Kern County Water Agency

Water Supply Report 1993

February 1995

Kern County Water Agency

WATER SUPPLY REPORT
1993

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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 five 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 = 450 gallons per minute
= 646,360 gallons per day
= 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 strata 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 extracted.

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) .0012335 = cubic hectometers
Feet (x) .0348 = meters
Inches (x) 2.54 = centimeters
Million gallons per day (x) .043813 = cubic meters per second

Overdraft A long-term condition in which groundwater extractions exceed 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 Folsum 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 strata 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 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 man's activities in Kern County. For instance, the natural pattern of evapotranspiration has been altered by the planting and harvesting of crops. Groundwater storage has been affected by 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 efforts have had a positive effect upon groundwater storage.

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.

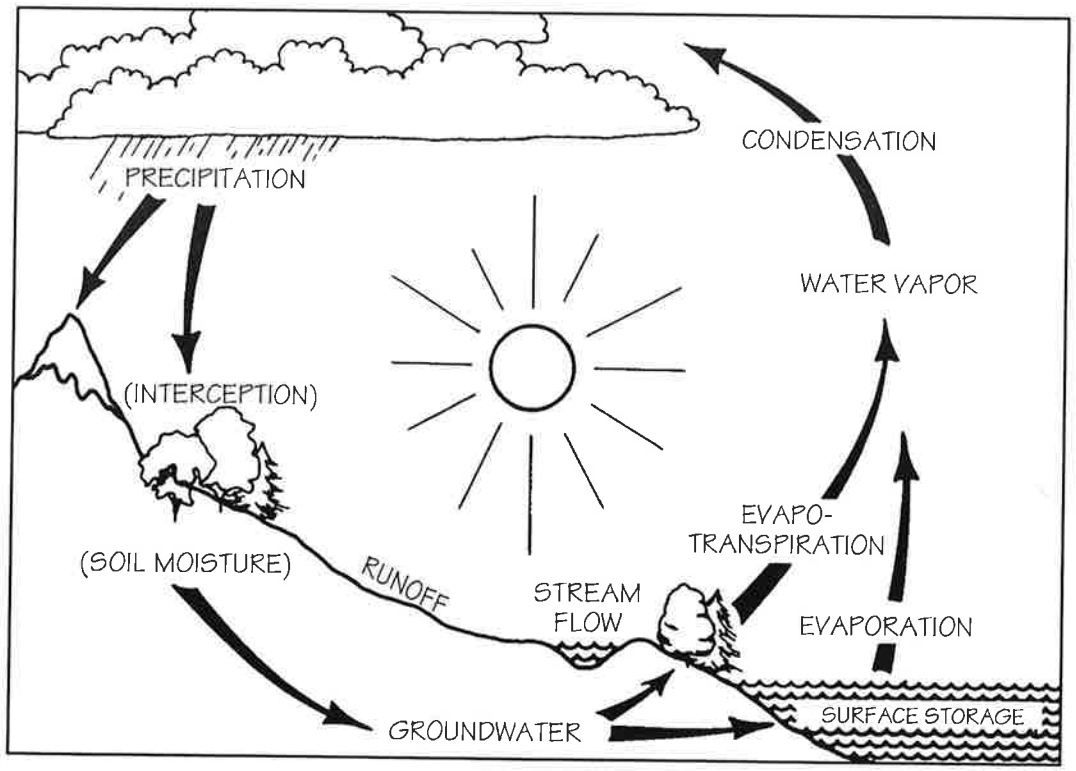


Figure 1. The Hydrologic Cycle

1993: The End of the Drought

The end of the 1987-92 drought was officially declared by Governor Pete Wilson on February 24, 1993. The Governor's proclamation ended one of California's worst droughts this century. Only one other drought compared with the 1987-92 period; the 1928-34 drought was slightly drier. The end of the drought signaled the first time since 1989 that full State Water Project ("SWP") supplies were available, as well as full Class I and Class II entitlements for Friant-Kern contractors. Federal contractors served from the Delta continued to suffer from drought-like conditions. Only 50 percent of Class I entitlements were approved for the Central Valley Project's Delta export contractors.

The water year didn't start out rosy. Initially, it looked like the drought would continue into 1993. Storage reservoirs had been severely depleted by the previous drought years. Beginning in December 1993 several storm systems hit the state. By the end of January 1994 the Feather River watershed's snowpack water content stood at 180 percent of normal. Once-depleted reservoirs filled rapidly from the heavy rains and snowmelt.

The Sacramento River Index ("SRI") is used to reflect SWP water supply conditions. The average SRI over 88 years of record is 17.7 million acre-feet ("MAF"). Any year with an index less than 10.2 MAF is classified as critically dry. Any year with an index greater than 19.6 MAF is classified as wet. Thus, 1993 was officially a wet year with an SRI of 22.4 MAF. Table 1 is a history of Sacramento River Indices. Figure 2 shows the same information graphically.

Another event that figured into 1993's water supply picture was the State Water Resources Control Board's ("SWRCB") proposed Decision 1630 ("D-1630"). This Decision would have modified the water quality standards for the Sacramento-San Joaquin Delta. Governor Pete Wilson had asked the SWRCB to develop interim water quality standards on a 'fast track' until final standards could be developed over the course of several years. Released December 10, 1992 D-1630 was ostensibly designed to halt the decline of fishery resources in the Delta and San Francisco Bay. D-1630's impacts on areas dependent upon Delta waters would have been dramatic and devastating. A high level of uncertainty was created over how the state and federal water supply projects would operate under D-1630's regulatory regime. Ultimately, D-1630 was shelved because of widespread opposition and the fact that federal agencies were already proposing to restrict Delta flows under authority of the federal Endangered Species Act ("ESA") and the Clean Water Act.

Surface water supplies from all sources during 1993 were about 2,598,000 acre-feet. Normal supplies are about 2,200,000 acre-feet. Therefore, water availability in 1993 was about 118 percent of normal. SWP deliveries from all sources totaled 1,219,653 acre-feet. Kern River supplies were 644,921 acre-feet, or 88 percent of average. Central Valley Project deliveries totaled 489,783 acre-feet, or 131 percent of the 1975-93 average.

Even with the return of normal water supplies, nearly 100,000 acres of farm land (mostly west side lands) remained idle during 1993. Irrigated acreage was 800,100 acres, slightly more than in 1992. Irrigated acreage did not significantly increase along with the water supply because the SWP water was allocated too late for farmers to use. The state Department of Water Resources ("DWR") didn't increase allocations to 100 percent until April 16, 1993. By then it was too late for farmers to make marketing and financing arrangements, and past the planting time for the major annual crops grown in Kern County. Operational restrictions on the SWP to protect two endangered fish species caused DWR to increase contractor's allocations more cautiously than in prior years. In spite of a northern California snowpack that was 180 percent of normal in January 1993, federal ESA-imposed pumping restrictions created a high degree of operational uncertainty for the SWP. Consequently, full entitlements weren't allocated until late-April 1993, nearly two months after the drought was officially declared ended.

The late allocation of SWP water meant that water would be available from some west side water districts for ground water programs. Early in the year KCWA formed plans for financing and implementing a ground water program using excess water from the west side districts. The "Settlement Allocation Fund" was used to pay part of the costs for the ground water program.

The change in ground water storage in 1993 was an increase of about 215,400 acre-feet. This marks the

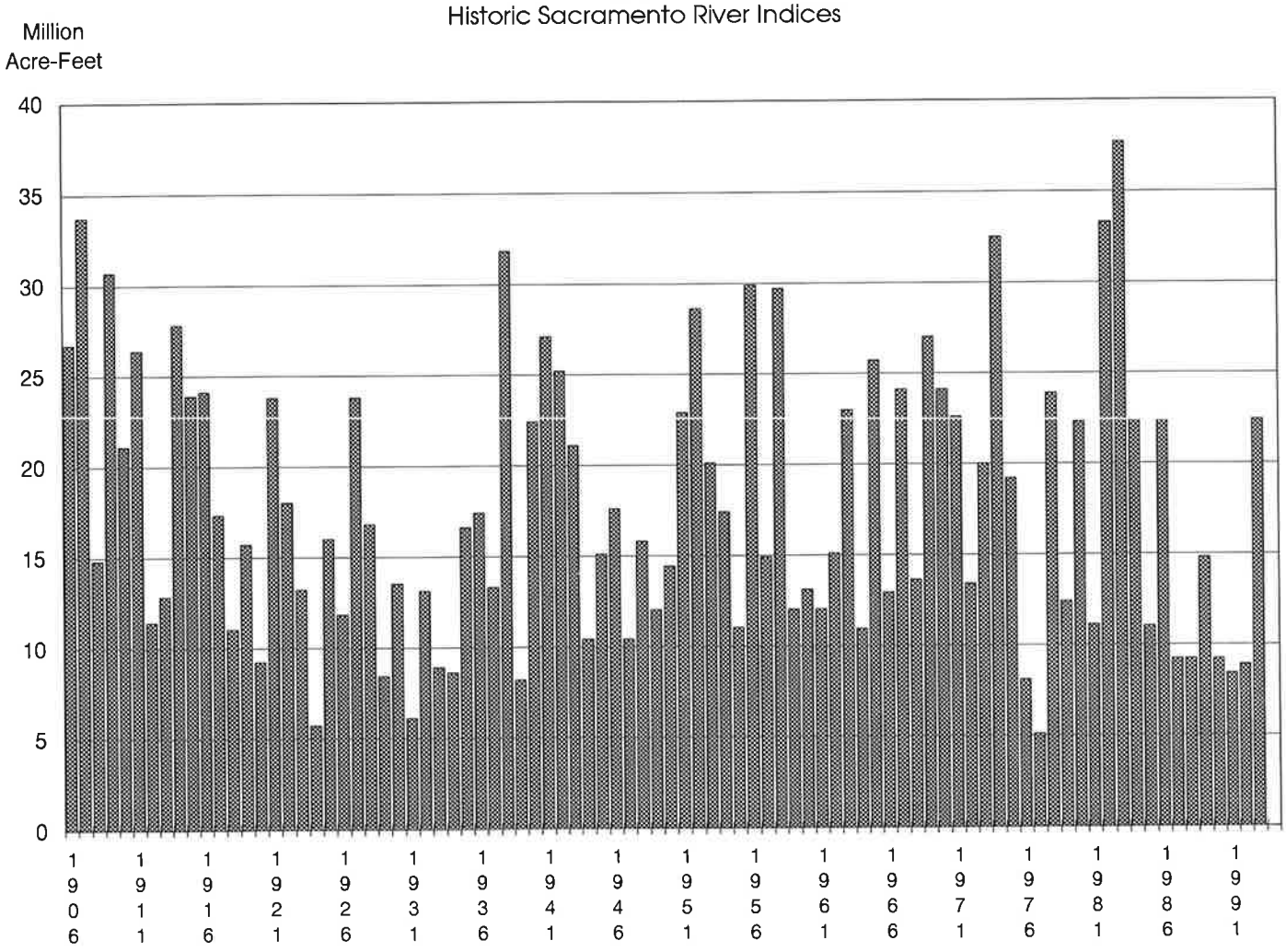
Table 1
Historic Sacramento River Indices *
(in million acre-feet)

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

88 years of record	
Average SRI	17.7
Median SRI	15.9

* 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 Folsum Reservoir. Formerly called Four-basin Index.

Figure 2
Historic Sacramento River Indices



first time since before the drought that an increase in ground water storage has occurred. The total withdrawals since 1970 have been about 11,900,000 acre-feet. The total additions to storage over the same period have been about 5,551,000 acre-feet. The net change in storage since 1970 has been a loss of about 6,342,000 acre-feet, or about 265,000 acre-feet per year. In terms of volume of water stored, the ground water basin is at a level below the last drought. During the six years of the 1987-92 drought, about 5,390,000 acre-feet was mined, or about 898,000 acre-feet per year. Even though 215,400 acre-feet was added to storage in 1993, it will take many years to recover the ground water basin to pre-drought conditions.

Water Supplies

State Water Project

On December 1, 1992 the Department of Water Resources announced their initial allocation of State Water Project supplies for 1993. Expectations were that the allocation would be small, since SWP reservoir storage was at historic lows after six years of drought. DWR made a conservative initial allocation of 10 percent of requested 1993 SWP entitlement. For Kern County Water Agency ("KCWA"), this amounted to 101,700 feet for agricultural use and 13,600 acre-feet for urban uses. DWR's low initial allocation reflects the uncertainty of the SWP's water delivery capabilities. Pumping restrictions to protect Winter Run Salmon, the impact of the State Water Resources Control Board's proposed interim water quality standards for the Delta, and a possible continuation of the drought have all complicated DWR's operational planning.

Above-average winter and early spring storms throughout California dramatically increased mountain snowpacks. In January 1993 DWR increased allocations to 25 percent of requests. Allocations were increased in 15 percent increments until a final allocation of 100 percent of revised requests was made in April. The chronology of 1993 allocations follows:

December 1, 1992	10 percent (initial allocation, original requests)
January 13, 1993	25 "
January 26	40 "
February 15	55 "
March 4	70 "
March 19	85 "
April 16	100 " (revised requests)

The low initial allocation left local water users again facing the problem of dealing with inadequate surface water supplies. Anticipating another low water supply year, in December 1992 KCWA began planning for a 1993 Emergency Water Supply Program. Emphasis was placed on purchasing any available surface supplies to offset shortages. Specifically, DWR was developing a 1993 State Bank, which local districts could draw upon if needed. Ground water bank accounts would only be pumped as a last resort. Potentially, ground water accounts could have yielded about 76,000 acre-feet (41,000 acre-feet for KCWA, the rest belonging to specific districts). With the February increase in SWP water allocation, the 1993 Emergency Water Supply Program was no longer necessary.

DWR's final allocation of 100 percent of requests was good news for KCWA. However, the lateness of the final allocation made it impossible for some of the water to be used for crop irrigation. Some water districts on the west side of Kern County rely exclusively on the SWP for irrigation supplies. Farmers must make marketing and financial arrangements for their crops early in the year. Field preparation and pre irrigation is also done early in the year. The caution with which DWR approached their allocations in 1993 made it uncertain whether sufficient water would be available to grow a crop to harvest.

As the need for an emergency water supply program diminished, the need for a ground water recharge program heightened. The local Kern River was expected to yield higher than normal runoff. The Friant-Kern system received above average rain and snowfall, and was expected to make some flood control releases from Millerton Lake. Also, the water allocated to still-idled west side lands could now be used for ground water programs. Early in the year KCWA began to formulate plans for financing and implementing a ground water program. Part of the financing would be via the "Allocation Settlement Fund." This special fund was established by KCWA in 1989 as part of a court settlement to ensure that all SWP entitlement allocated to Kern County was retained and used within Kern County. The fund provides a financing mechanism for purchasing marketed water.

The final 1993 Water Management Program was aimed at maximizing the use of SWP water within Kern County. A total of 206,341 acre-feet of SWP water was made available to the program, mostly by west side districts with still-idled lands. Expenditures from the Allocation Settlement Fund to support the program were $6.0 million.

Water transfers were a key element of the 1993 program. KCWA made use of water transfers that avoided the Cross Valley Canal. Thus, a cost savings for the overall program was realized. Areas served by the Friant-Kern system (on the east side of the valley) delivered water into the Kern River channel. The

water was transported by gravity downstream to areas that normally would have required conveyance up the Cross Valley Canal ("CVC").

A special water transfer program was developed with Westlands Water District. During 1993 federal Friant-Kern contractors were allocated their full Class I amounts, plus 87 percent of their Class II entitlements. Federal contractors served from the Delta-Mendota Canal were only allocated 50 percent of their Class I entitlements. Because of the low allocation, Westlands purchased some water from Friant-Kern contractors on the eastern part of the valley. The water could have been delivered to Westlands via the San Joaquin River. However, percolation losses would have exceeded 50 percent. Instead, Kern County Water Agency exchanged SWP entitlement for the Friant-Kern water. KCWA's SWP water was delivered to Westlands via the California Aqueduct. This avoided the high losses that would have occurred on the San Joaquin River. The Friant-Kern water from the sellers was delivered into the Kern River channel via the Friant-Kern Canal. From there, the water was diverted to recharge areas and water districts. A total of 77,600 acre-feet of water was delivered in this manner as part of the Westlands exchange program.

Westlands WD paid exchange fees totaling $451,000 to KCWA (slightly less than $6 per acre-foot). Proceeds from the exchange fee were distributed to those districts that received the exchange water from the Friant-Kern Canal.

Another benefit from the Westlands exchange program involved avoidance of the Cross Valley Canal. In order to get SWP water into ground water recharge facilities, the water must be conveyed up the CVC through at least four pumping plants. Energy costs for CVC pumping would have been about $10 per acre-foot. Delivering Westlands' Friant-Kern supply via the Kern River channel avoided these four CVC pumping plants, saving the $10 per acre-foot pumping costs. Innovative water management programs such as this are not only beneficial from a water supply perspective. They also are environmentally beneficial by saving energy.

Article 12(d) of the master contract between DWR and KCWA provides for future repayment of entitlement water that DWR is unable to deliver because of causes beyond its control. Such "12(d) water" will be delivered in succeeding years on an as-available basis. Article 12(d) was triggered in 1990 by the 50 percent agricultural reduction, and again in 1991 with the 100 percent agricultural and 70 percent urban reduction of requested SWP entitlement. The 55 percent agricultural and urban reduction in 1992 further added to KCWA's 12(d) credit. At the end of 1992, KCWA had a 12(d) credit of 2,267,202 acre-feet, nearly equal to two years of full entitlement. No 12(d) water was delivered in 1993, so KCWA's balance remains at 2,267,202 acre-feet. Terms under which 12(d) water will be delivered have not yet been decided. Furthermore, since the State Water Project is only half-completed, it is unlikely that the balance will ever be fully repaid.

Water Year	12(d) Account	12(d) Delivered	Balance
1990	516,900	0	516,900
1991	1,117,520	0	1,634,420
1992	632,782	0	2,267,202

A detailed summary of present member unit balances of 12(d) water is shown in Table 2a.

KCWA's annual entitlement to SWP water is according to a buildup schedule in the master contract. The buildup provided for increasing amounts of water beginning in 1968, reaching a maximum in 1990. Contracts between KCWA and its member units provided for additional decreasing amounts of surplus water, reaching a minimum of 100,000 acre-feet in 1990. The surplus water would be delivered on an as-available basis. When KCWA signed its master contract with DWR, it was envisioned that the State Water Project would be completed, and that some surplus water would be available during most years. Member units' contract entitlement for 1990 and after are shown on Table 2b. The table also breaks down 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 of 1,219,653 acre-feet of SWP water was delivered during 1993. Of this amount, 1,127,774 acre-feet was 1993 SWP entitlement, and 40,156 acre-feet was 1992 entitlement delivered in 1993. Another 50,000 acre-feet was delivered to Semitropic Water Storage District by Metropolitan Water District of Southern California as part of a joint banking program. The remaining 1,723 acre-feet were miscellaneous

Table 2a
Kern County Water Agency
State Water Project
Article 12(d) Account
(in acre-feet)

Member Unit	Article 12(d) Acquired 1990	1991	1992	Total	Article 12(d) Delivered	Available Balance
Berrenda Mesa WD	77,505	155,073	85,091	317,669	0	317,669
Lost Hills WD	70,159	140,376	77,027	287,562	0	287,562
Belridge WSD	81,453	162,972	89,426	333,851	0	333,851
Buttonwillow ID	41,476	82,986	45,536	169,998	0	169,998
Pond Poso ID	33,480	66,988	36,758	137,226	0	137,226
Semitropic WSD	3,998	7,999	4,389	16,386	0	16,386
Cawelo WD	19,089	38,193	20,957	78,239	0	78,239
Improvement District No. 4 (Ag)	5,135	10,274	5,638	21,047	0	21,047
Improvement District No. 4 (M&I)	0	53,900	42,244	96,144	0	96,144
Rosedale-Rio Bravo WSD	14,941	29,895	16,404	61,240	0	61,240
Buena Vista WSD	10,644	21,296	11,685	43,625	0	43,625
Kern Delta WD	12,742	25,495	13,990	52,227	0	52,227
Henry Miller WD	17,740	35,494	19,476	72,710	0	72,710
West Kern WD (M&I)	0	17,500	13,716	31,216	0	31,216
Wheeler Ridge-Maricopa WSD	126,389	252,880	138,760	518,029	0	518,029
Tehachapi-Cummings CWD (Ag)	2,149	4,299	2,359	8,807	0	8,807
Tehachapi-Cummings CWD (M&I)	0	10,500	8,229	18,729	0	18,729
Tejon-Castac WD (M&I)	0	1,400	1,097	2,497	0	2,497
Total	**516,900**	**1,117,520**	**632,782**	**2,267,202**	**0**	**2,267,202**

Table 2b
Kern County Water Agency
Member Unit Contract Entitlements
for 1990-2035

Member Unit	Firm	Surplus (1)	Total	M&I	Ag	Total
Berrenda Mesa WD	155,100	8,100	163,200		163,200	163,200
Lost Hills WD	140,400	0	140,400	2,000 (2)	138,400	140,398
Belridge WSD	163,000	0	163,000	15,000 (2)	148,000	162,998
Buttonwillow ID	83,000	13,100	96,100		96,100	96,100
Pond Poso ID	67,000	11,100	78,100		78,100	78,100
Semitropic WSD	8,000	900	8,900		8,900	8,900
Cawelo WD	38,200	6,800	45,000		45,000	45,000
Improvement District No. 4	87,276	1,554	88,830	77,000	11,830	88,830
Rosedale-Rio Bravo WSD	29,900	5,100	35,000		35,000	35,000
Buena Vista WSD	21,300	3,750	25,050		25,050	25,050
Kern Delta WD	25,500	4,500	30,000		30,000	30,000
Henry Miller WD	35,500	6,250	41,750		41,750	41,750
West Kern WD	25,000	0	25,000	25,000		25,000
Wheeler Ridge-Maricopa WSD	252,924	38,146	291,070		291,070	291,070
Tehachapi-Cummings CWD	19,300	700	20,000	15,000	5,000	20,000
Tejon-Castac WD	2,000	0	2,000	2,000		2,000
Total	**1,153,400**	**100,000**	**1,253,400**	**136,000**	**1,117,400**	**1,253,400**

Note: Maximum annual entitlement is reached in 1990.

(1) Surplus water is part of Kern County Water Agency's contracts with its member units, but is not provided as part of KCWA's master contract with the state Department of Water Resources. It is only delivered on an as-available basis, and reached its minimum in 1990.

(2) Agricultural entitlement converted to M&I use; retains agricultural delivery priority.

deliveries. Since the first deliveries in 1968, a total of 19.4 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 shown. Table 4 shows 1993 SWP deliveries by contract type.

The State Water Resources Control Board's proposed water rights Decision 1630 was released December 2, 1992. From its onset D-1630 was controversial. The proposed standards were requested by Governor Pete Wilson as an interim step to protect fishery resources in the Sacramento-San Joaquin Delta until final standards could be finalized. D-1630 was hailed by the SWRCB as "a bold attempt to protect the environmentally sensitive estuary" while minimizing the effect on water supplies diverted upstream and within the Delta. In issuing the standards, the SWRCB hoped to stave off threats by the U.S. Environmental Protection Agency ("EPA") to impose its own Delta standards under authority of the federal Clean Water Act.

Some provisions of D-1630 would have been crippling to the SWP and CVP Delta water supply projects:

- Increased pumping constraints on the SWP and CVP would be imposed through establishment of flow criteria for the lower Sacramento River for every month of the year.

- "Pulse flows" would be required in the spring and fall of each year to assist the out migration of salmon and striped bass. These pulse flows would have taken large amounts of water from upstream storage reservoirs.

- The Delta Cross Channel gates would be operated at the discretion of the SWRCB. In concert with state and federal wildlife agencies, the SWRCB would direct operation of the gates to protect migrating fish from becoming disoriented or lost. (The Delta Cross Channel allows Sacramento River water to be diverted into the internal Delta at the northern end. This allows for better water circulation in the internal Delta channels).

- Creation of a $60 million per year environmental restoration fund via fees charged for Delta water diversions. Upstream diverters would be assessed $5 per acre-foot, while exporters would be charged $10 per acre-foot. For KCWA, this fee would have raised water costs by 20 percent.

The various provisions of D-1630 would have taken from 800,000 to 1,900,000 acre-feet from water users in dry years for fish and wildlife purposes, without compensation and without providing identifiable wildlife benefits. DWR's early caution in allocating water supplies during 1993 (their initial allocation was 10 percent of requests) was partly due the uncertainty as to how D-1630 would affect SWP operations. In response to the water supply uncertainty surrounding D-1630, contractors for SWP water asked the state to suspend work on Los Banos Grandes (an off-stream reservoir) and Kern Water Bank (a conjunctive use ground water project). Also, water transfers across the Delta would have been nearly impossible if D-1630 had been implemented. Water transfers are viewed by many agencies and organizations as integral to meeting the state's long-term water supply needs.

Studies showed that the potential loss to the state's economy from D-1630 exceeded $13 billion annually. Within Kern County, whose economy is dependent upon agriculture, the economic loss could have been $300 million annually. West side agricultural lands that are entirely dependent upon SWP water would have been devastated. Long term, about 160,000 acres of prime agricultural land within Kern County could have gone out of production if D-1630 were implemented. For the San Joaquin Valley, D-1630 would have caused about 250,000 acres to be permanently idled. Statewide, the number of jobs lost could have exceed 90,000. Within Kern County, about 8,700 jobs would have been lost.

The long-term impacts of D-1630 were even more devastating. D-1630 would have guaranteed permanent water shortages for areas dependent upon Delta export water. For Kern County, the long-term economic losses associated with permanently idling 160,000 acres exceeded $12 billion. Losses of this magnitude from the local economy would have caused a major downsizing in agriculture. This downsizing would have severely threatened the economic stability of local water districts, county government, the State Water Project and the state of California.

On April 1, 1993 Governor Wilson asked the SWRCB to cease work on D-1630 and focus on developing long term water quality standards for the Delta. By then, the National Marine Fisheries Service ("NMFS") had already adopted some of the operational features of D-1630 and were requiring their implementation via the federal Endangered Species Act. Specifically,

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

Year	Annual (1) Deliveries	Cumulative Deliveries	Intertie Deliveries	Deliveries (2) Outside SJV	Annual Importations	Cumulative 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	34,865 (4)	17,763,127 (4)		2,213	32,656	17,107,407
1992	421,520	18,184,647		3,508	418,012	17,525,419
1993	1,219,653 (3)	19,404,300		14,139	1,205,514	18,730,933

Mean Deliveries	727,387 AF
Median Deliveries	828,437 AF
Mean Importations	701,807 AF
Median Importations	821,738 AF

(1) Includes Pre-consolidation water deliveries, 1977 Dry Year Pool, 1991 State Bank water.
(2) Includes Tehachapi-Cummings CWD and other deliveries outside the San Joaquin Valley portion of Kern County. Beginning in 1990, also includes local ground water programs.
(3) From Table 4.

Table 4
1993 State Water Project Deliveries by Contract
(in acre-feet)

District	No.1 Table A Entitlement	No.2 1992 Entitlement Carryover	No.3 Water Management Program Sales	No.4 Water Management Program Purchases	No.5 Long-Term M&I Pool	No.6 Landowner Transfers	No.7 Misc. Exchanges/ Transfers	No.8 KCWA Banking Program	No.9 Misc. Banking Programs	No.10 Total 1993 Entitlement
			State Water Project Supplies Entitlement Transfers, Exchanges and Banking Programs							
Berrenda Mesa WD	155,100	6,113	(67,000)	4,494				(7,000)	(943) (14)	90,764
Lost Hills WD	140,400	14,592	(22,000)			(16,317) (3)		(21,000)	(10,224) (15)	85,451
Belridge WSD	163,000	7,714	(74,000)	4,723		2,500		(6,100)	(8,159) (16)	89,678
Buttonwillow ID	83,000	617		75,304		3,817	(26,432) (4)		(30,000)	106,306
Pond Poso ID	67,000									67,000
Semitropic WSD	8,000									8,000
Cawelo WD	38,200	637		482			(35,500) (5)			3,819
Improvement Dist. No. 4 Ag	10,276									10,276
M&I	77,000	(1,083) (1)		10,722	5,310		9,984 (6)	(20,789)		81,144
Rosedale-Rio Bravo WSD	29,900	(90) (1)		25,826			24,500 (7)			80,136
Buena Vista WSD	21,300	21		35,909			93,628 (8)			150,858
Kern Delta WD	25,500			10,807			(30,622) (9)			5,685
Henry Miller WD	35,500	664		37,350			(16,707) (10)			56,807
West Kern WD	25,000			724	5,310		(30,405) (11)			629
Wheeler Ridge-Maricopa WSD	252,924	10,370	(38,066)					(40,000)	(18,418) (17)	166,810
Tehachapi-Cummings CWD Ag	4,300	320	(1,335)							3,285
M&I	15,000	54	(1,940)		(10,620)					2,494
Tejon-Castac WD	2,000		(2,000)							-
Banking Programs										
KCWA								94,889		94,889
Kern-Tulare/Rag Gulch									27,582	27,582
ID#4									10,162	10,162
STWSD/Cawelo WD									30,000	30,000
Subtotal								**94,889**	**67,744**	**162,633**
Exchanges/Transfers										
Westlands WD						10,000				10,000
Lower Tule River ID										-
Arvin-Edison WSD		227 (2)					5,122 (12)			5,349
North Kern WSD							6,432 (13)			6,432
Subtotal		**227**				**10,000**	**11,554**			**21,781**
Total	**1,153,400**	**40,156**	**(206,341)**	**206,341**	-	-	-	-	-	**1,193,556**

Note: This table shows contracted deliveries for calendar year 1992. 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) Reflects 1992 SWP entitlement over delivery.

(2) Reflects conversions of Arvin-Edison WSD's 1992 State Bank purchase to SWP entitlement by delivery of Arvin-Edison WSD's State Bank water to ID No. 4.

(3) Includes 10,000 AF (Shannon) to Westlands WD; 1,618 AF (Westfarmers) to Semitropic WSD; 2,500 AF (Ritchie) to Buena Vista WSD; 1,382 AF (Westfarmers) to Semitropic WSD; 330 AF (Adelaida) to Semitropic WSD; 487 AF (Lost Hills UD) to Semitropic WSD).

(4) Includes 20,000 AF exchange payback to ID No. 4; includes 6,432 AF exchange to North Kern WSD.

(5) Includes 34,000 AF SWP/Kern River exchange to Buena Vista WSD; includes 1,500 AF exchange to Rosedale-Rio Bravo WSD.

(6) Includes 20,000 AF exchange payback to Semitropic WSD; includes 5,000 AF SWP/Kern River exchange to Rosedale-Rio Bravo WSD; includes 3,000 AF Friant-Kern exchange to Rosedale-Rio Bravo WSD; includes 2,016 AF exchange payback to Buena Vista WSD.

(7) Includes 15,000 AF banking/exchange from Henry Miller WD; includes 5,000 AF SWP/Kern River exchange from ID No. 4; includes 3,000 AF Friant-Kern exchange from ID No. 4; includes 1,500 AF exchange from Cawelo WD.

(8) Includes long-term exchange of 30,405 AF from West Kern WD and 25,500 AF from Kern Delta WD (SWP/Kern River exchange); includes 34,000 AF Kern River exchange from Cawelo WD; includes 1,707 AF exchange from Henry Miller WD; includes 2,016 AF exchange payback from ID No. 4.

(9) Includes 25,500 AF of long-term exchange to Buena Vista WSD; includes 5,122 AF exchange to Arvin-Edison WSD.

(10) Includes 15,000 AF banking exchange to Rosedale-Rio Bravo WSD; includes 1,707 AF exchange to Buena Vista WSD.

(11) Long-term exchange to Buena Vista WSD.

(12) Exchange between Kern Delta WD and Arvin-Edison WSD.

(13) Exchange of 6,432 AF from Semitropic WSD to North Kern WSD.

(14) Includes 689 AF through Kern-Tulare WD/Rag Gulch WD banking program; includes 254 AF through ID No. 4 banking program.

(15) Includes 7,471 AF through Kern-Tulare WD/Rag Gulch WD banking program; includes 2,753 AF through ID No. 4 banking program.

(16) Includes 5,962 AF through Kern-Tulare WD/Rag Gulch WD banking program; includes 2,197 AF through ID No. 4 banking program.

(17) Includes 13,460 AF through Kern-Tulare WD/Rag GulchWD banking program; includes 4,958 AF through ID No. 4 banking program.

Table 4 (continued)
1993 State Water Project Deliveries by Contract
(in acre-feet)

	No.11		No.12	No.13	No.14	No.15	No.16
				Deliveries Through December 31, 1993			
District	Misc. Water Supplies		Total Supply Available	State Water Project	Friant-Kern (22) Exchanges	Total 1993 Deliveries	Supply Not Delivered
Berrenda Mesa WD			90,764	90,764		90,764	
Lost Hills WD	197	(18)	85,648	84,616		84,616	1,032
Belridge WSD			89,678	89,678		89,678	
Buttonwillow ID	50,000	(19)	156,306	231,215		231,215	91
Pond Poso ID			67,000			-	
Semitropic WSD			8,000			-	
Cawelo WD			3,819	3,819		3,819	
Improvement Dist. No. 4 Ag			10,276			-	
M&I	550	(20)	81,694	67,747	24,223	91,970	
Rosedale-Rio Bravo WSD			80,136	58,215	21,921	80,136	
Buena Vista WSD			150,858	147,866	2,992	150,858	
Kern Delta WD			5,685		5,685	5,685	
Henry Miller WD	331	(20)	57,138	55,938	1,200	57,138	
West Kern WD			629	629		629	
Wheeler Ridge-Maricopa WSD	645	(21)	167,455	144,592		144,592	22,863
Tehachapi-Cummings CWD Ag			3,285	1,661		1,661	1,624
M&I			2,494	2,478		2,478	16
Tejon-Castac WD			-			-	
Banking Programs							
KCWA			94,889	43,941	50,948	94,889	
Kern-Tulare/Rag Gulch			27,582	27,582		27,582	
ID#4			10,162	10,162		10,162	
STWSD/Cawelo WD			30,000	30,000		30,000	
Subtotal			**162,633**	**111,685**	**50,948**	**162,633**	
Exchanges/Transfers							
Westlands WD			10,000	87,600	(77,600)	10,000	
Lower Tule River ID			-	35,801	(35,801)	-	
Arvin-Edison WSD			5,349	5,349		5,349	
North Kern WSD			6,432		6,432	6,432	
Subtotal			**21,781**	**128,750**	**(106,969)**	**21,781**	
Total	**51,723**		**1,245,279**	**1,219,653**	**-**	**1,219,653**	**25,626**

(18) Landowner transfer of 1992 entitlement from Dudley Ridge WD (Paramount Farming) to Lost Hills WD.

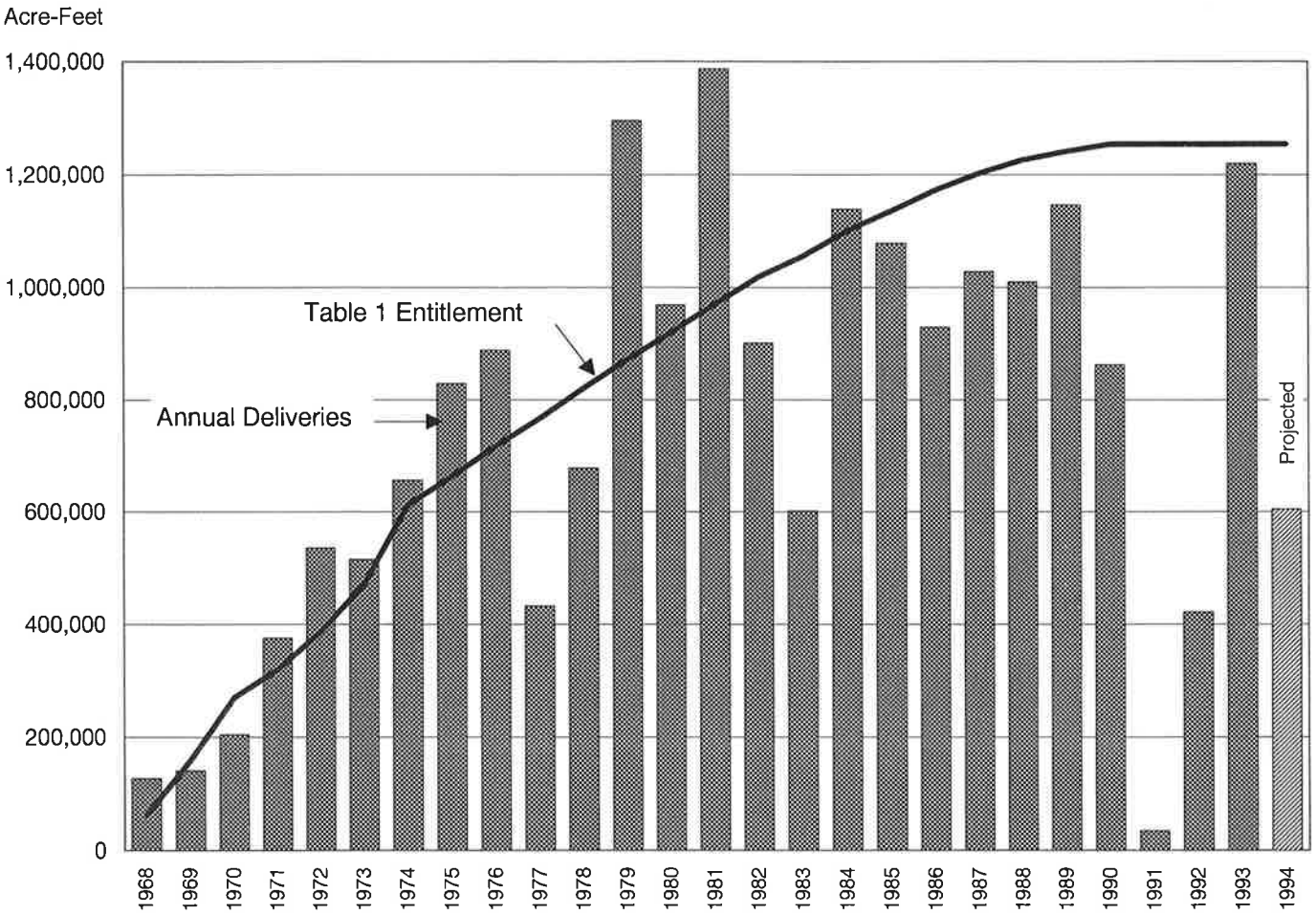
(19) Storage of a portion of Metropolitan Water District of Southern California's 1992 entitlement in Semitropic WSD.

