

KERN COUNTY WATER AGENCY

**WATER SUPPLY REPORT  
1999**

THOMAS N. CLARK  
GENERAL MANAGER

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## DEFINITIONS

**Acre-Foot (AF)** The quantity of water required to cover one acre of land to a depth of one foot (325,872 gallons). This amount of water is normally used by a family of four during a one-year period for residential use (not including water used for food or clothing).

**Agency** Kern County Water Agency (KCWA).

**Aquifer** Geologic formations or parts of formations containing sufficient saturated permeable material able to yield sufficient quantities of water.

**cfs** Cubic feet per second, a rate of flow.

1 cfs = 449 gallons per minute

1 cfs = 646,360 gallons per day

1 cfs = 1.983 acre-feet per day

**Change in Groundwater Storage** The change in volume of water retained by subsurface aquifers within the groundwater basin. A negative change reflects the fact that extractions have exceeded recharge.

**Confined Aquifer** A groundwater-bearing stratum constrained at its upper surface by an impervious unit, such as a regional clay.

**Corcoran Clay** A thick, impermeable layer of clay which lies under much of the San Joaquin Valley. This clay layer separates the groundwater basin into two distinct aquifers. One region, referred to as the "unconfined" aquifer, lies above the Corcoran Clay. The other region, referred to as the "confined" aquifer, lies entirely below the Corcoran Clay.

**CVC** The Cross Valley Canal.

**CVP** The federal Central Valley Project. The Friant-Kern Canal is its major feature in Kern County.

**DWR** California Department of Water Resources. The operators of the State Water Project (California Aqueduct).

**Electrical Conductance (EC)** A measure of the ability of water to conduct an electrical current, which can be related to the concentration of total dissolved solids. The normal unit of measurement is micromhos per centimeter.

**Groundwater Basin** An area underlain by one or more permeable formations (aquifers) capable of furnishing a substantial and beneficial water supply. The basin referred to in this report is within the San Joaquin Valley portion of Kern County but is connected hydrologically and geologically to a larger basin.

**Groundwater Recharge** Any act of nature or man which replenishes or adds water to that supply which is stored within the natural subsurface aquifer system.

**In-lieu Recharge** The process of recharging groundwater supplies by substituting surface water for groundwater that would otherwise be recovered.

**Irrigation Efficiency** The amount of applied irrigation water that actually goes to satisfy net crop water demands, expressed as a percent.

**Metric Conversions**

Acre-feet (x) 1233.5 = cubic meters

Acre-feet (x) 0.0012335 = cubic hectometers

Feet (x) 0.0348 = meters

Inches (x) 2.54 = centimeters

Million gallons per day (x) 0.043813 = cubic meters per second

Acres (x) .4047 = hectares

**Overdraft** A long-term condition in which groundwater recovery exceeds groundwater recharge.

**Sacramento River Index** An index used by the California Department of Water Resources to forecast available water supplies and SWP delivery capabilities. The index consists of the forecasted or computed unimpaired flows of the Sacramento River near Red Bluff, Feather River at Oroville Reservoir, Yuba River at Smartville and American River at Folsom Reservoir.

**SWP** The State Water Project. In Kern County, its major feature is the Edmund G. Brown California Aqueduct.

**TDS** Total dissolved solids. A measurement of the dissolved matter in water, consisting mainly of inorganic salts, and small amounts of organic matter and gases. Usually measured in parts per million (ppm).

**Unconfined Aquifer** A groundwater bearing stratum that is not constrained at its upper surface by an impervious or semi-impervious unit, such as a regional clay.

**USBR** United States Bureau of Reclamation. The operators of the Federal Central Valley Project.

# INTRODUCTION

The Kern County Water Agency was created by an act of the California Legislature in July 1961 and ratified by the electorate of Kern County in September 1961. The Agency was granted the primary power to acquire and contract for water supplies for Kern County, with additional powers to control flood and storm waters, to drain and reclaim land, to store and reclaim water, to protect the quality of underground waters, and to conduct investigations relative to water resources. The primary focus of the Agency, working with other water entities, is to coordinate management of the water supplies of Kern County, with particular emphasis on State Water Project supplies, in order to enhance our local economy.

Since its beginning in 1961, the Agency has been building a base of information on the water supply and demand characteristics of the San Joaquin Valley portion of Kern County. Since 1977, the Agency has published the annual Water Supply Report in order to present these statistics in one document and to assist water leaders and users in making water management decisions.

The Water Supply Report attempts to identify and quantify the interrelationships of the hydrologic cycle (see Figure 1) with human activities in Kern County. For instance, the planting and harvesting of crops has altered the natural pattern of evapotranspiration. Groundwater storage has been affected by the groundwater pumping and recharge, as the agricultural, municipal and industrial sectors attempt to meet their expanding needs. Local surface storage facilities and contracts for imported surface supplies have lessened our dependence upon groundwater supplies. Also, coordinated groundwater recharge and conjunctive use efforts have had a positive effect on groundwater.

The net result of the interactions between the available water supplies and the various demands for that water is a change in groundwater storage and groundwater quality. The Water Supply Report documents these changes and their causes.

All supporting data and calculations used to prepare this report are on file at the Agency and are open to public review.

## 1999 La Niña Brings Dry Local Conditions

The 1998 El Nino conditions, which brought record storms and precipitation in Kern County and almost all of California, paved the way for a predicted La Nina phenomenon in 1999. Historically, La Nina conditions signal dry weather patterns in California and 1999 began very dry with state, federal and local water supply sources receiving about 50 percent of normal precipitation in early January. An extremely unusual snowstorm blanketed Kern County on January 25, with some locations in Bakersfield measuring six inches. It was the first time since 1974 that snowfall occurred on the valley floor.

Because of the 1997-98 El Nino precipitation levels, Kern County water supplies were in relatively good shape despite these early dry conditions, with state and federal reservoirs filled by early January 1999. The initial State Water Project allocation for 1999 was 55 percent at the end of 1998. The La Nina conditions proved true to history in the southern Sierra regions of California with the Kern River Basin yielding only 53 percent of its average First Point April-July runoff during 1999. The actual April-July runoff at First Point during 1999 was 252,627 acre-feet.

The Kern River watershed saw more dry conditions in February and March 1999 but a late April storm series brought 1.65 inches at Isabella Dam, the fifth highest April rainfall total since 1950. Reservoir storage for 1999 began at 244,904 acre-feet and ended the year with 169,341 acre-feet, at 107 percent of the average December 31<sup>st</sup> carryover storage amount.

According to the Department of Water Resources, the northern California eight-station precipitation index rose early in the year to 265 percent then ended at a more normal rate of 103 percent. The Sacramento River Runoff was estimated at 23.4 million by March 1999 then ended the year slightly down at 21.2 million acre-feet. That was 17 percent above the mean of 18.5 million acre-feet.

In late February, the state's share of San Luis Reservoir was at about 104 percent of capacity or 1,100,000 acre-feet. DWR had pumped about 42,000 acre-feet of water into the federal share of San Luis until the Bureau filled its share in mid-March. Most of the storage excess went to refill southern California reservoirs which were drawn down during maintenance outages of the east and west branch of the aqueduct. DWR forecasts in February reported that the state's share of San Luis would remain full through the end of March. Oroville flood control storage was encroached upon in February due to inflow from storm. During a 10-day period, more than 400,000 acre-feet were released with about 150,000 acre-feet going down the spillway in order to maintain flood control storage space. Precipitation received in northern California watersheds through February 22, 1999 was about 130 percent of average and the northern Sierra snow pack stood at 140 percent of average.

By March 1999 the SWP allocation had increased to 100 percent for requested entitlement and the state's share of San Luis Reservoir was slightly above 100 percent of capacity. The federal storage at San Luis was about 950,000 acre-feet or about 98 percent of capacity. On March 5 the Bureau of Reclamation revised approved allocations to 75 percent of normal for south of Delta ag contractors (contractors receiving water

through the Delta-Mendota Canal) and 100 percent Class I water and 10 percent of Class II water for Friant Cross Valley Canal contractors.

In August, DWR meteorologists were predicting that the 1999-2000 fall and winter hydrology would be similar to the 1998-1999. Above normal precipitation was expected for the fall-early winter period then a gradual move to drier weather during the remainder of the rainy season. Based on upon these forecasts, greater than projected San Luis storage and DWR's preliminary year 2000 water budget forecast, there was a good chance that the state's share of San Luis storage would be full by the end of the year. The La Nina phenomenon continued through October with models indicating above normal precipitation for the fall and early winter with a gradual increase in dryness. Experts were also forecasting that the southern part of California would be drier than the north.

The water year finished with a Sacramento River Index (SRI) of 2.12 million acre-feet, which is 117 percent of the average at 18.1 million acre-feet. Table 1 is a history of Sacramento River indices; Figure 2 shows the same information as a graph.

Kern County surface water supplies from all sources (state, federal and local, excluding small streams) during 1999 were about 2,228,200 acre-feet. Normal supplies are about 2,200,000 acre-feet. Therefore, water availability was about 101 percent of normal. SWP entitlement deliveries from all sources totaled 1,316,282 acre-feet, or about 111 percent of entitlement. Kern River First Point supplies were 463,915 acre-feet, about 63 percent of average. Central Valley Project deliveries totaled 350,526 acre-feet, or 88 percent of the 1975-99 average.

Because of the adequate water supply conditions, about 954,045 acres of farmland was cropped. Total irrigated acreage was 887,500 acres, about 25,000 more than in 1998.

Change in groundwater storage in 1999 was a decrease of 437,600 acre-feet. Total direct recharge in 1999 was 566,800 acre-feet. The net change in storage since 1970 has been a net loss of about 6,253,164 acre-feet, or about 208,400 acre-feet per year.

## **Delta Issues**

One of the most significant water supply events to impact Kern County during 1999 was in early summer when a large population of Delta smelt congregated in the southern Delta. As a consequence, the number of smelt "take" at the SWP and Central Valley Project pumping plants increased to a point where endangered species issues became of concern. The U.S. Fish and Wildlife Service ordered the export pumps to an almost standstill.

By the end of July the Delta smelt take number had fallen significantly with the 14-day average below 150. The level of concern is an average of 400 per day. SWP exports resumed normal levels on July 1 with Banks Pumping Plant averaging about 12,000 acre-feet per day.

The pumping restrictions remained through most of July with some 500,000 acre-feet of

water supply lost. This sharp cutback in pumping became critical to San Joaquin Valley farmers who depended on that water for irrigation during the peak growing season.

Because of warm weather and the Delta pumping restrictions, withdrawals from San Luis Reservoir were occurring at a rate that was dropping the reservoir by as much as 2.5 feet per day. Water quality issues soon surfaced because of these large withdrawals and the dependancy on this water by high tech manufacturing areas in the Silicon Valley prompted emergency plans to shift some deliveries to fall plus utilize some groundwater from Kern banking programs, despite the year being classified as "wet."

## **Kern River Program**

In November 1999 a historic agreement on the Kern River was made between KCWA and the City of Bakersfield. This agreement provided for greater access to high quality Kern River water for the KCWA Garnett Purification Plant (ID4) and more frequent water flows in the Kern River channel during peak recreation seasons. ID4 would be able to have more access for Kern River water while substituting its SWP and other supply sources for the city's Kern River supply. This historic agreement has significant water supply management, water quality and recreation benefits for the resident of the urban Bakersfield areas.

## **Water Supplies**

### **State Water Project (SWP)**

Dry conditions prompted an initial allocation for State Water Project contractors of just 55 percent. Fortunately, a series of late winter storms provided a boost to snow pack levels so that by February the allocation increased to 60 percent, then to 100 percent by March.

The chronology of 1999 allocations follows:

|                   |                 |
|-------------------|-----------------|
| November 24, 1998 | 55% allocation  |
| February 10, 1999 | 60% allocation  |
| March 10, 1999    | 100% allocation |

Member Units' contract entitlements for 1990 and after are shown on Table 2. The table also breaks out entitlement between municipal and industrial (M&I) and agricultural uses. While the M&I entitlement is small compared to the agricultural, KCWA is the third largest M&I contractor with the SWP, and is the largest agricultural contractor.

A total SWP supply of 1,399,674 acre-feet was available during 1999, including 1,087,730 acre-feet of SWP entitlement, 58,241 acre-feet of "Interruptible Water", 45,360 acre-feet of DWR Turnback Pool Purchase and 208,343 acre-feet of SWP water transferred into Kern County by other entities. A total of 1,386,481 acre-feet of SWP water were actually delivered during 1999. Since the first deliveries in 1968, nearly 25 million acre-feet of SWP water has been brought into Kern County. A graph of historic SWP

deliveries is provided in Figure 3. Table 3 provides a history of SWP deliveries, with annual and cumulative deliveries and imports. Table 4 shows 1999 SWP deliveries by contract type.

## Kern River

The strong El Nino pattern of 1998 brought high Kern River stream flows well into the fall of that year. The Kern River maintained above average flows until the end of December 1998 until a major cooling of the Tropical Pacific in early 1999 signaled the end of El Nino and the beginning of La Nina. La Nina, typically a dry weather phenomenon, proved true as the Kern River Basin yielded only 53 percent of its average First Point April-July runoff during 1999.

The first quarter of the 1998-1999 water year saw very low precipitation until late January 1999 when a series of Pacific storms increased the snow pack at the Kern River watershed three-fold. February and March were extremely dry while late season April storms left 1.65 inches at Isabella Dam, the fifth highest April rainfall total over the past 50 years. Actual 1999 April-July Kern River inflow to Isabella Reservoir was 245,860 acre-feet (56 percent of average) and April-July runoff at First Point was 252,627 acre-feet (53 percent of the long-term average). Calendar year runoff at First Point of Measurement was 433,971 acre-feet (59 percent of the long-term average and 79 percent of the historical median).

The final tally for Kern River 1999 regulated snowmelt runoff at First Point of Measurement was 461,621 acre-feet.

|                   | <u>Apr 1</u><br><u>1997</u> | <u>Apr 1</u><br><u>1998</u> | <u>Apr 1</u><br><u>1999</u> | <u>Apr 1</u><br><u>Avg</u> | <u>1999%</u><br><u>of Avg</u> |
|-------------------|-----------------------------|-----------------------------|-----------------------------|----------------------------|-------------------------------|
| Upper Tyndall Cr. | 40.80                       | 46.70                       | 12.80                       | 27.70                      | 46                            |
| Crabtree Meadow   | 21.60                       | 29.80                       | 7.70                        | 19.80                      | 39                            |
| Chagoopa          | 29.20                       | 35.10                       | 13.50                       | 21.80                      | 62                            |
| Pascoe            | 37.70                       | 55.90                       | 22.30                       | 24.90                      | 90                            |
| Wet Meadow        | 19.90                       | 44.60                       | 13.70                       | 30.30                      | 45                            |
| Tunnel Guard      | 12.70                       | 27.10                       | 1.60                        | 15.60                      | 10                            |
| Casa Vieja Meadow | 17.60                       | 34.60                       | 11.10                       | 20.90                      | 53                            |
| Beach Meadows     | 0.30                        | 24.90                       | 0.60                        | 11.00                      | 5                             |
| Average           | 22.40                       | 37.30                       | 10.40                       | 21.50                      | 44%                           |

The outlook for Kern River supplies worsened during the April-July snowmelt period as the water year progressed, as shown below:

|                |                    |
|----------------|--------------------|
| February, 1999 | 75% of average     |
| March          | 70%                |
| April          | 59%                |
| May            | 61%                |
| Final          | 56% (final runoff) |

Table 5 shows historic Kern River runoff and cumulative runoff for the 106 years of complete record, including diversions above First Point. In calendar year 1999 a total of

461,621 acre-feet of regulated Kern River water flowed past First Point of measurement, which was 63 percent of the 1954-99 long-term average regulated flow at First Point of measurement of 734,300 acre-feet and 63 percent of the historical median of 587,500 acre-feet. An additional 2,480 acre-feet was diverted above First Point. During the last 106 years, the Kern River has yielded nearly 78 million acre-feet of runoff. Since Isabella Dam began regulating flows in 1954, over 33 million acre-feet of runoff has occurred. Figure 4 is a histogram of annual Kern River flows at First Point. Table 6 gives a summary of Kern River deliveries by entity in 1999.

## Central Valley Project (CVP)

Early in the year the allocation for south of Delta contractors started at 70 percent. Friant CVP contractors were approved for 75 percent of Class I supplies and 10 percent of Class II supplies. By May, south of Delta ag contractors remained at 70 percent of normal water supplies and Friant contractors were approved to receive 100 percent of Class I, and 15 percent of Class II supplies.

Following is a chronology of CVP water allocations:

|               | <u>Friant-Kern Supplies</u> | <u>CVP Delta Supplies</u> |
|---------------|-----------------------------|---------------------------|
| February 1999 | 100% Class I, 10%% Class II | 70%                       |
| March 1999    | 100% Class I, 10%% Class II | 70%                       |
| April 1999    | 100% Class I, 10% Class II  | 70%                       |
| May 1999      | 100% Class I, 15% Class II  | 70%                       |
| Final 1999    | 100% Class I, 10% Class II  | 70%                       |

Table 7 shows 1999 deliveries of CVP water by entity. As shown, 215,999 acre-feet of Class I entitlement and 58,224 acre-feet of Class II water was delivered. A total of 49,948 acre-feet of "Section 215" water was delivered in 1999, most of which was delivered to KCWA for groundwater recharge and banking programs. Also, 161,942 acre-feet of other water were delivered, to Arvin-Edison under its banking program with Metropolitan Water District of Southern California. This water is not included in the total CVP deliveries to the county.

Table 8 displays annual and cumulative deliveries of CVP water since 1950, when the first importations were made to Kern County. Figure 5 is a histogram of CVP deliveries since 1970. From 1950 to 1999, almost 15.5 million acre-feet of CVP water were imported into Kern County.

## Minor Streams

Local "minor stream" watersheds are the second largest local source of surface water, after the Kern River. Streams which yield measurable runoff are grouped into four watershed areas: the Poso group (including Poso Creek), the Caliente group (including Caliente and Tehachapi Creeks), the El Paso group (including El Paso Creek), and the San Emigdio group (including San Emigdio Creek). Grouping of minor streams is based upon hydrologic similarity of the watersheds and representative gauging records. Minor stream flows can be substantial during above-average precipitation years, such as 1982, 1983 and 1986.

Runoff for ungauged streams is estimated by statistical methods based on historic

relationships of the watershed area, precipitation and runoff for similar gauged streams. Gauges are in place on Poso and Tehachapi Creeks, and therefore actual measurements can usually be used for these watersheds. (KCWA, in cooperation with local water districts, monitors stream flows on Poso and Tehachapi Creeks). However, in very dry years the flow on Tehachapi Creek is too small for the gauge to record. In this report, flows are assumed to occur at the foothill line before they disappear into the valley alluvium. Total minor stream volumes in 1999 were estimated to be about 37,300 acre-feet as follows:

| <u>Stream Group</u> | <u>Acre-feet</u> |
|---------------------|------------------|
| Poso                | 28,300           |
| Caliente            | 4,600            |
| El Paso             | 1,200            |
| San Emigdio         | <u>3,200</u>     |
| Total               | 37,300           |

Some minor stream water is used for irrigation by farmers in the North Kern Water Storage District and Semitropic Water Storage District. Much of the remaining water percolates to the underlying aquifer. Some of this recharge probably contributes to the shallow groundwater in the Kern Lake Bed area and near the Kern National Wildlife Refuge. KCWA estimated that about 35,600 acre-feet of the minor stream flows during 1999 contributed to groundwater recharge. Table 9 shows annual minor stream runoff, along with cumulative runoff since 1970. The variability of minor stream flows is shown by the accompanying statistics, and shown graphically in Figure 6. Figures 7a and 7c show the hydrograph for Tehachapi and Poso in 1999. Figures 7b and 7d show cumulative runoff for Tehachapi and Poso for the year.

## Effective Precipitation

Rainfall that occurs during the growing season of a crop or that is stored in the soil for later use can reduce the total volume of water that needs to be imported or withdrawn from groundwater supplies. Rainfall can provide an alternate water supply, called "effective precipitation."

Only that portion of rainfall that satisfies crop water requirements can properly be called effective precipitation. A large portion of rainfall evaporates from the soil surface and the soil profile before the crop can use it. Timing of rainfall is also an important factor in determining its effectiveness. During years of extremely heavy rainfall, a small amount may percolate past the crop root zone and recharge the underlying aquifer, particularly during early stages of crop growth, thus becoming unavailable to the crop. In addition, heavy rain immediately after an irrigation cycle may not be useable by a crop.

Most urban storm runoff is captured in unlined sumps and allowed to percolate. This runoff is not usually measured. A small amount of storm runoff is diverted into the Kern River, where it becomes available for delivery or recharge. About 300 acre-feet of urban runoff was diverted into the Kern River system in 1999.

KCWA gathers monthly rainfall data for most of the measuring stations in the San Joaquin Valley portion of Kern County, along with data for some mountain stations. This rainfall data is used to compute effective precipitation and minor stream runoff. Table 10 gives monthly rainfall for every measuring station gathered by KCWA. Rainfall in 1999

contributed 136,500 acre-feet of effective precipitation, with 119,200 acre-feet occurring over the useable groundwater basin. This excludes urban storm water diverted into the Kern River. Rainfall at Meadows Field Airport near Bakersfield in 1999 was 92 percent of average, about 120 percent lower than 1998. Following is a tabulation of 1995-99 and average monthly rainfall (in inches) for Meadows Field. KCWA estimates that rainfall provided about 2.0 inches of useable water for crops grown during 1999.

| Rainfall at Meadows Field, Bakersfield |             |             |             |             |             |                                |
|----------------------------------------|-------------|-------------|-------------|-------------|-------------|--------------------------------|
|                                        | <u>1996</u> | <u>1997</u> | <u>1998</u> | <u>1999</u> | <u>Avg.</u> | <u>1999</u><br><u>% of Avg</u> |
| Jan                                    | 1.08        | 1.87        | 1.32        | 3.90        | 1.18        | 330                            |
| Feb                                    | 2.54        | 0.80        | 5.36        | 0.46        | 1.21        | 38                             |
| Mar                                    | 0.78        | 0.21        | 2.51        | 0.21        | 1.41        | 15                             |
| Apr                                    | 0.12        | 0.00        | 0.87        | 0.83        | 0.45        | 184                            |
| May                                    | 0.02        | 0.00        | 1.33        | 0.00        | 0.24        | 0                              |
| Jun                                    | 0.00        | 0.00        | 0.37        | 0.00        | 0.12        | 0                              |
| Jul                                    | 0.00        | 0.00        | 0.00        | 0.00        | 0.00        | 0                              |
| Aug                                    | 0.00        | 0.00        | 0.00        | 0.00        | 0.08        | 0                              |
| Sep                                    | 0.00        | 0.05        | 0.31        | 0.08        | 0.15        | 53                             |
| Oct                                    | 0.00        | 0.25        | 0.24        | 0.00        | 0.30        | 0                              |
| Nov                                    | 0.00        | 1.70        | 0.46        | 0.36        | 0.59        | 61                             |
| Dec                                    | 1.73        | 0.97        | 0.55        | 0.14        | 0.76        | 18                             |
| Total                                  | 6.27        | 5.85        | 13.32       | 5.98        | 6.40        | 92                             |

Figure 8 shows annual rainfall recorded at three selected climatic stations in Kern County. Rainfall in the Wheeler Ridge area is normally higher than on the valley floor. Orographic uplift associated with the mountains at the southern end of the valley account for the higher rainfall in this area. Table 11 lists the annual amounts of effective precipitation, expressed as total acre-feet and inches per acre, along with cumulative amounts and descriptive statistics. Figure 9 is a graphic depiction of the same information.

## Recycled Water

The reuse of municipal and industrial waste water provides an irrigation water source for Kern County agriculture. There are 14 active waste water recycling treatment plants in the San Joaquin Valley portion of Kern County. Recycling processes are classified as follows. "Primary" treatment removes most suspended matter from the sewage (usually via settling ponds), but removes little or no colloidal or dissolved matter. "Secondary" treatment provides some biological action or filtration to remove any remaining colloidal or dissolved substances from the sewage (nearly all recycling treatment facilities in Kern County provide secondary treatment of sewage). "Tertiary" treatment involves further filtration and disinfection to inactivate pathogens.

Most of the effluent from recycling treatment plants in Kern County is used to irrigate salt-tolerant crops on bordering lands, such as cotton, pasture and some grains. A small

amount percolates directly to the groundwater basin. The remainder is evaporated. In 1999 about 48,500 acre-feet of waste water was recycled (Table 12). KCWA estimated that about 44,600 acre-feet were used by agriculture, 88 acre-feet evaporated and 3,850 percolated to the underlying aquifer. Table 13 shows historic amounts of recycled water. Figure 10 shows the same information as a graph.

Another source of reusable waste water results from agricultural tail water return systems. Many farming operations have installed these systems to intercept water that would normally run off the field during irrigation. This recovered water is either transported back to the main irrigation system or is applied on an adjacent field (from the foot of one field to head of another). Tail water return systems are widely used on fields that are furrow or border irrigated. Their efficiency lies in the saving of energy required to recover the water from wells, or by reducing the need to import additional surface supplies. From a basin balance standpoint, these two water reuse activities are internal and do not add to the hydrologic system.

## **Oil Field Produced Water**

Another source of waste water is as a byproduct of oil production. Unlike treated municipal effluent or tail water, oilfield produced waters are a true addition to the hydrologic system, being drawn from deep, connate waters that are intermixed with oil deposits. In the Kern Front oil field, which lies astride the Kern River northeast of Bakersfield, substantial quantities of water are removed with each barrel of oil. The chemical quality of this water is generally within acceptable limits for agriculture. Thus, much of this water is discharged into irrigation canals.

A total of 2,700 acre-feet of produced water from the Kern Front oil field were reused in 1999. Table 14 shows historic oil field produced water flows. Figure 11 shows the same information as a graph.

## **Groundwater Extractions**

Most of the groundwater extractions in Kern County are not recorded. In the past, agricultural and urban power records from utility companies were matched with calculations for groundwater production. However, the accuracy of such power record calculations was unsatisfactory. In this report groundwater extractions are estimated by solving for the missing number in the groundwater change-in-storage equation.

Total groundwater extractions in 1999 were calculated to be about 1,569,000 acre-feet. This is about 308,000 acre-feet more than was extracted in 1998 and likely reflects the dryness in the Kern River service area and large amount of surface water used for direct recharge.

Groundwater is pumped for a variety of uses in the San Joaquin Valley portion of Kern County, with agriculture the largest user. In 1999 agriculture used about 1,416,100 acre-feet. Municipal and industrial uses were about 152,900 acre-feet.

Table 15 shows historic groundwater pumping in the San Joaquin Valley portion of Kern

County since 1970. Both annual and cumulative amounts are tabulated, along with descriptive statistics. Figure 12 is a histogram of groundwater pumping, a graphic display of relative variations.

## Water Requirements

### Agricultural

Gross irrigated acreage in the San Joaquin Valley portion of Kern County was about 887,540 acres in 1999. Since 19,400 acres were double-cropped, total net acreage in 1999 was 868,140 acres. Approximately 754,400 acres were irrigated over the usable groundwater basin, and 128,400 acres were irrigated on lands outside the usable groundwater basin.

A historic summary of irrigated acreage is provided in Table 16, along with descriptive statistics. Figure 13 shows historic irrigated acreage plotted as a bar graph. Figure 14 categorizes irrigated acreage by crop. Permanent crops (trees and vines) make up 41 percent of Kern County's total acreage. Cotton remained an important crop to Kern County's economy despite falling prices and encompassed 20 percent of the county's total acreage. Alfalfa and other green feeds accounted for about 10 percent of Kern County's total acreage, and are grown to support the dairy and cattle industries (milk and cream production are now California's number one crop), as well as for pleasure horses. Vegetables represent about another eight percent of Kern County's agricultural acreage.

Crops grown in Kern County are consumed throughout the United States and are exported to countries around the world. The top ten export crops are almonds, carrots, cotton, grapes, nursery stock, oranges, pistachios, plums and potatoes. Countries receiving products from Kern County include Canada, Mexico, countries in Central and South America, Africa, Europe, the Middle East, Japan, China, Southeast Asia, and Australia.

The Kern County Agricultural Commissioner's annual crop report for 1999 shows that all Kern agricultural products had a combined market value of \$2,129,569,400. That is a two percent increase from 1998. Total value for citrus decreased due to a December 1998 freeze. Total harvested acres were up by 1.6 percent and fruit and nut harvested acres rose 7.5 percent with a bearing cherry acreage increase of 32 percent. Cotton rebounded with an increase in production per acre of 48 percent.

|                         | <u>1998</u>     | <u>1999</u>   | <u>Change</u>  |
|-------------------------|-----------------|---------------|----------------|
| Fruit and nut crops     | \$1,076,593,000 | 975,316,000   | -\$101,277,000 |
| Field crops & rangeland | 300,487,000     | 418,658,000   | 118,171,000    |
| Vegetable crops         | 233,431,500     | 326,061,400   | 2,629,900      |
| Nursery crops           | 82,636,000      | 99,129,000    | 16,493,000     |
| Seed crops              | 4,449,000       | 10,180,000    | 5,737,000      |
| Other*                  | 292,878,000     | 300,279,000   | 7,341,000      |
| Total                   | \$2,080,474,500 | 2,129,569,400 | 49,094,900     |

\*Includes industrial and wood crops, livestock and poultry, livestock and poultry products and apiary products.

Trees and vines account for over half of Kern County's gross agricultural value, reflecting the importance of these crops to the local economy. In 1999, production of bell peppers, tomatoes, garlic and cantaloupes increased, primarily as a replacement for cotton which saw a reduction in acreage from 1998 of about 10,000 acres. The drop in cotton acreage stemmed from its continual downturn in price.

Agriculture is an important source of employment in Kern County. About 25 percent of all jobs in the county are agriculture-related. For some smaller communities, agriculture is nearly the sole source of employment:

Agriculture's Share of Employment

|              |     |
|--------------|-----|
| Arvin        | 92% |
| Buttonwillow | 77% |
| Delano       | 80% |
| Lost Hills   | 94% |
| Shafter      | 64% |
| Wasco        | 75% |

Source: US Census Bureau, 1990

Per unit crop demands in 1999 were just above normal based on local pan evaporation data. Table 17 is a summary of monthly evaporation as measured at three climatic stations in the county. Evaporation is a key parameter for measuring crop water use. The Bakersfield 12S and 14W stations (operated by the Department of Water Resources) typify evaporation on the San Joaquin Valley floor. Figure 15 displays monthly evaporation for these stations as percent of normal.

KCWA uses data from the California Irrigation Management and Information Service (CIMIS) to compute crop consumptive use. CIMIS is a statewide computerized irrigation scheduling system, funded and operated by the DWR Division of Local Assistance. The program helps farmers to schedule their irrigation based upon soil moisture budgets and real-time evapotranspiration data (ET.), which can help reduce total applied water requirements. There are four CIMIS weather stations in Kern County. Approximate crop water use as computed using CIMIS data for 1999 is summarized on Table 18, along with total irrigated acreage.

It is difficult to quantify applied water requirements for the San Joaquin Valley portion of Kern County. Areal differences, such as soil type, cultural practices, leaching requirements (typically five to 10 percent) and irrigation technologies employed around the valley result in different applied water rates on specific crops. Farmers in areas suffering from shallow groundwater will usually apply less water on their crops than they would if the soil were well drained, because their intent is to manage the shallow groundwater problem. In addition, a crop may consumptively use some shallow groundwater, thus reducing the amount the farmer needs to apply. Also, sprinkler or low volume irrigation typically requires less water than flood or furrow irrigation, although furrow or flood systems are not necessarily less efficient than other systems. Many factors govern the type of irrigation system chosen by a farmer. Under some conditions (such as level slopes and heavy soils), furrow irrigation may be as efficient as sprinklers or low volume systems. The efficiency of any given irrigation system is largely determined by how well the system is managed.

Gross agricultural requirements in 1999 were estimated to be about 3,079,000 acre-feet with 2,747,700 acre-feet occurring over the usable groundwater basin. Net agricultural requirements in 1999 were about 2,517,800 acre-feet with about 2,383,100 acre-feet occurring over the groundwater basin. The difference between gross and net water requirements over the basin is an estimate of agricultural return flows to groundwater. Not all return flows return to usable groundwater; some is lost to saline sinks such as shallow groundwater areas. In moisture deficient soils, return flows are absorbed by the soils and are irrecoverable. About 513,100 acre-feet of water were lost to saline sinks during 1999. About 564,600 acre-feet of agricultural water applied in 1999 returned to usable groundwater storage.

A large amount of applied water data has been collected over the years by many entities. Table 19 provides a basin-wide average applied water requirement for some major crops grown in Kern County.

## **Municipal and Industrial (M&I)**

Gross M&I requirements in 1999 were estimated to be about 200,000 acre-feet, with about 182,100 acre-feet required over the usable groundwater basin. Of this total, 26,500 acre-feet were supplied by KCWA's Henry C. Garnett Water Purification Plant. Olcese Water District served the Rio Bravo area with 725 acre-feet of treated Kern River water. East Niles Community Services District used about 1,800 acre-feet of CVP water obtained from Arvin-Edison Water Storage District. The remainder of M&I needs over the groundwater basin, 153,600 acre-feet, was supplied by groundwater. Table 20 gives a breakdown of urban water deliveries by water purveyor service area. The total production of the purveyors as shown on Table 20 is less than gross M&I requirements. This is because many rural families and businesses maintain their own water systems (wells), and their production volumes are not recorded. Gross M&I requirements include an estimate of the needs of these rural areas.

Average municipal and industrial water use over the groundwater basin was 302 gallons per capita per day, an increase of 10 gpcd over the previous year. Local long-term average M&I water use is in the range of about 250-300 gpcd. Residential water use is about 200 gpcd. Commercial, industrial and institutional use accounts for the difference. Domestic water use by west side towns (Taft, Maricopa, Lost Hills) is quite low in comparison to domestic use over the groundwater basin. The average domestic water use in these towns during 1999 was about 185 gpcd.

Net M&I consumptive use in 1999 was about 53,700 acre-feet over the groundwater basin. Gross return flows from M&I uses were about 128,400 acre-feet. About 48,800 acre-feet were treated in wastewater recycling facilities and evaporated, percolated or reused for agriculture. The remaining 79,600 acre-feet were returned to the usable groundwater basin. Most of the M&I water used outside the groundwater basin is for oil field operations (only about 30 percent is used for residential purposes), and is all consumptively used.

## Exports

During periods of high runoff, such as occurred during parts of the year in 1998, some water may be introduced into the California Aqueduct via the Kern River-California Aqueduct Intertie and exported over the Tehachapi Mountains into southern California. Some water may spill into the Kern River flood channel, where it can flow north into Tulare Lake in Kings County. This type of water is not a usable supply. In 1999 no water was exported from Kern County in this manner.

A potential source of water available for export exists in the ability to move groundwater supplies out of the groundwater basin to out-of-county interests who have previously delivered water for banking purposes. Many water districts not located in Kern County have expressed interest in storing water via water banking programs that have been proposed as a result of the Monterey Amendment. When water is imported to the county for banking purposes and subsequently exported out of county, the annual groundwater balance calculation will reflect those changes. The net effect over the long term will be zero, because exports will equal imports after adjusting for losses.

## Water Surface Evaporation

Water surface evaporation accounts for a small portion of water lost from the San Joaquin Valley portion of Kern County. Open canals, ditches and recharge ponds all lose water via evaporation. In 1999 about 46,300 acre-feet of evaporation losses occurred, with about 45,700 over the groundwater basin.

## Change in Groundwater Storage

Figure 16 displays a gross total water supply for the San Joaquin Valley portion of Kern County of 3,896,700 acre-feet in 1999. About 3,543,000 acre-feet of this demand occurred over the groundwater basin. A large amount of water, 566,800 acre-feet, was used for direct recharge or unlined delivery system losses. Total net consumptive water use was 2,736,800 acre-feet, with about 2,383,100 used over the groundwater basin. Gross available surface water supplies were about 2,335,700 acre-feet. There was a net decrease in groundwater storage of 437,600 acre-feet in 1999.

Figure 17 is a graph displaying the water supplies and demands of the San Joaquin Valley portion of Kern County since 1970, when SWP water was first introduced over the groundwater basin. During 1970-75, delivery systems were being developed, and the Cross Valley Canal had not been completed. During 1976-77, drought conditions restricted surface water supplies.

Between 1970 and 1999, the difference between additions and extractions has been minus 6,253,200 acre-feet. The average withdrawal from storage since 1970 is about 208,400 acre-feet per year. Figure 18 shows the cumulative groundwater balance since 1970. In volume of groundwater storage, the basin still stands below 1977 levels, although a definite upward trend continues.

Kern County's groundwater management plans depend upon the sustained delivery of surface water from all three major sources: Kern River, State Water Project and Central Valley Project. A reduction in one supply, unless accompanied by an increase in another, can have a serious impact on the groundwater basin. Table 21 provides a summary of supplies from these sources and shows their interdependence. An excellent example is the comparison of 1986 with 1987. During 1986 surface water supplies were ample, while in 1987 they were scarce. Groundwater pumping increased in 1987 to make up for the dry-year conditions. Conditions during the most recent drought also showed this dependence as reduced surface water supplies were replaced by groundwater pumping.

## **Basin-Wide Water Use Efficiency**

Water applied to a crop in excess of its evapotranspiration requirements percolates past the root zone and enters groundwater supplies, where it is available for reuse. Sometimes shallow clay layers in the soil can intercept this deep percolation, resulting in a condition called "shallow groundwater." In some areas deep percolation may enter unusable saline groundwater. In the western portion of Kern County, most soils are moisture-deficient (the water held in the soil is less than the amount of water the soil would normally retain after drainage via gravity). Any deep percolation occurring in these moisture-deficient soils will be absorbed until the water-holding capacity of the soils is reached.

Over the entire San Joaquin Valley portion of Kern County, gross water uses were about 3,896,700 acre-feet during 1999 (3,079,000 for agriculture, 200,000 for M&I use, 47,000 of evaporation losses, 566,800 for groundwater recharge, and 3,900 in unrecoverable delivery system losses). Total consumption of water was about 2,636,400 acre-feet (2,517,800 by agriculture, 71,600 by M&I, and 47,000 in evaporation losses). Effective precipitation was about 136,500 acre-feet. Agricultural irrigation efficiency was about 65 percent. A total of 48,500 acre-feet of M&I water was treated and reused, mostly by agriculture. The difference between gross and net requirements is an estimate of groundwater returns, which amounted to 693,500 acre-feet. However, about 100,400 acre-feet of deep percolation were lost by saline sinks. Therefore, net groundwater returns were 544,600 acre-feet in 1999.

Of the 3,896,700 acre-feet in gross water supply during 1999, 3,767,800 acre-feet was beneficially used or was available for reuse via net deep percolation. This means that 97 percent of the water used in 1999 was put to beneficial use or was available for reuse. This percentage is termed "basin-wide water use efficiency." Kern County is among the most water-efficient areas in the state.

## **Intertie Activity**

The Kern River-California Aqueduct Intertie is a structure connecting the Kern River to the California Aqueduct near Tupman. Its basic purpose is to dispose of floodwater, preventing damages downstream of the Kern River flood plain. Flows into the California Aqueduct through the Intertie may contain water from the Kern, Kaweah, Kings, San Joaquin or Tule Rivers, or a combination of these. Generally, Kern River flows must exceed about 200 percent of normal before the Intertie gates need to be opened. The structure has a capacity of 3,500 cfs. However, downstream Aqueduct demands can

become the limiting factor in wet years when demands are low. The intertie did not operate in 1999.

## Groundwater Conditions

### Groundwater Recharge

Many entities in Kern County are engaged in groundwater replenishment. Semitropic WSD, Rosedale-Rio Bravo WSD, North Kern WSD, Arvin-Edison WSD, City of Bakersfield, Kern Water Bank Authority and KCWA all operate recharge facilities. Kern River water is recharged by a combination of deliberate spreading in recharge areas, by losses in unlined canals, or by percolation in the Kern River's channel. Central Valley Project water is recharged in spreading ponds operated by Arvin-Edison WSD or in the channels of the Kern River and Poso Creek, as well as in recharge facilities on the Kern River alluvial fan. State Water Project water is recharged by KCWA and several other water districts in the Kern River channel (via the Cross Valley Canal), in unlined irrigation canals, and in district or KCWA operated recharge sites. During wet periods, every effort is made to deliver water through unlined canals to maximize groundwater recharge.

Many water districts in Kern County utilize conjunctive use and banking programs to help balance their supplies, as shown on Figure 19. A well-managed conjunctive use or banking program is an effective groundwater management tool that allows a district to maintain an adequate supply during periods when sufficient surface water is unavailable. The intent is to store surface water during times when available supply exceeds demand, and recover groundwater during periods when the opposite occurs. A correctly managed program monitors the effects of water recharge and withdrawals in any year, to help understand and anticipate local and regional groundwater impacts. A tremendous amount of groundwater recharge in Kern County is accomplished as part of these programs. Table 23 shows major conjunctive use and banking programs since 1971, listing the amounts of water by source. About 500,200 acre-feet of water were recharged in 1999, deliberately and incidentally. Following is the approximate breakdown between sources:

| <u>Source</u> | <u>Acre-feet</u> |
|---------------|------------------|
| Kern River    | 162,800          |
| SWP           | 218,400          |
| CVP           | 7,800            |
| Wastewater    | 2,200            |
| Minor Streams | 35,600           |
| Combined      | <u>72,300</u>    |
| Total         | 500,200          |

These numbers should be considered as "best estimates," since supplies are often intermixed in the same canal systems, making differentiation impossible. The amount of recharge shown in Table 23 is less than the amount of recharge listed here. This is because Table 23 also includes in-lieu recharge, and excludes incidental recharge and minor stream flows, which naturally recharged the groundwater basin. In-lieu recharge is accomplished by delivering surface water to users who would normally pump groundwater.

Such recharge activities show the importance of reducing groundwater overdraft, as well as water conservation, in Kern County. Since 1970 about 15,381,500 acre-feet of water has been recharged (deliberately and incidentally) as part of groundwater replenishment programs and banking operations. The effectiveness of such recharge activities is apparent in Figure 17. KCWA estimates that the 15,381,500 acre-feet of recharged water results in a gross basin-wide groundwater pumping lift reduction of about 150 feet, or about one foot for every 100,000 acre-feet. Figure 20 shows historic groundwater recharge as a bar graph.

## Groundwater Banking

Groundwater banking is a water management tool that has increased in use in recent years, and is directly related to the decreasing ability of the SWP and CVP to provide a reliable water supply. Because of limitations of existing surface water storage and conveyance facilities, coupled with regulatory restraints, DWR and USBR cannot meet their contractual obligations. Since groundwater storage is now more environmentally acceptable and economically feasible, KCWA and local water districts are expanding the development of several water banking programs. The purpose of banking programs is to store surface water underground when it is available and recover it in times when it is not available. Available surface water supplies are used in conjunction with groundwater.

The largest of these programs is the Kern Water Bank, formed in 1996. The Kern Water Bank has a storage capacity of nearly one million acre-feet and in 1999, recharged a total of 36,000 acre-feet.

Another local project, the City of Bakersfield 2800 Acre recharge facility, has been maintained as a banking and recovery facility for many years. During 1999 a total of 200 acre-feet were recharged in the 2800 Acres.

In 1992 KCWA purchased 2,253 acres of land to develop additional water recharge and banking facilities. The "Pioneer Project" comprises two parcels on either side of the Kern River southwest of Bakersfield. The Pioneer Property has an annual groundwater recharge capacity by about 146,000 acre-feet. During 1999, 21,400 acre-feet were recharged on the Pioneer Project.

The Agency also operates the Berrenda Mesa banking project, located along the south side of the Kern River just upstream of the Pioneer Project. The project consists of 369 acres with an annual recharge capacity of 58,000 acre-feet and an annual recovery capacity of 46,000 acre-feet.

Table 24 summarizes banking account balances for those entities involved as bankers in various banking programs. It displays in detail the banking portion of the information on Table 23, and includes recharge, extractions and transfers/sales of banking accounts. Recharge and recoverable balances shown have not been reduced to reflect evaporation or other losses.

