cab-2	1956	4,670	581	1	106	B	03-24-81	20	55	DeJKTe	N	480	—	
88	(D-7-2)2bbb-1	1947	4,535	340	N	+15	G	12-15-80	5	60	De	N	—	—	
89	(D-7-2)1bbb-1	1961	4,560	500	1	20	L	11-20-85	28	140	De	—	200	395	MI
90	(D-7-2)2adb-1	1970	4,545	200	N	2	G	12-17-80	—	—	De	N	150	200	
91	(D-7-3)6cdc-3	1938	4,545	250	N	+5	B	03-02-82	—	—	—	—	—	—	
92	(D-7-3)6dad	1988	4,548	22	N	3	L	06-28-88	—	—	De	N	10	20	
93	(D-7-3)7adc-1	1960	4,568	535	1	14	B	06-30-82	0	42	De	N	298	528	
94	(D-7-3)8caa-1	1970	4,765	460	Y	204	L	09-04-70	—	—	—	—	—	—	
95	(D-7-3)18daa-1	1981	4,499	35	N	F	L	03-04-81	20	35	De	N	25	35	
96	(D-7-3)20adb-1	1970	4,520	353	N	+1	L	03-11-70	38	80	De	N	115	350	
97	(D-7-3)28bdb-1	1963	4,520	338	N	+24	B	10-21-81	12	66	DeJe	N	270	330	
98	(D-7-3)33aab-1	1984	4,559	150	N	F	L	07-15-84	32	55	De	N	—	—	
99	(D-7-3)34cbb-1	1960	4,650	445	N	+59	G	02-06-67	—	—	D	N	—	—	
100	(D-8-1)3dda-1	1967	4,523	77	Y	33	L	11-10-67	—	—	De	15	70	75	
101	(D-8-1)10bcb-1	—	4,520	275	Y	19	L	04-30-76	—	—	De	200	—	—	
102	(D-8-1)11cbd-1	1940	4,494	151	1	8	G	04-02-64	6	40	De	N	—	—	
103	(D-8-1)14cdc-1	1975	4,515	250	N	+1	L	03-16-75	—	—	De	N	—	—	
104	(D-8-1)20abb-1	1984	4,510	205	1	8	L	09-14-84	60	160	De	200	—	—	
105	(D-8-1)26caa-1	1977	4,640	126	1	76	L	09-10-77	1	101	De	N	—	—	
106	(D-8-1)26dad-1	1973	4,518	310	N	F	L	10-10-73	4	105	De	N	—	—	
107	(D-8-1)35cab-1	1964	4,580	295	1	75	G	03-17-65	93	140	De	N	140	270	
108	(D-8-1)35adc	1979	4,522	280	N	+3	L	08-01-79	0	60	De	N	—	—	
109	(D-8-2)13acd-1	1964	4,556	373	N	F	L	06-05-64	15	134	De	N	—	—	
110	(D-8-2)13daa	1989	4,555	25	2	7	L	09-20-89	—	—	De	N	5	25	
111	(D-8-2)13ccc-1	1972	4,560	193	1	12	L	12-01-72	0	20	De	N	—	—	
112	(D-8-2)14dcc-1	1939	4,555	377	N	+14	G	07-09-65	—	—	—	—	—	—	
113	(D-8-2)23adc-2	1960	4,565	180	1	14	G	09-15-64	47	105	Je	N	—	—	
114	(D-8-2)23dca-2	1940	4,560	569	N	+17	B	03-20-67	15	200	De	N	475	500	
115	(D-8-2)26bbb-1	1973	4,560	260	1	40	L	09-20-73	120	180	De	N	246	256	

Table 11. Records of selected wells, Utah and Goshen Valleys, Utah—Continued

Site number	Local well number	Year well drilled	Altitude of land surface (feet)	Well depth (feet)	Recharge area	Water level (feet)	Water-level source	Water-level date	Top of first confining layer	Bottom of first confining layer	Log types	Depth to consolidated rock (feet)	Top of perforated interval	Bottom of perforated interval	