(20) SWP operational flood water; ID No. 4 = 550 AF, Henry Miller WD = 331 AF, Wheeler Ridge-Maricopa WSD = 20 AF, Total = 901 AF.

(21) Includes 20 AF of SWP operational flood water and 625 AF of Drought Program output during 1993.

(22) Exchanges for SWP entitlement; excludes Friant-Kern imports of 3,000 AF via Kern-Tulare WD/Rag Gulch WD/ID No. 4 and 25,432 AF of USBR Section 215 water.

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



control of the Delta Cross Channel gates (by NMFS), CVP/SWP pumping constraints, and flow criteria for the lower Sacramento River were adopted by NMFS to protect Winter Run Salmon. Governor Wilson pointed out that adoption of such D-1630 criteria by NMFS made the need for D-1630 moot. Additionally, the federal Environmental Protection Agency declared that D-1630 didn't go far enough to protect fish and wildlife resources in the Delta. By the end of 1993 EPA had developed their own water standards for the Delta. EPA also incorporated some D-1630 criteria into their own standards.

During 1993 the NMFS again imposed constraints on the SWP and CVP for the protection of Winter Run Salmon. These restrictions focused on (1) maximizing the number of returning adult fish that successfully spawned, and (2) maximizing the number of young fish (called "smolts") that successfully out-migrate to the ocean. The operational constraints began in February 1993 and continued through April 1993.

The Delta Smelt was declared a threatened species on March 4, 1993. The Delta Smelt is a three-inch long minnow that lives its entire year-long life cycle entirely within the Delta. Listing by the U.S. Fish and Wildlife Service ("USFWS") came after a stormy series of public hearings. Opposition to the listing was premised on the fact that USFWS was basing its decision on flawed science. Surveys indicate that the Delta Smelt's population fluctuates widely from year to year. Contention centered on the fact that USFWS had focused on a downturn in population as its basis for listing the species.

USFWS did not impose operational constraints on the SWP or CVP during 1993 to protect the Delta Smelt. Consultations between wildlife agencies and water project operators concluded that already-imposed restrictions to protect Winter Run Salmon were sufficient to also protect the Smelt. However, a "take" limit of one percent of the projected Delta Smelt population was imposed. Delta Smelt protections greatly compound the operational problems faced by water project operators. Unlike salmon, which spend most of their lives in the ocean, Delta Smelt spend their entire lives within the Delta. As such, there is no way of avoiding the take of Smelt during water project operations. Because of the abundant water supply, no major impacts were suffered in 1993 because of Delta Smelt. In the future, Delta Smelt may cause more water supply impacts than Winter Run Salmon.

The SWP's Harvey O. Banks Delta Pumping Plant is equipped with state of the art fish screens. These screens are designed to keep fish away from the SWP's pumps. Even so, some fish are inadvertently entrained. NMFS imposed restrictions on the number of Winter Run smolts that could be entrained by the Banks Pumping Plant. On February 23, 1993 the export pumps were slowed because of the presence of Winter Run. On February 24 they were shut down altogether for a five day period because increased numbers of Winter Run salmon smolts were being captured at the fish screens. Limited pumping was resumed beginning March 8, with only two pumps in operation. On March 23 an additional pump was started, increasing total export pumping to 30 percent of capacity. Unofficially, DWR estimated that about 600,000 acre-feet of water was lost to the SWP because of operational constraints to protect Winter Run Salmon. While this water was not needed to meet contractor's 1993 requests, it could have been exported into downstream reservoirs to improve carryover storage in case 1994 was a dry year. In 1992 EPA-imposed operational constraints caused the SWP to lose about 140,000 acre-feet.

Kern River

The 1993 water year started out dry. The month of November 1992 produced no rainfall in the Kern River watershed. By early December a series of powerful Pacific storms hit the southern Sierra Nevada mountains. For January-February 1993 rainfall in the Kern River watershed approached 200 percent of normal. Snowpack water content reached its highest level since before the 1987-92 drought. The above average rains and snows were due to the merging of warm, moist storms from the tropics with cold storm fronts originating in the Gulf of Alaska.

April through July is the primary runoff period for the Kern River watershed. During 1993, April-July runoff was 127 percent of normal. A comparison of the snow pack in the Kern River watershed during 1991-93 with the historic average (inches of water content) is shown as follows:

Kern River Watershed Snow Pack
(inches of water content on April 1)

	Apr 1 1991	Apr 1 1992	Apr 1 1993	Apr 1 Avg	1993 % of Avg
Upper Tyndall Cr.	16.0	12.7	34.0	27.7	123
Crabtree Meadow	13.1	9.0	22.7	19.8	115
Chagoopa	21.6	17.0	32.7	21.8	150
Pascoe	27.7	22.2	40.0	24.9	151
Wet Meadow	23.2	16.1	37.3	30.3	123
Tunnel Guard	13.2	8.2	21.6	15.6	138
Casa Vieja Meadows	19.0	13.7	28.1	20.9	134
Beach Meadows	9.0	3.9	12.6	11.0	115
Average	17.9	12.9	28.6	21.5	133

The outlook for Kern River supplies improved as the water year progressed, as shown below:

February, 1993	102 "
March	130 "
April	128 "
May	121 "
Final	118 " (final runoff)

Table 5 shows historic Kern River runoff and cumulative runoff for the 100 years of complete record, including diversions above First Point. In 1993 a total of 642,339 acre-feet of Kern River water flowed past First Point of Measurement. An additional 2,582 acre-feet was diverted above First Point. Total 1993 Kern River flows were 644,921 acre-feet, about 88 percent of the long-term average. During the last 100 years, the Kern River has yielded nearly 72 million acre-feet of runoff. Since Isabella Dam began regulating flows in 1954, over 29.4 million acre-feet of runoff has occurred. Figure 4 is a histograph of annual Kern River flows at First Point.

Entitlement to Kern River water is determined according to formulae established in the "Miller-Haggin Agreement" of 1888 and the "Shaw Decree," a judicial decree set in 1900 by Judge Lucien Shaw. Later amendments to these agreements have been adopted as circumstances warranted. These agreements establish diversion rights to Kern River water based on unimpaired flows at First Point of Measurement. Most of these diversion rights are now held by public water districts. Therefore, entitlement to Kern River water is diverted into district delivery facilities, and subsequently to users within the district. Table 6 gives a summary of Kern River deliveries by entity in 1993. Plate 9 shows the major canal distribution facilities operated by water districts that receive Kern River entitlement.

Central Valley Project ("CVP")

Like the SWP, water available from the CVP in 1993 was higher than the previous year. In 1993 deliveries of CVP water to Kern County totaled 489,783 acre-feet, over twice as much as in 1992. Original Friant-Kern and CVP Delta allocations on February 15, 1993 were: Friant-Kern contractors - 100 percent Class I and 30 percent Class II water; CVP Delta contractors - 25 percent of Class I water. By March the allocation had improved to 100 percent of both Class I and Class II for Friant-Kern supplies. CVP Delta supplies were increased to 40 percent of Class I. In April CVP Delta allocations were increased to 50 percent. However, in June allocations for Friant-Kern contractors were reduced to 100 percent of Class I water and 87 percent of Class II. This was the first time since 1986 that Class II supplies were available. Since 1966, Class II entitlement has been unavailable in only eight years (1976-77 and 1987-92). Below is a chronology of 1993 CVP allocations.

	Friant-Kern Supplies	CVP Delta Supplies
February 15, 1993	100 percent Class I 30 " Class II	25 percent Class I
March 5	100 " Class I 100 " Class II	(no change)
March 19	(no change)	40 " Class I
April 7	(no change)	50 " Class I
June 7	100 " Class I 87 " Class II	(no change)
August 13	100 " Class I 90 " Class II (final allocation)	(no change) (final allocation)

Table 7 shows 1993 deliveries of CVP water by entity. As shown, 185,394 acre-feet of Class I entitlement, 260,605 acre-feet of Class II entitlement and 43,784 acre-feet of Section 215 flood water was delivered. While the primary source of CVP water in Kern County is from the central Sierras (via the Friant-Kern Canal), 21,044 acre-feet was delivered from the Sac-

Figure 4
Kern River Flows at First Point of Measurement

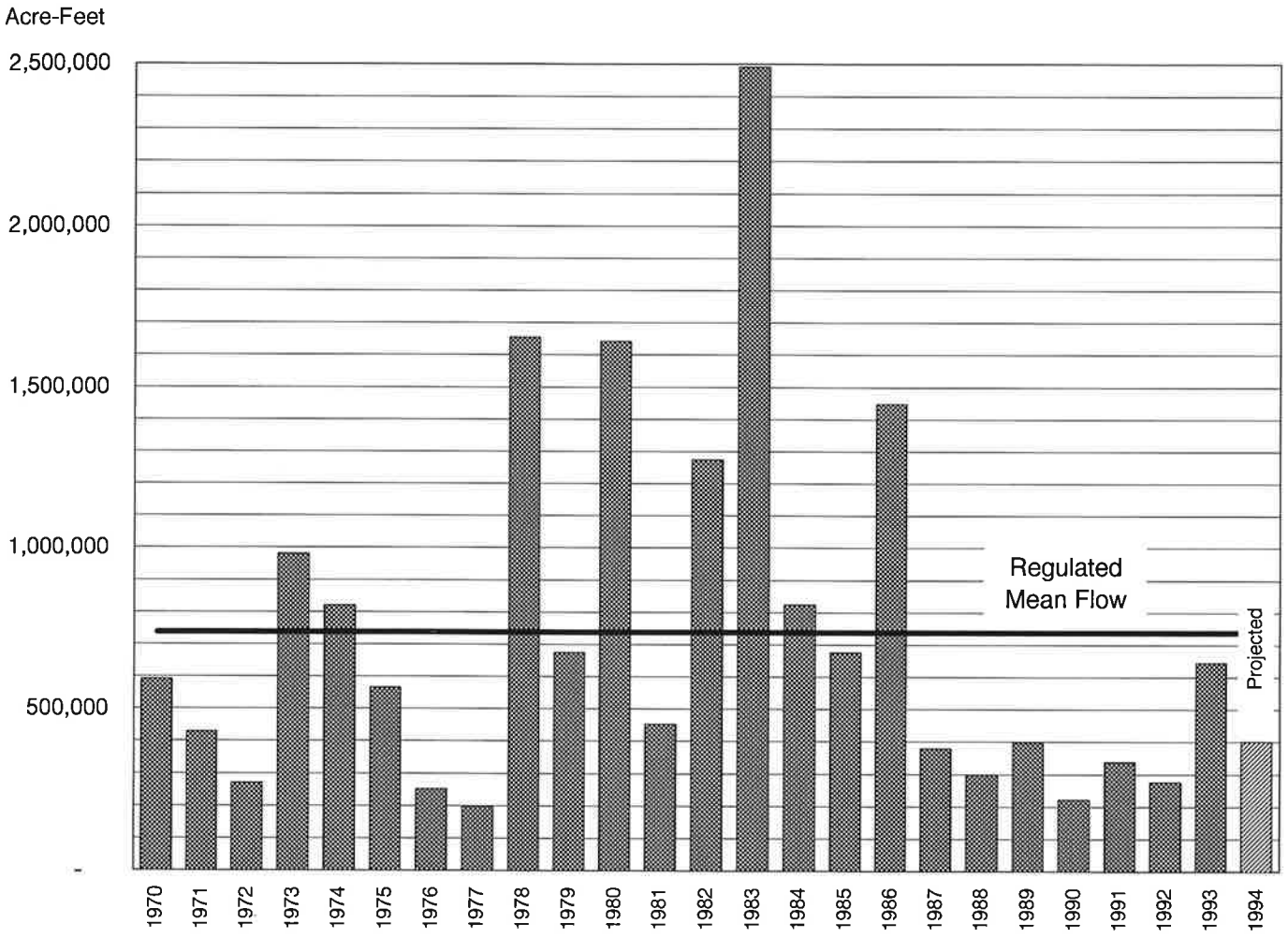


Table 5
Historic Kern River Flows *
(in acre-feet)

Calendar Year	Annual Flows	Cumulative Unregulated Flows	Calendar Year	Annual Flows	Cumulative Flows	
					Unregulated	Regulated
1894	533,326	533,326				
1895	1,023,052	1,556,378				
1896	619,692	2,176,070	1931	185,645	26,249,601	
1897	893,434	3,069,504	1932	737,727	26,987,328	
1898	251,827	3,321,331	1933	441,086	27,428,414	
1899	338,872	3,660,203	1934	227,665	27,656,079	
1900	332,373	3,992,576	1935	474,128	28,130,207	
1901	880,089	4,872,665	1936	796,447	28,926,654	
1902	552,539	5,425,204	1937	1,260,182	30,186,836	
1903	546,395	5,971,599	1938	1,358,685	31,545,521	
1904	492,949	6,464,548	1939	461,073	32,006,594	
1905	531,809	6,996,357	1940	789,098	32,795,692	
1906	1,900,540	8,896,897	1941	1,401,076	34,196,768	
1907	990,900 **	9,887,797	1942	771,966	34,968,734	
1908	498,503 **	10,386,300	1943	1,220,827	36,189,561	
1909	1,838,643	12,224,943	1944	625,537	36,815,098	
1910	658,911	12,883,854	1945	938,055	37,753,153	
1911	1,013,384	13,897,238	1946	650,683	38,403,836	
1912	387,432	14,284,670	1947	406,698	38,810,534	
1913	367,840	14,652,510	1948	329,506	39,140,040	
1914	1,113,513	15,766,023	1949	302,870	39,442,910	
1915	646,287	16,412,310	1950	601,360	40,044,270	
1916	2,520,149	18,932,459	1951	442,222	40,486,492	
1917	823,082	19,755,541	1952	1,500,999	41,987,491	
1918	538,503	20,294,044	1953	548,833	42,536,324	
1919	499,124	20,793,168	1954	528,357 ***	43,064,681	528,357
1920	600,643	21,393,811	1955	444,300	43,508,981	972,657
1921	509,519	21,903,330	1956	840,862	44,349,843	1,813,519
1922	861,426	22,764,756	1957	444,338	44,794,181	2,257,857
1923	500,515	23,265,271	1958	1,104,730	45,898,911	3,362,587
1924	187,727	23,452,998	1959	257,978	46,156,889	3,620,565
1925	465,913	23,918,911	1960	300,037	46,456,926	3,920,602
1926	366,706	24,285,617	1961	177,642	46,634,568	4,098,244
1927	792,580	25,078,197	1962	697,704	47,332,272	4,795,948
1928	312,828	25,391,025	1963	801,450	48,133,722	5,597,398
1929	322,958	25,713,983	1964	339,266	48,472,988	5,936,664
1930	349,973	26,063,956	1965	720,362	49,193,350	6,657,026

* Includes deliveries above First Point.
** Data incomplete. Flow extrapolated from available data.
*** Isabella Dam in operation. All subsequent flows are controlled releases.

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

Calendar Year	Annual Flows	Cumulative Flows	
		Unregulated	Regulated
1966	678,595	49,871,945	7,335,621
1967	1,396,227	51,268,172	8,731,848
1968	453,760	51,721,932	9,185,608
1969	2,461,370	54,183,302	11,646,978
1970	590,274	54,773,576	12,237,252
1971	428,254	55,201,830	12,665,506
1972	269,227	55,471,057	12,934,733
1973	980,452	56,451,509	13,915,185
1974	819,408	57,270,917	14,734,593
1975	565,367	57,836,284	15,299,960
1976	250,268	58,086,552	15,550,228
1977	197,798	58,284,350	15,748,026
1978	1,654,295	59,938,645	17,402,321
1979	673,451	60,612,096	18,075,772
1980	1,640,852	62,252,948	19,716,624
1981	452,152	62,705,100	20,168,776
1982	1,273,630	63,978,730	21,442,406
1983	2,491,313	66,470,043	23,933,719
1984	824,302	67,294,345	24,758,021
1985	675,419	67,969,764	25,433,440
1986	1,447,939	69,417,703	26,881,379
1987	378,335	69,796,038	27,259,714
1988	297,685	70,093,723	27,557,399
1989	399,151	70,492,874	27,956,550
1990	221,267	70,714,141	28,177,817
1991	338,332	71,052,473	28,516,149
1992	275,041	71,327,514	28,791,190
1993	644,921	71,972,435	29,436,111

100 Year Mean First Point Flow	719,724 AF
100 Year Median First Point Flow	558,953 AF
Regulated Mean First Point Flow	735,903 AF
Regulated Median First Point Flow	577,821 AF

Table 6
1993 Summary of Kern River Water
Diversions by Entity
(in acre-feet)

Area of Use	Deliveries
Above First Point	
Kern Valley Golf Course (Kernville)	166
La Hacienda, Inc.	93
Lake Ming	790
Olcese WD	1,533
Sub-total	**2,582**
Below First Point	
Arvin-Edison WSD	8,821
Buena Vista WSD	26,524
Cawelo WD	73,033
City of Bakersfield, Irrigation and Spreading	63,028 [1]
County of Kern (Buena Vista Aquatic Recreation Area)	4,125
Henry Miller WD	1,720
Improvement District No. 4	28,866
Kern County Water Agency (James Canal Program)	1,886
Kern Delta WD	225,284
North Kern WSD	160,572
Rosedale Ranch Improvement District	22,589
Rosedale-Rio Bravo WSD	24,930
South Fork	961
Sub-total	**642,339**
Grand Total	**644,921**

[1] Includes Kern River Canal & Irrigating Company deliveries, Carrier Canal losses and percolation, Kern River channel losses and percolation.

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Outlook: 1994

After a welcome respite from the recent drought, it appears that dry conditions are returning to the state. Early rainfall and snow pack data indicates that 1994 could be one of California's driest years of record. On May 2, 1994 California Resources Secretary Douglas Wheeler announced that California is in a drought watch because of a disappointing snow pack. However, high carryover storages in the state's major reservoirs should help soften the blow of another dry year.

In March 1994 the statewide mountain snow pack was slightly more than 40 percent of average, compared to 150 percent of average the previous year. The year was officially classified as critically dry, with a projected Sacramento River Index of 8.5 million acre-feet. Only seven years in this century have been drier.

The dry conditions caused the state Department of Water Resources to reactivate the State Water Bank, and plans to deliver water to needy cities and farms. The U.S. Bureau of Reclamation has already purchased 45,000 acre-feet of water for fisheries in the San Joaquin and Stanislaus rivers. Water districts in Kern County have requested delivery of 9,800 acre-feet for critical water needs. The estimated cost for State Bank water is $80-$84 per acre-foot delivered to Kern County.

The state Department of Water Resources has allocated 53 percent of requested entitlement, or 605,000 acre-feet for Kern County. The Kern River is expected to yield 57 percent of normal supplies, or about 400,000 acre-feet. Kern County CVP contractors' allocations mirror the SWP. Friant-Kern contractors have been allocated 70 percent of Class I entitlement. CVP Delta contractors have been allocated 35 percent of Class I entitlement. A total of about 172,000 acre-feet of CVP should be delivered in Kern County during 1993. Minor stream flows are expected to be less than in 1993, perhaps 50,000 acre-feet. Effective precipitation is also expected to be less than in 1993, due to lower spring rainfall, or about 150,000 acre-feet. Accordingly, total surface supplies in 1994 are expected to be about 1,377,000 acre-feet, over 1.2 million acre-feet less than in 1993.

Total water demands during 1993 are projected to be about 2,800,000 acre-feet. Irrigated acreage is not expected to increase over 1993 because of the dry conditions. Hence, irrigated acreage is projected to remain at about 800,000 acres. Consumption or losses for all types of uses are estimated to be about 2,100,000 acre-feet. Thus, KCWA projects that a net decrease in ground water storage of about 700,000 acre-feet will occur in 1993. Such a decrease will more than wipe out the positive change in storage that occurred in 1993.

Land uses within Improvement District No. 4 have been steadily changing from agricultural to urban uses. Since 1972 urban development has more than doubled, while agriculture has been about halved. The following table shows the steady increase in urban lands.

Year	Urban	Agriculture	Undeveloped	Total
1972	24,200	19,500	12,500	65,400
1974	30,700	18,400	16,300	65,400
1976	30,600	18,500	16,300	65,400
1978	33,500	18,000	13,900	65,400
1980	36,700	16,500	12,200	65,400
1982	38,600	14,700	12,100	65,400
1984	40,000	12,000	13,400	65,400
1986	42,000	10,800	12,600	65,400
1988	42,300	10,800	12,300	65,400
1990	49,400	8,600	7,400	65,400
1991	49,400	12,500	3,500	65,400
1992	49,800	11,600	4,000	65,400
1993	50,500	11,100	3,800	65,400

The Kern County Water Agency recognizes the need for advanced planning to meet the water supply needs of the growing metropolitan Bakersfield area. Studies have been initiated to determine the need for additional potable surface water supplies and the best way to meet these needs. As one first step in meeting those needs, ID#4 acquired 10,276 acre-feet of additional firm entitlement and 1,554 acre-feet of surplus entitlement from the Wheeler Ridge-Maricopa Water Storage District in 1988. This water will supplement the original 77,000 acre-feet.

Additional studies are aimed at better defining the aquifer characteristics within the ID#4 boundary and determine the perennial yield of the ground water service area of ID#4. This information will help define the long-term annual ground water replenishment necessary to maintain ground water levels.

Focus: Improvement District No. 4

It was known for many years before the formation of the Kern County Water Agency that a supplemental water supply would be needed for the growing metropolitan Bakersfield area. The Bakersfield Municipal Water District had been formed in 1922 with boundaries contiguous with the Bakersfield city limits. Because this entity could not serve the entire greater Bakersfield metropolitan area, it was dissolved in 1966. In 1967 formation of a Greater Bakersfield Metropolitan Water District was put to the voters, but was defeated. Local representatives then turned to another alternative, an Improvement District of the Kern County Water Agency, to serve the greater Bakersfield area. KCWA Resolutions 16-71 and 17-71 were adopted December 21, 1971, which finalized formation activity and established the boundaries of Improvement District No. 4 ("ID#4") as they now exist. An allocation of 77,000 acre-feet of SWP water was made for ID#4. In 1972 the KCWA Board of Directors held an election within ID#4 to ratify plans for construction of a canal and water treatment facilities. The new potable water treatment facility would provide drinking water for large portions of the northern and eastern metropolitan Bakersfield area. Capacity of 141 cubic feet per second was subsequently included in the joint-use Cross Valley Canal, for transmission of the 77,000 acre-feet per year from the California Aqueduct to the Bakersfield area.

The Henry C. Garnett Water Treatment Plant with a capacity of 25,000 acre-feet per year was completed in 1976. The remaining 52,000 acre-feet of SWP entitlement would be recharged into the ground water basin for extraction by ground water pumpers within ID#4. A pump tax was established (now $40 per acre-foot for urban water uses and $20 per acre-foot for agricultural uses) to help fund ID#4's activities. Contracts for treated water were executed with the North of the River Municipal Water District, the East Niles Community Services District, and California Water Service Company.

Although ID#4 has the capacity to convey its SWP water from the California Aqueduct via the Cross Valley Canal, every effort is made to exchange for Kern River or Central Valley Project water. These water supplies are available near the Bakersfield service area. Such exchanges allow ID#4 to avoid expensive CVC pumping costs. Also, since local Kern River water is of higher quality than SWP water, treatment costs are further reduced.

Besides the 77,000 acre-feet annually of SWP water, between 6,000 and 7,000 acre-feet of Kern River water annually is used for agriculture within ID#4. Also, agricultural lands receive water from both city and county sewage water treatment plants. These plants produced a total of 23,400 acre-feet of effluent in 1993, about 10,600 acre-feet of which was used by agriculture within ID#4. The remaining 12,800 acre-feet was exported to agricultural areas south of ID#4's boundary. Ground water pumping within ID#4 was about 85,000 acre-feet in 1993, nearly all which was for urban uses. Table 26 shows irrigated acreage within ID#4 for 1993.

Table 26
1993 Irrigated Acreage in the Improvement District No.4 of Kern County Water Agency

Crop	Acres
Annual Crops	
Alfalfa	626
Cotton	25
Dry Beans	15
Milo	8
Wheat	17
Subtotal	691
Permanent Crops	
Almonds	306
Apples	110
Citrus	745
Grapes	4,944
Olives	8
Persimmons	12
Plums	20
Quince	6
Subtotal	6,151
Total	**6,842**

ground water basin is much more complex than previously thought. Given the importance of the southwest portion of the valley as a future water supply, it is important that appropriate studies be designed to evaluate the ground water resource in this area.

In 1989 KCWA began a ground water monitoring program in the valley. Water level measurements for wells throughout the valley were the basis for Plate 7, "Depth to Ground Water, Indian Wells Valley" and Plate 8, "Ground Water Elevation, Indian Wells Valley." Plate 8 shows a large and deep pumping depression extending from Ridgecrest to Inyokern (called the intermediate area), where most of the population is centered. The areal extent of the depression has expanded by 21,000 acres since 1946. Comparatively, the population of the valley was about 15,000 in 1946, and about 63,000 today. Ground water levels in the intermediate area have declined as much as 45 feet since 1965. The long term (1921-93) rate of ground water decline in the intermediate area is 1.3 feet per year. Since 1965 the rate of decline ranges from 1.6 to 1.8 feet per year. A second, smaller pumping depression may exist in the northwest portion of the valley. Expanding ground water level monitoring along Browns Road could help verify the existence of this second depression.

In 1991 KCWA began a weather monitoring program for the Indian Wells Valley. The primary purpose is to collect precipitation and temperature data in the Scodie Mountain watershed tributary to the Indian Wells Valley. The collected data will help decide if climatic conditions justify a precipitation enhancement program. (The Department of Water Resources presently operates a precipitation enhancement program in the Feather River watershed in northern California). Even a modest increase in rainfall and runoff in this arid region could have a significant impact on the water supply for the population. In April 1991 KCWA installed monitoring equipment at Horse Peak to learn more about icing conditions. A precipitation gauge was installed in Indian Wells Canyon to collect rainfall data. This monitoring program is expected to continue through 1996.

consistent with a confined aquifer than unconfined. The large difference in ground water levels in the two wells also suggests that a minimum of two distinct aquifers exist in this area.

The delivery of CVP water to Arvin-Edison in the mid-1960's caused ground water levels to rise, as seen in the shallow well hydrograph. During the drought of 1977 ground water levels declined. The deep well showed rising ground water levels from 1978-86. The recent six-year drought has resulted in ground water levels declining to near 1977 levels in the deep well.

Indian Wells Valley

Indian Wells Valley is located in the northeast corner of Kern County. The valley encompasses about 480 square miles, extending about 35 miles in a north-south direction and 25 miles in an east-west direction. The valley is surrounded by the southern Sierra Nevada Mountains on the west, the Coso Range on the north, the Argus Mountains on the east, and the El Paso Mountains on the south. Elevations on the valley floor are around 2,300 feet above sea level, while surrounding mountains may reach 9,000 feet. The largest community in the valley is the city of Ridgecrest, with a population of about 27,000. Total population in the valley is about 63,000, most of which is centered in the Ridgecrest/China Lake community. The valley is an arid desert, with rainfall of only 3-4 inches per year. Little rainfall reaches the ground water table; it is rapidly evaporated by the high winds or transpired by desert plants. Presently, the only source of potable water is ground water.

In October 1987 a group of concerned citizens founded the Indian Wells Valley Water Coordinating Committee to address the ground water management needs of the valley. The committee's charge is to ensure that future water supplies are developed in a coordinated manner. The underground geology of the valley is quite complex. The USGS had studied the area for about 10 years, under a cost sharing arrangement with the US Naval Air Weapons Station ("NAWS"), KCWA and local entities. Others have also studied the area in recent years, but consensus has not been reached on the ground water conditions of the valley. Recognizing this, the Coordinating Committee suggested there be an independent review of available hydrologic data. A subsequent study (funded by the California Department of Water Resources, Indian Wells Valley Water District, East Kern Resource Conservation District and KCWA) resulted in the February 1989 report "Hydrologic Conditions in Indian Wells Valley and Vicinity." This report, along with USGS studies, states that ground water resources in the area are declining. Other studies suggest that complex, deep geologic structures beneath the basin and northwest of the valley provide inflow into the basin.

The conflicting results obtained by these studies prompted the U.S. Bureau of Reclamation to begin another study of the area. Initiated in 1990, USBR's Indian Wells Valley Ground Water Project was cost-shared with local entities. The objective of the project was to define the ground water resources in the area, and develop a long-term plan for optimal utilization of the region's ground water resource. The study reviewed existing data and obtained additional subsurface information by building seven multiple depth monitoring wells at locations throughout the valley. The Indian Wells Valley Water District drilled three additional multiple depth monitoring wells to assess the potential for new well fields and to supplement the project.

The USBR Ground Water Project was completed in 1994. The project concluded that the life of the ground water resource could be extended by a redistribution of pumping, and by blending good quality water with lesser quality water. The report suggests that ground water treatment should be given serious consideration.

The project identified good quality ground water to a depth of 2,000 feet in the southwest and intermediate portions of the basin. Poor quality water was identified at deeper depths in the northwest, north-central and outlying portions of the basin. The report estimated that Sierra runoff recharges about 6,000 acre-feet per year to the basin. The present basin-wide ground water production is about 30,000 acre-feet per year.

The Geothermal Division of NAWS recently drilled a geothermal test well (7,200 feet deep) within the valley and acquired seismic data within and peripheral to the valley. The well and seismic data were developed specifically to address the potential for geothermal resources in the area. A second geothermal test well will be drilled in 1994. These data may also benefit the ongoing studies of the basin by allowing the subsurface structural influences to be better defined. The seismic data suggests that the southwest portion of the

