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Ground-Water Occurrence and Movement, 2006, and Water-Level Changes in the Detrital, Hualapai, and Sacramento Valley Basins, Mohave County, Arizona

Scientific Investigations Report 2007–5182

U.S. Department of the Interior
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By David W. Anning, Margot Truini, Marilyn E. Flynn, and William H. Remick

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U.S. Geological Survey
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FRONT COVER—Clockwise from left: Windmill and well north of Long Mountain, Hualapai Valley (USGS photo by David W. Anning); view north across the City of Kingman, Hualapai Valley (USGS photo by Donald J. Bills); desert rangeland in southern Hualapai Valley with Long Mountain in the distance (USGS photo by David W. Anning); and water tank in Sacramento Valley (USGS photo by David W. Anning).

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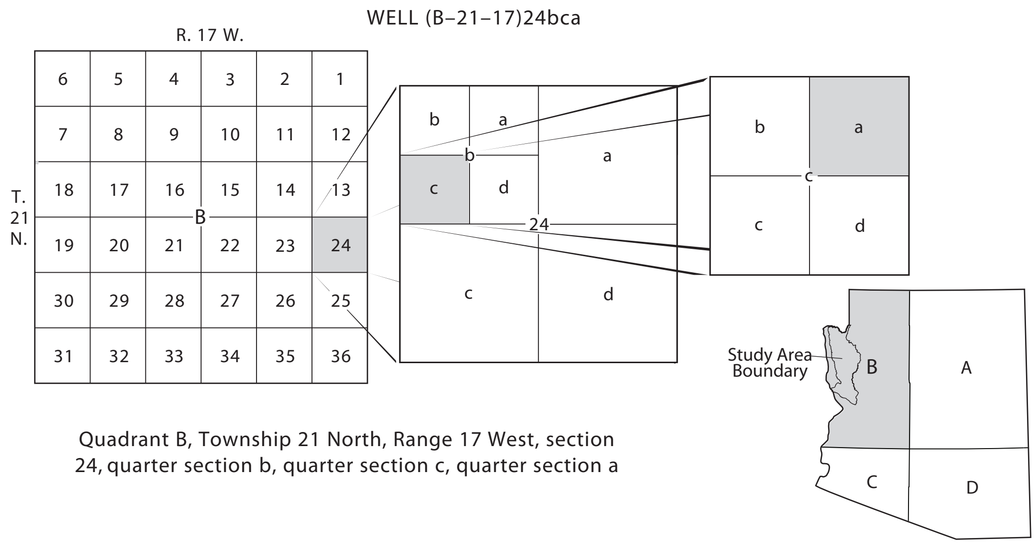
Conversion Factors and Datums

Multiply	By	To obtain
Length		
foot (ft)	0.3048	meter (m)
mile (mi)	1.609	kilometer (km)
Area		
acre-foot (acre-ft)	1,233	cubic meter (m^3)
acre-foot (acre-ft)	0.001233	cubic hectometer (hm^3)

Temperature in degrees Fahrenheit (°F) may be converted to degrees Celsius (°C) as follows: °C=(°F-32)/1.8

Vertical coordinate information is referenced to the North American Vertical Datum of 1988 (NAVD 88). Altitude, as used in this report, refers to distance above the vertical datum. Horizontal coordinate information is referenced to the North American Datum of 1983 (NAD 83).

ARIZONA WELL-NUMBERING AND NAMING SYSTEM



The well numbers used by the U.S. Geological Survey in Arizona are in accordance with the Bureau of Land Management's system of land subdivision. The land survey in Arizona is based on the Gila and Salt River meridian and base line, which divide the State into four quadrants and are designated by capital letters A, B, C, and D in a counterclockwise direction beginning in the northeast quarter. The first digit of a well number indicates the township, the second the range, and the third the section in which the well is situated. The lowercase letters a, b, c, and d after the section number indicate the well location within the section. The first letter denotes a particular 160-acre tract, the second the 40-acre tract and the third the 10-acre tract. These letters also are assigned in a counterclockwise direction beginning in the northeast quarter. If the location is known within the 10-acre tract, three lowercase letters are shown in the well number. Where more than one well is within a 10-acre tract, consecutive numbers beginning with 1 are added as suffixes. In the example shown, well number (B-21-17)24bca designates the well as being in the NE¼, SW¼, NW¼, section 24, Township 21 North, and Range 17 West.

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Ground-Water Occurrence and Movement, 2006, and Water-Level Changes for the Detrital, Hualapai, and Sacramento Valley Basins, Mohave County, Arizona

By David W. Anning, Margot Truini, Marilyn E. Flynn, and William H. Remick[1]

Abstract

Ground-water levels for water year 2006 and their change over time in Detrital, Hualapai, and Sacramento Valley Basins of northwestern Arizona were investigated to improve the understanding of current and past ground-water conditions in these basins. The potentiometric surface for ground water in the Basin-Fill aquifer of each basin is generally parallel to topography. Consequently, ground-water movement is generally from the mountain front toward the basin center and then along the basin axis toward the Colorado River or Lake Mead. Observed water levels in Detrital, Hualapai, and Sacramento Valley Basins have fluctuated during the period of historic water-level records (1943 through 2006). In Detrital Valley Basin, water levels in monitored areas have either remained the same, or have steadily increased as much as 3.5 feet since the 1980s. Similar steady conditions or water-level rises were observed for much of the northern and central parts of Hualapai Valley Basin. During the period of historic record, steady water-level declines as large as 60 feet were found in wells penetrating the Basin-Fill aquifer in areas near Kingman, northwest of Hackberry, and northeast of Dolan Springs within the Hualapai Valley Basin. Within the Sacramento Valley Basin, during the period of historic record, water-level declines as large as 55 feet were observed in wells penetrating the Basin-Fill aquifer in the Kingman and Golden Valley areas; whereas small, steady rises were observed in Yucca and in the Dutch Flat area.

Introduction

Detrital, Hualapai, and Sacramento Valley Basins are broad, intermountain desert basins in Mohave County, northwestern Arizona, and are home to residents in the City of Kingman and several rural communities (fig. 1). The spatial extent of these basins is defined by the Arizona Department of Water Resources' (ADWR) ground-water basin boundaries. Ground water is the primary source of water in these basins and is essential for many economic and cultural activities. As in many parts of the western United States, population growth in these basins is substantial. From 2000 to 2005, the population of Kingman grew from 20,100 to 25,900 — an increase of 29 percent (Arizona Department of Economic Security, 2006). During the same time period, the population of Mohave County increased by 21 percent. Management of the available ground-water resources in these basins, guided by a comprehensive scientific understanding of the area's natural resources, can help the growing communities to meet their water needs in a sustainable manner.

In 2005, the U.S. Geological Survey (USGS) began hydrogeologic investigations in the Detrital, Hualapai, and Sacramento Valley Basins in cooperation with ADWR as part of the Rural Watershed Initiative Program. The program, which was established by the State of Arizona and is managed by the ADWR, includes 17 areas throughout rural parts of the State. The overall objective of this investigation is to improve the understanding of the hydrogeologic systems of Detrital, Hualapai, and Sacramento Valley Basins. This investigation will be accomplished by:

- Evaluating current and past conditions of ground-water levels and ground-water movement.
- Evaluating ground-water quality for key water uses.
- Developing a better understanding of the extent and lithology of geologic units and structures, and their relation to the storage and movement of ground water.
- Developing improved estimates for ground-water budget terms, including recharge, discharge, and total water in storage.
- Establishing a hydrologic-monitoring network to detect and characterize changes in aquifer conditions.
- Informing the hydrologic community and basin residents about hydrologic conditions.

[1]Hydrologist, Arizona Department of Water Resources

Physical and Hydrogeologic Setting

Detrital, Hualapai, and Sacramento Valley Basins are three large, distinct northwest-southeast trending alluvial basins in northwestern Arizona (fig. 1). The valley floors of Detrital and Hualapai Valley Basins generally slope downward to the north, and the valley floor of Sacramento Valley Basin generally slopes downward to the south. Valley-floor elevations range from about 3,500 ft near Kingman, Arizona, to about 500 ft at the mouth of Sacramento Wash. Mountain crests typically are more than 1,000 ft above the valley floors, and in the case of the Hualapai Mountains, the crest is as much as 5,500 ft above the floor of Sacramento Valley.

The climate of the basins is arid to semiarid with maximum daily temperatures in the valley floors typically ranging from 90 to 110ºF during the summer, and from 50 to 70ºF during the winter (Western Regional Climate Center, 2005). Average annual precipitation on the valley floors ranges from about 5 to 10 in. (Western Regional Climate Center, 2005) whereas precipitation in the mountains is as much as 16 in. and is strongly correlated to elevation (Western Regional Climate Center, 2007). The valley floors generally are covered with sparse desert vegetation owing to the hot temperatures and little precipitation. Moderate to thick stands of shrubs and trees cover mountain slopes and peaks in the higher elevations where temperatures are cooler and precipitation is greater.

The structural basins of Detrital, Hualapai, and Sacramento Valley Basins were formed during the Basin and Range disturbance, during which mountain ranges and basins were formed on adjacent sides of high-angle normal faults (Scarborough and Pierce, 1978). The bedrock of the mountains that separate the valleys consists of volcanic, granitic, metamorphic, and consolidated sedimentary rocks (pl. 1). Where unfractured, bedrock is relatively impermeable compared to the basin fill and can form a barrier to ground-water movement where it separates adjacent Basin-Fill aquifers. Fractured bedrock, however, can form water-bearing zones and allow ground water to flow from one area to another. The structural basins of Detrital, Hualapai, and Sacramento Valley Basins contain unconsolidated and semi-consolidated sediments that range in thickness from thin veneers along the mountain fronts to more than 5,000 ft in parts of each basin (Freethey and others, 1986). This basin-fill material is divided into older, intermediate, and younger alluvium (Gillespie and Bentley, 1971).

Older alluvium is stratigraphically the oldest and deepest deposit, and consists of moderately consolidated fragments of rocks eroded from the surrounding mountains in a silty-clay or sandy matrix (Gillespie and Bently, 1971). Older alluvium generally corresponds to units mapped as QTs and Tsy in plate 1. The sediments are moderately consolidated, and the grain size decreases from boulder- and pebble-size fragments in the fanglomerate near the mountains to coarse sand and interbedded clay and silt in the basin center (Gillespie and Bentley, 1971). Each basin has large areas of older alluvium where the sediments are primarily fine grained (Freethey and others, 1986). In the northern part of the Detrital Valley Basin and central part of Hualapai Valley Basin, massive evaporite deposits occur in the older alluvium (Gillespie and Bentley, 1971; Laney, 1973; Freethey and others, 1986). In the northern parts of Detrital and Hualapai Valley Basins, clastic sediments, limestone, and basalt flows of the Muddy Creek Formation (Laney, 1973; Laney, 1977) are included in the older alluvium and correspond to units mapped as Tsy in plate 1.

The intermediate alluvium contains boulder- to pebble-size fragments in the fanglomerates near the mountains and gravel, sand, and silt in the middle of the valleys (Gillespie and Bently, 1971). Intermediate alluvium generally corresponds to the units mapped as Qo in plate 1. In contrast to the older alluvium, the intermediate alluvium generally is less consolidated and the thickness of the intermediate alluvium is on the order of a few hundred feet rather than a few thousand feet (Gillespie and Bently, 1971).

The younger alluvium consists of Holocene and Pleistocene weakly consolidated piedmont, stream, and playa deposits. Younger alluvium generally corresponds to units mapped as Qy and Q in plate 1. Younger alluvium is less thick than the intermediate and older alluvium (Gillespie and Bently, 1971). In the northern parts of Detrital and Hualapai Valley Basins, the younger alluvium contains the Chemehueve Formation, which consists of locally derived alluvial fan material from nearby mountains and silt, sand, and clay transported by the Colorado River (Laney, 1973; Laney, 1977). The Chemehueve Formation overlays the older alluvium (Laney, 1973; Laney, 1977) and generally corresponds to units mapped as Q in plate 1.