116	(D-8-2)26bcd-1	1988	4,550	320	N	+35	L	08-19-88	—	42	De	N	—	—	
117	(D-8-2)25bca-1	1978	4,610	280	1	27	L	12-30-78	140	200	De	N	—	—	
118	(D-8-2)25cdc	1968	4,564	210	N	+7	L	10-09-68	160	180	De	N	—	—	
119	(D-8-2)36dcb-3	1963	4,640	55	2	13	L	09-26-63	—	—	De	N	20	40	
120	(D-8-2)36dcd-1	1974	4,640	278	1	45	L	02-04-74	53	80	De	N	—	—	
121	(D-8-3)3aab-1	1978	4,733	275	1	150	L	08-11-78	153	173	De	N	—	—	
122	(D-8-3)4daa-1	1961	4,629	371	1	46	G	07-01-65	65	100	De	N	145	370	MI
123	(D-8-3)4cad-1	1935	4,580	231	N	+51	L	06-18-35	—	—	De	N	—	—	
124	(D-8-3)2dcd-1	1954	4,805	533	1	222	G	03-19-65	60	120	De	N	238	533	MI
125	(D-8-3)1ccc-1	1981	4,820	305	Y	101	L	05-10-81	—	—	De	60	62	300	MI
126	(D-8-3)11caa-1	1983	4,770	215	1	180	G	06-19-89	92	153	De	N	—	—	
127	(D-8-3)9bbc-1	1972	4,600	630	1	117	L	02-01-72	46	180	De	N	296	600	MI
128	(D-8-3)18aaa-3	1960	4,550	171	1	3	L	08-04-60	3	40	De	N	—	—	
129	(D-8-3)18bbd-2	1962	4,545	168	N	+8	L	11-02-62	40	152	De	N	158	168	
130	(D-8-3)14aac-1	1975	4,800	229	1	187	L	06-27-75	5	45	De	N	—	—	
131	(D-8-3)14dab-1	1972	4,800	363	Y	210	L	02-25-72	—	—	De	N	288	—	
132	(D-8-3)14acc-1	1963	4,775	675	1	172	G	01-23-90	0	82	KDeJTe	N	189	675	MI
133	(D-8-3)23dbb-1	1967	4,910	350	1	161	L	12-29-67	3	65	De	N	187	328	MI
134	(D-8-3)26ccb-1	1940	5,000	400	1	266	G	03-23-65	3	27	De	N	365	400	
135	(D-8-3)27dbb-1	1977	4,780	220	1	50	L	03-09-77	0	70	De	N	135	220	MI
136	(D-8-3)27cdc-1	1963	4,780	640	Y	169	G	06-30-65	—	—	De	N	220	589	MI
137	(D-8-3)34bbb-1	1973	4,720	151	1	70	G	01-25-90	110	130	De	N	135	146	
138	(D-8-3)33cab-1	1978	4,700	453	1	180	L	10-13-78	0	20	De	80	100	453	
139	(D-8-3)33cac-2	1973	4,800	693	Y	5	L	02-28-73	—	—	De	60	353	693	
140	(D-9-1)2cab-1	1973	4,700	210	Y	183	G	06-26-89	—	—	De	N	—	—	
141	(D-9-1)1bcb-2	1973	4,540	425	N	+8	L	11-19-73	3	24	De	N	—	—	
142	(D-9-1)2ddd-1	1945	4,556	60	2	5	L	11-14-45	—	40	De	N	—	—	
143	(D-9-1)1ccc	1978	4,549	265	1	10	L	11-30-78	—	40	De	N	—	—	
144	(D-9-1)11baa-1	1971	4,598	181	Y	58	G	11-14-89	—	—	De	N	118	165	
145	(D-9-1)11acc-2	1982	4,615	85	2	60	G	01-15-82	—	—	—	—	—	—	
146	(D-9-1)11acc-1	1974	4,610	253	1	73	L	07-20-73	34	63	De	N	175	250	
147	(D-9-1)11cca-1	1971	4,618	139	Y	73	L	08-01-71	—	—	De	N	—	—	