Figure 19d
Water Well Hydrograph
Arvin-Edison Area

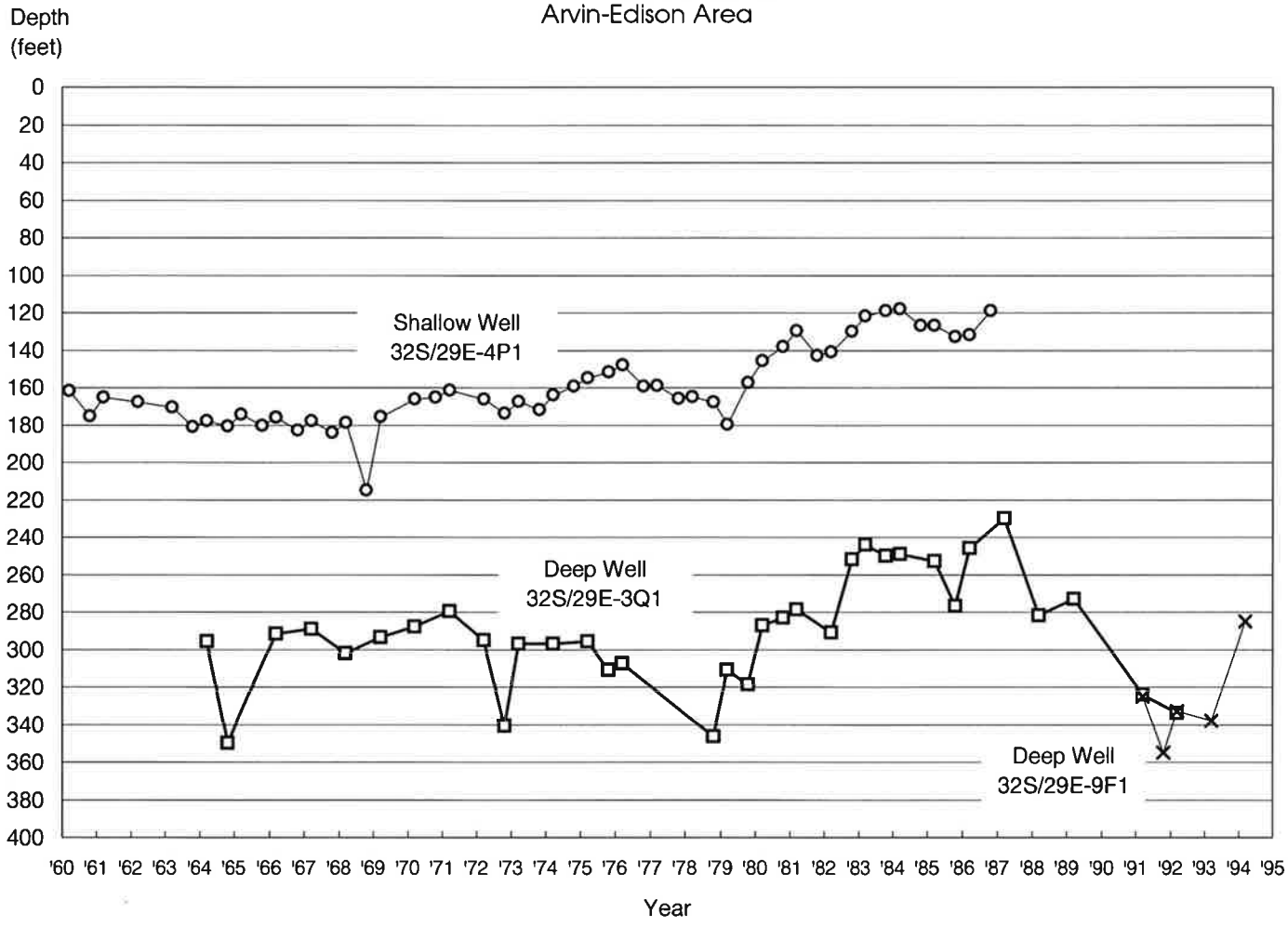


Figure 19c
Water Well Hydrograph
Southwest Bakersfield Area

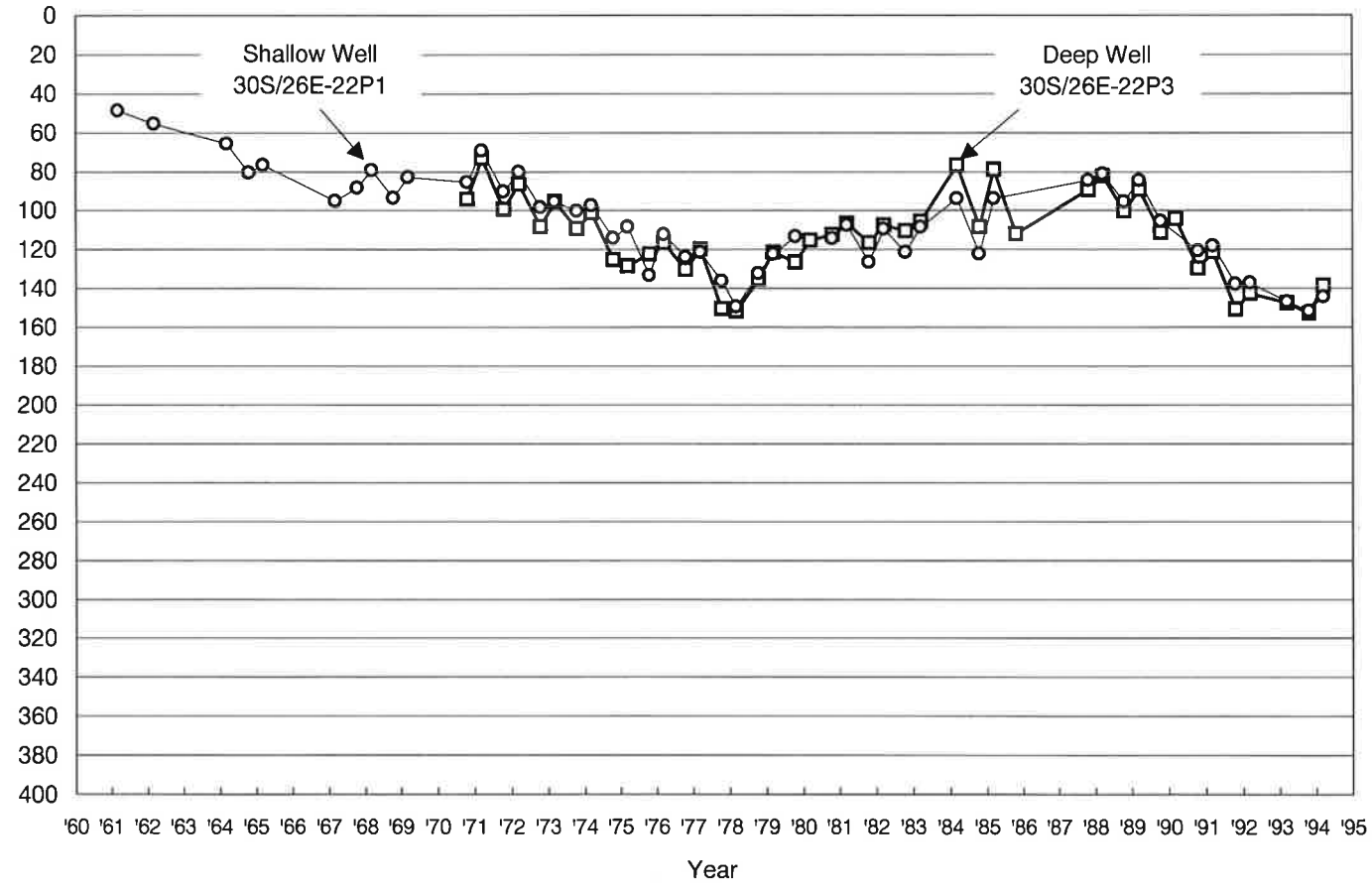


Figure 19b
Water Well Hydrograph
Shafter/Rosedale-Rio Bravo Area

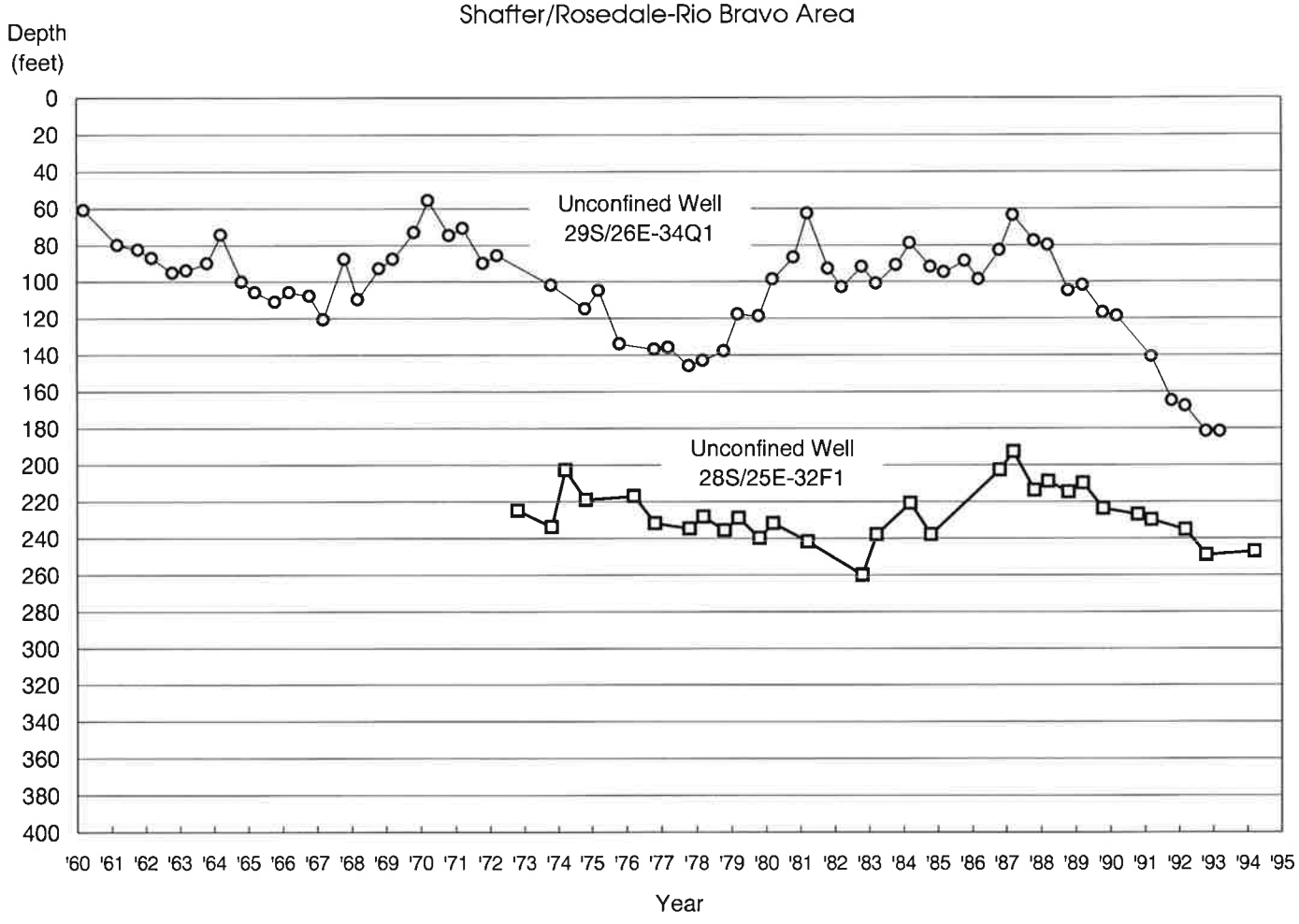
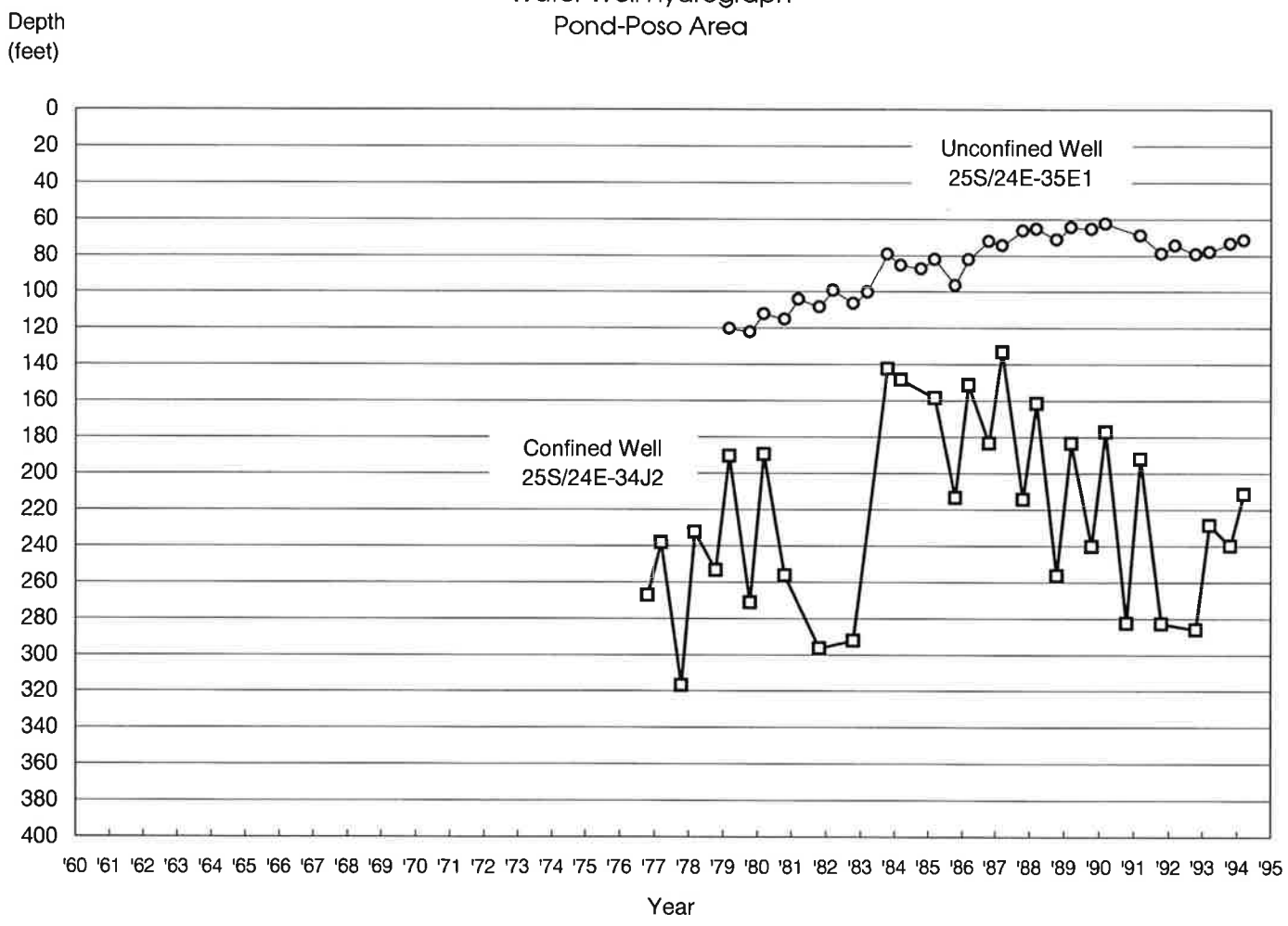


Figure 19a
Water Well Hydrograph
Pond-Poso Area



Ground water level data collected over the last two years has led to better understanding of trends on the west side of the valley. The "Ground water Surface Elevation" map (Plate 5) indicates that very steep ground water gradients exist in the area, roughly following Interstate 5 between the city of Buttonwillow and Goose Lake area. KCWA's Clay Study suggests that the steep gradient may be influenced by underlying geologic structures that inhibit the movement of water. Further study is warranted to understand the relationship between geologic structures, the observed steep gradients and ground water production in this area.

Plate 6 depicts ground water level changes from the spring of 1993 to the spring of 1994. Differences were plotted and contoured to show areas of relative improvement or decline. Color was added to emphasize significant level changes.

Unless the annual change exceeds 10 feet little impact (either losses or gains) to storage can be inferred. The potential error related to the timing of ground water level measurements and simple measuring errors make finer judgements difficult.

The ground water basin showed improved ground water levels in the areas near recharge sites. Within ID#4, the City of Bakersfield's 2,800 Acre recharge area and Rosedale-Rio Bravo Water Storage District levels improved by 10 feet. Within Arvin-Edison Water Storage District levels improved by as much as 20 feet over an extensive area. Southern San Joaquin Municipal Utility District, Semitropic Water Storage District and Kern Delta Water District generally showed improvements of 10 feet or more.

Water level changes in eight key water wells are displayed on hydrographs as Figures 19a, 19b, 19c and 19d. A pair of wells are located in the Pond-Poso area. Another pair are between Shafter and Rosedale-Rio Bravo. A third pair of wells are southwest of Bakersfield. The fourth pair of wells are in the Arvin area.

The two wells in the Pond-Poso area represent the unconfined and confined aquifer systems in the area. The hydrographs are plotted together to compare water level changes in both aquifers. The unconfined well reflects an upward trend since the 1977 drought. This trend is probably a continuation of a long-term rise in water levels, caused by surface water deliveries from the Friant-Kern system. During 1990-92 drought conditions were more severe, with an increased dependence on ground water. The recent decline in water levels reflects the expanded use of ground water during the drought. The confined well shows a steady rise of water levels from the 1977 drought up through 1987. This confined well reflects the increased ground water pumping due to the drought much sooner and to a larger extent than does the unconfined well.

The Shafter/Rosedale-Rio Bravo area hydrographs represent unconfined wells. The Rosedale-Rio Bravo well (T29S/R26E-34Q) is near the Kern River channel. 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 normal. The Kern River exceeded the mean Regulated First Point flow in only five years (1963, 1967, 1969, 1973 and 1974) between 1960-77. The wet period of 1978-86 is shown as a rapid ground water level rise, while the drought of 1987-92 shows a steep decline of ground water levels in the area.

The moderate ground water level changes in the Shafter well (T28S/R25S-32F1) reflects the greater distance from the main area of ground water recharge. The Shafter well is at the southeastern terminus of the Corcoran Clay, as interpreted by KCWA's Clay Study. Present data suggests that no confined aquifer exists easterly of this location. Deep wells in these areas show annual ground water levels and variations that are consistent with the shallow wells. Confined and unconfined aquifers usually exhibit characteristic differences in ground water level changes.

The southwest Bakersfield hydrograph shows continual declines until 1978. The wet period of 1978-86 shows up as a rise in water level. The 1987-92 drought shows a dramatic rate of water level decline.

In prior years these two wells were designated as unconfined and confined, respectively. However, similar ground water levels in both wells over a long period suggests that a classic confined aquifer may not exist in this area. Analysis of wells to the north and data from the Clay Study seems to corroborate this interpretation. On Figure 18c these wells are simply called the shallow well and deep well.

The Arvin-Edison area wells are similarly designated as shallow (T32S/R29E-04P1) and deep (T32S/R29E-03Q1). The Arvin-Edison deep well may be confined. It shows annual variability of ground water levels more

of a corresponding regional confining clay. The inability to correlate a southern clay is due to the broad northeast to southwest trending structure known as the Bakersfield arch. This uplifted fold in the sediments lies beneath the Kern River and is exposed at the ground surface. The exposed sediments have been eroded over time. The confining clay to the north ends on the northern surface of this broad structure. No corresponding clay on the southern side of the Arch could be identified.

The study's results have many immediate applications. It will help in correlation of strata(s) for carrying out the well ordinance and well head protection program. Information from the study will also be valuable in the design of industrial waste injection wells, ground water modeling, and designing conjunctive use programs. The study was subjected to a peer review by ground water geologists working in the public and private sectors.

The direction of future studies will remain unclear until a comprehensive ground water management plan for the basin is defined. A common technical data base and methodology for problem solving are needed for a ground water management plan to be effective.

Agricultural water well drilling decreased during 1993 compared to activity in 1992. A total of 32 agricultural water well permits were issued by the Kern County Environmental Health Services Department during 1993. Comparatively, a total of 51 permits were issued during 1992. The decrease in drilling activity was largely due to increased allocations of surface water in 1993, and the fact that many well drilling needs were fulfilled during 1991-92. Wells were drilled in the following water districts:

	No. of Wells
Arvin-Edison WSD	2
Buena Vista WSD	6
Cawelo WD	2
Henry Miller WD	1
Improvement District No. 4	1
North Kern WSD	2
Rosedale-Rio Bravo WSD	7
Southern San Joaquin MUD	1
Semitropic WSD	8
Unorganized areas	2
Total	**32**

Annular seals were required in five of the new wells to prevent degradation of lower ground water zones. Annular seals are plugs of cement between the well casing and the drilled hole next to a regional stratum of low permeability. From the origin of the Kern County Water Well Ordinance in 1981 to the end of 1993, a total of 613 agricultural water wells have been constructed, of which 206 required annular seals.

Ground Water Levels

Plate 4, "Depth to Ground Water, Spring 1994" was prepared by KCWA using hundreds of well measurements taken by KCWA and others semiannually. The water depths are plotted and contoured to aid in the evaluation of ground water trends. Control wells include unconfined and a few composite aquifer wells from areas where the two levels are compatible. The Depth to Ground water map shows the distances in feet from the ground surface to the water surface.

The highest pumping lifts occur on the extreme eastern edge of the valley, areas south and east of the community of Arvin and in the White Wolf basin area. These areas are on foothill regions of the valley. Their higher ground surface elevations account for the greater pumping lifts.

A "Ground Water Surface Elevation" map (Plate 5) was prepared, based on the same measured wells as the Depth to Ground water map. This map implies the horizontal movement of ground water from higher to lower elevations. The major direction of ground water movement is away from the sources of recharge.

Historically, the Kern River has been the major ground water recharge source. Mounding of water occurs along the Kern River channel, and ground water moves away from this area. In this area, the rate of horizontal ground water flow in the upper portions of the aquifer is 70-500 feet per year. Another high area is along the northeastern edge of the valley. Also, some local mounding is attributed to local water district's recharge efforts.

Ground water lows are areas of higher ground water pumping. The largest of these areas is in the central portion of the valley (west of Wasco) where the most intensive pumping occurs. Other low areas are in the extreme south end of the valley and in the Arvin area.

This suggests that more of a hydraulic connection between shallow ground water and the unconfined aquifer may exist than previously interpreted. Additionally, some irrigated lands throughout the shallow ground water area that were idled during the drought may have been brought back into production in 1993. The resulting increase in water use could cause the shallow ground water area to grow.

Ground Water Quality

The ground water basin in 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 water supplies are retained in the basin. The ground water is the recipient of these salts via recharge waters or return flows from irrigation and urban users.

Surface water supplies over the usable ground water basin in 1993 (some 2,372,700 acre-feet) carried about 691,800 tons of new salts into the ground water basin. This quantity of salt was about 388,000 tons more than was introduced in 1992, reflecting the higher delivery of surface water, particularly SWP supplies. It should be noted that SWP water carries about twice as much salt as local supplies. Following is a table of salt loads by surface water source for 1993:

Surface Water Salt Loads, 1993

Source	Volume (AF)	Avg. TDS (ppm)	Salt Load (Tons)
SWP Over G.W. Basin	982,900	345	461,000
Kern River	644,900	110	96,400
Minor Streams	72,800	495	49,000
Other Local Supplies*	162,300	138	30,600
CVP	489,800	82	54,800
Total	**2,352,700**	**216**	**691,800**

* Includes effective rainfall, oil field waste water.

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

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

Plate 3 is a compilation of data from water wells producing from the confined or lower aquifer system, as the system was understood in 1989. Data from many recent studies strongly suggests that the area of confinement is smaller than what was understood in 1989. The lower system is partially protected from surface contaminants by the Corcoran Clay. Contours on this map show the ground water quality of the lower aquifer to be superior to that of the unconfined zone.

In November 1981 the Kern County Board of Supervisors adopted an agricultural water well ordinance to prevent ground water quality deterioration. The ordinance is aimed at reducing degradation of the ground water by setting standards for construction and abandonment of wells. The standards were designed to prevent poor quality ground water from moving into high quality ground water. Close monitoring of new well construction and abandonment of old wells is done as part of the ordinance. The ordinance was revised in April 1989.

To address the technical needs of the revised ordinance, KCWA funded a study of the regional geologic structure of the valley's shallow sediments. This study mapped the structure and areal extent of the regional confining clay layer north of the Kern River. South of the river, the study was unable to verify the existence

Table 25
Areal Extent of Shallow Ground Water
(in acres)

	Summer Measurements						Winter Measurements					
Year	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 (1)	172,320	--	--	--	--	--	--	--
1977	19,320	68,980	--	95,960 (1)	184,260	180	16,930	52,530	--	67,300 (3)	136,760	143
1978	27,680	65,760	--	87,920 (1)	181,360	174	9,600	59,520	--	86,400 (3)	155,520	--
1979	30,270	67,310	--	95,870 (1)	193,450	--	15,320	83,200	--	80,640 (3)	179,160	126
1980	74,357	82,787	--	125,883 (1)	283,027	--	45,882	92,998	126,665	62,578	328,123	154
1981	62,002	85,556	--	128,323 (1)	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	-- (2)	241,641	350	--	--	--	--	--	--
1991	40,363	101,888	45,141	-- (2)	187,392	351	--	--	--	--	--	--
1992	9,954	102,114	46,287	-- (2)	158,355	344	--	--	--	--	--	--
1993	25,184	97,357	46,893	-- (2)	169,434	518	--	--	--	--	--	--

(1) 10-20 ft. measurement.

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

(3) No 15 foot contour established. Total is within 20 feet.

-- Data not available.

Note: Annual changes in shallow ground water 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.

Table 24g
Ground Water Banking Summaries
Semitropic Water Storage District
Recharge/*Purchase* and Recovery/*Sale*
(in acre-feet)

Calendar Year	Department of Water Resources			Metropolitan WD of So. California			Total of All Accounts		
	Recharge/ *Purchase*	Recovery/ *Sale*	Recoverable Balance	Recharge/ *Purchase*	Recovery/ *Sale*	Recoverable Balance	Recharge/ *Purchase*	Recovery/ *Sale*	Recoverable Balance
1978			0			0	0	0	0
1979			0			0	0	0	0
1980			0			0	0	0	0
1981			0			0	0	0	0
1982			0			0	0	0	0
1983			0			0	0	0	0
1984			0			0	0	0	0
1985			0			0	0	0	0
1986			0			0	0	0	0
1987			0			0	0	0	0
1988			0			0	0	0	0
1989			0			0	0	0	0
1990	105,500		105,500			0	105,500	0	105,500
1991			105,500			0	0	0	105,500
1992		41,499	64,001			0	0	41,499	64,001
1993			64,001	50,000		50,000	50,000	0	114,001
	105,500	**41,499**	**64,001**	**50,000**	**0**	**50,000**	**155,500**	**41,499**	**114,001**

Table 24f
Ground Water Banking Summaries
City of Bakersfield 2,800 Acre Recharge Facility*
Contracting Entities Other Than KCWA or DWR
Recharge/*Purchase* and Recovery/*Sale*
(in acre-feet)

Calendar	City of Bakersfield		Olcese/Hacienda WD		Buena Vista WSD		Total Banking		Storage
Year	Recharge	Extraction	Recharge	Extraction	Recharge	Extraction	Recharge	Extraction	Balance
1978	104,587		24,328		6,056		134,971	0	134,971
1979	4,505				9,913		14,418	0	149,389
1980	68,804	(13,772)	52,604				121,408	(13,772)	257,025
1981	2,603	(100,837)	4,465				7,068	(100,837)	163,256
1982	37,913		14,266		24,465		76,644	0	239,900
1983	113,380						113,380	0	353,280
1984	16,058	(472)					16,058	(472)	368,866
1985	402	(1,615)					402	(1,615)	367,653
1986	64,168		56,197		10,000		130,365	0	498,018
1987	109	(656)	5,344			(6,000)	5,453	(6,656)	496,815
1988		(5,432)	3,214			(5,000)	3,214	(10,432)	489,597
1989		(2,859)		(873)		(3,138)	0	(6,870)	482,727
1990		(23,318)		(99,405)		(2,242)	0	(124,965)	357,762
1991		(57,159)	22,096	(23,496)		(4,410)	22,096	(85,065)	294,793
1992	0	(30,266)	6,450	(6,450)	0	(4,004)	6,450	(40,720)	323,492
1993	32	0	0	0	7,849	0	0	0	294,793
	412,561	**(236,386)**	**188,964**	**(130,224)**	**58,283**	**(24,794)**	**651,927**	**(391,404)**	**294,793**

* A more detailed breakdown is provided in the City of Bakersfield 2,800 Acre Recharge Facility Report.

Source: City of Bakersfield 2,800 Acre Recharge Facility 1991 Report.

Table 24e
Department of Water Resources, Kern Water Bank
Ground Water Banking Summaries
Recharge and Recovery Accounting
(in acre-feet)

Contracting Entity or Location

Calendar Year	Buena Vista WSD	City of Bakersfield 2,800 Acres	KCWA ID#4	Kern Delta WD	Kern Fan Element	La Hacienda WD	North Kern WSD	Rosedale-Rio Bravo WSD	Semitropic WSD	West Kern WD	Total
1987	0	7,379	0	0	0	0	0	0	0	0	7,379
1988	0	0	0	0	0	0	0	0	0	0	0
1989	0	0	0	0	0	0	0	0	0	0	0
1990	20,000	9,500 (1)	0	7,500	0	98,005	0	7,500	105,500	0	248,006
1991	0	0	0	0	0	0	0	0	0	0	0
1992	(9,300)	0	0	(2,814)	0	(14,878)	0	(3,558)	(41,499)	0	(72,049)
1993	0	0	0	0	0	0	0	0	0	0	0
	10,700	**16,879**	**0**	**4,686**	**0**	**83,127**	**0**	**3,942**	**64,001**	**0**	**183,336**

(1) Transfer of storage account from Berrenda Mesa WD to DWR as a result of 1990 Demonstration Program.

Source: KCWA records.

Table 24d
Kern County Water Agency
Kern River Channel Within Improvement District No. 4
Ground Water Banking Summaries
Recharge and Recovery Accounting
(in acre-feet)

Calendar Year	Recharge			Recovery			Recoverable Balance		
	SWP	Imported Floodwater	Total	SWP	Imported Floodwater	Total	SWP	Imported Floodwater	Total
1981	33,552	0	33,552	0	0	0	33,552	0	33,552
1982	0	0	0	0	0	0	33,552	0	33,552
1983	0	0	0	0	0	0	33,552	0	33,552
1984	0	0	0	0	0	0	33,552	0	33,552
1985	0	0	0	0	0	0	33,552	0	33,552
1986	0	0	0	0	0	0	33,552	0	33,552
1987	0	0	0	0	0	0	33,552	0	33,552
1988	0	0	0	0	0	0	33,552	0	33,552
1989	0	0	0	0	0	0	33,552	0	33,552
1990	0	0	0	0	0	0	33,552	0	33,552
1991	0	0	0	18,161	0	18,161	15,391	0	15,391
1992	0	0	0	12,731	0	12,731	2,660	0	2,660
1993	0	0	0	0	0	0	2,660	0	2,660
	33,552	**0**	**33,552**	**30,892**	**0**	**30,892**	**2,660**	**0**	**2,660**

Table 24c
Kern County Water Agency
Berrenda Mesa Spreading Grounds
Ground Water Banking Summaries
Recharge/*Purchase* or Recovery/*Sale* by Year and Contracting Entity
(in acre-feet)

Calendar Year	KCWA General Account			Wheeler Ridge-Maricopa WSD			Berrenda Mesa WD		
	Recharge/ *Purchase*	Recovery/ *Sale*	Recoverable Balance	Recharge/ *Purchase*	Recovery/ *Sale*	Recoverable Balance	Recharge/ *Purchase*	Recovery/ *Sale*	Recoverable Balance
1981	0	0	0	0	0	0	0	0	0
1982	0	0	0	0	0	0	0	0	0
1983	14,155	0	14,155	0	0	0	0	0	0
1984	416	0	14,571	0	0	0	0	0	0
1985	0	0	14,571	0	0	0	0	0	0
1986	19,389	0	33,960	0	0	0	0	0	0
1987	0	0	33,960	0	0	0	0	0	0
1988	0	0	33,960	0	0	0	0	0	0
1989	0	0	33,960	0	0	0	0	0	0
1990	0	0	33,960	0	0	0	0	0	0
1991	0	15,298	18,662	0	0	0	0	0	0
1992	0	0	18,662	0	0	0	0	0	0
1993	0	0	18,662	1,076	0	1,076	5,197	0	5,197
	33,960	**15,298**	**18,662**	**1,076**	**0**	**1,076**	**5,197**	**0**	**5,197**

Calendar Year	Lost Hills WD			Belridge WSD			Total of All Accounts		
	Recharge/ *Purchase*	Recovery/ *Sale*	Recoverable Balance	Recharge/ *Purchase*	Recovery/ *Sale*	Recoverable Balance	Recharge/ *Purchase*	Recovery/ *Sale*	Recoverable Balance
1981	0	0	0	0	0	0	0	0	0
1982	0	0	0	0	0	0	0	0	0
1983	0	0	0	0	0	0	14,155	0	14,155
1984	0	0	0	0	0	0	416	0	14,571
1985	0	0	0	0	0	0	0	0	14,571
1986	0	0	0	0	0	0	19,389	0	33,960
1987	0	0	0	0	0	0	0	0	33,960
1988	0	0	0	0	0	0	0	0	33,960
1989	0	0	0	0	0	0	0	0	33,960
1990	0	0	0	0	0	0	0	0	33,960
1991	0	0	0	0	0	0	0	15,298	18,662
1992	0	0	0	0	0	0	0	0	18,662
1993	597	0	597	693	0	693	7,563	0	26,225
	597	**0**	**597**	**693**	**0**	**693**	**41,523**	**15,298**	**26,225**

Note: Purchases and sales are shown as italicized and larger.

Table 24b (continued)
Kern County Water Agency
City of Bakersfield 2,800 Acre Recharge Facility
Ground Water Banking Summaries
Recharge/*Purchase* or Recovery/*Sale* by Year and Contracting Entity
(in acre-feet)

Calendar Year	Lost Hills WD			Belridge WSD		
	Recharge/ *Purchase*	Recovery/ *Sale*	Recoverable Balance	Recharge/ *Purchase*	Recovery/ *Sale*	Recoverable Balance
1981	0	0	0	0	0	0
1982	0	0	0	0	0	0
1983	0	0	0	0	0	0
1984	0	0	0	0	0	0
1985	0	0	0	0	0	0
1986	0	0	0	0	0	0
1987	0	0	0	0	0	0
1988	0	0	0	0	0	0
1989	0	0	0	0	0	0
1990	0	0	0	0	0	0
1991	0	0	0	0	0	0
1992	0	0	0	0	0	0
1993	30,556	0	30,556	13,511	0	13,511
	30,556	**0**	**30,556**	**13,511**	**0**	**13,511**

Calendar Year	Semitropic WSD			Total of All Accounts		
	Recharge/ *Purchase*	Recovery/ *Sale*	Recoverable Balance	Recharge/ *Purchase*	Recovery/ *Sale*	Recoverable Balance
1981	0	0	0	35,412	0	35,412
1982	0	0	0	0	0	35,412
1983	0	0	0	0	0	35,412
1984	0	0	0	0	0	35,412
1985	0	0	0	15,055	0	50,467
1986	0	0	0	22,766	0	73,233
1987	0	0	0	7,379	0	80,612
1988	0	0	0	0	0	80,612
1989	0	0	0	18,519	16,105	83,026
1990	0	0	0	107,505	9,500	181,031
1991	0	0	0	44,131	33,316	191,846
1992	0	0	0	6,450	28,331	169,965
1993	19,972	0	19,972	153,011	0	322,976
	19,972	**0**	**19,972**	**410,228**	**87,252**	**322,976**

Table 24b
Kern County Water Agency
City of Bakersfield 2,800 Acre Recharge Facility
Ground Water Banking Summaries
Recharge/*Purchase* or Recovery/*Sale* by Year and Contracting Entity
(in acre-feet)

Calendar Year	KCWA General Account			Wheeler Ridge-Maricopa WSD			Berrenda Mesa WD		
	Recharge/ *Purchase*	Recovery/ *Sale*	Recoverable Balance	Recharge/ *Purchase*	Recovery/ *Sale*	Recoverable Balance	Recharge/ *Purchase*	Recovery/ *Sale*	Recoverable Balance
1981	29,812	0	29,812	5,600	0	5,600	9,500	0	9,500
1982	0	0	29,812	0	0	5,600	0	0	9,500
1983	0	0	29,812	0	0	5,600	0	0	9,500
1984	0	0	29,812	0	0	5,600	0	0	9,500
1985	15,055	0	44,867	0	0	5,600	0	0	9,500
1986	10,000	0	54,867	0	0	5,600	0	0	9,500
1987	0	0	54,867	0	0	5,600	0	0	9,500
1988	0	0	54,867	0	0	5,600	0	0	9,500
1989	0	***16,105*** (1)	38,762	***15,019***	0	20,619	0	0	9,500
1990	0	0	38,762	0	0	20,619	0	***9,500*** (3)	0
1991	***44,131***	33,316	49,577	0	0	20,619	0	0	0
1992	***6,450***	9,953	46,074	0	0	20,619	0	0	0
1993	5,541	0	51,615	57,214	0	77,833	2,739	0	2,739
	110,989	**59,374**	**51,615**	**77,833**	**0**	**77,833**	**12,239**	**9,500**	**2,739**

Calendar Year	Improvement District No. 4			State of California			Cawelo WD		
	Recharge/ *Purchase*	Recovery/ *Sale*	Recoverable Balance	Recharge/ *Purchase*	Recovery/ *Sale*	Recoverable Balance	Recharge/ *Purchase*	Recovery/ *Sale*	Recoverable Balance
1981	0	0	0	0	0	0	0	0	0
1982	0	0	0	0	0	0	0	0	0
1983	0	0	0	0	0	0	0	0	0
1984	0	0	0	0	0	0	0	0	0
1985	0	0	0	0	0	0	0	0	0
1986	12,766	0	12,766	0	0	0	0	0	0
1987	0	0	12,766	7,379	0	7,379	0	0	0
1988	0	0	12,766	0	0	7,379	0	0	0
1989	***3,500*** (2)	0	16,266	0	0	7,379	0	0	0
1990	0	0	16,266	***107,505***	0	114,884	0	0	0
1991	0	0	16,266	0	0	114,884	0	0	0
1992	0	***3,500***	12,766	0	14,878	100,006	0	0	0
1993	26,217	0	38,983	0	0	100,006	12,959	0	12,959
	42,483	**3,500**	**38,983**	**114,884**	**14,878**	**100,006**	**12,959**	**0**	**12,959**

(1) Total of 1,086 AF owed by ID#4 to KCWA General and delivered in 1991; 15,019 AF transferred to Wheeler Ridge-Maricopa WSD's account.

(2) Assignment of 3,500 AF from City of Bakersfield ground water storage to ID#4 on behalf of Kern-Tulare WD (2,800 AF) and Rag Gulch WD (700 AF).

(3) Transferred to DWR as part of 1990 Demonstration Program.

Note: Purchases and sales are shown as italicized and larger.

Table 24a (continued)
Kern County Water Agency
Summary of Ground Water Banking Activities

	1987	1988	1989	1990	1991	1992	1993	Total
Belridge WSD								
Recharge/Purchase							14,204	14,204
Recovery/Sale								
Storage Balance							14,204	14,204
Buena Vista WSD								
Recharge/Purchase							7,849	58,283
Recovery/Sale	(6,000)	(5,000)	(3,138)	(2,242)	(4,410)	(4,004)		(24,794)
Storage Balance	44,434	39,434	36,296	34,054	29,644	30,050	37,493	33,489
Berrenda Mesa WD								
Recharge/Purchase							7,936	17,436
Recovery/Sale				(9,500)				(9,500)
Storage Balance	9,500	9,500	9,500				7,936	7,936
Cawelo WD								
Recharge/Purchase							12,959	12,959
Recovery/Sale								
Storage Balance							12,959	12,959
City of Bakersfield								
Recharge/Purchase	109						32	412,561
Recovery/Sale	(656)	(5,432)	(2,859)	(23,318)	(57,159)	(30,266)		(236,386)
Storage Balance	295,177	289,745	286,886	263,568	206,409	233,302	206,441	176,175
Improvement District No. 4								
Recharge/Purchase			3,500				26,217	42,483
Recovery/Sale						(3,500)		(3,500)
Storage Balance	12,766	12,766	16,266	16,266	16,266	12,766	42,483	38,983
Kern County Water Agency								
Recharge/Purchase					44,131	6,450	5,541	178,501
Recovery/Sale			(16,105)		(66,775)	(22,684)		(105,564)
Storage Balance	122,379	122,379	106,274	106,274	83,630	90,040	89,171	72,937
Lost Hills WD								
Recharge/Purchase							31,153	31,153
Recovery/Sale								
Storage Balance							31,153	31,153
Metropolitan WD of So. Calif.								
Recharge/Purchase							50,000	50,000
Recovery/Sale								
Storage Balance							50,000	50,000
OlceseWD/Hacienda WD								
Recharge/Purchase	5,344	3,214			22,096	6,450		188,964
Recovery/Sale			(873)	(99,405)	(23,496)	(6,450)		(130,224)
Storage Balance	157,204	160,418	159,545	60,140	58,740	60,140	58,740	58,740
Semitropic WSD								
Recharge/Purchase							19,972	19,972
Recovery/Sale								
Storage Balance							19,972	19,972
State of California								
Recharge/Purchase	7,379			248,006				255,385
Recovery/Sale						(72,049)		(72,049)
Storage Balance	7,379	7,379	7,379	255,385	255,385	183,336	255,385	183,336
Wheeler Ridge-Maricopa WSD								
Recharge/Purchase			15,019				58,290	78,909
Recovery/Sale								
Storage Balance	5,600	5,600	20,619	20,619	20,619	20,619	78,909	78,909
Total of All Accounts								
Recharge/Purchase	12,832	3,214	18,519	248,006	66,227	12,900	234,153	1,360,810
Recovery/Sale	(6,656)	(10,432)	(22,975)	(134,465)	(151,840)	(138,953)		(582,017)
Storage Balance	654,439	647,221	642,765	756,306	670,693	630,253	904,846	778,793

Table 24a
Kern County Water Agency
Summary of Ground Water Banking Activities

	1978	1979	1980	1981	1982	1983	1984	1985	1986
Belridge WSD									
Recharge/Purchase									
Recovery/Sale									
Storage Balance									
Buena Vista WSD									
Recharge/Purchase	6,056	9,913			24,465				10,000
Recovery/Sale									
Storage Balance	6,056	15,969	15,969	15,969	40,434	40,434	40,434	40,434	50,434
Berrenda Mesa WD									
Recharge/Purchase				9,500					
Recovery/Sale									
Storage Balance				9,500	9,500	9,500	9,500	9,500	9,500
Cawelo WD									
Recharge/Purchase									
Recovery/Sale									
Storage Balance									
City of Bakersfield									
Recharge/Purchase	104,587	4,505	68,804	2,603	37,913	113,380	16,058	402	64,168
Recovery/Sale			(13,772)	(100,837)			(472)	(1,615)	
Storage Balance	104,587	109,092	164,124	65,890	103,803	217,183	232,769	231,556	295,724
Improvement District No. 4									
Recharge/Purchase									12,766
Recovery/Sale									
Storage Balance									12,766
Kern County Water Agency									
Recharge/Purchase				63,364		14,155	416	15,055	29,389
Recovery/Sale									
Storage Balance				63,364	63,364	77,519	77,935	92,990	122,379
Lost Hills WD									
Recharge/Purchase									
Recovery/Sale									
Storage Balance									
Metropolitan WD of So. Calif.									
Recharge/Purchase									
Recovery/Sale									
Storage Balance									
OlceseWD/Hacienda WD									
Recharge/Purchase	24,328		52,604	4,465	14,266				56,197
Recovery/Sale									
Storage Balance	24,328	24,328	76,932	81,397	95,663	95,663	95,663	95,663	151,860
Semitropic WSD									
Recharge/Purchase									
Recovery/Sale									
Storage Balance									
State of California									
Recharge/Purchase									
Recovery/Sale									
Storage Balance									
Wheeler Ridge-Maricopa WSD									
Recharge/Purchase				5,600					
Recovery/Sale									
Storage Balance				5,600	5,600	5,600	5,600	5,600	5,600
Total of All Accounts									
Recharge/Purchase	134,971	14,418	121,408	85,532	76,644	127,535	16,474	15,457	172,520
Recovery/Sale			(13,772)	(100,837)			(472)	(1,615)	
Storage Balance	134,971	149,389	257,025	241,720	318,364	445,899	461,901	475,743	648,263

Project. On the local level, the City of Bakersfield has maintained its 2,800-acre recharge area as a banking and recovery site for many years, where KCWA and others have deposited water.

During 1992 KCWA purchased 2,400 acres of land to develop additional water recharge and banking facilities. Named the Pioneer Spreading Grounds, the property comprises two parcels located southwest of Bakersfield. One parcel lies just north of the Kern River, and the other lies just south. Once completed, the Pioneer Spreading Grounds will increase Kern County's ground water recharge capacity by about 170,000 acre-feet annually.

