Figure 37 Tulare Lake Hydrologic Region

Basins and Subbasins of Tulare Lake Hydrologic Region

Basin/subbasin	Basin name
5-22	San Joaquin Valley
5-22.08	Kings
5-22.09	Westside
5-22.10	Pleasant Valley
5-22.11	Kaweah
5-22.12	Tulare Lake
5-22.13	Tule
5-22.14	Kern County
5-23	Panoche Valley
5-25	Kern River Valley
5-26	Walker Basin Creek Valley
5-27	Cummings Valley
5-28	Tehachapi Valley West
5-29	Castaic Lake Valley
5-71	Vallecitos Creek Valley
5-80	Brite Valley
5-82	Cuddy Canyon Valley
5-83	Cuddy Ranch Area
5-84	Cuddy Valley
5-85	Mil Potrero Area

Description of the Region

The Tulare Lake HR covers approximately 10.9 million acres (17,000 square miles) and includes all of Kings and Tulare counties and most of Fresno and Kern counties (Figure 37). The region corresponds to approximately the southern one-third of RWQCB 5. Significant geographic features include the southern half of the San Joaquin Valley, the Temblor Range to the west, the Tehachapi Mountains to the south, and the southern Sierra Nevada to the east. The region is home to more than 1.7 million people as of 1995 (DWR, 1998). Major population centers include Fresno, Bakersfield, and Visalia. The cities of Fresno and Visalia are entirely dependent on groundwater for their supply, with Fresno being the second largest city in the United States reliant solely on groundwater.

Groundwater Development

The region has 12 distinct groundwater basins and 7 subbasins of the San Joaquin Valley Groundwater Basin, which crosses north into the San Joaquin River HR. These basins underlie approximately 5.33 million acres (8,330 square miles) or 49 percent of the entire HR area.

Groundwater has historically been important to both urban and agricultural uses, accounting for 41 percent of the region's total annual supply and 35 percent of all groundwater use in the State. Groundwater use in the region represents about 10 percent of the State's overall supply for agricultural and urban uses (DWR 1998).

The aquifers are generally quite thick in the San Joaquin Valley subbasins with groundwater wells commonly exceeding 1,000 feet in depth. The maximum thickness of freshwater-bearing deposits (4,400 feet) occurs at the southern end of the San Joaquin Valley. Typical well yields in the San Joaquin Valley range from 300 gpm to 2,000 gpm with yields of 4,000 gpm possible. The smaller basins in the mountains surrounding the San Joaquin Valley have thinner aquifers and generally lower well yields averaging less than 500 gpm.

The cities of Fresno, Bakersfield, and Visalia have groundwater recharge programs to ensure that groundwater will continue to be a viable water supply in the future. Extensive groundwater recharge programs are also in place in the south valley where water districts have recharged several million acre-feet for future use and transfer through water banking programs.

The extensive use of groundwater in the San Joaquin Valley has historically caused subsidence of the land surface primarily along the west side and south end of the valley.

Groundwater Quality

In general, groundwater quality throughout the region is suitable for most urban and agricultural uses with only local impairments. The primary constituents of concern are high TDS, nitrate, arsenic, and organic compounds.

The areas of high TDS content are primarily along the west side of the San Joaquin Valley and in the trough of the valley. High TDS content of west-side water is due to recharge of stream flow originating from marine sediments in the Coast Range. High TDS content in the trough of the valley is the result of concentration of salts because of evaporation and poor drainage. In the central and west-side portions of the valley, where the Corcoran Clay confining layer exists, water quality is generally better beneath the clay than above it. Nitrates may occur naturally or as a result of disposal of human and animal waste products and fertilizer. Areas of high nitrate concentrations are known to exist near the town of Shafter and other isolated areas in the San Joaquin Valley. High levels of arsenic occur locally and appear to be associated with lakebed areas. Elevated arsenic levels have been reported in the Tulare Lake, Kern Lake and Buena Vista Lake bed areas. Organic contaminants can be broken into two categories, agricultural and industrial. Agricultural pesticides and herbicides have been detected throughout the valley, but primarily along the east side where soil permeability is higher and depth to groundwater is shallower. The most notable agricultural contaminant is DBCP, a now-banned soil fumigant and known carcinogen once used extensively on grapes. Industrial organic contaminants include TCE, DCE, and other solvents. They are found in groundwater near airports, industrial areas, and landfills.