Water-saturated sediments that fill the structural basins in the Detrital, Hualapai, and Sacramento Valley Basins form the principal aquifer and for consistency in this report will be referred to as the Basin-Fill aquifer. The older alluvium is the principal aquifer in the Detrital, Hualapai, and Sacramento Valley Basins (Gillespie and Bentley, 1971; Laney, 1973; and Dillenburg, 1987). The intermediate alluvium and younger alluvium are above the water table in most areas of all three basins (Gillespie and Bentley, 1971; Remick, 1981; Dillenberg, 1987; and Rascona, 1991).

Water-bearing zones occur in volcanic, granitic, metamorphic, and consolidated sedimentary rocks in parts of the mountain that surround the margins of all three valleys (Gillespie and Bentley, 1971; Laney, 1977). Volcanic rocks (Tb and Tv in plate 1), divided into younger and older volcanic rocks by Gillespie and Bentley (1971), crop out along the mountain fronts bordering Detrital, Hualapai, and Sacramento Valleys and in the Kingman area. These volcanic rocks are also interbedded with older alluvium in places in Hualapai and Sacramento Valleys (Gillespie and Bentley, 1971). The older volcanic rocks are mostly a thick sequence of andesite and latite flows and tuff beds, while the younger volcanic rocks are mostly basalt flows, basaltic and andesitic flows and tuff, and rhyolitic tuff (Gillispie and Bentley, 1971). In the Kingman area, volcanic rocks are locally permeable near two fault zones, and ground-water stored in the fractures is used as part of the municipal water supply and for many domestic

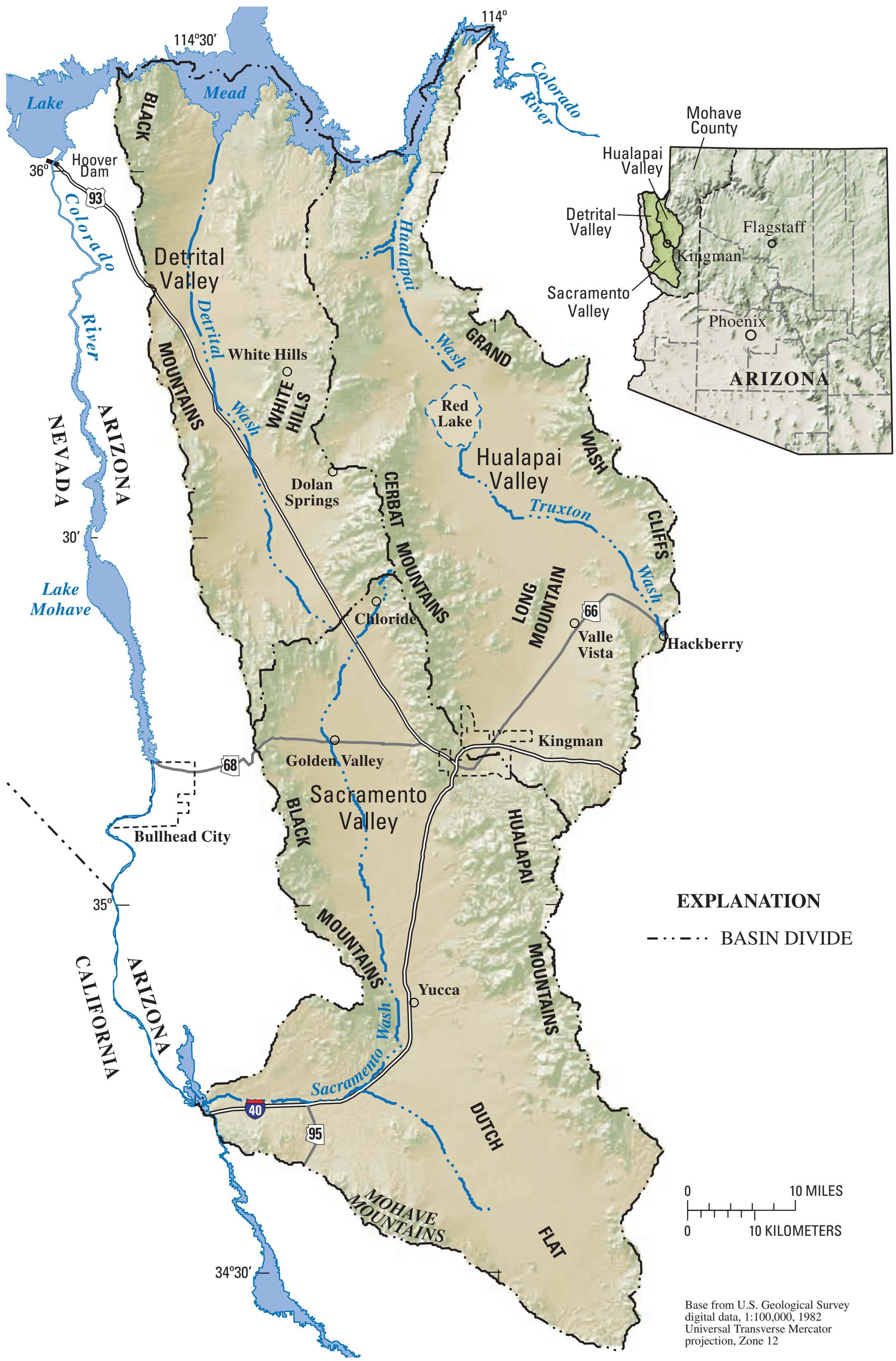

Figure 1. Physiography and location of Detrital, Hualapai, and Sacramento Valley Basins, Mohave County, Arizona.

wells (Gillespie and Bentley, 1971). Ground water stored in consolidated sediments and granitic and metamorphic rocks serves as a water supply in some areas, especially where rocks are faulted, fractured, and weathered (Gillespie and Bently, 1971; Remick, 1981; Dillenberg, 1987; and Rascona, 1991). Several springs issue from these consolidated rocks, and in some cases the springs serve as water supplies for livestock and wildlife.

The combined annual ground-water withdrawal for the three valleys was about 6,600 acre-ft in 1991, almost all of which was from Hualapai and Sacramento Valleys (Tadayon, 2005). By 2000, withdrawals had nearly doubled to about 11,000 acre-ft (Tadayon, 2005). The ground-water withdrawals were used primarily for municipal, domestic, and industrial uses and to a lesser extent for livestock and agriculture.

Purpose and Scope

As noted in the Introduction section, one of the objectives of this investigation is to describe ground-water levels and their change over time in the Detrital, Hualapai, and Sacramento Valley Basins of northwestern Arizona in order to improve the understanding of current and past conditions in the ground-water systems in these basins. The purpose of this report is to document (1) depth to water and ground-water altitude data measured during water year 2006 for wells in the Detrital, Hualapai, and Sacramento Valley Basins, (2) the potentiometric surface of the Basin-Fill aquifers and the ground-water movement in these basins, and (3) long-term changes in ground-water levels over time in these basins.

Approach and Data

Measurements of ground-water levels in 306 wells were collected during water year 2006 (October 1, 2005, through September 30, 2006) to develop a potentiometric surface map of the Basin-Fill aquifers in the Detrital, Hualapai, and Sacramento Valley Basins. These data were supplemented with water-level measurements collected from 24 wells, from October through December of 2006, to aide in the development of the potentiometric-surface map. The distribution of the combined 330 water-level measurements by basin is 67 wells in Detrital Valley Basin, 100 wells in Hualapai Valley Basin, and 163 wells in Sacramento Valley Basin. Where available, driller's logs were examined to determine the representative aquifer or water-bearing zone (basin fill, crystalline, limestone, or volcanic rock) in each well.

Long-term water-level changes were assessed by using two analysis methods. The first method was to visually examine trends apparent in ground-water level hydrographs for wells that had 10 or more water-level measurements that spanned a minimum of 10 years. Within the study area, 35 wells met these analysis criteria. Water-level and time scales for the 35 hydrographs were made consistent to facilitate comparison of trends by well.

The second method of analyzing long-term trends in water-level changes was to examine net water-level changes that were computed for individual wells. Net water-level changes were computed by subtracting the water-levels measured during a particular time period from the water-levels measured in 2006. Net water-level changes were interpreted as indicating declines for values less than -1.0 ft, no change for values between -1.0 ft and 1.0 ft, and increases for values greater than 1.0 ft. The analysis examined net water-level changes in the three basins for the following three time periods: (1) water year 1996, which had data for 116 wells; (2) water years 1979–80, which had data for 64 wells; and (3) 1964–65, which had data for 28 wells. These were the most data-rich periods for comparison of 2006 and previous years' water levels for the three basins. More net water-level change data were available for wells in the Hualapai and Sacramento Valley Basins than for wells in the Detrital Valley Basin.

Depth-to-water data usually are measured in the field to one-tenth or one-hundredth of a foot, and they are reported in the appendixes (available only online at http://pubs.usgs.gov/sir/2007/5182/appendixes/) to one-tenth of a foot. On plate 1, depth-to-water data are listed to the nearest foot to ease visual analysis of data. Net water-level change data are computed from depth-to-water data, and therefore, are also reported to the tenth of a foot in the appendixes. Water-level altitude data are computed from the depth-to-water data and the altitude of the well on the land surface. The well altitude typically is taken from a topographic map, which generally has 20-ft altitude contours. Assuming the well location is correct, the well-altitude data typically have an accuracy of about 1–10 ft, and, therefore, reported in the appendixes and on plate 1 to the nearest foot.

Previous studies have reported ground-water conditions in Detrital, Hualapai, and Sacramento Valley Basins (table 1). Much of the water-level data used in the net water-level change analysis were reported by these studies. Water-level and well-location data presented in this report are tabulated in appendixes 1–4. These data are available on request from the USGS National Water Information System and the ADWR Ground Water Site Information databases.

Ground-Water Levels and Movement, Water Year 2006

Ground-water altitudes in water-bearing zones of volcanic, granitic, metamorphic, and consolidated sedimentary rocks in the mountains typically are higher than ground-water altitudes of nearby wells in the Basin-Fill aquifer and indicate the potential for ground-water movement from the basin margins towards the Basin-Fill aquifers in the basins. The flow path through these consolidated rock units and the hydraulic connection to the Basin-Fill aquifer is dependant on the location and density of fractures within the rock units. In the Basin-Fill aquifer, ground-water movement is through sedi-

Table 1. Summary of previous ground-water investigations in Detrital, Hualapai, and Sacramento Valley Basins, Mohave County, Arizona.
[X, data or information included in report; — data or information not included or a minor part of report]

Report about investigation results	Primary study period	Basin(s) in study area	Types of data or information presented in report					
			Well data, including water-levels	Spring data	Ground-water chemistry data	Well hydro-graphs	Potentio-metric surface map	Hydro-geologic information
Gillespie and others (1966)	Generally through 1965	Hualapai, Sacra-mento, and north-ern part of Big Sandy	X	X	X	X	X	—
Gillespie and Bently (1971)	Generally through 1967	Hualapai and Sac-ramento	X	X	X	X	X	X
Laney (1973)	Generally through 1979	Northern part of Detrital	X	X	X	—	—	X
Laney (1977)	Generally through 1979	Northern part of Hualapai	X	X	X	—	—	X
Pfaff and Clay (1981)	1979	Sacaramento	X	X	X	X	X	—
Remick (1981)	1980	Hualapai and parts of adjacent areas	X	X	X	X	X	—
Dillenburg (1987)	1987	Detrital	X	X	X	—	X	—
Rascona (1991)	1990	Sacaramento	X	X	X	X	X	—

ment pore-spaces along paths from the mountain front towards the basin center, and then along the basin axis north to Lake Mead or south to the Colorado River. The potentiometric surface of the Basin-Fill aquifer in the three basins is characterized by areas with flat gradients altering with areas with steep gradients, which may reflect different hydraulic conductivities and (or) cross-sectional areas of the aquifer in each area.

Ground-water altitudes in the Basin-Fill aquifer along the axis of Detrital Valley Basin range from greater than 2,200 ft in the southern part of the basin to less than 1,300 ft in the northern part of the basin near Lake Mead (pl. 1). At the northern end of Detrital Valley, Lake Mead onlaps rock units of the Basin-Fill aquifer. Laney (1977) and data from the few wells in this area suggest that water levels in the aquifer in this area fluctuate with the water level in the lake. Depth-to-water measurements range from less than 100 ft below land surface in the mountains and near Lake Mead, to as much as 984 ft below land surface in the southern part of the basin.