Tables 24a-24g outline the banking account balances for those entities who are involved in various banking programs. These tables are detailed summaries of the banking portion of Table 23, and include recharge, extractions and transfer/sales of banking accounts.

Shallow Ground Water

When the downward movement of water is intercepted by shallow clay beds or strata of low permeability, shallow ground water accumulations result. These accumulations generally are undesirable in farming operations if the water reaches the crop root zone. Poor crop yield, soil salt buildup, and farm equipment bogging in poorly drained fields are all symptoms of shallow ground water problems.

Not enough is known about the shallow ground water phenomenon to allow for definite conclusions as to its causes. Recent investigations of Kern County's regional geologic structure do not suggest a low permeability layer near the ground surface in all areas of the shallow ground water phenomenon. In 1986 KCWA began a pilot program to measure shallow ground water levels and associated information monthly. The program was designed to develop long-term, consistent data on which to base a reliable analysis of shallow ground water. Because of staff constraints, the program was stopped in 1992.

The areas suffering from shallow ground water in Kern County follow the historic lower-elevation trace of the Kern River channel. Increases in shallow ground water area appear after a year of high Kern River runoff. Similarly, contractions seem to occur during years when runoff is low. In this sense, shallow ground water may be a natural phenomenon. Table 24 lists historic areas with shallow ground water problems, categorized into five foot increments, along with the number of monitoring wells measured. At first glance, it seems that an enormous increase in shallow water area occurred between 1979 and 1980, and again in 1993. Likely, this increase is perceived and not real. KCWA and cooperating water districts have been expanding the monitoring grid. During 1992-93 the Buena Vista Water Storage District and Lost Hills Water District both expanded their shallow ground water monitoring programs. As a result, the number of data points increased from 344 (in 1992) to 518 (in 1993). As shown on Table 25 and Plate 1, expanding the grid has now allowed the eastern and western boundaries of the shallow ground water areas to be fairly well defined Monitoring wells located in these areas are consistently dry. The expanded grid has also resulted in better definition of the 0-5 feet interval.

Depth to shallow ground water as measured in shallow monitoring wells is contoured on Plate 1. In the summer of 1993 water within five feet of the ground surface was found under an area of about 25,000 acres. This was a 150 percent increase from the summer of 1992 area. The area of shallow ground water between 5-10 feet of the ground surface was about 97,400 acres, slightly less than the previous year. The area with shallow ground water between 10-15 feet of the surface was 46,900 acres in 1993, about the same as in 1992. The total area with shallow ground water between ground surface and 15 feet below increased about seven percent from 1992, reflecting the wet winter of 1993.

Since the summer of 1990 the area with shallow ground water from 15-20 feet has not been computed. Many wells are dry that had previously shown shallow ground water at 15 feet or less. Data from the summer of 1993 indicates that some of these wells are now showing water levels less than 15 feet. As a result, the Summer 1993 map shows less dashed 15 foot contours. In a few areas, enough data is present to show limited 20 foot contours. It appears that the boundary areas and areas outlined by the five foot contour are most affected by wet and dry years. The increase in the shallow ground water area in 1993 may be the result of a combination of factors. Surface water supplies, severely restricted during the drought, was more plentiful in 1993. As a result, ground water pumping decreased, allowing ground water levels to rebound.

Table 23
Summary of Ground Water Recharge Activities *
(in acre-feet)

Entity/Location	Source	1971-88	1989	1990	1991	1992	1993	Total
BANKING								
City of Bakersfield **								
2,800 Acre Spreading Area	Kern	525,132 (2)	0	0	0	0	865	525,997
	SWP	21,010	0	0	0	0	0	21,010
	F-K	68,681 (2)	0	0	0	0	7,016	75,697
Subtotal COB		**0**	**0**	**0**	**0**	**0**	**7,881**	**622,704**
Kern County Water Agency		0						
Berrenda Mesa Spreading Area	Combined	33,960 (1)	0	0	0	0	7,563	41,523 (1)
Kern River Channel (in ID4)	SWP	33,552	0	0	0	0	0	33,552
2,800 Acre Spreading Area	SWP	82,733	0	0	0	0	168,709	251,442
Subtotal KCWA		**0**	**0**	**0**	**0**	**0**	**176,272**	**326,517**
DWR-Kern Water Bank		0						
2800 Acre Spreading Area	SWP	7,379	0	0	0	0	0	7,379
Local Elements*** In-lieu Rechg.	SWP	0	0	136,300	0	0	0	136,300
Local Elements*** Direct Rechg.	SWP	0	0	4,200	0	0	0	4,200
Subtotal DWR		**0**	**0**	**140,500**	**0**	**0**	**0**	**147,879**
Total Banking		**0**	**0**	**140,500**	**0**	**0**	**184,153**	**1,097,100**
CONJUNCTIVE USE								
Arvin-Edison WSD	F-K	752,323	0	0	170	9,253	122,917	884,663
Buena Vista WSD	Kern	242,446	2,723	0	0	0	11,949	257,118
	SWP	28,900	809	0	0	0	16,965	46,674
	F-K	0	0	0	0	0	1,818	1,818
Semitropic WSD Direct Rechg.	SWP	17,618	18,654	16,400	6,800	9,326	9,738	78,536
In-Lieu Rechg.	SWP	540,653	60,751	34,870	697	1,531	31,728	670,230
	Combined	7,289 (1)	--	--	--	--	--	7,289 (1)
I.D. No. 4 Direct Rechg.	Kern	397,540	14,040	3,116	6,279	4,437	30,319	455,731
	SWP	239,904	6,990	10,713	1,651	2,574	44,557	306,389
	F-K	18,835	0	0	0	0	8,084	26,919
Kern Delta WD Direct Rechg.	Kern	189,123	49,966	0	0	0	0	239,089
	SWP	1,351	0	0	0	0	0	1,351
	F-K						3,874	3,874
North Kern WSD Direct Rechg.	Kern	1,365,469	15,707	0	4,038	26,017	61,482	1,472,713
In-Lieu Rechg.	Kern	452,743	6,762	0	1,326	26,739	45,218	532,788
Rosedale-Rio Bravo WSD	Kern	501,404	7,500	0	9,076	1,041	26,890	545,911
	SWP	481,943	32,700	0	0	8,282	55,636	578,561
	F-K	161,807	0	0	62	0	6,859	168,728
	Combined	279,800 (1)	--	--	--	--	--	279,800 (1)
Wheeler Ridge-Maricopa WSD								
In-Lieu Recharge	SWP	86,563	0	9,000	0	0	6,882	102,445
Total Conjunctive Use		**0**	**216,602**	**74,099**	**30,099**	**89,200**	**484,916**	**6,660,627**
OVERDRAFT CORRECTION								
Ground Water Replenishment								
Program (GRP) In-Lieu Rechg.	SWP	96,871	0	0	0	0	0	96,871
Direct Rechg.	SWP	257,920	0	0	0	0	521	258,441
	Kern	57,230	0	0	0	0	0	57,230
	F-K	7,723	0	0	0	0	0	7,723
Idle Lands Spreading	Kern	130,955	0	0	0	0	0	130,955
In-Lieu Recharge	Kern	0	0	0	0	0	573	573
Total Overdraft Correciton		**550,699**	**0**	**0**	**0**	**0**	**1,094**	**551,793**
GRAND TOTALS	**Kern**	**3,862,042**	**96,698**	**3,116**	**20,719**	**58,234**	**177,296**	**4,218,105**
	SWP	**1,896,397**	**119,904**	**211,483**	**9,148**	**21,713**	**334,736**	**2,593,381**
	F-K	**1,009,369**	**0**	**0**	**232**	**9,253**	**148,750**	**1,167,604**
	Combined	**321,049**	**0**	**0**	**0**	**0**	**7,563**	**328,612 (1)**
	Total	**7,088,857 (1)**	**216,602**	**214,599**	**30,099**	**89,200**	**668,345**	**8,307,702**

* Includes direct and in-lieu recharge.

** Includes banking by Olcese WD, Hacienda WD, Buena Vista WSD, City of Bakersfield; for breakdown between districts see Table 23.

*** Includes 1990 Kern Water Bank Demonstration Program deliveries.

(1) Breakdown between sources not available.

(2) Revised from 1992 Water Supply Report.

Note: For a breakdown of 1971 to 1987, see prior Water Supply Reports.

Ground Water Conditions

Ground Water Recharge

Several entities in Kern County are actively engaged in ground water replenishment operations. The Semitropic WSD, Rosedale-Rio Bravo WSD, North Kern WSD, Arvin-Edison WSD, City of Bakersfield 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 channel. Central Valley Project water is recharged in spreading ponds operated by the Arvin-Edison Water Storage District or in the Kern River and Poso Creek channels. State Water Project water is recharged by KCWA and several water districts in the Kern River channel via the Cross Valley Canal, in unlined irrigation canals, or in district operated recharge sites. During wet periods, every effort is made to deliver water through unlined canals to maximize ground water recharge.

Many water districts in Kern County use conjunctive use and banking programs to help balance their supplies. A correctly managed conjunctive use or banking program is an effective ground water management tool that allows a district to smooth over periods when surface water is unavailable. The intent is to store water during times when the available supply exceeds demand, and recover the water when the opposite is true. Also, a correctly managed program monitors the effects of water withdrawals in any year, so adverse local and regional impacts are minimized. A tremendous amount of ground water 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 656,400 acre-feet of water was recharged in 1993, both deliberately and incidentally. The approximate breakdown between sources was:

Kern River	132,100	af
SWP	295,100	
CVP	148,800	
Waste Water	3,600	
Minor Streams	69,200	
Combined	7,600	
Total	**656,400**	**af**

These numbers should only be considered as best estimates since often the supplies are intermixed in the same canal systems. Therefore, any differentiation becomes impossible. The amount of recharge shown on Table 22 is more than the amount of recharge listed here. This is because Table 22 includes in lieu recharge, but excludes incidental recharge and minor stream flows that have naturally recharged the ground water basin. In lieu recharge is accomplished by delivering surface water to users who would normally pump ground water.

Such recharge efforts show the importance attached to reducing ground water overdraft in Kern County, and conserving water. Since 1970, a total of about 8,308,000 acre-feet of water has been recharged (both deliberately and incidentally) to replenish ground water supplies. The effectiveness of such recharge activities is apparent in Figure 17. KCWA estimates that the 8,308,000 acre-feet of recharged water results in a gross basin-wide ground water pumping lift difference of about 83 feet, or about one foot for every 100,000 acre-feet.

Ground Water Banking

Ground water banking is a water management tool that has increased in use during recent years, corresponding to the decreasing ability of the SWP and CVP to provide a dependable water supply. Because of limitations of existing surface storage facilities coupled with regulatory restraints DWR cannot presently meet its long-term contractual obligations. Since ground water storage is now more environmentally acceptable and financially feasible, DWR, KCWA and local water districts are expanding the development of water banking programs. The purpose of banking programs is to store surface water in the underground when it is available and recover it during times of need. Therefore, available surface water supplies are used conjunctively with ground water. While conjunctive use has been used since the turn of the century by local water managers, it is a new approach for the SWP.

The Kern Water Bank is a planned banking/recovery program that will ultimately provide as much as 100,000 acre-feet of annual dry-year yield for the State Water

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
Total	**1,010,220**	**132,861**	**1,143,081**			**608,665**			**534,416**

* A breakdown between sources was not available.
Source: State Deparment of Water Resources and City of Bakersfield Kern River Annual Reports.

Intertie Activity

The Kern River-California Aqueduct Intertie is a structure connecting the Kern River to the California Aqueduct near Tupman. Built by the Army Corps of Engineers in 1977, its basic purpose is to dispose of flood water, preventing damages downstream of the Kern River flood plain. Flows into the California Aqueduct through the Intertie may contain water from the Kern, Kaweah, 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. Water from the Kern River channel first passes through a sedimentation basin to remove sand and silt. Water then passes through trash racks to remove floating debris before it enters the aqueduct. 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.

When it enters the California Aqueduct, Intertie water becomes the property of the State Department of Water Resources, and is used to meet SWP system needs. During periods of extremely heavy runoff (such as in 1983), temporary pumps may be installed to pump the water to aqueduct reaches north (upstream) of the Intertie as well. Such water displaces an equal amount of SWP water that would have been pumped from the Sacramento-San Joaquin River Delta, producing a power saving for the SWP users.

The Intertie has not operated since 1986. Through the end of 1986, a total cumulative flow of 1,143,081 acre-feet of water has passed through its gates into the California Aqueduct. About 47 percent of this was used in Kern County, the remainder went to southern California. Table 22 is a historical summary of Intertie activity to date, showing the inflow by source, and amounts exported and retained in the County. It is expected that water banking programs operated by KCWA and DWR will reduce this loss in the future.

Basin-Wide Water Use Efficiency

Water applied to a crop that is over its evapotranspiration requirements percolates past the root zone and returns to ground water supplies, where it is available for reuse. Sometimes the deep percolation is intercepted by shallow clay lenses in the soil. This condition is called shallow ground water. In some areas the deep percolation may return to unusable saline ground water. In the western portion of Kern County, most of the soils are moisture-deficient. That is, the water held in the soil is less than the amount of water the soil would normally retain after gravity drainage. Any deep percolation occurring over these moisture-deficient soils will be absorbed until the water holding capacity of the soils is satisfied. Geologists estimate it would take over three million acre-feet of water to satisfy the holding capacity of these moisture-deficient soils.

Over the entire San Joaquin Valley portion of Kern County, gross water uses were about 3,579,100 acre-feet during 1993 (2,712,100 for agriculture, 169,700 for M&I, 37,900 of evaporation losses, 656,400 for ground water recharge, and 3,000 of unrecoverable delivery system losses). The total consumption of water was about 2,258,000 acre-feet (2,159,100 by agriculture, 61,000 by M&I, 37,900 of evaporation losses). Effective precipitation was about 168,700 acre-feet. The agricultural irrigation efficiency, therefore, was about 77 percent. A total of 47,600 acre-feet of M&I water was treated and reused, mostly by agriculture. The difference between gross and net requirements is an estimate of ground water returns, which amounted to 664,700 acre-feet. However, about 110,500 acre-feet of deep percolation was intercepted by shallow ground water. Another 7,500 acre-feet was absorbed by moisture-deficient soils. Therefore, net ground water returns were 546,700 acre-feet in 1993. Expressed another way, of the 3,579,100 acre-feet of gross water demand during 1993, 3,423,200 acre-feet was beneficially used or available for reuse (via net deep percolation). As a percent, 95 percent of the water used during 1993 was put to beneficial use or available for reuse. This percentage is termed basin-wide water use efficiency. Kern County is among the most efficient areas of the state in terms of basin-wide water use efficiency.

Table 21
Historic Surface* and Ground Water Usage or Availablity
in the San Joaquin Valley Portion of Kern County
(in acre-feet)

	Kern River		Other Local Water		Central Valley Project		State Water Project		Ground Water		
	Available	% of Total	Available	% of Total	Usage	% of Total	Usage	% of Total	Usage	% of Total	Total Supplies
1970	590,300	19.1	517,900	16.8	351,400	11.4	204,600	6.6	1,422,000	46.1	3,086,200
1971	428,300	14.0	217,100	7.1	348,900	11.4	375,500	12.2	1,700,000	55.4	3,069,800
1972	269,200	8.4	292,600	9.2	238,500	7.5	535,600	16.8	1,857,000	58.2	3,192,900
1973	980,500	26.3	161,200	4.3	412,200	11.0	515,500	13.8	1,662,000	44.5	3,731,400
1974	819,400	22.7	332,000	9.2	480,600	13.3	651,800	18.0	1,333,000	36.9	3,616,800
1975	565,400	15.3	287,300	7.8	442,100	11.9	821,700	22.2	1,587,000	42.9	3,703,500
1976	250,300	7.5	225,700	6.8	226,500	6.8	883,400	26.6	1,738,000	52.3	3,323,900
1977	197,800	7.4	239,400	8.9	121,500	4.5	429,400	16.0	1,703,000	63.3	2,691,100
1978	1,654,300	36.8	1,050,200	23.3	357,800	8.0	611,500	13.6	825,000	18.3	4,498,800
1979	673,500	17.1	258,700	6.6	462,500	11.7	1,291,800	32.7	1,260,000	31.9	3,946,500
1980	1,640,900	37.8	356,500	8.2	462,800	10.7	900,300	20.8	977,000	22.5	4,337,500
1981	452,200	11.9	329,100	8.7	470,000	12.4	1,384,700	36.5	1,161,000	30.6	3,797,000
1982	1,273,600	30.9	502,800	12.2	656,600	15.9	884,500	21.5	802,200	19.5	4,119,700
1983	2,491,300	51.7	777,400	16.1	550,900	11.4	238,200	4.9	762,700	15.8	4,820,500
1984	824,300	21.7	165,300	4.4	425,400	11.2	1,123,000	29.6	1,252,200	33.0	3,790,200
1985	675,400	18.9	192,600	5.4	337,500	9.4	1,074,100	30.1	1,293,800	36.2	3,573,400
1986	1,447,900	35.3	207,000	5.0	589,300	14.4	913,600	22.3	947,600	23.1	4,105,400
1987	378,300	12.2	206,800	6.6	292,000	9.4	1,025,900	33.0	1,208,700	38.8	3,111,700
1988	297,700	9.0	179,800	5.4	292,800	8.8	1,006,200	30.3	1,540,200	46.4	3,316,700
1989	399,200	11.3	141,500	4.0	293,900	8.3	1,097,200	31.2	1,588,500	45.1	3,520,300
1990	221,300	6.9	112,800	3.5	200,100	6.3	857,300	26.9	1,796,500	56.4	3,188,000
1991	338,300	12.1	220,400	7.9	204,400	7.3	32,700	1.2	2,002,400	71.6	2,798,200
1992	275,000	9.9	203,200	7.3	208,000	7.5	418,000	15.0	1,673,600	60.2	2,777,800
1993	644,900	18.0	251,100	7.0	489,800	13.7	1,205,500	33.7	987,700	27.6	3,579,000
Avg.	**741,200**	**22.7**	**227,000**	**7.0**	**371,500**	**11.4**	**770,100**	**23.6**	**1,378,400**	**42.3**	**3,261,200**

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

Figure 18
Cumulative Change in Ground Water Storage
in the San Joaquin Valley Portion of Kern County

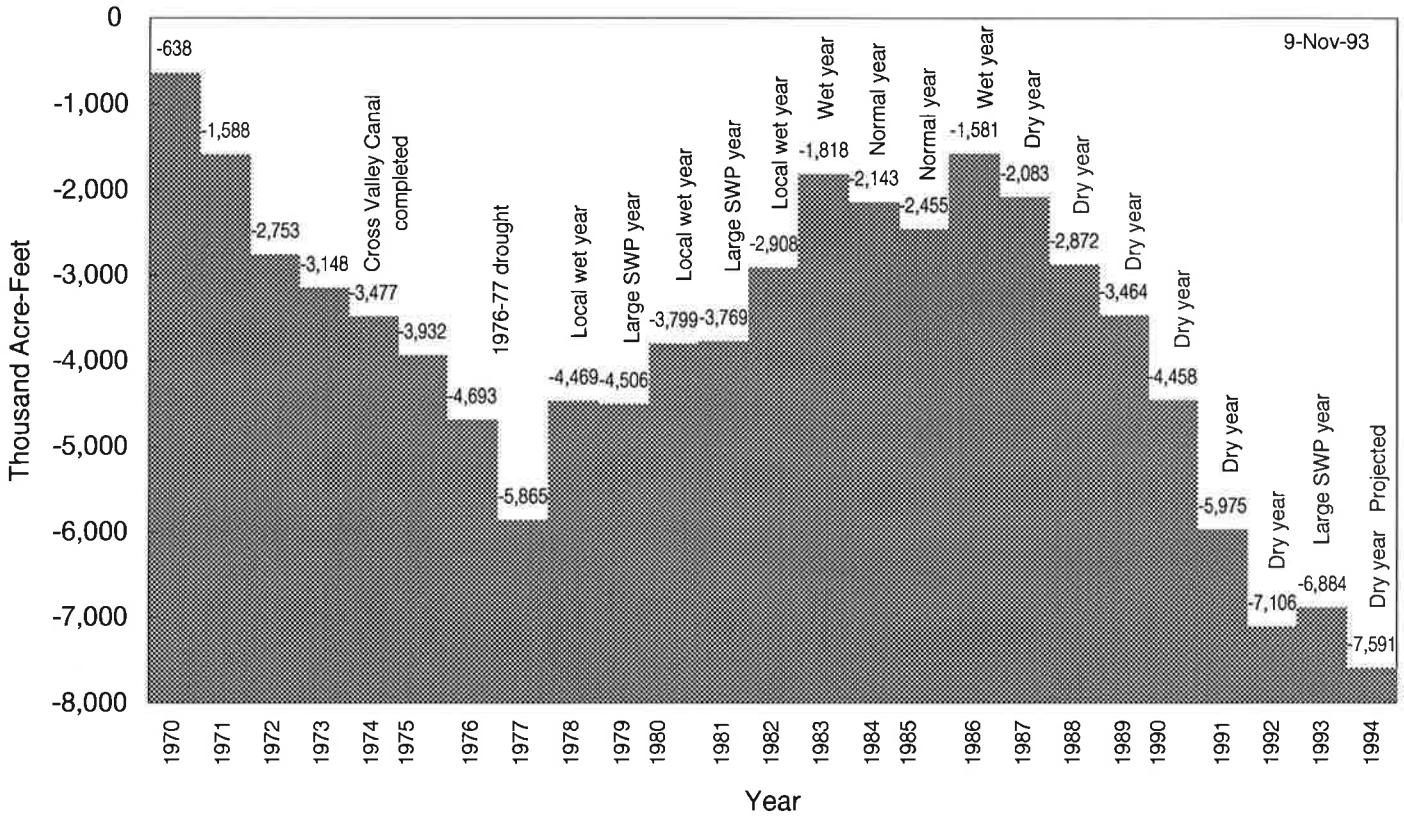


Figure 17
Gross Water Supplies and Net Water Requirements
San Joaquin Valley Portion of Kern County, California

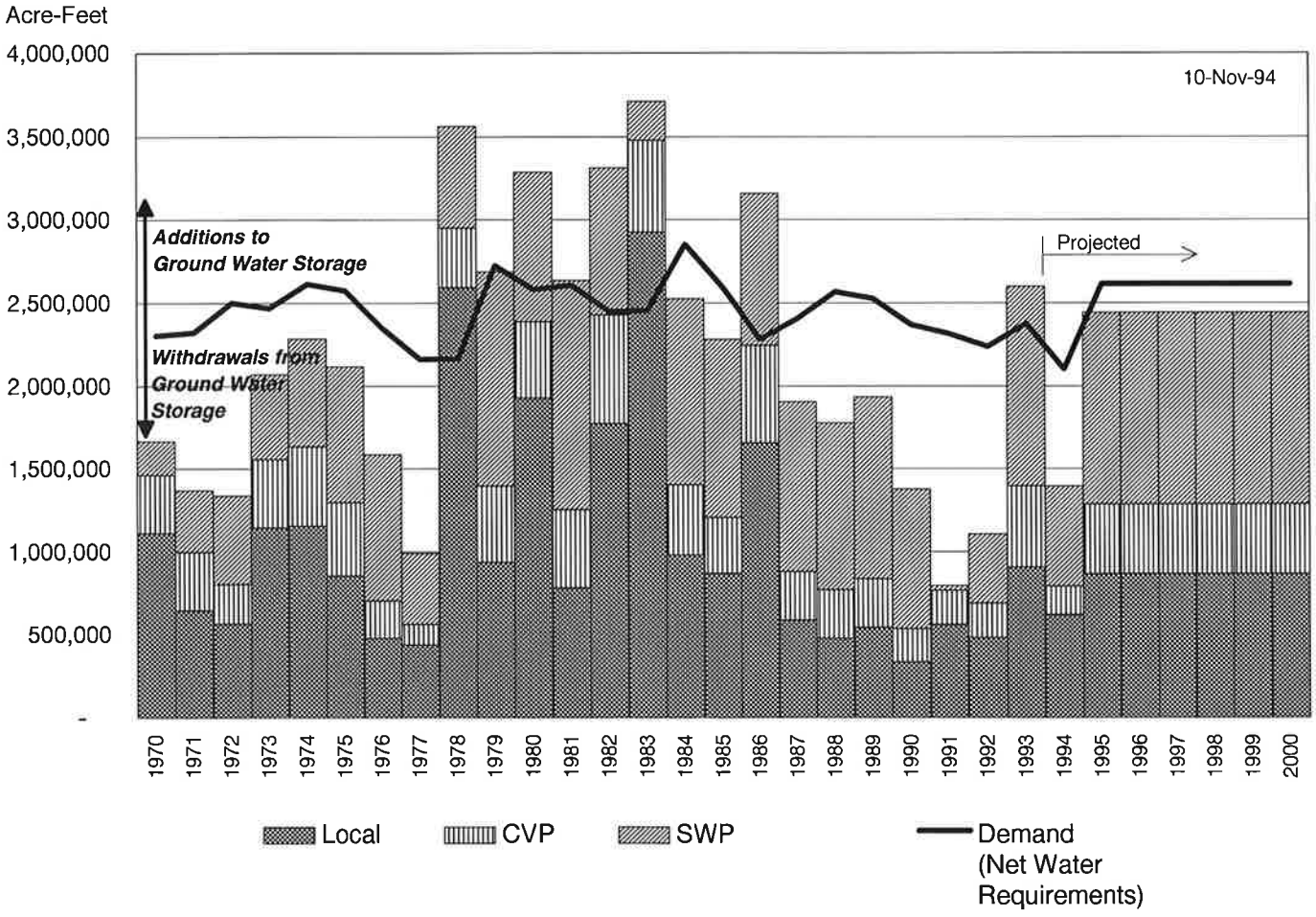
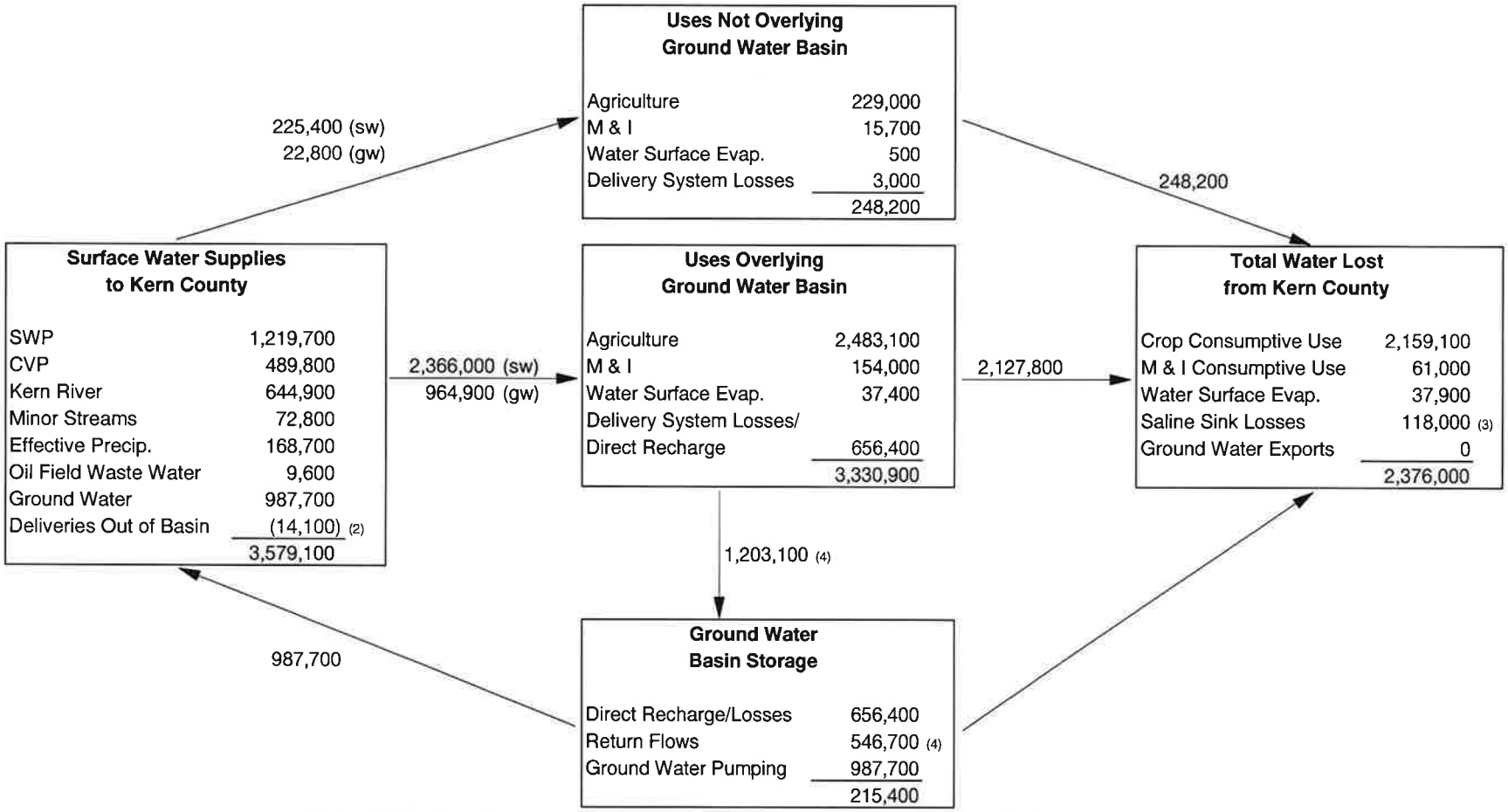


Figure 16
1993 Water Resources Inventory
San Joaquin Valley Portion of Kern County
(in acre-feet)



2,591,400 (Surface Supplies) minus 2,376,000 (Consumptive Use) equals 215,400 (Change in Storage)

Notes:

(1) Includes 13,500 AF Drought Bank water and 500 AF other imports.
(2) Delivered to other SWP contractors and Tehachapi-Cummings WD (3,500 AF).
(3) Includes 4,500 AF return flows, 3,000 AF delivery losses lost to moisture deficient soils.
(4) Of this, 47,600 AF was treated in waste water facilities and reused.

(sw) Surface Water
(gw) Ground Water

Change in Ground Water Storage

Figure 16 shows a total gross water demand for the San Joaquin Valley portion of Kern County of 2,922,700 acre-feet in 1992. About 2,674,500 acre-feet occurred over the ground water basin. An additional 656,400 acre-feet of water was used for direct recharge or delivery system losses. Total net water use was about 2,376,000 acre-feet, with about 2,127,800 acre-feet used over the ground water basin. Gross available surface water supplies were about 2,591,400 acre-feet. Therefore, there was a net increase in ground water storage of about 215,400 acre-feet. This was consistent with the fact that 1993 was a higher than normal runoff year.

The 1987-92 drought period proved to be more severe than the 1976-77 drought, in terms of water withdrawn from ground water storage. During the 1976-77 period, 1,933,000 acre-feet of water was removed from underground storage. The 1987-92 period saw 5,390,000 acre-feet of water withdrawn from storage.

Figure 17 graphically displays the water supplies and demands of the San Joaquin Valley portion of Kern County since 1970 (when SWP water was first introduced over the ground water 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.

During 1970-93 about 11,900,000 acre-feet of water was withdrawn from ground water storage. Over the same period the balance of additions over extractions has replenished about 5,551,000 acre-feet. Figure 18 shows the cumulative ground water balance since 1970 when SWP water was first introduced over the Kern County ground water basin. In volume of ground water storage, the basin now stands below 1977 levels. Improvements achieved during the 1978-86 wet period have been erased by the present drought.

Kern County's ground water management plans depend upon the sustained delivery of 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 upon the ground water basin. Table 21 provides a summary of supplies from these sources and shows this relative dependence. The dependence is especially illustrated by comparing the year 1986 with 1987. During 1986 surface water supplies were ample. Therefore, ground water comprised only 25 percent of the total water supply. In 1987 the reverse was true, and ground water pumping increased to make up for the dry-year conditions. Conditions during the ongoing drought have shown this dependence; as surface water sources were reduced, ground water pumping increased to make up the shortfall.

Table 20
1993 Urban Water Use, San Joaquin Valley Portion of Kern County

Water Purveyor Service area	Metered Connections	Non-metered Connections	Annual Water Use: Million Gals.	Annual Water Use: Acre Feet	Permanent Population	GPCD (1)
Arvin						
Arvin CSD	2,079	--	619	1,900	10,245	166
Bakersfield Metro Area						
Airport Mutual WC	--	--	17	52	--	--
California Water Service	14,880	38,861	22,225	68,202	182,000	335
Casa Loma WC	--	215	401	1,231	2,000	549
City of Bakersfield						
Ashe Water Division	17,235	--	7,185	22,049	66,000	298
East Niles CSD	6,130	--	2,755	8,454	21,382	353
Fairfax WC	--	--	2	6	--	--
Greenfield CWD	644	363	365	1,120	5,384	186
North of the River MWD	416	1,460	786	2,412	5,500	392
Oildale MWC	366	5,815	2,063	6,331	19,000	297
Rancho Verdugo WC	--	289	127	390	1,156	301
Stockdale MWC	--	80	43	132	200	589
Stockdale Annex MWC	--	138	98	301	320	839
Vaughn WC	2,673	1,028	1,933	5,932	11,785	449
Victory MWC	--	155	58	178	620	256
Metro Area Subtotal	**42,344**	**48,404**	**38,058**	**116,788**	**325,592**	**325**
Buttonwillow						
Buttonwillow CWD	--	406	155	476	1,250	340
Delano						
City of Delano	1,731	4,032	2,100	6,444	26,775	215
Lamont						
Lamont PUD and ID#1	261	2,429	1,736	5,327	12,000	396
Lost Hills						
Lost Hills Utility District	203	--	103	316	1,200	235 (2)
McFarland						
McFarland MWC	1,590	6	404	1,240	7,000	158
Rio Bravo						
Olcese WD	329	--	202	620	823	672 (3)
Shafter						
City of Shafter	65	2,985	840	2,578	10,133	227
Taft-Maricopa-McKittrick						
West Kern WD	7,105	--	3,812	11,698	16,530	632 (2)
Wasco						
City of Wasco	612	2,921	1,171	3,593	13,460	238
Wasco State Prison	2	--	198	608	4,500	121
Total	**56,321**	**61,183**	**49,398**	**151,587**	**429,508**	**306** (4)

(1) Gallons per capita per day. Note that the computed GPCD on this table includes residential, commercial, industrial and public authority water use. Residential use is about 200 GPCD.
(2) Includes significant quantities of water used by oil companies.
(3) Includes significant quantities of water used to irrigate a golf course.
(4) Weighted average gpcd, excluding Rio Bravo, Lost Hills and Taft-Maricopa-McKittrick.

Municipal and Industrial (M&I)

Gross M&I requirements in 1993 were estimated to be about 169,700 acre-feet, with about 154,000 acre-feet required over the usable ground water basin. Of the total amount used over the usable basin, 27,600 acre-feet was supplied by KCWA's water treatment plant. The Olcese Water District, which serves the Rio Bravo area, used about 700 acre-feet of Kern River water. East Niles Community Services District used about 100 acre-feet of CVP water obtained from the Arvin-Edison Water Storage District. The remainder, about 125,600 acre-feet, was drawn from ground water. Table 20 gives a breakdown of urban water deliveries by water purveyor service area. The total production of these purveyors, as listed on Table 20, is less than the gross M&I requirements. Many rural families and businesses maintain their own water systems, and as such, their volumes of production are not recorded. In addition, some small water companies do not keep accurate records of their water production. The gross M&I requirements reflect this fact and include an estimate of the needs of these rural areas and small water companies.

The average municipal and industrial water use over the ground water basin in 1993 was 306 gallons per capita per day (gpcd), about 10 percent higher than in 1992. Long-term, average M&I water use is about 250 gpcd. Residential water use is about 200 gpcd. Industrial, commercial and public authority water use accounts for the difference. It should be noted that domestic water uses by the west side towns (Taft, Maricopa, Lost Hills) are quite low when compared to the domestic water use over the ground water basin. The average domestic water usage during 1993 was about 136 gallons per capita per day for the west side towns.

Net M&I consumptive use in 1993 was about 45,300 acre-feet over the ground water basin. Gross return flows from M&I uses over the ground water basin were about 108,700 acre-feet. About 47,600 acre-feet of M&I return flows were treated in sewage treatment facilities and evaporated, percolated or reused for agriculture. The remaining 61,100 acre-feet returned to ground water supplies. Since most of the M&I water used outside the ground water basin is for oil field operations (only about 16 percent is used domestically), it is all consumptively used. Any water not consumptively used is lost to moisture deficient soils.

Exports

During periods of high runoff, some water may be introduced into the California Aqueduct via the Kern River-California Aqueduct Intertie and exported over the Tehachapi Mountains. Some water may be spilled into the Kern River Flood Channel, where it may flow north into Tulare Lake in Kings County. Essentially, this is not a usable surface supply. No water was exported from Kern County during 1993.

Water Surface Evaporation

Water surface evaporation normally accounts for a small amount of water lost from the valley portion of Kern County. In 1993, about 37,900 acre-feet of evaporation losses occurred, with about 37,400 acre-feet occurring over the ground water basin. This was about the same as in 1992. Any water lost in this manner is lost from this regional hydrologic system.

Table 19
Average Applied Water Requirements for Various Crops
in Kern County
(in acre-feet per acre)

Crop	Drip (1)	Sprinkler (2)	Row/Border (3)
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 Tre	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

(1) Includes emitters, misters, mini-sprinklers and fan jets.
(2) Includes portables, solid-sets, linear moves, sprinkler guns.
(3) Border includes border strip, level basin, contour strip.
Note: A blank entry indicates that an irrigation system is generally not utilized on a crop.