## Shallow Groundwater

When the downward movement of groundwater is interrupted by shallow clay or other strata of low permeability, shallow groundwater accumulations result. These are generally undesirable for farming operations if the water reaches the crop root zone. Poor crop yield, soil salt buildup and poorly drained fields are symptoms of shallow groundwater problems.

Kern County areas suffering from shallow groundwater tend to follow the historic lower-elevation trace of the Kern River channel, and increases in shallow groundwater area appear after years of high Kern River runoff. Conversely, contractions in shallow groundwater area occur during years when runoff is low. Thus, shallow groundwater appears to be a natural phenomenon. Table 25 lists areas with historic shallow groundwater problems, categorized into five-foot increments, along with the number of monitoring wells measured. While the number of data points (monitoring wells) has increased and decreased through time, the current data set incorporates 264 wells, covering the historic drainage of the Kern River.

Depth to shallow groundwater as measured in shallow monitoring wells is contoured on Plate 1. In the summer of 1999 water within five feet of the ground surface was found under an area of about 37,000 acres. This was a 9 percent decrease from the summer 1998 areal extent. The areal extent of shallow groundwater between 5-10 feet of the ground surface was about 119,300 acres, about 2 percent lower than 1998. The areal extent of shallow groundwater between 10-15 feet of the surface was 56,000 acres in 1990, a 49 percent increase over 1998. An examination of Table 25 shows that a large increase in shallow groundwater area commonly occurs in wet years, while constrictions occur in relatively drier years.

## Groundwater Quality

The groundwater basin of the Kern County portion of the San Joaquin Valley is a basin of interior drainage. It has no appreciable surface or subsurface outflow, except in extremely wet years. Therefore, new salts introduced into the basin with imported surface water supplies are retained in the basin. Groundwater is the recipient of these salts via recharge water or return flows from irrigation and urban users.

Surface water supplies over the usable groundwater basin in 1999 (about 2,161,700 acre-feet), carried about 425,900 tons of new salts into the groundwater basin.

### Surface Water Salt Loads, 1999

| <u>Source</u>         | <u>Volume</u><br>(af) | <u>Avg. TDS</u><br>(ppm) | <u>Salt Load</u><br>(tons) |
|-----------------------|-----------------------|--------------------------|----------------------------|
| SWP over gw basin     | 1,003,800             | 268                      | 305,700                    |
| Kern River            | 463,900               | 92                       | 57,000                     |
| Minor Streams         | 36,300                | 324                      | 16,400                     |
| Other Local Supplies* | 166,200               | 65                       | 14,700                     |
| CVP                   | 490,500               | 32                       | 21,300                     |
| Total                 | 2,161,700             | 162                      | 425,900                    |

\*Includes effective rainfall, oil field produced water

Groundwater pumped and used for irrigation becomes degraded as salts are leached from the crop root zone. A portion of applied water (averaging about 25 percent in this basin) percolates through the soil profile to the groundwater. This smaller volume of water carries the salts once held by the total volume applied, and the result is a concentration of salts. The construction of local drainage projects helps reduce this buildup of salts by removing some near-surface accumulations in shallow groundwater areas. In areas of interior drainage like Kern County, the sustained importation of water, with large-scale agriculture, unless properly managed, will eventually result in the degradation of groundwater supplies. This is a normal by-product of water use by humans, whether for agricultural or urban purposes. A great challenge for water managers is to relieve the contamination of precious groundwater by improved management, including salt management.

Chemical analyses of well water samples collected through the years have been used as a basis for drafting the water quality maps in this report. Plate 2 illustrates the variations in groundwater quality samples taken from the unconfined (upper) water system, as revealed by the total dissolved solids (TDS) data obtained. TDS are shown in parts per million (ppm). These are generally more shallow areas, usually less than 400 feet below ground surface level. Higher salt contents are prevalent on the west side of the southern San Joaquin Valley and in an area west of Delano.

Plate 3 is a compilation of data from water wells producing from the confined (lower) aquifer system. This lower system is partially protected from surface contaminants by the Corcoran Clay. Contours on this map show the groundwater quality of the lower aquifer to be superior to that of the unconfined zone.

Agricultural water well drilling increased slightly during 1999 compared to activity in 1998. The Kern County Environmental Health Services Department issued 54 agricultural water well permits in 1999, in comparison to 28 permits issued during 1998. The increase in drilling activity was due to reduced surface water supplies from the return to drought conditions. An additional 116 domestic wells were permitted and drilled during 1999, along with 568 wells for non-agricultural and non-domestic purposes (e.g., monitoring and cathodic protection wells). A total of 170 new agricultural and domestic water wells were drilled during 1999. Annular seals were required on four of the new wells to prevent degradation of lower groundwater zones (annular seals are plugs of concrete between the well casing and the drilled hole near a regional stratum of low permeability to prevent movement of water between two aquifer systems).

## Groundwater Levels

Plate 4, "Depth to Groundwater, Spring 2000," was prepared using over 1,400 well measurements taken by KCWA and others. Water depths are plotted and contoured to aid in the evaluation of groundwater trends. Control wells include unconfined and select composite aquifer wells throughout most of the basin. In areas north of Wasco, water levels in confined wells are used for contouring because they best represent the most utilized aquifer. The "Depth to Groundwater" map shows the distance in feet from the ground surface to the groundwater surface.

Plate 5, "Groundwater Surface Elevation" map, was prepared based on the same measured wells as the "Depth to Groundwater" map. It displays the horizontal movement of groundwater from higher to lower elevations. The major direction of groundwater movement is away from sources of recharge. Plate 5 also shows what appear to be steep gradients between Semitropic Water Storage District and neighboring Buena Vista Water Storage District. Contours in these areas are based on well data from both unconfined and confined aquifers.

Historically, the Kern River has been the major groundwater recharge source in the basin. Mounding of groundwater occurs along the river channel, and groundwater moves away from this area. The rate of horizontal flow in the upper portions of the aquifer is estimated to range from 70 to 500 feet per year. Also, some mounding is attributed to various water districts' local recharge efforts.

Plate 6 depicts groundwater level changes from spring 1999 to spring 2000. Differences were plotted and contoured to show areas of relative improvement or decline. Shading was added to emphasize significant changes. Unless the annual change exceeds 10 feet, little impact to storage (as either losses or gains) can be inferred. The potential error related to the timing of groundwater level measurements, along with simple measuring errors preclude more precision.

Changes in groundwater levels from 1999 to 2000 show a reversal of the trend of increasing water levels that started in 1995. This is due to dry conditions in 1999 and lack of large amounts of surface water deliveries to groundwater recharge facilities.

Areas that showed the greatest drops in groundwater levels were in the area of the Kern Water Bank, KCWA Pioneer Project, City of Bakersfield 2800 Acres and Arvin-Edison Water Storage District recharge facilities. Groundwater levels in those areas dropped 10 to 30 feet below the 1999 levels. Areas of the central and eastern portions of the valley showed approximately equal areas of groundwater level increases and drops in the range of -10 feet to +10 feet. These areas essentially remained static compared to the previous years.

Water level changes in eight key water wells are displayed on hydrographs as Figures 21a, 21b, 21c and 21d. Each hydrograph represents water levels for a pair of wells, one unconfined and the other confined. One well pair is located in the Pond-Poso area, another between the city of Shafter and Rosedale-Rio Bravo Water Storage District, a third pair southwest of Bakersfield, and the fourth pair in the Arvin area.

The two wells in the Pond-Poso area represent the confined and unconfined aquifer systems in that region. The hydrographs are plotted together to compare water level changes in both aquifers. The unconfined well reflects an upward trend since the 1977 drought, probably a continuation of a long-term rise in water levels caused by surface water deliveries via the Friant-Kern system. During 1990-92 drought conditions were more severe, with an increased dependence on groundwater; this is reflected by the decline in water levels during that period. The confined well shows a variable pattern of rises and falls from year to year. Since 1999 there has been a downward trend, corresponding to the current dry year condition.

The Shafter/Rosedale-Rio Bravo area hydrographs represent the unconfined aquifer. The wells are located between the Kern River channel and Rosedale-Rio Bravo WSD's recharge facilities. The hydrograph reflects a long-term decline in water levels from 1960 through the 1977 drought, with transient rises during years when Kern River flows were above average. Since these wells are situated close to the Kern River and recharge facilities, the hydrographs show rapid water level rises during the 1978-86 and 1993-98 wet periods, and declines during the 1987-92 drought. These wells show a downward trend since 1999 due to dry conditions.

The more moderate groundwater level changes in the Shafter well (T28S/R25E-32F01) reflect the greater distance from the main areas of groundwater recharge. This well appears to be at the southeastern terminus of the Corcoran Clay. Present groundwater level data suggests that no confined aquifer exists east and south of this location. Deep wells in these areas show annual groundwater levels and fluctuations that are consistent with the shallow wells. Confined and unconfined aquifers usually exhibit characteristic differences in seasonal groundwater level changes.

The southwest Bakersfield hydrographs show continual declines until 1978. The wet period 1978-86 appears as a rise in groundwater level. The 1987-92 drought shows another period of decline. Levels are continuing a downward trend since the beginning of 1999 due to the dry conditions. In the past, these two wells (T30S/R26E-22P1 and T30S/R26E-22P3) were classified as unconfined and confined, respectively. However, similar groundwater levels in both wells over a long period of time suggest that a confined aquifer may not exist in this area.

The Arvin-Edison area wells are designated as shallow (T32S/R29E-04P1) and deep (T32S/R29E-03Q1). The Arvin-Edison deep well may be in a confined aquifer, since it has shown annual variability in groundwater levels more consistent with the behavior of a confined aquifer. The large difference in groundwater levels between the two wells also suggests that two or more aquifers may exist in this area. The delivery of CVP water to Arvin-Edison in the mid-1960s caused groundwater levels to rise, as seen in the shallow well hydrograph. During the 1976-77 and 1978-86 droughts, groundwater levels declined. During the 1978-86 and current wet years, water levels rose. This well shows a slight downward trend since 1998.

## Indian Wells Valley

Indian Wells Valley is located in the northeast corner of Kern County. The extended valley floor encompasses about 450 square miles. It is bounded by the Sierra Nevada Mountains on the west, the Coso Range on the north, the Argus Mountains on the east, the Rademacher Hills on the southeast and the El Paso Mountains on the south. Elevations on the valley floor range from 2,300 to 3,000 feet above sea level, and surrounding mountains may reach 9,000 feet. The largest community in the valley is the city of Ridgecrest, with a population of over 29,000. The valley is an arid high desert, with rainfall of only 3-4 inches per year. Little rainfall reaches the groundwater table; it is rapidly evaporated by high winds and temperatures or transpired by desert plants. The only source of potable water is groundwater, much of which is of good to excellent quality, and is provided by recharge from the adjacent mountain ranges.

The Indian Wells Valley Water Management Steering Committee was established in 1995 as part of the "Cooperative Groundwater Management Plan for Indian Wells Valley." The committee's goal is to coordinate operations in a manner that meets ongoing water supply demands while ensuring the availability of good quality groundwater for future generations. Additionally, a technical subcommittee was formed to address technical issue requests from the water management committee. The committee is made up of hydrogeologists, engineers, representatives from KCWA and various groundwater users in the valley. Among the issues being studied by the technical subcommittee are: development of a groundwater quality monitoring program, review of groundwater data, review of weather station data, and installation of stream gauges in two ephemeral streams in the nearby Sierra Nevada. KCWA is also providing use of its groundwater database for storage of data generated by the technical subcommittee's projects.

Indian Wells Valley Water District (IWWVD), Brown Road Farming Company, China Lake Naval Air Weapons Station (NAWS) and North American Chemical Company (NACC) are the major groundwater pumpers within the valley. Inyokern Community Services District (ICSD) meets most of the water demands for the City of Inyokern. The City of Ridgecrest pumps a small amount of groundwater to meet landscaping needs. Independent well owners (9,000-10,000 residents within the valley) account for additional pumping in the range of 3,000-6,000 acre-feet per year.

Based on past studies total pumping in the valley is from 26,000 to 29,000 acre-feet per year, as follows:

|                         | <u>Acre-feet</u>    |
|-------------------------|---------------------|
| Brown Road Farming      | 7,500               |
| IWWVD                   | 8,000               |
| NAWS                    | 4,400               |
| NACC                    | 2,500               |
| ICSD                    | 300                 |
| Independent well owners | 3,000-6,000         |
| City of Ridgecrest      | 100                 |
| <br>Total               | <br>25,800 - 28,800 |

Several technical investigations have attempted to determine the hydrologic balance for the valley. Results have varied considerably, due to differing assumptions of natural annual recharge to and discharge from the valley. Long-term average annual recharge has been estimated from a conservative low of 3,000 acre-feet to more than 43,000 acre-feet. Determining the hydrologic balance for Indian Wells Valley is much more difficult than for the San Joaquin Valley portion of Kern County. The San Joaquin Valley is heavily influenced by large amounts of imported surface water and Kern River flows, while Indian Wells Valley's water balance is entirely related to natural groundwater recharge.

Water level measurements for wells throughout the valley are the basis for Plate 7, "Depth to Groundwater, Indian Wells Valley" and Plate 8, "Groundwater Elevation, Indian Wells Valley." Plate 8 shows two sinks for groundwater flow in the valley. The first is naturally occurring and represents the discharge of groundwater (via evaporation) within the China Lake playa, located about 5 miles northeast of Ridgecrest. The second sink is a regional pumping depression extending from southeast Ridgecrest to north of Inyokern,

called the Ridgecrest-Inyokern pumping corridor. This depression is the most important from a basin-wide groundwater management perspective, as it has expanded by about 30,000 acres since 1946. This extensive pumping depression is a response to increased population in the valley, from about 15,000 in 1946 to about 38,000 today.

Hydrographs for key wells are shown in Figures 21e, 21f and 21g. These hydrographs reflect the consistent decline in water levels over broad portions of the valley. They represent water levels in wells located along the perimeter of the valley, at sufficient distance from large pumping capacity wells as to avoid their influence. Figure 21e charts a well in the northwest portion of the basin (about 5 miles northwest of Inyokern) near the foot of the Sierra Nevada (26S/38E-35B1). Figure 21f shows a well in the southeast portion of the basin, about 1.5 miles north of Cerro Coso College in southern Ridgecrest (27S/39E-7R11). Figure 21g shows a well in the southwest portion of the basin, about 3 miles south of Inyokern and within the Little Dixie Wash (27S/40E-15D1).

In general, water levels have been declining from 0.5 to 1.0 feet per year in areas outside the Ridgecrest-Inyokern pumping corridor. In the center of the pumping area water levels have declined by an average of 1.5 feet annually. In this central area, water levels declined only 15 feet between 1920 and 1953, while between 1953 and 1993 they declined 60 to 70 feet.

More recently, 1995-2000, Plate 10, water levels in the Inyokern area have dropped between 3 to 11 feet. A drop of 4 to 13 feet occurred in the Ridgecrest area for this time period and the Brown Road Farming area saw a drop of 5 to 8 feet. Another area that shows a significant drop in water levels is the area on the far eastern side of the valley near the intersections of Water Road and South Pole Line Road. The groundwater system represented in these areas is the shallow groundwater phenomenon, found along the eastern fringe of the basin. This shallow groundwater system is a result of disposal of sewage effluent from Ridgecrest and the Naval Air Weapons Station (NAWS). During this time period, effluent water normally sent to ponds that contributed to the shallow groundwater problem in this areas were diverted for irrigation of the NAWS golf course and to the southern end of the basin for agriculture. As a result, the change in water levels in this area is due to lack of sewage effluent for the percolation ponds in the area (decreased recharge) and not groundwater pumping as is seen in other areas of the valley. In Figure 21f, recent water levels have declined from 1.0 to 1.5 feet per year, a matter of interest since groundwater pumping in this area is limited.

The accelerated decline of groundwater levels in the southwest area is probably linked to a dramatic change in understanding of the subsurface geology. Plate 8, "Groundwater Surface Elevations," presents an anomalous steep hydraulic gradient in the southwest portion of the valley. A series of studies suggests that these extreme water level differences might be the manifestation of complex structural geology or stratigraphic relationships. The interpretation of continuity of groundwater flow along this steep gradient is tentative at best. It is presented to convey the existence of extreme differences in water levels in the southwest area and does not infer that continuous groundwater flow exists there. Additional work is needed to address whether such continuous flow exists.

Plate 8 shows an apparent steep hydraulic gradient in the two to three mile-wide zone trending southeast from Armitage Field to Ridgecrest Blvd. This trend parallels the Little Lake Fault Zone. In this area, wells and piezometers perforated at various depths show significant water level differences. The degree of hydraulic communication across the Little Lake Fault Zone needs evaluation to determine whether pumping in the Ridgecrest-Inyokern pumping corridor influences the lateral or vertical migration of poor-quality groundwater.

Plate 9, "Groundwater Quality, Indian Wells Valley," shows the distribution of total dissolved solids (TDS) throughout the basin. The map represents a compilation of data acquired between 1980 and 1994 by the U.S. Geological Survey, KCWA, U.S. Bureau of Reclamation, IWVWD and private well owners. The distribution of relatively good quality water (TDS less than 500 parts per million, ppm) reflects areas that probably benefit from recharge via adjacent mountain ranges. The map displays the distribution of very poor quality groundwater (TDS greater than 2,000 ppm) in large portions of T25S/R39E and T25S/R40E, and in the eastern portion of T26S/R40E. To the southeast, south and southwest of Ridgecrest there is poor quality groundwater (TDS greater than 1,000 ppm).

Participants in the Indian Wells Valley Groundwater Management Plan recognize that acquisition of additional hydrologic and geologic data is required to develop sound management practices for the valley. A multi-agency technical committee is developing programs to acquire and analyze needed data, to propose prudent water management practices, and to serve as a consultant to the Management Steering Committee. The principle long-term goal is to produce a more accurate hydrologic balance for the valley.

## **Outlook: 2000**

As the year 1999 drew to a close, forecasters were predicting a repeat of the year's La Nina effect. Fall and early winter hydrology was expected to be above normal with a gradual shift to dry conditions in the rest of the rainy season. On December 1, the Department of Water Resources announced an initial allocation of 50 percent for requested entitlement of SWP water. Preliminary forecasts also indicated that the Kern River watershed would again receive below normal precipitation during 1999-2000.

**Table 1. Sacramento River Indices\* (in million acre-feet)**

| Ascending Order by Year |       |      |       | Ascending Order by Index |       |      |       |
|-------------------------|-------|------|-------|--------------------------|-------|------|-------|
| Year                    | Index | Year | Index | Year                     | Index | Year | Index |
| 1906                    | 26.7  | 1955 | 11    | 1977                     | 5.1   | 1954 | 17.4  |
| 1907                    | 33.7  | 1956 | 29.9  | 1924                     | 5.7   | 1936 | 17.4  |
| 1908                    | 14.8  | 1957 | 14.9  | 1931                     | 6.1   | 1946 | 17.6  |
| 1909                    | 30.7  | 1958 | 29.7  | 1994                     | 7.8   | 1922 | 18.0  |
| 1910                    | 21.1  | 1959 | 12    | 1976                     | 8.1   | 1975 | 19.2  |
| 1911                    | 26.4  | 1960 | 13.1  | 1939                     | 8.2   | 1973 | 20.0  |
| 1912                    | 11.4  | 1961 | 12    | 1929                     | 8.4   | 1953 | 20.1  |
| 1913                    | 12.8  | 1962 | 15.1  | 1991                     | 8.4   | 1943 | 21.1  |
| 1914                    | 27.8  | 1963 | 23    | 1934                     | 8.6   | 1910 | 21.1  |
| 1915                    | 23.9  | 1964 | 10.9  | 1992                     | 8.9   | 1999 | 21.2  |
| 1916                    | 24.1  | 1965 | 25.7  | 1933                     | 8.9   | 1996 | 22.2  |
| 1917                    | 17.3  | 1966 | 12.9  | 1990                     | 9.2   | 1980 | 22.3  |
| 1918                    | 11    | 1967 | 24.1  | 1988                     | 9.2   | 1993 | 22.4  |
| 1919                    | 15.7  | 1968 | 13.6  | 1987                     | 9.2   | 1986 | 22.4  |
| 1920                    | 9.2   | 1969 | 27    | 1920                     | 9.2   | 1984 | 22.4  |
| 1921                    | 23.8  | 1970 | 24.1  | 1947                     | 10.4  | 1940 | 22.4  |
| 1922                    | 18    | 1971 | 22.6  | 1944                     | 10.4  | 1971 | 22.6  |
| 1923                    | 13.2  | 1972 | 13.4  | 1964                     | 10.9  | 1951 | 22.9  |
| 1924                    | 5.7   | 1973 | 20    | 1985                     | 11.0  | 1963 | 23.0  |
| 1925                    | 16    | 1974 | 32.5  | 1955                     | 11.0  | 1927 | 23.8  |
| 1926                    | 11.8  | 1975 | 19.2  | 1918                     | 11.0  | 1921 | 23.8  |
| 1927                    | 23.8  | 1976 | 8.1   | 1981                     | 11.1  | 1978 | 23.9  |
| 1928                    | 16.8  | 1977 | 5.1   | 1912                     | 11.4  | 1915 | 23.9  |
| 1929                    | 8.4   | 1978 | 23.9  | 1926                     | 11.8  | 1970 | 24.1  |
| 1930                    | 13.5  | 1979 | 12.4  | 1961                     | 12.0  | 1967 | 24.1  |
| 1931                    | 6.1   | 1980 | 22.3  | 1959                     | 12.0  | 1916 | 24.1  |
| 1932                    | 13.1  | 1981 | 11.1  | 1949                     | 12.0  | 1942 | 25.2  |
| 1933                    | 8.9   | 1982 | 33.3  | 1979                     | 12.4  | 1997 | 25.2  |
| 1934                    | 8.6   | 1983 | 37.7  | 1913                     | 12.8  | 1965 | 25.7  |
| 1935                    | 16.6  | 1984 | 22.4  | 1966                     | 12.9  | 1911 | 26.4  |
| 1936                    | 17.4  | 1985 | 11    | 1960                     | 13.1  | 1906 | 26.7  |
| 1937                    | 13.3  | 1986 | 22.4  | 1932                     | 13.1  | 1969 | 27.0  |
| 1938                    | 31.8  | 1987 | 9.2   | 1923                     | 13.2  | 1941 | 27.1  |
| 1939                    | 8.2   | 1988 | 9.2   | 1937                     | 13.3  | 1914 | 27.8  |
| 1940                    | 22.4  | 1989 | 14.8  | 1972                     | 13.4  | 1952 | 28.6  |
| 1941                    | 27.1  | 1990 | 9.2   | 1930                     | 13.5  | 1958 | 29.7  |
| 1942                    | 25.2  | 1991 | 8.4   | 1968                     | 13.6  | 1956 | 29.9  |
| 1943                    | 21.1  | 1992 | 8.9   | 1950                     | 14.4  | 1909 | 30.7  |
| 1944                    | 10.4  | 1993 | 22.4  | 1989                     | 14.8  | 1998 | 31.4  |
| 1945                    | 15.1  | 1994 | 7.8   | 1908                     | 14.8  | 1938 | 31.8  |
| 1946                    | 17.6  | 1995 | 33.9  | 1957                     | 14.9  | 1974 | 32.5  |
| 1947                    | 10.4  | 1996 | 22.2  | 1962                     | 15.1  | 1982 | 33.3  |
| 1948                    | 15.8  | 1997 | 25.2  | 1945                     | 15.1  | 1907 | 33.7  |
| 1949                    | 12    | 1998 | 31.4  | 1919                     | 15.7  | 1995 | 33.9  |
| 1950                    | 14.4  | 1999 | 21.2  | 1948                     | 15.8  | 1983 | 37.7  |
| 1951                    | 22.9  |      |       | 1925                     | 16.0  |      |       |
| 1952                    | 28.6  |      |       | 1935                     | 16.6  |      |       |
| 1953                    | 20.1  |      |       | 1928                     | 16.8  |      |       |
| 1954                    | 17.4  |      |       | 1917                     | 17.3  |      |       |

|                 |      |
|-----------------|------|
| 94 year average | 18.1 |
| 94 year median  | 94.0 |
| Minimum (1977)  | 5.1  |
| Maximum (1983)  | 37.7 |

\* An index used by the California Department of Water Resources to forecast available water supplies and SWP delivery capabilities. The index consists of the forecasted or computed unimpaired flows of the Sacramento River near Red Bluff, Feather River at Oroville Reservoir, Yuba River at Smartville and American River at Folsom Reservoir.

**Table 2. Kern County Water Agency, Member Unit Contract Entitlements for 1999-2035 (in acre-feet)**

| Member Unit                | Firm             | Surplus <sup>(1)</sup> | Existing Table 1<br>Entitlement <sup>(2)</sup> | Firm Entitlement      |                |                  |
|----------------------------|------------------|------------------------|------------------------------------------------|-----------------------|----------------|------------------|
|                            |                  |                        |                                                | M&I                   | Ag             | Total            |
| Berrenda Mesa WD           | 130,100          | 6,976                  | 137,076                                        |                       | 130,100        | 130,100          |
| Lost Hills WD              | 134,110          | 0                      | 134,110                                        | 2,000 <sup>(3)</sup>  | 132,110        | 134,110          |
| Belridge WSD               | 147,508          | 0                      | 147,508                                        | 15,000 <sup>(3)</sup> | 132,508        | 147,508          |
| Buttonwillow ID            | 83,000           | 13,100                 | 96,100                                         |                       | 83,000         | 83,000           |
| Pond Poso ID               | 67,000           | 11,100                 | 78,100                                         |                       | 67,000         | 67,000           |
| Semitropic WSD             | 5,000            | 562                    | 5,562                                          |                       | 5,000          | 5,000            |
| Cawelo WD                  | 38,200           | 6,800                  | 45,000                                         |                       | 38,200         | 38,200           |
| Improvement District No. 4 | 82,946           | 899                    | 83,845                                         | 77,000                | 5,946          | 82,946           |
| Rosedale-Rio Bravo WSD     | 29,900           | 5,100                  | 35,000                                         |                       | 29,900         | 29,900           |
| Buena Vista WSD            | 21,300           | 3,750                  | 25,050                                         |                       | 21,300         | 21,300           |
| Kern Delta WD              | 25,500           | 4,500                  | 30,000                                         |                       | 25,500         | 25,500           |
| Henry Miller WD            | 35,500           | 6,250                  | 41,750                                         |                       | 35,500         | 35,500           |
| West Kern WD               | 25,000           | 0                      | 25,000                                         | 25,000                |                | 25,000           |
| Wheeler Ridge-Maricopa WSD | 238,088          | 35,907                 | 273,995                                        |                       | 238,088        | 238,088          |
| Tehachapi-Cummings CWD     | 19,300           | 700                    | 20,000                                         | 15,000                | 4,300          | 19,300           |
| Tejon-Castac WD            | 5,278            | 471                    | 5,749                                          | 2,000                 | 3,278          | 5,278            |
| <b>Total</b>               | <b>1,087,730</b> | <b>96,115</b>          | <b>1,183,845</b>                               | <b>136,000</b>        | <b>951,730</b> | <b>1,087,730</b> |

Note: Maximum annual entitlement is reached in 1990.

(1) Per the Monterey Agreement surplus water was removed from the Member Unit contracts. Surplus water entitlements are still used in the allocation of interruptible water in proportion to the Member Unit's Former Table 1 Entitlements, if demands for interruptible water are greater than the supply of interruptible water (see footnote 2).

(2) Former Table 1 Entitlement is the Member Unit's contract entitlement plus the amount of surplus water (see footnote 1).

(3) Agricultural entitlement converted to M&I use.

**Table 3. SWP Deliveries to the San Joaquin Valley Portion of Kern County (in acre-feet)**

| Year                | Annual <sup>(1)</sup><br>Deliveries | Cumulative<br>Deliveries | Intertie<br>Deliveries      | Deliveries <sup>(2)</sup><br>Outside SJV | Annual<br>Importations | Cumulative<br>Importations |
|---------------------|-------------------------------------|--------------------------|-----------------------------|------------------------------------------|------------------------|----------------------------|
| 1968                | 127,384                             | 127,384                  |                             |                                          | 127,384                | 127,384                    |
| 1969                | 141,265                             | 268,649                  |                             |                                          | 141,265                | 268,649                    |
| 1970                | 204,634                             | 473,283                  |                             |                                          | 204,634                | 473,283                    |
| 1971                | 375,505                             | 848,788                  |                             |                                          | 375,505                | 848,788                    |
| 1972                | 535,573                             | 1,384,361                |                             |                                          | 535,573                | 1,384,361                  |
| 1973                | 515,546                             | 1,899,907                |                             | 25                                       | 515,521                | 1,899,882                  |
| 1974                | 656,773                             | 2,556,680                |                             | 4,992                                    | 651,781                | 2,551,663                  |
| 1975                | 828,437                             | 3,385,117                |                             | 6,699                                    | 821,738                | 3,373,401                  |
| 1976                | 888,112                             | 4,273,229                |                             | 4,755                                    | 883,357                | 4,256,758                  |
| 1977                | 432,837                             | 4,706,066                |                             | 3,424                                    | 429,413                | 4,686,171                  |
| 1978                | 678,400                             | 5,384,466                | 64,100                      | 2,826                                    | 611,474                | 5,297,645                  |
| 1979                | 1,295,388                           | 6,679,854                |                             | 3,630                                    | 1,291,758              | 6,589,403                  |
| 1980                | 968,092                             | 7,647,946                | 64,792                      | 3,041                                    | 900,259                | 7,489,662                  |
| 1981                | 1,386,641                           | 9,034,587                |                             | 1,897                                    | 1,384,744              | 8,874,406                  |
| 1982                | 900,973                             | 9,935,560                | 13,679                      | 2,791                                    | 884,503                | 9,758,909                  |
| 1983                | 601,183                             | 10,536,743               | 365,505                     | 724                                      | 234,954                | 9,993,863                  |
| 1984                | 1,138,040                           | 11,674,783               | 13,639                      | 1,360                                    | 1,123,041              | 11,116,904                 |
| 1985                | 1,078,147                           | 12,752,930               |                             | 4,015                                    | 1,074,132              | 12,191,036                 |
| 1986                | 929,178                             | 13,682,108               | 12,701                      | 2,916                                    | 913,561                | 13,104,597                 |
| 1987                | 1,028,124                           | 14,710,232               |                             | 2,217                                    | 1,025,907              | 14,130,504                 |
| 1988                | 1,009,520                           | 15,719,752               |                             | 3,307                                    | 1,006,213              | 15,136,717                 |
| 1989                | 1,146,062                           | 16,865,814               |                             | 48,833                                   | 1,097,229              | 16,233,946                 |
| 1990                | 862,448                             | 17,728,262               |                             | 21,643                                   | 840,805                | 17,074,751                 |
| 1991                | 34,886                              | 17,763,148               |                             | 2,213                                    | 32,673                 | 17,107,424                 |
| 1992                | 421,520                             | 18,184,668               |                             | 3,508                                    | 418,012                | 17,525,436                 |
| 1993                | 1,219,653                           | 19,404,321               |                             | 14,139                                   | 1,205,514              | 18,730,950                 |
| 1994                | 711,002                             | 20,115,323               |                             | 15,616                                   | 695,386                | 19,426,336                 |
| 1995                | 1,219,146                           | 21,334,469               |                             | 107,950                                  | 1,111,196              | 20,537,532                 |
| 1996                | 1,335,394                           | 22,669,863               |                             | 88,209                                   | 1,247,185              | 21,784,717                 |
| 1997                | 1,303,900                           | 23,973,763               |                             | 290,523                                  | 1,013,377              | 22,798,094                 |
| 1998                | 987,299                             | 24,961,062               |                             | 148,101                                  | 839,198                | 23,637,292                 |
| 1999                | 1,386,481                           | 26,347,543               |                             | 78,181                                   | 1,308,300              | 24,945,592                 |
| Mean Deliveries     |                                     | 805,196 AF               | Minimum Deliveries (1991)   |                                          | 34,886 AF              |                            |
| Median Deliveries   |                                     | 888,112 AF               | Maximum Deliveries (1981)   |                                          | 1,386,641 AF           |                            |
| Mean Importations   |                                     | 765,029 AF               | Minimum Importations (1991) |                                          | 32,673 AF              |                            |
| Median Importations |                                     | 857,336 AF               | Maximum Importations (1981) |                                          | 1,384,744 AF           |                            |

<sup>(1)</sup> Includes Pre-consolidation water deliveries, 1977 Dry Year Pool, 1991 State Bank water.

<sup>(2)</sup> Includes Tehachapi-Cummings CWD and other deliveries outside the San Joaquin Valley portion of Kern County. Beginning in 1990, also includes local Groundwater programs.

Table 4. 1999 State Water Project Deliveries by Contract (in acre-feet)

|                            | (1)                    | (2)                                             | (3)                                 | (4)                    | (5)                                 | (6)                                             | (7)                                         | (8)                                                | (9)                                       | (10)                                      | (11)                                             |
|----------------------------|------------------------|-------------------------------------------------|-------------------------------------|------------------------|-------------------------------------|-------------------------------------------------|---------------------------------------------|----------------------------------------------------|-------------------------------------------|-------------------------------------------|--------------------------------------------------|
|                            | SWP Water Supplies     |                                                 |                                     |                        |                                     |                                                 |                                             |                                                    |                                           |                                           |                                                  |
| District                   | Table 1<br>Entitlement | Article 21<br>Water<br>(Interruptible<br>Water) | DWR<br>Turnback<br>Pool<br>Purchase | Total<br>SWP<br>Supply | 1999<br>Local<br>Settlement<br>Pool | Landowner<br>Transfers<br>Out of<br>Kern County | Misc.<br>Transfers<br>Out of<br>Kern County | Westlands (8)<br>Exchange<br>Out of<br>Kern County | Misc.<br>Transfers<br>Into<br>Kern County | Misc.<br>Transfers,<br>Exchanges<br>Other | Misc. and<br>Simultaneous<br>Exchanges,<br>Other |
| Berrenda Mesa WD           | 130,100                | 1,544                                           | 960                                 | 132,604                | (18,000)                            | (17,878) (3)                                    |                                             | (2,021)                                            |                                           | 3,000                                     |                                                  |
| Lost Hills WD              | 134,110                | 6,426                                           |                                     | 140,536                | (10,500)                            | (17,658) (4)                                    | (400) (7)                                   | (2,083)                                            |                                           | (235) (13)                                |                                                  |
| Belridge WSD               | 147,508                | 4,000                                           |                                     | 151,508                | (31,000)                            | (5,240) (5)                                     |                                             | (2,291)                                            |                                           | (3,000)                                   | 508                                              |
| Semitropic WSD             | 155,000                | 7,077                                           |                                     | 162,077                |                                     |                                                 |                                             | (2,407)                                            | 144,860 (9)                               | 235 (13)                                  |                                                  |
| Cawelo WD                  | 38,200                 |                                                 | 4,000 (1)                           | 42,200                 |                                     |                                                 |                                             |                                                    |                                           | (1,940) (14)                              | (17,434)                                         |
| Improvement Dist. No. 4    | 82,946                 | 16,633                                          | 12,920 (2)                          | 112,499                | 68,180                              |                                                 |                                             |                                                    |                                           | (65,129) (15)                             | (31,959)                                         |
| Rosedale-Rio Bravo WSD     | 29,900                 | 3,790                                           | 1,338                               | 35,028                 | 28,662                              |                                                 |                                             |                                                    | 1,875 (10)                                | (29,900) (16)                             | 657                                              |
| Buena Vista WSD            | 21,300                 | 1,107                                           | 1,142                               | 23,549                 | 23,858                              |                                                 |                                             |                                                    |                                           | 71,184 (17)                               | 235                                              |
| Kern Delta WD              | 25,500                 | 140                                             | 1,875                               | 27,515                 | 500                                 |                                                 |                                             |                                                    |                                           | (25,500) (18)                             | 22,434                                           |
| Henry Miller WD            | 35,500                 | 8,110                                           | 10,000                              | 53,610                 |                                     |                                                 |                                             |                                                    |                                           | (7,015) (19)                              | (235)                                            |
| West Kern WD               | 25,000                 |                                                 |                                     | 25,000                 |                                     |                                                 |                                             |                                                    |                                           | (25,000) (18)                             |                                                  |
| Wheeler Ridge-Maricopa WSD | 238,088                | 8,798                                           |                                     | 246,886                | (55,000)                            |                                                 |                                             | (3,698)                                            |                                           | 278 (20)                                  | 78                                               |
| Tehachapi-Cummings CWD Ag  | 4,300                  |                                                 |                                     | 4,300                  |                                     |                                                 |                                             |                                                    |                                           |                                           |                                                  |
| Tehachapi-Cummings CWD M&I | 15,000                 | 616                                             |                                     | 15,616                 | (1,700)                             |                                                 |                                             |                                                    |                                           | (10,600) (21)                             |                                                  |
| Tejon-Castac WD Ag         | 3,278                  |                                                 |                                     | 3,278                  | (3,000)                             |                                                 |                                             |                                                    |                                           | (278) (20)                                | 4                                                |
| Tejon-Castac WD M&I        | 2,000                  |                                                 |                                     | 2,000                  | (2,000)                             |                                                 |                                             |                                                    |                                           |                                           |                                                  |
| MWD (AEWSD)                |                        |                                                 |                                     | 0                      |                                     |                                                 |                                             |                                                    | 60,287 (11)                               | 29,900                                    | 31,161                                           |
| Westside Mutual WC         |                        |                                                 |                                     | 0                      |                                     |                                                 |                                             |                                                    |                                           |                                           | 81                                               |
| Westlands WD               |                        |                                                 |                                     | 0                      |                                     | 40,776                                          |                                             | 12,500                                             |                                           |                                           |                                                  |
| Tulare Lake Basin WSD      |                        |                                                 |                                     | 0                      |                                     |                                                 | 400                                         |                                                    |                                           |                                           |                                                  |
| Dudley Ridge WD (KWB)      |                        |                                                 |                                     | 0                      |                                     |                                                 |                                             |                                                    | 1,321 (12)                                |                                           | 16                                               |
| KCWA                       |                        |                                                 | 8,125                               | 8,125                  |                                     |                                                 |                                             |                                                    |                                           |                                           | (546)                                            |
| North Kern WSD             |                        |                                                 | 5,000                               | 5,000                  |                                     |                                                 |                                             |                                                    |                                           | 64,000                                    | (5,000)                                          |
| Total                      | 1,087,730              | 58,241                                          | 45,360                              | 1,191,331              | 0                                   | 0                                               | 0                                           | 0                                                  | 208,343                                   | 0                                         | 0                                                |
| Deliveries to Kern County  | 1,087,730              | 58,241                                          | 45,360                              | 1,191,331              | 0                                   | (40,776)                                        | (400)                                       | (12,500)                                           | 208,343                                   | 0                                         | 0                                                |

Note: This table shows contracted deliveries for calendar year 1999. District deliveries may vary from amounts shown, due to: (a) current year SWP/Kern River exchanges, (b) payback of SWP water from prior year exchanges, and (c) conjunctive use agreements.

- (1) Pool A water initially purchased by Henry Miller WD (3,900 AF)/Berrenda Mesa WD (100 AF) and later sold to Cawelo WD at the Pool B water cost; Henry Miller WD/Berrenda Mesa WD to remain responsible for the cost differential.
- (2) Includes Pool A water initially purchased by Henry Miller WD (4,100 AF) and later sold to Improvement District No. 4 at the Pool B water cost; Henry Miller WD to remain responsible for the cost differential.
- (3) Pool A requests of 24,060 AF (BM = 9,100 AF, HM = 10,000 AF and CAW = 4,000 AF) and Pool B requests of 21,300 AF (ID4 = 3,820 AF, RRB = 1,338 AF, BV = 1,142 AF, KD = 1,875 AF, KCWA = 8,125 AF and NKWD = 5,000 AF).
- (4) Landowner transfer (17,878 AF) to Westlands WD (Woolf = 16,858 AF; Vista Verde = 1,200 AF).
- (5) Landowner transfer (17,658 AF) to Westlands WD (Woolf = 7,658 AF; Shannon family = 5,000 AF; Chevron USA = 5,000 AF).
- (6) Landowner transfer (5,240 AF) to Westlands WD (Woolf Enterprises, Inc)
- (7) Transfer of 400 AF from Lost Hills WD to Tulare Lake Basin WSD (Westlake Farms, Inc) for mitigation purposes.
- (8) SWP Entitlement deliveries to Westlands WD during 1999 in exchange for a like amount of water returned to the exchange participants from the Friant-Kern Canal within the next 10 years.

- (9) Includes storage transfers from MWD (75,850 AF), Santa Clara Valley WD (30,000 AF), Alameda County WD (16,100 AF) and Alameda County - Zone 7 (22,910 AF).
- (10) MWD entitlement destined for storage in Arvin-Edison WSD; delivered to Rosedale Rio-Bravo WSD in exchange for a like amount of RRB's Friant-Kern water (see footnote 21) delivered to Arvin-Edison WSD on behalf of MWD.
- (11) MWD entitlement scheduled for storage in Arvin-Edison WSD.
- (12) Dudley Ridge WD transfer of interruptible water (1,321 AF) for storage in Kern Water Bank.
- (13) Landowner transfer from Lost Hills WD to Semitropic WSD on behalf of Lost Hills Utility District.
- (14) Cawelo WD's 1999 SWP Entitlement delivered to Buena Vista WSD as payback for Buena Vista WSD's 1998 Kern River water delivered to Cawelo WD.
- (15) Includes Long-Term M&I quantity (10,600 AF) from Tehachapi-Cummings CWD; includes 11,729 AF to Buena Vista WSD; includes 64,000 AF to North Kern WSD.
- (16) Return water from Rosedale Rio-Bravo WSD to Arvin-Edison WSD pursuant to the 1995 RRBWSD/AEWSD Banking Agreement.
- (17) Includes long-term exchange amounts from Kern Delta WD (25,500 AF) and West Kern WD (25,000 AF); includes 7,015 AF of interruptible water from Henry Miller WD; includes 11,729 AF from Improvement District No. 4; includes 1,940 AF from Cawelo WD.
- (18) Long-Term exchange amounts to Buena Vista WSD from Kern Delta WD (25,500 AF) and West Kern WD (25,000 AF)
- (19) Interruptible water purchased by Henry Miller WD on behalf of Buena Vista WSD (7,015 AF).
- (20) Transfer of 278 AF from Tejon-Castac WD to Wheeler Ridge-Maricopa WSD for recharge in WRMWSD's newly constructed recharge ponds.
- (21) Long-Term M&I Pool quantity (10,600 AF) to Improvement District No. 4.
- (22) Includes 22,434 AF from Cawelo WD to Kern Delta WD in exchange for a like quantity of KDWD's Kern River water to CWD (22,434 AF); includes 5,000 AF from North Kern WD to Cawelo WD.
- (23) Exchange to facilitate the delivery of Kern River water purchased by Westlands WD from Nickel Family LLC.
- (24) Both Berrenda Mesa WD and Lost Hills WD exchanged their shares of the Friant-Kern exchange water to the City of Bakersfield for a like amount of COB's banked water transferred to an Agency storage account on behalf of said districts.
- (25) Cawelo WD exchanged their share of the Friant-Kern exchange water to Rosedale Rio-Bravo WSD for a like amount of RRB's Kern River water returned to Cawelo WD before December 20, 2000.