148	(D-9-1)14aad-1	1961	4,619	360	1	57	B	03-30-67	0	60	De	N	90	360	
149	(D-9-1)13acc-1	1989	4,608	126	N	4	L	09-12-89	—	18	De	N	—	—	
150	(D-9-1)14ddb-1	1974	4,660	365	1	160	L	10-03-74	60	80	De	235	250	365	
151	(D-9-1)23ada-1	1959	4,665	323	1	22	B	03-25-67	21	45	De	N	44	308	
152	(D-9-1)23acc-2	1977	4,820	373	Y	243	L	05-05-77	—	—	De	N	120	355	MI
153	(D-9-1)24bda	1986	4,655	134	N	+6	L	09-12-86	35	60	De	N	—	—	
154	(D-9-1)24aac-1	1958	4,630	110	1	8	G	10-14-64	0	71	De	N	—	—	
155	(D-9-1)23dcb-1	1970	4,760	205	1	114	L	10-22-70	19	55	De	N	126	198	
156	(D-9-1)25acc	1978	4,718	210	1	45	L	09-05-78	—	—	De	N	168	175	
157	(D-9-1)25ada-1	1934	4,680	124	N	+13	G	07-20-89	0	40	De	N	—	—	
158	(D-9-1)27aca-1	1943	4,765	320	Y	227	G	10-25-89	—	—	De	70	—	—	
159	(D-9-1)35aba-1	1963	4,798	435	1	103	G	03-29-67	2	23	De	N	145	430	
160	(D-9-1)36bbc-1	1961	4,798	386	Y	99	L	07-09-61	—	—	De	N	—	—	

Table 11. Records of selected wells, Utah and Goshen Valleys, Utah—Continued

Site number	Local well number	Year well drilled	Altitude of land surface (feet)	Well depth (feet)	Re-charge area	Water level (feet)	Water-level source	Water-level date	Top of first confin-ing layer	Bottom of first confin-ing layer	Log types	Depth to consol-idated rock (feet)	Top of perfor-ated interval	Bottom of perfor-ated interval	
161	(D-9-1)25dcd-1	1985	4,758	181	Y	30	L	07-30-85	—	—	De	N	—	—	
162	(D-9-1)12acc-2	1980	4,570	160	N	+5	L	02-15-80	94	115	De	N	115	140	
163	(D-9-2)1baa-11	1944	4,597	200	N	—	L	08-31-44	10	40	De	N	—	—	
164	(D-9-2)1aab-1	1976	4,640	254	1	61	L	10-11-76	15	37	De	N	—	—	
165	(D-9-2)1dcc-1	1957	4,662	288	1	76	L	06-15-57	240	284	De	N	—	—	
166	(D-9-2)11aaa-1	1933	4,585	320	N	+31	B	03-25-67	45	91	—	N	—	—	
167	(D-9-2)12aab-1	1981	4,670	500	1	60	L	01-06-81	20	115	De	N	—	—	
168	(D-9-2)11ddd-1	1940	4,710	137	1	95	L	11-20-40	0	100	De	N	—	—	
169	(D-9-2)10ddb-1	1966	4,600	380	N	+28	G	09-20-89	12	138	DeJ	N	—	—	
170	(D-9-2)10cac-2	1963	4,584	153	N	25	L	07-01-63	40	135	De	N	—	—	
171	(D-9-2)9bac-1	1961	4,610	445	1	37	L	03-12-61	169	202	De	N	50	427	MI
172	(D-9-2)9dab-1	1977	4,580	237	Y	12	L	07-27-77	—	—	De	N	152	162	
173	(D-9-2)9ddb-1	1964	4,588	200	Y	15	G	10-06-64	—	—	De	N	70	80	
174	(D-9-2)4cdc-1	1943	4,582	310	N	+12	G	02-10-67	—	—	—	—	—	—	