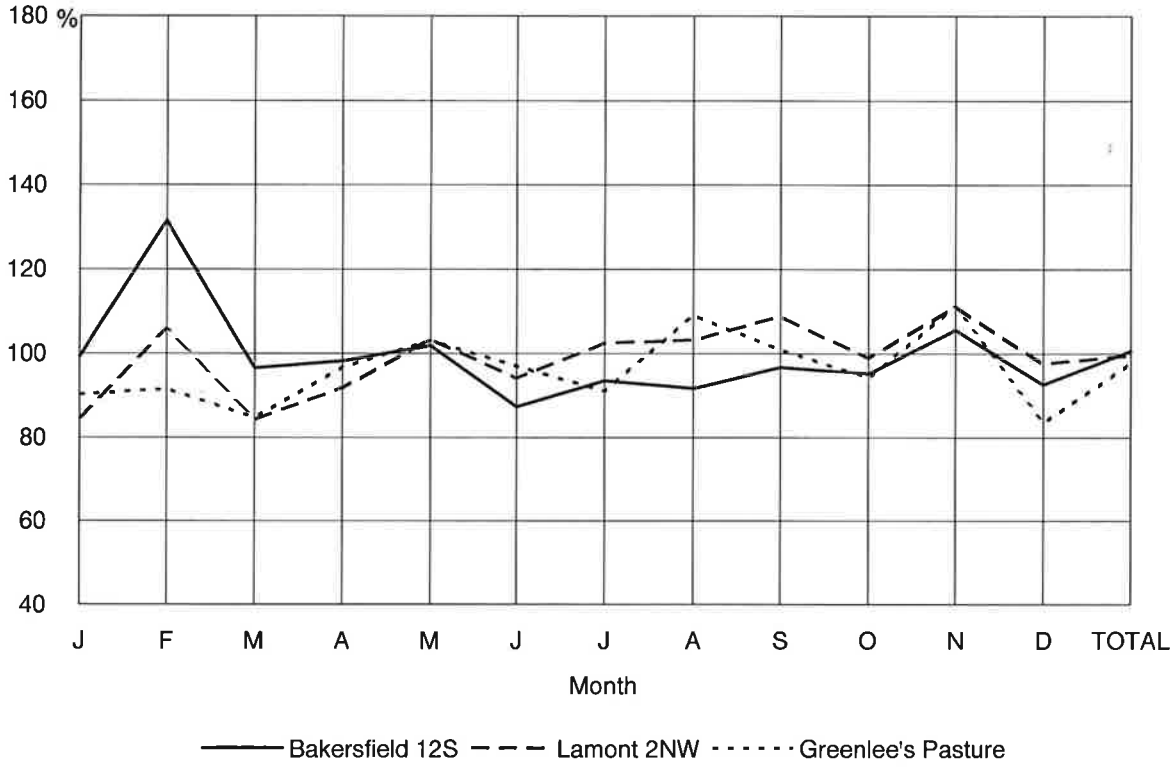
Table 18
1993 Irrigated Acreage
in the San Joaquin Valley Portion of Kern County, California

Crop	Acres	Percent of Total	Consumptive Water Use (AF/Acre)
Alfalfa (including seed)	79,332	9.9	3.75
Almonds	73,765	9.2	3.54
Apples	3,894	0.5	3.37
Apricots	643	-	3.35
Asparagus	424	-	3.00
Avocado	0	-	-
Barley	14,681	1.8	1.70
Beans	4,371	0.5	1.86
Broccoli	0	-	-
Carrots	22,240	2.8	0.60
Citrus	40,256	5.0	3.25
Corn, Field	2,015	0.3	-
Cotton	294,815	36.8	2.85
Figs	510	-	3.50
Grapes	83,945	10.5	2.45
Guayale and Jojoaba	405	-	1.00
Kiwi	363	-	2.45
Lettuce	3,451	0.4	0.20
Melons, Squash, Cucumbers	6,995	0.9	1.82
Misc. Deciduous Trees	6,105	0.8	3.54
Misc. Field Crop	1,511	0.2	2.76
Misc. Hay/Grain	11,626	1.5	1.62
Misc. Subtropical Trees	359	-	1.03
Misc. Truck Crop	5,576	0.7	0.20
Nursery	4,663	0.6	2.02
Oats	1,582	0.2	1.64
Olives	2,552	0.3	3.42
Onions, Garlic	10,332	1.3	3.51
Pasture, Turf	4,327	0.5	4.72
Peaches, Nectarines	5,696	0.7	3.31
Pears	72	-	3.54
Peas	320	-	1.57
Peppers	1,448	0.2	2.02
Pistachios	25,529	3.2	3.34
Plums, Prunes	2,686	0.3	3.38
Potatoes	22,652	2.8	1.94
Rice	0	-	-
Safflower	14,127	1.8	2.56
Sorghum/Milo	1,130	0.1	2.23
Sudan Grass	1,601	0.2	2.00
Sugar Beets	10,395	1.3	3.46
Tomatoes	3,630	0.5	2.46
Turnips	43	-	-
Walnuts	1,594	0.2	2.78
Wheat	28,454	3.6	2.33
Total	**800,115**	**100.0**	**2.79***

Note: Double-cropped acreage is counted twice, since it is irrigated twice.
* Weighted average consumptive use of all crops.

Figure 15

1993
Percent of Normal Evaporation



Percent of Normal, Total:	
Bakersfield 12S	**100.5**
Lamont 2NW	**99.6**
Greenlee's Pasture	**97.7**

Bakersfield 12S

1993 observed monthly EP, Bakersfield 12S (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.

Lamont 2NW

1993 observed monthly EP, Lamont 2NW (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

1993 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.

Table 17
1993 Monthly Evaporation for
Three San Joaquin Valley Climatic Stations
(in inches)

	Bakersfield 12S	Lamont 2NW	USDA Cotton Station	Avg. All Stations
January	1.40	1.19	1.09	1.23
February	2.88	2.32	2.02	2.41
March	3.83	3.34	3.39	3.52
April	5.70	5.33	6.24	5.76
May	8.45	8.57	10.38	9.13
June	8.34	8.99	11.44	9.59
July	9.05	9.92	10.78	9.92
August	7.80	8.78	8.46	8.35
September	6.18	6.95	7.36	6.83
October	4.11	4.27	4.85	4.41
November	2.27	2.39	2.19	2.28
December	1.12	1.18	1.40	1.23
Total	**61.13**	**63.23**	**69.60**	**64.65**
Percent of Normal	**101**	**100**	**115**	**105**

Station Locations

Bakersfield 12S	NW1/4,NW1/4, Section 36, T31S, R27E, MDB&M. Equipment: USWB Class "A" evaporation pan in an irrigated pasture environment.
Lamont 2NW	NW1/4, SW1/4, Section 25, T30S, R28E, MDB&M. Equipment: USWB Class "A" evaporation pan in an irrigated pasture environment.
USDA Cotton Station	NW1/4, SE1/4, Section 33, T27S, R25E, MDB&M. Equipment: USWB Class "A" evaporation pan in an irrigated grass turf environment.

Table 15
Historic Ground Water Pumping
(in acre-feet)

Year	Annual Ground Water Pumped	Cumulative Ground Water Pumped
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

Mean Ground Water Pumping	1,395,400 AF
Median Ground Water Pumping	1,422,000 AF
Minimum Pumping in 1983	762,700 AF
Maximum Pumping in 1991	2,002,400 AF

Figure 11
Waste Water Reuse in Kern County

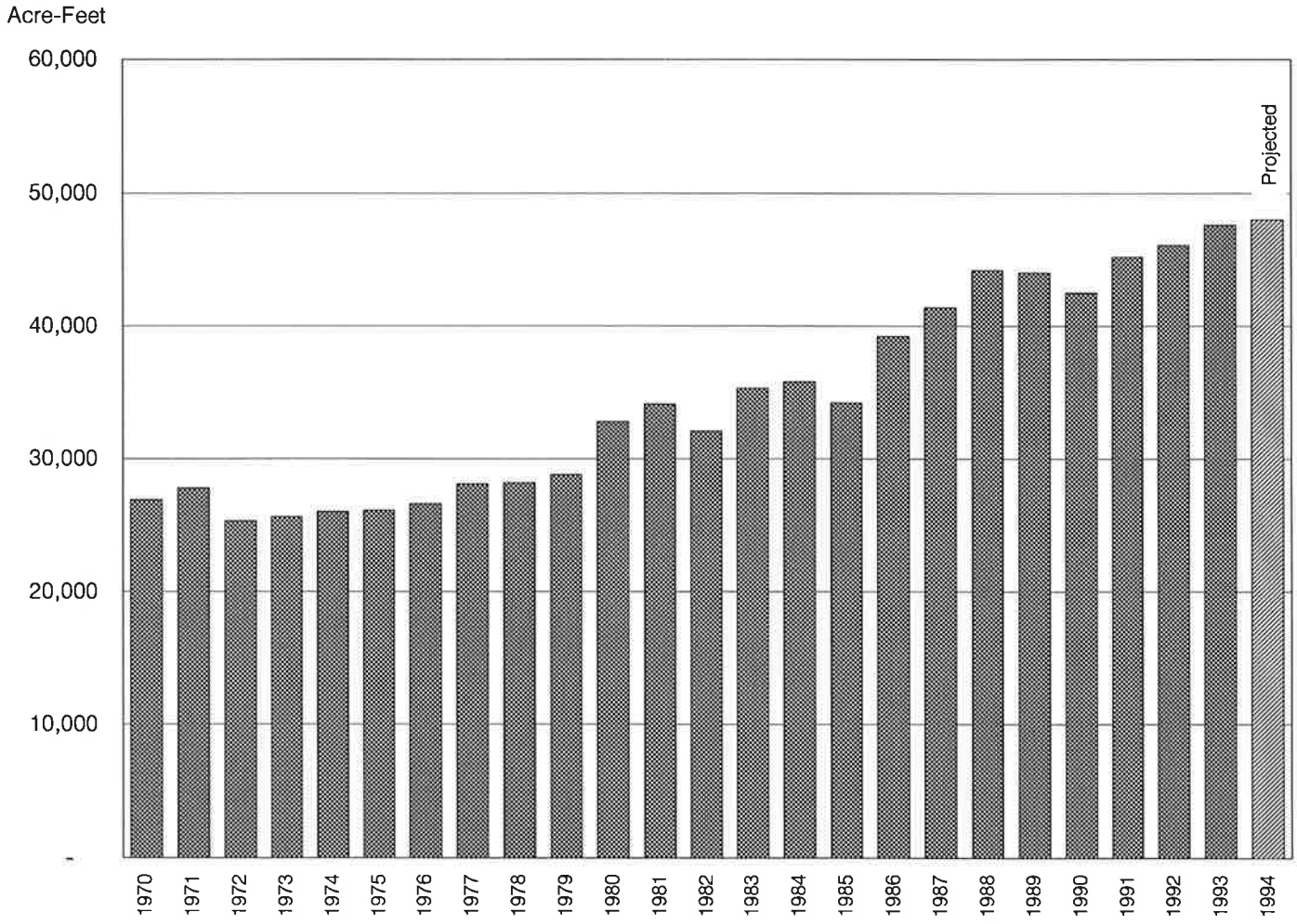
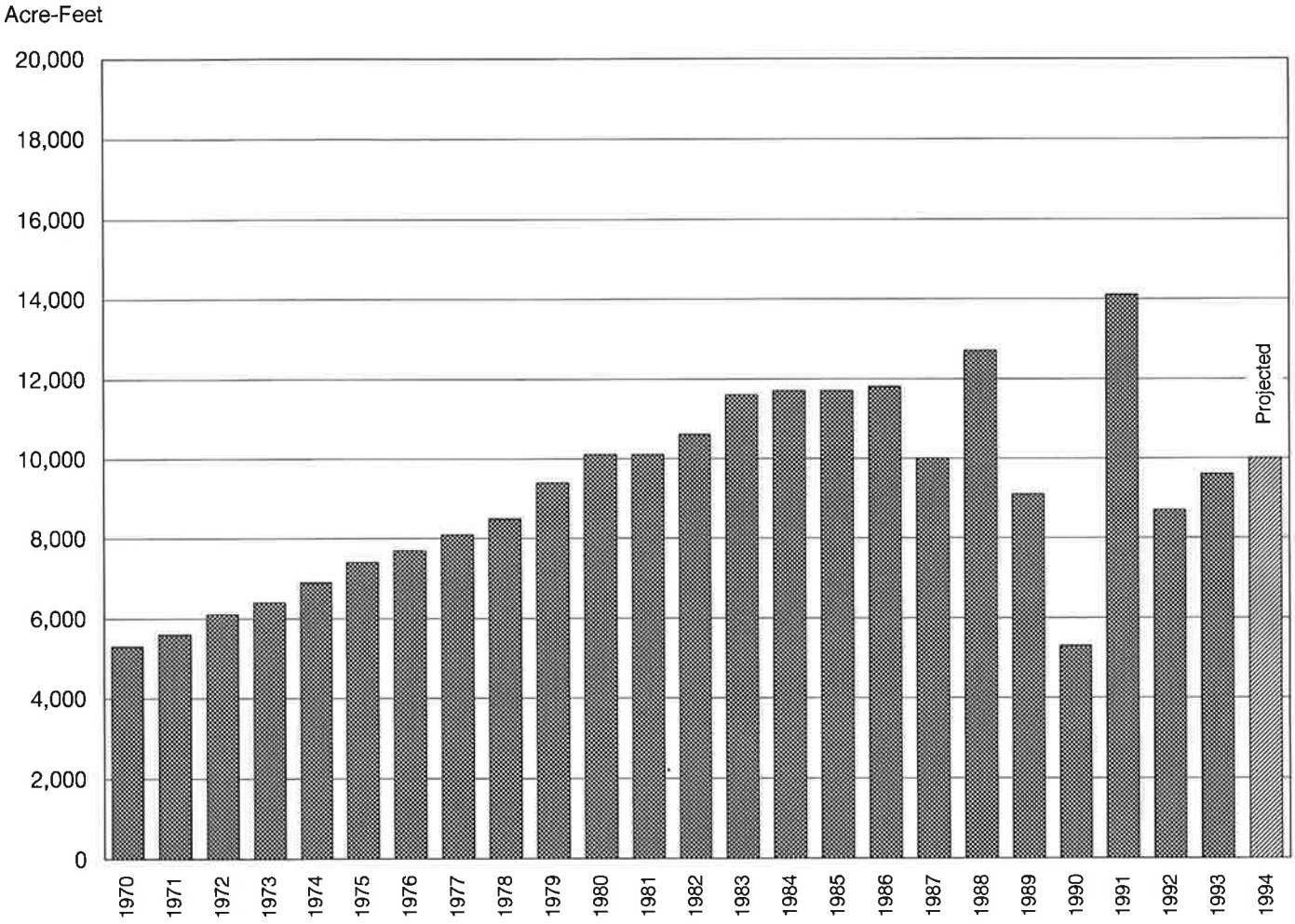


Table 14
Historic Waste Water Reuse
(in acre-feet)

Year	Annual Flows	Cumulative Flows
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

Mean Waste Water Flows	34,300 AF
Median Waste Water Flows	33,500 AF

Figure 10
Oil Field Production Water in Kern County



Agriculture is a major employer in Kern County. About 25 percent of all jobs within the county are agricultural or agriculture related. For some smaller communities, agriculture is the overwhelming employer, such as:

	Agriculture's Share of Employment
Arvin	92 percent
Buttonwillow	77 "
Delano	80 "
Lost Hills	94 "
Shafter	64 "
Wasco	75 "

Source: 1992 Agricultural Statistics

Per unit crop water demands in 1993 were quite normal. 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 Lamont 2NW stations (operated by the state Department of Water Resources) typify evaporation on the valley floor. Figure 15 displays monthly evaporation for these stations as a percent of normal.

Following are some crops that experienced significant yield increases over 1992.

Crop	Yield increase over 1992
Carrots	+ 19 percent
Citrus	+ 32 "
Sugar beets	+ 18 "
Wine grapes	+ 11 "
Winter potatoes	+ 277 "

KCWA uses data from the California Irrigation Management and Information Service (CIMIS) to compute crop consumptive use on a district-by-district and crop-by-crop basis. CIMIS is a statewide computerized irrigation scheduling system that can help farmers to schedule their irrigations based upon soil moisture budgets. This method affords the opportunity to reduce total applied water requirements. There are four CIMIS weather stations in Kern County. CIMIS is funded and operated by the state Office of Water Conservation. Approximate crop water use, as computed using the CIMIS data for 1993, is summarized on Table 18 along with total irrigated acreage.

It is difficult to quantify applied water requirements over the valley. Areal differences, soil differences, cultural practices, leaching requirements (typically 5-10 percent) and irrigation technologies employed across the valley result in very different applied water rates on specific crops. For instance, farmers in areas suffering from shallow ground water will usually apply less water on their crops than they would if the soil were well drained. The intent is to manage the shallow ground water problem. In addition, the crop may consumptively use some shallow ground water, reducing the amount the farmer needs to apply. Also, sprinkler or low-volume irrigation typically requires less water than furrow or flood irrigation. Many factors govern the type of irrigation system chosen by a farmer. Furrow or flood irrigation systems are not necessarily less efficient than other systems. Under some conditions (such as level slopes and heavy soils), furrow irrigation may be as efficient as sprinklers. The efficiency of any given irrigation system is determined by how well the system is managed.

Gross agricultural water requirements in 1993 were estimated to be about 2,712,100 acre-feet with 2,483,100 acre-feet occurring over the usable ground water basin. This was about 187,100 acre-feet more than was applied in 1992. This increase from 1993 reflected the rise in irrigated acreage during 1993. Net agricultural requirements in 1993 were about 2,159,100 acre-feet with about 1,935,200 acre-feet occurring over the ground water basin. The difference between gross and net water requirements over the basin is an estimate of agricultural return flows to ground water. Not all return flows return to usable ground water. Some is lost to saline sinks (such as shallow ground water areas). Over moisture deficient soils, return flows are absorbed by the soils and are irrecoverable. About 110,000 acre-feet of water was lost to saline sinks during 1993, and about 5,100 acre-feet was lost to moisture deficient soils. About 437,900 acre-feet of agricultural applied water in 1993 returned to usable ground water storage.

Quite a large amount of applied water data has been collected over the years by many entities. The amount of water applied on a crop is affected by several factors: the slope and texture of the soil, the type of irrigation system and the age of the crop (for trees and vines). Table 19 provides a basin-wide average applied water requirement for some major crops grown in Kern County.

Figure 14
Summary of Irrigated Acreage, 1993

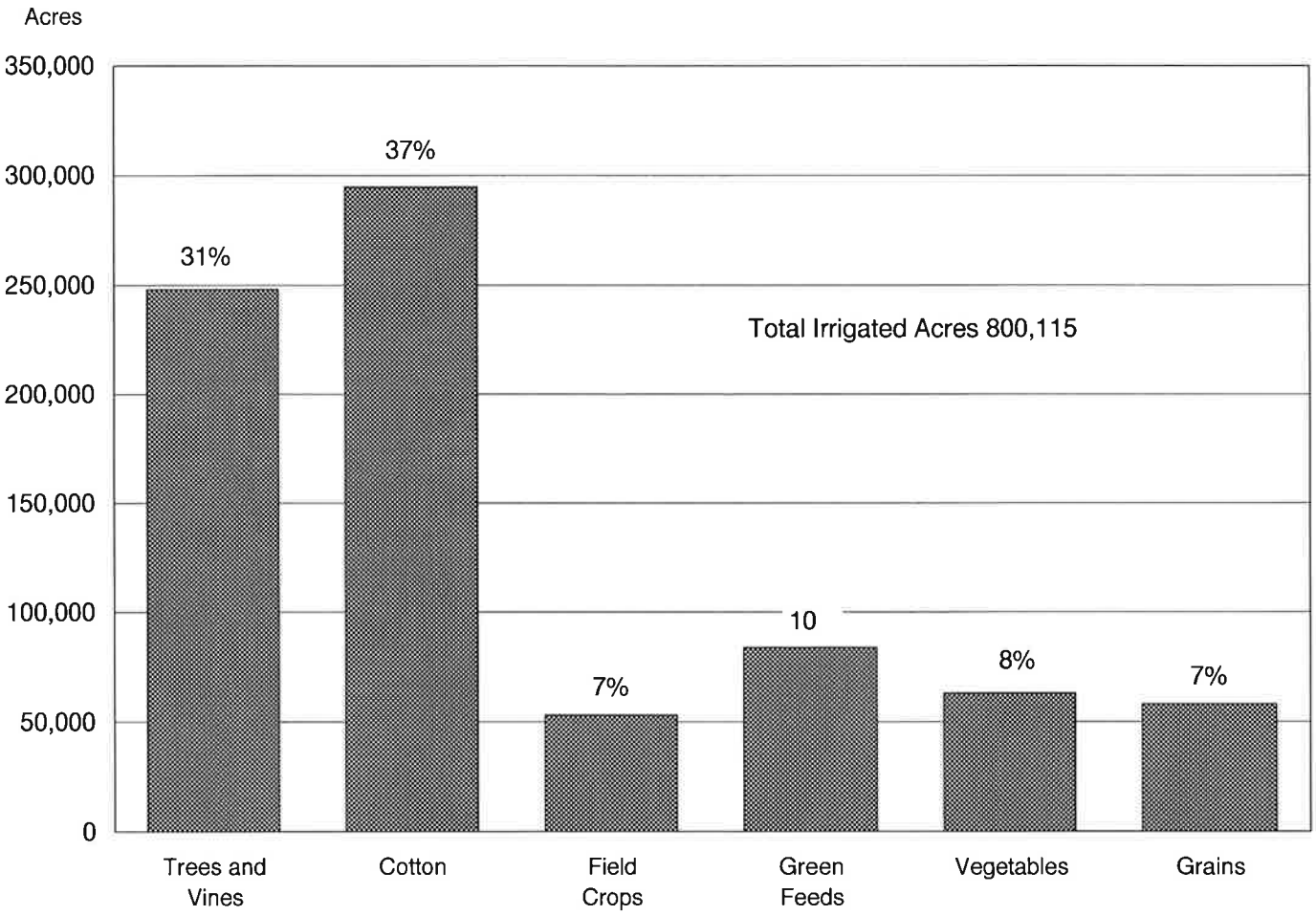


Figure 13
Irrigated Acreage in the
San Joaquin Valley Portion of Kern County

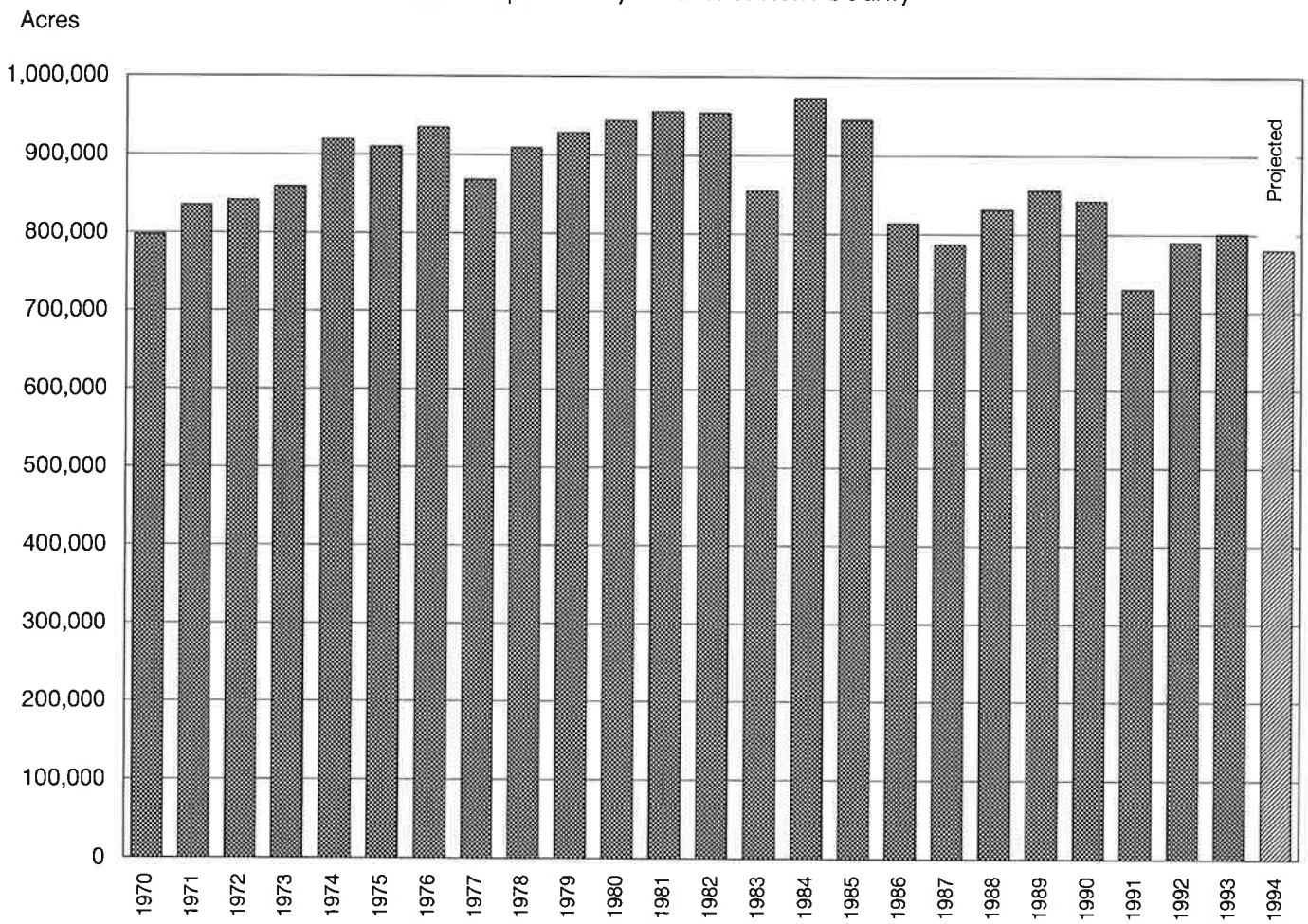


Table 16
Historic Irrigated Acreage *
in the San Joaquin Valley Portion of Kern County
(in Acres)

Year	Total Irrigated Acreage
1970	797,300
1971	834,800
1972	841,000
1973	858,700
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

Mean Irrigated Acreage	869,800 Acres
Maximum Irrigated Acreage in 1984	972,800 Acres
Minimum Irrigated Acreage in 1991	729,400Acres

* 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 5,000 to 8,000 acres annually.

Water Requirements

Agricultural

Gross irrigated acreage in the San Joaquin Valley portion of Kern County was about 800,100 acres in 1993. Since about 13,100 acres were double-cropped, total gross cropped acreage in 1993 was about 787,000 acres. About 695,900 acres (including double-cropping) were irrigated over the usable ground water basin, and 104,200 acres were irrigated on lands outside the usable ground water basin. Total irrigated acreage was increased over 1992 by about 10,500 acres. Districts on the west side of the valley experienced an 18,000 acre increase in irrigated acreage. Much of this increase was planted to late season vegetables. Areas overlying the ground water basin experienced a 7,500 acre decrease in irrigated area.

Cotton acreage increased about 20,000 acres from 1992, reflecting the better water supply conditions. Spring carrots decreased about 16,000 acres from 1992, likely because of the early water supply uncertainty. Kern County produces about 40 percent of the nation's carrots, and has been called the "carrot capital of the world." Safflower increased about 6,800 acres from 1992. A total of about 155,400 acres were idled during 1993. Most of this land was idled during the drought, and remained out of production because of the late SWP water allocation. Much of this reduction (about 84,000 acres) came from the west side areas, which are entirely dependent upon surface water for irrigation. A historical summary of irrigated acreage is provided on Table 16, along with descriptive statistics. Figure 13 shows historic irrigated acreage plotted as a bar graph. Figure 14 breaks down irrigated acreage into major categories. Permanent crops account for one-third of Kern County's total acreage. Cotton is an important crop to Kern County's economy, also accounting for about one-third of Kern's total acreage. Vegetables account for eight percent of irrigated acreage. Before the drought, vegetable plantings began increasing. This trend will likely resume when water supply conditions improve. Thousands of acres of vegetables are usually grown on the west side of the valley. This area has suffered the worst water supply reductions during the drought. Green feeds (alfalfa and pasture) represent about 10 percent of total acreage. Alfalfa grown in Kern County supports the local dairy industry and pleasure horses in Kern County and southern California.

Crops grown in Kern County are consumed throughout the United States. Exports of Kern's agricultural commodities are made to countries all over the world. The top ten exports in 1993 were almonds, carrots, cotton, grapes, nursery stock, oranges, peaches, pistachios, plums and potatoes. Nearly every continent of the world receives some agricultural products from Kern County. A total of 93 countries obtained part of their food supplies from Kern County during 1993. These included Canada, Mexico, countries in both Central and South America, Africa, Europe, the Middle East, China and the Far East, Australia, and island countries scattered throughout the world's oceans.

The Kern County Agricultural Commissioner's annual crop report shows that, in 1993, the agricultural products of Kern County had a market value of $1,914,437,000. This was up 24 percent from 1992's value. The increase can be attributed to a few crops that showed dramatic jumps in value. Citrus, which was devastated by the December 1990 freeze, finally had rebounded to full production. Total sales of citrus were about $100 million more than in 1992. Grapes were another crop that had a large increase in value, increasing nearly $100 million over 1992. Overall, fruit and nut crops accounted for almost $300 million increase in total value. A comparison of 1993 to 1992 gross crop values shows:

	1993	1992	Change
Trees and Vines	$980,043,000	$688,328,000	$291,715,000
Cotton	301,177,000	304,761,000	-3,584,000
Field crops	39,140,000	39,348,000	-208,000
Green Feeds	62,083,000	52,041,000	10,042,000
Vegetables	320,215,000	329,274,000	-9,059,000
Grains	16,338,000	7,336,000	9,002,000
Other	94,441,000	126,127,000	68,314,000
Total	**$1,914,437,000**	**$1,547,215,000**	**$367,222,000**

Note that trees and vines accounted for over 50 percent of Kern County's gross agricultural value, reflecting the importance these crops hold in the local economy. Cotton is usually the number one crop in Kern County in terms of production value. During 1993 grapes enjoyed a 10 percent production increase, and a 25 percent increase in market prices. The combination of these factors allowed grapes to capture the number one spot.

Figure 12
Ground Water Pumping
in the San Joaquin Valley Portion of Kern County

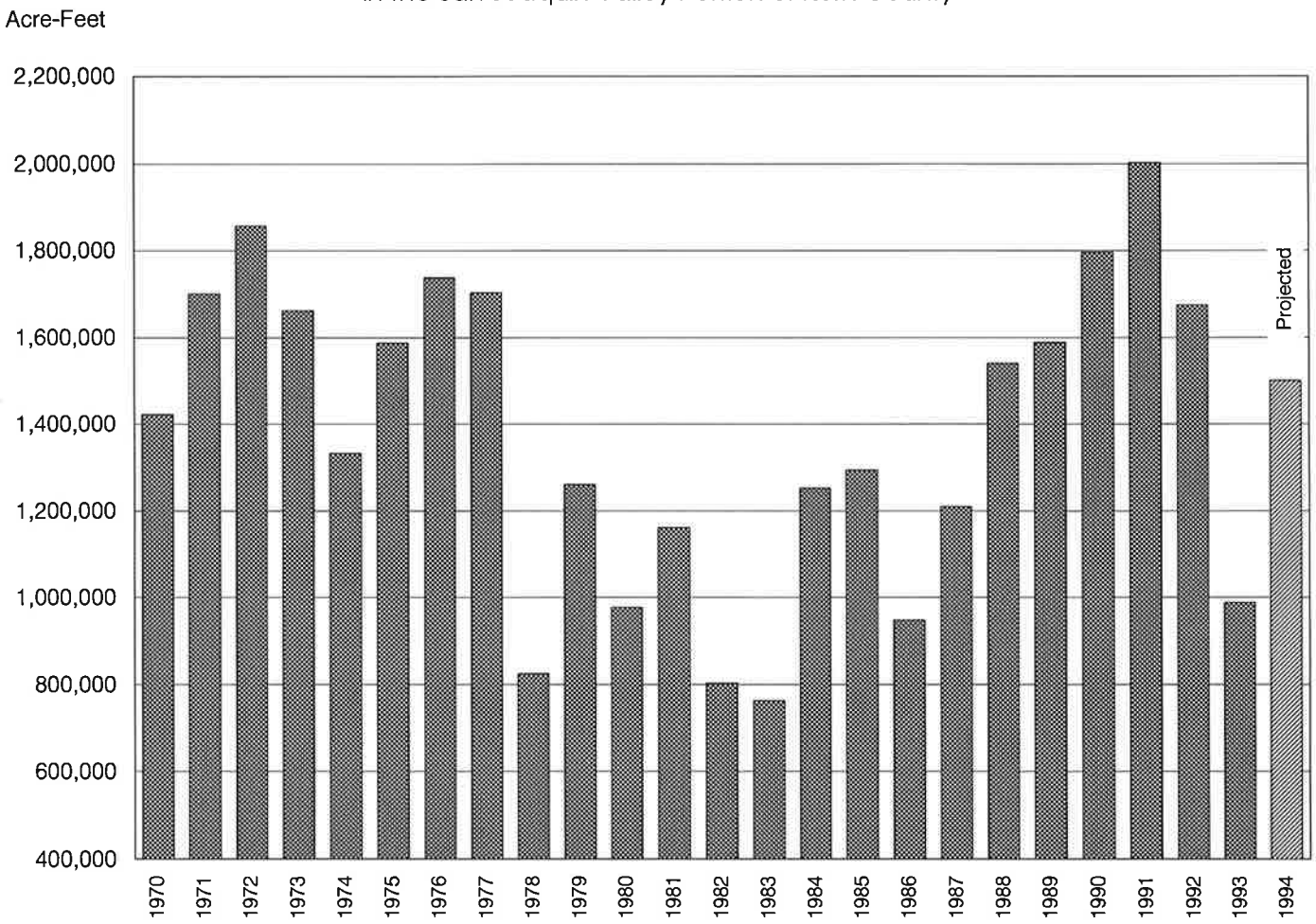


Table 13
Historic Oil Field Production Water
(in acre-feet)

Year	Annual Flows	Cumulative 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

Mean Oil Field Flows	9,100 AF
Median Oil Field Flows	9,300 AF

Oil Field Waste Water

Another source of waste water is a by-product of oil field production. Unlike treated municipal effluent or tail water, oil field waste 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 east 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 9,600 acre-feet of production water from the Kern Front oil field was reused in 1993. This was slightly more than was produced during 1992. Likely, this reflects the continued oil field slowdown that has accompanied lower prices for crude oil. Table 13 shows historic oil field waste water flows. Figure 10 show the same information as a graph.

In other areas, some oil companies discharge their waste waters into lined and unlined sumps, some of which recharges the underlying aquifer, probably degrading it in the process. These amounts cannot be quantified, since accurate records of such discharges are seldom kept.

Total waste water reuse was estimated to be about 57,200 acre-feet in 1993, excluding any tail water reuse, which was not estimated. Table 14 gives a historical summary of waste water reuse in the San Joaquin Valley portion of Kern County since 1970. Figure 11 shows the same information as a hydrograph. Note that waste water production stays fairly constant.

Ground Water Extractions

Most of the ground water extractions in Kern County are not recorded. In the past, agricultural power records from the utility companies were matched with calculations for ground water production. However, the accuracy of power record calculations were unsatisfactory. Thus, in this report ground water extractions are estimated by backing in, or solving for the missing number in the ground water change-in-storage equation (see Figure 16).

Total ground water extractions in 1993 were calculated to be about 987,700 acre-feet. This is about 686,000 acre-feet less than was extracted in 1992, or a reduction of about 40 percent. The obvious reason for this decrease was the additional surface water supplies available.

Ground water is pumped for a variety of uses in the valley. Agriculture, the largest user of ground water, used about 862,100 acre-feet in 1993. Municipal and industrial uses of ground water were about 125,600 acre-feet. During the 1987-92 drought about 9,809,900 acre-feet of ground water has been pumped. Water level declines of 40-90 feet have resulted.

Since 1977 it has become apparent that ground water pumping is very sensitive to available surface water supplies. When abundant surface water is available at a price commensurate with the price of pumping, farmers use the surface water instead of ground water. However, when surface water supplies are low, the opposite is true and farmers are forced to rely more on their ground water pumps to grow their crops.

Timing is another factor affecting ground water pumping. Although surface water may be available during the early spring months, it may not be available during the peak irrigation season (typically during the hot summer months). Absent a storage facility (like Lake Isabella) or a conjunctive use program to normalize the availability of surface water, farmers would be forced to pump additional ground water to meet peak demands.

The development of additional water storage facilities that can supply a firm yield at a reasonable cost would greatly benefit Kern County's ground water basin. Capturing high water flows for dry year use could reduce ground water pumping in dry years and reduce ground water overdraft.

Table 15 gives historic ground water 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 provides a histograph of ground water pumping, graphically displaying the relative variations.

Table 12
1993 Waste Water Treatment Plant Volumes

Facility	Volume (MG)*	Volume (AF)	Influent Source	Treatment System	Effluent Use
City of Arvin	336	1,031	Dom	Secondary	Agriculture
City of Bakersfield					
#2	6,205	19,041	Dom/Ind	Secondary	Restricted Agriculture
#3	3,285	10,081	Dom/Ind	Secondary	Restricted Agriculture
Kern County Waste Management Department					
KSA (Mt. Vernon)	1,503	4,612	Dom	1/2 Primary, 1/2 Secondary	Agriculture, Evaporation,
BVARA	7	20	Agr	Secondary	Percolation
Sheriff's Lerdo Facility	100	307	Dom	Secondary	Same
Reeder Tract	12	35	Dom	Secondary	Same
NOR Sanitary District #1	1,278	3,920	Dom/Ind	Secondary	Restricted Agriculture, Percolation
City of Delano	1,074	3,296	Dom	Secondary	Restricted Agriculture
Lamont Public Utilities District	438	1,344	Dom	Primary	Agriculture
City of McFarland	245	750	Dom	Secondary	Agriculture
City of Shafter	415	1,275	Dom/Ind	Secondary	Agriculture
Shafter Airport	68	208	Ind	Secondary	Percolation
City of Wasco	540	1,657	Dom/Ind	Secondary	Agriculture
Total	**15,504**	**47,577**			

For influent source:
Dom - domestic
Ind - industrial
Agr - agricultural

* Million gallons, based on daily average flow.