Table 4. (cont.) 1999 State Water Project Deliveries by Contract (in acre-feet)

|                            | (12)                                 | (13)                                   | (14)                                           | (15)                      | (16)                   | (17)                                | (18)                                         |
|----------------------------|--------------------------------------|----------------------------------------|------------------------------------------------|---------------------------|------------------------|-------------------------------------|----------------------------------------------|
| District                   | Kern<br>River<br>for SWP<br>Exchange | Friant-<br>Kern<br>for SWP<br>Exchange | (Col 3..11)<br>Total<br>SWP Water<br>Available | In-District<br>Deliveries | Recharge<br>Deliveries | (Col 15..16)<br>Total<br>Deliveries | (Col 14-17)<br>Balance<br>to be<br>Delivered |
| Berrenda Mesa WD           |                                      | (1,500) (24)                           | 96,205                                         | 92,095                    | 0                      | 92,095                              | 4,110                                        |
| Lost Hills WD              |                                      | (1,875) (24)                           | 107,785                                        | 107,490                   | 1,905                  | 109,395                             | (1,610)                                      |
| Belridge WSD               |                                      |                                        | 110,485                                        | 107,213                   | 1,708                  | 108,921                             | 1,564                                        |
| Semitropic WSD             |                                      |                                        | 304,765                                        | 286,182                   | 19,896                 | 306,078                             | (1,313)                                      |
| Cawelo WD                  |                                      | (1,875) (25)                           | 20,951                                         | 20,184                    | 0                      | 20,184                              | 767                                          |
| Improvement Dist. No. 4    | (7,923) (23)                         | (1,875)                                | 73,793                                         | 73,716                    | 77                     | 73,793                              | 0                                            |
| Rosedale-Rio Bravo WSD     |                                      |                                        | 36,322                                         | 36,322                    | 0                      | 36,322                              | 0                                            |
| Buena Vista WSD            |                                      |                                        | 118,826                                        | 118,826                   | 0                      | 118,826                             | 0                                            |
| Kern Delta WD              |                                      | (1,875)                                | 23,074                                         | 22,736                    | 0                      | 22,736                              | 338                                          |
| Henry Miller WD            |                                      |                                        | 46,360                                         | 44,881                    | 0                      | 44,881                              | 1,479                                        |
| West Kern WD               |                                      |                                        | 0                                              | 0                         | 0                      | 0                                   | 0                                            |
| Wheeler Ridge-Maricopa WSD |                                      |                                        | 188,544                                        | 176,824                   | 3,896                  | 180,720                             | 7,824                                        |
| Tehachapi-Cummings CWD Ag  |                                      |                                        | 4,300                                          | 4,266                     | 0                      | 4,266                               | 34                                           |
| Tehachapi-Cummings CWD M&I |                                      |                                        | 3,316                                          | 3,316                     | 0                      | 3,316                               | 0                                            |
| Tejon-Castac WD Ag         |                                      |                                        | 4                                              | 0                         | 4                      | 4                                   | 0                                            |
| Tejon-Castac WD M&I        |                                      |                                        | 0                                              | 0                         | 0                      | 0                                   | 0                                            |
| MWD (AEWSD)                |                                      |                                        | 121,348                                        | 121,348                   | 0                      | 121,348                             | 0                                            |
| Westside Mutual WC         |                                      |                                        | 81                                             | 0                         | 81                     | 81                                  | 0                                            |
| Westlands WD               | 7,923                                |                                        | 61,199                                         | 61,199                    | 0                      | 61,199                              | 0                                            |
| Tulare Lake Basin WSD      |                                      | 9,000                                  | 9,400                                          | 9,400                     | 0                      | 9,400                               | 0                                            |
| Dudley Ridge WD (KWB)      |                                      |                                        | 1,337                                          | 0                         | 1,337                  | 1,337                               | 0                                            |
| KCWA                       |                                      |                                        | 7,579                                          | 0                         | 7,579                  | 7,579                               | 0                                            |
| North Kern WSD             |                                      |                                        | 64,000                                         | 64,000                    | 0                      | 64,000                              | 0                                            |
| Total                      | 0                                    | 0                                      | 1,399,674                                      | 1,349,998                 | 36,483                 | 1,386,481                           | 13,193                                       |
| Deliveries to Kern County  | (7,923)                              | (9,000)                                | 1,329,075                                      | 1,279,399                 | 36,483                 | 1,315,882                           | 13,193                                       |

Table 5. Kern River Flows (in acre-feet)

| Calendar Year | Natural Flows | Cumulative Natural Flows | Calendar Year | Natural Flows | Regulated Flows <sup>(1)</sup> | Cumulative Flows |           |
|---------------|---------------|--------------------------|---------------|---------------|--------------------------------|------------------|-----------|
|               |               |                          |               |               |                                | Natural          | Regulated |
| 1894          | 533,326       | 533,326                  | 1931          | 185,645       |                                | 26,249,601       |           |
| 1895          | 1,023,052     | 1,556,378                | 1932          | 737,727       |                                | 26,987,328       |           |
| 1896          | 619,692       | 2,176,070                | 1933          | 441,086       |                                | 27,428,414       |           |
| 1897          | 893,434       | 3,069,504                | 1934          | 227,665       |                                | 27,656,079       |           |
| 1898          | 251,827       | 3,321,331                | 1935          | 474,128       |                                | 28,130,207       |           |
| 1899          | 338,872       | 3,660,203                | 1936          | 796,447       |                                | 28,926,654       |           |
| 1900          | 332,373       | 3,992,576                | 1937          | 1,260,182     |                                | 30,186,836       |           |
| 1901          | 880,089       | 4,872,665                | 1938          | 1,358,685     |                                | 31,545,521       |           |
| 1902          | 552,539       | 5,425,204                | 1939          | 461,073       |                                | 32,006,594       |           |
| 1903          | 546,395       | 5,971,599                | 1940          | 789,098       |                                | 32,795,692       |           |
| 1904          | 492,949       | 6,464,548                | 1941          | 1,401,076     |                                | 34,196,768       |           |
| 1905          | 531,809       | 6,996,357                | 1942          | 771,966       |                                | 34,968,734       |           |
| 1906          | 1,900,540     | 8,896,897                | 1943          | 1,220,827     |                                | 36,189,561       |           |
| 1907          | 990,900       | 9,887,797                | 1944          | 625,537       |                                | 36,815,098       |           |
| 1908          | 498,503       | 10,386,300               | 1945          | 938,055       |                                | 37,753,153       |           |
| 1909          | 1,838,643     | 12,224,943               | 1946          | 650,683       |                                | 38,403,836       |           |
| 1910          | 658,911       | 12,883,854               | 1947          | 406,698       |                                | 38,810,534       |           |
| 1911          | 1,013,384     | 13,897,238               | 1948          | 329,506       |                                | 39,140,040       |           |
| 1912          | 387,432       | 14,284,670               | 1949          | 302,870       |                                | 39,442,910       |           |
| 1913          | 367,840       | 14,652,510               | 1950          | 601,360       |                                | 40,044,270       |           |
| 1914          | 1,113,513     | 15,766,023               | 1951          | 442,222       |                                | 40,486,492       |           |
| 1915          | 646,287       | 16,412,310               | 1952          | 1,500,999     |                                | 41,987,491       |           |
| 1916          | 2,520,149     | 18,932,459               | 1953          | 548,833       |                                | 42,536,324       |           |
| 1917          | 823,082       | 19,755,541               | 1954          | 528,357       | 510,320 <sup>(2)</sup>         | 43,064,681       | 510,320   |
| 1918          | 538,503       | 20,294,044               | 1955          | 444,300       | 367,783                        | 43,508,981       | 878,103   |
| 1919          | 499,124       | 20,793,168               | 1956          | 840,862       | 755,500                        | 44,349,843       | 1,633,603 |
| 1920          | 600,643       | 21,393,811               | 1957          | 444,338       | 445,859                        | 44,794,181       | 2,079,462 |
| 1921          | 509,519       | 21,903,330               | 1958          | 1,104,730     | 967,511                        | 45,898,911       | 3,046,973 |
| 1922          | 861,426       | 22,764,756               | 1959          | 257,978       | 353,165                        | 46,156,889       | 3,400,138 |
| 1923          | 500,515       | 23,265,271               | 1960          | 300,037       | 324,088                        | 46,456,926       | 3,724,226 |
| 1924          | 187,727       | 23,452,998               | 1961          | 177,642       | 177,063                        | 46,634,568       | 3,901,289 |
| 1925          | 465,913       | 23,918,911               | 1962          | 697,704       | 607,848                        | 47,332,272       | 4,509,137 |
| 1926          | 366,706       | 24,285,617               | 1963          | 801,450       | 676,237                        | 48,133,722       | 5,185,374 |
| 1927          | 792,580       | 25,078,197               | 1964          | 339,266       | 361,624                        | 48,472,988       | 5,546,998 |
| 1928          | 312,828       | 25,391,025               | 1965          | 720,362       | 634,303                        | 49,193,350       | 6,181,301 |
| 1929          | 322,958       | 25,713,983               | 1966          | 678,595       | 504,506                        | 49,871,945       | 6,685,807 |
| 1930          | 349,973       | 26,063,956               | 1967          | 1,396,227     | 1,465,855                      | 51,268,172       | 8,151,662 |

<sup>(1)</sup> Regulated flows do not include deliveries above First Point.

<sup>(2)</sup> Isabella Dam in operation. All subsequent flows are controlled releases.

**Table 5. (continued) Kern River Flows (in acre-feet)**

| Calendar<br>Year | Natural<br>Flows | Regulated<br>Flows <sup>(1)</sup> | Cumulative Flows |            |
|------------------|------------------|-----------------------------------|------------------|------------|
|                  |                  |                                   | Natural          | Regulated  |
| 1966             | 678,595          | 504,506                           | 49,871,945       | 6,685,807  |
| 1967             | 1,396,227        | 1,465,855                         | 51,268,172       | 8,151,662  |
| 1968             | 453,760          | 497,026                           | 51,721,932       | 8,648,688  |
| 1969             | 2,461,370        | 2,313,769                         | 54,183,302       | 10,962,457 |
| 1970             | 589,474          | 601,254                           | 54,772,776       | 11,563,711 |
| 1971             | 427,454          | 442,651                           | 55,200,230       | 12,006,362 |
| 1972             | 268,427          | 311,291                           | 55,468,657       | 12,317,653 |
| 1973             | 979,652          | 785,133                           | 56,448,309       | 13,102,786 |
| 1974             | 818,608          | 745,903                           | 57,266,917       | 13,848,689 |
| 1975             | 564,567          | 572,091                           | 57,831,484       | 14,420,780 |
| 1976             | 249,468          | 320,784                           | 58,080,952       | 14,741,564 |
| 1977             | 196,998          | 200,702                           | 58,277,950       | 14,942,266 |
| 1978             | 1,653,505        | 1,390,675                         | 59,931,455       | 16,332,941 |
| 1979             | 672,661          | 656,068                           | 60,604,116       | 16,989,009 |
| 1980             | 1,639,957        | 1,560,652                         | 62,244,073       | 18,549,661 |
| 1981             | 449,263          | 460,469                           | 62,693,336       | 19,010,130 |
| 1982             | 1,271,139        | 1,121,088                         | 63,964,475       | 20,131,218 |
| 1983             | 2,489,128        | 2,381,575                         | 66,453,603       | 22,512,793 |
| 1984             | 821,797          | 834,036                           | 67,275,400       | 23,346,829 |
| 1985             | 672,431          | 668,971                           | 67,947,831       | 24,015,800 |
| 1986             | 1,444,939        | 1,331,561                         | 69,392,770       | 25,347,361 |
| 1987             | 375,935          | 432,309                           | 69,768,705       | 25,779,670 |
| 1988             | 294,685          | 335,473                           | 70,063,390       | 26,115,143 |
| 1989             | 397,038          | 348,773                           | 70,460,428       | 26,463,916 |
| 1990             | 203,571          | 219,501                           | 70,663,999       | 26,683,417 |
| 1991             | 406,289          | 333,494                           | 71,070,288       | 27,016,911 |
| 1992             | 296,829          | 272,822                           | 71,367,117       | 27,289,733 |
| 1993             | 853,760          | 642,339                           | 72,220,877       | 27,932,072 |
| 1994             | 336,456          | 422,361                           | 72,557,333       | 28,354,433 |
| 1995             | 1,385,160        | 1,197,100                         | 73,942,493       | 29,551,533 |
| 1996             | 1,038,261        | 968,036                           | 74,980,754       | 30,519,569 |
| 1997             | 1,181,969        | 1,133,463                         | 76,162,723       | 31,653,032 |
| 1998             | 1,717,967        | 1,662,556                         | 77,880,690       | 33,315,588 |
| 1999             | 433,971          | 461,621                           | 78,314,661       | 33,777,209 |

|                                           |            |                                           |              |
|-------------------------------------------|------------|-------------------------------------------|--------------|
| 106 Year Mean Natural First Point Flow    | 738,800 AF | Minimum Natural First Point Flow (1961)   | 177,642 AF   |
| 106 Year Median Natural First Point Flow  | 589,500 AF | Maximum Natural First Point Flow (1916)   | 2,520,149 AF |
| 46 Year Mean Regulated First Point Flow   | 734,300 AF | Minimum Regulated First Point Flow (1961) | 177,063 AF   |
| 46 Year Median Regulated First Point Flow | 586,700 AF | Maximum Regulated First Point Flow (1983) | 2,381,575 AF |

**Table 6. 1999 Kern River Water Diversions by Entity (in acre-feet)**

| <b>Area of Use</b>                                           | <b>Diversions</b> |
|--------------------------------------------------------------|-------------------|
| <b>Above First Point</b>                                     |                   |
| California Water Service                                     | 151               |
| Kern Valley Golf Course (Kernville)                          | 186               |
| La Hacienda, Inc.                                            | 45                |
| Lake Ming                                                    | 790               |
| Olcese WD                                                    | 1,308             |
| <b>Subtotal</b>                                              | <b>2,480</b>      |
| <b>Below First Point</b>                                     |                   |
| Arvin-Edison WSD                                             | 35,000            |
| Buena Vista WSD                                              | 12,563            |
| Cawelo WD                                                    | 55,021            |
| City of Bakersfield, Irrigation and Spreading <sup>(1)</sup> | 43,294            |
| Henry Miller WD                                              | 0                 |
| Improvement District No. 4                                   | 30,590            |
| Kern County Water Agency (Pioneer Property)                  | 4,060             |
| Kern Delta WD                                                | 169,824           |
| Kern -Tulare WD                                              | 0                 |
| Kern Water Bank Authority                                    | 0                 |
| North Kern WSD                                               | 95,625            |
| Rag Gulch WD                                                 | 0                 |
| Rosedale Ranch Improvement District                          | 5,800             |
| Rosedale-Rio Bravo WSD                                       | 8,948             |
| South Fork                                                   | 896               |
| <b>Subtotal</b>                                              | <b>461,621</b>    |
| <b>Total</b>                                                 | <b>464,101</b>    |

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<sup>(1)</sup> Includes Kern River Canal & Irrigating Company deliveries, Truxtun Lakes deliveries, Carrier Canal losses and percolation, Kern River channel losses and percolation.

**Table 7. 1999 Central Valley Project Deliveries by Entity<sup>(1)</sup> (in acre-feet)**

|                               | Class I        | Class II      | 215 Water     | Other <sup>(3)</sup><br>Water | sub<br>Total   | Other <sup>(4)</sup><br>Water | Total          |
|-------------------------------|----------------|---------------|---------------|-------------------------------|----------------|-------------------------------|----------------|
| Arvin-Edison WSD              | 43,575         | 37,473        | -             |                               | 81,048         | 161,942                       | 242,990        |
| Delano-Earlimart ID           | 13,293         | 2,831         | -             | 6,736                         | 22,860         |                               | 22,860         |
| Kern County Water Agency      | -              |               | 46,045        |                               | 46,045         |                               | 46,045         |
| Kern-Tulare WD <sup>(2)</sup> | 6,284          | -             |               |                               | 6,284          |                               | 6,284          |
| North Kern WSD                | -              | -             |               |                               | -              |                               | -              |
| Rosedale-Rio Bravo WSD        | 3,187          | -             |               |                               | 3,187          |                               | 3,187          |
| Shafter-Wasco ID              | 52,660         | 7,920         | 3,903         | 3,240                         | 67,723         |                               | 67,723         |
| So. San Joaquin MUD           | 97,000         | 10,000        |               | 16,379                        | 123,379        |                               | 123,379        |
| <b>Total</b>                  | <b>215,999</b> | <b>58,224</b> | <b>49,948</b> | <b>26,355</b>                 | <b>350,526</b> | <b>161,942</b>                | <b>512,468</b> |

<sup>(1)</sup> Quantities for water year March 1997 - February 1998.

<sup>(2)</sup> Per exchange of Cross Valley Canal water with Arvin-Edison WSD.

<sup>(3)</sup> Includes DEID Carryover into 1999; SWID return water from NKWSD & SWSD.

<sup>(4)</sup> Includes MWD exchange water.

**Table 8. 1999 Central Valley Project Deliveries to Kern County (in acre-feet)**

| Year | Annual<br>Delivery | Cumulative<br>Delivery | Year | Annual<br>Delivery | Cumulative<br>Delivery |
|------|--------------------|------------------------|------|--------------------|------------------------|
| 1950 | 762                | 762                    |      |                    |                        |
| 1951 | 27,005             | 27,767                 | 1981 | 469,966            | 7,899,255              |
| 1952 | 49,500             | 77,267                 | 1982 | 656,608            | 8,555,863              |
| 1953 | 83,558             | 160,825                | 1983 | 550,874            | 9,106,737              |
| 1954 | 112,093            | 272,918                | 1984 | 425,371            | 9,532,108              |
| 1955 | 126,238            | 399,156                | 1985 | 337,514            | 9,869,622              |
| 1956 | 279,134            | 678,290                | 1986 | 589,262            | 10,458,884             |
| 1957 | 141,684            | 819,974                | 1987 | 291,981            | 10,750,865             |
| 1958 | 223,830            | 1,043,804              | 1988 | 292,828            | 11,043,693             |
| 1959 | 166,099            | 1,209,903              | 1989 | 293,865            | 11,337,558             |
| 1960 | 156,978            | 1,366,881              | 1990 | 200,141            | 11,537,699             |
| 1961 | 126,412            | 1,493,293              | 1991 | 204,396            | 11,742,095             |
| 1962 | 231,045            | 1,724,338              | 1992 | 208,021            | 11,950,116             |
| 1963 | 234,283            | 1,958,621              | 1993 | 489,783            | 12,439,899             |
| 1964 | 189,330            | 2,147,951              | 1994 | 186,303            | 12,626,202             |
| 1965 | 245,482            | 2,393,433              | 1995 | 647,077            | 13,273,279             |
| 1966 | 232,084            | 2,625,517              | 1996 | 611,262            | 13,884,541             |
| 1967 | 319,706            | 2,945,223              | 1997 | 630,026            | 14,514,567             |
| 1968 | 206,499            | 3,151,722              | 1998 | 466,490            | 14,981,057             |
| 1969 | 372,826            | 3,524,548              | 1999 | 447,983            | 15,429,040             |
| 1970 | 351,392            | 3,875,940              |      |                    |                        |
| 1971 | 348,865            | 4,224,805              |      |                    |                        |
| 1972 | 238,475            | 4,463,280              |      |                    |                        |
| 1973 | 412,178            | 4,875,458              |      |                    |                        |
| 1974 | 480,575            | 5,356,033              |      |                    |                        |
| 1975 | 442,130            | 5,798,163              |      |                    |                        |
| 1976 | 226,512            | 6,024,675              |      |                    |                        |
| 1977 | 121,469            | 6,146,144              |      |                    |                        |
| 1978 | 357,847            | 6,503,991              |      |                    |                        |
| 1979 | 462,526            | 6,966,517              |      |                    |                        |
| 1980 | 462,772            | 7,429,289              |      |                    |                        |

|                         |            |                 |                |            |
|-------------------------|------------|-----------------|----------------|------------|
| Mean Delivery           | 308,581 AF | Median Delivery | 1975-98        | 442,130 AF |
| Median Delivery         | 285,558 AF | Min. Delivery   | 1975-98 (1977) | 121,469 AF |
| Mean Delivery 1975-1998 | 402,920 AF | Max. Delivery   | 1975-98 (1982) | 656,608 AF |

**Table 9. Minor Stream Flows in the San Joaquin Valley Portion of Kern County (in acre-feet)**

| Year                | Annual<br>Stream Flows | Cumulative<br>Stream Flows |
|---------------------|------------------------|----------------------------|
| 1970                | 132,400                | 132,400                    |
| 1971                | 63,200                 | 195,600                    |
| 1972                | 21,600                 | 217,200                    |
| 1973                | 22,900                 | 240,100                    |
| 1974                | 104,900                | 345,000                    |
| 1975                | 39,400                 | 384,400                    |
| 1976                | 42,700                 | 427,100                    |
| 1977                | 32,900                 | 460,000                    |
| 1978                | 429,200                | 889,200                    |
| 1979                | 96,700                 | 985,900                    |
| 1980                | 65,200                 | 1,051,100                  |
| 1981                | 63,600                 | 1,114,700                  |
| 1982                | 91,700                 | 1,206,400                  |
| 1983                | 273,300                | 1,479,700                  |
| 1984                | 43,200                 | 1,522,900                  |
| 1985                | 20,200                 | 1,543,100                  |
| 1986                | 32,600                 | 1,575,700                  |
| 1987                | 61,900                 | 1,637,600                  |
| 1988                | 22,900                 | 1,660,500                  |
| 1989                | 6,900                  | 1,667,400                  |
| 1990                | 17,000                 | 1,684,400                  |
| 1991                | 34,600                 | 1,719,000                  |
| 1992                | 52,200                 | 1,771,200                  |
| 1993                | 72,900                 | 1,844,100                  |
| 1994                | 36,800                 | 1,880,900                  |
| 1995                | 162,100                | 2,043,000                  |
| 1996                | 88,100                 | 2,131,100                  |
| 1997                | 100,000                | 2,231,100                  |
| 1998                | 286,400                | 2,517,500                  |
| 1999                | 37,300                 | 2,554,800                  |
| Mean Flow           |                        | 86,800 AF                  |
| Median Flow         |                        | 61,900 AF                  |
| Minimum Flow (1989) |                        | 6,900 AF                   |
| Maximum Flow (1978) |                        | 429,200 AF                 |

**Table 10. 1999 Monthly Rainfall at Selected Stations (in inches).**

| OPERATOR/Station                              | Elev. | Location    | Jan        | Feb  | Mar  | Apr  | May  | Jun  | Jul  | Aug  | Sep  | Oct | Nov  | Dec  | Total |
|-----------------------------------------------|-------|-------------|------------|------|------|------|------|------|------|------|------|-----|------|------|-------|
| (ft)                                          |       |             |            |      |      |      |      |      |      |      |      |     |      |      |       |
| ARVIN-EDISON WATER STORAGE DISTRICT           |       |             |            |      |      |      |      |      |      |      |      |     |      |      |       |
| District Headquarters                         | 500   | 31S/30E-29  | 3.23       | 0.90 | 0.27 | 0.62 | 0    | 0    | 0    | 0    | 0    | 0   | 0.69 | 0.09 | 5.80  |
| Sycamore                                      | 420   | 31S/30E-20  | 3.09       | 0.91 | 0.23 | 0.62 | 0    | 0    | 0    | 0    | 0    | 0   | 0.65 | 0.09 | 5.59  |
| Tejon                                         | 480   | 32S/29E-15  | 2.52       | 0.57 | 0.31 | 1.27 | 0    | 0    | 0    | 0    | 0    | 0   | 0.57 | 0.04 | 5.28  |
| CALIFORNIA DEPARTMENT OF WATER RESOURCES      |       |             |            |      |      |      |      |      |      |      |      |     |      |      |       |
| Lost Hills O&M Center                         | 300   | 27S/21E-03  | 2.18       | 0.18 | 0.85 | 0.70 | 0    | 0    | 0    | 0    | 0    | 0   | 0.29 | 0.02 | 4.22  |
| Wasco 7E                                      | 410   | 27S/26E-06  | 3.73       | 0.53 | 0.48 | 0.62 | 0    | 0    | 0.07 | 0    | 0.13 | 0   | 0.31 | 0.18 | 6.05  |
| Wind Gap O&M Center                           | 780   | 11N/20W-26  | 2.75       | 0.39 | 0.63 | 1.82 | 0    | 0    | 0    | 0    | 0    | 0   | 0.58 | 0.66 | 6.83  |
| J.G. BOSWELL COMPANY                          |       |             |            |      |      |      |      |      |      |      |      |     |      |      |       |
| Buena Vista #4                                | 300   | 32S/25E-06  | 2.78       | 0.23 | 0.83 | 1.19 | 0    | 0    | 0    | 0    | 0.02 | 0   | 0.24 | 0.36 | 5.65  |
| Buena Vista Gin                               | 300   | 32S/25E-12  | 2.69       | 0.27 | 0.66 | 1.14 | 0    | 0    | 0    | 0    | 0.02 | 0   | 0.18 | 0.37 | 5.33  |
| Buena Vista Office                            | 290   | 31S/25E-25  | 2.86       | 0.36 | 0.52 | 1.15 | 0    | 0    | 0.46 | 0    | 0.03 | 0   | 0.53 | 0    | 5.91  |
| Kern Lake Shop                                | 280   | 32S/28E-18  | 2.68       | 0.46 | 0.35 | 0.99 | 0    | 0    | 0.80 | 0    | 0.04 | 0   | 0.46 | 0.05 | 5.83  |
| Kern Lake Time Room                           | 280   | 32S/27E-16  | 2.62       | 0.32 | 0.43 | 1.17 | 0    | 0    | 0.12 | 0    | 0.03 | 0   | 0.42 | 0.06 | 5.17  |
| Paloma                                        | 290   | 32S/24E-02  | 2.79       | 0.37 | 0.46 | 1.26 | 0    | 0    | 0.31 | 0    | 0.02 | 0   | 0.23 | 0.20 | 5.64  |
| KERN COUNTY PLANNING DEPARTMENT               |       |             |            |      |      |      |      |      |      |      |      |     |      |      |       |
| Arvin Fire Station                            | 450   | 31S/29E-28  | 2.19       | 0.46 | 0.15 | 0.51 | 0    | 0    | 0    | 0    | 0    | 0   | 0.41 | 0.04 | 3.76  |
| Buena Vista Aquatic Rec Area                  | 300   | 31S/25E-15  | 2.38       | 0.22 | 0.48 | 1.06 | 0    |      | 0.17 | 0    | 0.10 | 0   | 0.50 | 0    | 4.91  |
| Buttonwillow Fire Station                     | 270   | 29S/23E-14  | incomplete |      |      |      |      |      |      |      |      |     |      |      |       |
| Communications Center                         | 770   | 29S/28E-16  | 3.12       | 0.51 | 0.04 | 1.15 | 0    | 0    | 0    | 0    | 0    | 0   | 0.35 | 0.07 | 5.24  |
| Edmonston Pump Station                        | 1,310 | 10N/18W-17M | 2.12       | 0.95 | 1.64 | 1.81 | 0    | 0    | 0.08 | 0    | 0    | 0   | 0.77 | 0.17 | 7.54  |
| McFarland Fire Station                        | 350   | 26S/25E-10  | 3.03       | 0.54 | 0.41 | 0.65 | 0    | 0    | 0    | 0.05 | 0.13 | 0   | 0.24 | 0.12 | 5.17  |
| Pine Mountain                                 | 5,200 | 09N/21W-19  | 2.67       | 0.70 | 1.98 | 2.24 | 0.03 | 0.06 | 0.26 | 0    | 0.28 | 0   | 0.47 | 0.60 | 9.29  |
| Rio Bravo Fire Station                        | 610   | 29S/29E-04  | 2.84       | 0.45 | 0.02 | 0.90 | 0    | 0    | 0    | 0    | 0    | 0   | 0.33 | 0.06 | 4.60  |
| NATIONAL WEATHER SERVICE                      |       |             |            |      |      |      |      |      |      |      |      |     |      |      |       |
| Bakersfield                                   | 380   | 30S/28E-08  | 3.90       | 0.46 | 0.21 | 0.83 | 0    | 0    | 0    | 0    | 0.08 | 0   | 0.36 | 0.14 | 5.98  |
| Bear Valley                                   | 4,100 | 32S/31E-03  | 2.17       | 1.72 | 0.43 | 1.39 | 0.07 | 0.04 | 0.05 | 0    | 0.03 | 0   | 0.40 | 0.12 | 6.42  |
| Delano                                        | 320   | 25S/25E-S11 | 3.98       | 0.52 | 0.31 | 0.58 | 0    | 0    | 0    | 0    | 0    | 0   | 0.41 | 0.06 | 5.86  |
| Glennville                                    | 3,100 | 25S/30E-25  | 5.27       | 1.53 | 0.99 | 2.22 | 0.03 | 0.01 | 0.20 | 0    | 0.04 | 0   | 1.07 | 0.12 | 11.48 |
| Keene                                         | 2,900 | 31S/32E-20  | 3.99       | 1.38 | 0.07 | 1.70 | 0    | 0.03 | 0    | 0    | 0    | 0   | 0.21 | 0    | 7.38  |
| Lebec                                         | 3,600 | 09N/19W-26  | --         | 0.27 | 0.84 | 2.69 | 0    | 0.04 | 0    | 0    | 0    | 0   | 0.07 | 0.04 | --    |
| Lost Hills                                    | 280   | 26S/21E-35  | 2.82       | 0.05 | 0.90 | 0.95 | 0    | 0    | 0    | 0    | 0.06 | 0   | 0.31 | 0    | 5.09  |
| Maricopa                                      | 700   | 10N/24W-11  | 2.70       | 0    | 1.34 | 0.82 | 0    | 0    | 0    | 0    | 0    | 0   | 0.27 | 0    | 5.13  |
| Piute                                         | 4,290 | 29S/33E-36  | 3.57       | 0.25 | 0.42 | 0.99 | 0.02 | 0    | 0.50 | 0    | 0.16 | 0   | 0.27 | 0    | 6.18  |
| Tehachapi                                     | 3,980 | 32S/33E-21  | 3.17       | 0.92 | 0.44 | 0.95 | 0    | 0    | 1.01 | 0.01 | 0.03 | 0   | 0.23 | 0.10 | 6.86  |
| Wasco                                         | 300   | 27S/24E-11  | 3.25       | 0.20 | 0.60 | 0.41 | 0    | 0    | 0    | 0    | 0.26 | 0   | 0.22 | 0.02 | 4.96  |
| Woody                                         | 1,600 | 25S/29E-35  | 4.08       | 1.20 | 0.69 | 1.59 | 0.07 | 0    | 0    | 0.08 | 0    | 0   | 0.58 | 0    | 8.29  |
| TEHACHAPI-CUMMINGS COUNTY WATER DISTRICT      |       |             |            |      |      |      |      |      |      |      |      |     |      |      |       |
| Station 6                                     | 4,890 | 12N/15W-01  | 3.28       | 1.20 | 0.56 | 1.14 | 0.05 | 0.05 | 1.05 | 0    | 0.05 | 0   | 0.22 | 0.05 | 7.65  |
| Station 20                                    | 5,730 | 12N/15W-12  | 4.95       | 1.72 | 1.09 | 1.55 | 0.10 | 0.10 | 1.35 | 0    | 0.05 | 0   | 0.30 | 0.16 | 11.37 |
| WHEELER RIDGE-MARICOPA WATER STORAGE DISTRICT |       |             |            |      |      |      |      |      |      |      |      |     |      |      |       |
| SP-P2                                         | 590   | 11N/22W-09  | 2.51       | 0.34 | 0.81 | 1.19 | 0    | 0    | 0    | 0    | 0    | 0   | 0.63 | 0.29 | 5.77  |
| District Headquarters                         | 480   | 11N/12W-11  | 2.93       | 0.38 | 0.48 | 1.49 | 0    | 0    | 0.07 | 0    | 0    | 0   | 0.54 | 0.15 | 6.04  |
| Greenlee's Pasture                            | 380   | 12N/21W-36  | 2.51       | 0.31 | 0.53 | 1.40 | 0    | 0    | 0    | 0    | 0.07 | 0   | 0.58 | 0.13 | 5.53  |
| PA-2                                          | 960   | 11N/19W-30  | 2.72       | 0.54 | 1.11 | 1.29 | 0    | 0    | 0    | 0    | 0    | 0   | 0.55 | 0.12 | 6.33  |
| Spill Basin                                   | 850   | 11N/18W-31  | 3.08       | 1.02 | 1.03 | 1.32 | 0    | 0    | 0    | 0    | 0    | 0   | 0.57 | 0.12 | 7.14  |
| WRM-2                                         | 510   | 32S-24E-35  | 2.58       | 0.23 | 1.11 | 1.04 | 0    | 0    | 0    | 0    | 0    | 0   | 0.30 | 0.24 | 5.50  |

**Table 10 continued. 1999 Monthly Rainfall at Selected Stations (in inches).**

| OPERATOR/Station                            | Elev. (ft) | Location    | Jan         | Feb         | Mar         | Apr         | May         | Jun         | Jul         | Aug         | Sep         | Oct      | Nov         | Dec         | Total       |
|---------------------------------------------|------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|----------|-------------|-------------|-------------|
| <b>OTHER OPERATORS</b>                      |            |             |             |             |             |             |             |             |             |             |             |          |             |             |             |
| Belridge WSD Office                         | 550        | 28S/21E-34  | 3.20        | 0.20        | 0.80        | 0.85        | 0           | 0           | 0           | 0           | 0           | 0        | 0.20        | 0           | 5.25        |
| Blackwell's Corner (BMWD)                   | 630        | 27S/20E-06  | 2.99        | 0.18        | 1.07        | 1.05        | 0           | 0           | 0           | 0           | 0           | 0        | 0.05        | 0           | 5.34        |
| City of Bakersfield DWR Yd.                 | 400        | 30S/27E-06  | 3.28        | 0.65        | 0.24        | 0.71        | 0           | 0           | 0           | 0           | 0.03        | 0        | 0.32        | 0.16        | 5.39        |
| Del Kern Station (KDWD)                     | 350        | 31S/28E-06C | 2.41        | 0.37        | 0.27        | 0.75        | 0           | 0           | 0           | 0           | 0.05        | 0        | 0.34        | 0.11        | 4.30        |
| Shafter Cotton Research Sta.                | 370        | 27S/25E-33J | 3.97        | 0.58        | 0.52        | 0.58        | 0           | 0           | 0.08        | 0.01        | 0.13        | 0        | 0.24        | 0.21        | 6.32        |
| So. Belridge (Cal Resources)                | 600        | 28S/21E-33  | 3.06        | 0.24        | 0.84        | 0.56        | 0           | 0           | 0           | 0           | 0.09        | 0        | 0.17        | 0.10        | 5.06        |
| <b>Approximate Average For All Stations</b> |            |             | <b>3.06</b> | <b>0.57</b> | <b>0.63</b> | <b>1.13</b> | <b>0.01</b> | <b>0.01</b> | <b>0.15</b> | <b>0.00</b> | <b>0.04</b> | <b>0</b> | <b>0.39</b> | <b>0.12</b> | <b>6.12</b> |

Note: Boxed numbers are estimated values

"m" indicates missing data

**Table 11. Effective Precipitation in the San Joaquin Valley Portion of Kern County (in acre-feet)**

|      | <b>Annual Effective<br/>Precipitation</b> | <b>Unit Rate<br/>( inches per acre)</b> | <b>Cumulative<br/>Effective<br/>Precipitation</b> |
|------|-------------------------------------------|-----------------------------------------|---------------------------------------------------|
| 1970 | 380,200                                   | 5.72                                    | 380,200                                           |
| 1971 | 148,300                                   | 2.13                                    | 528,500                                           |
| 1972 | 264,900                                   | 3.78                                    | 793,400                                           |
| 1973 | 131,900                                   | 1.84                                    | 925,300                                           |
| 1974 | 220,200                                   | 2.88                                    | 1,145,500                                         |
| 1975 | 240,500                                   | 3.17                                    | 1,386,000                                         |
| 1976 | 175,300                                   | 2.25                                    | 1,561,300                                         |
| 1977 | 198,400                                   | 2.74                                    | 1,759,700                                         |
| 1978 | 612,500                                   | 8.08                                    | 2,372,200                                         |
| 1979 | 152,600                                   | 1.97                                    | 2,524,800                                         |
| 1980 | 281,200                                   | 3.58                                    | 2,806,000                                         |
| 1981 | 255,400                                   | 3.21                                    | 3,061,400                                         |
| 1982 | 332,300                                   | 4.18                                    | 3,393,700                                         |
| 1983 | 438,100                                   | 6.15                                    | 3,831,800                                         |
| 1984 | 139,300                                   | 1.72                                    | 3,971,100                                         |
| 1985 | 160,700                                   | 2.04                                    | 4,131,800                                         |
| 1986 | 162,600                                   | 2.40                                    | 4,294,400                                         |
| 1987 | 168,200                                   | 2.57                                    | 4,462,600                                         |
| 1988 | 144,200                                   | 2.08                                    | 4,606,800                                         |
| 1989 | 106,100                                   | 1.49                                    | 4,712,900                                         |
| 1990 | 90,500                                    | 1.29                                    | 4,803,400                                         |
| 1991 | 171,700                                   | 2.82                                    | 4,975,100                                         |
| 1992 | 142,300                                   | 2.16                                    | 5,117,400                                         |
| 1993 | 168,700                                   | 2.53                                    | 5,286,100                                         |
| 1994 | 169,100                                   | 2.53                                    | 5,455,200                                         |
| 1995 | 192,400                                   | 2.72                                    | 5,647,600                                         |
| 1996 | 192,500                                   | 2.62                                    | 5,840,100                                         |
| 1997 | 105,600                                   | 1.43                                    | 5,945,700                                         |
| 1998 | 575,200                                   | 8.01                                    | 6,520,900                                         |
| 1999 | 136,490                                   | 1.85                                    | 6,657,390                                         |

|                      |                  |
|----------------------|------------------|
| Mean EP (total)      | 221,900 AF       |
| Median EP (total)    | 170,400 AF       |
| Mean EP (per acre)   | 3.06 Inches/Acre |
| Median EP (per acre) | 2.55 Inches/Acre |

**Table 12. 1999 Waste Water Treatment Plant Volumes**

| Facility                                | Volume        |               | Influent Source | Treatment System | Effluent Use                          |
|-----------------------------------------|---------------|---------------|-----------------|------------------|---------------------------------------|
|                                         | (MG)          | (AF)          |                 |                  |                                       |
| City of Arvin                           | 392           | 1,202         | Dom             | Secondary        | Agriculture                           |
| City of Bakersfield                     |               |               |                 |                  |                                       |
| #2                                      | 5,756         | 17,663        | Dom/Ind         | Secondary        | Restricted Agriculture                |
| #3                                      | 4,061         | 12,462        | Dom/Ind         | Secondary        | Restricted Agriculture                |
| Kern County Waste Management Department |               |               |                 |                  |                                       |
| KSA (Mt. Vernon)                        | 1,607         | 4,930         | Dom             | Secondary        | Agriculture                           |
| BVARA                                   | 8             | 23            | Agr             | Secondary        | Percolation                           |
| Sheriff's Lerdo Facility                | 100           | 307           | Dom             | Secondary        | Same                                  |
| Reeder Tract                            | 12            | 37            | Dom             | Secondary        | Same                                  |
| NOR Sanitary District #1                | 1,424         | 4,370         | Dom/Ind         | Secondary        | Restricted Agriculture<br>Percolation |
| City of Delano                          | 1,525         | 4,680         | Dom             | Secondary        | Restricted Agriculture                |
| Lamont Public Utilities District        | 537           | 1,647         | Dom             | Primary          | Agriculture                           |
| City of McFarland                       | 322           | 988           | Dom             | Secondary        | Agriculture                           |
| City of Shafter                         | 1             | 4             | Dom/Ind         | Secondary        | Agriculture                           |
| Shafter Airport <sup>(1)</sup>          | 51            | 156           | Ind             | Secondary        | Percolation                           |
| City of Wasco                           | 21            | 64            | Dom/Ind         | Secondary        | Agriculture                           |
| <b>Total</b>                            | <b>15,816</b> | <b>48,533</b> |                 |                  |                                       |

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For influent source:

Dom - domestic  
Ind - industrial  
Agr - agricultural

**Primary treatment** removes settleable solids.

**Secondary treatment** involves further oxidation of waste water to remove dissolved and biologically degradable substances.

**Tertiary treatment** involves further filtration and disinfection to inactivate pathogens.

<sup>(1)</sup> No information available for 1999; 1998 data used as an estimation.

**Table 13. Waste Water Reuse (in acre-feet)**

| <b>Year</b> | <b>Annual<br/>Flows</b> | <b>Cumulative<br/>Flows</b> |
|-------------|-------------------------|-----------------------------|
| 1970        | 26,900                  | 26,900                      |
| 1971        | 27,800                  | 54,700                      |
| 1972        | 25,300                  | 80,000                      |
| 1973        | 25,600                  | 105,600                     |
| 1974        | 26,000                  | 131,600                     |
| 1975        | 26,100                  | 157,700                     |
| 1976        | 26,600                  | 184,300                     |
| 1977        | 28,100                  | 212,400                     |
| 1978        | 28,200                  | 240,600                     |
| 1979        | 28,800                  | 269,400                     |
| 1980        | 32,800                  | 302,200                     |
| 1981        | 34,100                  | 336,300                     |
| 1982        | 32,100                  | 368,400                     |
| 1983        | 35,300                  | 403,700                     |
| 1984        | 35,800                  | 439,500                     |
| 1985        | 34,200                  | 473,700                     |
| 1986        | 39,200                  | 512,900                     |
| 1987        | 41,400                  | 554,300                     |
| 1988        | 44,200                  | 598,500                     |
| 1989        | 44,000                  | 642,500                     |
| 1990        | 42,500                  | 685,000                     |
| 1991        | 45,200                  | 730,200                     |
| 1992        | 46,100                  | 776,300                     |
| 1993        | 47,600                  | 823,900                     |
| 1994        | 49,700                  | 873,600                     |
| 1995        | 49,700                  | 923,300                     |
| 1996        | 51,300                  | 974,600                     |
| 1997        | 50,800                  | 1,025,400                   |
| 1998        | 48,800                  | 1,074,200                   |
| 1999        | 48,533                  | 1,122,733                   |

|                            |           |
|----------------------------|-----------|
| Mean Water Reuse           | 37,000 AF |
| Median Water Reuse         | 35,300 AF |
| Minimum Water Reuse (1972) | 25,300 AF |
| Maximum Water Reuse (1999) | 51,300 AF |

**Table 14. Oil Field Produced Water (in acre-feet)**

| Year | Annual<br>Flows | Cumulative<br>Flows |
|------|-----------------|---------------------|
| 1970 | 5,300           | 5,300               |
| 1971 | 5,600           | 10,900              |
| 1972 | 6,100           | 17,000              |
| 1973 | 6,400           | 23,400              |
| 1974 | 6,900           | 30,300              |
| 1975 | 7,400           | 37,700              |
| 1976 | 7,700           | 45,400              |
| 1977 | 8,100           | 53,500              |
| 1978 | 8,500           | 62,000              |
| 1979 | 9,400           | 71,400              |
| 1980 | 10,100          | 81,500              |
| 1981 | 10,100          | 91,600              |
| 1982 | 10,600          | 102,200             |
| 1983 | 11,600          | 113,800             |
| 1984 | 11,700          | 125,500             |
| 1985 | 11,700          | 137,200             |
| 1986 | 11,800          | 149,000             |
| 1987 | 10,000          | 159,000             |
| 1988 | 12,700          | 171,700             |
| 1989 | 9,100           | 180,800             |
| 1990 | 5,300           | 186,100             |
| 1991 | 14,100          | 200,200             |
| 1992 | 8,700           | 208,900             |
| 1993 | 9,600           | 218,500             |
| 1994 | 16,800          | 235,300             |
| 1995 | 19,800          | 255,100             |
| 1996 | 13,800          | 268,900             |
| 1997 | 4,200           | 273,100             |
| 1998 | 2,000           | 275,100             |
| 1999 | 2,700           | 277,800             |

|                                |           |
|--------------------------------|-----------|
| Mean Oil Field Water           | 9,500 AF  |
| Median Oil Field Water         | 9,400 AF  |
| Minimum Oil Field Water (1998) | 2,000 AF  |
| Maximum Oil Field Water (1995) | 19,800 AF |

**Table 15. Groundwater Pumping in the San Joaquin Valley Portion of Kern County  
(in acre-feet)**

| <b>Year</b>                | <b>Annual<br/>Groundwater<br/>Pumped</b> | <b>Cumulative<br/>Groundwater<br/>Pumped</b> |
|----------------------------|------------------------------------------|----------------------------------------------|
| 1970                       | 1,422,000                                | 1,422,000                                    |
| 1971                       | 1,700,000                                | 3,122,000                                    |
| 1972                       | 1,857,000                                | 4,979,000                                    |
| 1973                       | 1,662,000                                | 6,641,000                                    |
| 1974                       | 1,333,000                                | 7,974,000                                    |
| 1975                       | 1,587,000                                | 9,561,000                                    |
| 1976                       | 1,738,000                                | 11,299,000                                   |
| 1977                       | 1,703,000                                | 13,002,000                                   |
| 1978                       | 825,000                                  | 13,827,000                                   |
| 1979                       | 1,260,000                                | 15,087,000                                   |
| 1980                       | 977,000                                  | 16,064,000                                   |
| 1981                       | 1,161,000                                | 17,225,000                                   |
| 1982                       | 802,200                                  | 18,027,200                                   |
| 1983                       | 762,700                                  | 18,789,900                                   |
| 1984                       | 1,252,200                                | 20,042,100                                   |
| 1985                       | 1,293,800                                | 21,335,900                                   |
| 1986                       | 947,600                                  | 22,283,500                                   |
| 1987                       | 1,208,700                                | 23,492,200                                   |
| 1988                       | 1,540,200                                | 25,032,400                                   |
| 1989                       | 1,588,500                                | 26,620,900                                   |
| 1990                       | 1,796,500                                | 28,417,400                                   |
| 1991                       | 2,002,400                                | 30,419,800                                   |
| 1992                       | 1,673,600                                | 32,093,400                                   |
| 1993                       | 987,700                                  | 33,081,100                                   |
| 1994                       | 1,897,700                                | 34,978,800                                   |
| 1995                       | 1,242,800                                | 36,221,600                                   |
| 1996                       | 1,609,600                                | 37,831,200                                   |
| 1997                       | 1,091,400                                | 38,922,600                                   |
| 1998                       | 1,290,200                                | 40,212,800                                   |
| 1999                       | 1,471,500                                | 41,684,300                                   |
| Mean Groundwater Pumping   |                                          | 1,389,500 AF                                 |
| Median Groundwater Pumping |                                          | 1,377,500 AF                                 |
| Minimum Pumping (1983)     |                                          | 762,700 AF                                   |
| Maximum Pumping (1991)     |                                          | 2,002,400 AF                                 |

**Table 16. Irrigated Acreage<sup>(1)</sup> in the San Joaquin Valley Portion of Kern County**

| Year | Total<br>Irrigated Acreage | Year | Total<br>Irrigated Acreage |
|------|----------------------------|------|----------------------------|
| 1970 | 797,300                    | 1996 | 880,600                    |
| 1971 | 834,800                    | 1997 | 886,700                    |
| 1972 | 841,000                    | 1998 | 861,500                    |
| 1973 | 858,700                    | 1999 | 887,540                    |
| 1974 | 919,000                    |      |                            |
| 1975 | 909,600                    |      |                            |
| 1976 | 934,800                    |      |                            |
| 1977 | 868,100                    |      |                            |
| 1978 | 909,400                    |      |                            |
| 1979 | 928,700                    |      |                            |
| 1980 | 943,500                    |      |                            |
| 1981 | 955,400                    |      |                            |
| 1982 | 954,100                    |      |                            |
| 1983 | 854,200                    |      |                            |
| 1984 | 972,800                    |      |                            |
| 1985 | 945,100                    |      |                            |
| 1986 | 813,900                    |      |                            |
| 1987 | 786,800                    |      |                            |
| 1988 | 831,100                    |      |                            |
| 1989 | 856,100                    |      |                            |
| 1990 | 842,400                    |      |                            |
| 1991 | 729,400                    |      |                            |
| 1992 | 789,600                    |      |                            |
| 1993 | 800,100                    |      |                            |
| 1994 | 802,400                    |      |                            |
| 1995 | 848,400                    |      |                            |

|                                  |               |
|----------------------------------|---------------|
| Mean Irrigated Acreage           | 867,400 Acres |
| Minimum Irrigated Acreage (1991) | 729,400 Acres |
| Maximum Irrigated Acreage (1984) | 972,800 Acres |

<sup>(1)</sup> Double-cropped acreage is counted twice, since it is irrigated twice. Double-cropping is generally a small percentage of total irrigated acreage, in the order of 10,000 to 20,000 acres annually.