175	(D-9-2)8acb-1	1959	4,600	161	N	+6	L	08-31-59	—	—	De	N	—	—	
176	(D-9-2)8bcc-1	1977	4,587	97	N	+2	L	01-27-77	68	73	De	N	—	—	
177	(D-9-2)7abb-1	1956	4,557	173	N	2	G	10-05-64	—	—	De	N	—	—	
178	(D-9-2)7bca-1	1979	4,571	150	Y	35	L	01-08-79	—	—	De	30	—	—	
179	(D-9-2)7dcc-1	1956	4,603	310	Y	12	G	10-05-64	120	160	De	N	—	—	
180	(D-9-2)18bba-1	1969	4,604	80	N	+1	L	05-03-69	20	70	De	N	—	—	
181	(D-9-2)18dad	1948	4,644	50	2	22	L	02-04-48	—	—	De	N	—	—	
182	(D-9-2)17cbc-1	—	4,650	600	1	40	G	04-24-89	85	135	De	N	235	580	MI
183	(D-9-2)17daa-1	1954	4,764	225	Y	159	G	01-18-67	—	—	De	N	160	220	
184	(D-9-2)17ada-1	1961	4,720	166	1	114	G	01-25-90	30	60	De	N	—	—	
185	(D-9-2)16add-1	1971	4,700	111	Y	97	L	08-09-71	—	—	De	N	—	—	
186	(D-9-2)15bbb-2	1976	4,615	215	1	12	L	10-19-76	0	80	De	N	185	200	
187	(D-9-2)15aac-3	1980	4,666	150	1	47	L	04-30-80	55	84	De	N	—	—	
188	(D-9-2)14cbb-2	1971	4,740	135	Y	73	L	08-01-71	—	—	De	N	—	—	
189	(D-9-2)14abc-1	1979	4,712	205	Y	76	L	05-08-79	—	—	De	N	—	—	
190	(D-9-2)12dcc-1	1976	4,760	193	1	132	L	10-12-76	62	129	De	N	160	175	
191	(D-9-2)13ada-1	1980	4,920	270	Y	230	L	04-15-80	—	—	De	N	—	—	
192	(D-9-2)19aca-1	1977	4,645	343	Y	34	L	06-01-77	180	220	De	N	160	34	MI
193	(D-9-2)19ddb-1	1951	4,665	112	1	45	L	11-29-51	77	97	De	N	—	—	
194	(D-9-2)20cba-1	1964	4,720	280	Y	105	L	07-01-64	—	—	De	N	—	—	
195	(D-9-2)20ccd-2	1952	4,738	69	3	25	L	06-07-52	—	—	De	N	—	—	
196	(D-9-2)30aba-1	1978	4,662	125	1	48	L	06-30-78	3	46	De	N	—	—	
197	(D-9-2)30acc-1	1949	4,694	72	N	+12	L	06-22-49	0	35	De	N	—	—	
198	(D-9-2)29acd-1	1950	4,780	70	N	+13	G	08-09-89	—	—	De	—	—	—	
199	(D-9-2)29dbd-2	1989	4,850	200	1	65	L	10-16-89	20	40	De	N	5	150	MI
200	(D-9-2)31aab-1	1973	4,750	173	1	45	L	12-13-73	—	—	De	N	163	173	
201	(D-9-2)32bbb-1	1970	4,800	505	Y	87	L	12-01-70	—	—	De	N	127	500	
202	(D-9-3)5aba-1	1960	4,715	272	1	132	L	01-25-60	80	263	De	—	—	—	
203	(D-9-3)5ccc-2	1971	4,709	189	1	93	L	10-01-71	3	37	De	48	—	—	
204	(D-9-3)5cdc-1	1946	4,820	105	Y	42	L	10-25-46	—	—	De	N	—	—	
205	(D-10-1)2bba-1	1961	4,880	554	Y	145	G	03-14-73	—	—	De	527	270	520	

Table 11. Records of selected wells, Utah and Goshen Valleys, Utah—Continued