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

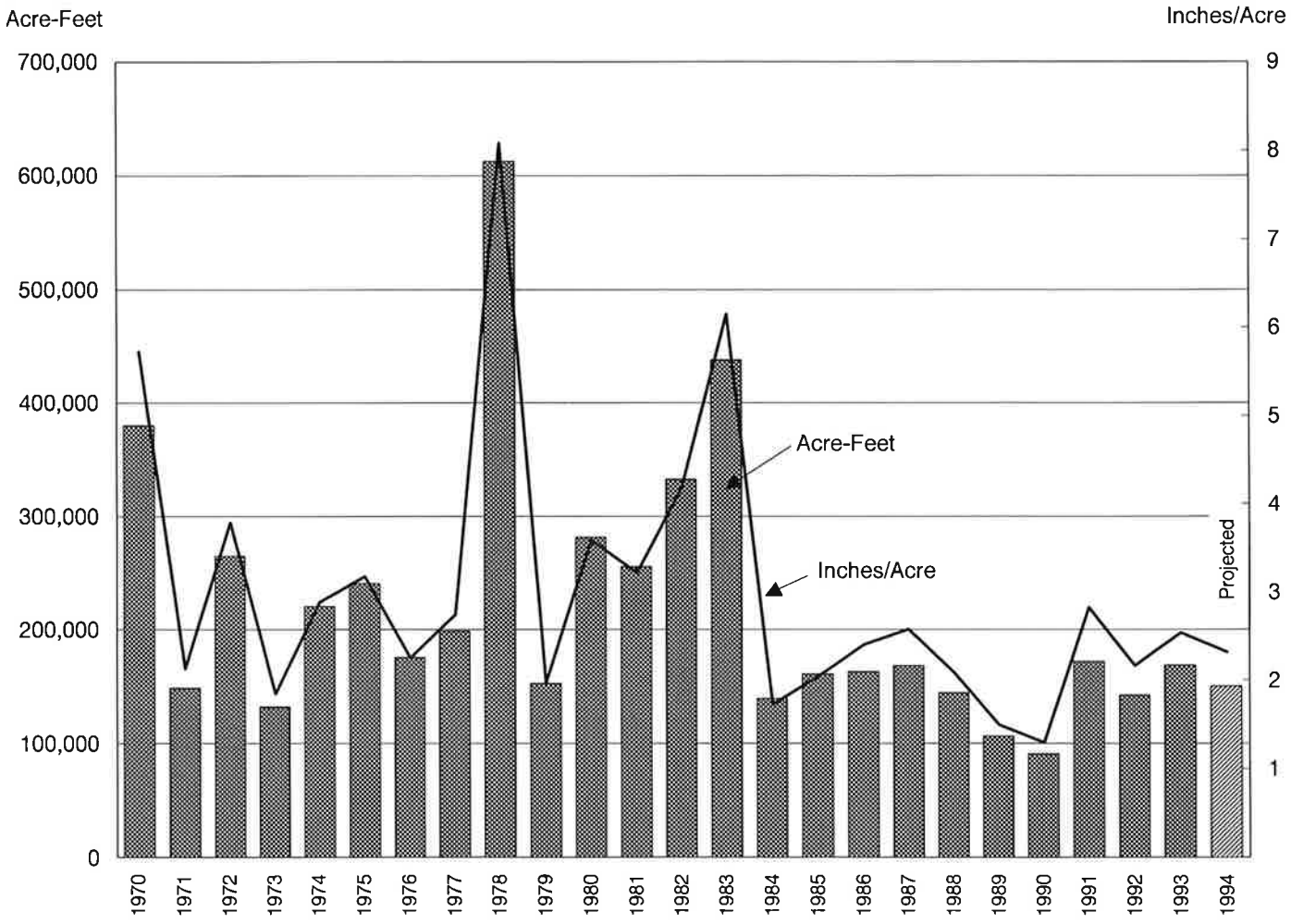


Table 11
Annual and Cumulative Effective Precipation
in the San Joaquin Valley Portion of Kern County
(in acre-feet)

	Annual Effective Precipitation	Unit Rate (inches per acre)	Cumulative Effective Precipitation
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

Mean EP (total)	220,300	AF
Median EP (total)	170,200	AF
Mean EP (per acre)	3.03	Inches/Acre
Median EP (per acre)	2.55	Inches/Acre

Table 10 (continued)
1993 Monthly Rainfall at Selected Stations (in inches)

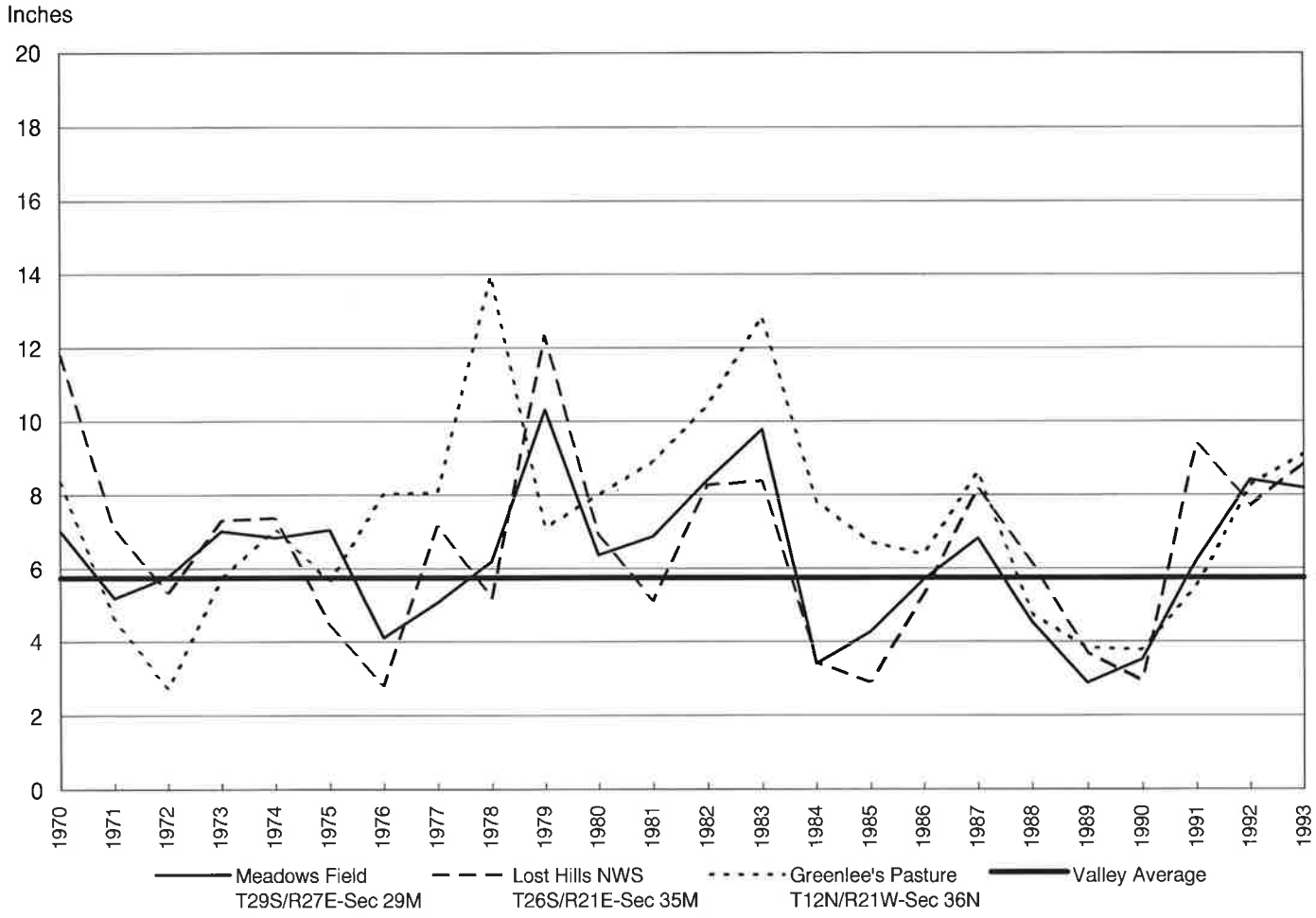
OPERATOR/Station	Elev. (ft)	Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
OTHER OPERATORS															
City of Bakersfield Corp. Yd.	400	30S/27E-06	2.20	1.55	1.65			0.59				0.17	0.63	0.50	7.29
Del Kern Station (KDWD)	350	31S/28E-06C	2.44	1.96	1.67	0.01		0.89				0.09	0.77	0.80	8.63
Delano Fire Station	320	25S/25E-11A	2.01	2.35	1.59	0.01		0.34				0.27	0.67	0.62	7.86
Belridge WSD Office	550	28S/21E-34	2.55	2.00	2.60		0.10	0.10				0.20	0.30	0.40	8.25
Blackwell's Corner (BMWD)	630	27S/20E-06	2.50	2.76	2.49	0.10	0.05	0.02				0.16	0.61	0.51	9.20
Shafter Cotton Research Sta.	370	27S/25E-33J	2.78	2.19	1.71	0.10		0.36				0.24	0.63	0.56	8.57
So. Belridge (Shell Calif.)	600	28S/21E-33	2.48	2.31	2.91	0.02	0.26					0.26	0.23	0.22	8.69

Note: Boxed numbers are estimated values.

Table 10
1993 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
ARVIN-EDISON WATER STORAGE DISTRICT															
District Headquarters	500	31S/30E-29	3.11	1.42	1.78	0.13		1.10				0.04	0.55	1.27	9.40
Sycamore	420	31S/30E-20	3.19	1.24	1.59			1.08				0.04	0.58	1.27	8.99
Tejon	480	32S/29E-15	3.18	0.81	1.31			1.34					0.48	0.98	8.10
CALIFORNIA DEPARTMENT OF WATER RESOURCES															
Lamont 2NW	380	30S/28E-25M	2.51	1.69	1.58	0.01		0.77				0.11	0.93	1.05	8.65
Lost Hills O&M Center	300	27S/21E-03	2.19	2.30	2.52	0.25	0.21	0.27				0.27	0.56	0.30	8.87
Wind Gap O&M Center	780	11N/20W-26	3.31	1.97	1.41	0.57		1.92				0.10	0.96	0.75	10.99
Buena Vista Ranch	310	30S/25E-03	2.28	1.53	1.66			0.38				0.15	0.53	0.43	6.96
Bakersfield 12S	300	31S/27E-36D	2.55	1.64	1.54	0.01		0.93				0.08	0.63	0.91	8.29
J.G. BOSWELL COMPANY															
Kern Lake Shop	280	32S/28E-18	2.72	1.55	1.52	0.03		0.98				0.09	0.15	0.71	7.75
Paloma	290	32S/24E-02	2.48	2.09	1.98	0.05		1.25				0.12	0.28	0.54	8.79
Kern Lake Time Room	280	32S/27E-16	2.56	2.12	1.77	0.03		0.82				0.07	0.19	0.65	8.21
Buena Vista Gin	300	32S/25E-12	2.40	1.62	1.30	0.04		1.10				0.11	0.29	0.59	7.45
Buena Vista #4	300	32S/25E-06	2.23	1.66	1.42	0.03		0.49				0.12	0.13	0.52	6.60
Buena Vista Office	290	31S/25E-25	2.66	1.66	1.35	0.03		0.46				0.25	0.30	0.53	7.24
KERN COUNTY PLANNING DEPARTMENT															
Edmonston Pump Station	1,310	10N/18W-17M	4.60	4.15	2.25	0.30	0.07	1.61				0.07	0.71	0.96	14.72
Arvin Fire Station	450	31S/29E-28	2.36	0.79	1.47	0.05		0.87					0.76	0.78	7.08
Buttonwillow Fire Station	270	29S/23E-14	1.48	1.50	1.67	0.13		0.16				0.20	0.52	0.29	5.95
Buena Vista Aquatic Rec Area	300	31S/25E-15	1.93	1.51	1.24	0.04		0.29				0.14	0.52	0.36	6.03
Communications Center	770	29S/28E-16	2.07	1.95	1.53			0.80				0.16	1.18	0.69	8.38
McFarland Fire Station	350	26S/25E-10	2.19	2.64	1.43	0.02		0.80				0.26	0.53	0.62	8.49
Rio Bravo Fire Station	610	29S/29E-04	2.28	2.27	1.45			1.06				0.19	1.30	0.56	9.11
Pine Mountain	520	09N/21W-19	9.22	8.73	3.18		0.15	1.34				0.20	1.95	1.67	26.44
NATIONAL WEATHER SERVICE															
Piute	4,290	29S/33E-36	4.70	3.57	1.20			1.18				0.35	1.98	1.74	14.72
Maricopa	700	10N/24W-11	2.70	1.91	1.56	0.07	0.03	1.03				0.19	0.77	0.63	8.89
Bakersfield NWS	380	30S/28E-08	2.33	2.02	1.76			0.48				0.17	0.79	0.62	8.17
Wasco	300	27S/24E-11	2.34	2.13	1.91	0.11	0.01	0.29				0.21	0.54	0.32	7.86
Woody	1,600	25S/29E-35	3.95	3.96	2.79	0.05		1.92				0.64	1.50	1.63	16.44
Keene	2,900	31S/32E-20	4.93	4.82	2.07	0.10		2.38				0.33	1.74	1.37	17.74
Tehachapi	3,980	32S/33E-21	4.87	4.08	1.46	0.10		1.82				0.41	1.19	1.06	14.99
Lost Hills	280	26S/21E-35	1.85	2.86	2.95	0.10	0.20	0.29				0.30	0.27		8.82
Glennville	3,100	25S/30E-25	6.00	5.80	3.54	0.15		2.16				0.45	2.70	2.64	23.44
Bear Valley	4,100	32S/31E-03	4.51	4.07	3.72	0.52	0.03	2.95				0.25	2.61	2.47	21.13
Lebec	3,600	09N/19W-26	5.66	7.23	2.77	0.10		0.75				0.20	1.05	1.91	19.67
TEHACHAPI-CUMMINGS COUNTY WATER DISTRICT															
Station 6	4,890	12N/15W-01	10.32	5.30	1.80	0.05		0.95				0.50	1.25	2.20	22.37
Station 20	5,730	12N/15W-12	10.89	5.90	2.15	0.15		1.15				0.60	1.35	2.50	24.69
WHEELER RIDGE-MARICOPA WATER STORAGE DISTRICT															
District Headquarters	480	11N/12W-11	3.04	1.96	1.65	0.18	0.27	1.11				0.08	0.90	0.63	9.82
PA-2	960	11N/19W-30	3.46	2.54	1.00	0.18	0.08	1.19				0.05	0.90	0.83	10.23
WRM-2	510	32S-24E-35	2.34	1.63	1.20	0.03	0.05	0.39				0.13	0.58	0.51	6.86
5P-P2	590	11N/22W-09	2.78	1.23	1.67	0.07	0.63	0.52				0.09	0.63	0.63	8.25
Spill Basin	850	11N/18W-31	3.59	2.20	1.57	0.17	0.02	1.39				0.06	0.93	0.77	10.70
Greenlee's Pasture	380	12N/21W-36	2.78	1.89	1.71	0.15	0.20	0.83				0.14	0.85	0.56	9.11

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



to compute effective precipitation and minor stream runoffs. Table 10 gives monthly rainfall for every measuring station gathered by KCWA. Rainfall in 1993 contributed 168,700 acre-feet of effective precipitation, with 148,300 acre-feet occurring over the usable ground water basin. This includes the urban storm water diverted into the Kern River. Rainfall at Meadows Field in 1993 was 142 percent of normal, about the same as during 1992. Following is a tabulation of 1990-93 and average monthly rainfall for Meadows Field near Bakersfield. KCWA estimates that rainfall provided about 2.5 inches of usable water for crops grown during 1993. This is about average for Kern County.

Rainfall at Meadows Field, Bakersfield (inches)

	1990	1991	1992	1993	Avg	1993 % of Avg
Jan	0.85	0.62	1.56	2.33	1.02	228
Feb	0.93	0.13	2.14	2.02	1.00	202
Mar	0.45	4.33	1.86	1.76	0.94	187
Apr	0.18	0.66	—	—	0.65	—
May	0.29	--	0.08	—	0.30	—
Jun	--	--	—	0.48	0.07	686
Jul	--	--	0.03	—	0.01	—
Aug	--	--	—	—	0.02	--
Sep	0.05	0.01	—	—	0.10	—
Oct	0.03	0.30	0.92	.17	0.31	55
Nov	0.47	0.01	—	.79	0.52	152
Dec	0.26	1.04	1.81	.62	0.80	78
Total	**3.51**	**6.50**	**8.40**	**8.17**	**5.74**	**142**

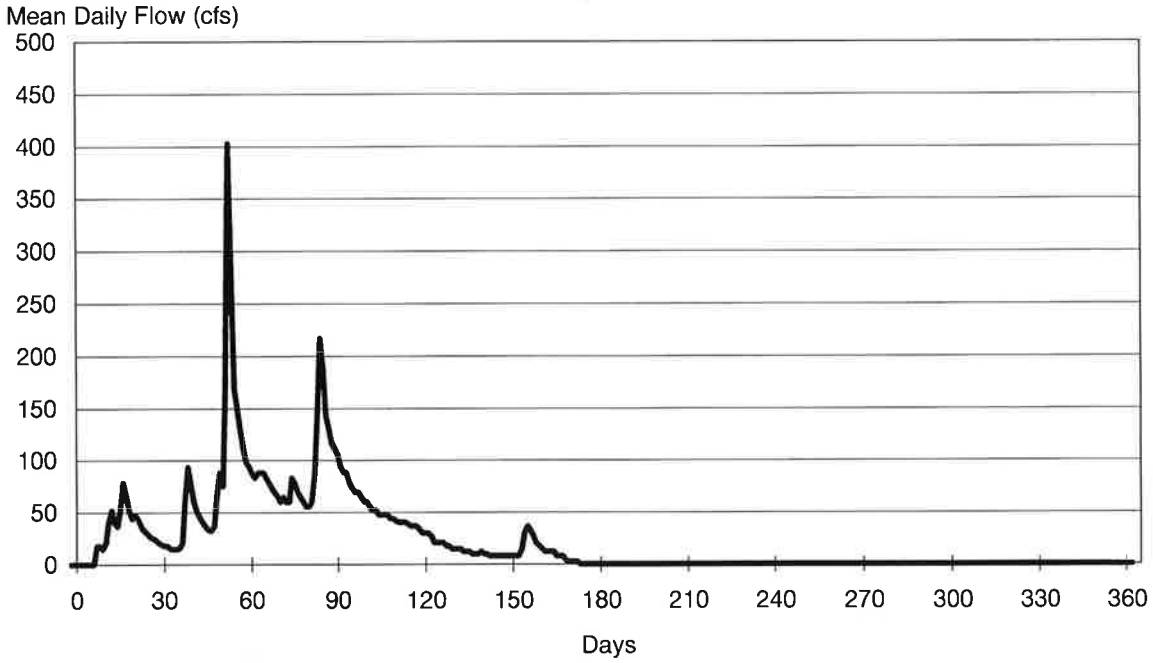
The early spring months from January-March showed above-average rainfall. Normally, about half of Kern County's rainfall occurs during these months. During January-March 1993 a total of 6.11 inches of rain fell, more than usually falls in an average year. The following three months yielded practically no rainfall, except for June, when summer thunderstorm activity dropped nearly one-half inch. This shows the erratic nature of precipitation in the arid climate of the southern San Joaquin Valley. 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 the Wheeler Ridge 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.

Waste Water Reuse

The reuse of municipal and industrial waste water provides a minor source of water for Kern County agriculture. There are 14 active waste water sewage treatment plants in the valley portion of Kern County. Waste water treatment processes are classified as primary, secondary or tertiary. Primary treatment removes most of the suspended matter from the sewage (usually via settling ponds), but little or no colloidal or dissolved matter. Secondary treatment provides some biological action or filtration to remove any remaining organic matter from the sewage. Tertiary treatment removes harmful chemicals (such as heavy metals) and nutrients. Nearly all of the waste water treatment facilities in Kern County provide secondary treatment of sewage. Most of the effluent from these treatment plants is used to irrigate some salt-tolerant crops on bordering lands, such as cotton, pasture and some grains. A small amount is directly recharged to the ground water basin. The remainder is evaporated. In 1993, about 47,600 acre-feet of waste water was treated (see Table 12). KCWA estimated that about 43,900 acre-feet was used by agriculture, 100 acre-feet evaporated and 3,600 acre-feet percolated to the underlying aquifer.

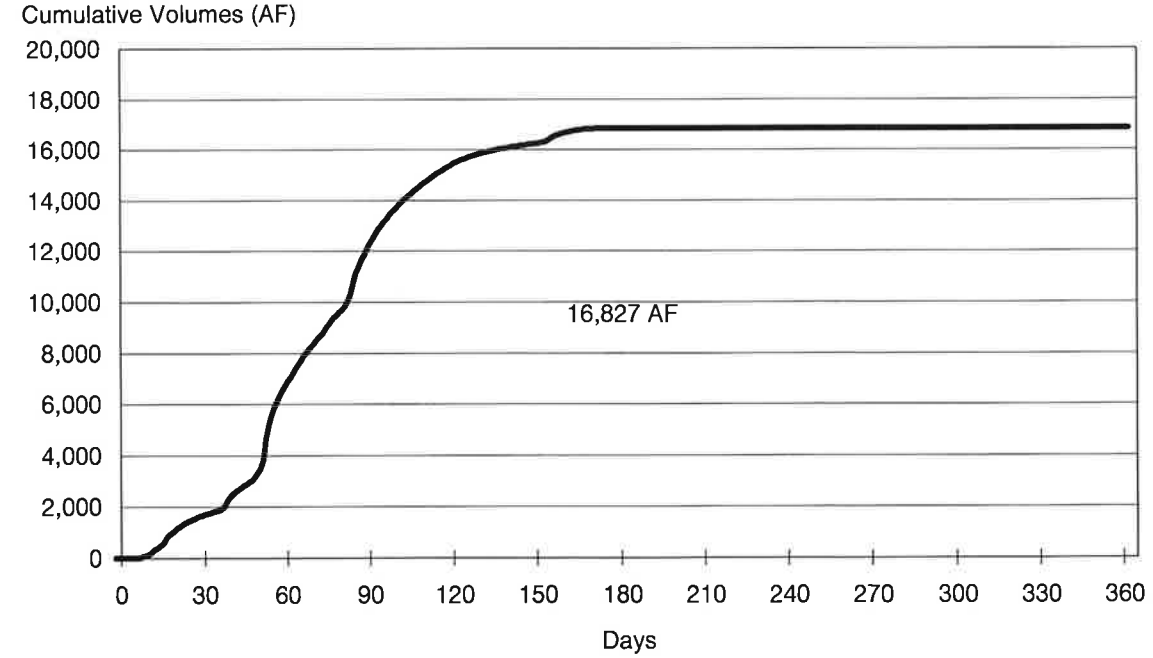
Another source of waste water reuse results from agricultural tail water return systems. Many farming operations have installed these systems to intercept water that would normally run off the field during irrigation. This recovered water is either transported back to the main irrigation system or it is applied on an adjacent field (from the foot of one field to the 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.

Figure 7a
Poso Creek
Hydrograph,1993



Note:
1. Hydrograph began 0000 hrs on 1/1/93 and ended at 2400 hrs on 12/31/1993.
2. Located at Lat.35 30' 49", Long. 118 54' 17", SW 1/4, SW 1/4, Sec. 6, T.28S., R.29E. Kern County.
3. Peak Discharge, 403 cfs, 2/2/93.

Figure 7b
Poso Creek
Cumulative Volumes,1993



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Volume (AF)	1,630	4,467	5,541	3,621	950	618	0	0	0	0	0	0
Cumulative Volume (AF)	1,630	6,097	11,638	15,259	16,209	16,827	16,827	16,827	16,827	16,827	16,827	16,827

Figure 6
Minor Stream Flows in Kern County

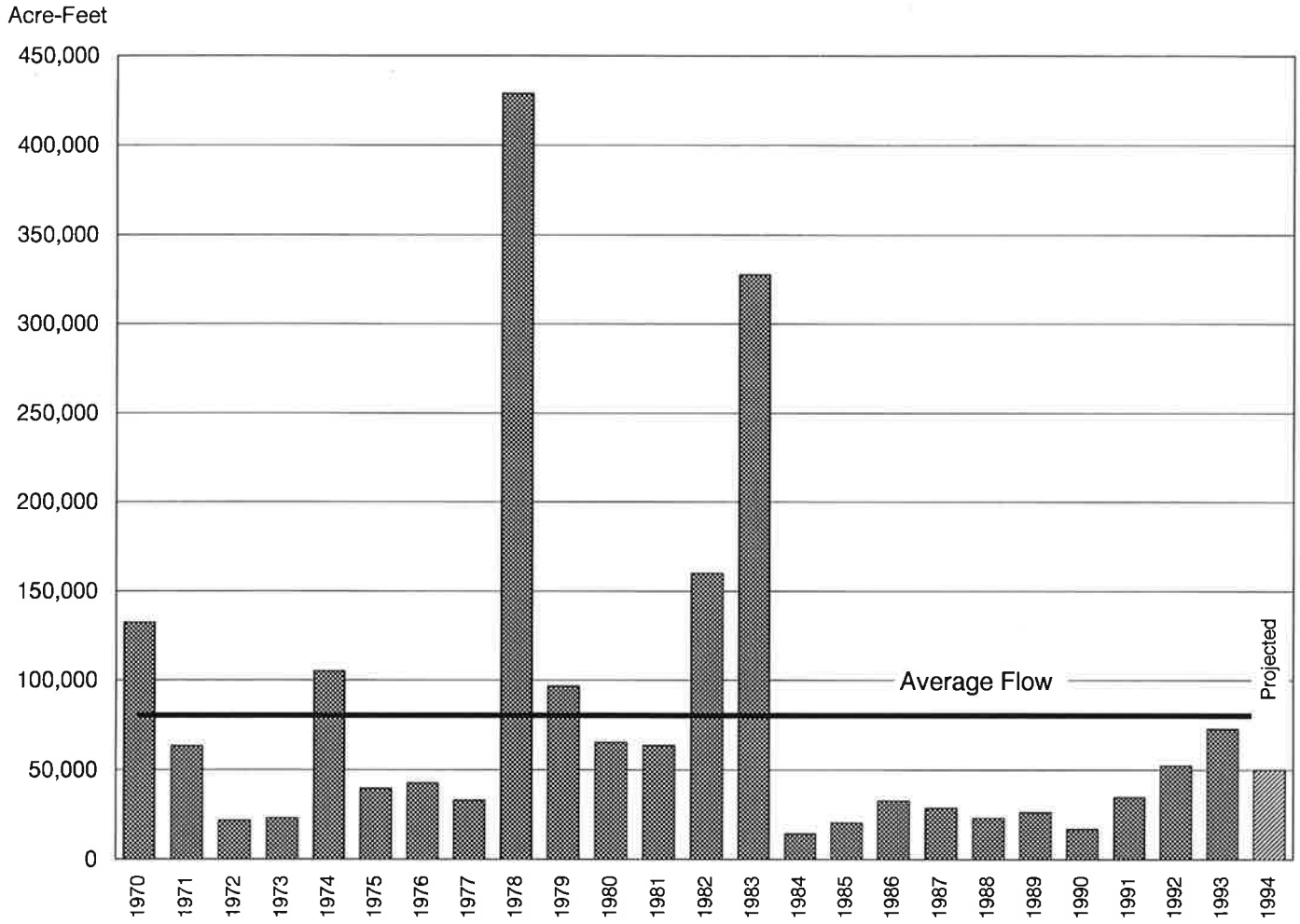


Table 9
Annual and Cumulative
Minor Stream Flows in the
San Joaquin Valley Portion of Kern County
(in acre-feet)

Year	Annual Stream Flows	Cumulative 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
1982	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	159,900	1,274,600
1983	327,700	1,602,300
1984	14,300	1,616,600
1985	20,200	1,636,800
1986	32,600	1,669,400
1987	28,600	1,698,000
1988	22,900	1,720,900
1989	26,300 *	1,747,200
1990	17,000 *	1,764,200
1991	34,600	1,798,800
1992	52,200	1,851,000
1993	72,800	1,923,800

Mean Flow	80,200AF
Median Flow	41,100AF

* Modified from previous Water Supply Reports

Figure 5
Central Valley Project Deliveries to Kern County

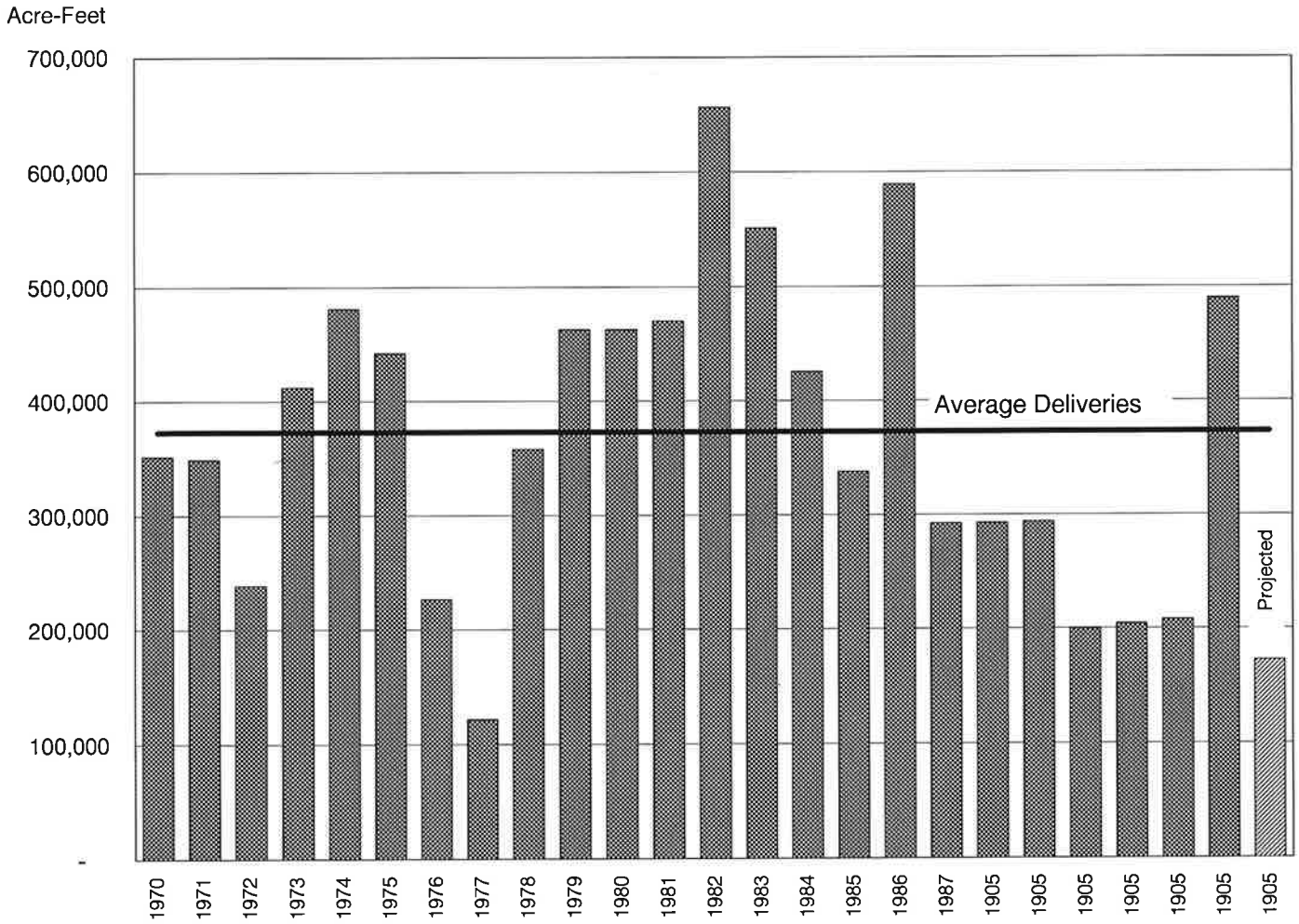


Table 8
Annual and Cumulative
Central Valley Project Deliveries
to Kern County
(in acre-feet)

Year	Annual Delivery	Cumulative Delivery	Year	Annual Delivery	Cumulative 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			
1965	245,482	2,393,433			
1966	232,084	2,625,517			
1967	319,706	2,945,223			
1968	206,499	3,151,722			
1969	372,826	3,524,548			
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	282,725 AF
Median Delivery	241,979 AF
Mean Delivery 1975-93	372,835 AF
Median Delivery 1975-93	357,847 AF

ramento Delta via the California Aqueduct and the Cross Valley Canal. These deliveries are made under a long-term exchange agreement between Kern County federal districts and out-of-county districts to the north. Table 8 shows annual and cumulative deliveries of CVP water since 1950, when the first importations were made to Kern County. Figure 5 is a histograph of CVP deliveries since 1970. From 1970 to 1993, 12.4 million acre-feet of CVP water had been imported into Kern County.

Minor Streams

Local "minor stream" watersheds are the second largest local source of water, behind the Kern River. Streams which yield measurable runoffs 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 gaging 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 on Poso and Tehachapi Creeks are operating, 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. Total minor stream volumes in 1993 were estimated to be about 72,800 acre-feet as follows;

Group	Acre-feet
Poso	20,700
Caliente	18,600
El Paso	10,600
San Emigdio	22,900
Total	72,800

During most years, some minor stream water is used for irrigation by farmers in the North Kern Water Storage District and Pond-Poso Improvement District. Much of the remaining water percolates to the underlying aquifer. Some of this recharge probably contributes to shallow ground water in the Kern Lake Bed area and near the Kern National Wildlife Refuge. KCWA estimated that about 69,200 acre-feet of the minor stream flows during 1993 contributed to ground water recharge. Table 9 shows annual minor stream runoffs, along with cumulative runoff since 1970. The variability of minor stream flows is shown by the accompanying statistics, and shown graphically in Figure 6. Figure 7a shows the hydrograph for Poso Creek in 1993. Figure 7b shows cumulative runoff for Poso Creek for the year.

Effective Precipitation

Rainfall that occurs during the growing season of a crop or is otherwise stored in the soil for later use, provides water that would otherwise be applied by the farmer. By reducing the total crop water needs that the farmer must fulfill, rainfall can reduce the total volume of water that needs to be imported or withdrawn from ground water supplies. So, rainfall can provide an alternate water supply, called effective precipitation.

Not all rainfall contributes to crop water needs. Only the portion that satisfies crop water requirements can properly be called effective precipitation. A large portion of rainfall evaporates from the soil surface and the profile before it can be used by the crop. The timing of the rainfall is also an important factor determining its effectiveness. During years of extremely heavy rainfall, a small amount may percolate past the crop root zone and recharge the underlying ground water, particularly during early stages of growth. In addition, heavy rain immediately after an irrigation cycle may not be usable by the crop.

Most urban storm runoff is captured in unlined sumps and allowed to percolate. It 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 200 acre-feet of urban storm runoff was diverted into the Kern River system in 1993.

KCWA gathers monthly rainfall data for most of the measuring stations in the San Joaquin Valley portion of Kern County. Data for some mountain stations are also gathered. This rainfall data is subsequently used

Table 7
1993 Central Valley Project
Deliveries by Entity
(in acre-feet)

	Class I	Class II	Section 215 Flood Water	Total
Arvin-Edison WSD (1)	33,469	160,344	3,720	197,533
Buena Vista WSD			9,283	9,283
Cawelo WD			1,109	1,109
Delano-Earlimart ID	15,483	9,220	1,641	26,344
Kern County Water Agency			5,542	5,542
Kern National Wildlife Refuge (2)	12,552			12,552
Kern-Tulare WD (3)	2,919	11,773		14,692
Pond Poso ID			2,714	2,714
Rag Gulch WD (3)	2,309	7,069		9,377
Rosedale-Rio Bravo WSD			5,859	5,859
Shafter-Wasco ID	52,519	33,026	8,090	93,635
So. San Joaquin MUD	66,143	39,174	5,826	111,143
Total	**185,394**	**260,605**	**43,784**	**489,783**

(1) Includes 21,044 AF delivered via the Cross Valley Canal.
(2) Delivered via the San Luis Canal.
(3) Per exchange of Cross Valley Canal water with Arvin-Edison WSD.

Table 6
1993 Summary of Kern River Water
Diversions by Entity
(in acre-feet)

Area of Use	Deliveries
Above First Point	
Kern Valley Golf Course (Kernville)	166
La Hacienda, Inc.	93
Lake Ming	790
Olcese WD	1,533
Sub-total	**2,582**
Below First Point	
Arvin-Edison WSD	8,821
Buena Vista WSD	26,524
Cawelo WD	73,033
City of Bakersfield, Irrigation and Spreading	63,028 [1]
County of Kern (Buena Vista Aquatic Recreation Area)	4,125
Henry Miller WD	1,720
Improvement District No. 4	28,866
Kern County Water Agency (James Canal Program)	1,886
Kern Delta WD	225,284
North Kern WSD	160,572
Rosedale Ranch Improvement District	22,589
Rosedale-Rio Bravo WSD	24,930
South Fork	961
Sub-total	**642,339**
Grand Total	**644,921**

[1] Includes Kern River Canal & Irrigating Company deliveries, Carrier Canal losses and percolation, Kern River channel losses and percolation.