**Table 17. 1999 Monthly Evaporation for San Joaquin Valley Climatic Station (in inches)**

|                          | <b>Wasco<br/>7E</b> | <b>USDA<br/>Cotton<br/>Station</b> | <b>Greenlee's<br/>Pasture</b> | <b>Avg. All<br/>Stations</b> |
|--------------------------|---------------------|------------------------------------|-------------------------------|------------------------------|
| January                  | 1.24                | 1.33                               | 1.34                          | 1.30                         |
| February                 | 2.35                | 2.32                               | 3.5                           | 2.72                         |
| March                    | 4.23                | 4.44                               | 4.12                          | 4.26                         |
| April                    | 6.49                | 5.97                               | 6.52                          | 6.33                         |
| May                      | 9.05                | 9.29                               | 9.51                          | 9.28                         |
| June                     | 10.51               | 9.18                               | 9.29                          | 9.66                         |
| July                     | 11.15               | 10.03                              | 10.12                         | 10.43                        |
| August                   | 9.45                | 8.36                               | 9.62                          | 9.14                         |
| September                | 7.15                | 7.54                               | 7.76                          | 7.48                         |
| October                  | 5.33                | 5.72                               | 5.54                          | 5.53                         |
| November                 | 2.23                | 2.66                               | 2.45                          | 2.45                         |
| December                 | 1.83                | 1.88                               | 1.77                          | 1.83                         |
| <b>Total</b>             | <b>71.01</b>        | <b>68.72</b>                       | <b>71.54</b>                  | <b>70.42</b>                 |
| <b>Percent of Normal</b> | <b>96</b>           | <b>111</b>                         | <b>98</b>                     | <b>101</b>                   |

**Station Locations**

|                            |                                                                                                                      |
|----------------------------|----------------------------------------------------------------------------------------------------------------------|
| <b>Wasco 7E</b>            | Section 6Q, T27S, R26E, MDB&M.<br>Equipment: USWB Class "A" evaporation pan in an irrigated pasture environment.     |
| <b>USDA Cotton Station</b> | Section 33F, T27S, R25E, MDB&M.<br>Equipment: USWB Class "A" evaporation pan in an irrigated grass turf environment. |
| <b>Greenlee's Pasture</b>  | Section 36N, T12N, R21W, SBB&M.<br>Equipment: USWB Class "A" evaporation pan in an irrigated pasture environment.    |

**Table 18. 1999 Irrigated Acreage, San Joaquin Valley Portion of Kern County**

| Crop                         | Acres <sup>(2)</sup> | Percent of Total | Consumptive                           |
|------------------------------|----------------------|------------------|---------------------------------------|
|                              |                      |                  | Water Use <sup>(1)</sup><br>(AF/Acre) |
| Alfalfa (including seed)     | 73,602               | 6.6              | 3.96                                  |
| Almonds                      | 118,699              | 10.7             | 2.79                                  |
| Apples                       | 4,716                | 0.4              | 2.66                                  |
| Apricots                     | 1,371                | 0.1              | 2.66                                  |
| Asparagus                    | 861                  | -                | 3.84                                  |
| Avocado                      | -                    | -                | 2.86                                  |
| Barley                       | 1,452                | 0.1              | 1.59                                  |
| Beans                        | 8,463                | 0.8              | 2.03                                  |
| Broccoli                     | 210                  | -                | 0.57                                  |
| Carrots                      | 19,876               | 1.8              | 0.63                                  |
| Citrus                       | 51,130               | 4.6              | 2.51                                  |
| Corn, Field & Sweet          | 29,521               | 2.7              | 2.68                                  |
| Cotton                       | 182,828              | 16.5             | 3.18                                  |
| Dry Farmed Grains, Pasture   | 66,505               | 6.0              | -                                     |
| Figs                         | 538                  | -                | 2.65                                  |
| Grapes                       | 131,926              | 11.9             | 1.95                                  |
| Guayale, Jojoba              | 31                   | -                | 2.01                                  |
| Idle, Fallow Lands           | 155,870              | 14.0             | -                                     |
| Kiwi                         | 280                  | -                | 2.04                                  |
| Lettuce                      | 2,932                | 0.3              | 0.34                                  |
| Melons, Squash, Cucumbers    | 5,071                | 0.5              | 1.69                                  |
| Misc. Deciduous Trees        | 3,237                | 0.3              | 2.65                                  |
| Misc. Field Crops            | 488                  | -                | 2.65                                  |
| Misc. Hay/Grain              | 38,353               | 3.5              | 1.73                                  |
| Misc. Subtropical Trees      | 407                  | -                | 2.51                                  |
| Misc. Vegetables             | 15,460               | 1.4              | 1.33                                  |
| Nursery                      | 5,808                | 0.5              | 4.02                                  |
| Oats                         | 1,091                | -                | 1.54                                  |
| Olives                       | 1,126                | 0.1              | 2.68                                  |
| Onions, Garlic               | 15,548               | 1.4              | 3.50                                  |
| Pasture, Turf                | 12,848               | 1.2              | 4.89                                  |
| Peaches, Nectarines          | 5,167                | 0.5              | 2.63                                  |
| Pears                        | 85                   | -                | 2.79                                  |
| Peas                         | -                    | -                | 1.48                                  |
| Peppers                      | 2,707                | 0.2              | 2.13                                  |
| Pistachios                   | 39,401               | 3.5              | 2.68                                  |
| Plums, Prunes                | 3,831                | 0.3              | 2.68                                  |
| Potatoes                     | 19,426               | 1.8              | 1.82                                  |
| Rice                         | 4,426                | 0.4              | 3.50                                  |
| Safflower                    | 12,944               | 1.2              | 2.55                                  |
| Sorghum/Milo                 | 1,159                | 0.1              | 2.49                                  |
| Sudan Grass                  | 1,694                | 0.2              | 2.20                                  |
| Sugar Beets                  | 5,009                | 0.5              | 3.60                                  |
| Tomatoes                     | 6,965                | 0.6              | 2.63                                  |
| Turnips                      | 56                   | -                | 1.70                                  |
| Walnuts                      | 1,621                | 0.1              | 2.29                                  |
| Wheat                        | 55,175               | 5.0              | 2.21                                  |
| <b>Total Irrigated Lands</b> | <b>887,540</b>       | <b>100.0</b>     | <b>2.48</b>                           |
| <b>Total Harvested Lands</b> | <b>954,045</b>       |                  |                                       |
| <b>Double Cropped</b>        | <b>19,378</b>        |                  |                                       |

Note: Double-cropped acreage is counted twice, since it is irrigated twice.

<sup>(1)</sup> Weighted average consumptive use of all crops.

<sup>(2)</sup> Excludes acreage in Arvin-Edison WSD/Wheeler Ridge-Maricopa WSD overlap area.

**Table 19. Average Applied Water Requirements for Various Crops, San Joaquin Valley Portion of Kern County (in acre-feet per acre)**

| <b>Crop</b>               | <b>Drip <sup>(1)</sup></b> | <b>Sprinkler <sup>(2)</sup></b> | <b>Row/Border <sup>(3)</sup></b> |
|---------------------------|----------------------------|---------------------------------|----------------------------------|
| Alfalfa                   |                            | 3.45-4.35                       | 3.5-5.15                         |
| Almonds                   | 2.85-4.10                  | 2.85-4.50                       | 2.85-4.50                        |
| Apples                    | 1.95-3.80                  | 3.40-4.75                       |                                  |
| Beans (dry)               |                            |                                 | 2.00-2.75                        |
| Carrots                   |                            | 1.75-2.45                       |                                  |
| Citrus                    | 2.05-3.75                  | 2.75-4.40                       | 3.50-4.50                        |
| Corn (field)              |                            |                                 | 3.00-5.00                        |
| Cotton                    |                            | 2.25-3.75                       | 2.45-3.75                        |
| Grapes                    | 2.00-4.00                  | 2.15-4.50                       | 2.35-4.85                        |
| Lettuce                   |                            |                                 | 1.50-2.50                        |
| Onions, Garlic            |                            | 1.00-2.65                       | 1.25-4.25                        |
| Melons, Squash, Cucumbers |                            |                                 | 2.00-3.40                        |
| Misc. Deciduous Trees     | 2.75-3.35                  | 3.00-4.00                       | 3.00-4.50                        |
| Nursery                   |                            |                                 | 2.25-3.50                        |
| Pasture, Irrigated        |                            | 3.50-4.50                       | 3.50-6.00                        |
| Pistachios                | 2.65-4.40                  | 2.35-3.35                       | 3.00-3.50                        |
| Potatoes                  |                            | 1.10-2.30                       |                                  |
| Small Grains              |                            | 1.00-2.50                       | 1.00-2.50                        |
| Tomatoes                  |                            |                                 | 2.50-3.50                        |
| Walnuts                   |                            |                                 | 3.50-5.00                        |

<sup>(1)</sup> Includes emitters, misters, mini-sprinklers and fan jets.

<sup>(2)</sup> Includes portables, solid-sets, linear moves, sprinkler guns.

<sup>(3)</sup> Border includes border strip, level basin, contour strip.

Note: A blank entry indicates that an irrigation system is generally not utilized on a crop.

**Table 20. 1999 Urban Water Use, San Joaquin Valley Portion of Kern County**

| Water Purveyor<br>Service area         | Metered<br>Connections | Non-metered<br>Connections | Annual Water Use |                | Permanent<br>Population | GPCD <sup>(1)</sup>       |
|----------------------------------------|------------------------|----------------------------|------------------|----------------|-------------------------|---------------------------|
|                                        |                        |                            | Million<br>Gals. | Acre<br>Feet   |                         |                           |
| <b><u>Arvin</u></b>                    |                        |                            |                  |                |                         |                           |
| Arvin CSD                              | 2,528                  | -                          | 848              | 2,602          | 11,500                  | 202                       |
| <b><u>Bakersfield Metro Area</u></b>   |                        |                            |                  |                |                         |                           |
| Airport Mutual WC                      | 70                     | -                          | 5                | 15             | 280                     | 49                        |
| California Water Service               |                        |                            |                  |                |                         |                           |
| Bakersfield Division                   | 19,117                 | 36,897                     | 19,455           | 59,701         | 173,431                 | 307                       |
| Ashe Water Division                    | 24,109                 | 216                        | 9,971            | 30,598         | 90,433                  | 302                       |
| Casa Loma WC <sup>(2)</sup>            | -                      | 215                        | -                | -              | 2,000                   | -                         |
| East Niles CSD                         | 6,488                  | -                          | 3,575            | 10,971         | 24,049                  | 407 ✓                     |
| Greenfield CWD                         | 728                    | 368                        | 363              | 1,114          | 6,200                   | 160                       |
| North of the River MWD                 | 472                    | 1,476                      | 794              | 2,437          | 7,000                   | 311                       |
| Oildale MWC                            | 537                    | 6,022                      | 2,292            | 7,033          | 22,000                  | 285 ✓                     |
| Rancho Verdugo WC                      | -                      | 300                        | -                | -              | 0                       | -                         |
| Stockdale MWC                          | -                      | 80                         | 65               | 198            | 191                     | 932                       |
| Stockdale Annex MWC                    | -                      | 142                        | 55               | 169            | 490                     | -                         |
| Vaughn WC                              | 5,200                  | 778                        | 2,802            | 8,598          | 16,900                  | 454 ✓                     |
| Victory MWC                            | -                      | 188                        | 66               | 203            | 432                     | 419                       |
| <b>Metro Area Subtotal</b>             | <b>56,721</b>          | <b>46,682</b>              | <b>39,443</b>    | <b>121,037</b> | <b>343,406</b>          | <b>321</b>                |
| <b><u>Buttonwillow</u></b>             |                        |                            |                  |                |                         |                           |
| Buttonwillow CWD                       | -                      | 465                        | 53               | 161            | 1,500                   | 97                        |
| <b><u>Delano</u></b>                   |                        |                            |                  |                |                         |                           |
| City of Delano                         | 3,385                  | 3,779                      | 2,860            | 8,776          | 34,466                  | 227                       |
| <b><u>Lamont</u></b>                   |                        |                            |                  |                |                         |                           |
| Lamont PUD and ID# 1                   | 367                    | 2,515                      | 1,944            | 5,966          | 14,677                  | 363                       |
| <b><u>Lost Hills</u></b>               |                        |                            |                  |                |                         |                           |
| Lost Hills Utility District            | 279                    | -                          | 100              | 307            | 1,291                   | 212 <sup>(3)</sup>        |
| <b><u>McFarland</u></b>                |                        |                            |                  |                |                         |                           |
| McFarland MWC                          | 1,791                  | -                          | 514              | 1,577          | 8,000                   | 176                       |
| <b><u>Rio Bravo</u></b>                |                        |                            |                  |                |                         |                           |
| Olcese WD <sup>(4)</sup>               | 472                    | -                          | 333              | 1,022          | 0                       | n/a <sup>(5)</sup>        |
| <b><u>Shafter</u></b>                  |                        |                            |                  |                |                         |                           |
| City of Shafter                        | 29                     | 4,000                      | 1,375            | 4,219          | 11,645                  | 323                       |
| <b><u>Taft-Maricopa-McKittrick</u></b> |                        |                            |                  |                |                         |                           |
| West Kern WD                           | 7,086                  | -                          | 4,902            | 15,043         | 17,500                  | 767 <sup>(3)</sup>        |
| <b><u>Wasco</u></b>                    |                        |                            |                  |                |                         |                           |
| City of Wasco                          | 145                    | 3,545                      | 1,365            | 4,189          | 17,500                  | 214                       |
| Wasco State Prison                     | 1,767                  | -                          | 318              | 976            | 7,150                   | 122                       |
| <b>Total</b>                           | <b>74,570</b>          | <b>60,986</b>              | <b>54,055</b>    | <b>165,875</b> | <b>468,635</b>          | <b>296 <sup>(6)</sup></b> |

(1) Gallons per capita per day. Note that the computed GPCD includes residential, commercial, industrial and public Authority water use.

(2) Casa Loma WC is reported by DHS

(3) Includes significant quantities of water used by oil companies.

(4) Per Cal Water Service: Olcese sold to CWS in 1999. 472 connections reported

(5) Water used to irrigate a golf course.

(6) Weighted average GPCD, excluding Rio Bravo, Lost Hills and Taft-Maricopa-McKittrick.

**Table 21. Surface\* and Groundwater Usage or Availability, San Joaquin Valley Portion of Kern County (in acre-feet)**

|      | Kern River |            | Other Local Water <sup>(1)</sup> |            | Central Valley Project |            | State Water Project |            | Groundwater |            | Total Supplies |
|------|------------|------------|----------------------------------|------------|------------------------|------------|---------------------|------------|-------------|------------|----------------|
|      | Available  | % of Total | Available                        | % of Total | Usage                  | % of Total | Usage               | % of Total | Usage       | % of Total |                |
| 1970 | 589,500    | 19.1       | 517,900                          | 16.8       | 351,400                | 11.4       | 204,600             | 6.6        | 1,422,000   | 46.1       | 3,085,400      |
| 1971 | 427,500    | 13.9       | 217,100                          | 7.1        | 348,900                | 11.4       | 375,500             | 12.2       | 1,700,000   | 55.4       | 3,069,000      |
| 1972 | 268,400    | 8.4        | 292,600                          | 9.2        | 238,500                | 7.5        | 535,600             | 16.8       | 1,857,000   | 58.2       | 3,192,100      |
| 1973 | 979,700    | 26.3       | 161,200                          | 4.3        | 412,200                | 11.0       | 515,500             | 13.8       | 1,662,000   | 44.6       | 3,730,600      |
| 1974 | 818,600    | 22.6       | 332,000                          | 9.2        | 480,600                | 13.3       | 651,800             | 18.0       | 1,333,000   | 36.9       | 3,616,000      |
| 1975 | 564,600    | 15.2       | 287,300                          | 7.8        | 442,100                | 11.9       | 821,700             | 22.2       | 1,587,000   | 42.9       | 3,702,700      |
| 1976 | 249,500    | 7.5        | 225,700                          | 6.8        | 226,500                | 6.8        | 883,400             | 26.6       | 1,738,000   | 52.3       | 3,323,100      |
| 1977 | 197,000    | 7.3        | 239,400                          | 8.9        | 121,500                | 4.5        | 429,400             | 16.0       | 1,703,000   | 63.3       | 2,690,300      |
| 1978 | 1,653,500  | 36.8       | 1,050,200                        | 23.3       | 357,800                | 8.0        | 611,500             | 13.6       | 825,000     | 18.3       | 4,498,000      |
| 1979 | 672,700    | 17.0       | 258,700                          | 6.6        | 462,500                | 11.7       | 1,291,800           | 32.7       | 1,260,000   | 31.9       | 3,945,700      |
| 1980 | 1,640,000  | 37.8       | 356,500                          | 8.2        | 462,800                | 10.7       | 900,300             | 20.8       | 977,000     | 22.5       | 4,336,600      |
| 1981 | 449,300    | 11.8       | 329,100                          | 8.7        | 470,000                | 12.4       | 1,384,700           | 36.5       | 1,161,000   | 30.6       | 3,794,100      |
| 1982 | 1,271,100  | 31.4       | 434,600                          | 10.7       | 656,600                | 16.2       | 884,500             | 21.8       | 802,200     | 19.8       | 4,049,000      |
| 1983 | 2,489,100  | 52.2       | 723,000                          | 15.2       | 550,900                | 11.6       | 238,200             | 5.0        | 762,700     | 16.0       | 4,763,900      |
| 1984 | 821,800    | 21.5       | 194,200                          | 5.1        | 425,400                | 11.1       | 1,123,000           | 29.4       | 1,252,200   | 32.8       | 3,816,600      |
| 1985 | 672,400    | 18.8       | 192,600                          | 5.4        | 337,500                | 9.5        | 1,074,100           | 30.1       | 1,293,800   | 36.2       | 3,570,400      |
| 1986 | 1,444,900  | 35.2       | 207,000                          | 5.0        | 589,300                | 14.4       | 913,600             | 22.3       | 947,600     | 23.1       | 4,102,400      |
| 1987 | 375,900    | 12.0       | 240,100                          | 7.6        | 292,000                | 9.3        | 1,025,900           | 32.6       | 1,208,700   | 38.5       | 3,142,600      |
| 1988 | 294,700    | 8.9        | 179,800                          | 5.4        | 292,800                | 8.8        | 1,006,200           | 30.4       | 1,540,200   | 46.5       | 3,313,700      |
| 1989 | 397,000    | 11.3       | 122,100                          | 3.5        | 293,900                | 8.4        | 1,097,200           | 31.4       | 1,588,500   | 45.4       | 3,498,700      |
| 1990 | 203,600    | 6.4        | 112,800                          | 3.6        | 200,100                | 6.3        | 857,300             | 27.0       | 1,796,500   | 56.7       | 3,170,300      |
| 1991 | 406,300    | 14.2       | 220,400                          | 7.7        | 204,400                | 7.1        | 32,700              | 1.1        | 2,002,400   | 69.9       | 2,866,200      |
| 1992 | 296,800    | 10.6       | 203,200                          | 7.3        | 208,000                | 7.4        | 418,000             | 14.9       | 1,673,600   | 59.8       | 2,799,600      |
| 1993 | 853,800    | 22.5       | 251,200                          | 6.6        | 489,800                | 12.9       | 1,205,500           | 31.8       | 987,700     | 26.1       | 3,788,000      |
| 1994 | 336,500    | 10.1       | 222,700                          | 6.7        | 186,300                | 5.6        | 695,400             | 20.8       | 1,897,700   | 56.8       | 3,338,600      |
| 1995 | 1,385,200  | 29.1       | 374,300                          | 7.9        | 647,100                | 13.6       | 1,111,200           | 23.3       | 1,242,800   | 26.1       | 4,760,600      |
| 1996 | 1,038,300  | 21.6       | 294,400                          | 6.1        | 611,300                | 12.7       | 1,247,200           | 26.0       | 1,609,600   | 33.5       | 4,800,800      |
| 1997 | 1,182,000  | 28.2       | 209,800                          | 5.0        | 630,000                | 15.1       | 1,072,200           | 25.6       | 1,091,400   | 26.1       | 4,185,400      |
| 1998 | 1,718,000  | 33.2       | 863,600                          | 16.7       | 466,500                | 9.0        | 839,200             | 16.2       | 1,290,200   | 24.9       | 5,177,500      |
| 1999 | 434,000    | 11.6       | 176,500                          | 4.7        | 350,500                | 9.4        | 1,315,900           | 35.1       | 1,471,500   | 39.3       | 3,748,400      |
| Avg. | 817,200    | 21.9       | 321,200                          | 8.6        | 395,100                | 10.6       | 808,500             | 21.7       | 1,386,600   | 37.2       | 3,728,500      |

\* Adjusted for deliveries within Kern County. SWP includes Intertie deliveries.

<sup>(1)</sup> Includes effective precipitation, minor stream flows and wastewater reuse.

**Table 22. Summary of Kern River-California Aqueduct Intertie Activity (in acre-feet)**

|              | Intertie Inflow  |                |                                 | Amount Exported |             |                | Retained in County |             |                               |
|--------------|------------------|----------------|---------------------------------|-----------------|-------------|----------------|--------------------|-------------|-------------------------------|
|              | Kern River       | Friant-Kern    | Total                           | Kern River      | Friant-Kern | Total          | Kern River         | Friant-Kern | Total                         |
| 1978         | 168,818          | 9,113          | 177,931                         | n/a*            | n/a*        | 113,831        | n/a*               | n/a*        | 64,100                        |
| 1980         | 138,816          | 0              | 138,816                         | 74,024          | 0           | 74,024         | 64,792             | 0           | 64,792                        |
| 1982         | 10,339           | 11,968         | 22,307                          | 5,928           | 2,700       | 8,628          | 4,411              | 9,268       | 13,679                        |
| 1983         | 662,856          | 96,200         | 759,056                         | n/a*            | n/a*        | 393,551        | n/a*               | n/a*        | 365,505                       |
| 1984         | 27,524           | 0              | 27,524                          | 13,885          | 0           | 13,885         | 13,639             | 0           | 13,639                        |
| 1986         | 1,867            | 15,580         | 17,447                          | 0               | 4,746       | 4,746          | 1,867              | 10,834      | 12,701                        |
| 1995         | (13,117)         | 0              | (13,117) <sup>(1)</sup>         | 0               | 0           | 0              | (13,117)           | 0           | (13,117) <sup>(1)</sup>       |
| 1997         | 1,793            | 51,055         | 52,848                          | 1,793           | 47,496      | 49,289         | 0                  | 5,352       | 5,352 <sup>(1)</sup>          |
| 1998         | 130,226          | 57,822         | 188,048                         | 130,226         | 57,822      | 188,048        | 0                  | 0           | 0                             |
| <b>Total</b> | <b>1,129,122</b> | <b>241,738</b> | <b>1,370,860</b> <sup>(2)</sup> |                 |             | <b>846,002</b> |                    |             | <b>526,651</b> <sup>(2)</sup> |

\* A breakdown between sources was not available.

<sup>(1)</sup> A major flood event north of Kern County caused SWP water to be reverse flowed into the Kern River flood channel. This is the opposite operation for which the Intertie was designed and constructed.

<sup>(2)</sup> The year 1995 is not included in totals.

Source: State Department of Water Resources and City of Bakersfield Kern River Annual Reports.

**Table 23. Summary of Groundwater Recharge Activities (in acre-feet)**

| Entity/Location                      | Source                         | 1971-94           | 1995             | 1996             | 1997           | 1998             | 1999             | Total             |
|--------------------------------------|--------------------------------|-------------------|------------------|------------------|----------------|------------------|------------------|-------------------|
| <b>BANKING</b>                       |                                |                   |                  |                  |                |                  |                  |                   |
| City of Bakersfield ***              |                                |                   |                  |                  |                |                  |                  |                   |
| 2,800 Acre Spreading Area            | Combined <sup>(1)</sup>        | 622,704           | 39,117           | 21,994           | 27,510         | 68,481           | 210              | 780,016           |
| Kern County Water Agency             |                                |                   |                  |                  |                |                  |                  |                   |
| Kern Water Bank                      | Combined <sup>(1)</sup>        | --                | 688              | 18,069           | --             | --               | --               | 18,757            |
| Pioneer Property                     | Combined <sup>(1)</sup>        | --                | 102,693          | 52,367           | 13,235         | 61,667           | 21,416           | 251,378           |
| Berrenda Mesa Spreading Area         | Combined <sup>(1)</sup>        | 43,856            | 34,280           | 9,554            | 6,565          | 20,349           | 1,904            | 116,508           |
| Kern River Channel                   | Combined <sup>(1)</sup>        | 60,046            | 2,029            | 6,179            | 5,883          | 458              | 2,003            | 76,598            |
| 2,800 Acre Spreading Area            | Combined <sup>(1)</sup>        | 229,018           | 73,337           | 16,612           | 875            | --               | --               | 319,842           |
| <b>Subtotal KCWA</b>                 |                                | <b>332,920</b>    | <b>213,027</b>   | <b>102,781</b>   | <b>26,558</b>  | <b>82,474</b>    | <b>25,323</b>    | <b>783,083</b>    |
| DWR-Kern Water Bank                  |                                |                   |                  |                  |                |                  |                  |                   |
| 2800 Acre Spreading Area             | SWP                            | 7,379             | --               | --               | --             | --               | --               | 7,379             |
| Local Elements In-lieu Rechg.        | SWP                            | 136,300           | --               | --               | --             | --               | --               | 136,300           |
| Local Elements Direct Rechg.         | SWP                            | 4,200             | --               | --               | --             | --               | --               | 4,200             |
| <b>Subtotal DWR</b>                  |                                | <b>147,879</b>    | <b>--</b>        | <b>--</b>        | <b>--</b>      | <b>--</b>        | <b>--</b>        | <b>147,879</b>    |
| Kern Water Bank Authority            |                                |                   |                  |                  |                |                  |                  |                   |
| Kern Water Bank                      | Combined <sup>(1)</sup>        | --                | 230,938          | 143,615          | 115,590        | 306,641          | 36,031           | 832,815           |
| 2800 Acres                           | Combined <sup>(1)</sup>        | --                | --               | --               | --             | --               | --               | --                |
| Pioneer Property                     | Combined <sup>(1)</sup>        | --                | --               | --               | --             | --               | --               | --                |
| <b>Subtotal KWBA</b>                 |                                | <b>--</b>         | <b>230,938</b>   | <b>143,615</b>   | <b>115,590</b> | <b>306,641</b>   | <b>36,031</b>    | <b>832,815</b>    |
| Semitropic WSD In-lieu               | SWP                            |                   |                  |                  |                |                  | 151,850          | 151,850           |
| Arvin-Edison WSD Direct              | SWP                            |                   |                  |                  |                |                  | 80,667           | 80,667            |
| In-lieu                              | SWP                            |                   |                  |                  |                |                  | 4,644            | 4,644             |
| <b>Total Banking</b>                 |                                | <b>1,103,503</b>  | <b>483,082</b>   | <b>268,390</b>   | <b>169,658</b> | <b>457,596</b>   | <b>298,725</b>   | <b>2,543,793</b>  |
| <b>CONJUNCTIVE USE</b>               |                                |                   |                  |                  |                |                  |                  |                   |
| Arvin-Edison WSD Direct Rechg.       | F-K                            | 847,583           | 108,664          | 51,954           | 73,151         | 49,000           | --               | 1,130,352         |
|                                      | SWP                            | --                | --               | --               | --             | --               | --               | --                |
| In-Lieu Rechg.                       | SWP                            | --                | --               | --               | --             | --               | --               | --                |
| Buena Vista WSD Direct Rechg.        | Combined <sup>(1)</sup>        | 1,471,926         | 128,203          | 81,156           | 52,831         | 89,321           | 13               | 1,823,450         |
|                                      | Kern                           | --                | --               | --               | --             | --               | 28,634           | 28,634            |
|                                      | SWP                            | --                | --               | --               | --             | --               | 7,640            | 7,640             |
|                                      | F-K                            | --                | --               | --               | --             | --               | 3,807            | 3,807             |
| In-Lieu Rechg.                       | Combined ***                   | --                | --               | --               | --             | --               | 15,617           | 15,617            |
|                                      | Kern                           | --                | --               | --               | --             | --               | 25,385           | 25,385            |
|                                      | SWP                            | --                | --               | --               | --             | --               | 75,529           | 75,529            |
|                                      | F-K                            | --                | --               | --               | --             | --               | 5,135            | 5,135             |
| Semitropic WSD Direct Rechg.         | SWP                            | 87,496            | 20,881           | 23,560           | 21,997         | 103,596          | 17,231           | 274,761           |
|                                      | Combined ***                   | --                | --               | --               | --             | --               | 273              | 273               |
|                                      | Kern                           | --                | --               | --               | --             | --               | 495              | 495               |
| In-Lieu Rechg.                       | SWP                            | 704,868           | 73,954           | 114,135          | 110,995        | 13,736           | 130,978          | 1,148,666         |
|                                      | F-K                            | --                | --               | --               | --             | --               | 1,383            | 1,383             |
|                                      | Combined <sup>(1)</sup>        | 7,289             | --               | --               | --             | 69,040           | --               | 76,329            |
| I.D. No. 4 Direct Rechg.             | Kern                           | 470,981           | 30,692           | 64,753           | 60,224         | 26,345           | 13,872           | 666,867           |
|                                      | SWP                            | 320,419           | 19,523           | 138              | --             | --               | 70,821           | 410,901           |
|                                      | F-K                            | 27,112            | 7,098            | 9,754            | 2,629          | 2,547            | 842              | 49,982            |
| Kern Delta WD Direct Rechg.          | Combined <sup>(1)</sup>        | 1,243,611         | 61,252           | 65,301           | 69,016         | 52,034           | 679              | 1,491,893         |
|                                      | Kern                           | --                | --               | --               | --             | --               | 53,636           | 53,636            |
|                                      | SWP                            | --                | --               | --               | --             | --               | 5,275            | 5,275             |
| North Kern WSD Direct Rechg.         | Kern                           | 1,540,419         | 242,263          | 121,233          | 137,340        | 264,694          | 52,010           | 2,357,959         |
|                                      | Combined ***                   | --                | --               | --               | --             | --               | 9,736            | 9,736             |
| In-Lieu Rechg.                       | Kern                           | 2,506,036         | 124,873          | 140,781          | 135,657        | 95,135           | 36,787           | 3,039,269         |
|                                      | SWP                            | --                | --               | --               | --             | --               | 67,922           | 67,922            |
|                                      | F-K                            | --                | --               | --               | --             | --               | 5,175            | 5,175             |
|                                      | Combined ***                   | --                | --               | --               | --             | --               | 239              | 239               |
| Rosedale-Rio Bravo WSD Direct Rechg. | Kern                           | 545,911           | 102,307          | 44,293           | 72,875         | 104,879          | 14,787           | 885,052           |
|                                      | SWP                            | 584,680           | 48,375           | 29,545           | 17,080         | 26,923           | 34,009           | 740,612           |
|                                      | F-K                            | 168,728           | 8,470            | 25,919           | 31,843         | 4,660            | 3,187            | 242,807           |
|                                      | Combined <sup>(1)</sup>        | 279,800           | --               | --               | --             | --               | --               | 279,800           |
| In-Lieu Rechg.                       | SWP                            | 2,657             | --               | --               | --             | --               | 10,344           | 13,001            |
|                                      | F-K                            | --                | --               | --               | --             | --               | --               | --                |
|                                      | Kern                           | --                | --               | --               | --             | --               | 354              | 354               |
| Rosedale Ranch ID Direct Rechg.      | Kern                           | --                | --               | --               | --             | --               | 413              | 413               |
| In-Lieu Rechg.                       | Kern                           | --                | --               | --               | --             | --               | 5,387            | 5,387             |
|                                      | SWP                            | --                | --               | --               | --             | --               | 121              | 121               |
| Wheeler Ridge-Maricopa WSD           | SWP                            | --                | --               | --               | --             | --               | 2,788            | 2,788             |
| In-Lieu Recharge                     | SWP                            | 200,596           | 12,650           | --               | --             | --               | --               | 213,246           |
| <b>Total Conjunctive Use</b>         |                                | <b>11,010,112</b> | <b>989,205</b>   | <b>772,522</b>   | <b>785,638</b> | <b>901,910</b>   | <b>700,504</b>   | <b>15,159,891</b> |
| <b>OVERDRAFT CORRECTION</b>          |                                |                   |                  |                  |                |                  |                  |                   |
| Groundwater Replenishment Programs   |                                |                   |                  |                  |                |                  |                  |                   |
| Direct Rechg.                        | Kern                           | 188,185           | --               | 5,365            | 10,084         | 58,321           | --               | 261,955           |
|                                      | SWP                            | 258,441           | --               | 38,795           | 1,912          | 3,129            | --               | 302,277           |
|                                      | F-K                            | 7,723             | --               | 4,396            | 6,969          | 3,144            | 2,070            | 24,302            |
| In Lieu Rechg.                       | Kern                           | 573               | 3,725            | 3,189            | 889            | 6,631            | --               | 15,007            |
|                                      | SWP                            | 98,065            | --               | --               | --             | --               | --               | 98,065            |
| <b>Total Overdraft Correction</b>    |                                | <b>552,987</b>    | <b>3,725</b>     | <b>51,745</b>    | <b>19,854</b>  | <b>71,225</b>    | <b>2,070</b>     | <b>701,606</b>    |
| <b>GRAND TOTALS</b>                  | <b>Kern</b>                    | <b>5,252,105</b>  | <b>503,860</b>   | <b>379,614</b>   | <b>417,069</b> | <b>556,005</b>   | <b>231,760</b>   | <b>7,340,413</b>  |
|                                      | <b>SWP</b>                     | <b>2,405,101</b>  | <b>175,383</b>   | <b>206,173</b>   | <b>151,984</b> | <b>147,384</b>   | <b>659,819</b>   | <b>3,745,844</b>  |
|                                      | <b>F-K</b>                     | <b>1,051,146</b>  | <b>124,232</b>   | <b>92,023</b>    | <b>114,592</b> | <b>59,351</b>    | <b>21,599</b>    | <b>1,462,943</b>  |
|                                      | <b>Combined <sup>(1)</sup></b> | <b>3,958,250</b>  | <b>672,537</b>   | <b>414,847</b>   | <b>291,505</b> | <b>667,991</b>   | <b>88,121</b>    | <b>6,093,251</b>  |
|                                      | <b>Total</b>                   | <b>12,666,602</b> | <b>1,476,012</b> | <b>1,092,657</b> | <b>975,150</b> | <b>1,430,731</b> | <b>1,001,299</b> | <b>18,642,451</b> |

<sup>(1)</sup> Breakdown between sources not available.

<sup>(2)</sup> Includes banking by Olcese WD, Hacienda WD, Buena Vista WSD, City of Bakersfield; for breakdown between districts see Table 24.

Note: For a breakdown of 1971 to 1994, see prior Water Supply Reports. These numbers may be revised from previous years Water Supply Reports.