Site number	Local well number	Year well drilled	Altitude of land surface (feet)	Well depth (feet)	Re-charge area	Water level (feet)	Water-level source	Water-level date	Top of first confin-ing layer	Bottom of first confin-ing layer	Log types	Depth to consol-idated rock (feet)	Top of perfor-ated interval	Bottom of perfor-ated interval	
206	(D-10-1)5cad-1	1978	4,540	101	N	5	L	04-25-78	0	21	De	N	30	80	
207	(D-10-1)17cca-1	1955	4,515	102	1	32	B	03-08-67	0	80	De	N	80	102	
208	(D-10-1)17dbc-1	1980	4,645	160	Y	120	L	07-22-80	—	—	De	26	—	—	
209	(D-10-1)19bdc-1	1970	4,650	455	1	125	L	08-31-70	0	131	De	N	200	420	
210	(D-10-1)30bac-1	1983	4,840	600	1	260	L	11-02-83	136	177	De	—	300	572	MI
211	(D-9-1)33bbb-1	1934	4,597	214	Y	51	G	03-25-66	—	—	DeJe	N	—	—	
212	(D-9-1)21cdd-1	1925	4,553	135	I	30	L	03-14-36	0	60	De	N	—	—	
213	(D-9-1)21cbc-1	1933	4,510	100	N	—	G	04-10-65	—	—	—	—	—	—	
214	(C-10-1)25aab-1	1964	4,778	645	1	260	G	—	147	208	De	N	372	600	MI
215	(C-10-1)27dba-1	1958	4,744	220	1	220	G	07-01-60	100	150	De	180	—	—	
216	(C-10-1)33cbb-1	1961	4,680	567	1	124	B	03-08-67	40	145	DeJKTe	N	155	567	
217	(C-10-1)32ccc-1	1961	4,740	515	Y	189	L	02-01-61	—	—	De	—	210	—	
218	(C-10-1)29cdd-1	1961	4,680	862	Y	144	G	05-05-64	—	—	De	N	280	574	
219	(C-10-1)29ddd-1	1962	4,660	702	1	114	G	03-08-67	80	120	De	—	162	695	MI
220	(C-10-1)15cdd-1	1951	4,600	168	1	33	B	03-11-67	70	105	DJKTe	N	50	65	
221	(C-10-1)17aaa-1	1957	4,710	517	Y	178	G	04-01-65	—	—	De	N	—	—	
222	(C-10-1)9ccd-1	1977	4,640	360	1	136	L	03-18-77	121	145	De	N	290	350	
223	(C-10-1)11ccd-1	1980	4,547	160	1	7	L	05-19-80	3	35	De	N	150	157	
224	(C-10-1)2bcd-1	—	4,530	60	2	6	B	03-11-67	—	—	—	—	—	—	
225	(C-10-1)2bcc-1	1981	4,526	100	I	20	L	11-03-81	60	100	De	N	—	—	
226	(C-10-1)1aca-1	1964	4,513	60	N	+4	G	04-09-64	—	—	—	—	—	—	
227	(C-10-1)4cbb-1	1962	4,680	1,218	Y	144	L	04-10-62	—	—	DeEe	—	406	850	MI
228	(C-10-1)4bbb-1	1962	4,672	882	1	161	B	03-08-67	14	45	De	N	525	860	
229	(C-9-1)34ddc-1	1961	4,517	292	N	+4		—	0	100	DJe	N	—	—	
230	(C-9-1)34ccc-1	1966	4,551	650	1	29	G	03-08-67	0	50	TeDJe	N	70	650	MI
231	(C-9-1)28ccb-1	1962	4,643	802	Y	128	G	03-03-89	—	—	De	N	350	800	MI
232	(C-9-1)27acc-1	1949	4,504	106	N	2	L	05-28-49	0	97	De	N	—	—	
233	(C-9-1)3ddb-1	1964	4,510	575	Y	19	B	03-08-67	—	—	De	N	190	565	MI
234	(C-8-1)35dcb-1	1945	4,489	212	N	3	G	06-15-64	15	75	De	N	—	—	
235	(C-8-1)34bcc-1	1970	4,535	412	Y	42	L	12-17-70	—	—	De	N	250	350	