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

Calendar Year	Annual Flows	Cumulative Flows Unregulated	Cumulative Flows Regulated
1966	678,595	49,871,945	7,335,621
1967	1,396,227	51,268,172	8,731,848
1968	453,760	51,721,932	9,185,608
1969	2,461,370	54,183,302	11,646,978
1970	590,274	54,773,576	12,237,252
1971	428,254	55,201,830	12,665,506
1972	269,227	55,471,057	12,934,733
1973	980,452	56,451,509	13,915,185
1974	819,408	57,270,917	14,734,593
1975	565,367	57,836,284	15,299,960
1976	250,268	58,086,552	15,550,228
1977	197,798	58,284,350	15,748,026
1978	1,654,295	59,938,645	17,402,321
1979	673,451	60,612,096	18,075,772
1980	1,640,852	62,252,948	19,716,624
1981	452,152	62,705,100	20,168,776
1982	1,273,630	63,978,730	21,442,406
1983	2,491,313	66,470,043	23,933,719
1984	824,302	67,294,345	24,758,021
1985	675,419	67,969,764	25,433,440
1986	1,447,939	69,417,703	26,881,379
1987	378,335	69,796,038	27,259,714
1988	297,685	70,093,723	27,557,399
1989	399,151	70,492,874	27,956,550
1990	221,267	70,714,141	28,177,817
1991	338,332	71,052,473	28,516,149
1992	275,041	71,327,514	28,791,190
1993	644,921	71,972,435	29,436,111

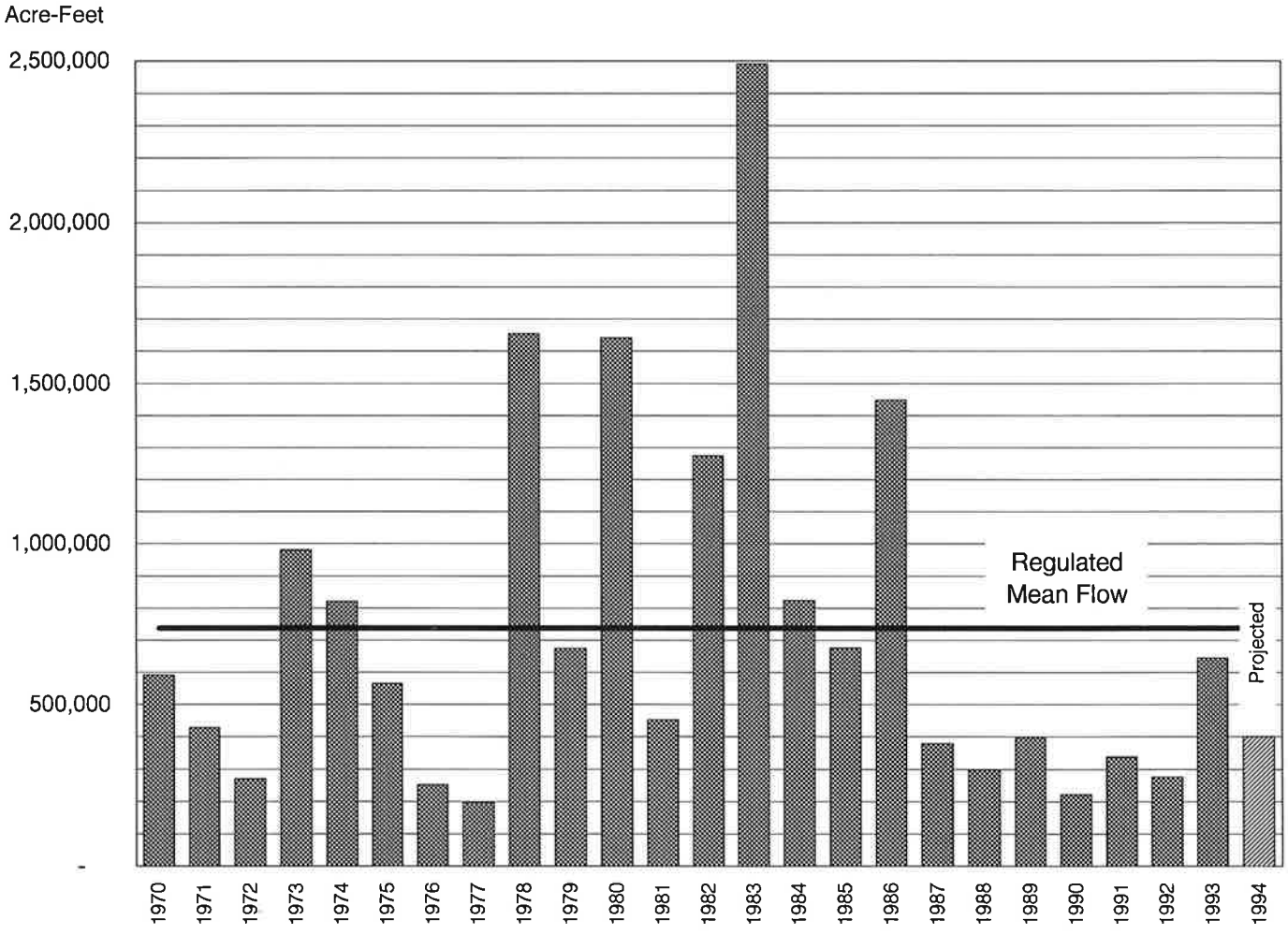
100 Year Mean First Point Flow	719,724 AF
100 Year Median First Point Flow	558,953 AF
Regulated Mean First Point Flow	735,903 AF
Regulated Median First Point Flow	577,821 AF

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

Calendar Year	Annual Flows	Cumulative Unregulated Flows	Calendar Year	Annual Flows	Cumulative Flows	
					Unregulated	Regulated
1894	533,326	533,326				
1895	1,023,052	1,556,378				
1896	619,692	2,176,070	1931	185,645	26,249,601	
1897	893,434	3,069,504	1932	737,727	26,987,328	
1898	251,827	3,321,331	1933	441,086	27,428,414	
1899	338,872	3,660,203	1934	227,665	27,656,079	
1900	332,373	3,992,576	1935	474,128	28,130,207	
1901	880,089	4,872,665	1936	796,447	28,926,654	
1902	552,539	5,425,204	1937	1,260,182	30,186,836	
1903	546,395	5,971,599	1938	1,358,685	31,545,521	
1904	492,949	6,464,548	1939	461,073	32,006,594	
1905	531,809	6,996,357	1940	789,098	32,795,692	
1906	1,900,540	8,896,897	1941	1,401,076	34,196,768	
1907	990,900 **	9,887,797	1942	771,966	34,968,734	
1908	498,503 **	10,386,300	1943	1,220,827	36,189,561	
1909	1,838,643	12,224,943	1944	625,537	36,815,098	
1910	658,911	12,883,854	1945	938,055	37,753,153	
1911	1,013,384	13,897,238	1946	650,683	38,403,836	
1912	387,432	14,284,670	1947	406,698	38,810,534	
1913	367,840	14,652,510	1948	329,506	39,140,040	
1914	1,113,513	15,766,023	1949	302,870	39,442,910	
1915	646,287	16,412,310	1950	601,360	40,044,270	
1916	2,520,149	18,932,459	1951	442,222	40,486,492	
1917	823,082	19,755,541	1952	1,500,999	41,987,491	
1918	538,503	20,294,044	1953	548,833	42,536,324	
1919	499,124	20,793,168	1954	528,357 ***	43,064,681	528,357
1920	600,643	21,393,811	1955	444,300	43,508,981	972,657
1921	509,519	21,903,330	1956	840,862	44,349,843	1,813,519
1922	861,426	22,764,756	1957	444,338	44,794,181	2,257,857
1923	500,515	23,265,271	1958	1,104,730	45,898,911	3,362,587
1924	187,727	23,452,998	1959	257,978	46,156,889	3,620,565
1925	465,913	23,918,911	1960	300,037	46,456,926	3,920,602
1926	366,706	24,285,617	1961	177,642	46,634,568	4,098,244
1927	792,580	25,078,197	1962	697,704	47,332,272	4,795,948
1928	312,828	25,391,025	1963	801,450	48,133,722	5,597,398
1929	322,958	25,713,983	1964	339,266	48,472,988	5,936,664
1930	349,973	26,063,956	1965	720,362	49,193,350	6,657,026

* Includes deliveries above First Point.
** Data incomplete. Flow extrapolated from available data.
*** Isabella Dam in operation. All subsequent flows are controlled releases.

Figure 4
Kern River Flows at First Point of Measurement



Kern River Watershed Snow Pack
(inches of water content on April 1)

	Apr 1 1991	Apr 1 1992	Apr 1 1993	Apr 1 Avg	1993 % of Avg
Upper Tyndall Cr.	16.0	12.7	34.0	27.7	123
Crabtree Meadow	13.1	9.0	22.7	19.8	115
Chagoopa	21.6	17.0	32.7	21.8	150
Pascoe	27.7	22.2	40.0	24.9	151
Wet Meadow	23.2	16.1	37.3	30.3	123
Tunnel Guard	13.2	8.2	21.6	15.6	138
Casa Vieja Meadows	19.0	13.7	28.1	20.9	134
Beach Meadows	9.0	3.9	12.6	11.0	115
Average	17.9	12.9	28.6	21.5	133

The outlook for Kern River supplies improved as the water year progressed, as shown below:

February, 1993	102 "
March	130 "
April	128 "
May	121 "
Final	118 " (final runoff)

Table 5 shows historic Kern River runoff and cumulative runoff for the 100 years of complete record, including diversions above First Point. In 1993 a total of 642,339 acre-feet of Kern River water flowed past First Point of Measurement. An additional 2,582 acre-feet was diverted above First Point. Total 1993 Kern River flows were 644,921 acre-feet, about 88 percent of the long-term average. During the last 100 years, the Kern River has yielded nearly 72 million acre-feet of runoff. Since Isabella Dam began regulating flows in 1954, over 29.4 million acre-feet of runoff has occurred. Figure 4 is a histograph of annual Kern River flows at First Point.

Entitlement to Kern River water is determined according to formulae established in the "Miller-Haggin Agreement" of 1888 and the "Shaw Decree," a judicial decree set in 1900 by Judge Lucien Shaw. Later amendments to these agreements have been adopted as circumstances warranted. These agreements establish diversion rights to Kern River water based on unimpaired flows at First Point of Measurement. Most of these diversion rights are now held by public water districts. Therefore, entitlement to Kern River water is diverted into district delivery facilities, and subsequently to users within the district. Table 6 gives a summary of Kern River deliveries by entity in 1993. Plate 9 shows the major canal distribution facilities operated by water districts that receive Kern River entitlement.

Central Valley Project ("CVP")

Like the SWP, water available from the CVP in 1993 was higher than the previous year. In 1993 deliveries of CVP water to Kern County totaled 489,783 acre-feet, over twice as much as in 1992. Original Friant-Kern and CVP Delta allocations on February 15, 1993 were: Friant-Kern contractors - 100 percent Class I and 30 percent Class II water; CVP Delta contractors - 25 percent of Class I water. By March the allocation had improved to 100 percent of both Class I and Class II for Friant-Kern supplies. CVP Delta supplies were increased to 40 percent of Class I. In April CVP Delta allocations were increased to 50 percent. However, in June allocations for Friant-Kern contractors were reduced to 100 percent of Class I water and 87 percent of Class II. This was the first time since 1986 that Class II supplies were available. Since 1966, Class II entitlement has been unavailable in only eight years (1976-77 and 1987-92). Below is a chronology of 1993 CVP allocations.

	Friant-Kern Supplies	CVP Delta Supplies
February 15, 1993	100 percent Class I 30 " Class II	25 percent Class I
March 5	100 " Class I 100 " Class II	(no change)
March 19	(no change)	40 " Class I
April 7	(no change)	50 " Class I
June 7	100 " Class I 87 " Class II	(no change)
August 13	100 " Class I 90 " Class II (final allocation)	(no change) (final allocation)

Table 7 shows 1993 deliveries of CVP water by entity. As shown, 185,394 acre-feet of Class I entitlement, 260,605 acre-feet of Class II entitlement and 43,784 acre-feet of Section 215 flood water was delivered. While the primary source of CVP water in Kern County is from the central Sierras (via the Friant-Kern Canal), 21,044 acre-feet was delivered from the Sac-

control of the Delta Cross Channel gates (by NMFS), CVP/SWP pumping constraints, and flow criteria for the lower Sacramento River were adopted by NMFS to protect Winter Run Salmon. Governor Wilson pointed out that adoption of such D-1630 criteria by NMFS made the need for D-1630 moot. Additionally, the federal Environmental Protection Agency declared that D-1630 didn't go far enough to protect fish and wildlife resources in the Delta. By the end of 1993 EPA had developed their own water standards for the Delta. EPA also incorporated some D-1630 criteria into their own standards.

During 1993 the NMFS again imposed constraints on the SWP and CVP for the protection of Winter Run Salmon. These restrictions focused on (1) maximizing the number of returning adult fish that successfully spawned, and (2) maximizing the number of young fish (called "smolts") that successfully out-migrate to the ocean. The operational constraints began in February 1993 and continued through April 1993.

The Delta Smelt was declared a threatened species on March 4, 1993. The Delta Smelt is a three-inch long minnow that lives its entire year-long life cycle entirely within the Delta. Listing by the U.S. Fish and Wildlife Service ("USFWS") came after a stormy series of public hearings. Opposition to the listing was premised on the fact that USFWS was basing its decision on flawed science. Surveys indicate that the Delta Smelt's population fluctuates widely from year to year. Contention centered on the fact that USFWS had focused on a downturn in population as its basis for listing the species.

USFWS did not impose operational constraints on the SWP or CVP during 1993 to protect the Delta Smelt. Consultations between wildlife agencies and water project operators concluded that already-imposed restrictions to protect Winter Run Salmon were sufficient to also protect the Smelt. However, a "take" limit of one percent of the projected Delta Smelt population was imposed. Delta Smelt protections greatly compound the operational problems faced by water project operators. Unlike salmon, which spend most of their lives in the ocean, Delta Smelt spend their entire lives within the Delta. As such, there is no way of avoiding the take of Smelt during water project operations. Because of the abundant water supply, no major impacts were suffered in 1993 because of Delta Smelt. In the future, Delta Smelt may cause more water supply impacts than Winter Run Salmon.

The SWP's Harvey O. Banks Delta Pumping Plant is equipped with state of the art fish screens. These screens are designed to keep fish away from the SWP's pumps. Even so, some fish are inadvertently entrained. NMFS imposed restrictions on the number of Winter Run smolts that could be entrained by the Banks Pumping Plant. On February 23, 1993 the export pumps were slowed because of the presence of Winter Run. On February 24 they were shut down altogether for a five day period because increased numbers of Winter Run salmon smolts were being captured at the fish screens. Limited pumping was resumed beginning March 8, with only two pumps in operation. On March 23 an additional pump was started, increasing total export pumping to 30 percent of capacity. Unofficially, DWR estimated that about 600,000 acre-feet of water was lost to the SWP because of operational constraints to protect Winter Run Salmon. While this water was not needed to meet contractor's 1993 requests, it could have been exported into downstream reservoirs to improve carryover storage in case 1994 was a dry year. In 1992 EPA-imposed operational constraints caused the SWP to lose about 140,000 acre-feet.

Kern River

The 1993 water year started out dry. The month of November 1992 produced no rainfall in the Kern River watershed. By early December a series of powerful Pacific storms hit the southern Sierra Nevada mountains. For January-February 1993 rainfall in the Kern River watershed approached 200 percent of normal. Snowpack water content reached its highest level since before the 1987-92 drought. The above average rains and snows were due to the merging of warm, moist storms from the tropics with cold storm fronts originating in the Gulf of Alaska.

April through July is the primary runoff period for the Kern River watershed. During 1993, April-July runoff was 127 percent of normal. A comparison of the snow pack in the Kern River watershed during 1991-93 with the historic average (inches of water content) is shown as follows:

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

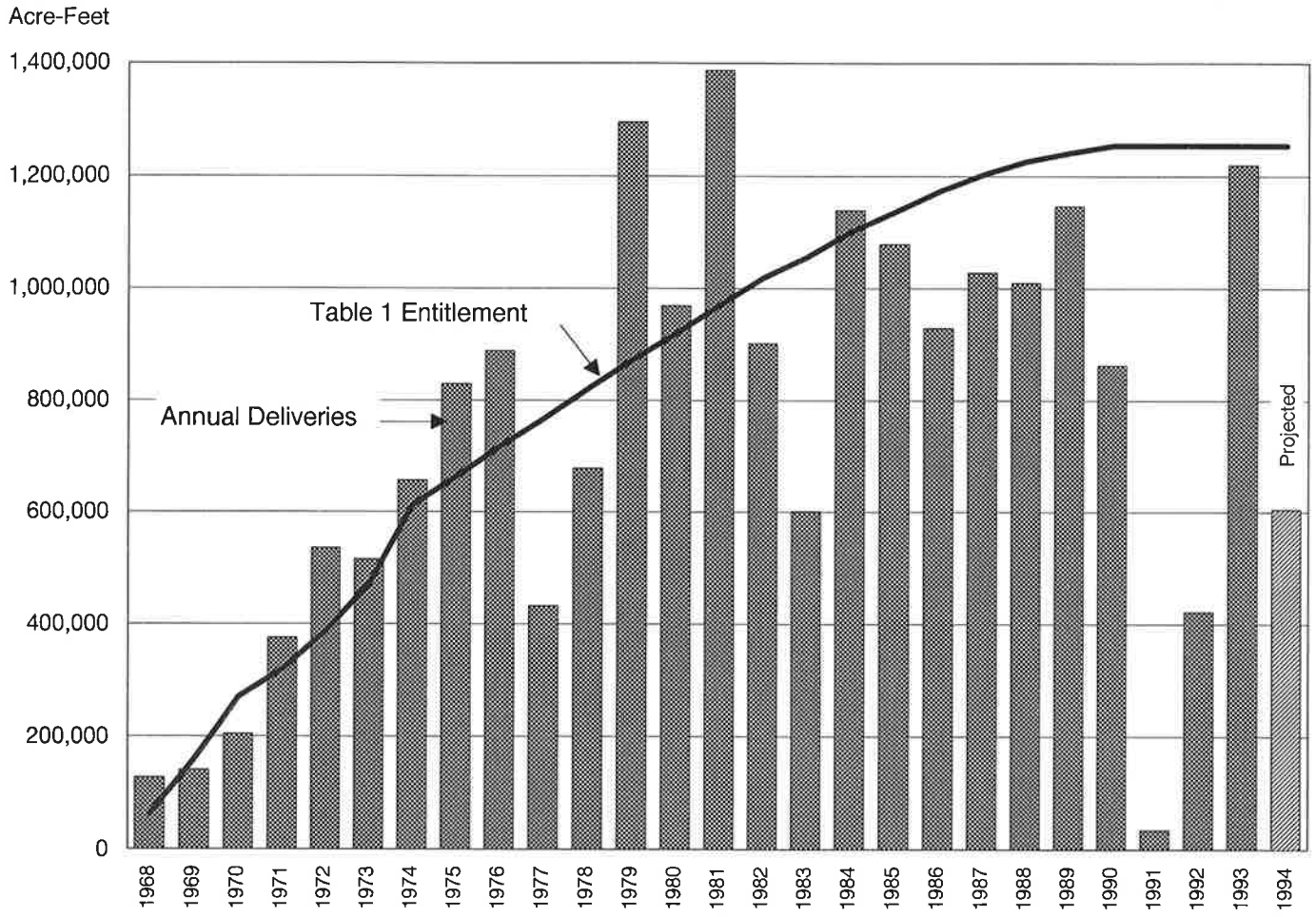


Table 4 (continued)
1993 State Water Project Deliveries by Contract
(in acre-feet)

	No.11		No.12	No.13	No.14	No.15	No.16
				Deliveries Through December 31, 1993			
District	Misc. Water Supplies		Total Supply Available	State Water Project	Friant-Kern (22) Exchanges	Total 1993 Deliveries	Supply Not Delivered
Berrenda Mesa WD			90,764	90,764		90,764	
Lost Hills WD	197	(18)	85,648	84,616		84,616	1,032
Belridge WSD			89,678	89,678		89,678	
Buttonwillow ID	50,000	(19)	156,306	231,215		231,215	91
Pond Poso ID			67,000			-	
Semitropic WSD			8,000			-	
Cawelo WD			3,819	3,819		3,819	
Improvement Dist. No. 4 Ag			10,276			-	
M&I	550	(20)	81,694	67,747	24,223	91,970	
Rosedale-Rio Bravo WSD			80,136	58,215	21,921	80,136	
Buena Vista WSD			150,858	147,866	2,992	150,858	
Kern Delta WD			5,685		5,685	5,685	
Henry Miller WD	331	(20)	57,138	55,938	1,200	57,138	
West Kern WD			629	629		629	
Wheeler Ridge-Maricopa WSD	645	(21)	167,455	144,592		144,592	22,863
Tehachapi-Cummings CWD Ag			3,285	1,661		1,661	1,624
M&I			2,494	2,478		2,478	16
Tejon-Castac WD			-			-	
Banking Programs							
KCWA			94,889	43,941	50,948	94,889	
Kern-Tulare/Rag Gulch			27,582	27,582		27,582	
ID#4			10,162	10,162		10,162	
STWSD/Cawelo WD			30,000	30,000		30,000	
Subtotal			**162,633**	**111,685**	**50,948**	**162,633**	
Exchanges/Transfers							
Westlands WD			10,000	87,600	(77,600)	10,000	
Lower Tule River ID			-	35,801	(35,801)	-	
Arvin-Edison WSD			5,349	5,349		5,349	
North Kern WSD			6,432		6,432	6,432	
Subtotal			**21,781**	**128,750**	**(106,969)**	**21,781**	
Total	**51,723**		**1,245,279**	**1,219,653**	**-**	**1,219,653**	**25,626**

(18) Landowner transfer of 1992 entitlement from Dudley Ridge WD (Paramount Farming) to Lost Hills WD.

(19) Storage of a portion of Metropolitan Water District of Southern California's 1992 entitlement in Semitropic WSD.

(20) SWP operational flood water; ID No. 4 = 550 AF, Henry Miller WD = 331 AF, Wheeler Ridge-Maricopa WSD = 20 AF, Total = 901 AF.

(21) Includes 20 AF of SWP operational flood water and 625 AF of Drought Program output during 1993.

(22) Exchanges for SWP entitlement; excludes Friant-Kern imports of 3,000 AF via Kern-Tulare WD/Rag Gulch WD/ID No. 4 and 25,432 AF of USBR Section 215 water.

Table 4
1993 State Water Project Deliveries by Contract
(in acre-feet)

District	No.1 Table A Entitlement	No.2 1992 Entitlement Carryover	No.3 Water Management Program Sales	No.4 Water Management Program Purchases	No.5 Long-Term M&I Pool	No.6 Landowner Transfers	No.7 Misc. Exchanges/ Transfers	No.8 KCWA Banking Program	No.9 Misc. Banking Programs	No.10 Total 1993 Entitlement
	State Water Project Supplies		Entitlement Transfers, Exchanges and Banking Programs							
Berrenda Mesa WD	155,100	6,113	(67,000)	4,494				(7,000)	(943) (14)	90,764
Lost Hills WD	140,400	14,592	(22,000)			(16,317) (3)		(21,000)	(10,224) (15)	85,451
Belridge WSD	163,000	7,714	(74,000)	4,723		2,500		(6,100)	(8,159) (16)	89,678
Buttonwillow ID	83,000	617		75,304		3,817	(26,432) (4)		(30,000)	106,306
Pond Poso ID	67,000									67,000
Semitropic WSD	8,000									8,000
Cawelo WD	38,200	637		482			(35,500) (5)			3,819
Improvement Dist. No. 4 Ag	10,276									10,276
M&I	77,000	(1,083) (1)		10,722	5,310		9,984 (6)	(20,789)		81,144
Rosedale-Rio Bravo WSD	29,900	(90) (1)		25,826			24,500 (7)			80,136
Buena Vista WSD	21,300	21		35,909			93,628 (8)			150,858
Kern Delta WD	25,500			10,807			(30,622) (9)			5,685
Henry Miller WD	35,500	664		37,350			(16,707) (10)			56,807
West Kern WD	25,000			724	5,310		(30,405) (11)			629
Wheeler Ridge-Maricopa WSD	252,924	10,370	(38,066)					(40,000)	(18,418) (17)	166,810
Tehachapi-Cummings CWD Ag	4,300	320	(1,335)							3,285
M&I	15,000	54	(1,940)		(10,620)					2,494
Tejon-Castac WD	2,000		(2,000)							-
Banking Programs										
KCWA								94,889		94,889
Kern-Tulare/Rag Gulch									27,582	27,582
ID#4									10,162	10,162
STWSD/Cawelo WD									30,000	30,000
Subtotal								**94,889**	**67,744**	**162,633**
Exchanges/Transfers										
Westlands WD						10,000				10,000
Lower Tule River ID										-
Arvin-Edison WSD		227 (2)					5,122 (12)			5,349
North Kern WSD							6,432 (13)			6,432
Subtotal		**227**				**10,000**	**11,554**			**21,781**
Total	**1,153,400**	**40,156**	**(206,341)**	**206,341**	-	-	-	-	-	**1,193,556**

Note: This table shows contracted deliveries for calendar year 1992. 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) Reflects 1992 SWP entitlement over delivery.

(2) Reflects conversions of Arvin-Edison WSD's 1992 State Bank purchase to SWP entitlement by delivery of Arvin-Edison WSD's State Bank water to ID No. 4.

(3) Includes 10,000 AF (Shannon) to Westlands WD; 1,618 AF (Westfarmers) to Semitropic WSD; 2,500 AF (Ritchie) to Buena Vista WSD; 1,382 AF (Westfarmers) to Semitropic WSD; 330 AF (Adelaida) to Semitropic WSD; 487 AF (Lost Hills UD) to Semitropic WSD).

(4) Includes 20,000 AF exchange payback to ID No. 4; includes 6,432 AF exchange to North Kern WSD.

(5) Includes 34,000 AF SWP/Kern River exchange to Buena Vista WSD; includes 1,500 AF exchange to Rosedale-Rio Bravo WSD.

(6) Includes 20,000 AF exchange payback to Semitropic WSD; includes 5,000 AF SWP/Kern River exchange to Rosedale-Rio Bravo WSD; includes 3,000 AF Friant-Kern exchange to Rosedale-Rio Bravo WSD; includes 2,016 AF exchange payback to Buena Vista WSD.

(7) Includes 15,000 AF banking/exchange from Henry Miller WD; includes 5,000 AF SWP/Kern River exchange from ID No. 4; includes 3,000 AF Friant-Kern exchange from ID No. 4; includes 1,500 AF exchange from Cawelo WD.

(8) Includes long-term exchange of 30,405 AF from West Kern WD and 25,500 AF from Kern Delta WD (SWP/Kern River exchange); includes 34,000 AF Kern River exchange from Cawelo WD; includes 1,707 AF exchange from Henry Miller WD; includes 2,016 AF exchange payback from ID No. 4.

(9) Includes 25,500 AF of long-term exchange to Buena Vista WSD; includes 5,122 AF exchange to Arvin-Edison WSD.

(10) Includes 15,000 AF banking exchange to Rosedale-Rio Bravo WSD; includes 1,707 AF exchange to Buena Vista WSD.

(11) Long-term exchange to Buena Vista WSD.

(12) Exchange between Kern Delta WD and Arvin-Edison WSD.

(13) Exchange of 6,432 AF from Semitropic WSD to North Kern WSD.

(14) Includes 689 AF through Kern-Tulare WD/Rag Gulch WD banking program; includes 254 AF through ID No. 4 banking program.

(15) Includes 7,471 AF through Kern-Tulare WD/Rag Gulch WD banking program; includes 2,753 AF through ID No. 4 banking program.

(16) Includes 5,962 AF through Kern-Tulare WD/Rag Gulch WD banking program; includes 2,197 AF through ID No. 4 banking program.

(17) Includes 13,460 AF through Kern-Tulare WD/Rag GulchWD banking program; includes 4,958 AF through ID No. 4 banking program.

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

Year	Annual (1) Deliveries	Cumulative Deliveries	Intertie Deliveries	Deliveries (2) Outside SJV	Annual Importations	Cumulative 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	34,865 (4)	17,763,127 (4)		2,213	32,656	17,107,407
1992	421,520	18,184,647		3,508	418,012	17,525,419
1993	1,219,653 (3)	19,404,300		14,139	1,205,514	18,730,933

Mean Deliveries	727,387 AF
Median Deliveries	828,437 AF
Mean Importations	701,807 AF
Median Importations	821,738 AF

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

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

(3) From Table 4.

deliveries. Since the first deliveries in 1968, a total of 19.4 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 shown. Table 4 shows 1993 SWP deliveries by contract type.

The State Water Resources Control Board's proposed water rights Decision 1630 was released December 2, 1992. From its onset D-1630 was controversial. The proposed standards were requested by Governor Pete Wilson as an interim step to protect fishery resources in the Sacramento-San Joaquin Delta until final standards could be finalized. D-1630 was hailed by the SWRCB as "a bold attempt to protect the environmentally sensitive estuary" while minimizing the effect on water supplies diverted upstream and within the Delta. In issuing the standards, the SWRCB hoped to stave off threats by the U.S. Environmental Protection Agency ("EPA") to impose its own Delta standards under authority of the federal Clean Water Act.

Some provisions of D-1630 would have been crippling to the SWP and CVP Delta water supply projects:

- Increased pumping constraints on the SWP and CVP would be imposed through establishment of flow criteria for the lower Sacramento River for every month of the year.

- "Pulse flows" would be required in the spring and fall of each year to assist the out migration of salmon and striped bass. These pulse flows would have taken large amounts of water from upstream storage reservoirs.

- The Delta Cross Channel gates would be operated at the discretion of the SWRCB. In concert with state and federal wildlife agencies, the SWRCB would direct operation of the gates to protect migrating fish from becoming disoriented or lost. (The Delta Cross Channel allows Sacramento River water to be diverted into the internal Delta at the northern end. This allows for better water circulation in the internal Delta channels).

- Creation of a $60 million per year environmental restoration fund via fees charged for Delta water diversions. Upstream diverters would be assessed $5 per acre-foot, while exporters would be charged $10 per acre-foot. For KCWA, this fee would have raised water costs by 20 percent.

The various provisions of D-1630 would have taken from 800,000 to 1,900,000 acre-feet from water users in dry years for fish and wildlife purposes, without compensation and without providing identifiable wildlife benefits. DWR's early caution in allocating water supplies during 1993 (their initial allocation was 10 percent of requests) was partly due the uncertainty as to how D-1630 would affect SWP operations. In response to the water supply uncertainty surrounding D-1630, contractors for SWP water asked the state to suspend work on Los Banos Grandes (an off-stream reservoir) and Kern Water Bank (a conjunctive use ground water project). Also, water transfers across the Delta would have been nearly impossible if D-1630 had been implemented. Water transfers are viewed by many agencies and organizations as integral to meeting the state's long-term water supply needs.

Studies showed that the potential loss to the state's economy from D-1630 exceeded $13 billion annually. Within Kern County, whose economy is dependent upon agriculture, the economic loss could have been $300 million annually. West side agricultural lands that are entirely dependent upon SWP water would have been devastated. Long term, about 160,000 acres of prime agricultural land within Kern County could have gone out of production if D-1630 were implemented. For the San Joaquin Valley, D-1630 would have caused about 250,000 acres to be permanently idled. Statewide, the number of jobs lost could have exceed 90,000. Within Kern County, about 8,700 jobs would have been lost.

The long-term impacts of D-1630 were even more devastating. D-1630 would have guaranteed permanent water shortages for areas dependent upon Delta export water. For Kern County, the long-term economic losses associated with permanently idling 160,000 acres exceeded $12 billion. Losses of this magnitude from the local economy would have caused a major downsizing in agriculture. This downsizing would have severely threatened the economic stability of local water districts, county government, the State Water Project and the state of California.

On April 1, 1993 Governor Wilson asked the SWRCB to cease work on D-1630 and focus on developing long term water quality standards for the Delta. By then, the National Marine Fisheries Service ("NMFS") had already adopted some of the operational features of D-1630 and were requiring their implementation via the federal Endangered Species Act. Specifically,

Table 2b
Kern County Water Agency
Member Unit Contract Entitlements
for 1990-2035

Member Unit	Firm	Surplus (1)	Total	M&I	Ag	Total
Berrenda Mesa WD	155,100	8,100	163,200		163,200	163,200
Lost Hills WD	140,400	0	140,400	2,000 (2)	138,400	140,398
Belridge WSD	163,000	0	163,000	15,000 (2)	148,000	162,998
Buttonwillow ID	83,000	13,100	96,100		96,100	96,100
Pond Poso ID	67,000	11,100	78,100		78,100	78,100
Semitropic WSD	8,000	900	8,900		8,900	8,900
Cawelo WD	38,200	6,800	45,000		45,000	45,000
Improvement District No. 4	87,276	1,554	88,830	77,000	11,830	88,830
Rosedale-Rio Bravo WSD	29,900	5,100	35,000		35,000	35,000
Buena Vista WSD	21,300	3,750	25,050		25,050	25,050
Kern Delta WD	25,500	4,500	30,000		30,000	30,000
Henry Miller WD	35,500	6,250	41,750		41,750	41,750
West Kern WD	25,000	0	25,000	25,000		25,000
Wheeler Ridge-Maricopa WSD	252,924	38,146	291,070		291,070	291,070
Tehachapi-Cummings CWD	19,300	700	20,000	15,000	5,000	20,000
Tejon-Castac WD	2,000	0	2,000	2,000		2,000
Total	**1,153,400**	**100,000**	**1,253,400**	**136,000**	**1,117,400**	**1,253,400**

Note: Maximum annual entitlement is reached in 1990.

(1) Surplus water is part of Kern County Water Agency's contracts with its member units, but is not provided as part of KCWA's master contract with the state Department of Water Resources. It is only delivered on an as-available basis, and reached its minimum in 1990.

(2) Agricultural entitlement converted to M&I use; retains agricultural delivery priority.

Table 2a
Kern County Water Agency
State Water Project
Article 12(d) Account
(in acre-feet)

Member Unit	Article 12(d) Acquired 1990	1991	1992	Total	Article 12(d) Delivered	Available Balance
Berrenda Mesa WD	77,505	155,073	85,091	317,669	0	317,669
Lost Hills WD	70,159	140,376	77,027	287,562	0	287,562
Belridge WSD	81,453	162,972	89,426	333,851	0	333,851
Buttonwillow ID	41,476	82,986	45,536	169,998	0	169,998
Pond Poso ID	33,480	66,988	36,758	137,226	0	137,226
Semitropic WSD	3,998	7,999	4,389	16,386	0	16,386
Cawelo WD	19,089	38,193	20,957	78,239	0	78,239
Improvement District No. 4 (Ag)	5,135	10,274	5,638	21,047	0	21,047
Improvement District No. 4 (M&I)	0	53,900	42,244	96,144	0	96,144
Rosedale-Rio Bravo WSD	14,941	29,895	16,404	61,240	0	61,240
Buena Vista WSD	10,644	21,296	11,685	43,625	0	43,625
Kern Delta WD	12,742	25,495	13,990	52,227	0	52,227
Henry Miller WD	17,740	35,494	19,476	72,710	0	72,710
West Kern WD (M&I)	0	17,500	13,716	31,216	0	31,216
Wheeler Ridge-Maricopa WSD	126,389	252,880	138,760	518,029	0	518,029
Tehachapi-Cummings CWD (Ag)	2,149	4,299	2,359	8,807	0	8,807
Tehachapi-Cummings CWD (M&I)	0	10,500	8,229	18,729	0	18,729
Tejon-Castac WD (M&I)	0	1,400	1,097	2,497	0	2,497
Total	**516,900**	**1,117,520**	**632,782**	**2,267,202**	**0**	**2,267,202**

water was transported by gravity downstream to areas that normally would have required conveyance up the Cross Valley Canal ("CVC").

A special water transfer program was developed with Westlands Water District. During 1993 federal Friant-Kern contractors were allocated their full Class I amounts, plus 87 percent of their Class II entitlements. Federal contractors served from the Delta-Mendota Canal were only allocated 50 percent of their Class I entitlements. Because of the low allocation, Westlands purchased some water from Friant-Kern contractors on the eastern part of the valley. The water could have been delivered to Westlands via the San Joaquin River. However, percolation losses would have exceeded 50 percent. Instead, Kern County Water Agency exchanged SWP entitlement for the Friant-Kern water. KCWA's SWP water was delivered to Westlands via the California Aqueduct. This avoided the high losses that would have occurred on the San Joaquin River. The Friant-Kern water from the sellers was delivered into the Kern River channel via the Friant-Kern Canal. From there, the water was diverted to recharge areas and water districts. A total of 77,600 acre-feet of water was delivered in this manner as part of the Westlands exchange program.

Westlands WD paid exchange fees totaling $451,000 to KCWA (slightly less than $6 per acre-foot). Proceeds from the exchange fee were distributed to those districts that received the exchange water from the Friant-Kern Canal.

Another benefit from the Westlands exchange program involved avoidance of the Cross Valley Canal. In order to get SWP water into ground water recharge facilities, the water must be conveyed up the CVC through at least four pumping plants. Energy costs for CVC pumping would have been about $10 per acre-foot. Delivering Westlands' Friant-Kern supply via the Kern River channel avoided these four CVC pumping plants, saving the $10 per acre-foot pumping costs. Innovative water management programs such as this are not only beneficial from a water supply perspective. They also are environmentally beneficial by saving energy.