Water Quality in Public Supply Wells

From 1994 through 2000, 1,476 public supply water wells were sampled in 14 of the 19 groundwater basins and subbasins in the Tulare Lake HR. Evaluation of analyzed samples shows that 1,049 of the wells, or 71 percent, met the state primary MCLs for drinking water. Four-hundred-twenty-seven wells, or 29 percent, exceeded one or more MCL. Figure 38 shows the percentages of each contaminant group that exceeded MCLs in the 427 wells.

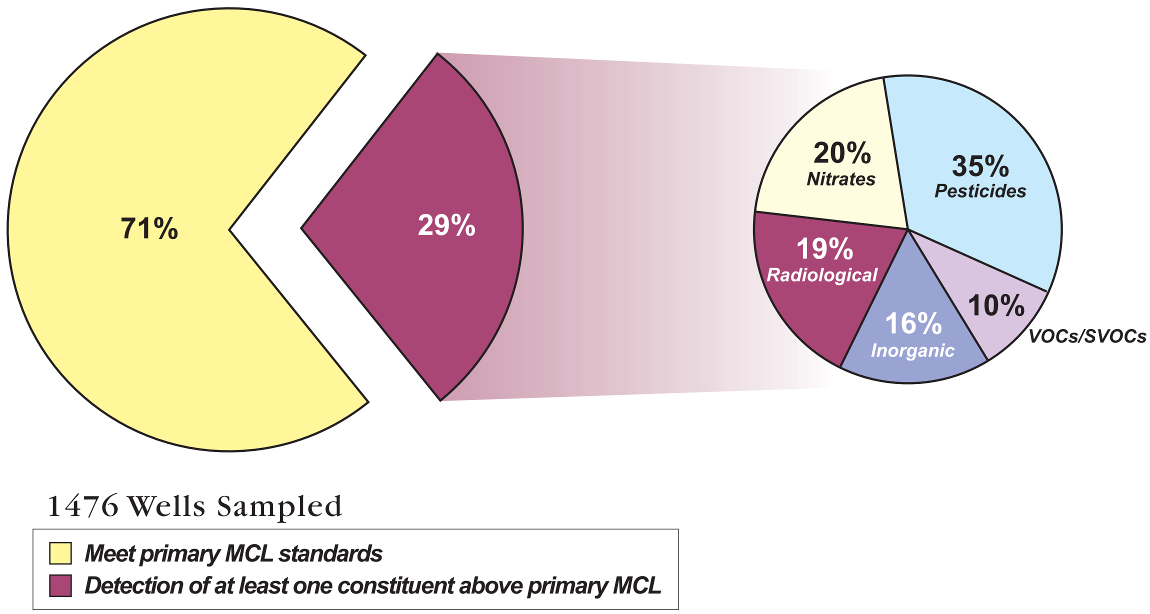

Figure 38 MCL exceedances by contaminant group in public supply wells in the Tulare Lake Hydrologic Region

Table 31 lists the three most frequently occurring contaminants in each of the six contaminant groups and shows the number of wells in the HR that exceeded the MCL for those contaminants.

Table 31 Most frequently occurring contaminants by contaminant group in the Tulare Lake Hydrologic Region

Contaminant group	Contaminant - # of wells	Contaminant - # of wells	Contaminant - # of wells
Inorganics - Primary	Fluoride – 32	Arsenic – 16	Aluminum – 13
Inorganics - Secondary	Iron – 155	Manganese – 82	TDS – 9
Radiological	Gross Alpha – 74	Uranium – 24	Radium 228 – 8
Nitrates	Nitrate(as NO_3) – 83	Nitrate + Nitrite – 14	Nitrite(as N) – 3
Pesticides	DBCP – 130	EDB – 24	Di(2-Ethylhexyl)phthalate – 7
VOCs/SVOCs	TCE – 17	PCE – 16	Benzene – 6 MTBE – 6

DBCP = Dibromochloropropane
EDB = Ethylenedibromide
TCE = Trichloroethylene
PCE = Tetrachloroehylene
VOC = Volatile organic compound
SVOC = Semivolatile organic compound

Changes from Bulletin 118-80

There are no newly defined basins since Bulletin 118-80. However, the subbasins of the San Joaquin Valley, which were delineated as part of the 118-80 update, are given their first numeric designation in this report (Table 32).