The potentiometric surface of the Basin-Fill aquifer in the southern part of the Detrital Valley Basin is relatively flat, and ground-water altitudes range from 2,220 to 2,249 ft. Ground-water altitudes less than 2,100 ft in wells in the northern part of T. 26 N., R. 20 W. indicate that flow in the southern part of Detrital Valley Basin generally is towards the north (pl. 1). Ground-water altitudes of 2,097, 2,141, and 2,154 ft in three wells in T. 23 N., R. 18 W. of the adjacent Sacramento Valley Basin, however, indicate a potential for some flow southward across the basin boundary (pl. 1). A ground-water divide that separates northward flow and southward flow occurs in the southern part of Detrital Valley Basin or at the basin boundary with Sacramento Valley Basin. However, the exact location of the ground-water divide cannot be determined because of the lack of ground-water altitude data near the basin boundary, and because the range in water-level altitudes qualitatively is not substantially greater than the uncertainty of water-level altitude data.

Near the community of White Hills, wells having ground-water altitudes between 3,001 and 3,023 ft indicate potential for ground-water movement northwestward from this area toward Detrital Wash. Ground-water in these wells comes from the Basin-Fill aquifer and from water-bearing units in crystalline rocks (pl. 1); and the similar ground-water altitudes indicate a hydraulic connection between these hydrogeologic units. Similar hydraulic connections occur elsewhere in Detrital Valley Basin, as well as parts of Hualapai and Sacramento Valley Basins.

In 2003, deep drilling in sec. 25, T. 27 N., R. 21 W. of the Detrital Valley Basin revealed the presence of a water-bearing zone beneath the primary water-bearing zone in the Basin-Fill aquifer. This lower zone occurs at a depth of about 1,380 ft below land surface. At this well site, driller's logs indicate that the lower water-bearing zone (1) consists of alluvial sediments interbedded with volcanic flows, (2) is separated from the upper water-bearing zone by about 800 ft of non water-bearing clay and gypsum, and (3) is confined with about 1,000 ft of pressure head at the time of drilling. Since the time this well was drilled, a small number of additional wells have been completed in the lower water-bearing zone in the same vicinity. Water-level altitudes are higher in the lower water-bearing zone than in the upper, primary water-bearing zone and range from 2,074 to 2,195 ft. The lateral extent of the lower water-bearing zone is unknown, however, well-log data from test holes indicate the clay and gypsum layer may extend across the northern two-thirds of the basin, and therefore, the lower water-bearing zone may be present in that area as well.

The northern part of Detrital Valley Basin generally lacks wells for defining ground-water levels and movement in detail. A comparison of water levels from wells in T. 29 N., R. 21 W. and those in wells near Lake Mead, however, indicate ground-water movement is towards the north and that the gradient, about 60 ft/mi, is steep in this area compared to the central and southern parts of the basin.

Ground-water altitudes in the Basin-Fill aquifer along the axis of Hualapai Valley Basin range from greater than 2,700 ft in the southern part of the valley to less than 1,900 ft in the northern part of the valley (pl. 1). Although there are no water-level data available for the area adjacent to Lake Mead in Hualapai Valley Basin, ground-water altitudes are probably comparable to lake elevations, as is the case in Detrital Valley Basin. Depth-to-water measurements range from less than 100 ft below land surface in the mountains, to as much as 959 ft below land surface in the southern part of the basin.

In the southern part of Hualapai Valley Basin, ground-water altitude data indicate the presence of a cone of depression in T. 22 N., R. 16 W., northeast of Kingman (pl. 1). While ground water in that area flows towards the cone of depression, ground-water movement near Valle Vista is northward to the east of Long Mountain. Ground water likely flows northward on the western side of Long Mountain as well, however, flow is through granitic, metamorphic, and volcanic rocks and the overlying basin fill in that area. The water-level altitude in a well in sec. 2 of T. 22 N., R. 16 W. was 2,808 ft (pl. 1), and may mark the northern end of the cone of depression. The well was drilled as a monitoring site for the City of Kingman's sewage-treatment facility, and the elevated water-level altitude may also reflect mounding of water from recharge occurring at the facility.

Ground water flows into the central part of Hualapai Valley Basin from the southern part and also from the area where Truxton Wash enters the basin near Hackberry (pl. 1). The potentiometric surface in the central part of Hualapai Valley Basin, which contains Red Lake, is relatively flat with a gradient of about 7 ft per mile and ground-water altitudes between 2,514 and 2,402 ft. The area contributing surface flow into Red Lake playa is a closed basin and retains flow as a result of a low topographic divide near Pierce Ferry Road. Ground-water in the central part of Hualapai Valley Basin, however, flows north underneath the topographic divide.

Ground water flows into the northern part of Hualapai Valley Basin from the central part and also from a small valley northeast of Dolan Springs (pl. 1). Ground-water flows north towards Lake Mead. Similar to conditions in the Detrital Valley Basin, the potentiometric-surface gradient in northern Hualapai Valley Basin, about 39 feet per mile, is much steeper than in the southern and central parts of the basin.

Ground-water altitudes for the Basin-Fill aquifer along the axis of Sacramento Valley Basin range from greater than 2,100 ft in the northern part of the basin to less than 500 ft in the southern part of the basin near the Colorado River (pl. 1). Depth-to-water measurements range from less than 100 ft below land surface in the mountains and along Sacramento Wash near the Colorado River, to as much as 1,229 ft below land surface in the northern part of the basin.

Ground-water movement in Sacramento Valley Basin north of Yucca (T. 17 N., R. 18 W.) generally is toward the basin center and south along the basin axis. Ground-water altitude data indicate that the potentiometric-surface gradient is relatively steep from the Santa Claus area to Golden Valley, about 55 ft per mile, and relatively shallow from Golden Valley to Yucca, about 11 ft per mile. The ground-water altitude of 2,479 ft for a well in T. 23 N., R. 18 W. is elevated compared to the altitude of water in nearby wells also developed in the Basin-Fill aquifer. This difference in water levels was also present in 1990 (Rascona, 1991).

The potentiometric-surface gradient in the Dutch Flat area is relatively flat with a large area containing several wells with ground-water altitudes of about 1,400 ft. Ground-water movement in Dutch Flat is northwestward toward Sacramento Wash, near the Buck Mountains, and then primarily westward towards the Colorado River. The potentiometric surface gradient is relatively steep from the area near the Buck Mountains to the Colorado River, about 45 ft per mile.

Long-Term Water-Level Changes

Water levels from 1943 through 2006 in the Detrital, Hualapai, and Sacramento Valley Basins have fluctuated in some areas and remained steady in other areas. Long-term water-level changes were evaluated from selected ground-water level data (appendixes 3 and 4) collected during this period for selected wells throughout the study area. The analy-

Figure 2. Location of wells with hydrographs, Detrital, Hualapai, and Sacramento Valley Basins, Mohave County, Arizona.

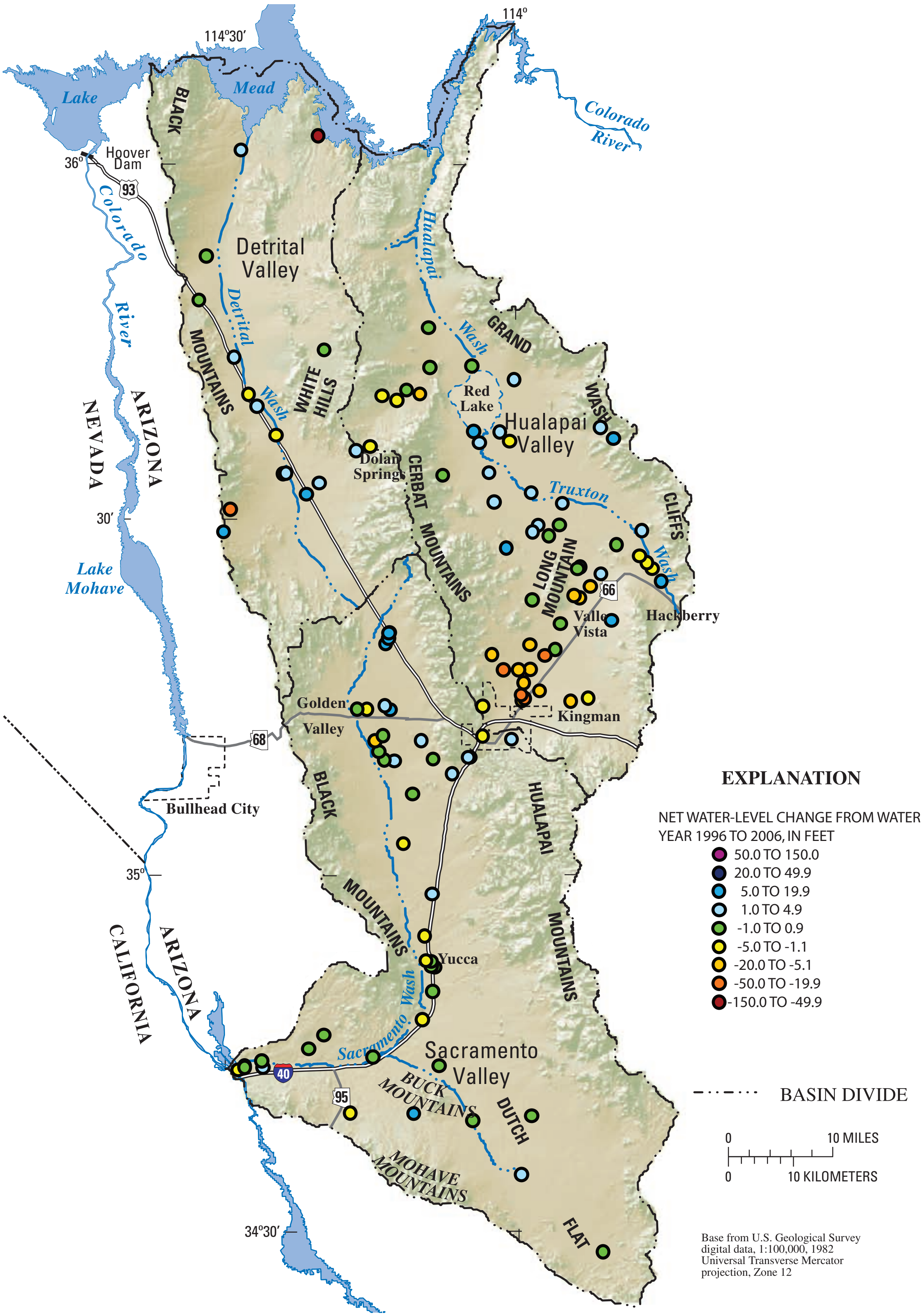

Figure 3. Net water-level change from water year 1996 to 2006 for selected wells, Detrital, Hualapai, and Sacramento Valley Basins, Mohave County, Arizona.