Table 24. Groundwater Banking Summary

|                                                            | 1978    | 1979    | 1980     | 1981      | 1982    | 1983    | 1984    | 1985    | 1986    | 1987    | 1988    | 1989     |
|------------------------------------------------------------|---------|---------|----------|-----------|---------|---------|---------|---------|---------|---------|---------|----------|
| <b>Alameda County WD</b><br>(banking in STWSD)             |         |         |          |           |         |         |         |         |         |         |         |          |
| Recharge/Purchase                                          |         |         |          |           |         |         |         |         |         |         |         |          |
| Recovery/Sale                                              |         |         |          |           |         |         |         |         |         |         |         |          |
| Storage Balance                                            |         |         |          |           |         |         |         |         |         |         |         |          |
| <b>Belridge WSD</b>                                        |         |         |          |           |         |         |         |         |         |         |         |          |
| Recharge/Purchase                                          |         |         |          |           |         |         |         |         |         |         |         |          |
| Recovery/Sale                                              |         |         |          |           |         |         |         |         |         |         |         |          |
| Storage Balance                                            |         |         |          |           |         |         |         |         |         |         |         |          |
| <b>Buena Vista WSD</b>                                     |         |         |          |           |         |         |         |         |         |         |         |          |
| Recharge/Purchase                                          | 6,056   | 9,913   |          |           | 24,465  |         |         |         | 10,000  |         |         |          |
| Recovery/Sale                                              |         |         |          |           |         |         |         |         |         | (6,000) | (5,000) | (3,138)  |
| Storage Balance                                            | 6,056   | 15,969  | 15,969   | 15,969    | 40,434  | 40,434  | 40,434  | 40,434  | 50,434  | 44,434  | 39,434  | 36,296   |
| <b>Berrenda Mesa WD</b>                                    |         |         |          |           |         |         |         |         |         |         |         |          |
| Recharge/Purchase                                          |         |         |          | 9,500     |         |         |         |         |         |         |         |          |
| Recovery/Sale                                              |         |         |          |           |         |         |         |         |         |         |         |          |
| Storage Balance                                            |         |         |          | 9,500     | 9,500   | 9,500   | 9,500   | 9,500   | 9,500   | 9,500   | 9,500   | 9,500    |
| <b>Cawelo WD</b>                                           |         |         |          |           |         |         |         |         |         |         |         |          |
| Recharge/Purchase                                          |         |         |          |           |         |         |         |         |         |         |         |          |
| Recovery/Sale                                              |         |         |          |           |         |         |         |         |         |         |         |          |
| Storage Balance                                            |         |         |          |           |         |         |         |         |         |         |         |          |
| <b>City of Bakersfield</b>                                 |         |         |          |           |         |         |         |         |         |         |         |          |
| Recharge/Purchase                                          | 104,587 | 4,505   | 68,804   | 2,603     | 37,913  | 113,380 | 16,058  | 402     | 64,168  | 109     |         |          |
| Recovery/Sale                                              |         |         | (13,772) | (100,837) |         |         | (472)   | (1,615) |         | (656)   | (5,432) | (2,859)  |
| Storage Balance                                            | 104,587 | 109,092 | 164,124  | 65,890    | 103,803 | 217,183 | 232,769 | 231,556 | 295,724 | 295,177 | 289,745 | 286,886  |
| <b>Dudley Ridge WD</b>                                     |         |         |          |           |         |         |         |         |         |         |         |          |
| Recharge/Purchase                                          |         |         |          |           |         |         |         |         |         |         |         |          |
| Recovery/Sale                                              |         |         |          |           |         |         |         |         |         |         |         |          |
| Storage Balance                                            |         |         |          |           |         |         |         |         |         |         |         |          |
| <b>Henry Miller WD</b>                                     |         |         |          |           |         |         |         |         |         |         |         |          |
| Recharge/Purchase                                          |         |         |          |           |         |         |         |         |         |         |         |          |
| Recovery/Sale                                              |         |         |          |           |         |         |         |         |         |         |         |          |
| Storage Balance                                            |         |         |          |           |         |         |         |         |         |         |         |          |
| <b>Improvement District No. 4</b>                          |         |         |          |           |         |         |         |         |         |         |         |          |
| Recharge/Purchase                                          |         |         |          |           |         |         |         |         | 12,766  |         |         | 3,500    |
| Recovery/Sale                                              |         |         |          |           |         |         |         |         |         |         |         |          |
| Storage Balance                                            |         |         |          |           |         |         |         |         | 12,766  | 12,766  | 12,766  | 16,266   |
| <b>Kern County Water Agency</b>                            |         |         |          |           |         |         |         |         |         |         |         |          |
| Recharge/Purchase                                          |         |         |          | 63,364    |         | 14,155  | 416     | 15,055  | 29,389  |         |         |          |
| Recovery/Sale                                              |         |         |          |           |         |         |         |         |         |         |         | (16,105) |
| Storage Balance                                            |         |         |          | 63,364    | 63,364  | 77,519  | 77,935  | 92,990  | 122,379 | 122,379 | 122,379 | 106,274  |
| <b>Kern Delta WD</b>                                       |         |         |          |           |         |         |         |         |         |         |         |          |
| Recharge/Purchase                                          |         |         |          |           |         |         |         |         |         |         |         |          |
| Recovery/Sale                                              |         |         |          |           |         |         |         |         |         |         |         |          |
| Storage Balance                                            |         |         |          |           |         |         |         |         |         |         |         |          |
| <b>Lost Hills WD</b>                                       |         |         |          |           |         |         |         |         |         |         |         |          |
| Recharge/Purchase                                          |         |         |          |           |         |         |         |         |         |         |         |          |
| Recovery/Sale                                              |         |         |          |           |         |         |         |         |         |         |         |          |
| Storage Balance                                            |         |         |          |           |         |         |         |         |         |         |         |          |
| <b>Metropolitan WD of So. Calif.</b><br>(banking in AEWS)  |         |         |          |           |         |         |         |         |         |         |         |          |
| Recharge/Purchase                                          |         |         |          |           |         |         |         |         |         |         |         |          |
| Recovery/Sale                                              |         |         |          |           |         |         |         |         |         |         |         |          |
| Storage Balance                                            |         |         |          |           |         |         |         |         |         |         |         |          |
| <b>Metropolitan WD of So. Calif.</b><br>(banking in STWSD) |         |         |          |           |         |         |         |         |         |         |         |          |
| Recharge/Purchase                                          |         |         |          |           |         |         |         |         |         |         |         |          |
| Recovery/Sale                                              |         |         |          |           |         |         |         |         |         |         |         |          |
| Storage Balance                                            |         |         |          |           |         |         |         |         |         |         |         |          |
| <b>OlceseWD/Hacienda WD</b>                                |         |         |          |           |         |         |         |         |         |         |         |          |
| Recharge/Purchase                                          | 24,328  |         | 52,604   | 4,465     | 14,266  |         |         |         | 56,197  | 5,344   | 3,214   |          |
| Recovery/Sale                                              |         |         |          |           |         |         |         |         |         |         |         | (873)    |
| Storage Balance                                            | 24,328  | 24,328  | 76,932   | 81,397    | 95,663  | 95,663  | 95,663  | 95,663  | 151,860 | 157,204 | 160,418 | 159,545  |
| <b>Rosedale-Rio Bravo WSD</b>                              |         |         |          |           |         |         |         |         |         |         |         |          |
| Recharge/Purchase                                          |         |         |          |           |         |         |         |         |         |         |         |          |
| Recovery/Sale                                              |         |         |          |           |         |         |         |         |         |         |         |          |
| Storage Balance                                            |         |         |          |           |         |         |         |         |         |         |         |          |
| <b>Semitropic WSD</b>                                      |         |         |          |           |         |         |         |         |         |         |         |          |
| Recharge/Purchase                                          |         |         |          |           |         |         |         |         |         |         |         |          |
| Recovery/Sale                                              |         |         |          |           |         |         |         |         |         |         |         |          |
| Storage Balance                                            |         |         |          |           |         |         |         |         |         |         |         |          |
| <b>Santa Clara Valley WD</b>                               |         |         |          |           |         |         |         |         |         |         |         |          |
| Recharge/Purchase                                          |         |         |          |           |         |         |         |         |         |         |         |          |
| Recovery/Sale                                              |         |         |          |           |         |         |         |         |         |         |         |          |
| Storage Balance                                            |         |         |          |           |         |         |         |         |         |         |         |          |
| <b>State of California</b>                                 |         |         |          |           |         |         |         |         |         |         |         |          |
| Recharge/Purchase                                          |         |         |          |           |         |         |         |         |         | 7,379   |         |          |
| Recovery/Sale                                              |         |         |          |           |         |         |         |         |         |         |         |          |
| Storage Balance                                            |         |         |          |           |         |         |         |         |         | 7,379   | 7,379   | 7,379    |
| <b>Tejon-Castac WD</b>                                     |         |         |          |           |         |         |         |         |         |         |         |          |
| Recharge/Purchase                                          |         |         |          |           |         |         |         |         |         |         |         |          |
| Recovery/Sale                                              |         |         |          |           |         |         |         |         |         |         |         |          |
| Storage Balance                                            |         |         |          |           |         |         |         |         |         |         |         |          |
| <b>Westside Mutual Water Co.</b>                           |         |         |          |           |         |         |         |         |         |         |         |          |
| Recharge/Purchase                                          |         |         |          |           |         |         |         |         |         |         |         |          |
| Recovery/Sale                                              |         |         |          |           |         |         |         |         |         |         |         |          |
| Storage Balance                                            |         |         |          |           |         |         |         |         |         |         |         |          |
| <b>Wheeler Ridge-Maricopa WSD</b>                          |         |         |          |           |         |         |         |         |         |         |         |          |
| Recharge/Purchase                                          |         |         |          | 5,600     |         |         |         |         |         |         |         | 15,019   |
| Recovery/Sale                                              |         |         |          |           |         |         |         |         |         |         |         |          |
| Storage Balance                                            |         |         |          | 5,600     | 5,600   | 5,600   | 5,600   | 5,600   | 5,600   | 5,600   | 5,600   | 20,619   |
| <b>Total of All Accounts</b>                               |         |         |          |           |         |         |         |         |         |         |         |          |
| Recharge/Purchase                                          | 134,971 | 14,418  | 121,408  | 85,532    | 76,644  | 127,535 | 16,474  | 15,457  | 172,520 | 12,832  | 3,214   | 18,519   |

Table 24 (continued). Groundwater Banking Summary

|                                                         | 1990      | 1991     | 1992     | 1993    | 1994     | 1995    | 1996     | 1997    | 1998     | 1999    | Total     |
|---------------------------------------------------------|-----------|----------|----------|---------|----------|---------|----------|---------|----------|---------|-----------|
| <b>Alameda County WD</b> (banking in STWSD)             |           |          |          |         |          |         |          |         |          |         |           |
| Recharge/Purchase                                       |           |          |          |         |          |         | 5,580    | 10,000  | 9,750    | 39,010  | 64,340    |
| Recovery/Sale                                           |           |          |          |         |          |         |          |         |          |         |           |
| Storage Balance                                         |           |          |          |         |          |         | 5,580    | 15,580  | 25,330   | 64,340  | 64,340    |
| <b>Belridge WSD</b>                                     |           |          |          |         |          |         |          |         |          |         |           |
| Recharge/Purchase                                       |           |          |          | 14,204  | 325      | 15,642  | 3,942    | 2,196   | 13,204   | 3,234   | 52,747    |
| Recovery/Sale                                           |           |          |          |         | (2,029)  |         |          |         |          |         | (2,029)   |
| Storage Balance                                         |           |          |          | 14,204  | 12,500   | 28,142  | 32,084   | 34,280  | 47,484   | 50,718  | 50,718    |
| <b>Buena Vista WSD</b>                                  |           |          |          |         |          |         |          |         |          |         |           |
| Recharge/Purchase                                       |           |          |          | 7,849   |          | 27,535  | 20,000   | 215     | 15,875   | 210     | 122,118   |
| Recovery/Sale                                           | (2,242)   | (4,410)  | (4,004)  |         |          |         |          |         |          |         | (24,794)  |
| Storage Balance                                         | 34,054    | 29,644   | 25,640   | 33,489  | 33,489   | 61,024  | 81,024   | 81,239  | 97,114   | 97,324  | 97,324    |
| <b>Berrenda Mesa WD</b>                                 |           |          |          |         |          |         |          |         |          |         |           |
| Recharge/Purchase                                       |           | 4,002    |          | 7,936   | 6,568    | 59,819  | 4,686    | 7,125   | 29,065   | 3,426   | 132,127   |
| Recovery/Sale                                           | (9,500)   | (4,002)  |          |         | (400)    |         |          |         |          |         | (13,902)  |
| Storage Balance                                         |           |          |          | 7,936   | 14,104   | 73,923  | 78,609   | 85,734  | 114,799  | 118,225 | 118,225   |
| <b>Cawelo WD</b>                                        |           |          |          |         |          |         |          |         |          |         |           |
| Recharge/Purchase                                       |           |          |          | 14,068  |          | 3,245   | 2,000    |         |          |         | 19,313    |
| Recovery/Sale                                           |           |          |          |         | (44)     |         |          |         |          |         | (44)      |
| Storage Balance                                         |           |          |          | 14,068  | 14,024   | 17,269  | 19,269   | 19,269  | 19,269   | 19,269  | 19,269    |
| <b>City of Bakersfield</b>                              |           |          |          |         |          |         |          |         |          |         |           |
| Recharge/Purchase                                       |           |          |          | 32      |          | 13,089  | 300      | 16,635  | 52,606   |         | 495,191   |
| Recovery/Sale                                           | (23,318)  | (57,159) | (30,266) |         | (8,311)  | (1,297) | (1,781)  | (618)   | (30,269) | (6,741) | (285,403) |
| Storage Balance                                         | 263,568   | 206,409  | 176,143  | 176,175 | 167,864  | 179,656 | 178,175  | 194,192 | 216,529  | 223,270 | 223,270   |
| <b>Dudley Ridge WD</b>                                  |           |          |          |         |          |         |          |         |          |         |           |
| Recharge/Purchase                                       |           |          |          |         |          | 1,587   | 20,748   | 10,246  | 22,721   | 1,307   | 56,609    |
| Recovery/Sale                                           |           |          |          |         |          |         |          |         |          |         |           |
| Storage Balance                                         |           |          |          |         |          | 1,587   | 22,335   | 32,581  | 55,302   | 56,609  | 56,609    |
| <b>Henry Miller WD</b>                                  |           |          |          |         |          |         |          |         |          |         |           |
| Recharge/Purchase                                       |           |          |          |         |          | 3,999   | 5,223    | 664     | 1,885    | 1,483   | 13,254    |
| Recovery/Sale                                           |           |          |          |         |          |         |          |         |          |         |           |
| Storage Balance                                         |           |          |          |         |          | 3,999   | 9,222    | 9,886   | 11,771   | 13,254  | 13,254    |
| <b>Improvement District No. 4</b>                       |           |          |          |         |          |         |          |         |          |         |           |
| Recharge/Purchase                                       |           |          |          | 23,007  | 10,641   | 92,765  | 71,851   | 6,720   | 39,373   | 77      | 260,700   |
| Recovery/Sale                                           |           |          | (3,500)  |         | (100)    | (1,500) |          |         |          |         | (5,100)   |
| Storage Balance                                         | 16,266    | 16,266   | 12,766   | 35,773  | 46,314   | 137,579 | 209,430  | 216,150 | 255,523  | 255,600 | 255,600   |
| <b>Kern County Water Agency</b>                         |           |          |          |         |          |         |          |         |          |         |           |
| Recharge/Purchase                                       |           | 42,096   | 6,450    | 5,542   |          | 28,999  | 45,069   |         | 6,690    | 8,104   | 265,329   |
| Recovery/Sale                                           |           | (66,775) | (22,684) |         |          |         |          |         |          |         | (105,564) |
| Storage Balance                                         | 106,274   | 81,595   | 65,361   | 70,903  | 70,903   | 99,902  | 144,971  | 144,971 | 151,661  | 159,765 | 159,765   |
| <b>Kern Delta WD</b>                                    |           |          |          |         |          |         |          |         |          |         |           |
| Recharge/Purchase                                       |           |          |          |         |          |         |          |         | 647      | 534     | 1,181     |
| Recovery/Sale                                           |           |          |          |         |          |         |          |         |          |         |           |
| Storage Balance                                         |           |          |          |         |          |         |          |         | 647      | 1,181   | 1,181     |
| <b>Lost Hills WD</b>                                    |           |          |          |         |          |         |          |         |          |         |           |
| Recharge/Purchase                                       |           | 2,035    |          | 31,153  | 5,280    | 26,191  | 8,079    | 10,898  | 18,633   | 5,275   | 107,544   |
| Recovery/Sale                                           |           |          |          |         |          |         |          |         |          |         |           |
| Storage Balance                                         |           | 2,035    | 2,035    | 33,188  | 38,468   | 64,659  | 72,738   | 83,636  | 102,269  | 107,544 | 107,544   |
| <b>Metropolitan WD of So. Calif.</b> (banking in AEWS)  |           |          |          |         |          |         |          |         |          |         |           |
| Recharge/Purchase                                       |           |          |          |         |          |         |          | 1,332   | 26,466   | 85,311  | 113,109   |
| Recovery/Sale                                           |           |          |          |         |          |         |          |         |          |         |           |
| Storage Balance                                         |           |          |          |         |          |         |          | 1,332   | 27,798   | 113,109 | 113,109   |
| <b>Metropolitan WD of So. Calif.</b> (banking in STWSD) |           |          |          |         |          |         |          |         |          |         |           |
| Recharge/Purchase                                       |           |          |          | 50,000  |          | 45,000  | 85,499   | 156,220 | 39,500   | 75,850  | 452,069   |
| Recovery/Sale                                           |           |          |          |         |          |         |          |         |          |         |           |
| Storage Balance                                         |           |          |          | 50,000  | 50,000   | 95,000  | 180,499  | 336,719 | 376,219  | 452,069 | 452,069   |
| <b>OlceseWD/Hacienda WD</b>                             |           |          |          |         |          |         |          |         |          |         |           |
| Recharge/Purchase                                       |           | 22,096   | 6,450    |         |          | 6,028   | 1,694    | 10,000  |          |         | 206,686   |
| Recovery/Sale                                           | (104,305) | (23,496) | (6,450)  |         | (1,160)  |         |          |         |          |         | (136,284) |
| Storage Balance                                         | 55,240    | 53,840   | 53,840   | 53,840  | 52,680   | 58,708  | 60,402   | 70,402  | 70,402   | 70,402  | 70,402    |
| <b>Rosedale-Rio Bravo WSD</b>                           |           |          |          |         |          |         |          |         |          |         |           |
| Recharge/Purchase                                       |           |          |          |         |          | 6,355   | 14,342   | 2,288   |          |         | 22,985    |
| Recovery/Sale                                           |           |          |          |         |          |         | (12,265) |         |          |         | (12,265)  |
| Storage Balance                                         |           |          |          |         |          | 6,355   | 8,432    | 10,720  | 10,720   | 10,720  | 10,720    |
| <b>Semitropic WSD</b>                                   |           |          |          |         |          |         |          |         |          |         |           |
| Recharge/Purchase                                       |           |          |          | 19,972  |          | 1,100   | 29,945   | 35,310  | 16,458   | 19,784  | 122,569   |
| Recovery/Sale                                           |           |          |          |         | (181)    |         |          |         |          |         | (181)     |
| Storage Balance                                         |           |          |          | 19,972  | 19,791   | 20,891  | 50,836   | 86,146  | 102,604  | 122,388 | 122,388   |
| <b>Santa Clara County FC&amp;WD</b> (banking in STWSD)  |           |          |          |         |          |         |          |         |          |         |           |
| Recharge/Purchase                                       |           |          |          |         |          |         | 40,500   | 35,000  | 23,800   | 30,000  | 129,300   |
| Recovery/Sale                                           |           |          |          |         |          |         |          |         |          |         |           |
| Storage Balance                                         |           |          |          |         |          |         | 40,500   | 75,500  | 99,300   | 129,300 | 129,300   |
| <b>State of California</b>                              |           |          |          |         |          |         |          |         |          |         |           |
| Recharge/Purchase                                       | 248,005   |          |          |         |          |         |          |         |          |         | 255,384   |
| Recovery/Sale                                           |           |          | (72,049) |         | (12,458) | (752)   | (41,563) |         |          |         | (126,822) |
| Storage Balance                                         | 255,384   | 255,384  | 183,335  | 183,335 | 170,877  | 170,125 | 128,562  | 128,562 | 128,562  | 128,562 | 128,562   |
| <b>Tejon-Castac WD</b>                                  |           |          |          |         |          |         |          |         |          |         |           |
| Recharge/Purchase                                       |           |          |          |         | 70       | 2,324   | 6,211    | 1,675   | 5,795    | 359     | 16,434    |
| Recovery/Sale                                           |           |          |          |         |          |         |          |         |          |         |           |
| Storage Balance                                         |           |          |          |         | 70       | 2,394   | 8,605    | 10,280  | 16,075   | 16,434  | 16,434    |
| <b>Westside Mutual Water Co.</b>                        |           |          |          |         |          |         |          |         |          |         |           |
| Recharge/Purchase                                       |           |          |          |         |          | 134,517 | 65,321   | 51,183  | 150,920  | 7,883   | 409,824   |
| Recovery/Sale                                           |           |          |          |         |          |         | (5,000)  |         |          |         | (5,000)   |
| Storage Balance                                         |           |          |          |         |          | 134,517 | 194,838  | 246,021 | 396,941  | 404,824 | 404,824   |
| <b>Wheeler Ridge-Maricopa WSD</b>                       |           |          |          |         |          |         |          |         |          |         |           |
| Recharge/Purchase                                       |           |          |          | 58,290  |          | 61,387  | 27,807   | 14,232  | 83,634   | 9,888   | 275,857   |
| Recovery/Sale                                           |           |          |          |         | (7,551)  |         |          |         |          |         | (7,551)   |
| Storage Balance                                         | 20,619    | 20,619   | 20,619   | 78,909  | 71,358   | 132,745 | 160,552  | 174,784 | 258,418  | 268,306 | 268,306   |
| <b>Total of All Accounts</b>                            |           |          |          |         |          |         |          |         |          |         |           |
| Recharge/Purchase                                       | 248,005   | 70,229   | 12,900   | 232,053 | 22,884   | 529,582 | 458,797  | 371,939 | 557,022  | 291,735 | 3,594,670 |

**Table 25. Areal Extent of Shallow Groundwater, San Joaquin Valley Portion of Kern County (in acres)**

| Year | Summer Measurements |          |           |                        |                        |                    | Winter Measurements |          |           |                       |                     |                |
|------|---------------------|----------|-----------|------------------------|------------------------|--------------------|---------------------|----------|-----------|-----------------------|---------------------|----------------|
|      | 0-5 ft.             | 5-10 ft. | 10-15 ft. | 15-20 ft.              | Total Within 20 ft.    | No. of Piezo's     | 0-5 ft.             | 5-10 ft. | 10-15 ft. | 15-20 ft.             | Total Within 20 ft. | No. of Piezo's |
| 1976 | 27,940              | 64,700   | --        | 79,680 <sup>(1)</sup>  | 172,320                | --                 | --                  | --       | --        | --                    | --                  | --             |
| 1977 | 19,320              | 68,980   | --        | 95,960 <sup>(1)</sup>  | 184,260                | 180                | 16,930              | 52,530   | --        | 67,300 <sup>(3)</sup> | 136,760             | 143            |
| 1978 | 27,680              | 65,760   | --        | 87,920 <sup>(1)</sup>  | 181,360                | 174                | 9,600               | 59,520   | --        | 86,400 <sup>(3)</sup> | 155,520             | --             |
| 1979 | 30,270              | 67,310   | --        | 95,870 <sup>(1)</sup>  | 193,450                | --                 | 15,320              | 83,200   | --        | 80,640 <sup>(3)</sup> | 179,160             | 126            |
| 1980 | 74,357              | 82,787   | --        | 125,883 <sup>(1)</sup> | 283,027                | --                 | 45,882              | 92,998   | 126,665   | 62,578                | 328,123             | 154            |
| 1981 | 62,002              | 85,556   | --        | 128,323 <sup>(1)</sup> | 275,881                | 178                | 46,746              | 75,318   | 36,736    | 104,200               | 263,000             | 168            |
| 1982 | 78,725              | 95,615   | 76,271    | 30,226                 | 280,837                | 259                | 90,658              | 85,541   | 55,392    | 43,181                | 274,772             | 199            |
| 1983 | 109,915             | 90,090   | 63,510    | 48,980                 | 312,495                | 227                | --                  | --       | --        | --                    | --                  | --             |
| 1984 | 110,500             | 57,650   | 45,400    | 47,649                 | 261,199                | 246                | --                  | --       | --        | --                    | --                  | --             |
| 1985 | 49,396              | 120,396  | 123,776   | 90,323                 | 383,891                | 290                | --                  | --       | --        | --                    | --                  | --             |
| 1986 | 84,160              | 79,774   | 73,698    | 83,264                 | 320,896                | 330                | --                  | --       | --        | --                    | --                  | --             |
| 1987 | 57,600              | 84,864   | 89,816    | 76,672                 | 308,952                | 261                | 90,800              | 74,100   | 61,200    | 72,200                | 298,300             | --             |
| 1988 | 82,700              | 86,500   | 83,900    | 93,400                 | 346,500                | 288                | --                  | --       | --        | --                    | --                  | --             |
| 1989 | 65,536              | 95,949   | 83,558    | 85,760                 | 330,803                | 328                | --                  | --       | --        | --                    | --                  | --             |
| 1990 | 67,561              | 91,257   | 82,823    | -- <sup>(2)</sup>      | 241,641 <sup>(3)</sup> | 350                | --                  | --       | --        | --                    | --                  | --             |
| 1991 | 40,363              | 101,888  | 45,141    | -- <sup>(2)</sup>      | 187,392 <sup>(3)</sup> | 351                | --                  | --       | --        | --                    | --                  | --             |
| 1992 | 9,954               | 102,114  | 46,287    | -- <sup>(2)</sup>      | 158,355 <sup>(3)</sup> | 344                | --                  | --       | --        | --                    | --                  | --             |
| 1993 | 25,184              | 97,357   | 46,893    | -- <sup>(2)</sup>      | 169,434 <sup>(3)</sup> | 518                | --                  | --       | --        | --                    | --                  | --             |
| 1994 | 19,176              | 106,506  | 69,362    | -- <sup>(2)</sup>      | 195,044 <sup>(3)</sup> | 422                | --                  | --       | --        | --                    | --                  | --             |
| 1995 | 96,431              | 82,231   | 57,427    | 55,416                 | 291,505                | 377                | --                  | --       | --        | --                    | --                  | --             |
| 1996 | 27,117              | 157,484  | 68,300    | 65,176                 | 318,077                | 398                | --                  | --       | --        | --                    | --                  | --             |
| 1997 | 29,597              | 146,439  | 58,702    | 62,982                 | 297,720                | 240 <sup>(2)</sup> | --                  | --       | --        | --                    | --                  | --             |
| 1998 | 40,702              | 121,414  | 37,566    | 88,523                 | 288,205                | 273                | --                  | --       | --        | --                    | --                  | --             |
| 1999 | 37,016              | 119,333  | 56,017    | 71,638                 | 284,004                | 264                | --                  | --       | --        | --                    | --                  | --             |

<sup>(1)</sup> 10-20 ft. measurement.

<sup>(2)</sup> Data insufficient to establish a 20 foot contour. Total is area within 15 feet.

<sup>(3)</sup> No 15 foot contour established. Total is within 20 feet.

<sup>(4)</sup> Some cooperators did not report shallow groundwater data in 1997.

-- Data not available.

Note: Annual changes in shallow Groundwater area may be perceived rather than real, due to increases in the number of monitoring wells used to prepare the maps. More monitoring wells may have provided better coverage, allowing for a more accurate map to be produced.

Figure 1. The Hydrologic Cycle)

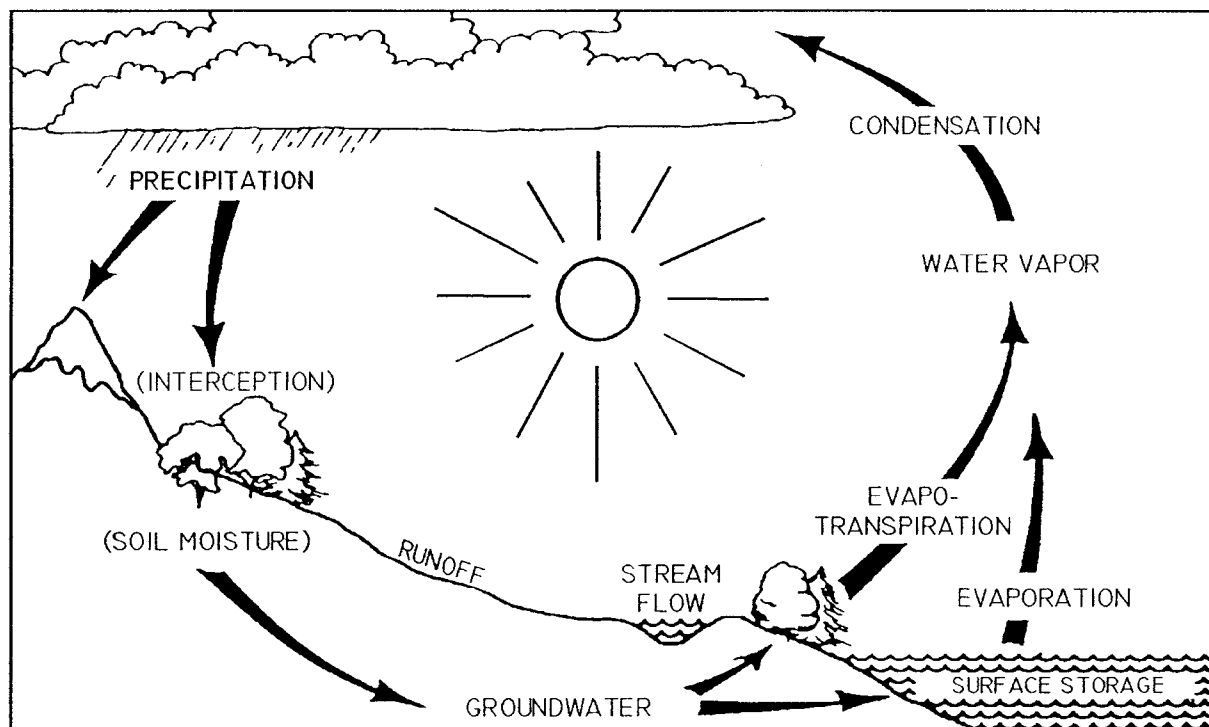


Figure 2. Sacramento River Indices

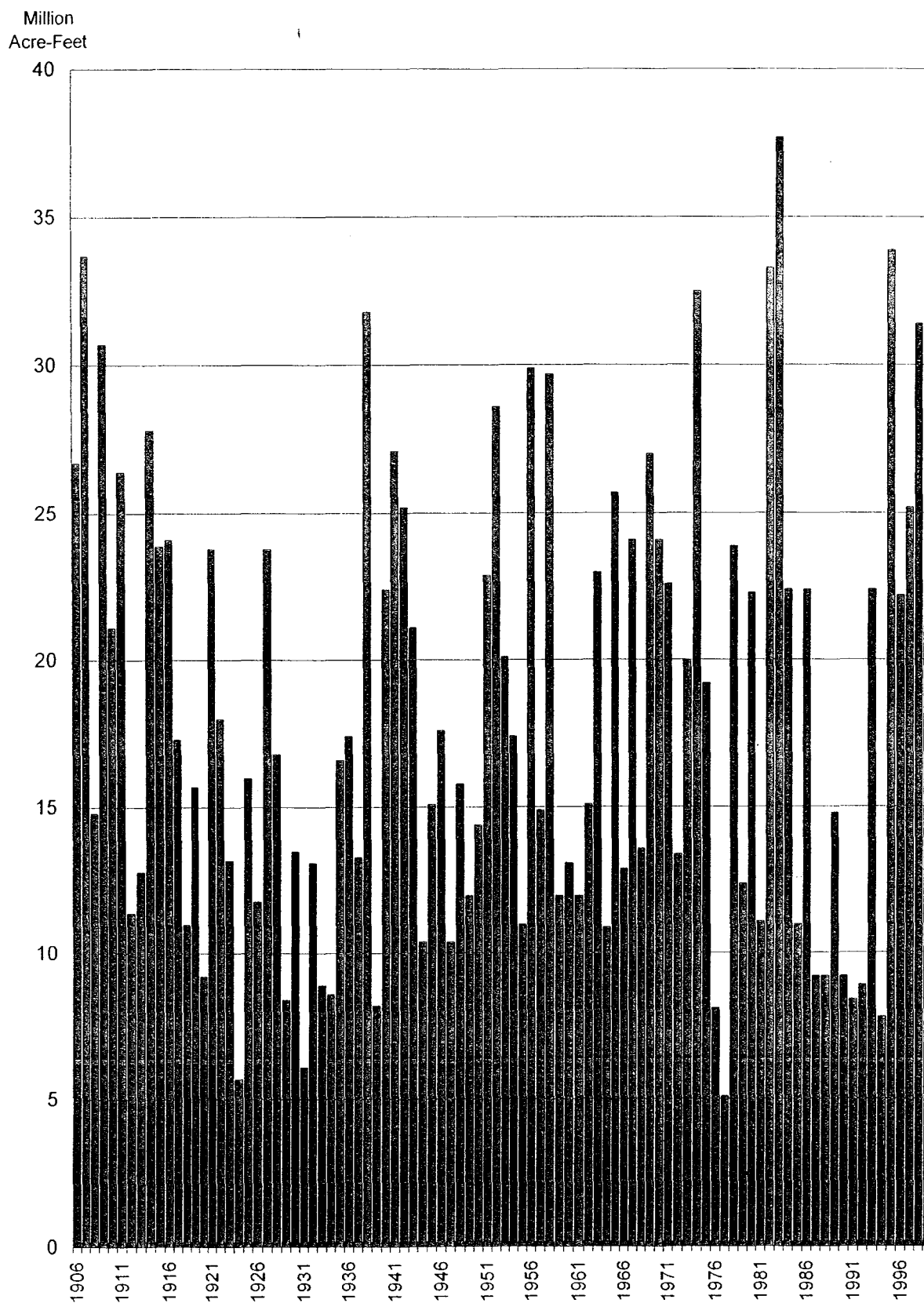


Figure 3. State Water Project Deliveries to Kern County Water Agency

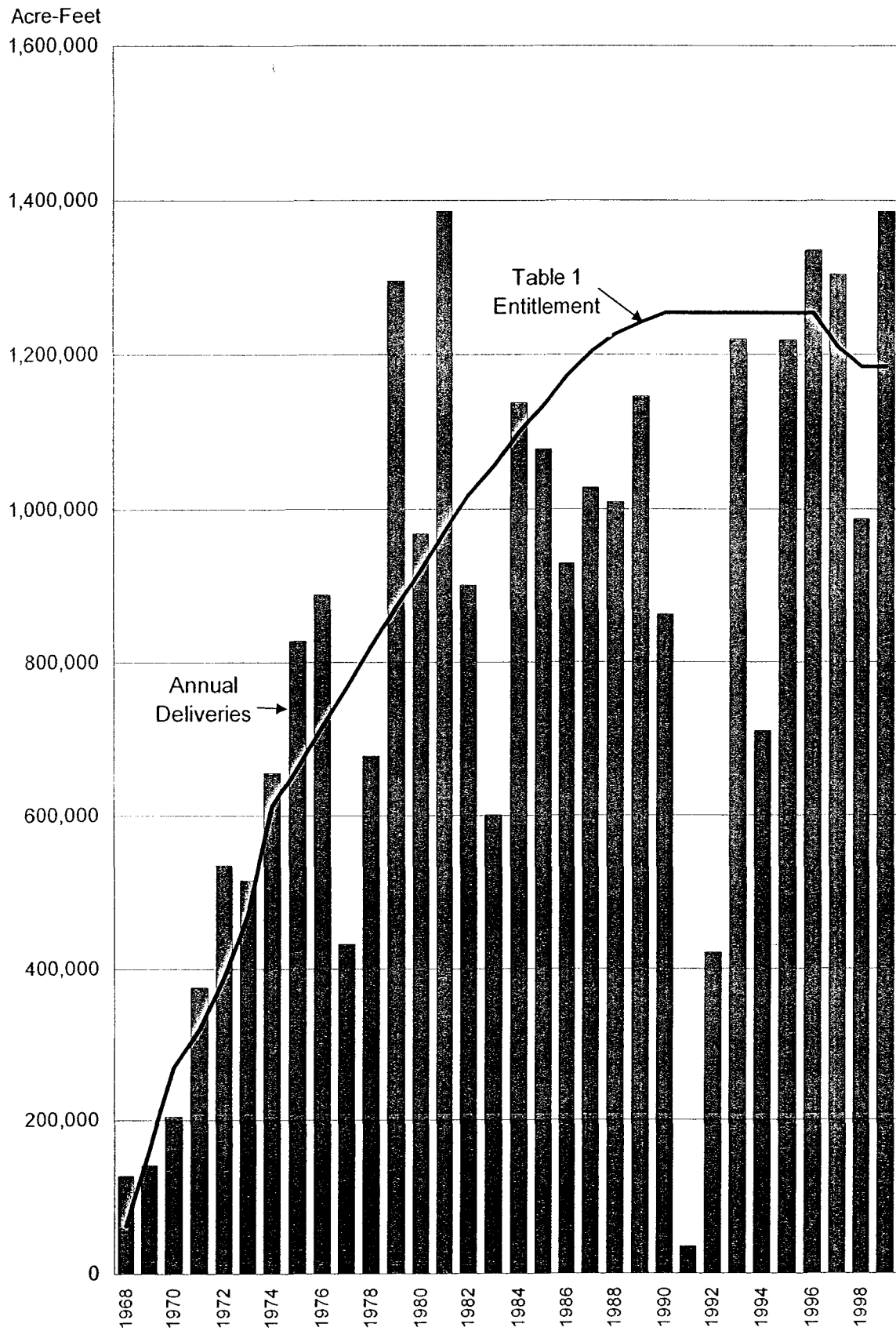


Figure 4. Kern River Regulated Flows at First Point of Measurement

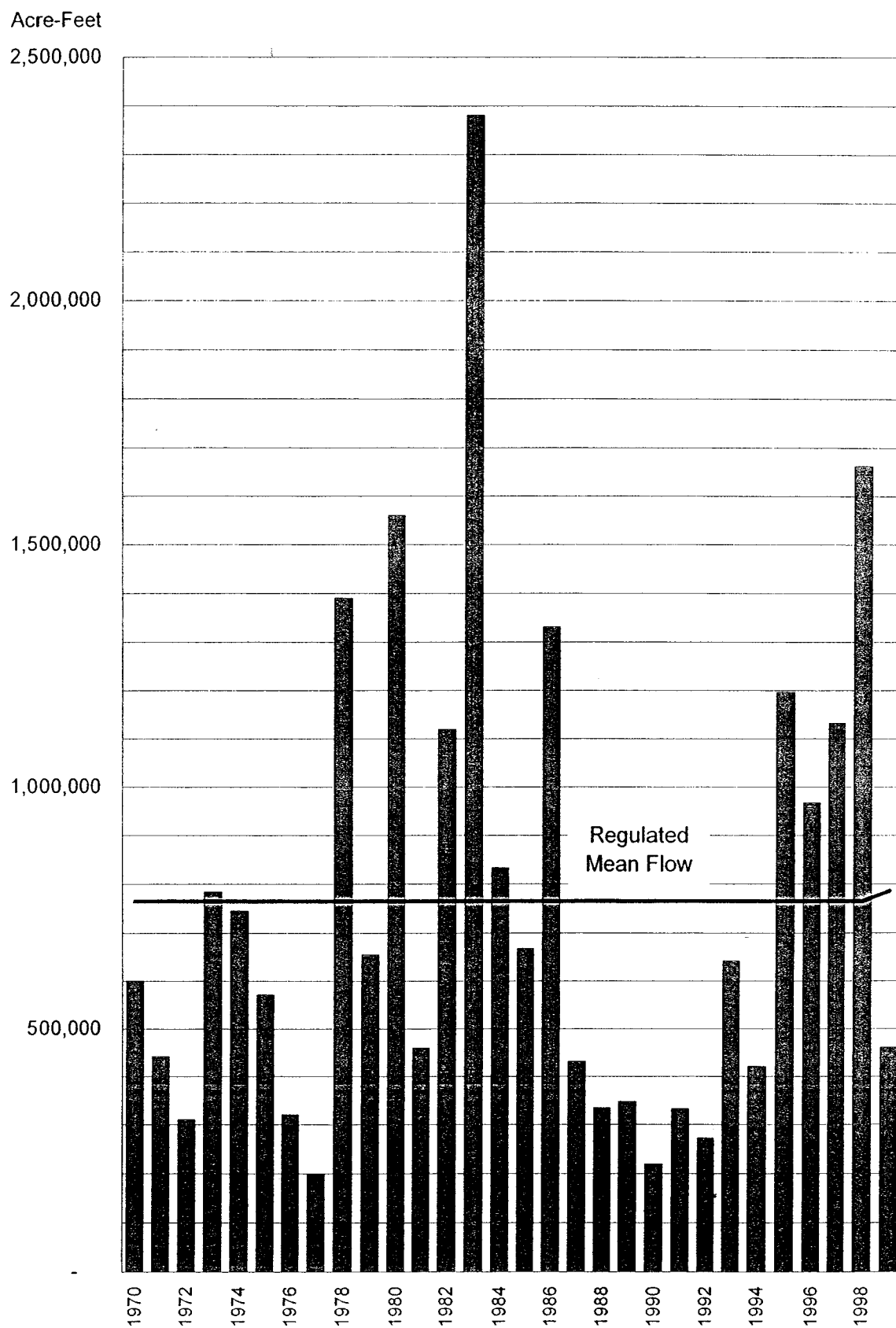


Figure 5. Central Valley Project Deliveries to Kern County

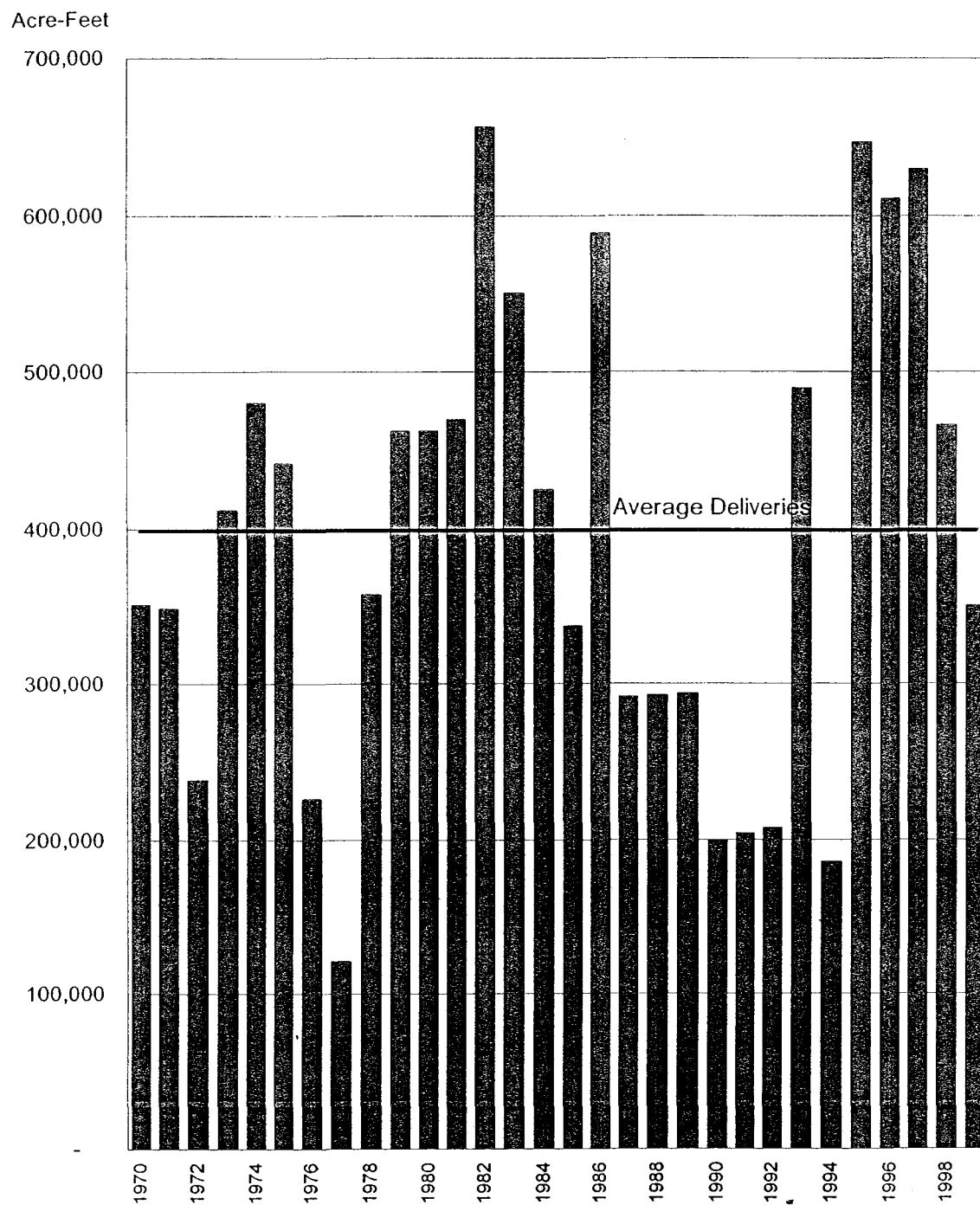


**Figure 6. Minor Stream Flows in the San Joaquin Valley Portion of Kern County**

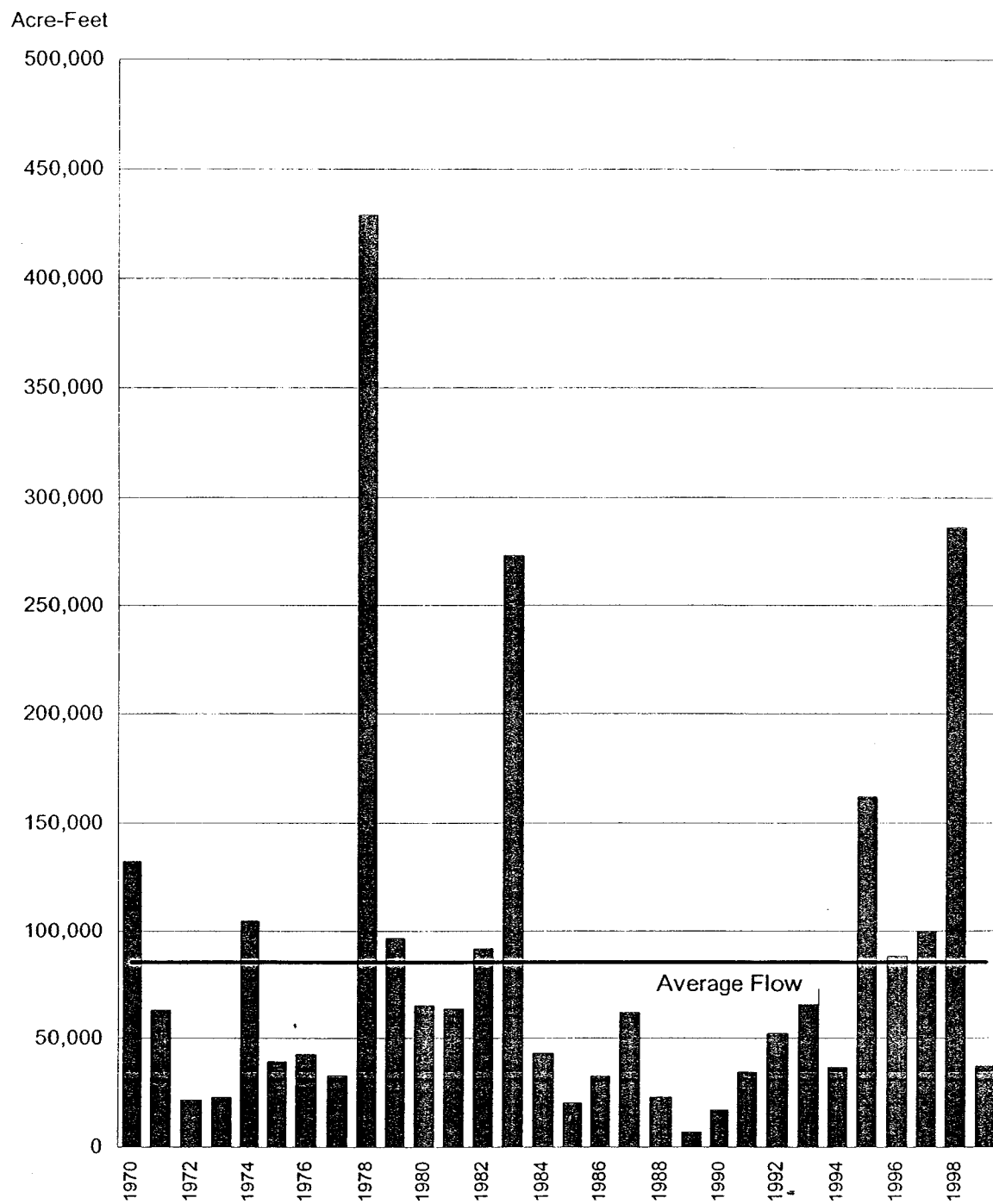
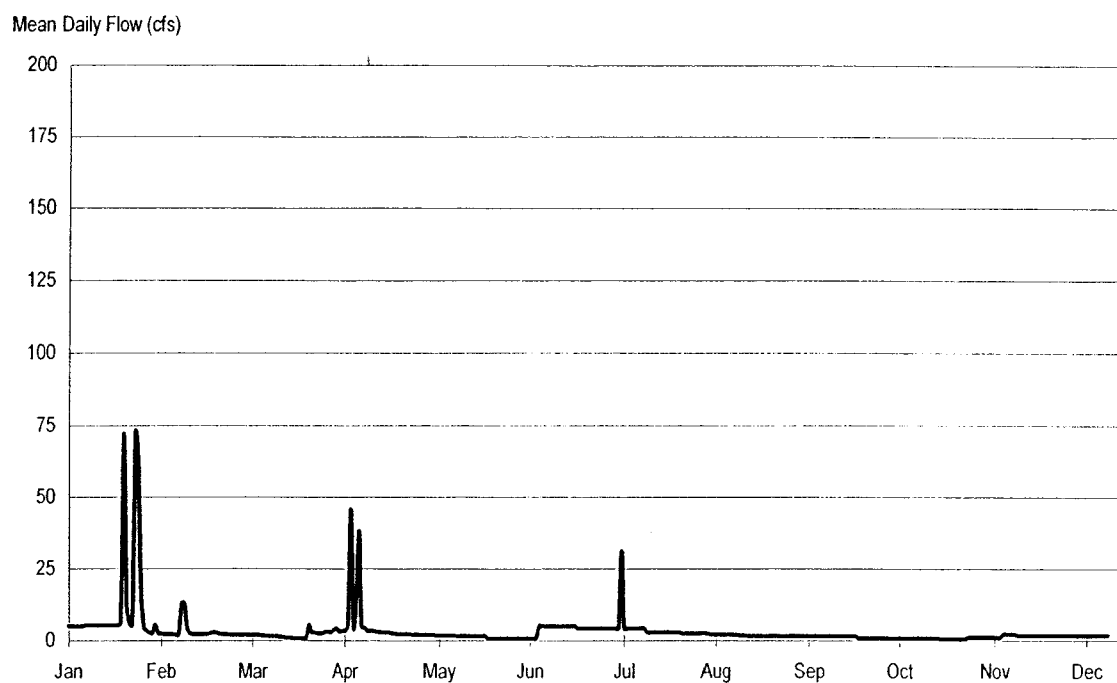