Table 32 Modifications since Bulletin 118-80 of groundwater basins and subbasins in Tulare Lake Hydrologic Region

Subbasin name	New number	Old number
Kings	5-22.08	5-22
Westside	5-22.09	5-22
Pleasant Valley	5-22.10	5-22
Kaweah	5-22.11	5-22
Tulare Lake	5-22.12	5-22
Tule	5-22.13	5-22
Kern County	5-22.14	5-22
Squaw Valley	deleted	5-24
Cedar Grove Area	deleted	5-72
Three Rivers Area	deleted	5-73
Springville Area	deleted	5-74
Templeton Mountain Area	deleted	5-75
Manache Meadow Area	deleted	5-76
Sacator Canyon Valley	deleted	5-77
Rockhouse Meadows Valley	deleted	5-78
Inns Valley	deleted	5-79
Bear Valley	deleted	5-81

Several basins have been deleted from the Bulletin 118-80 report. In Squaw Valley (5-24) all 118 wells are completed in hard rock. Cedar Grove Area (5-72) is a narrow river valley in Kings Canyon National Park with no wells. Three Rivers Area (5-73) has a thin alluvial terrace deposit but 128 of 130 wells are completed in hard rock. Springville Area (5-74) is this strip of alluvium adjacent to Tule River and all wells are completed in hard rock. Templeton Mountain Area (5-75), Manache Meadow Area (5-76), and Sacator Canyon Valley (5-77) are all at the crest of mountains with no wells. Rockhouse Meadows Valley (5-78) is in wilderness with no wells. Inns Valley (5-79) and Bear Valley (5-81) both have all wells completed in hard rock.

Table 33 Tulare Lake Hydrologic Region groundwater data

Basin/Subbasin	Basin Name	Area (acres)	Groundwater Budget Type	Well Yields (gpm)		Types of Monitoring			TDS (mg/L)	
				Maximum	Average	Levels	Quality	Title 22	Average	Range
5-22	SAN JOAQUIN VALLEY									
5-22.08	KINGS	976,000	C	3,000	500-1,500	909	-	722	200-700	40-2000
5-22.09	WESTSIDE	640,000	C	2,000	1,100	960	-	50	520	220-35,000
5-22.10	PLEASANT VALLEY	146,000	B	3,300	-	151	-	2	1,500	1000-3000
5-22.11	KAWEAH	446,000	B	2,500	1,000-2,000	568	-	270	189	35-580
5-22.12	TULARE LAKE	524,000	B	3,000	300-1,000	241	-	86	200-600	200-40,000
5-22.13	TULE	467,000	B	3,000	-	459	-	150	256	200-30,000
5-22.14	KERN COUNTY	1,950,000	A	4,000	1,200-1,500	2,258	249	476	400-450	150-5000
5-23	PANOCHE VALLEY	33,100	C	-	-	48	-	-	1,300	394-3530
5-25	KERN RIVER VALLEY	74,000	C	3,650	350	-	-	92	378	253-480
5-26	WALKER BASIN CREEK VALLEY	7,670	C	650	-	-	-	1	-	-
5-27	CUMMINGS VALLEY	10,000	A	150	56	51	-	15	344	-
5-28	TEHACHAPI VALLEY WEST	14,800	A	1,500	454	64	-	19	315	280-365
5-29	CASTAC LAKE VALLEY	3,600	C	400	375	-	-	3	583	570-605
5-71	VALLECITOS CREEK VALLEY	15,100	C	-	-	-	-	0	-	-
5-80	BRITE VALLEY	3,170	A	500	50	-	-	-	-	-
5-82	CUDDY CANYON VALLEY	3,300	C	500	400	-	-	3	693	695
5-83	CUDDY RANCH AREA	4,200	C	300	180	-	-	4	550	480-645
5-84	CUDDY VALLEY	3,500	A	160	135	3	-	3	407	325-645
5-85	MIL POTRERO AREA	2,300	C	3,200	240	7	-	7	460	372-657

gpm - gallons per minute
mg/L - milligram per liter
TDS -total dissolved solids

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San Joaquin Valley Groundwater Basin
Kern County Subbasin

- Groundwater Basin Number: 5-22.14
- County: Kern
- Surface Area: 1,945,000 acres (3,040 square miles)

Basin Boundaries & Hydrology

The San Joaquin Valley is surrounded on the west by the Coast Ranges, on the south by the San Emigdio and Tehachapi Mountains, on the east by the Sierra Nevada and on the north by the Sacramento-San Joaquin Delta and Sacramento Valley. The northern portion of the San Joaquin Valley drains toward the Delta by the San Joaquin River and its tributaries, the Fresno, Merced, Tuolumne, and Stanislaus Rivers. The southern portion of the valley is internally drained by the Kings, Kaweah, Tule, and Kern Rivers that flow into the Tulare drainage basin including the beds of the former Tulare, Buena Vista, and Kern Lakes.