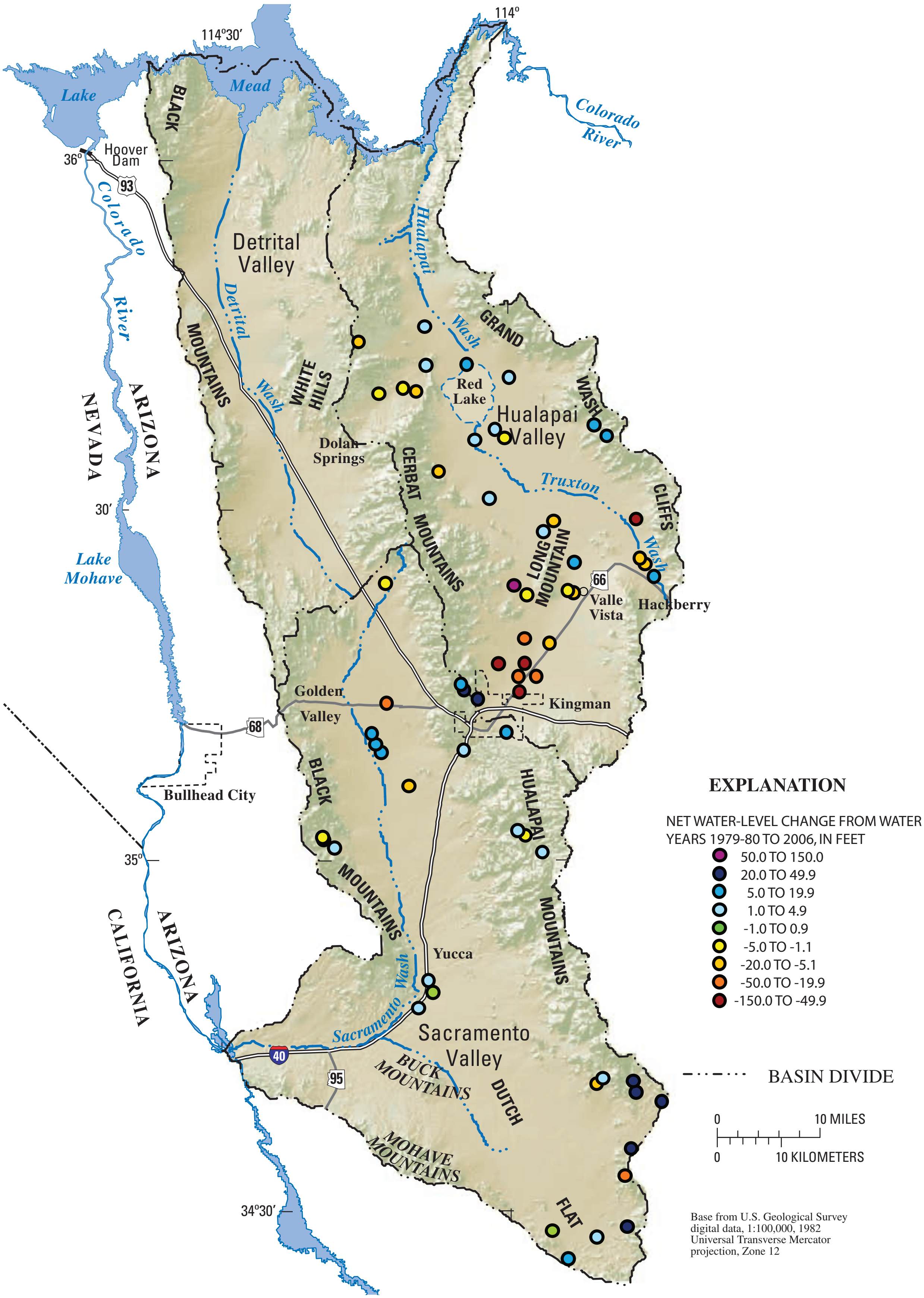

Figure 4. Net water-level change from water years 1979–80 to 2006 for selected wells, Detrital, Hualapai, and Sacramento Valley Basins, Mohave County, Arizona.

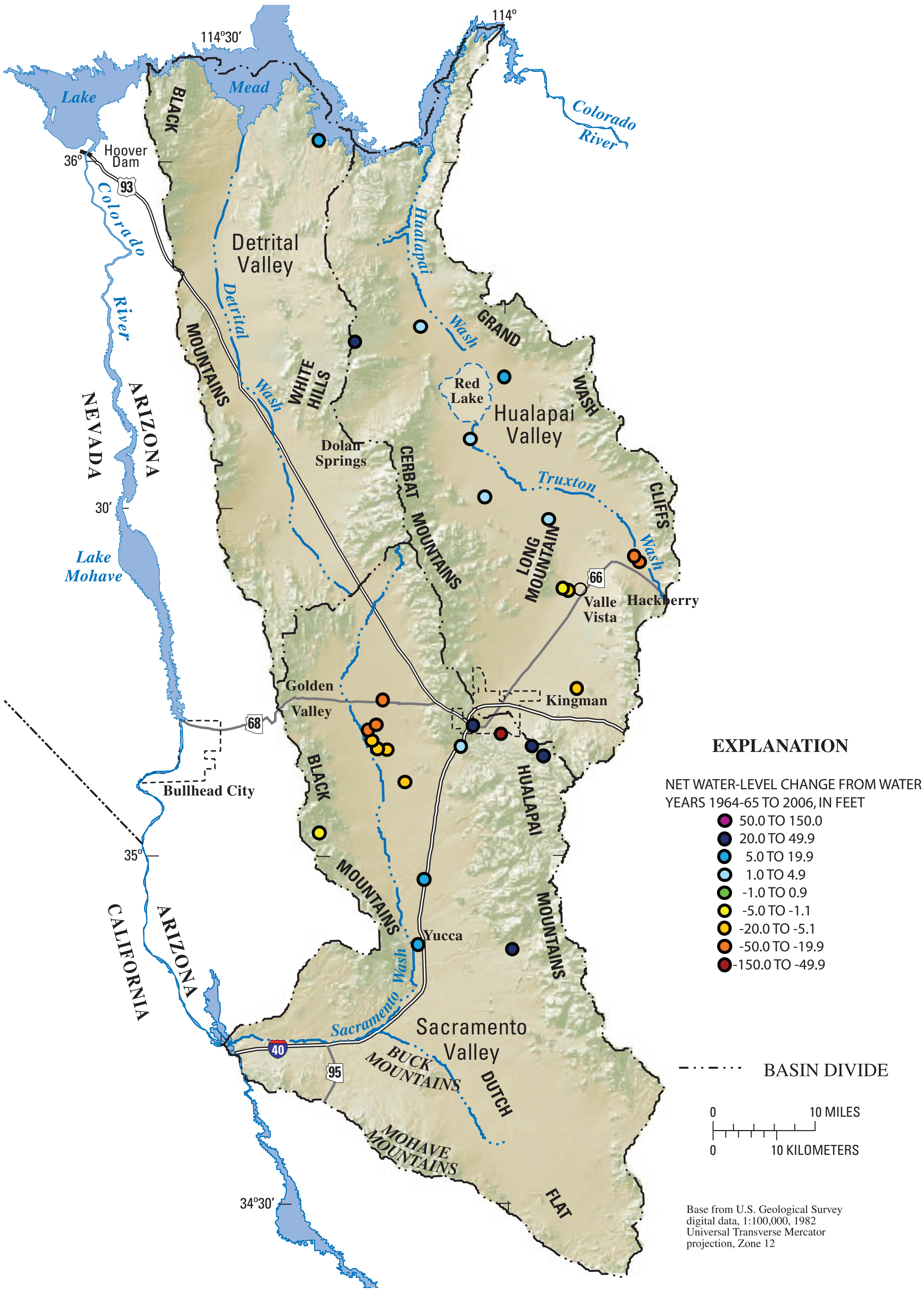

Figure 5. Net water-level change from water years 1964–65 to 2006 for selected wells, Detrital, Hualapai, and Sacramento Valley Basins, Mohave County, Arizona.

sis includes evaluation of hydrographs of selected data for 35 wells (fig. 2; appendix 4) and evaluation of net water-level change data for periods between 1996 and 2006 (fig. 3; appendix 3), 1979–80 and 2006 (fig. 4; appendix 3); and 1964–65 and 2006 (fig. 5; appendix 3).

With some exceptions, water levels generally have remained the same or have risen since the 1980s in areas monitored in the Detrital Valley Basin. Three of the four wells with hydrographs [(B-28-21)20ADB, (B-26-20)06ABC, and (B-25-20)15AAA] indicate water levels have gradually increased as much as 3.5 ft during their period of record, which began in the early to mid-1980s (fig. 6). The fourth hydrograph, for well (B-30-20)06CAD, indicates water levels have remained about the same at the well. Net water-level changes in 12 wells from 1996 to 2006 indicated either no change, or increasing water levels by as much as 11.8 ft (fig. 3, table 2). In four wells, however, net water-level changes for this period decreased, the largest decrease being -66.7 ft for a well near Lake Mead (fig. 3, table 2). This large decrease, in part, is likely due to a decrease in lake levels of about 54 ft that occurred during the same time period (Bureau of Reclamation, 2007). For many of the wells, water-level changes from 1996 to 2006 were small, between declines of 0.9 ft and rises of 2.0 ft, as indicated by the 25th and 75th percentiles for net water-level change (table 2). Net water-level change data were available for only one well for 1964–65 to 2006, which was an increase of 6.2 ft (fig. 5).

Long-term water-level changes vary for different areas in Hualapai Valley Basin. Summary statistics for the three net water-level change periods for the three basins indicate that the most extreme changes observed, a 134.8 ft decline and a 107.8 ft rise, were for two wells in Hualapai Valley Basin for 1979–80 to 2006 (table 2). These two wells are completed in fractured volcanic and granitic rocks, and the large fluctuations are likely due to low storage coefficients associated with

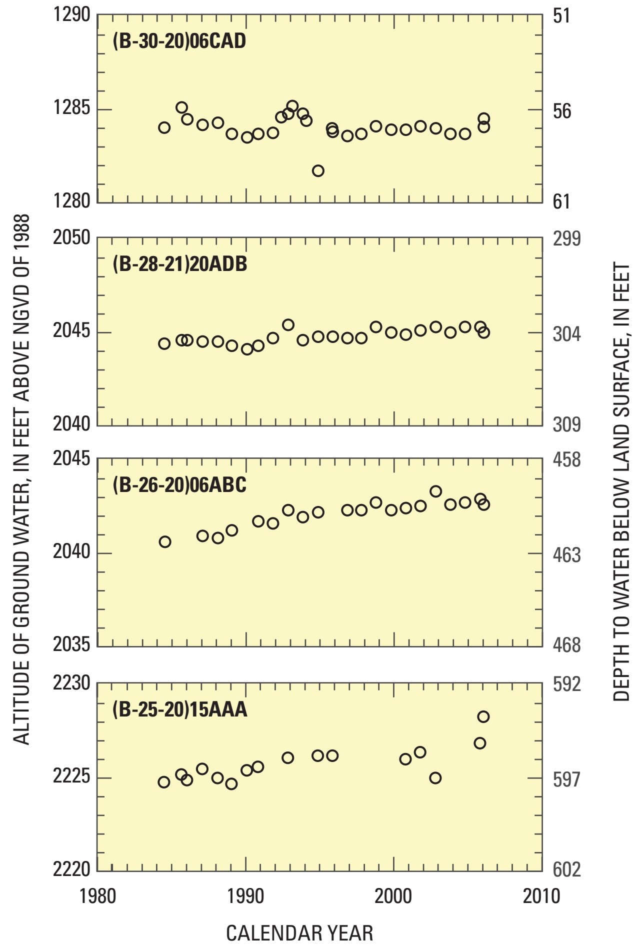

Figure 6. Hydrographs of water levels in selected wells of Detrital Valley Basin, Mohave County, Arizona.

Table 2. Summary statistics for net water-level change from water years 1996 to 2006, 1979–80 to 2006, and 1964–65 to 2006 for selected wells in Detrital, Hualapai, and Sacramento Valley Basins, Mohave County, Arizona.

Period	Number of wells	Summary statistics for net water-level change, in feet					
		Minimum	25th percentile	Mean	Median	75th percentile	Maximum
Detrital Valley Basin							
1996 to 2006	16	−66.7	−0.9	−4.9	1.0	2.0	11.8
Hualapai Valley Basin							
1996 to 2006	55	−34.8	−8.5	−4.4	−0.6	1.4	16.3
1979–80 to 2006	34	−134.8	−8.7	−7.6	−3.9	2.5	107.8
1964–65 to 2006	11	−30.5	−11.8	−3.4	1.2	3.0	28.0
Sacramento Valley Basin							
1996 to 2006	45	−8.2	−0.3	1.2	0.5	2.4	18.8
1979–80 to 2006	30	−38.1	0.6	6.9	3.1	12.1	47.8
1964–65 to 2006	16	−52.7	−16.5	−0.9	−4.5	14.6	43.7

water-bearing consolidated-rocks. For many of the wells, however, water-level changes for the three periods were small and between declines of 11.8 ft and rises of 3.0 ft, as indicated by the 25th and 75th percentiles for net water-level change (table 2).