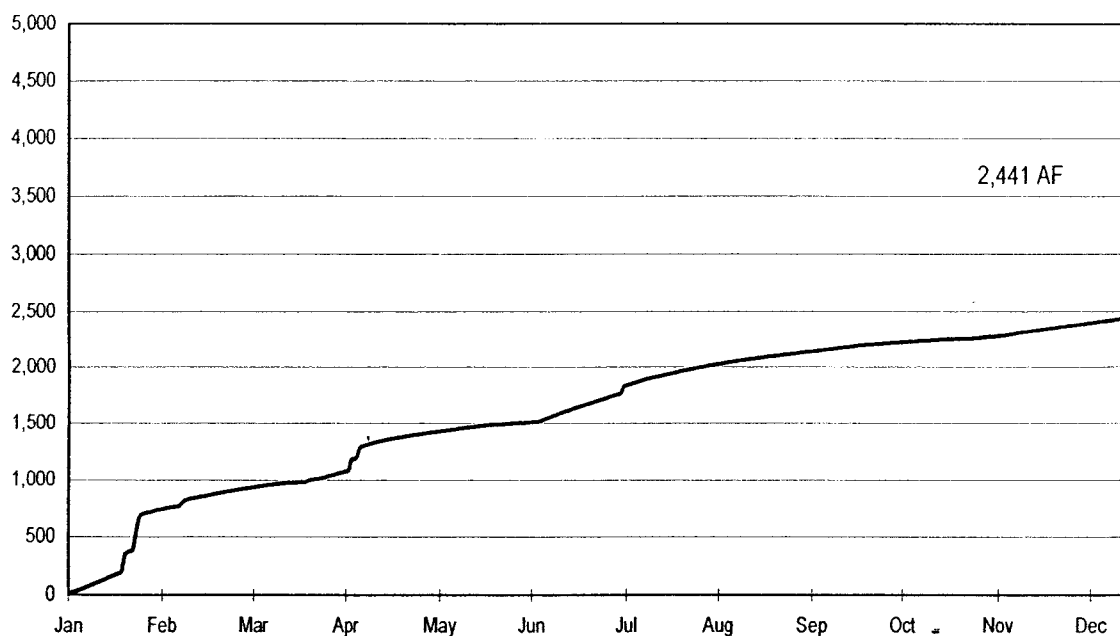
**Figure 7a. Tehachapi Creek Hydrograph (cfs) 1999**



Note:

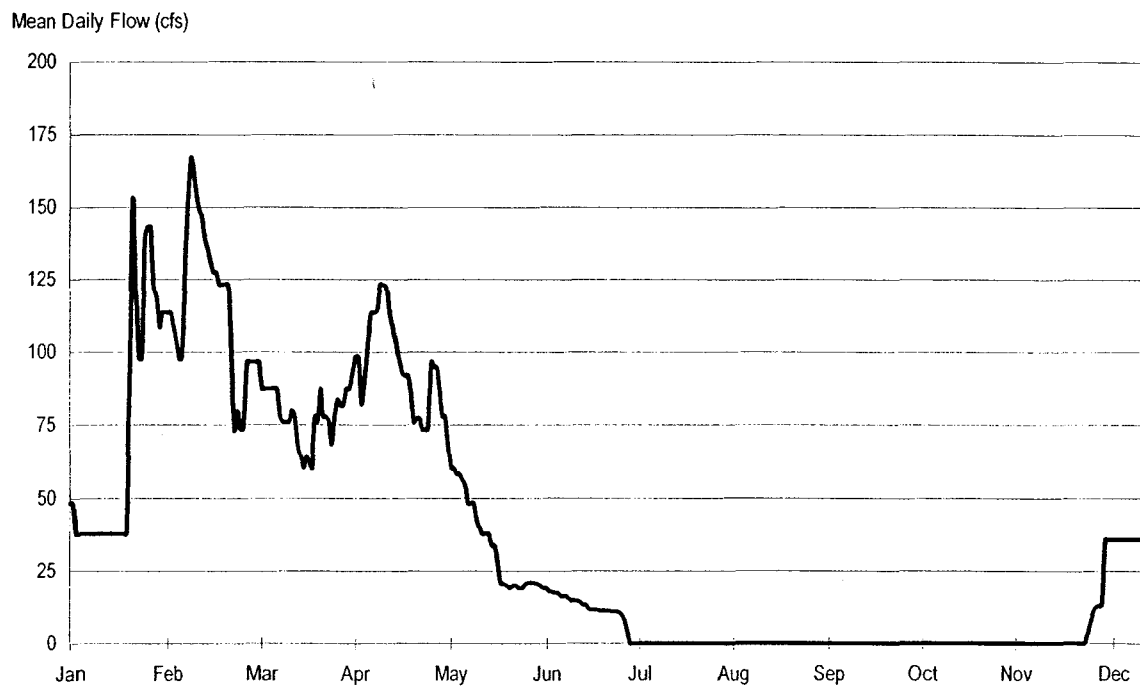
1. Hydrograph began 0000 hrs on 1/1/99 and ended at 2400 hrs on 12/31/99.
2. Located at Lat. 35 10' 26", Long. 118 28' 43"; NE 1/4, SW 1/4, Sec. 6, T32S, R33E, Kern County.
3. Peak discharge, 143.1 cfs, 1/20/99.

**Figure 7b. Tehachapi Creek Cumulative Volumes (acre-feet), 1999**



|                        | Jan | Feb | Mar   | Apr   | May   | Jun   | Jul   | Aug   | Sep   | Oct   | Nov   | Dec   |
|------------------------|-----|-----|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| Volume (AF)            | 732 | 177 | 118   | 367   | 100   | 189   | 280   | 130   | 97    | 55    | 82    | 114   |
| Cumulative Volume (AF) | 732 | 910 | 1,028 | 1,395 | 1,494 | 1,683 | 1,963 | 2,092 | 2,189 | 2,245 | 2,327 | 2,441 |

**Figure 7c. Poso Creek Hydrograph Mean Daily Flow (cfs) 1999**



1. Hydrograph began 0000 hrs on 1/1/99 and ended at 2400 hrs on 12/31/99.
2. Located at Lat. 35 30' 49", Long. 118 54' 17"; SW 1/4, SW 1/4, Sec. 6, T28S, R29E, Kern County.
3. 3. Peak Discharge, 170 cfs, 2/10/99

**Figure 7d. Poso Creek Cumulative Volumes (acre-feet), 1999**

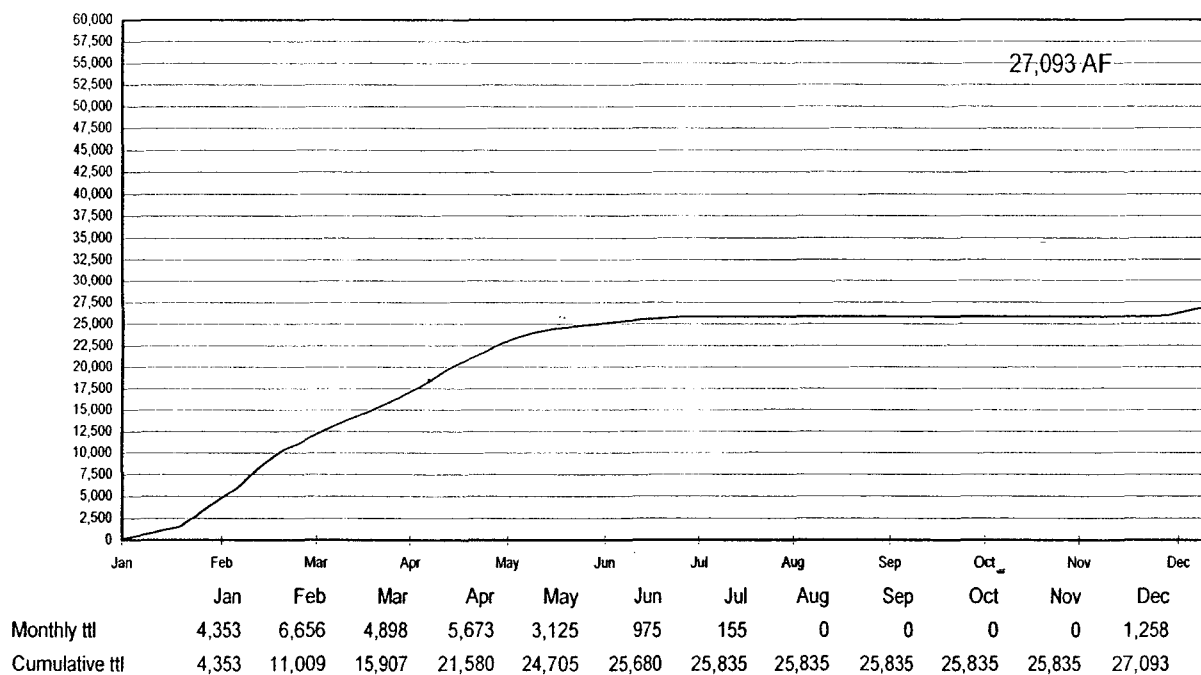


Figure 8. Annual Precipitation at Three Stations in the San Joaquin Valley Portion of Kern County

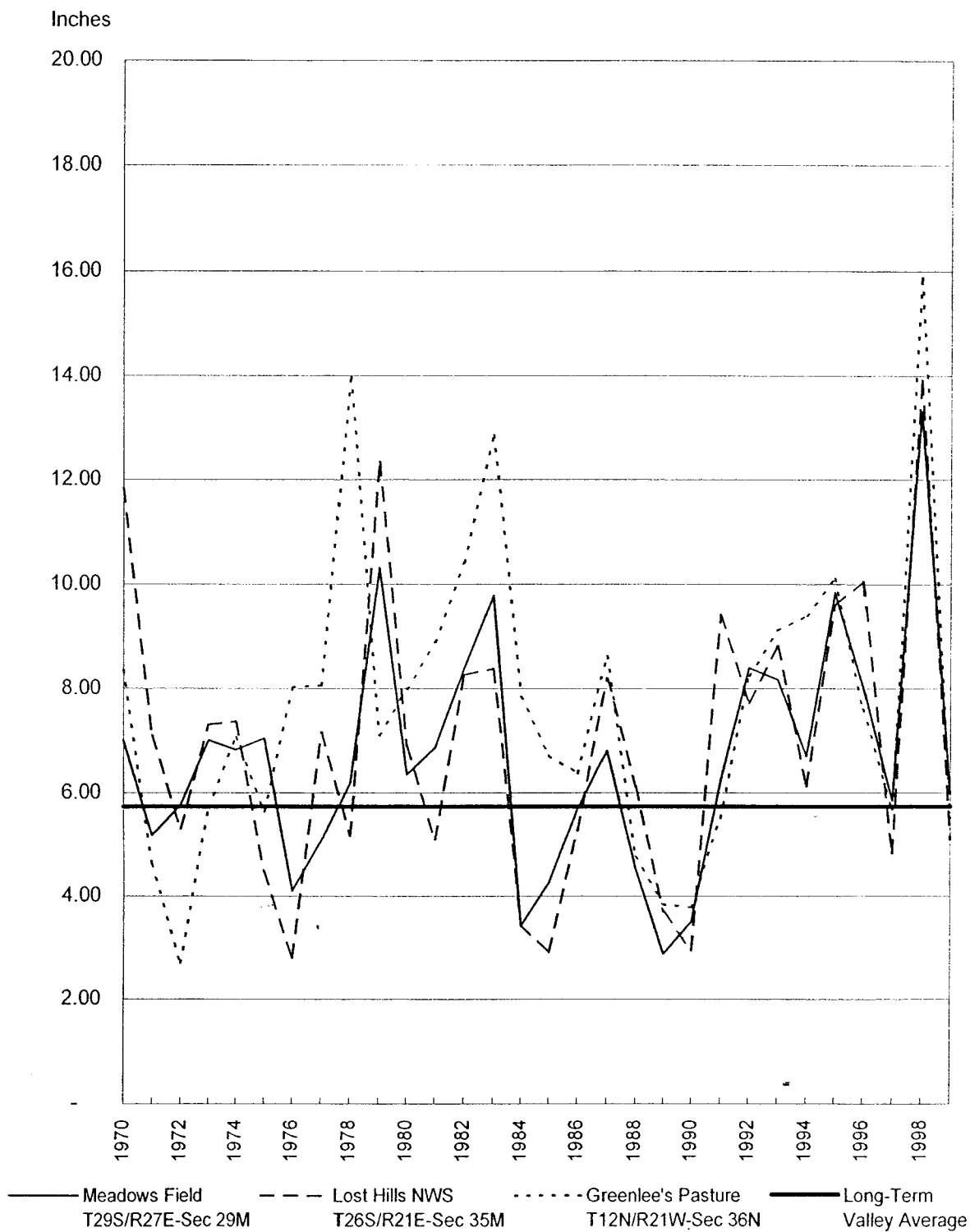


Figure 9. Effective Precipitation in the San Joaquin Valley Portion of Kern County

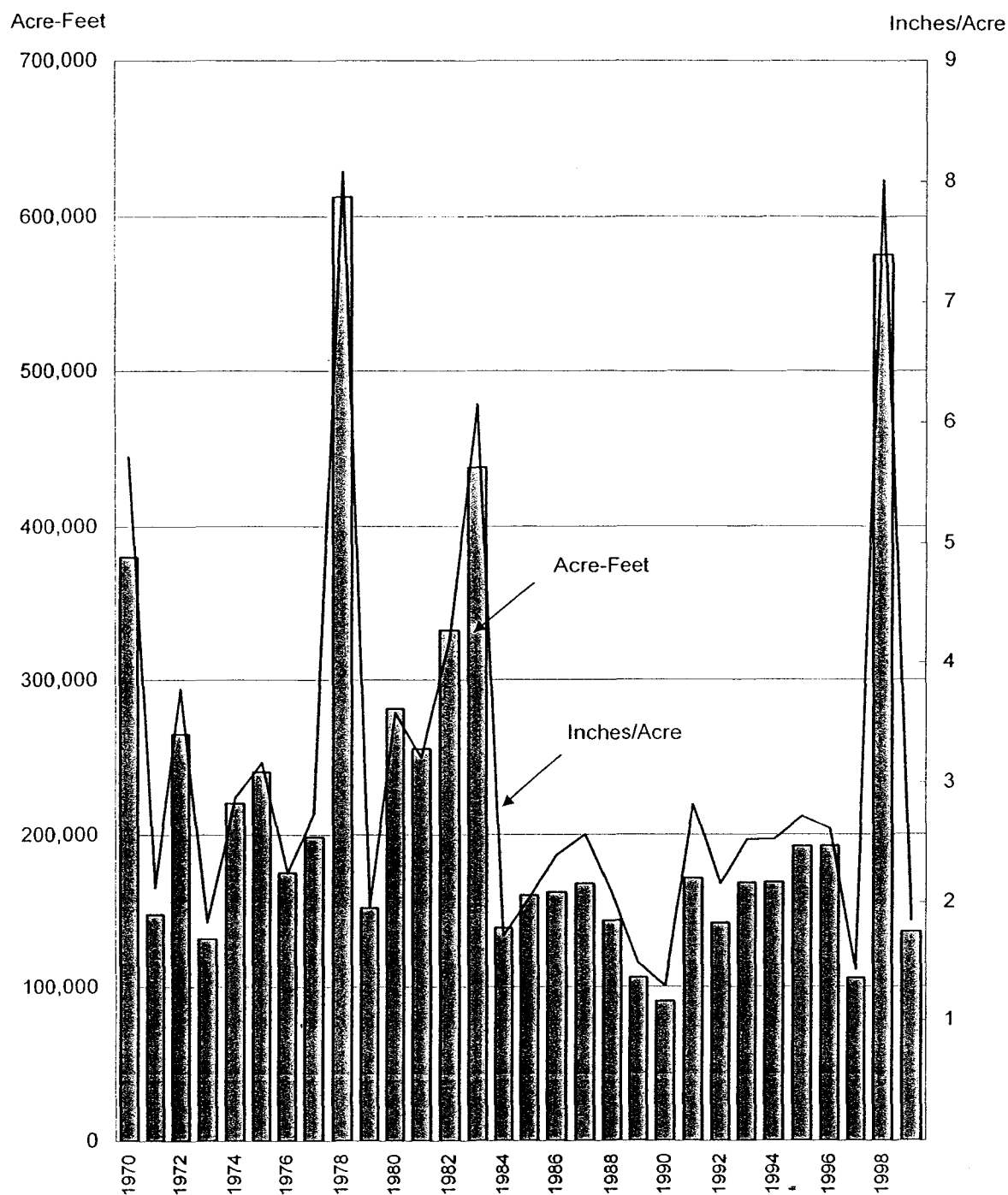


Figure 10. Waste Water Reuse in Kern County

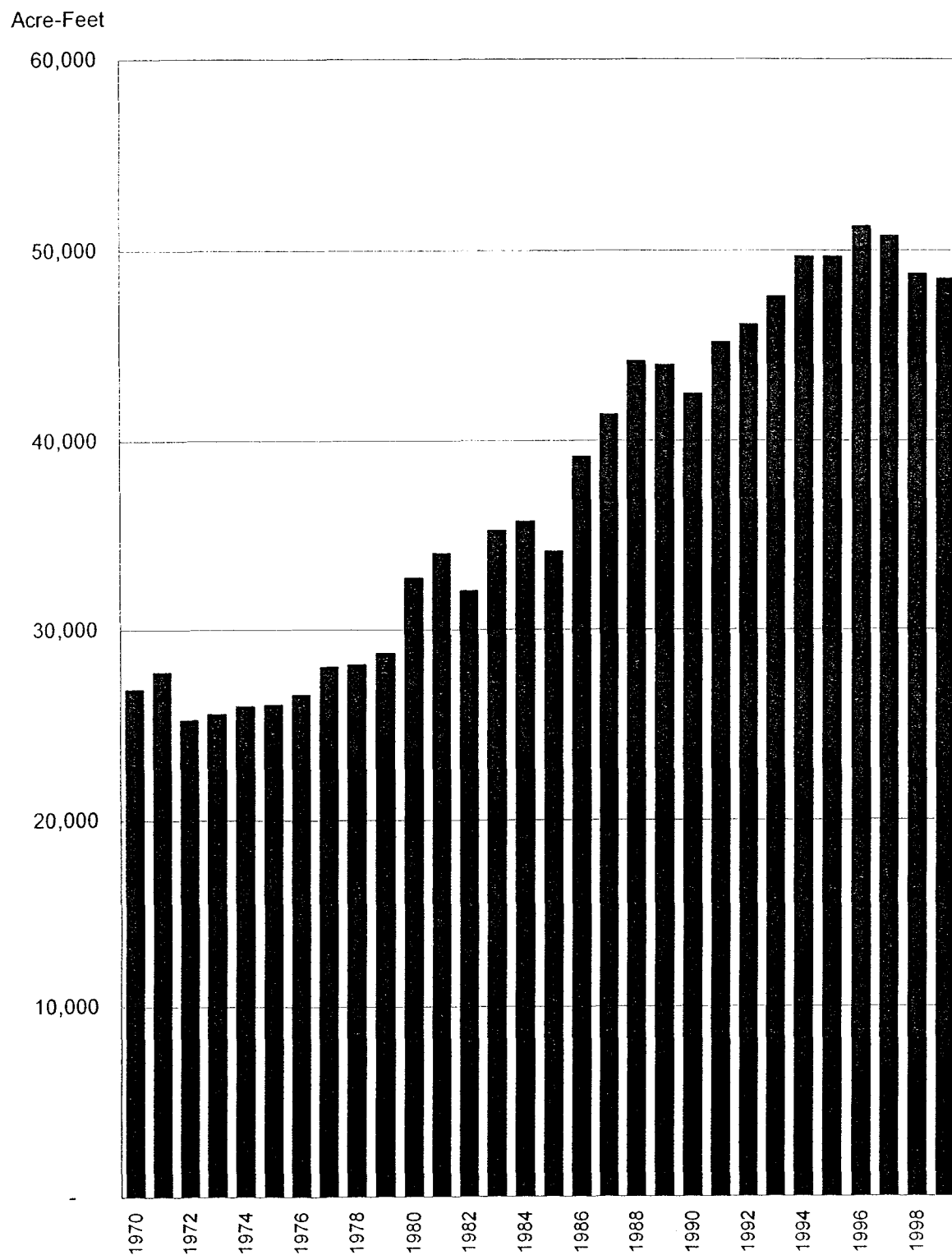


Figure 11. Oil Field Produced Water in Kern County

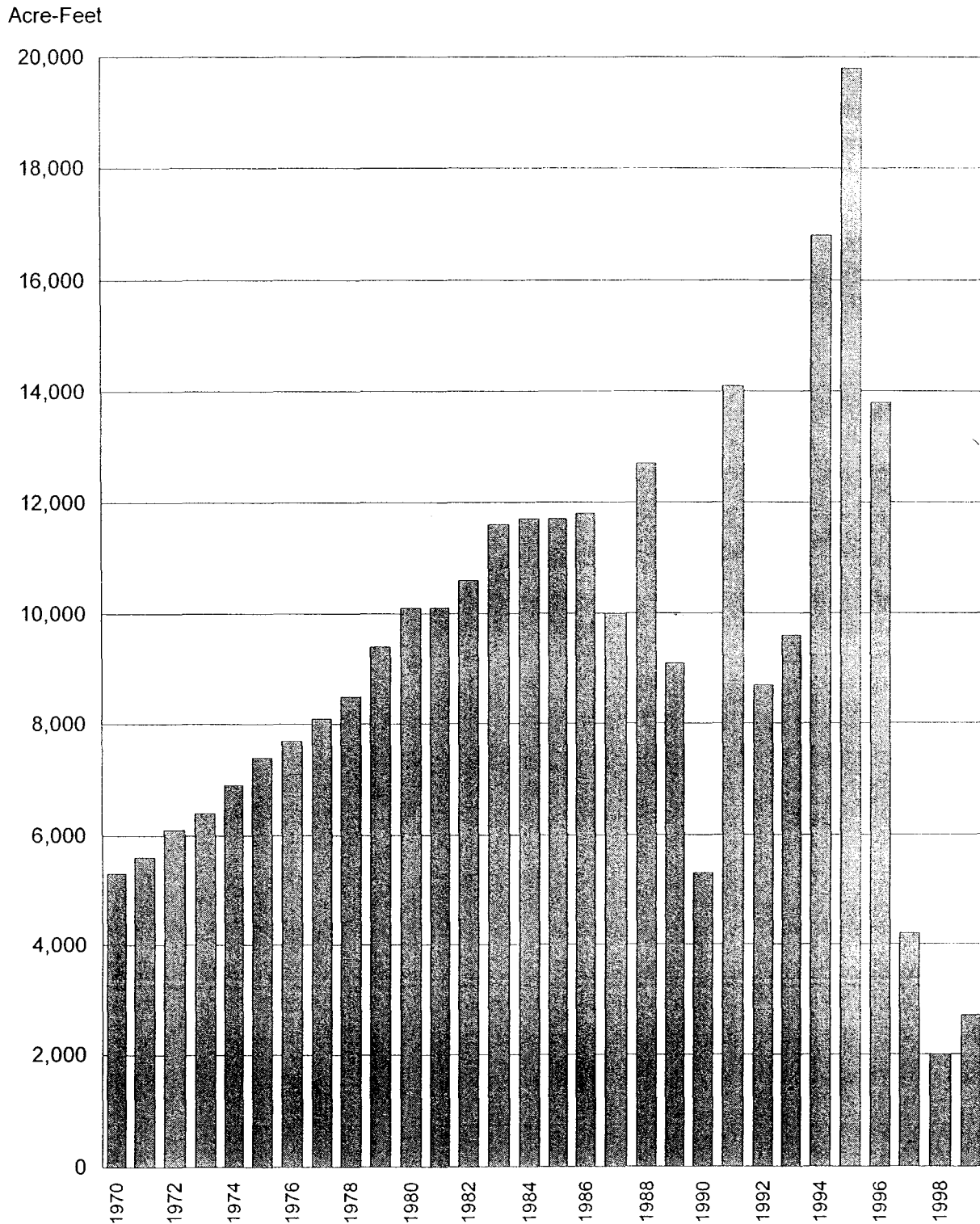


Figure 12. Groundwater Pumping in the San Joaquin Valley Portion of Kern County

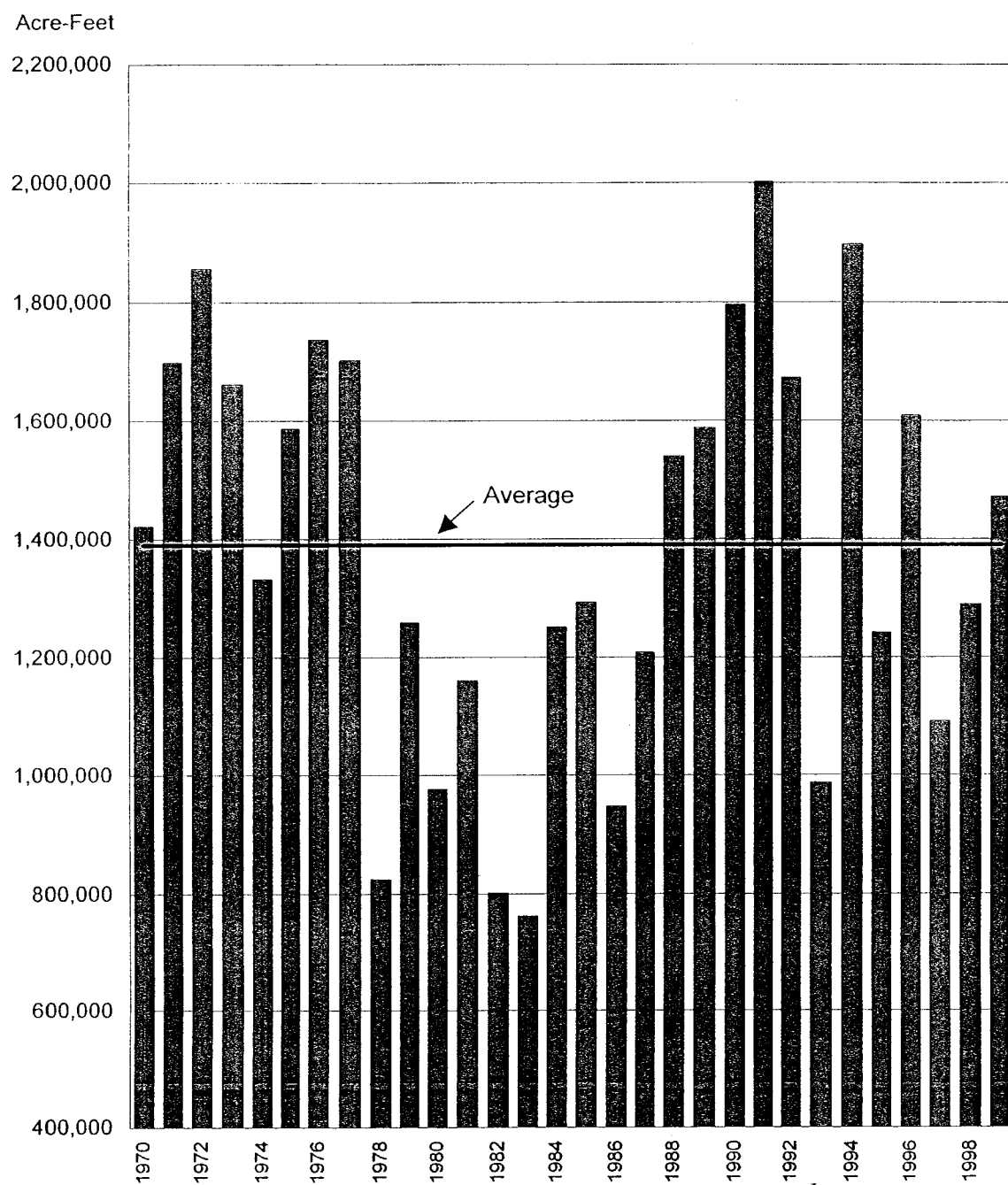


Figure 13. Irrigated Acreage in the San Joaquin Valley Portion of Kern County

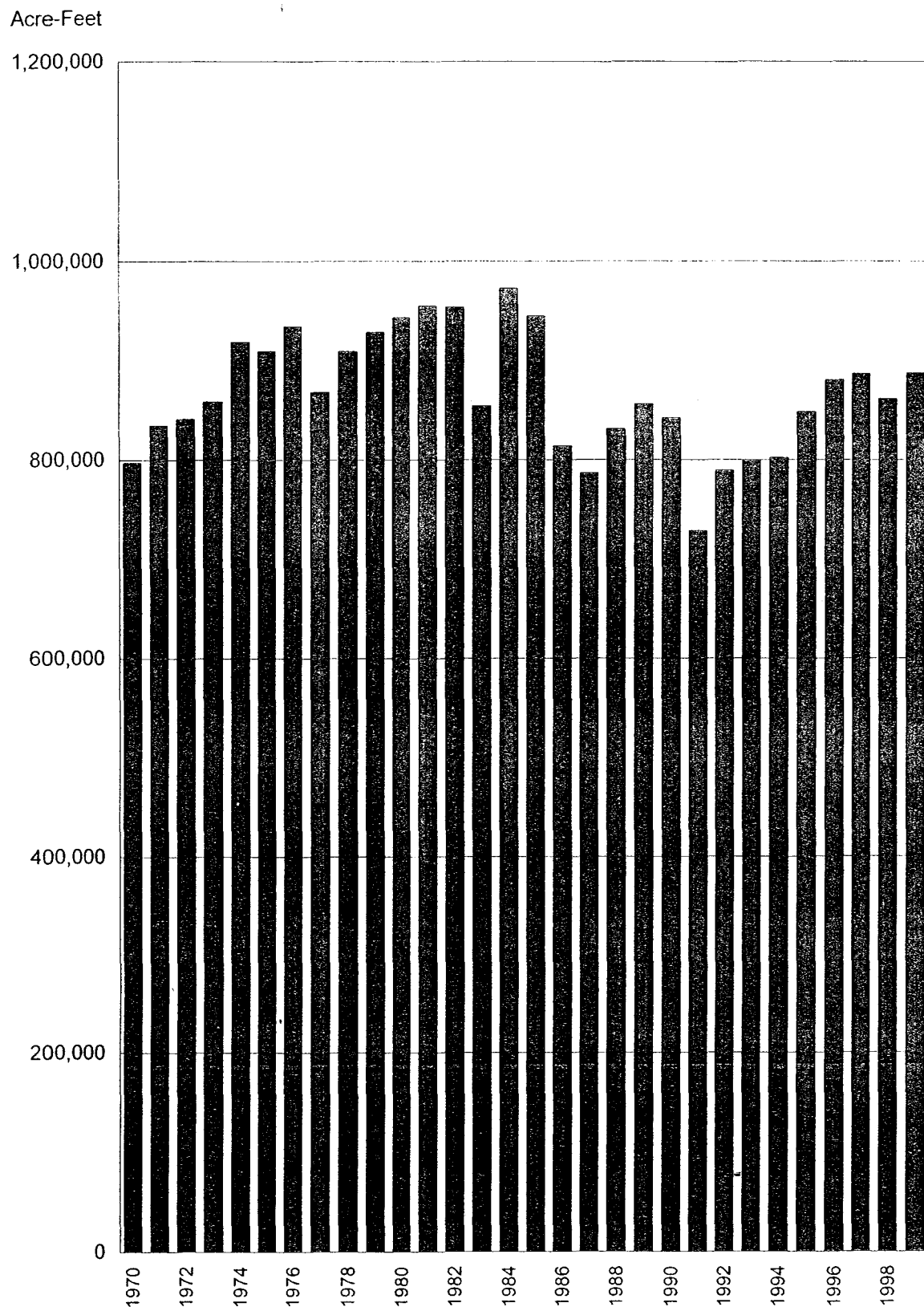


Figure 14. 1999 Summary of Irrigated Acreage

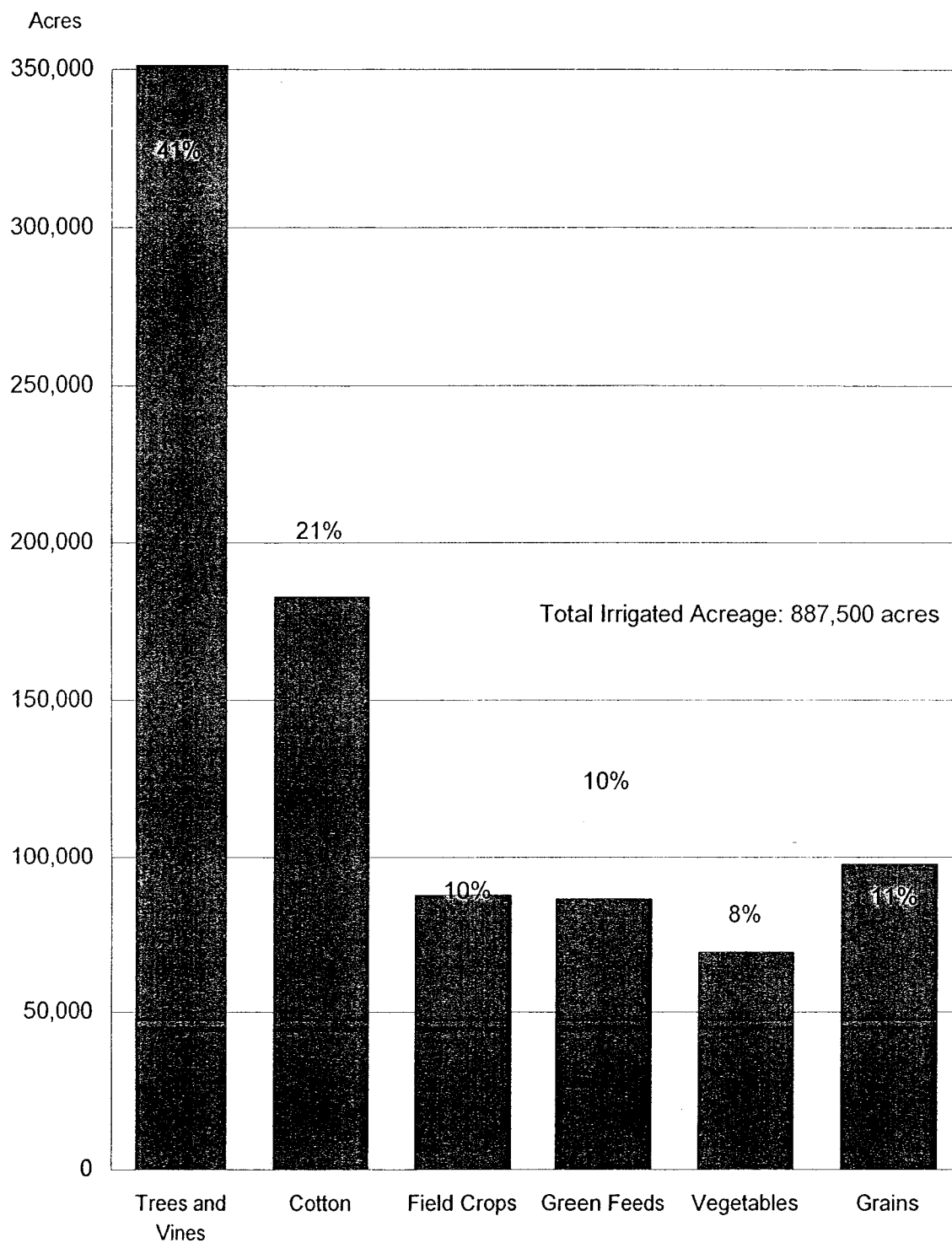
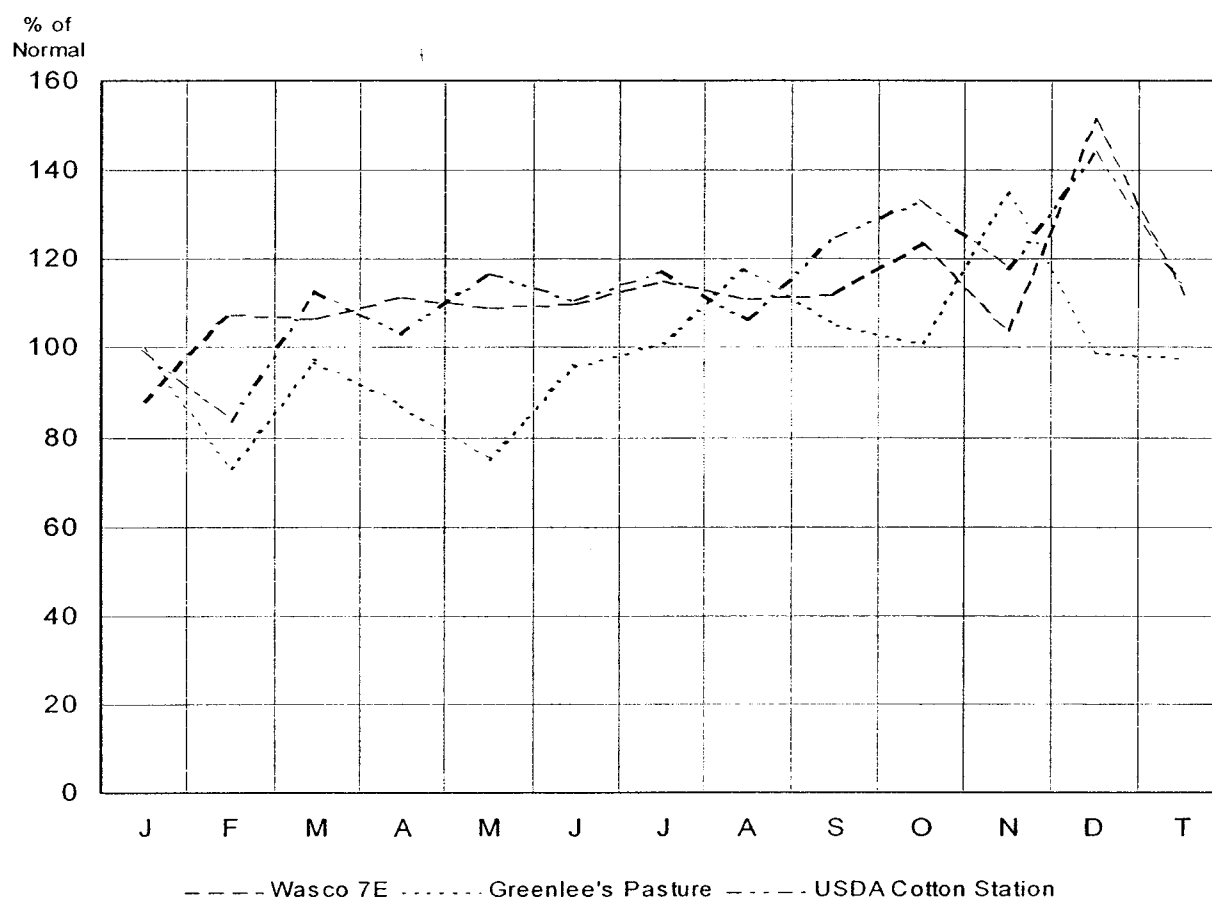


**Figure 15. 1999 Percent of Normal Evaporation**



**Percent of Normal, Total:**

|                            |              |
|----------------------------|--------------|
| <b>Wasco 7E</b>            | <b>111.8</b> |
| <b>Greenlee's Pasture</b>  | <b>97.8</b>  |
| <b>USDA Cotton Station</b> | <b>113.7</b> |

**Wasco 7E**

1999 observed monthly EP, Wasco 7E (irrigated pasture) compared to long-term average for pasture pans in the San Joaquin Valley. This station is indicative of EP on the valley floor.

**Greenlee's Pasture**

1999 observed monthly EP, Greenlee's Pasture (irrigated pasture - Wheeler Ridge area) compared to long-term average for pasture pans in the San Joaquin Valley. This station is indicative of EP in the foothill regions of the valley.

**USDA Cotton Station**

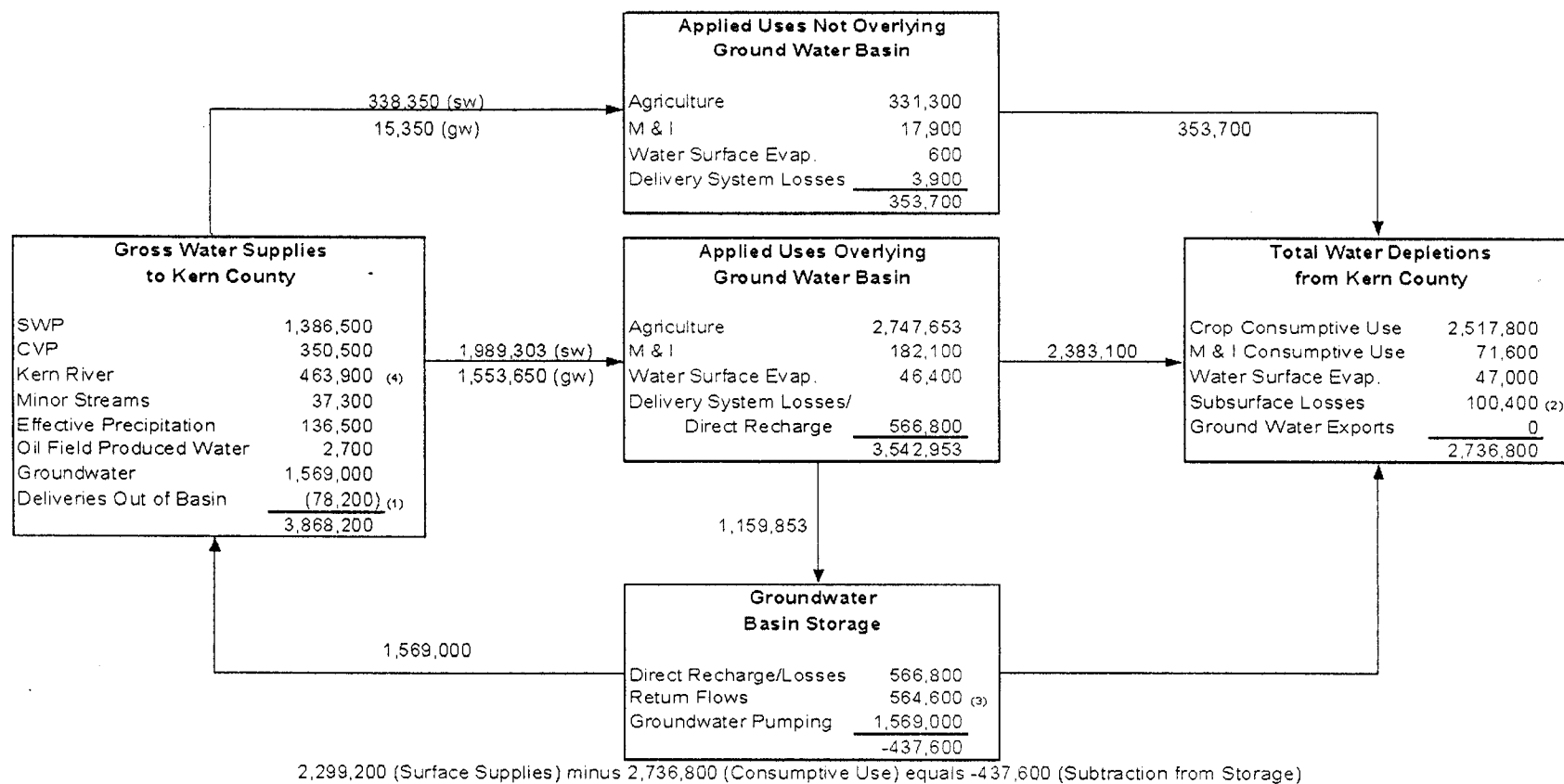
1999 observed monthly EP, USDA Cotton Station (irrigated turf) compared to long-term average for long-term average for USDA Cotton Station in the San Joaquin Valley. This station is indicative of EP for cotton in Kern County.