The Kern County Groundwater subbasin is bounded on the north by the Kern County line and the Tule Groundwater subbasin, on the east and southeast by granitic bedrock of the Sierra Nevada foothills and Tehachapi mountains, and on the southwest and west by the marine sediments of the San Emigdio Mountains and Coast Ranges. Principal rivers and streams include Kern River and Poso Creek. Active faults include the Edison, Pond-Poso, and White Wolf faults. Average precipitation values range from 5 in. at the subbasin interior to 9 to 13 in. at the subbasin margins to the east, south, and west.

Hydrogeologic Information

The San Joaquin Valley represents the southern portion of the Great Central Valley of California. The San Joaquin Valley is a structural trough up to 200 miles long and 70 miles wide filled with up to 32,000 feet of marine and continental sediments deposited during periodic inundation by the Pacific Ocean and by erosion of the surrounding mountains, respectively. Continental deposits shed from the surrounding mountains form an alluvial wedge that thickens from the valley margins toward the axis of the structural trough. This depositional axis is below to slightly west of the series of rivers, lakes, sloughs, and marshes that mark the current and historic axis of surface drainage in the San Joaquin Valley.

Water Bearing Formations

Sediments that comprise the shallow to intermediate depth water-bearing deposits in the groundwater subbasin are primarily continental deposits of Tertiary and Quaternary age. From oldest to youngest the deposits include the Olcese and Santa Margarita Formations; the Tulare Formation (western subbasin) and its eastern subbasin equivalent, the Kern River Formation; older alluvium/stream deposits; and younger alluvium and coeval flood basin deposits. Specific yield values for the unconfined aquifer (Tulare and Kern River Formations and overlying alluvium) were compiled from two sources. The DWR's San Joaquin District office estimates (unpublished) ranges from 5.3 to 19.6 percent and averages 11.8 percent for the interval from surface to

300 feet below grade. The DWR (1977) groundwater model of Kern County lists the range as 8.0 to 19.5 percent with an average value of 12.4 percent representing an interval thickness of 175 to 2,900 feet and averaging approximately 600 feet. The greatest thickness of unconfined aquifer occurs along the eastern subbasin margin. The highest specific yield values are associated with sediments of the Kern River Fan west of Bakersfield.

Olcese and Santa Margarita Formations
The origin of these Miocene-age deposits varies from continental to marine from east to west across the subbasin (Bartow and McDougall 1984). The Olcese and Santa Margarita Formations are current or potential sources of drinking water only in the northeastern portion of the subbasin where they occur as confined aquifers. The Olcese Formation is primarily sand, ranging in thickness from 100 to 450 feet. The Santa Margarita Formation is from 200 to 600 feet thick and consists of coarse sand (Hilton and others 1963).

Tulare and Kern River Formations
These units are both Plio-Pleistocene age and represent a west/east facies change across the subbasin. The Tulare Formation (western subbasin) contains up to 2,200 feet of interbedded, oxidized to reduced sands; gypsiferous clays and gravels derived predominantly from Coast Range sources. The formation includes the Corcoran Clay Member, which is present in the subsurface from the Kern River Outlet Channel on the west through the central and much of the eastern subbasin at depths of 300 to 650 feet (Croft 1972), groundwater beneath the Corcoran Clay is confined. The Kern River Formation includes from 500 to 2,000 feet of poorly sorted, lenticular deposits of clay, silt, sand, and gravel derived from the Sierra Nevada. Both units are moderately to highly permeable and yield moderate to large quantities of water to wells (Hilton and others 1963).

Older Alluvium/Stream and Terrace Deposits
This unit is composed of up to 250 feet of Pleistocene-age lenticular deposits of clay, silt, sand, and gravel that are loosely consolidated to cemented and are exposed mainly at the subbasin margins. The unit is moderately to highly permeable and yields large quantities of water to wells (Hilton and others 1963; Wood and Davis 1959; Wood and Dale 1964). This sedimentary unit is often indistinguishable from the Tulare and Kern Formations below and together with these underlying formations, forms the principal aquifer body in the Kern County Groundwater subbasin.