For the area north of Long Mountain, hydrographs (fig.7) for wells (B-28-17)31CCC, (B-27-16)33BAA, (B-26-18)03AAA1, (B-26-17)35AAA, and (B-24-16)01DDD1 generally indicate small, steady water-level increases of up to about 8.0 ft over the span of their hydrographs—all of which extend from 2006 to 1980, and one of which extends back to 1958. With a few exceptions, net water-level changes for 1996–2006, 1979–80 to 2006, and 1964–65 to 2006 indicate either no change or rising water levels for most wells in this same area (figs. 3–5). For 1996 to 2006 and 1979–80 to 2006, however, net water-level changes in four wells northeast of Dolan Springs indicate declining water levels (figs. 3 and 4).

Hydrographs and net water-level changes for the area north of Hackberry show some significant water-level declines, although some water-level rises do occur. The hydrograph for (B-24-14)28CAD shows a steady decline of about 60 ft from 1944 to 1991 and fluctuating water levels thereafter (fig. 7). The hydrograph for (B-23-14)03ADC shows about a 40 ft decline from 1944 to the mid-1950s, followed by a net rise of 25 ft to 2006 (fig. 7). Wells in this area with net water-level change data also show a mix of water-level declines and rises (figs. 3–5).

Hydrographs and net water-level changes for the Hualapai Valley Basin south of Long Mountain generally indicate that water levels are remaining the same or declining. While the hydrograph for (B-23-15)30CBB shows steady water-level conditions for 1990 to 2006, hydrographs for (B-22-16)03CBB and (B-22-16)28BAD show steady water-level declines of about 34 and 50 ft, respectively, from 1980 to 2006 (fig. 7). Net water-level changes for most wells in this area also indicate declining or unchanging water levels for all three periods (figs. 3–5). These water-level declines are consistent with the cone of depression in the potentiometric surface that was previously discussed for the southwestern part of this area near Kingman.

Long-term water-level changes vary for different areas in Sacramento Valley Basin. For many of the wells, water-level changes during the three periods were small and between declines of 16 ft and rises of 15 ft, as indicated by the 25th and 75th percentiles for net water-level change (table 2). In the Kingman area of the Sacramento Valley Basin, hydrographs for wells (B-21-17)03DAD and (B-21-17)03CDA2 show sharp declines of 12 and 55 ft, respectively, from 1943 to the mid-1950s (fig. 8). Although the wells are near each other, these water-level changes may vary as a result of different storage coefficients for the rock in which they are completed. Hydrographs show an overall decline of about 10 ft from 1944 to 1978 in well (B-21-17)24CDD2, and an additional 18-ft decline from 1978 to 2006 in nearby well (B-21-17)24CBC; both wells are completed in volcanic rocks. Well (B-21-17)34DDB is down-gradient of the four previously mentioned wells in the Kingman area and is completed in the basin fill; the hydrograph for this well shows a relatively steady water level (fig. 8). Net water-level changes for wells in the Kingman area of Sacramento Valley are mixed, however, the declines are smaller than those observed to the northwest in Hualapai Valley (figs. 3–5).

In the north-central part of Sacramento Valley Basin near Golden Valley, hydrographs for wells (B-21-18)32DCC and (B-20-18)04BBB show water levels generally declined about 30 ft from 1964 to the mid-1970s and then generally rose about 15 ft by 2006 (fig. 8). Net water-level changes in nearby wells are consistent with this pattern for all 3 periods (figs. 3–5). Net water-level changes for 1964–65 to 2006 indicate declines ranging between 5.0 and 50 ft for 7 wells in this area (fig. 5). The hydrograph for (B-20-18)22AAC shows a steady decline in water level from 1964 to about 1990 and a fairly steady water level through 2006 (fig. 8).

In the Yucca and Dutch Flat areas, hydrographs for (B-18-18)01DCD, (B-17-17W)19BAD, (B-15-16)07BDD, (B-15-17)07DCA1, and (B-13-15)CAC2, which extend from at least 1986 to 2006 (fig. 8), show small, steady rises in water levels over time. Net water-level changes in these areas are small for 1996–2006, generally between declines of 5.0 ft and rises of 5.0 ft (fig. 3). Net water-level change data in these areas for 1979–80 to 2006 indicate rising or unchanging water levels in all but two wells (fig. 4).

In the southern part of Sacramento Valley Basin, west of the Buck Mountains, hydrographs show fluctuating water levels, with the lowest water levels typically occurring between 1990 and 2000, and a vaguely defined decline during the period of record (fig. 8). Net water-level changes for wells in this area indicate unchanging conditions or declines of less than 5.0 ft for 1996–2006 (fig. 3).

Summary

Ground-water levels for water year 2006 and their change over time in the Detrital, Hualapai, and Sacramento Valley Basins of northwestern Arizona were examined in this study. The potentiometric surface is generally parallel to topography, and ground-water movement is generally from the mountain front toward the basin center and then along the basin axis toward the Colorado River or Lake Mead. Water levels observed over time in Detrital, Hualapai, and Sacramento Valley Basins have fluctuated from 1943 through 2006. Small water-level rises, typically less than 5.0 ft, were found to occur for recent decades in parts of all three basins. Water-level declines, however, were found in the Kingman area, an area northwest of Hackberry, an area northeast of Dolan Springs, and in the Golden Valley area.

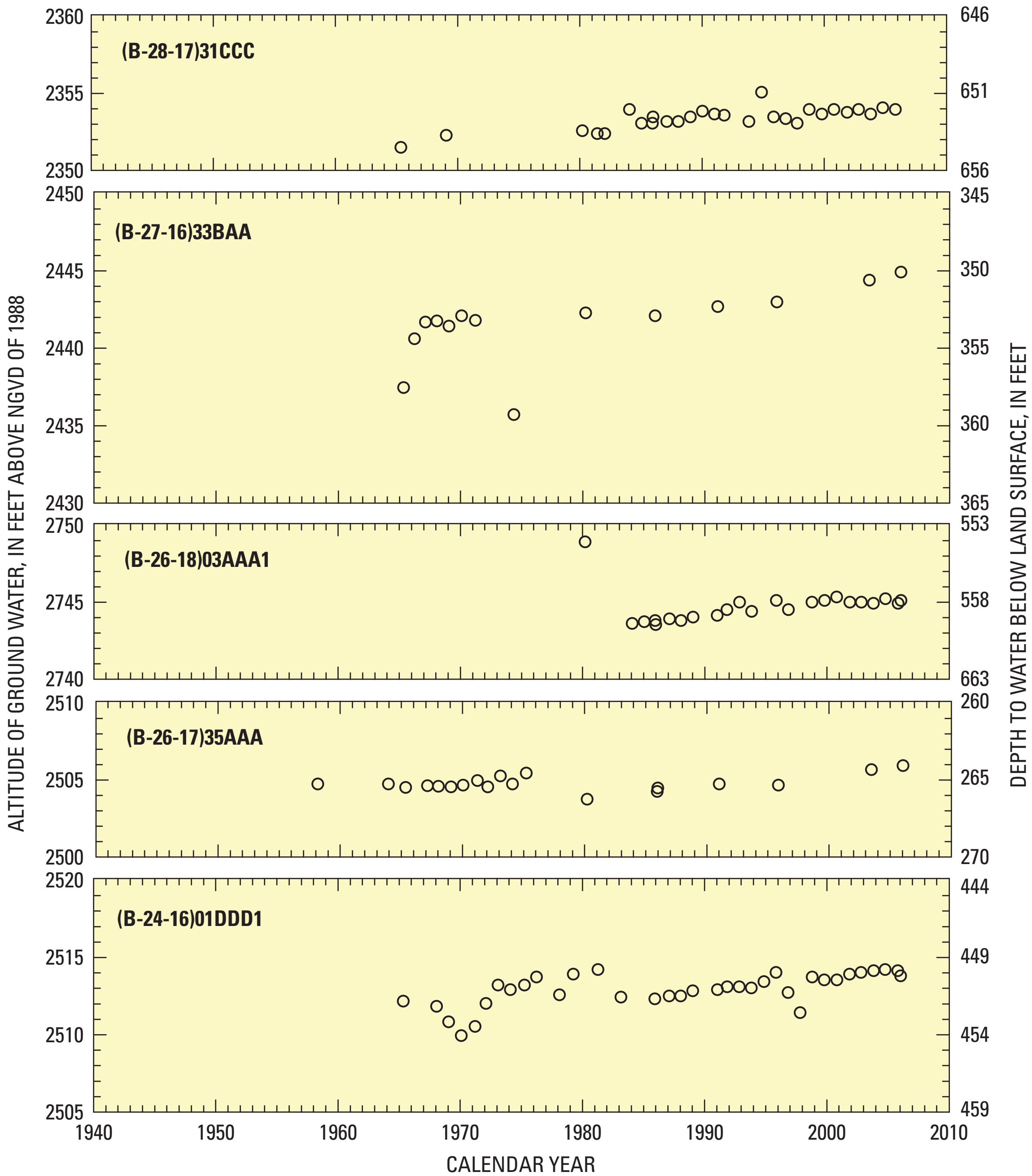

Figure 7. Hydrographs of water levels in selected wells of Hualapai Valley Basin, Mohave County, Arizona.

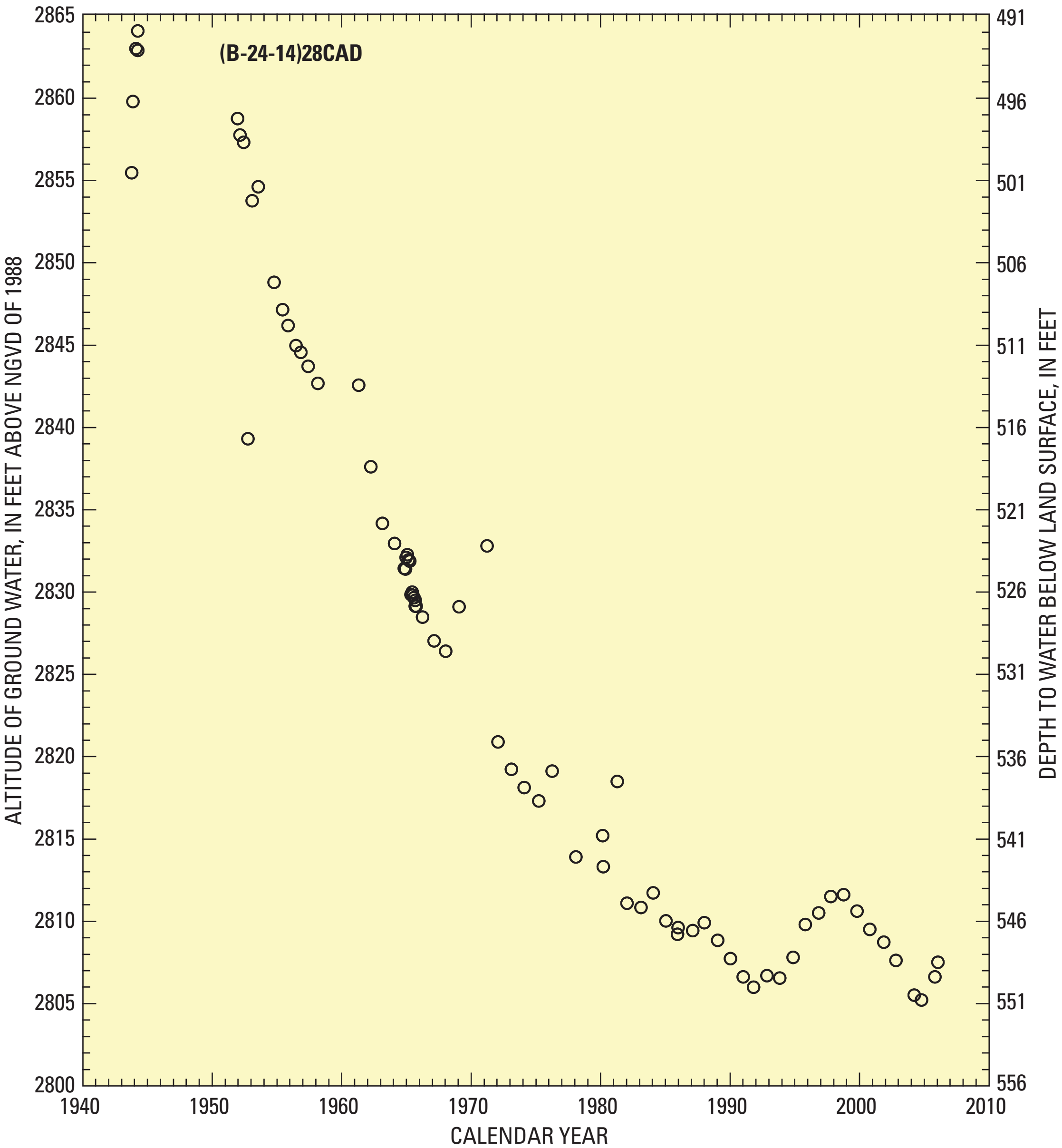

Figure 7. Hydrographs of water levels in selected wells of Hualapai Valley Basin, Mohave County, Arizona—Continued.