236	(C-8-1)29dda-1	1973	4,590	690	Y	89	G	03-02-87	—	—	De	N	100	575	MI
237	(C-8-1)16cbb-1	1949	4,545	392	1	43	L	06-10-49	3	58	De	300	60	240	
238	(C-7-1)26cdd-1	1979	4,495	125	1	22	L	03-05-79	0	20	De	—	—	—	
239	(C-7-1)13adc-1	1973	4,800	452	I	180	L	06-21-73	65	103	De	103	—	—	
240	(D-6-1)19bcd-1	1973	4,720	320	1	12	L	09-01-73	-0	35	De	N	274	289	
241	(D-6-1)18dcc-1	1979	4,563	160	Y	7	L	04-15-79	—	—	De	N	120	160	
242	(D-6-1)18bca-1	1988	4,570	305	Y	10	L	07-05-88	—	—	De	N	240	274	MI
243	(C-5-1)35abc-1	1988	4,545	163	Y	88	L	11-28-88	43	59	De	N	—	—	
244	(C-5-1)25cbb-1	1951	4,503	147	N	+5	G	04-17-58	—	—	—	—	—	—	
245	(C-5-1)24dbc-1	1960	4,492	400	N	+4	G	10-09-80	2	67	De	N	70	370	MI
246	(C-5-1)27dad	1962	4,583	335	1	95	L	08-01-62	63	88	De	N	220	300	
247	(C-5-1)14dbc-1	1971	4,520	184	Y	18	G	10-09-80	63	90	De	N	147	153	
248	(C-5-1)22daa-1	1979	4,565	137	I	65	L	06-20-79	0	21	De	N	100	112	
249	(C-5-1)23daa-1	1976	4,500	205	I	22	L	09-21-76	2	36	De	N	128	203	
250	(C-5-1)24bbb	1980	4,491	210	N	+14	L	12-27-80	2	23	De	N	—	—	

Table 11. Records of selected wells, Utah and Goshen Valleys, Utah—Continued

Site number	Local well number	Year well drilled	Altitude of land surface (feet)	Well depth (feet)	Re-charge area	Water level (feet)	Water-level source	Water-level date	Top of first confin-ing layer	Bottom of first confin-ing layer	Log types	Depth to consol-idated rock (feet)	Top of perfor-ated interval	Bottom of perfor-ated interval	
251	(C-5-1)14acc-1	1974	4,530	189	1	17	L	07-13-74	1	25	De	N	135	145	
252	(C-5-1)13bbb	1966	4,518	148	N	6	L	07-12-66	3	28	De	N	100	136	MI
253	(C-5-1)15acc-1	1977	4,663	250	1	156	G	10-20-80	155	187	De	N	—	—	
254	(C-5-1)11bab-1	1971	4,647	220	1	40	G	03-10-81	3	88	De	N	125	137	
255	(C-5-1)11aca-1	1953	4,502	82	N	+32	L	07-28-53	28	42	De	N	76	—	
256	(C-5-1)1aba-1	1987	4,497	106	N	+12	L	02-18-87	36	64	De	N	77	85	
257	(C-4-1)26cdd-1	1984	4,745	600	Y	176	L	08-14-83	—	—	De	N	305	445	MI
258	(C-4-1)36daa-1	1980	4,600	480	Y	53	G	11-10-80	0	55	De	—	150	300	
259	(C-4-1)36bab-1	—	4,575	26	2	18	G	03-11-81	—	—	—	—	—	—	
260	(C-4-1)25caa-1	1974	4,615	230	Y	98	L	04-08-74	158	185	De	N	113	188	MI
261	(C-4-1)26aad-1	1973	4,630	540	1	140	G	11-10-80	164	195	De	N	225	269	MI

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