Younger Alluvium/Flood Basin Deposits
This Holocene-age unit varies in character and thickness about the subbasin. At the eastern and southern subbasin margins the unit is composed of up to 150 feet of interstratified and discontinuous beds of clay, silt, sand, and gravel. In the southwestern subbasin it is finer grained and less permeable as it grades into fine-grained flood basin deposits underlying the historic beds of Buena Vista and Kern Lakes in the southern subbasin (Hilton and others 1963; Wood and Dale 1964). The flood basin deposits consist of silt, silty clay, sandy clay, and clay interbedded with poorly permeable sand layers. These flood basin deposits are difficult to distinguish from underlying fine-grained older alluvium and the total thickness of both units may be as much as 1,000 feet (Wood and Dale 1964).

Restrictive Structures

Faults that affect groundwater movement include the Edison, Pond-Poso, and White Wolf faults. Other barriers to groundwater movement include folds such as Elk Hills and Buena Vista Hills, angular unconformities, and contacts with crystalline and consolidated sedimentary rocks at the subbasin margins (DWR 1977). The Corcoran Clay significantly impedes vertical groundwater movement where present.

Recharge Areas

Natural recharge is primarily from stream seepage along the eastern subbasin and the Kern River; recharge of applied irrigation water, however, is the largest contributor (DWR 1995).

Groundwater Level Trends

The average subbasin water level is essentially unchanged from 1970 to 2000, after experiencing cumulative changes of approximately -15 feet through 1978, a 15-foot increase through 1988, and an 8-foot decrease through 1997. However, net water level changes in different portions of the subbasin were quite variable through the period 1970-2000. These changes ranged from increases of over 30 feet at the southeast valley margin and in the Lost Hills/Buttonwillow areas to decreases of over 25 and 50 feet in the Bakersfield area and McFarland/Shafter areas, respectively. The above information is a summary of unpublished DWR water level data.

Groundwater Storage

Kern County Water Agency estimates the total water in storage to be 40,000,000 af and dewatered aquifer storage to be 10,000,000 af (Fryer 2002). It appears that these calculations consider areas of the subbasin which are known to overlay useable groundwater, which they report to be about 1,000,000 acres.

Additional Information

Between 1926 and 1970, groundwater extraction has resulted in more than 8 feet of subsidence in the north-central portion of the subbasin, and approximately 9 feet in the south-central area (Ireland and others 1984).

Water banking was initiated in the subbasin in 1978, and as of 2000, seven projects contain over 3 million af (MAF) of banked water in a combined potential storage volume of 3.9 MAF (KCWA 2001). Approximately two-thirds of this storage is in the Kern River Fan area west of Bakersfield; the remainder is in the Arvin-Edison WSD in the southeastern subbasin or in the Semitropic WSD in the northwestern subbasin.

Groundwater Budget (Type A)

The budget presented below is based on data collected as part of DWR's Bulletin 160 preparation. The basis for calculations include a 1990 normalized year and land and water use data, with subsequent analysis by a DWR water budget spreadsheet to estimate overall applied water demands, agricultural groundwater pumpage, urban pumping demand, and other extraction data. As no data for subsurface inflow or outflow exists in Bulletin 160 data, these values were obtained from a 1977 groundwater model developed by DWR and the Kern County Water Agency (DWR 1977). Inflows to the subbasin include natural recharge of 150,000 af per year, artificial recharge of 308,000 af per year, applied water recharge 843,000 af per year, and a 1958-1966 average estimated subsurface inflow of 233,000 af per year (DWR 1977), for a total subbasin inflow of 1,534,000 af per year. Subbasin outflows are urban extraction of 154,000 af per year, agricultural extraction of 1,160,000 af per year, other extractions (oil industry related) of 86,333, and subsurface outflow was considered minimal, for a total subbasin outflow of 1,400,300 af per year. In addition to the above budget, KCWA has prepared a detailed long-term water balance from 1970 to 1998 which shows an average change in storage of minus 325,000 af per year (Fryer 2002). This analysis does not consider subsurface inflow.