1999

**Wasco 7E Greenlee's P USDA Cotton Station**

|          |              |             |              |
|----------|--------------|-------------|--------------|
| <b>J</b> | <b>88</b>    | <b>99</b>   | <b>99</b>    |
| <b>F</b> | <b>107</b>   | <b>73</b>   | <b>83</b>    |
| <b>M</b> | <b>107</b>   | <b>97</b>   | <b>113</b>   |
| <b>A</b> | <b>112</b>   | <b>87</b>   | <b>103</b>   |
| <b>M</b> | <b>109</b>   | <b>75</b>   | <b>117</b>   |
| <b>J</b> | <b>110</b>   | <b>96</b>   | <b>111</b>   |
| <b>J</b> | <b>115</b>   | <b>101</b>  | <b>117</b>   |
| <b>A</b> | <b>111</b>   | <b>118</b>  | <b>106</b>   |
| <b>S</b> | <b>112</b>   | <b>105</b>  | <b>125</b>   |
| <b>O</b> | <b>123</b>   | <b>101</b>  | <b>133</b>   |
| <b>N</b> | <b>104</b>   | <b>135</b>  | <b>118</b>   |
| <b>D</b> | <b>151</b>   | <b>99</b>   | <b>144</b>   |
| <b>T</b> | <b>111.8</b> | <b>97.8</b> | <b>113.7</b> |

Figure 16. 1999 Water Resources Inventory, San Joaquin Valley Portion of Kern County (acre-feet)



Notes:

- <sup>(1)</sup> Delivered to Tulare Lake Basin WSD (9,400 AF), Westlands WD (61,199 AF) and Tehachapi-Cummings WD (7,582 AF).
- <sup>(2)</sup> Includes 91,100 AF to saline sinks, and 9,300 AF losses to moisture deficient soils.
- <sup>(3)</sup> A total of 48,500 AF of municipal waste water was treated and reused. The reuse is not included here.
- <sup>(4)</sup> Total excludes 186 AF delivered to Kern Valley Golf Course (Kenville).

(sw) Surface Water  
(gw) Ground Water

**Figure 17. Gross Water Supplies and Net Water Requirements, San Joaquin Valley Portion of Kern County**

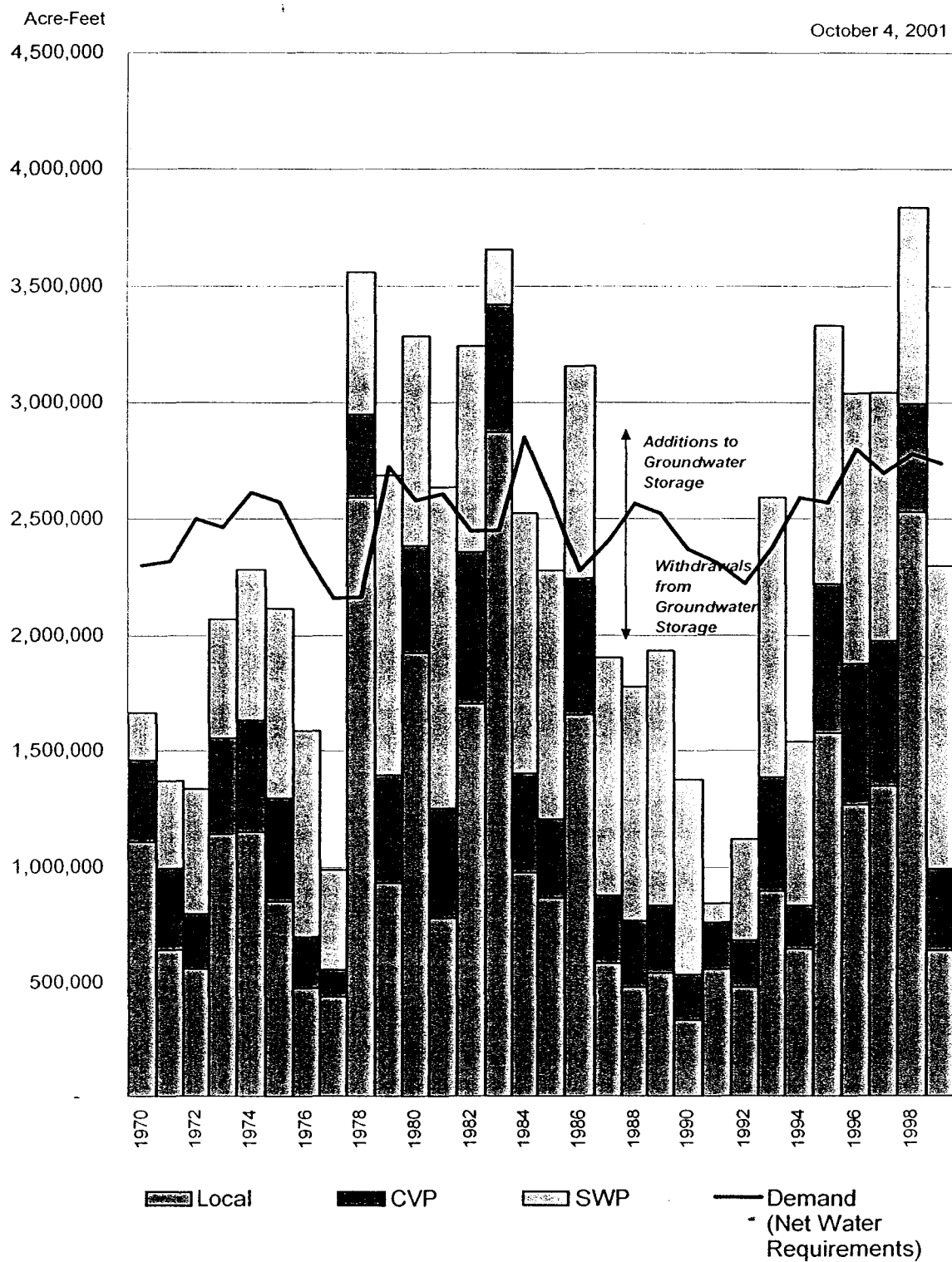


Figure 18. Cumulative Change in Groundwater Storage, San Joaquin Valley Portion of Kern County

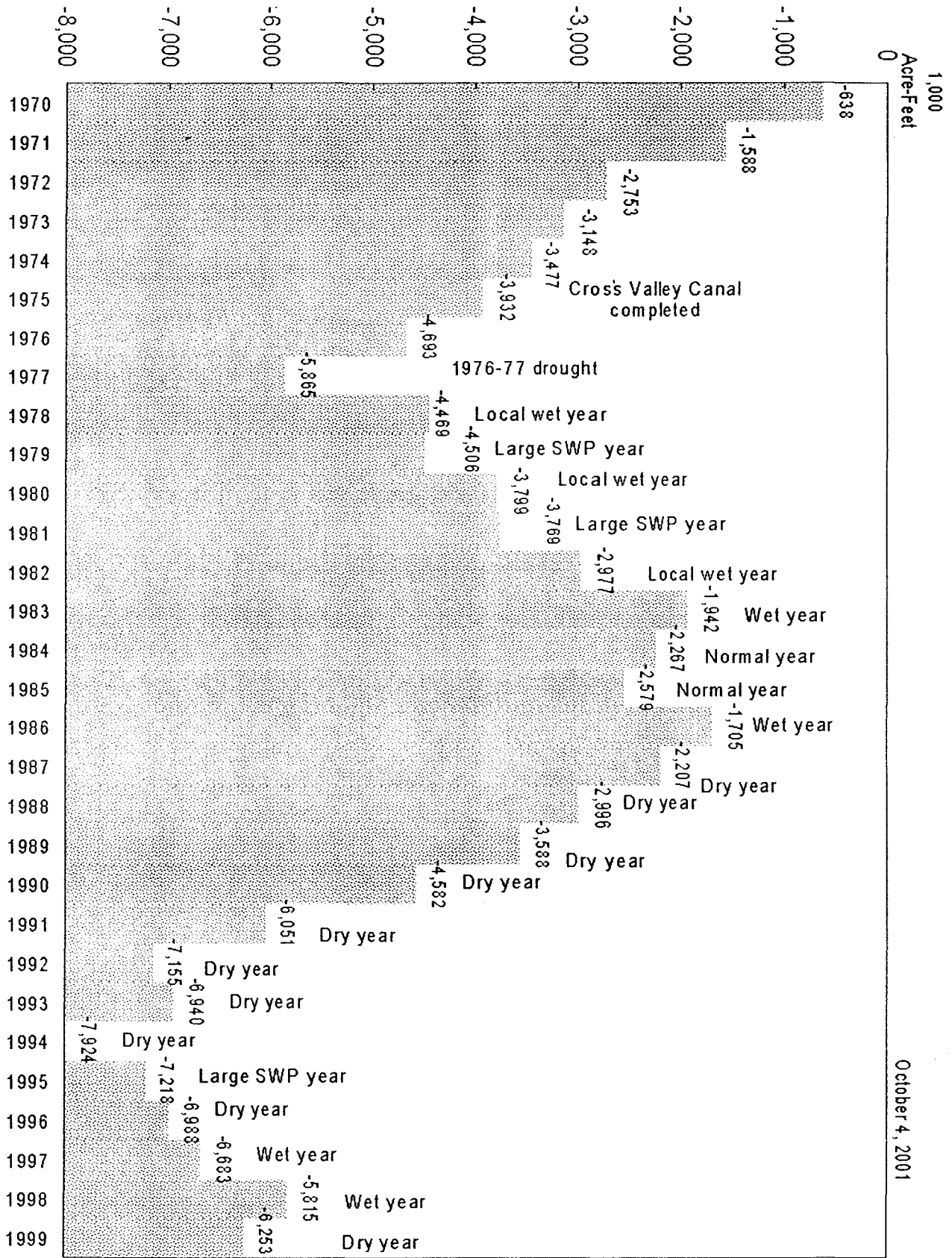
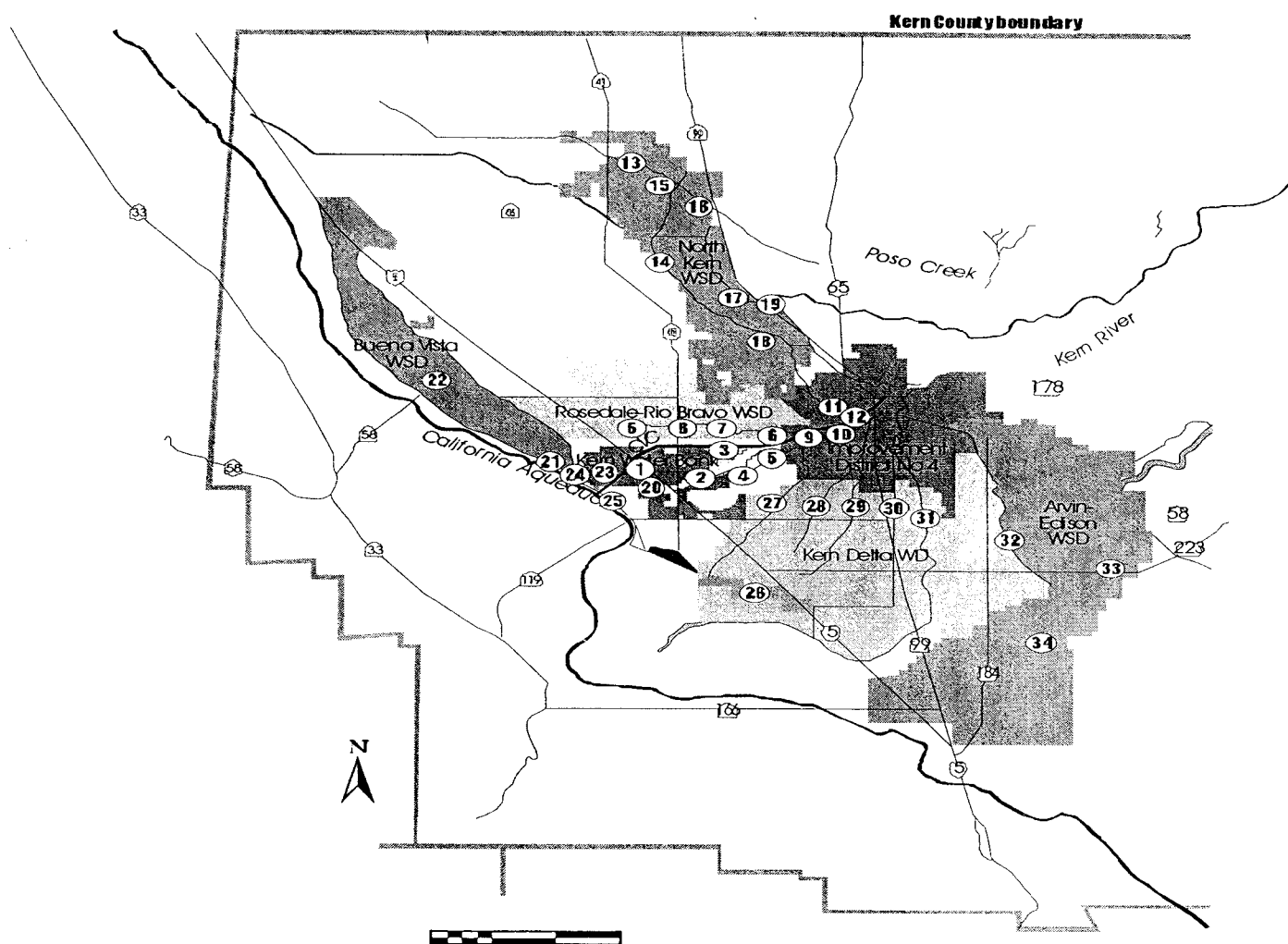


**Figure 19. Groundwater Recharge Sites, 1999 Summary, Southern San Joaquin Valley Portion of Kern County**



| Location                        | Recharge (AF) | Location                      | Recharge (AF) |
|---------------------------------|---------------|-------------------------------|---------------|
| 1 Kern Water Bank               | 36,000        | 20 Kern River Bypass/Channel  | 105           |
| 2 COB 2800 Acres                | 200           | 21 Kern River Flood Channel   | 0             |
| 3 Pioneer North and South       | 21,400        | 22 Buttonwillow Canals        | 31,414        |
| 4 Pioneer South                 | 0             | 23 Main Canal                 | 0             |
| 5 Berrenda Mesa Spreading       | 1,900         | 24 Outlet Elk Pen             | 431           |
| 6 Rosedale-Rio Bravo WSD        |               | 25 Outlet Canal               | 5,839         |
| 7 Goose Lake Slough             |               | 26 Maples Canal               | 2,305         |
| 8 KFE/RRB                       |               | Buena Vista WSD Total         | 40,094        |
| RRBWSD Total                    | 52,400        | 27 Buena Vista Canal          |               |
| 9 Kern River                    | 78,400        | 28 Stine Canal                |               |
| 10 Truxtun Lakes                | 3,600         | 29 Farmers Canal              |               |
| 11 Calloway Canal and One Ditch | 30,300        | 30 Kern Island Canal          |               |
| 12 Cross Valley Canal Extension | 2,400         | 31 Central Branch Canal       |               |
| 13 Poso Creek                   |               | 32 Eastside Canal             |               |
| 14 Calloway Canal and One Ditch |               | Kern Delta WD Total           | 59,600        |
| 15 Poso 27                      |               | 33 Sycamore Spreading Grounds |               |
| 16 Switch Field                 |               | 34 Tejon Spreading Grounds    |               |
| 17 Minter Field                 |               | Arvin-Edison WSD              | 80,700        |
| 18 Rosedale Ponds               |               |                               |               |
| 19 Lerdo Canal                  |               |                               |               |
| North Kern WSD Total            | 61,700        | Grand Total                   | 468,694       |

Figure 20. Groundwater Recharge, San Joaquin Valley Portion of Kern County

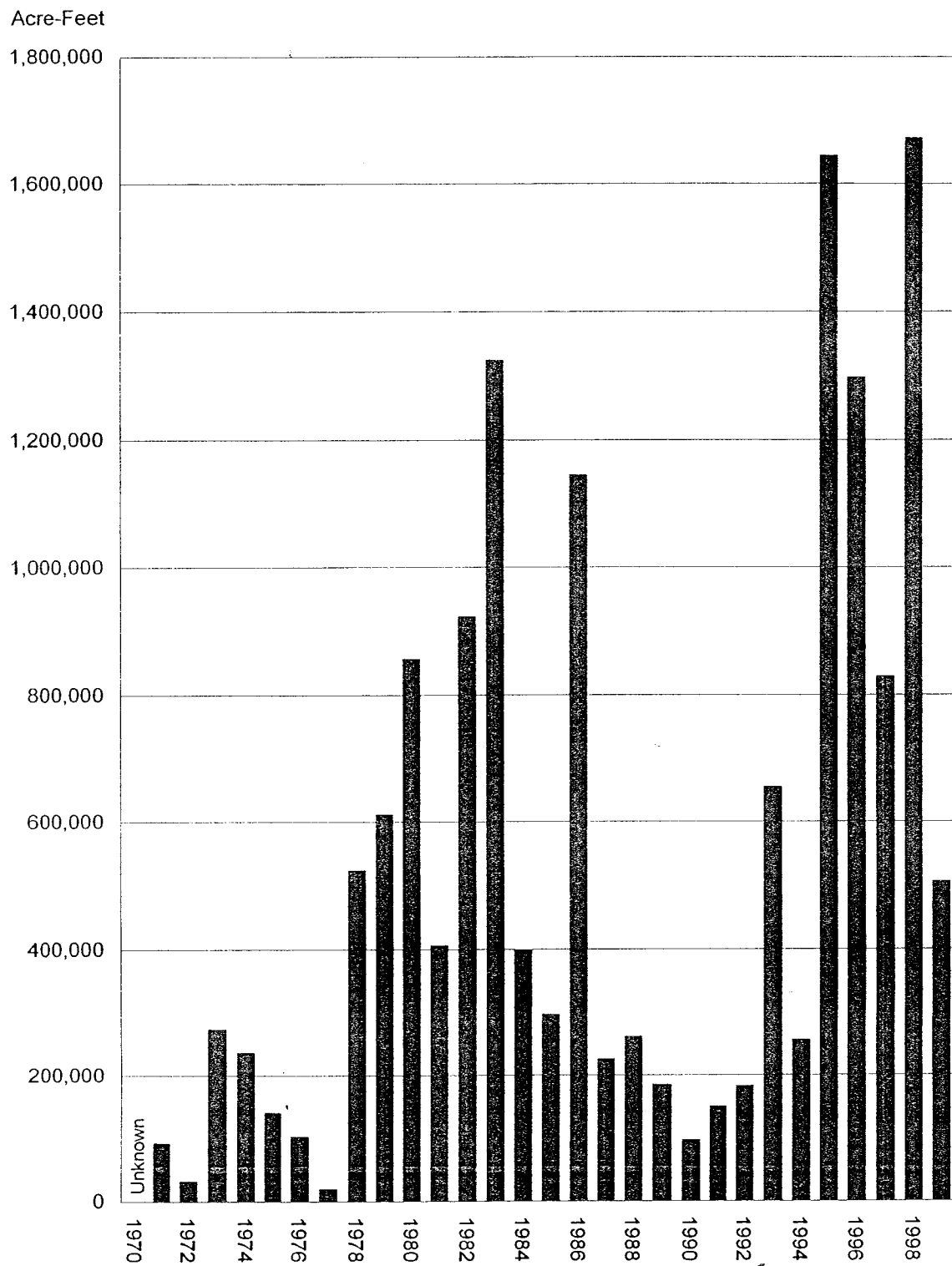


**Figure 21a. Water Well Hydrograph Pond-Poso Area**

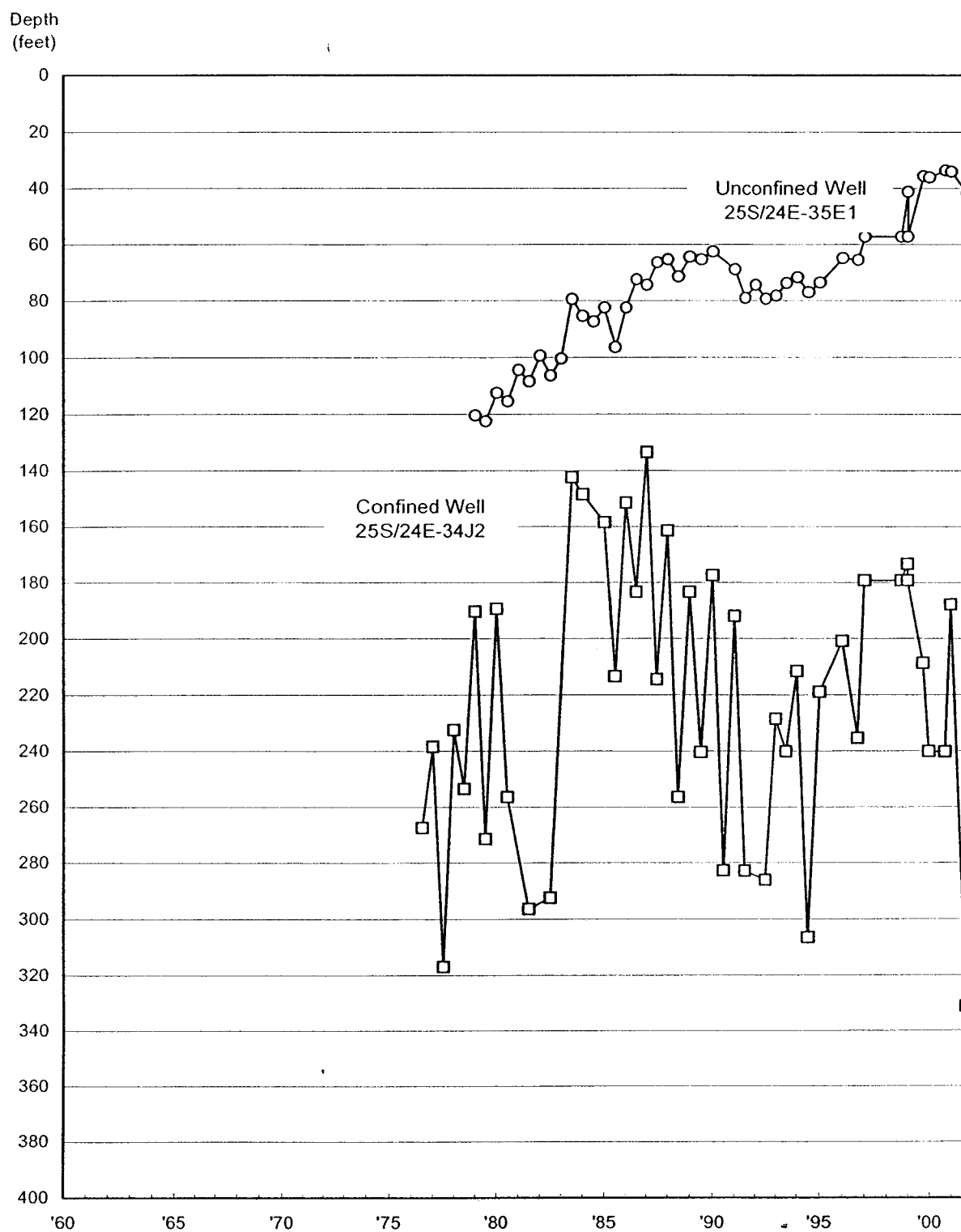


Figure 21b. Water Well Hydrograph Shafter/Rosedale-Rio Bravo Area

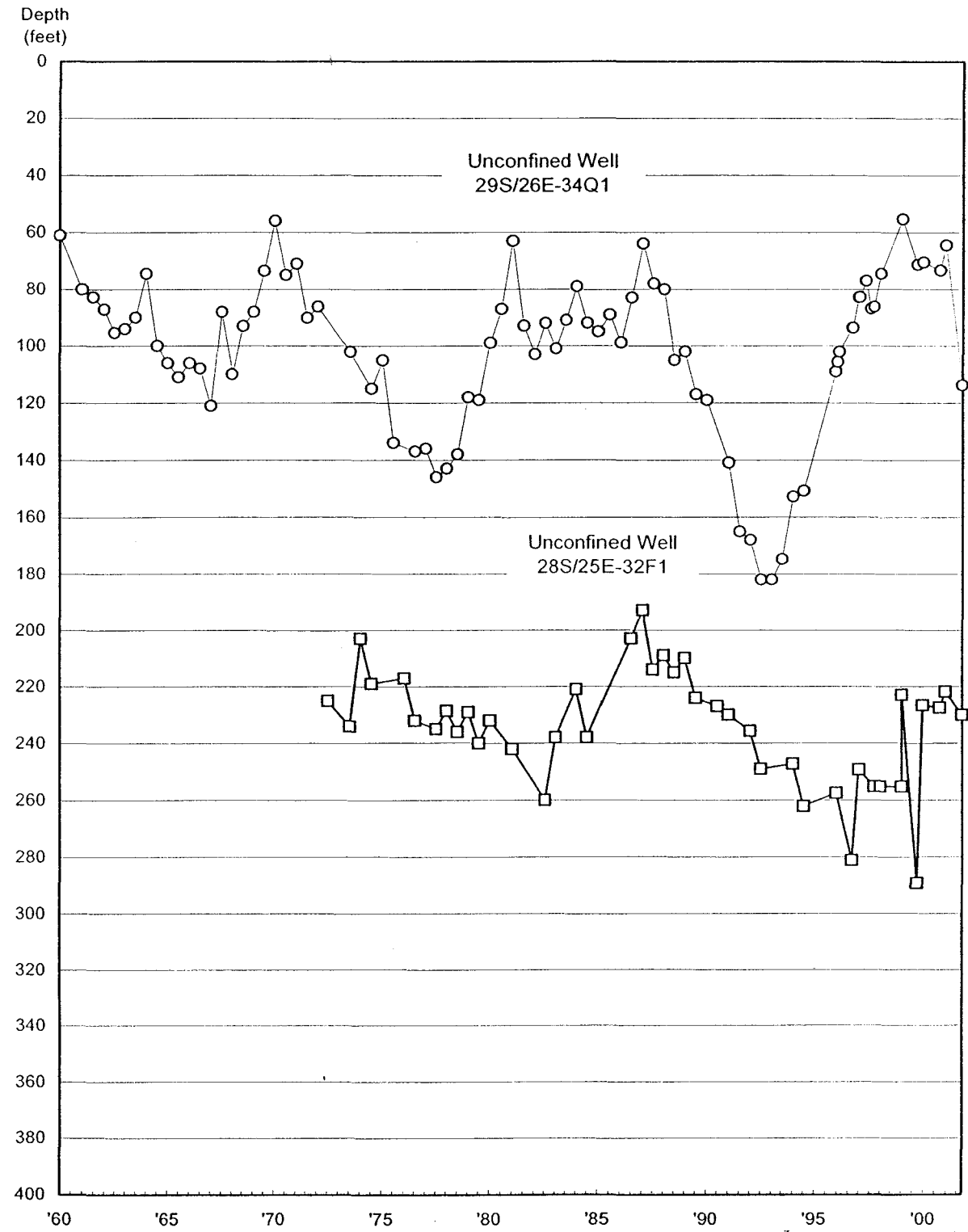


Figure 21c. Water Well Hydrograph Southwest Bakersfield Area

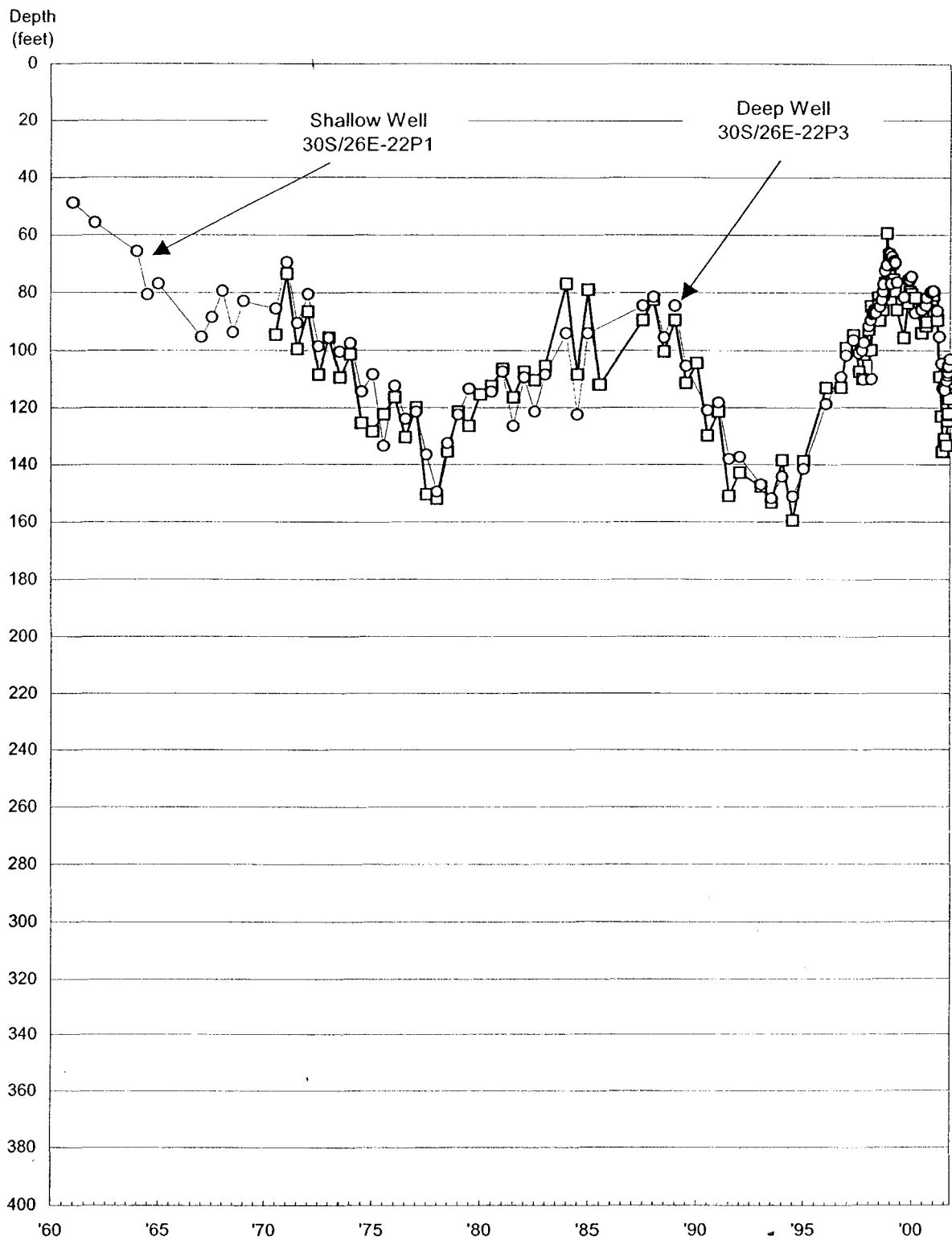


Figure 21d. Water Well Hydrograph Arvin-Edison Area

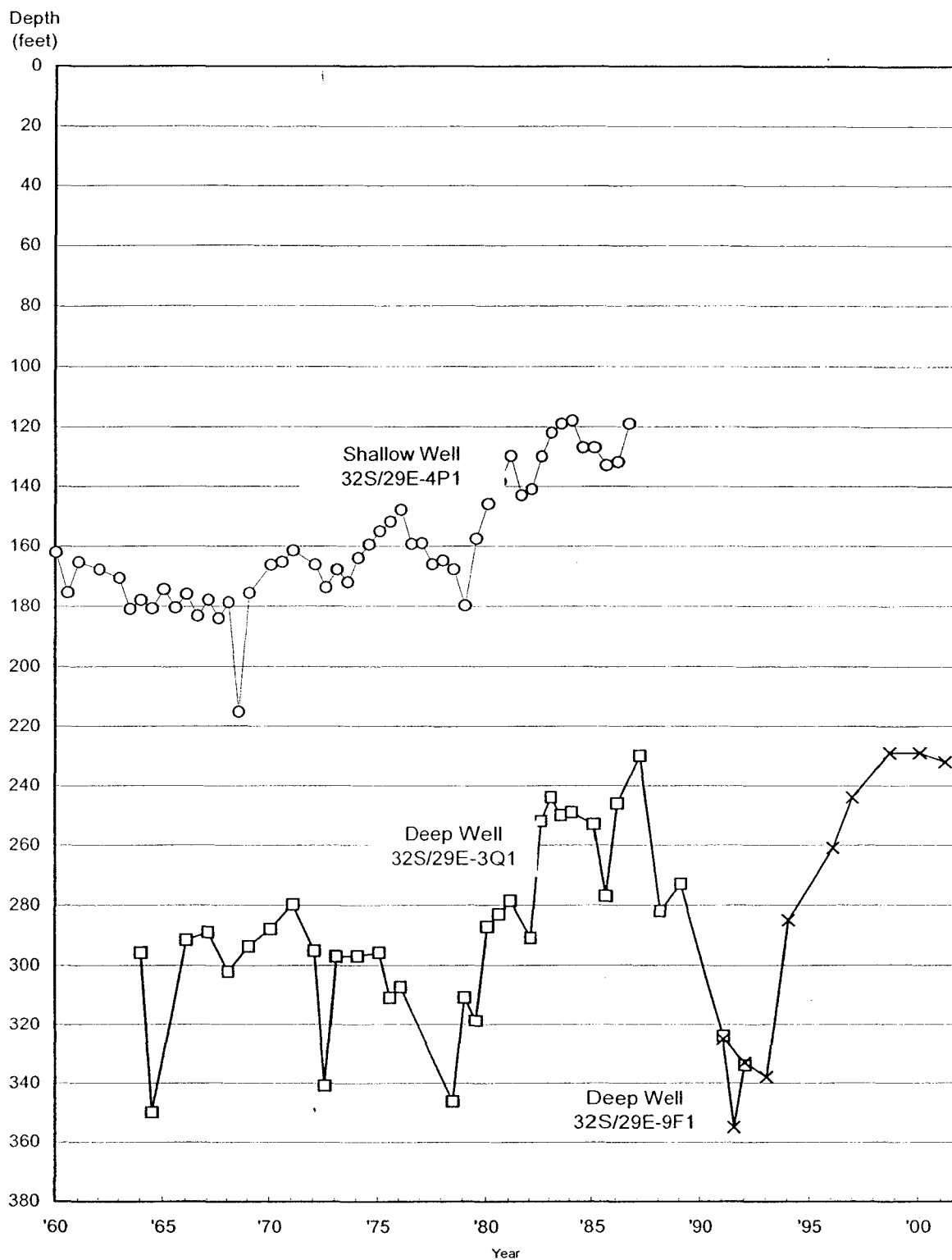


Figure 21e. Water Well Hydrograph Indian Wells Valley

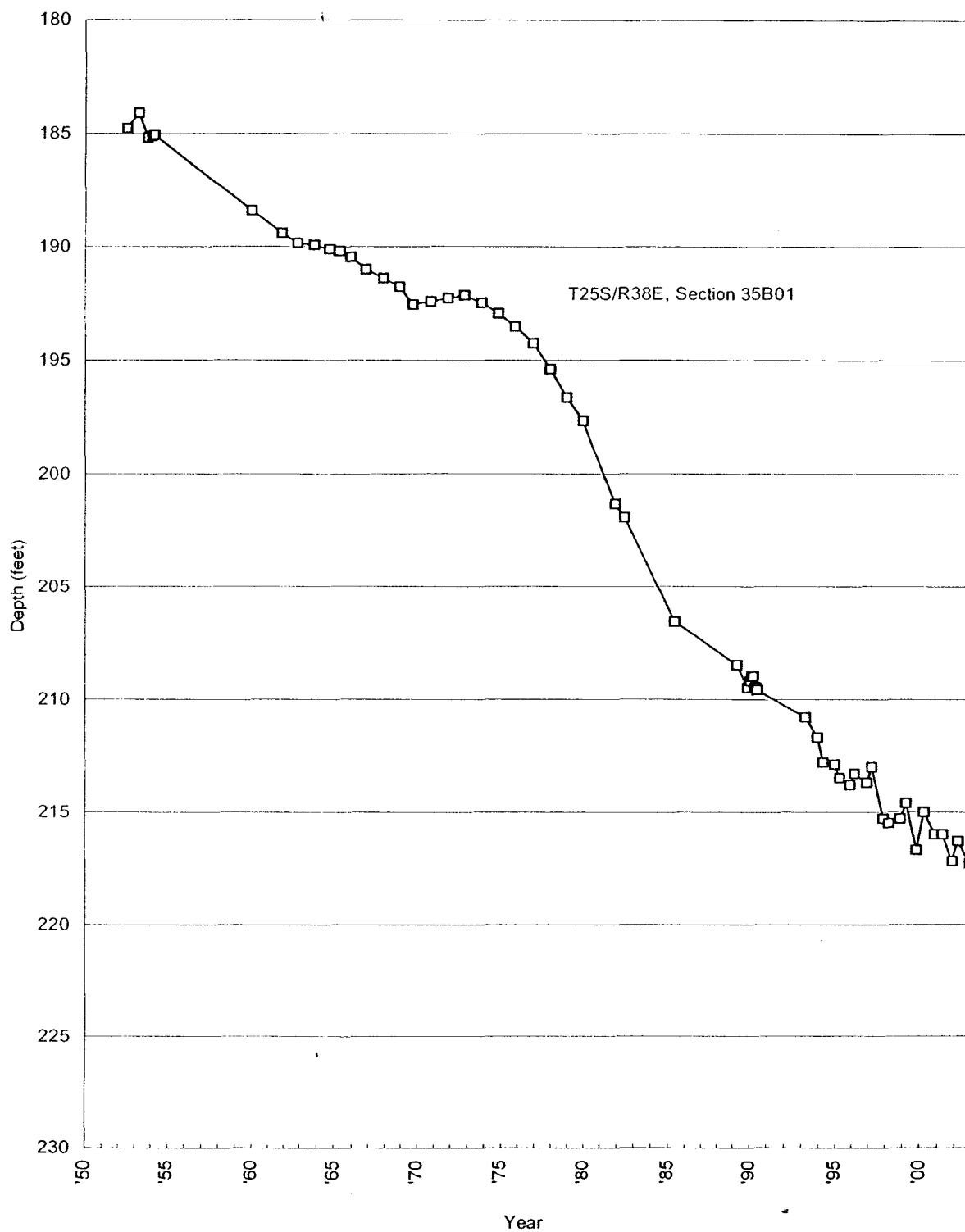


Figure 21f . Water Well Hydrograph Indian Wells Valley

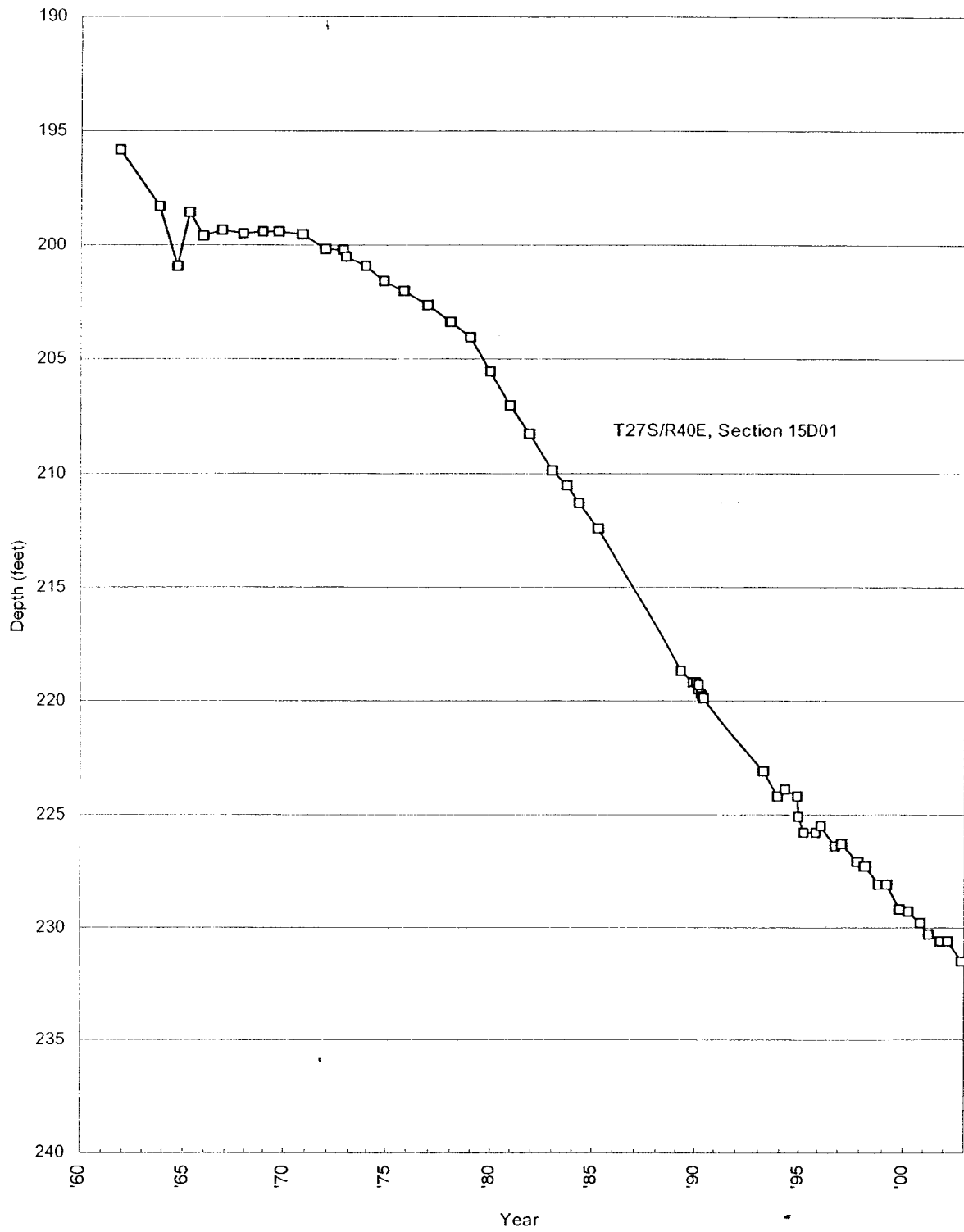
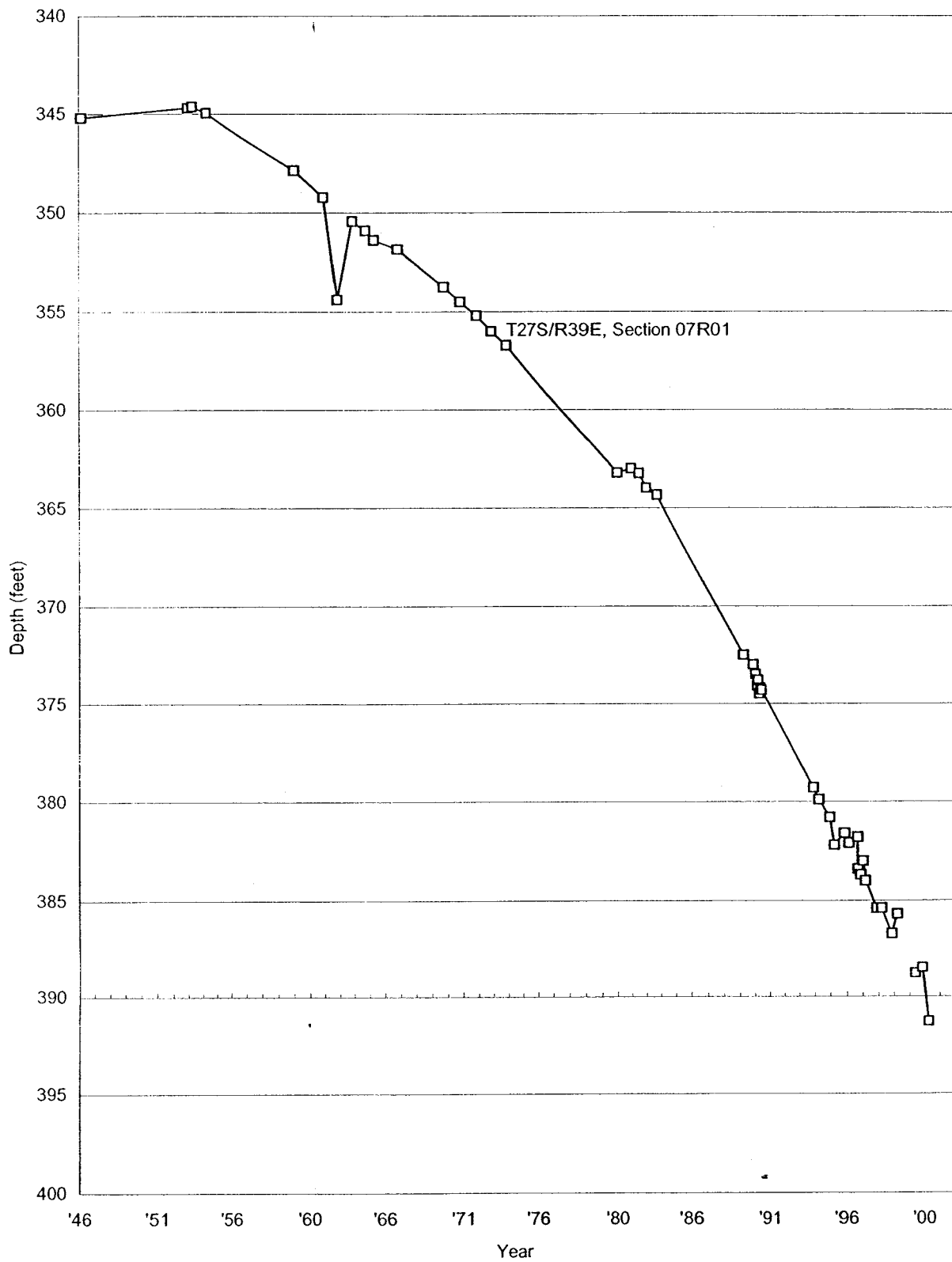