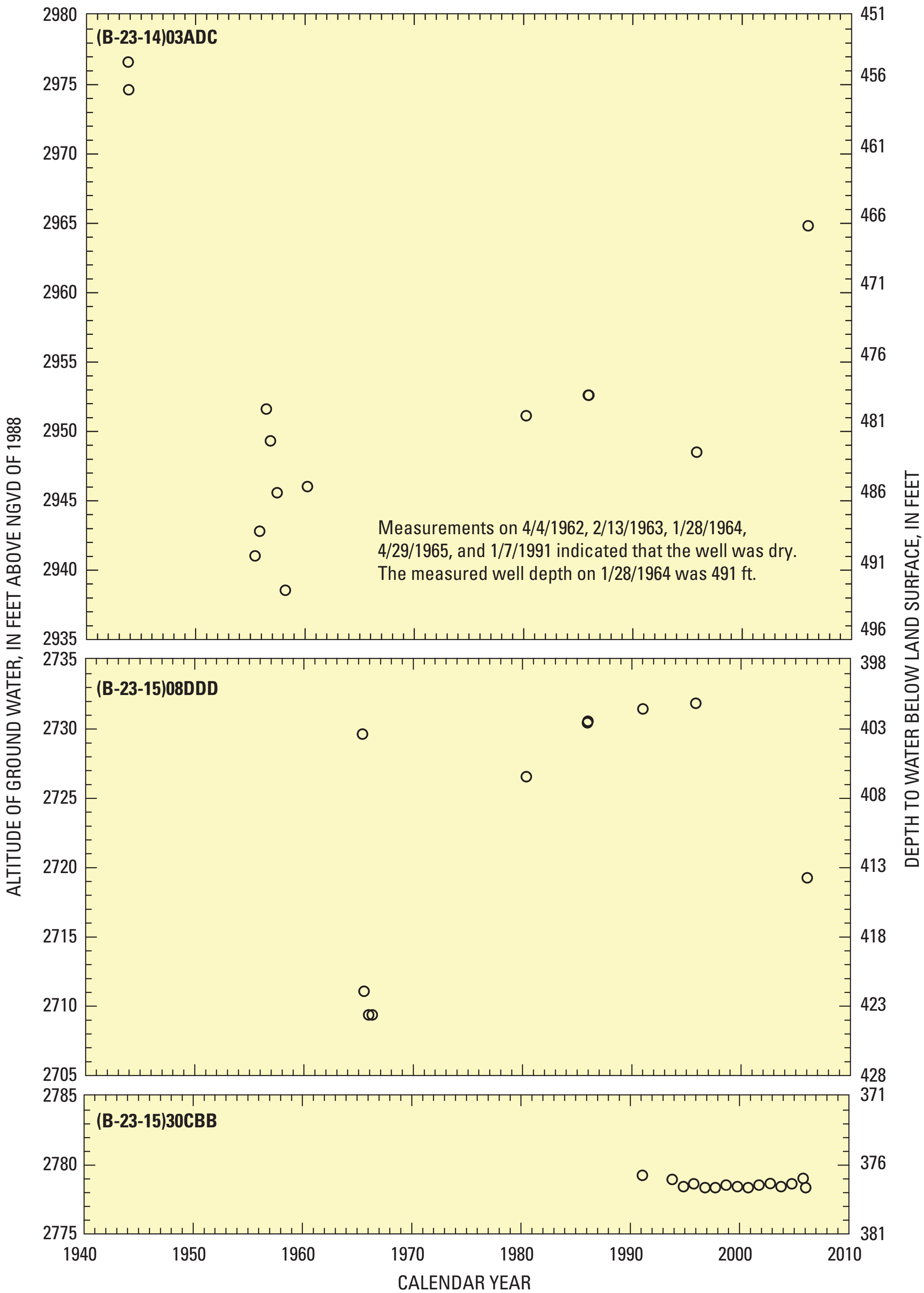

Figure 7. Hydrographs of water levels in selected wells of Hualapai Valley Basin, Mohave County, Arizona—Continued.

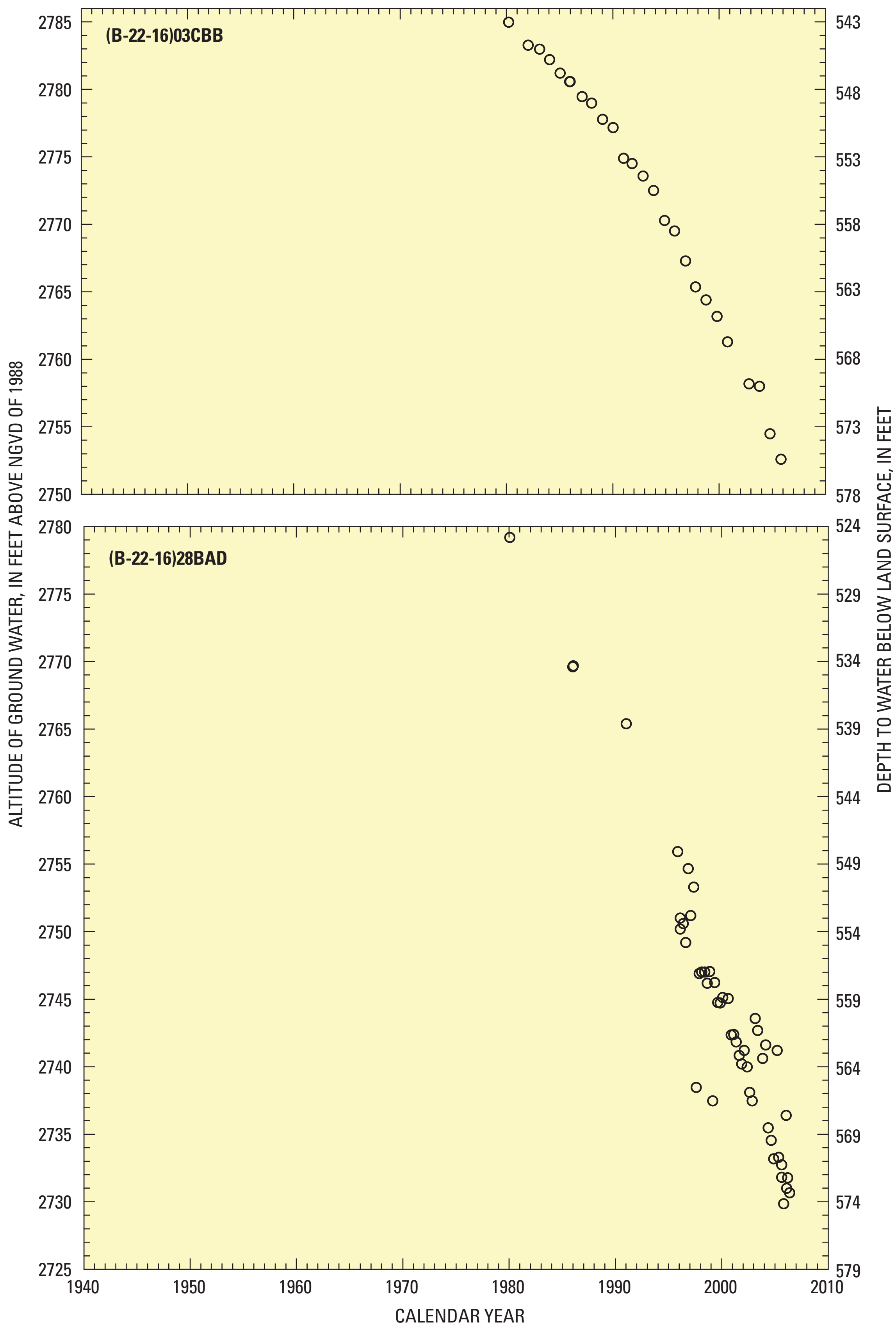

Figure 7. Hydrographs of water levels in selected wells of Hualapai Valley Basin, Mohave County, Arizona — Continued.

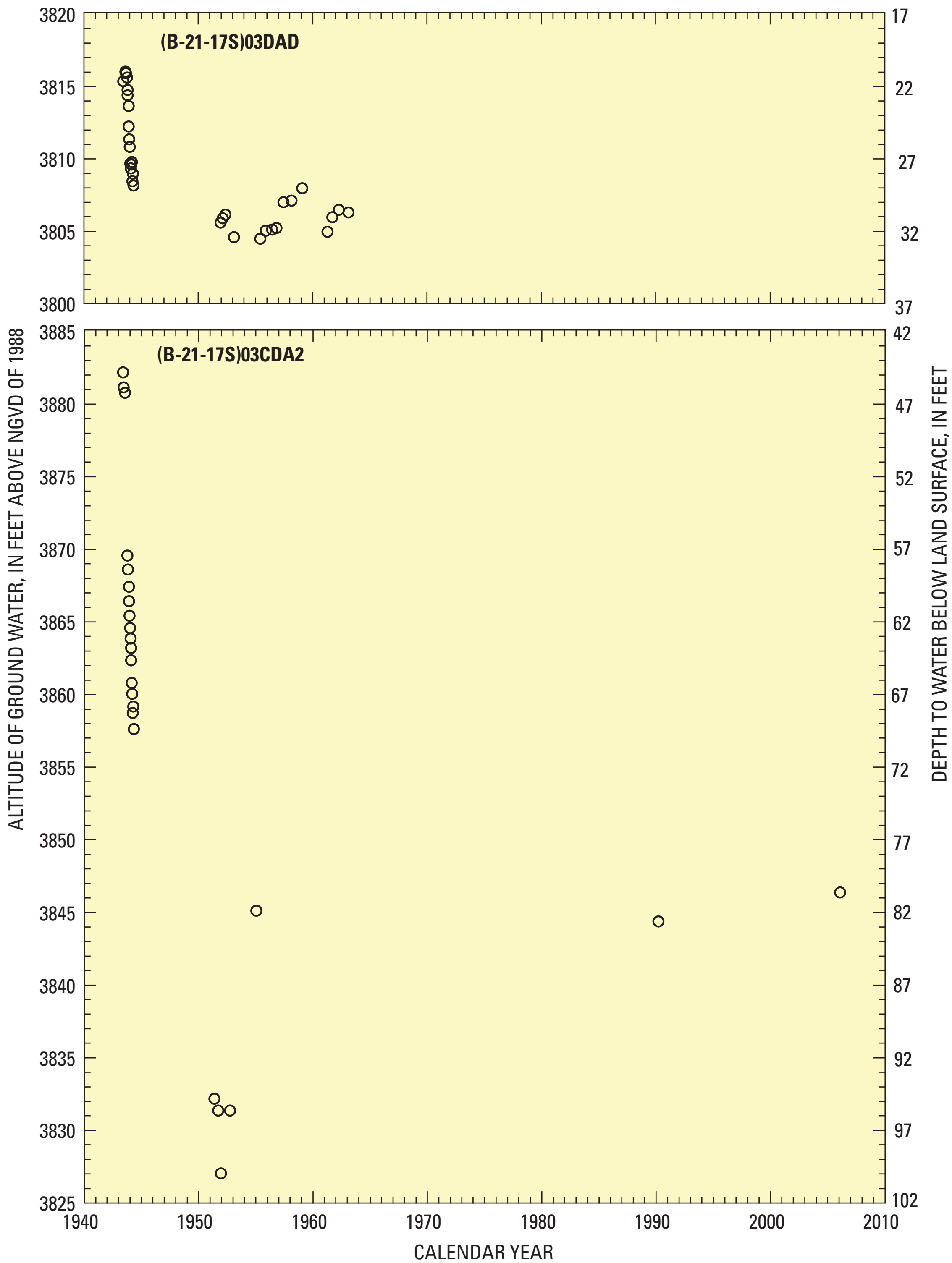

Figure 8. Hydrographs of water levels in selected wells of Sacramento Valley Basin, Mohave County, Arizona.