Groundwater Quality

Characterization. The eastern subbasin contains primarily calcium bicarbonate waters in the shallow zones, increasing in sodium with depth. Bicarbonate is replaced by sulfate and lesser chloride in an east to west trend across the subbasin. West side waters are primarily sodium sulfate to calcium-sodium sulfate type (Hilton and others 1963; Wood ands Dale 1964; Wood and Davis 1959; Dale and others, 1966). The average TDS of groundwater is 400-450 mg/L with a range of 150 – 5,000 mg/L (KCWA 1995).

Impairments. Shallow groundwater presents problems for agriculture in the western portion of the basin. High TDS, sodium chloride, and sulfate are associated with the axial trough of the subbasin. Elevated arsenic concentrations exist in some areas associated with lakebed deposits. Nitrate, DBCP, and EDB concentrations exceed MCLs in various areas of the basin. Specific data for municipal production wells are available in the DHS water quality data base.

Water Quality in Public Supply Wells

Constituent Group[1]	Number of wells sampled[2]	Number of wells with a concentration above an MCL[3]
Inorganics – Primary	444	18
Radiological	372	15
Nitrates	475	38
Pesticides	436	23
VOCs and SVOCs	409	19
Inorganics – Secondary	444	60

[1] A description of each member in the constituent groups and a generalized discussion of the relevance of these groups are included in *California's Groundwater – Bulletin 118* by DWR (2003).
[2] Represents distinct number of wells sampled as required under DHS Title 22 program from 1994 through 2000.
[3] Each well reported with a concentration above an MCL was confirmed with a second detection above an MCL. This information is intended as an indicator of the types of activities that cause contamination in a given basin. It represents the water quality at the sample location. It does not indicate the water quality delivered to the consumer. More detailed drinking water quality information can be obtained from the local water purveyor and its annual Consumer Confidence Report.

Well Characteristics

	Well yields (gal/min)	
Municipal/Irrigation	Range: 200-4,000	Average: 1,200-1,500 (KCWA 1995)
	Total depths (ft)	
Domestic	Range: Not determined	Average: Not determined
Municipal/Irrigation	Range: 150-1,200	Average: 300-600 (KCWA 1995)

Active Monitoring Data

Agency	Parameter	Number of wells /measurement frequency
DWR (incl. Cooperators)	Groundwater levels	1,487 Semi-annually
Arvin Edison WSD	Quality	50-75 Annually
Arvin Edison WSD	Levels	250-300 Biennially
Cawelo WD	Quality	45 Annually
Kern Delta WD	Quality (EC, TDS, pH)	17 Infrequently
Kern Delta WD	Levels	115 Semi-annually
West Kern WD	Levels	5 Monthly
West Kern WD	Gen. mineral, organic chemicals, and radiological.	5 Every 3 years
Wheeler Ridge-Maricopa WSD	Quality (Irregular) Title 22	12 Annually 17 During Drought Years
Wheeler Ridge-Maricopa WSD	Levels	88-110 Annually
Buena Vista WSD	Quality (EC, TDS)	25 Quarterly 94 Biennially
Buena Vista WSD	Levels	76 Quarterly
Semitropic WSD	Levels	300 Annually
Department of Health Services and cooperators	Title 22 water quality	476 Varies

Basin Management

Groundwater management:	Recharge and in-lieu programs are operated by various water districts, the City of Bakersfield, and Kern County Water Agency (see Comments below). Buena Vista WSD is currently drafting an AB 255 Management Plan. Shafter-Wasco ID implemented an AB 255 management plan in June 1993. West Kern Water District and Kern Delta WD have adopted groundwater management plans. Rosedale-Rio Bravo WSD's AB 3030 plan commenced in 1996. Arvin-Edison WSD plan is under review by the district personnel and counsel. Cawelo WD adopted an AB 3030 management plan in 1994. Wheeler Ridge-Maricopa WSD while they have not formally adopted an AB 255 of AB 3030 plan, it has implemented the groundwater management plan contained in its Project Report.
Water agencies	
Public	Kern County Water Agency, City of Bakersfield, and numerous water districts and small Community Services Districts.
Private	California Water Service Co., McFarland Mutual Water Company, Stockdale Mutual Water Company, and numerous small community water groups.
Water Projects	Kern Fan Banking Unit; Arvin-Edison Banking Project; Semitropic Banking Project; Cross Valley Canal; Friant-Kern Canal.

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Errata

Changes made to the basin description will be noted here.