Figure 21g. Water Well Hydrograph Indian Wells Valley



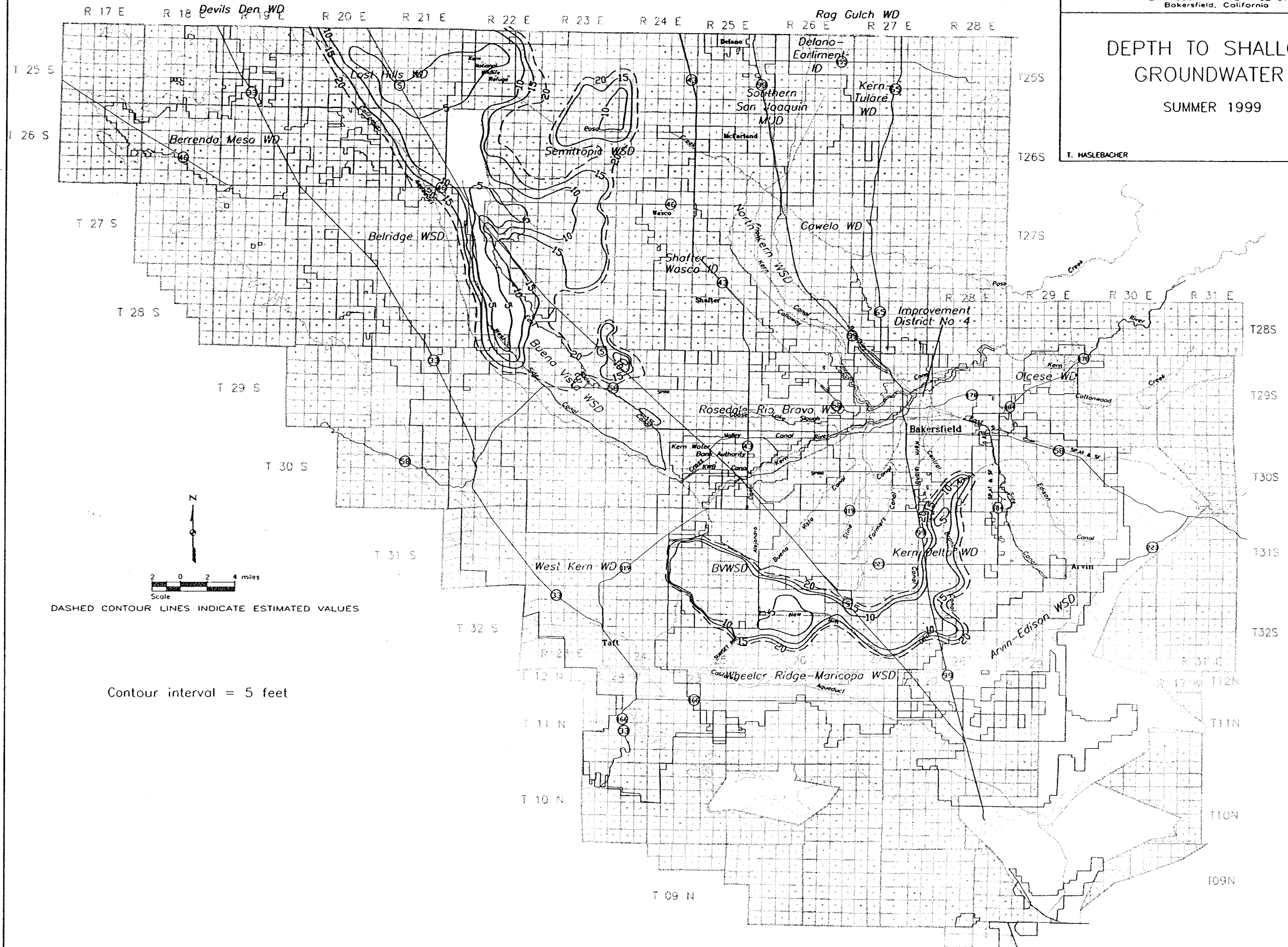
KERN COUNTY WATER AGENCY  
Bakersfield, California

# DEPTH TO SHALLOW GROUNDWATER

SUMMER 1999

T. HASLEBACHER

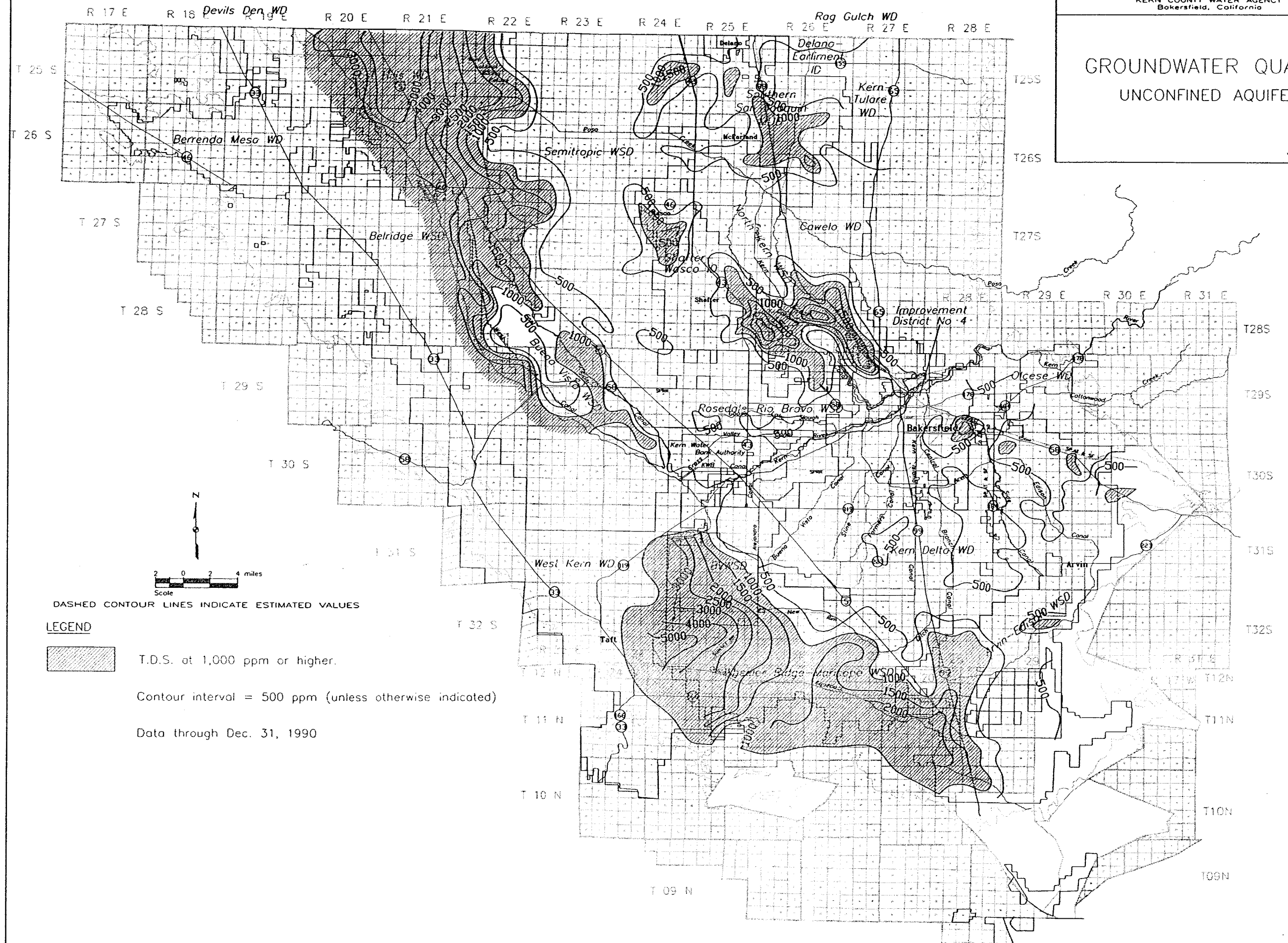
FEBRUARY 2003



KERN COUNTY WATER AGENCY  
Bakersfield, California

# GROUNDWATER QUALITY UNCONFINED AQUIFER

JULY 1997



DASHED CONTOUR LINES INDICATE ESTIMATED VALUES

## LEGEND



T.D.S. at 1,000 ppm or higher.

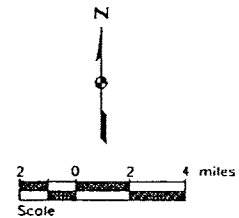
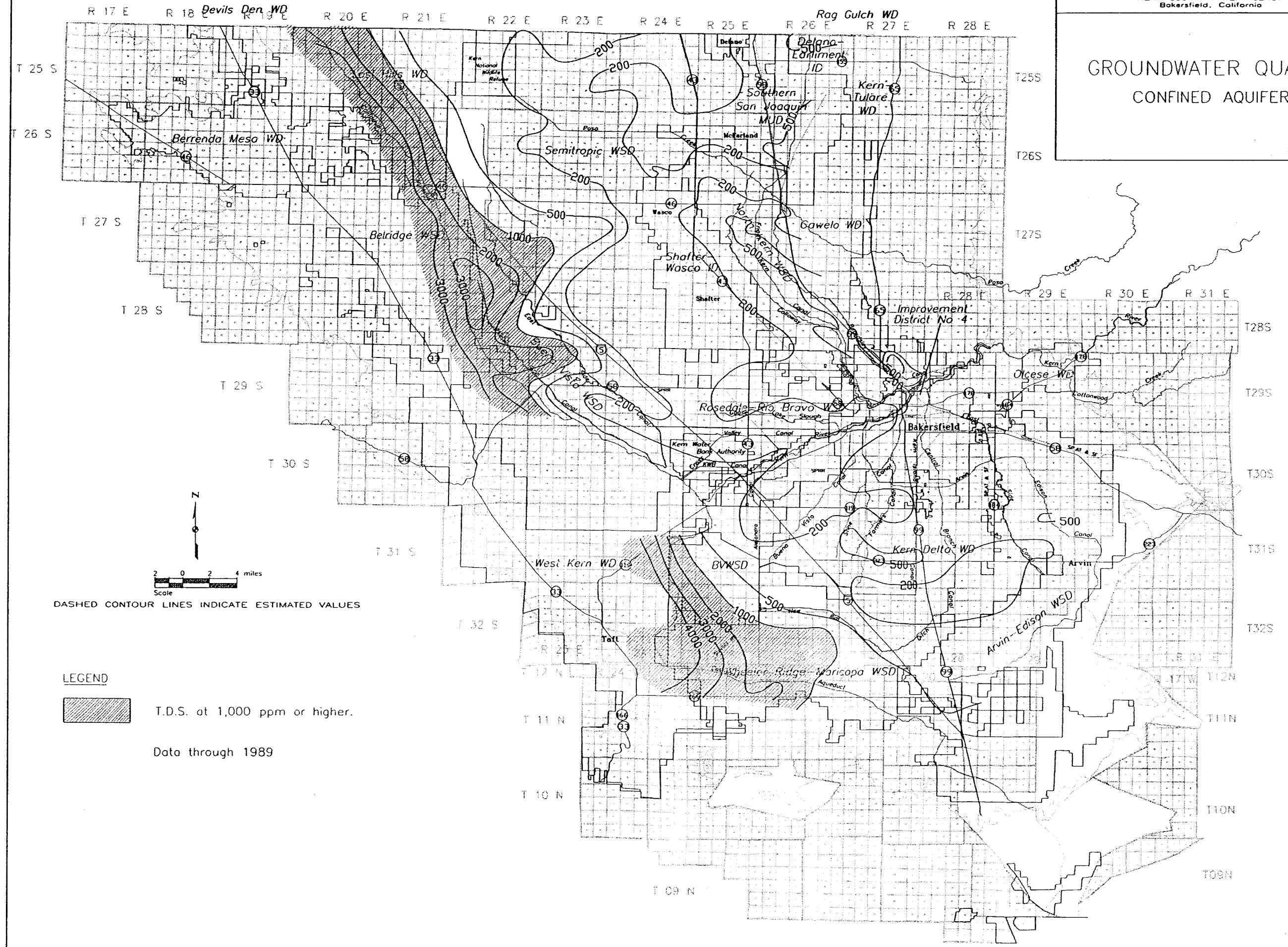
Contour interval = 500 ppm (unless otherwise indicated)

Data through Dec. 31, 1990

KERN COUNTY WATER AGENCY  
Bakersfield, California

# GROUNDWATER QUALITY CONFINED AQUIFER

MARCH 1997



DASHED CONTOUR LINES INDICATE ESTIMATED VALUES

## LEGEND

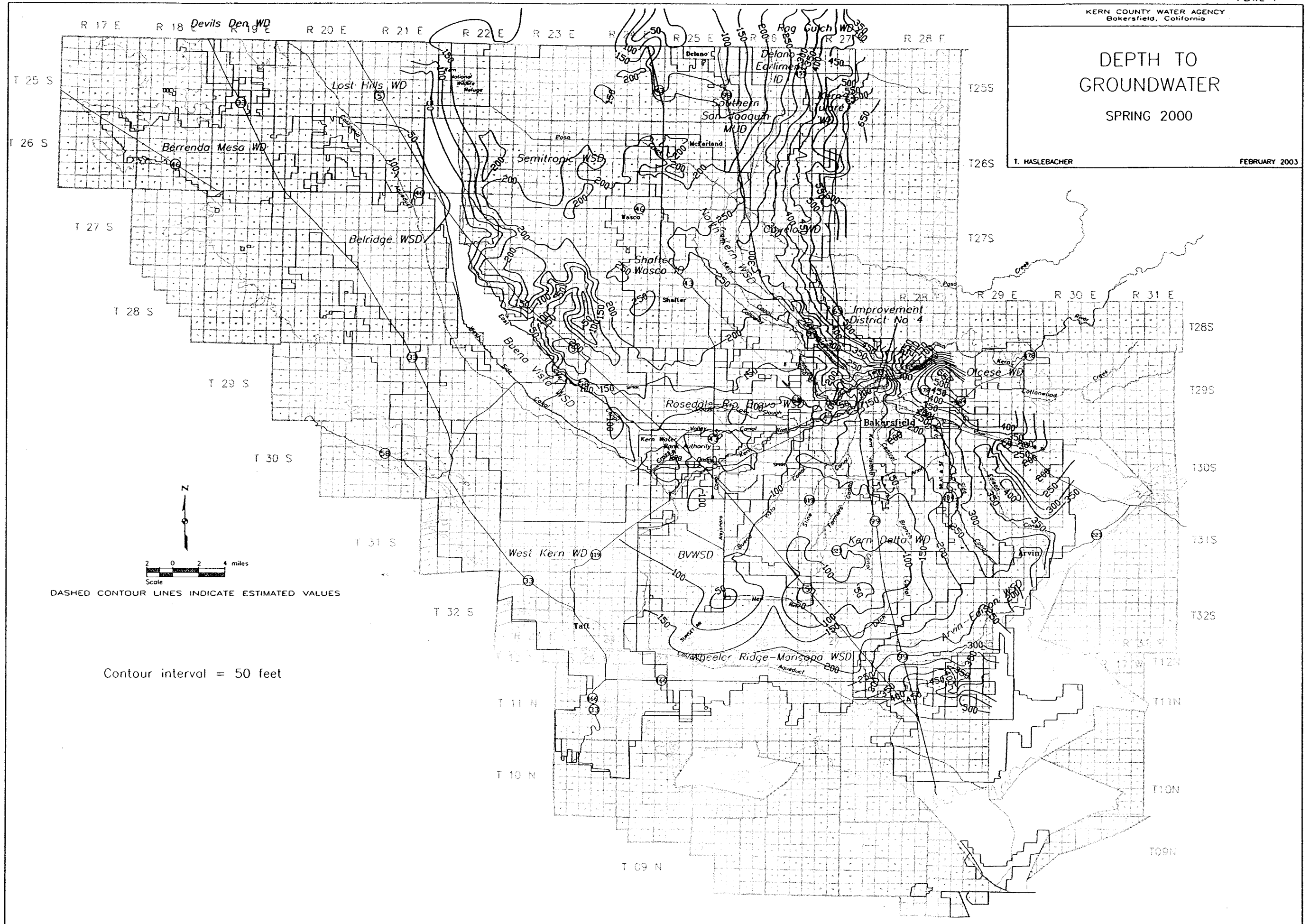
-  T.D.S. at 1,000 ppm or higher.
- Data through 1989

KERN COUNTY WATER AGENCY  
Bakersfield, California

# DEPTH TO GROUNDWATER SPRING 2000

T. HASLEBACHER

FEBRUARY 2003



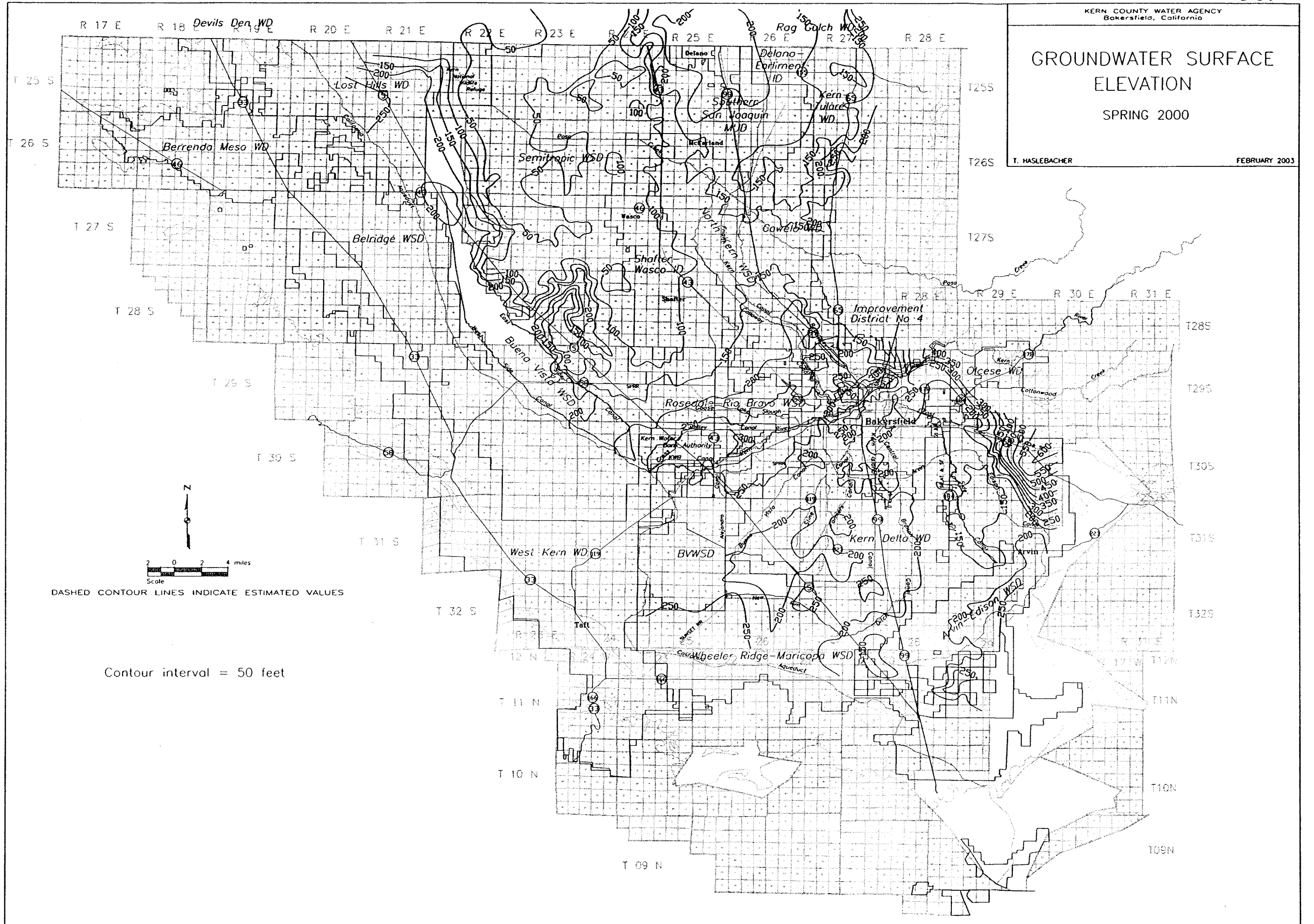
KERN COUNTY WATER AGENCY  
Bakersfield, California

# GROUNDWATER SURFACE ELEVATION

SPRING 2000

T. HASLEBACHER

FEBRUARY 2003



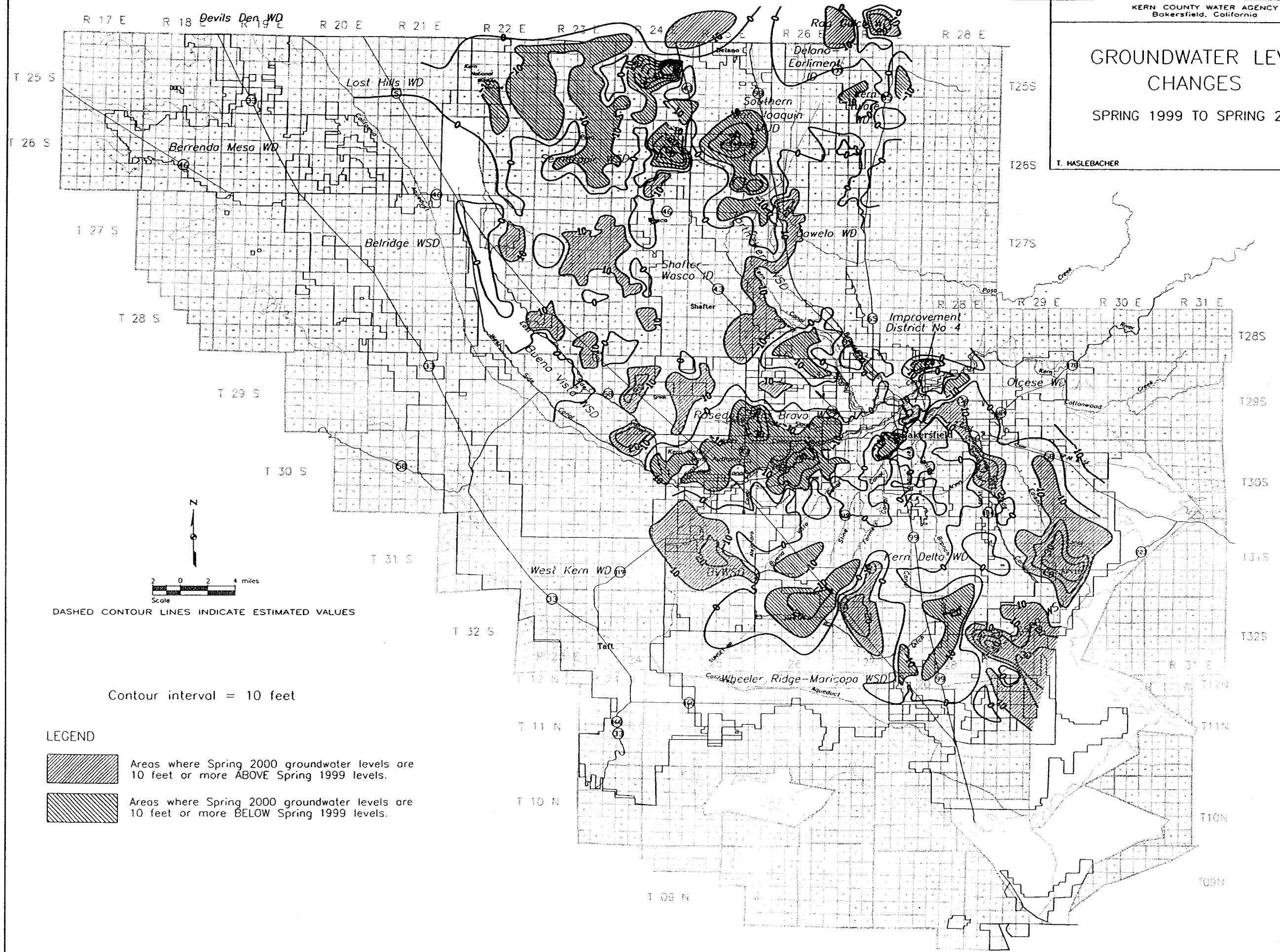
KERN COUNTY WATER AGENCY  
Bakersfield, California

# GROUNDWATER LEVEL CHANGES

SPRING 1999 TO SPRING 2000

T. HASLEBACHER

FEBRUARY 2003

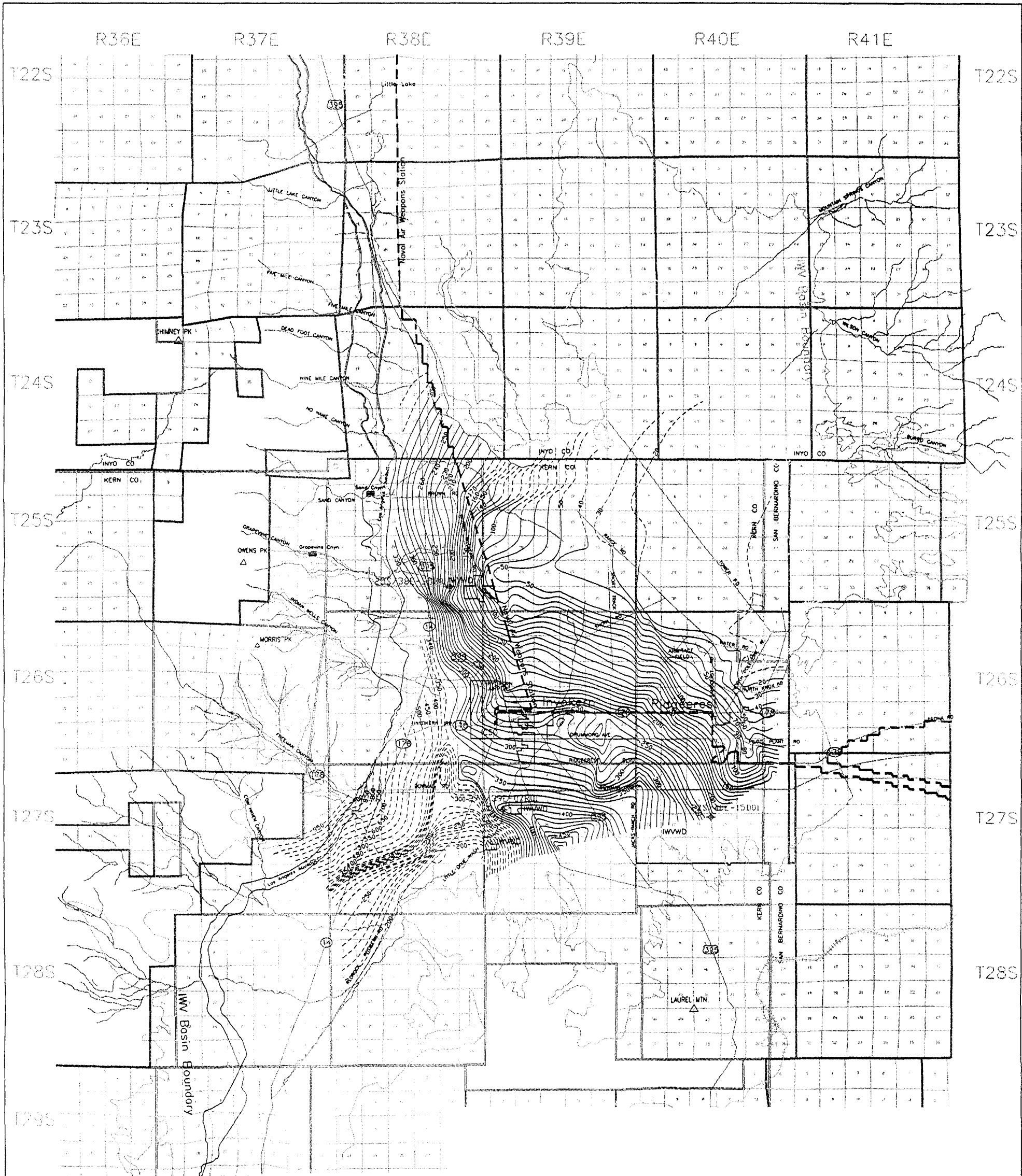


DASHED CONTOUR LINES INDICATE ESTIMATED VALUES

Contour interval = 10 feet

## LEGEND

-  Areas where Spring 2000 groundwater levels are 10 feet or more ABOVE Spring 1999 levels.
-  Areas where Spring 2000 groundwater levels are 10 feet or more BELOW Spring 1999 levels.



27/40-1501  
HYDROGRAPH WELL  
STREAM RECORDING  
STATION (KCWA)  
CONTOUR INTERVAL=10'  
DASHED CONTOUR LINES INDICATE ESTIMATED VALUES

KERN COUNTY  
WATER AGENCY

0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100

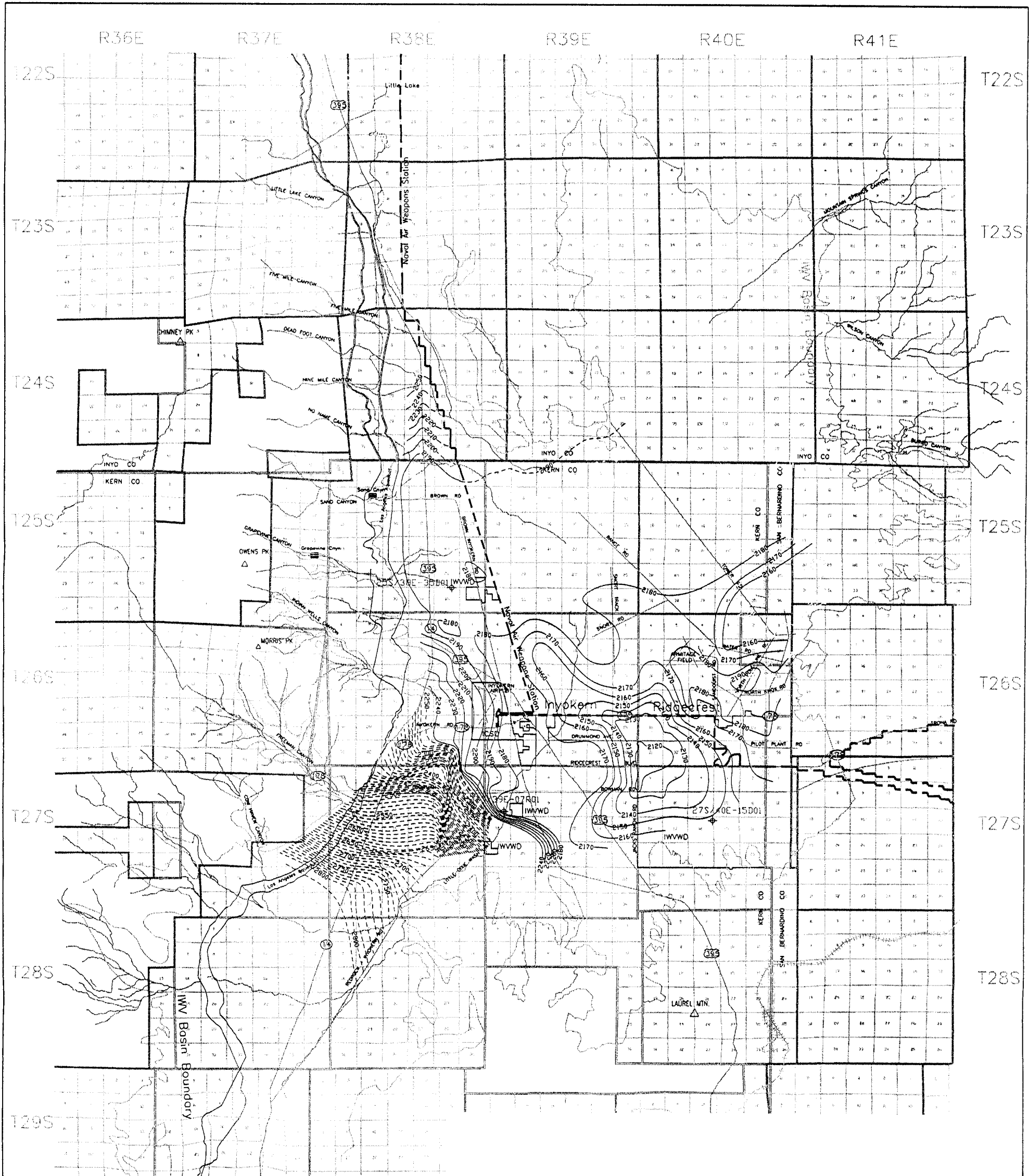
T.HASLEBACHER

Kern County Water Agency  
Kern County, California  
INDIAN WELLS VALLEY  
DEPTH TO GROUNDWATER  
SPRING 2000

(based on NIMA Survey Data)

MARCH 2003

PLATE 7



27/40-1501  
HYDROGRAPH WELL  
STREAM RECORDING STATION (KCWA)  
CONTOUR INTERVAL=10'  
DASHED CONTOUR LINES INDICATE ESTIMATED VALUES

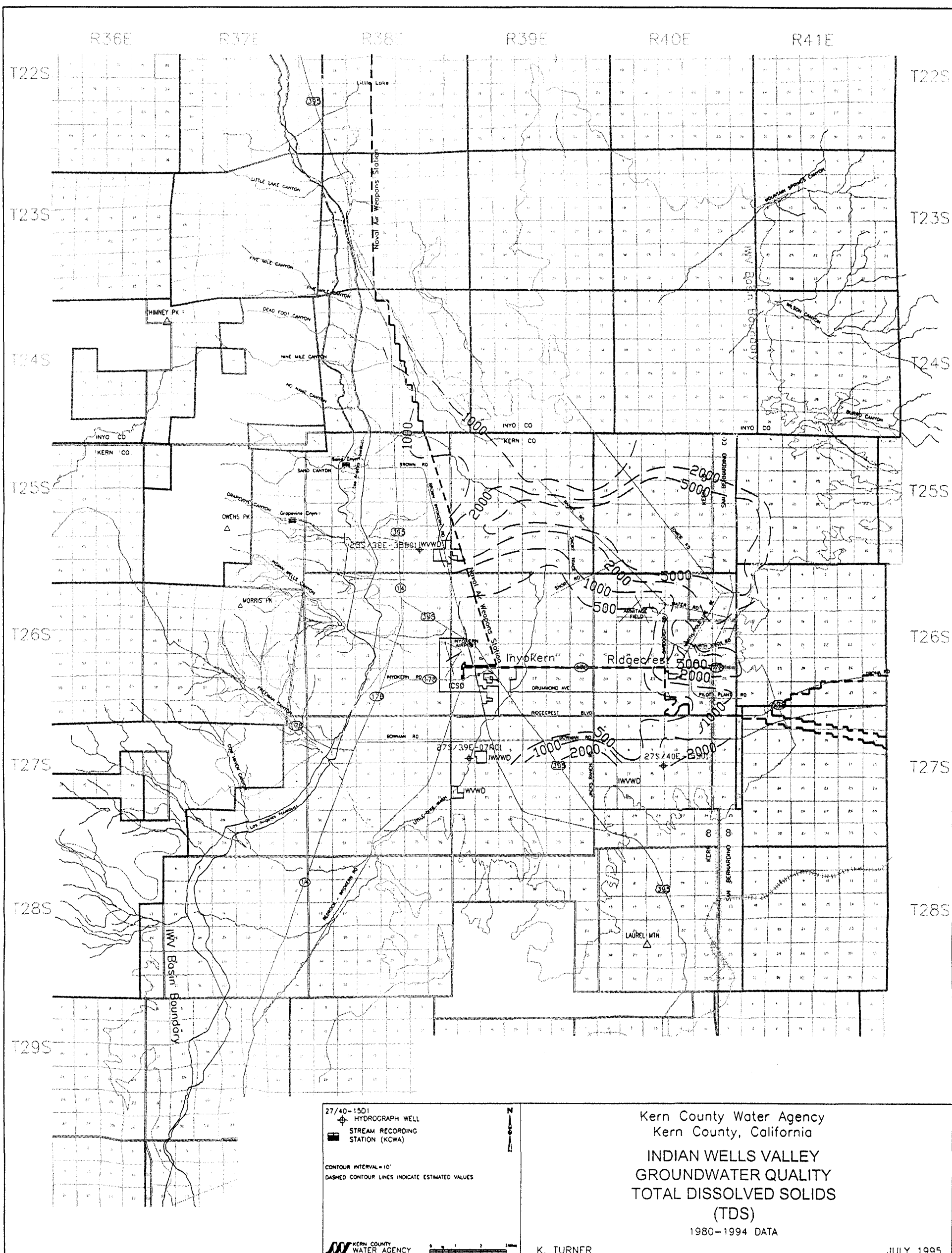
KERN COUNTY WATER AGENCY

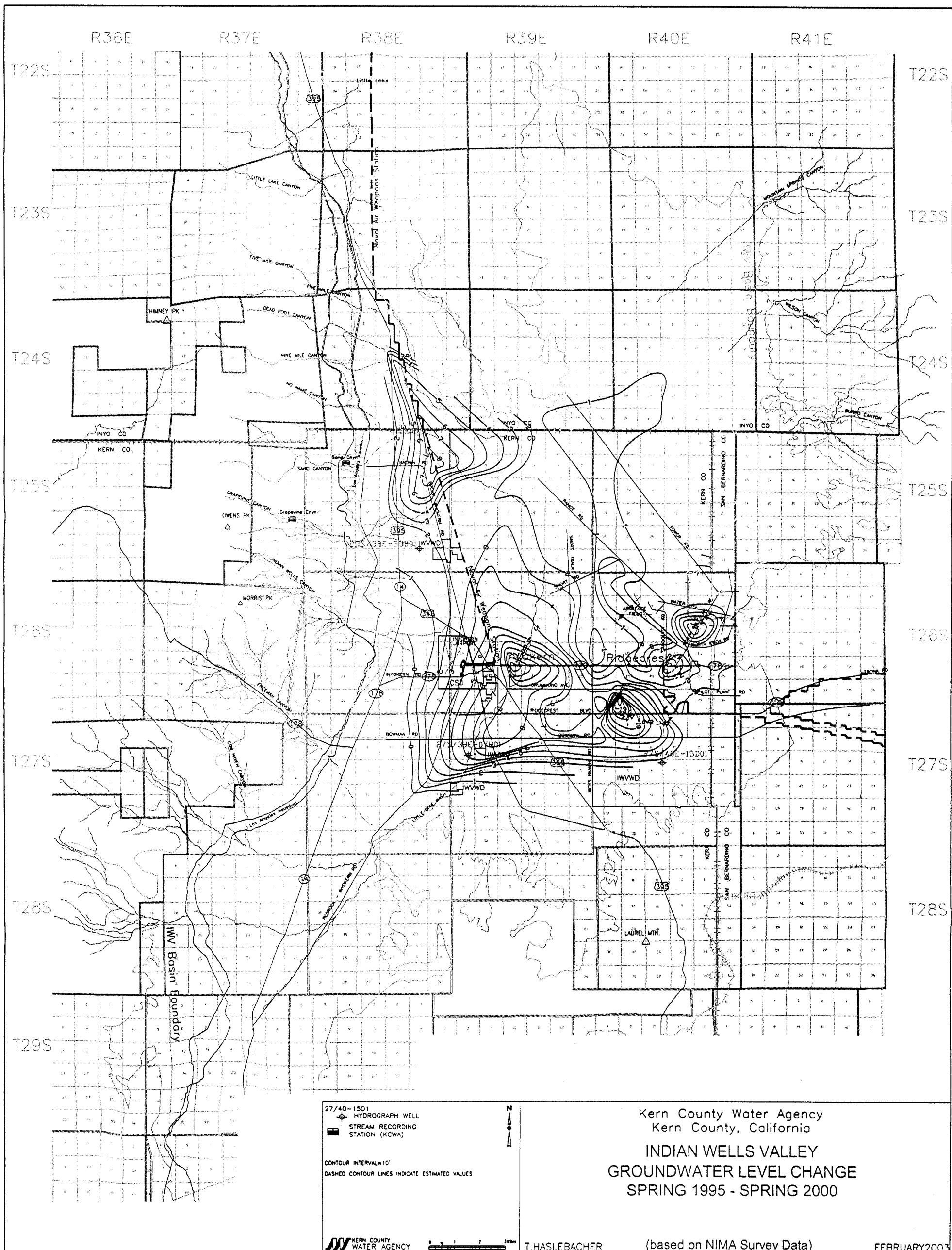
Kern County Water Agency  
Kern County, California

INDIAN WELLS VALLEY  
GROUNDWATER SURFACE ELEVATION  
SPRING 2000

T.HASLEBACHER (based on NIMA Survey Data)

MARCH 2003





27/40-1501  
HYDROGRAPH WELL  
STREAM RECORDING  
STATION (KCWA)  
CONTOUR INTERVAL=10'  
DASHED CONTOUR LINES INDICATE ESTIMATED VALUES

Kern County Water Agency  
Kern County, California  
INDIAN WELLS VALLEY  
GROUNDWATER LEVEL CHANGE  
SPRING 1995 - SPRING 2000