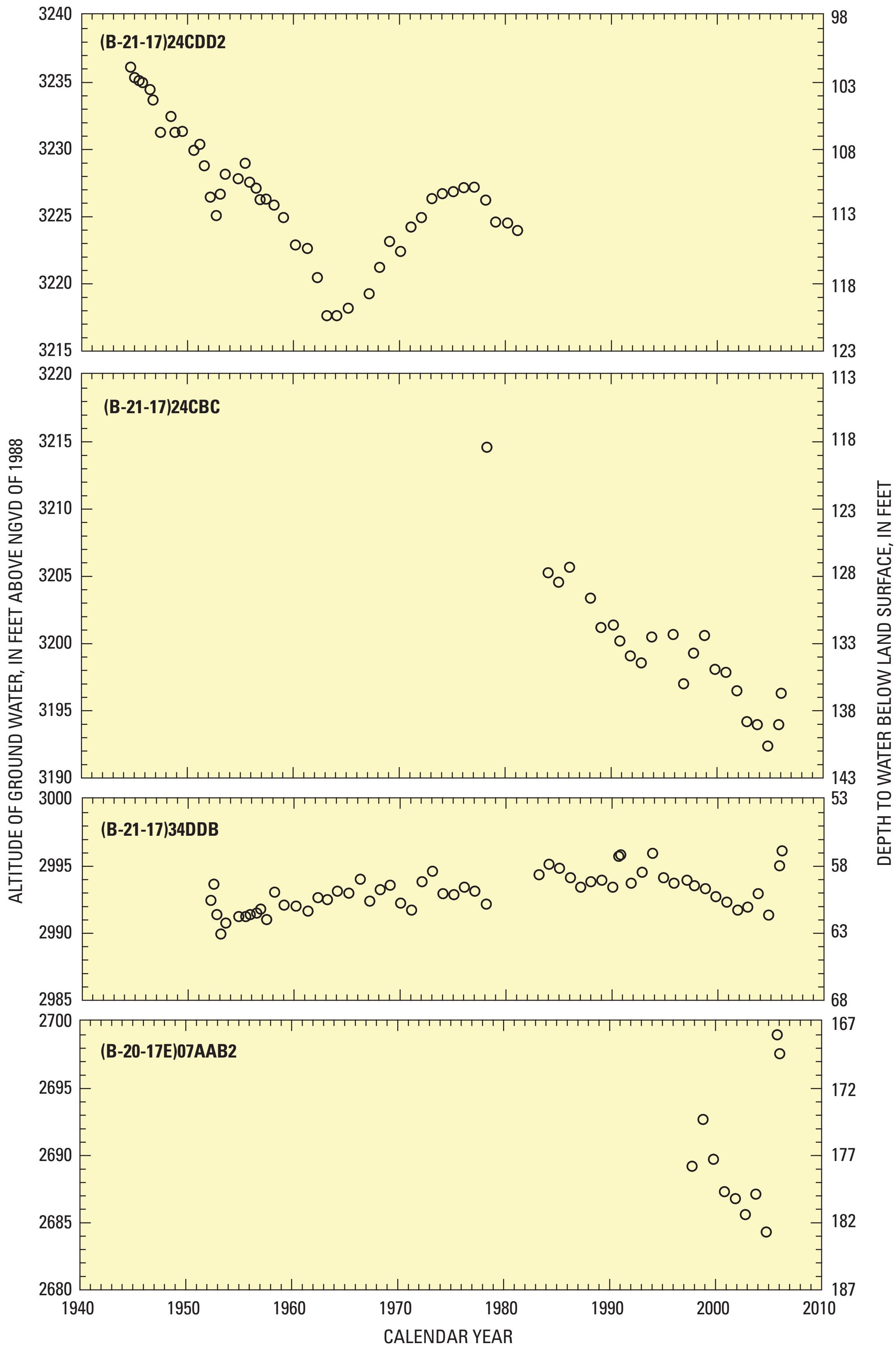

Figure 8. Hydrographs of water levels in selected wells of Sacramento Valley Basin, Mohave County, Arizona—Continued.

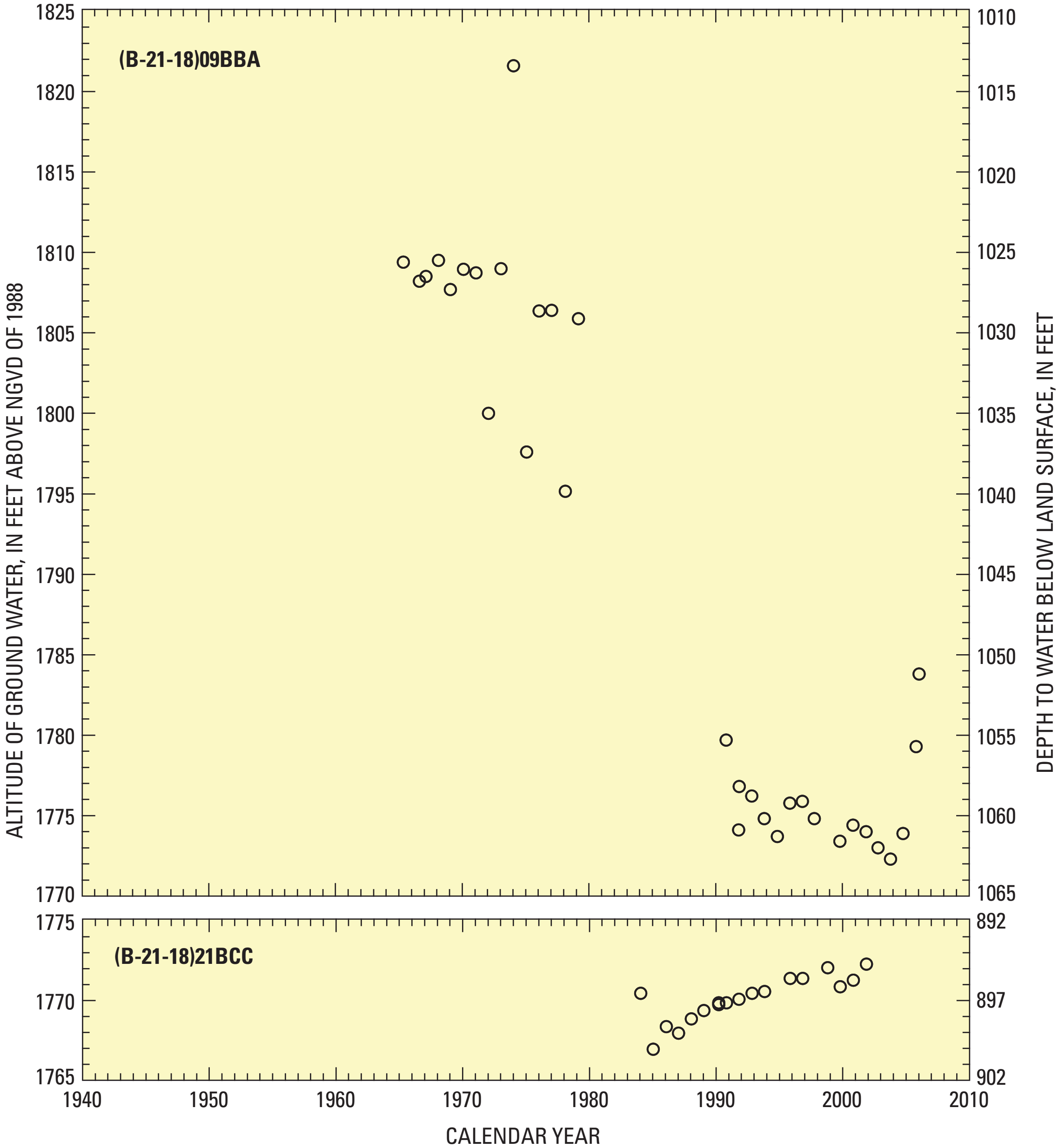

Figure 8. Hydrographs of water levels in selected wells of Sacramento Valley Basin, Mohave County, Arizona—Continued.

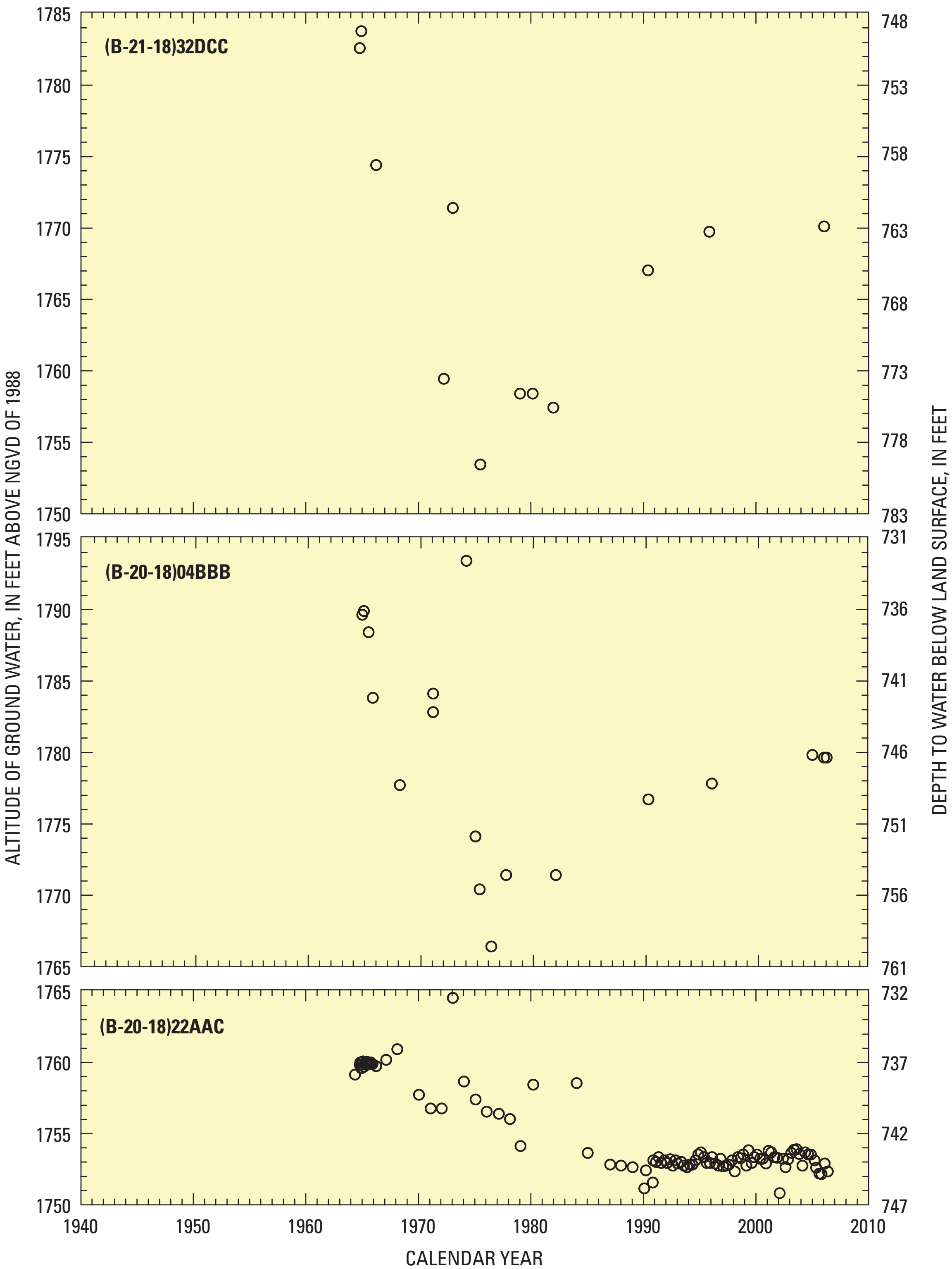

Figure 8. Hydrographs of water levels in selected wells of Sacramento Valley Basin, Mohave County, Arizona—Continued.

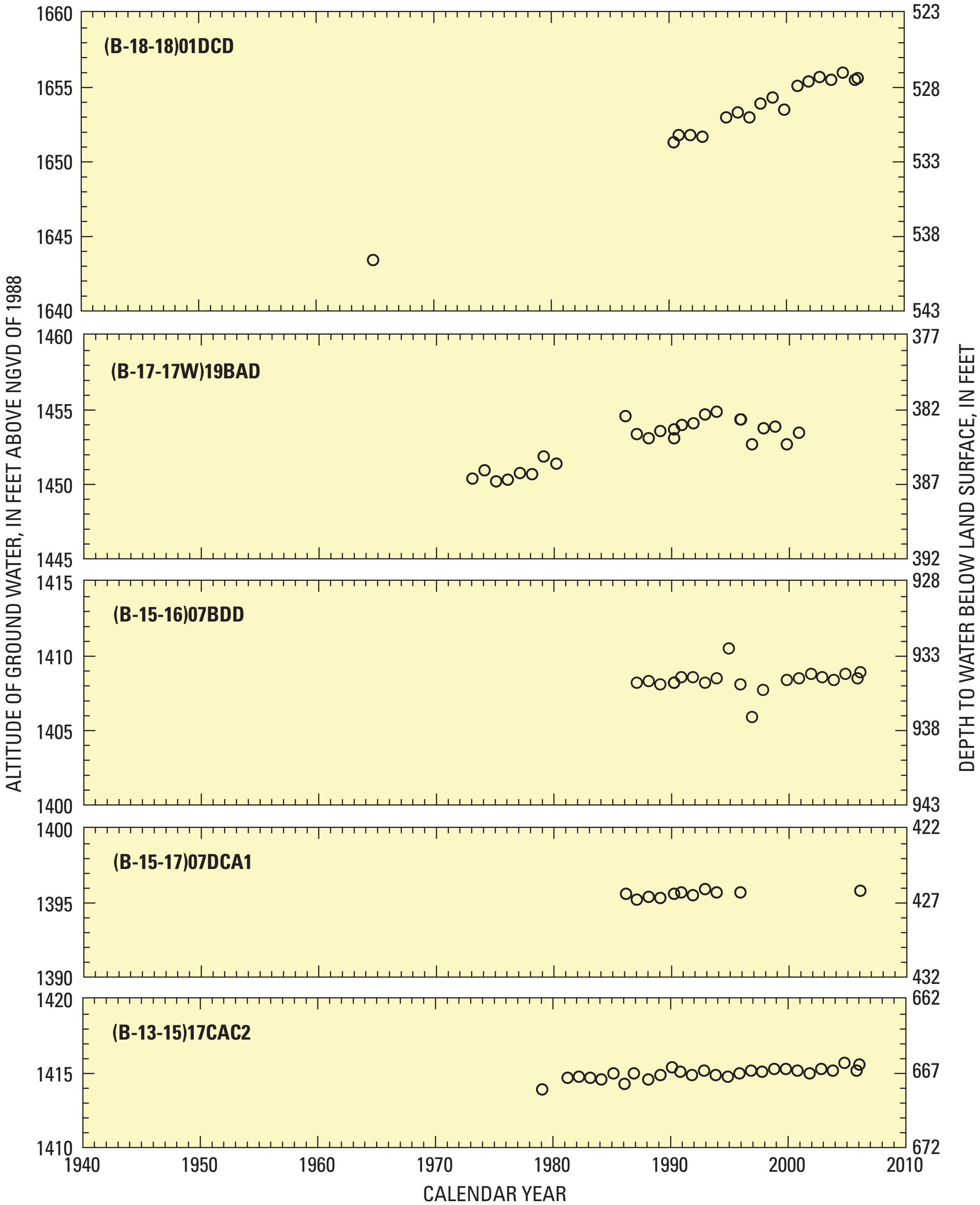

Figure 8. Hydrographs of water levels in selected wells of Sacramento Valley Basin, Mohave County, Arizona—Continued.

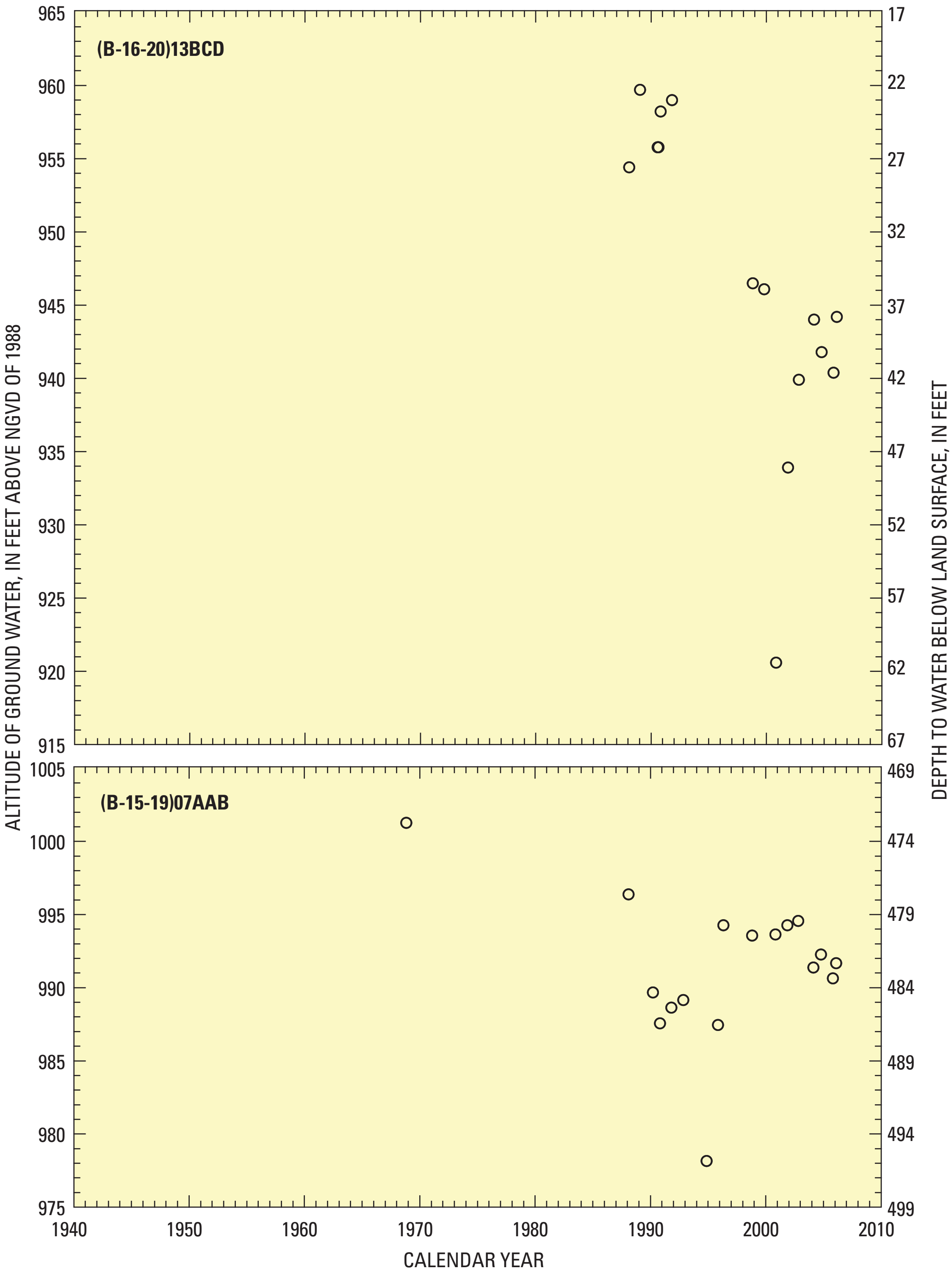

Figure 8. Hydrographs of water levels in selected wells of Sacramento Valley Basin, Mohave County, Arizona—Continued.

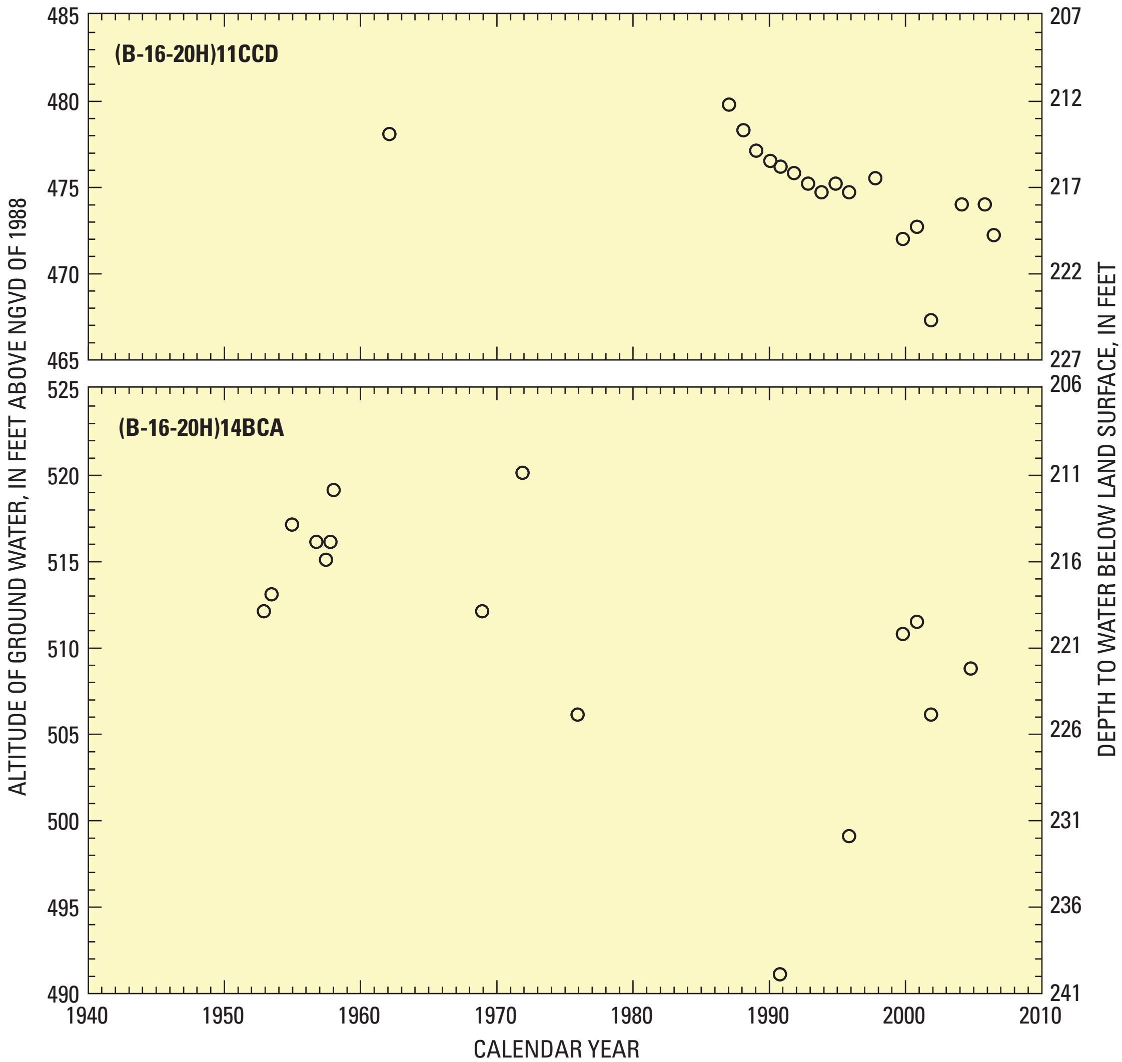

Figure 8. Hydrographs of water levels in selected wells of Sacramento Valley Basin, Mohave County, Arizona—Continued.

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