Article 12(d) of the master contract between DWR and KCWA provides for future repayment of entitlement water that DWR is unable to deliver because of causes beyond its control. Such "12(d) water" will be delivered in succeeding years on an as-available basis. Article 12(d) was triggered in 1990 by the 50 percent agricultural reduction, and again in 1991 with the 100 percent agricultural and 70 percent urban reduction of requested SWP entitlement. The 55 percent agricultural and urban reduction in 1992 further added to KCWA's 12(d) credit. At the end of 1992, KCWA had a 12(d) credit of 2,267,202 acre-feet, nearly equal to two years of full entitlement. No 12(d) water was delivered in 1993, so KCWA's balance remains at 2,267,202 acre-feet. Terms under which 12(d) water will be delivered have not yet been decided. Furthermore, since the State Water Project is only half-completed, it is unlikely that the balance will ever be fully repaid.

Water Year	12(d) Account	12(d) Delivered	Balance
1990	516,900	0	516,900
1991	1,117,520	0	1,634,420
1992	632,782	0	2,267,202

A detailed summary of present member unit balances of 12(d) water is shown in Table 2a.

KCWA's annual entitlement to SWP water is according to a buildup schedule in the master contract. The buildup provided for increasing amounts of water beginning in 1968, reaching a maximum in 1990. Contracts between KCWA and its member units provided for additional decreasing amounts of surplus water, reaching a minimum of 100,000 acre-feet in 1990. The surplus water would be delivered on an as-available basis. When KCWA signed its master contract with DWR, it was envisioned that the State Water Project would be completed, and that some surplus water would be available during most years. Member units' contract entitlement for 1990 and after are shown on Table 2b. The table also breaks down 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 of 1,219,653 acre-feet of SWP water was delivered during 1993. Of this amount, 1,127,774 acre-feet was 1993 SWP entitlement, and 40,156 acre-feet was 1992 entitlement delivered in 1993. Another 50,000 acre-feet was delivered to Semitropic Water Storage District by Metropolitan Water District of Southern California as part of a joint banking program. The remaining 1,723 acre-feet were miscellaneous

Water Supplies

State Water Project

On December 1, 1992 the Department of Water Resources announced their initial allocation of State Water Project supplies for 1993. Expectations were that the allocation would be small, since SWP reservoir storage was at historic lows after six years of drought. DWR made a conservative initial allocation of 10 percent of requested 1993 SWP entitlement. For Kern County Water Agency ("KCWA"), this amounted to 101,700 feet for agricultural use and 13,600 acre-feet for urban uses. DWR's low initial allocation reflects the uncertainty of the SWP's water delivery capabilities. Pumping restrictions to protect Winter Run Salmon, the impact of the State Water Resources Control Board's proposed interim water quality standards for the Delta, and a possible continuation of the drought have all complicated DWR's operational planning.

Above-average winter and early spring storms throughout California dramatically increased mountain snowpacks. In January 1993 DWR increased allocations to 25 percent of requests. Allocations were increased in 15 percent increments until a final allocation of 100 percent of revised requests was made in April. The chronology of 1993 allocations follows:

December 1, 1992	10 percent (initial allocation, original requests)
January 13, 1993	25 "
January 26	40 "
February 15	55 "
March 4	70 "
March 19	85 "
April 16	100 " (revised requests)

The low initial allocation left local water users again facing the problem of dealing with inadequate surface water supplies. Anticipating another low water supply year, in December 1992 KCWA began planning for a 1993 Emergency Water Supply Program. Emphasis was placed on purchasing any available surface supplies to offset shortages. Specifically, DWR was developing a 1993 State Bank, which local districts could draw upon if needed. Ground water bank accounts would only be pumped as a last resort. Potentially, ground water accounts could have yielded about 76,000 acre-feet (41,000 acre-feet for KCWA, the rest belonging to specific districts). With the February increase in SWP water allocation, the 1993 Emergency Water Supply Program was no longer necessary.

DWR's final allocation of 100 percent of requests was good news for KCWA. However, the lateness of the final allocation made it impossible for some of the water to be used for crop irrigation. Some water districts on the west side of Kern County rely exclusively on the SWP for irrigation supplies. Farmers must make marketing and financial arrangements for their crops early in the year. Field preparation and pre irrigation is also done early in the year. The caution with which DWR approached their allocations in 1993 made it uncertain whether sufficient water would be available to grow a crop to harvest.

As the need for an emergency water supply program diminished, the need for a ground water recharge program heightened. The local Kern River was expected to yield higher than normal runoff. The Friant-Kern system received above average rain and snowfall, and was expected to make some flood control releases from Millerton Lake. Also, the water allocated to still-idled west side lands could now be used for ground water programs. Early in the year KCWA began to formulate plans for financing and implementing a ground water program. Part of the financing would be via the "Allocation Settlement Fund." This special fund was established by KCWA in 1989 as part of a court settlement to ensure that all SWP entitlement allocated to Kern County was retained and used within Kern County. The fund provides a financing mechanism for purchasing marketed water.

The final 1993 Water Management Program was aimed at maximizing the use of SWP water within Kern County. A total of 206,341 acre-feet of SWP water was made available to the program, mostly by west side districts with still-idled lands. Expenditures from the Allocation Settlement Fund to support the program were $6.0 million.

Water transfers were a key element of the 1993 program. KCWA made use of water transfers that avoided the Cross Valley Canal. Thus, a cost savings for the overall program was realized. Areas served by the Friant-Kern system (on the east side of the valley) delivered water into the Kern River channel. The

first time since before the drought that an increase in ground water storage has occurred. The total withdrawals since 1970 have been about 11,900,000 acre-feet. The total additions to storage over the same period have been about 5,551,000 acre-feet. The net change in storage since 1970 has been a loss of about 6,342,000 acre-feet, or about 265,000 acre-feet per year. In terms of volume of water stored, the ground water basin is at a level below the last drought. During the six years of the 1987-92 drought, about 5,390,000 acre-feet was mined, or about 898,000 acre-feet per year. Even though 215,400 acre-feet was added to storage in 1993, it will take many years to recover the ground water basin to pre-drought conditions.

Figure 2
Historic Sacramento River Indices

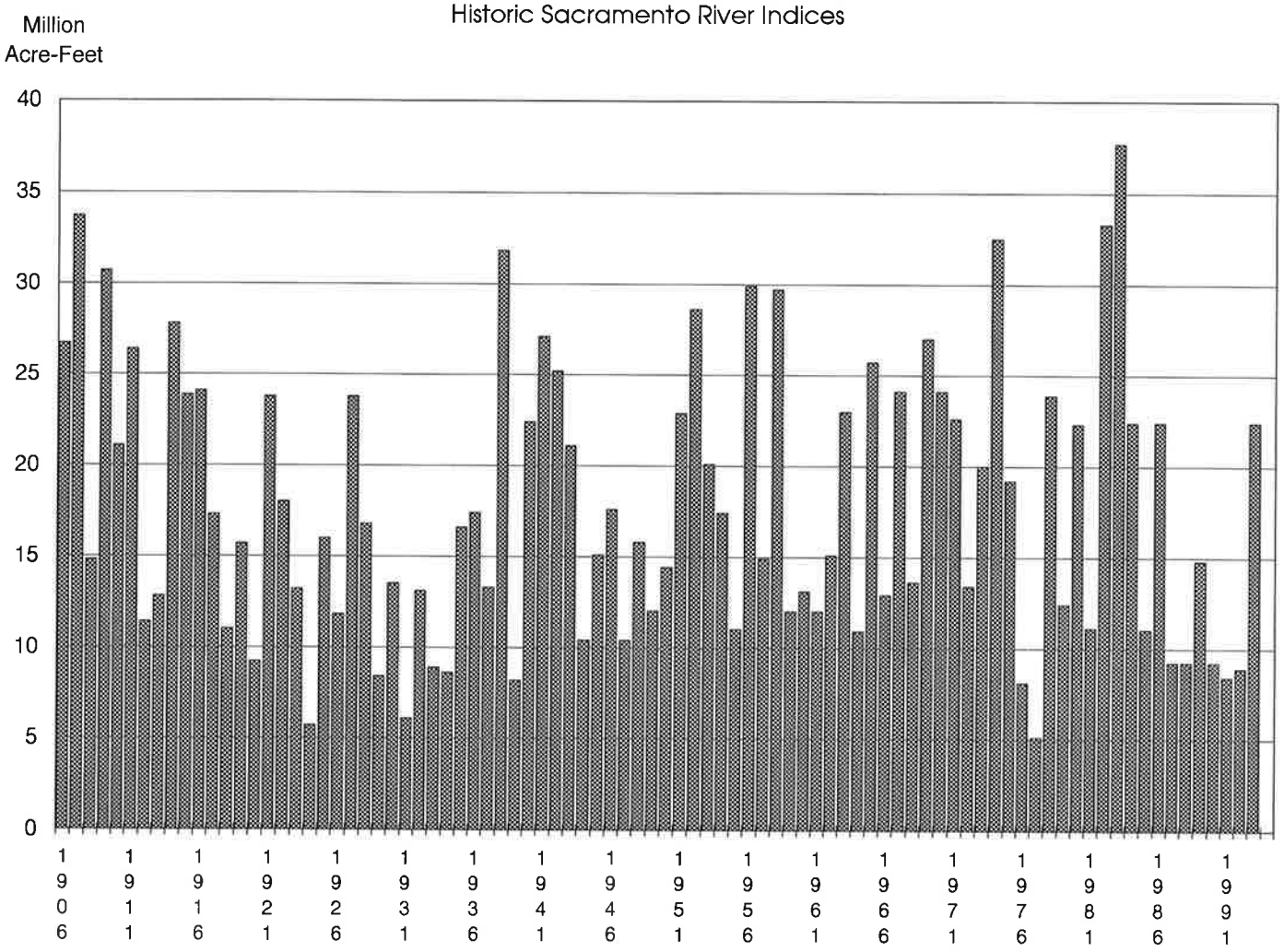


Table 1
Historic Sacramento River Indices *
(in million acre-feet)

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

88 years of record	
Average SRI	17.7
Median SRI	15.9

* 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 Folsum Reservoir. Formerly called Four-basin Index.

1993: The End of the Drought

The end of the 1987-92 drought was officially declared by Governor Pete Wilson on February 24, 1993. The Governor's proclamation ended one of California's worst droughts this century. Only one other drought compared with the 1987-92 period; the 1928-34 drought was slightly drier. The end of the drought signaled the first time since 1989 that full State Water Project ("SWP") supplies were available, as well as full Class I and Class II entitlements for Friant-Kern contractors. Federal contractors served from the Delta continued to suffer from drought-like conditions. Only 50 percent of Class I entitlements were approved for the Central Valley Project's Delta export contractors.

The water year didn't start out rosy. Initially, it looked like the drought would continue into 1993. Storage reservoirs had been severely depleted by the previous drought years. Beginning in December 1993 several storm systems hit the state. By the end of January 1994 the Feather River watershed's snowpack water content stood at 180 percent of normal. Once-depleted reservoirs filled rapidly from the heavy rains and snowmelt.

The Sacramento River Index ("SRI") is used to reflect SWP water supply conditions. The average SRI over 88 years of record is 17.7 million acre-feet ("MAF"). Any year with an index less than 10.2 MAF is classified as critically dry. Any year with an index greater than 19.6 MAF is classified as wet. Thus, 1993 was officially a wet year with an SRI of 22.4 MAF. Table 1 is a history of Sacramento River Indices. Figure 2 shows the same information graphically.

Another event that figured into 1993's water supply picture was the State Water Resources Control Board's ("SWRCB") proposed Decision 1630 ("D-1630"). This Decision would have modified the water quality standards for the Sacramento-San Joaquin Delta. Governor Pete Wilson had asked the SWRCB to develop interim water quality standards on a 'fast track' until final standards could be developed over the course of several years. Released December 10, 1992 D-1630 was ostensibly designed to halt the decline of fishery resources in the Delta and San Francisco Bay. D-1630's impacts on areas dependent upon Delta waters would have been dramatic and devastating. A high level of uncertainty was created over how the state and federal water supply projects would operate under D-1630's regulatory regime. Ultimately, D-1630 was shelved because of widespread opposition and the fact that federal agencies were already proposing to restrict Delta flows under authority of the federal Endangered Species Act ("ESA") and the Clean Water Act.

Surface water supplies from all sources during 1993 were about 2,598,000 acre-feet. Normal supplies are about 2,200,000 acre-feet. Therefore, water availability in 1993 was about 118 percent of normal. SWP deliveries from all sources totaled 1,219,653 acre-feet. Kern River supplies were 644,921 acre-feet, or 88 percent of average. Central Valley Project deliveries totaled 489,783 acre-feet, or 131 percent of the 1975-93 average.

Even with the return of normal water supplies, nearly 100,000 acres of farm land (mostly west side lands) remained idle during 1993. Irrigated acreage was 800,100 acres, slightly more than in 1992. Irrigated acreage did not significantly increase along with the water supply because the SWP water was allocated too late for farmers to use. The state Department of Water Resources ("DWR") didn't increase allocations to 100 percent until April 16, 1993. By then it was too late for farmers to make marketing and financing arrangements, and past the planting time for the major annual crops grown in Kern County. Operational restrictions on the SWP to protect two endangered fish species caused DWR to increase contractor's allocations more cautiously than in prior years. In spite of a northern California snowpack that was 180 percent of normal in January 1993, federal ESA-imposed pumping restrictions created a high degree of operational uncertainty for the SWP. Consequently, full entitlements weren't allocated until late-April 1993, nearly two months after the drought was officially declared ended.

The late allocation of SWP water meant that water would be available from some west side water districts for ground water programs. Early in the year KCWA formed plans for financing and implementing a ground water program using excess water from the west side districts. The "Settlement Allocation Fund" was used to pay part of the costs for the ground water program.

The change in ground water storage in 1993 was an increase of about 215,400 acre-feet. This marks the

Introduction

The Kern County Water Agency was created by 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 man's activities in Kern County. For instance, the natural pattern of evapotranspiration has been altered by the planting and harvesting of crops. Groundwater storage has been affected by 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 efforts have had a positive effect upon groundwater storage.

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.

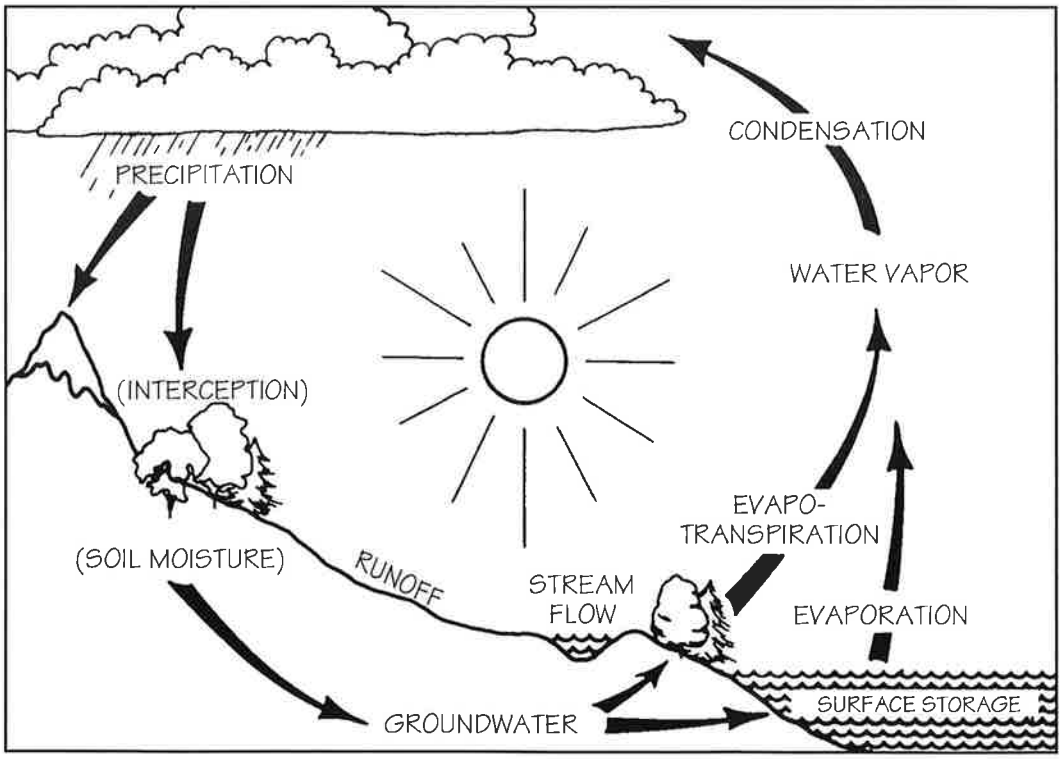


Figure 1. The Hydrologic Cycle

Metric Conversions Acre-feet (x) 1233.5 = cubic meters
Acre-feet (x) .0012335 = cubic hectometers
Feet (x) .0348 = meters
Inches (x) 2.54 = centimeters
Million gallons per day (x) .043813 = cubic meters per second

Overdraft A long-term condition in which groundwater extractions exceed 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 Folsum 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 strata 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.

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 five 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 = 450 gallons per minute
= 646,360 gallons per day
= 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 strata 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 extracted.

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

Figures (continued)

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WATER SUPPLY REPORT
1993

Thomas N. Clark
General Manager

February 1995

Kern County Water Agency

Water Supply Report 1993

February 1995

PLATE I

KERN COUNTY WATER AGENCY
BAKERSFIELD, CALIFORNIA

DEPTH TO SHALLOW GROUNDWATER

JUNE 1993

T. HASLEBACHER, JUNE 1994

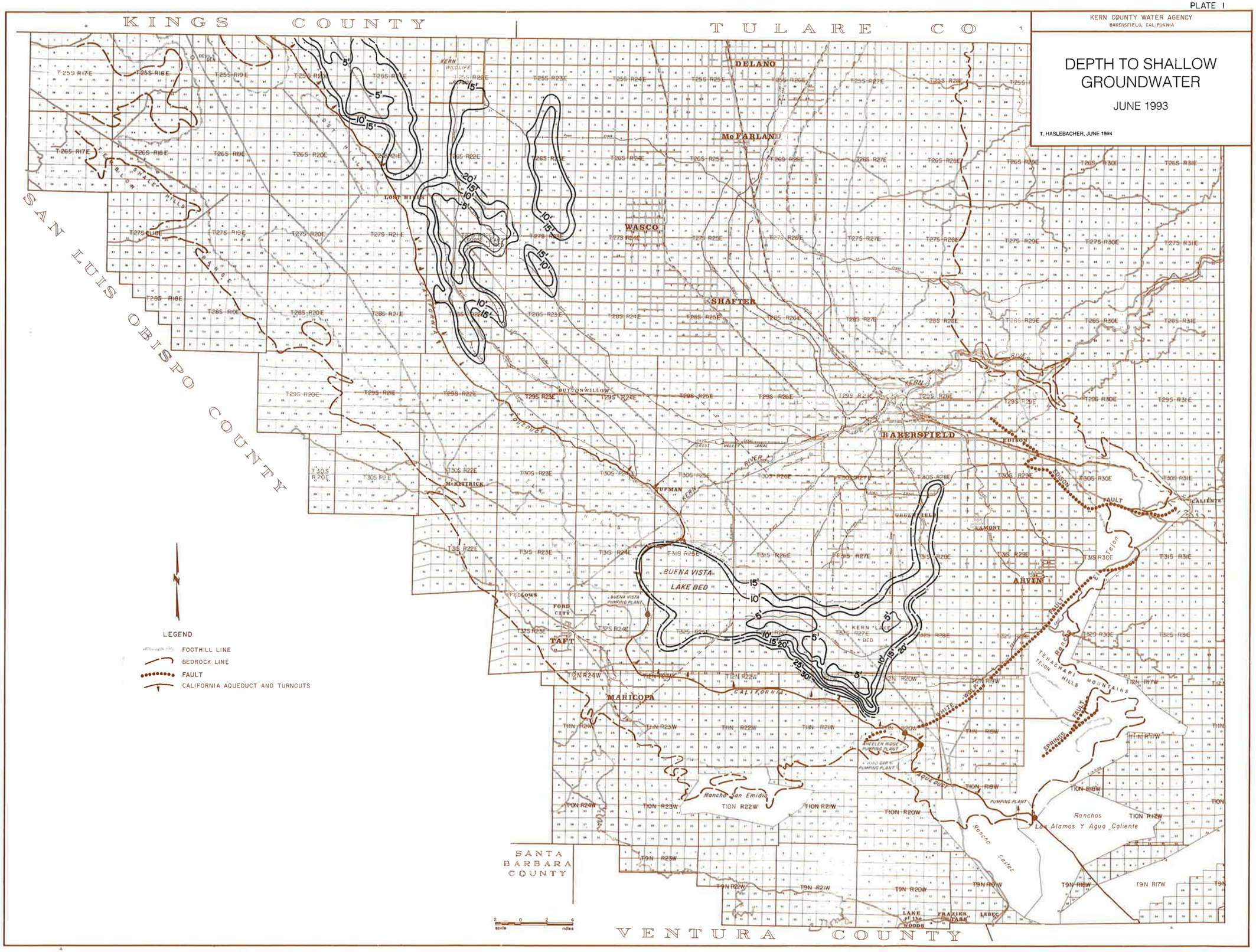


PLATE 2

KERN COUNTY WATER AGENCY
BAKERSFIELD, CALIFORNIA

GROUNDWATER QUALITY MAP

UNCONFINED AQUIFER

(DATA THROUGH DEC. 31, 1990)

K. TURNER

JULY 1991

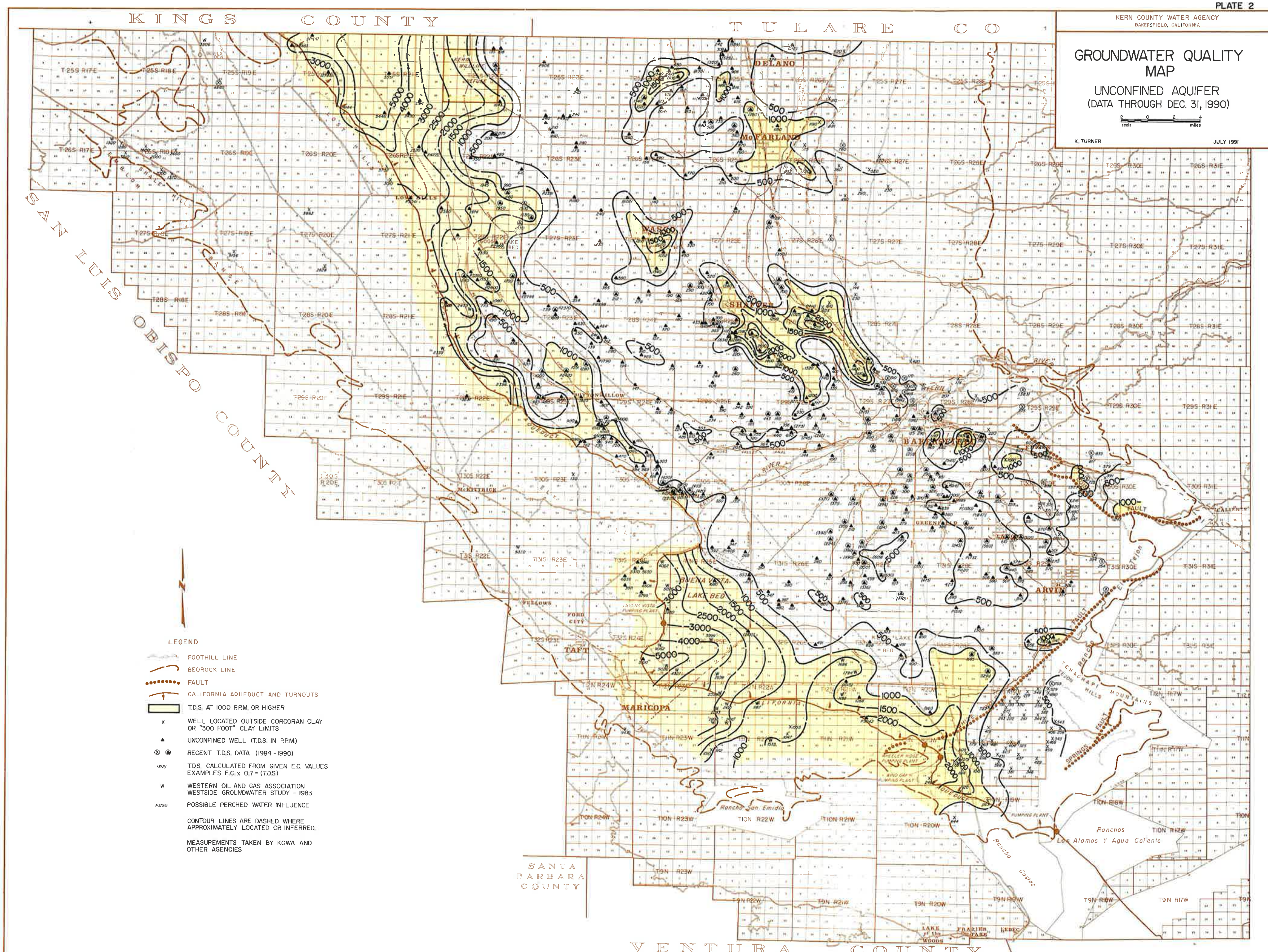


PLATE 3

KERN COUNTY WATER AGENCY
BAKERSFIELD, CALIFORNIA

GROUNDWATER QUALITY MAP

CONFINED AQUIFER

2 0 2 4
scale miles

MARCH 1990

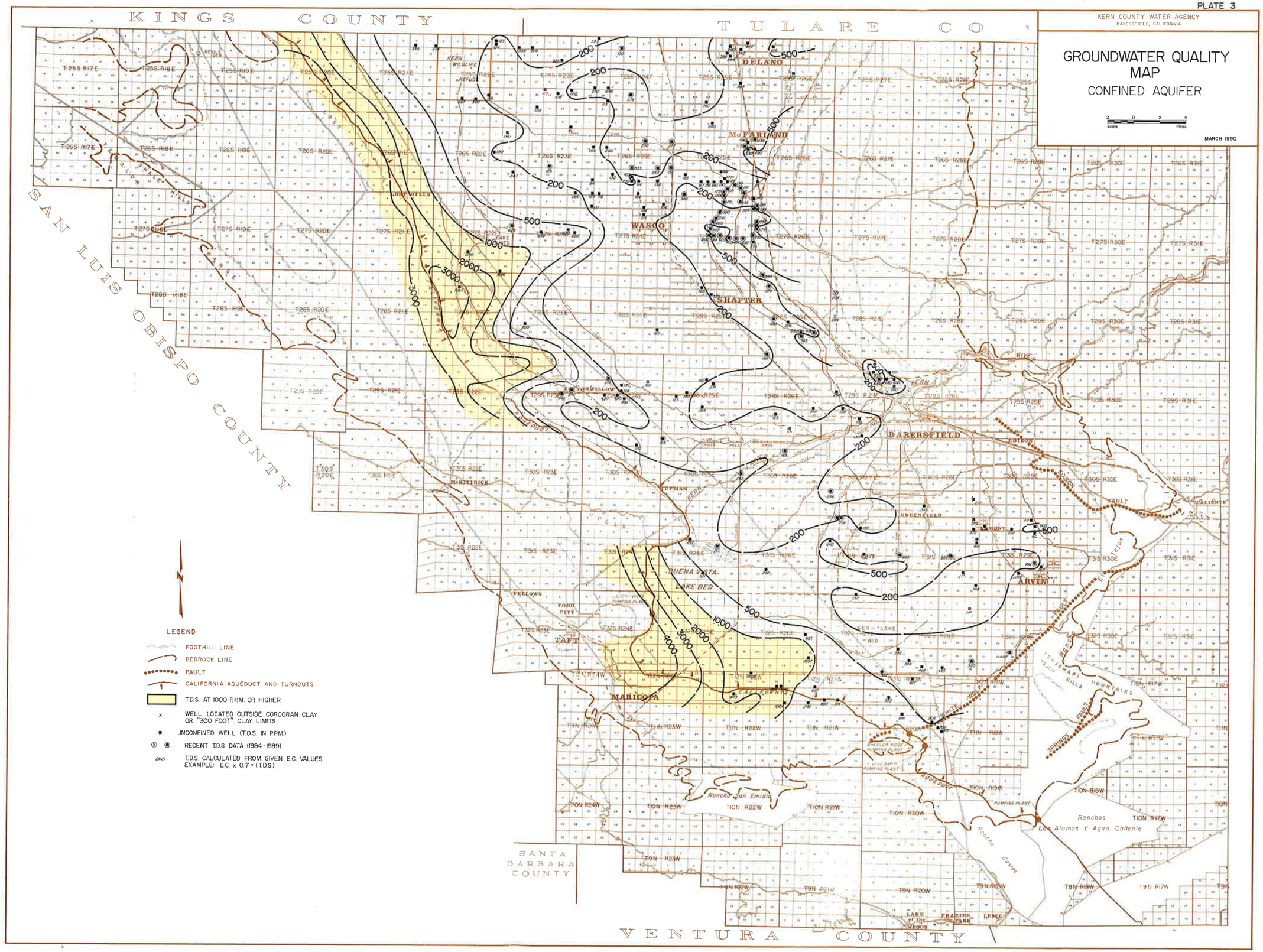


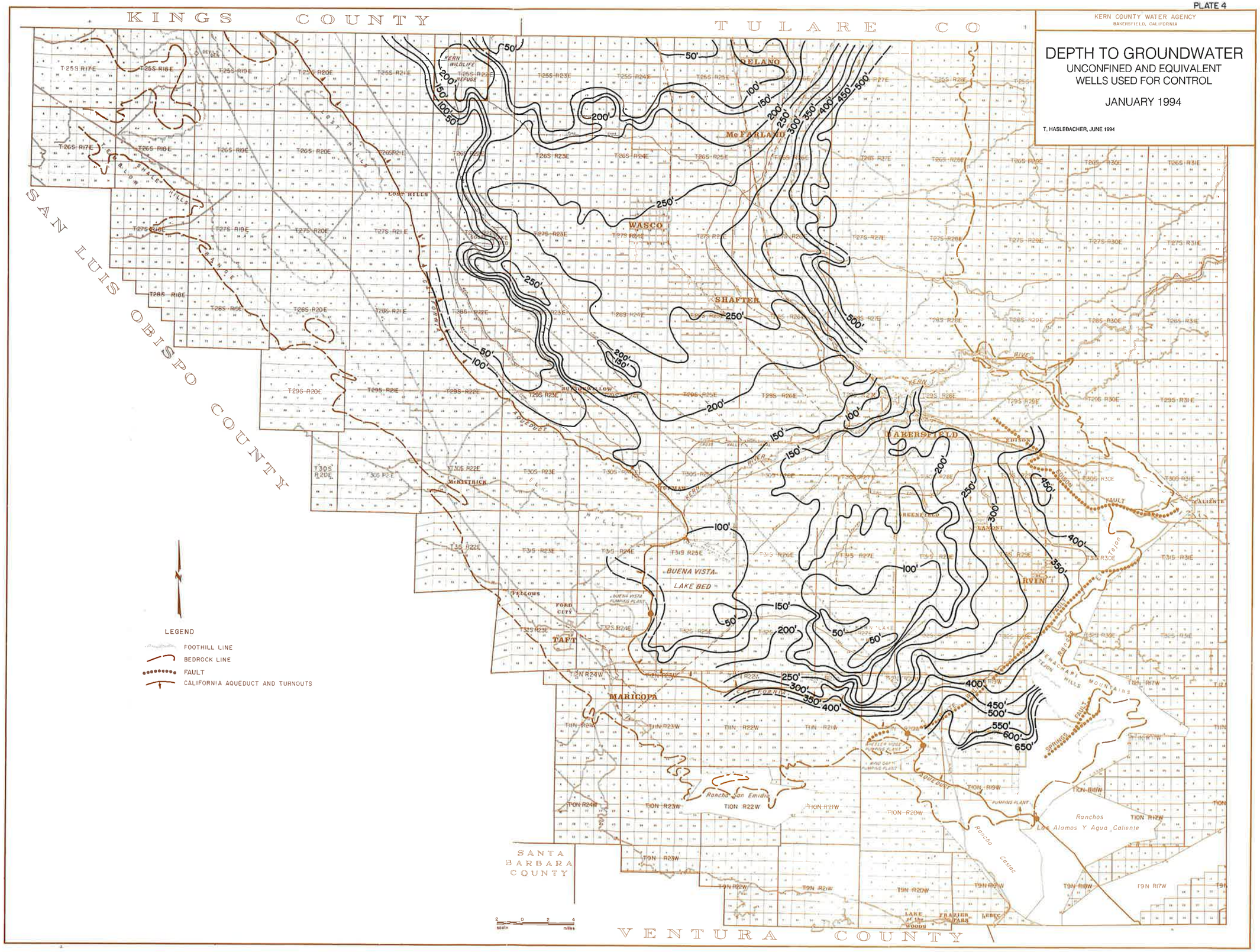
PLATE 4

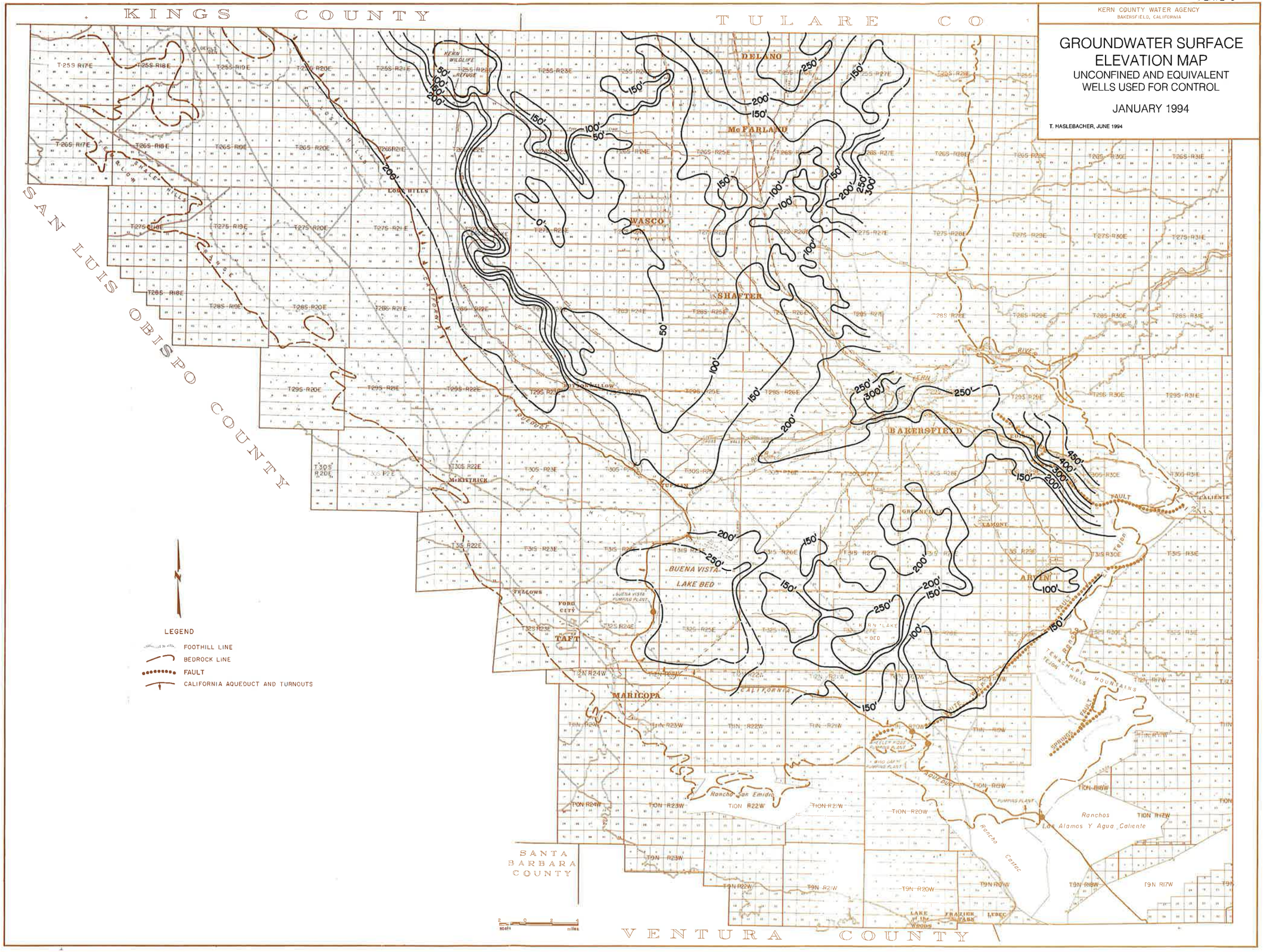
KERN COUNTY WATER AGENCY
BAKERSFIELD, CALIFORNIA

DEPTH TO GROUNDWATER
UNCONFINED AND EQUIVALENT
WELLS USED FOR CONTROL

JANUARY 1994

T. HASLEBACHER, JUNE 1994




KINGS COUNTY
TULARE CO
SAN LUIS OBISPO COUNTY
SANTA BARBARA COUNTY
VENTURA COUNTY
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GROUNDWATER SURFACE ELEVATION MAP
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McFARLAND
WASCO
SHAFTER
BAKERSFIELD
BUENA VISTA
LAKE BED
MAXWELL
MERIDIAN
FELLOWS
TAFT
MARICOPA
ARVIN
LAMONT
Ranchos
Los Alamos Y Agua Caliente
Rancho San Emidio
Rancho Castac
LEGEND
FOOTHILL LINE
BEDROCK LINE
FAULT
CALIFORNIA AQUEDUCT AND TURNOUTS

KERN COUNTY WATER AGENCY
BAKERSFIELD, CALIFORNIA

GROUNDWATER LEVEL CHANGES

UNCONFINED AND EQUIVALENT WELLS

SPRING 1993 TO SPRING 1994

T. LONG, JUNE 1994

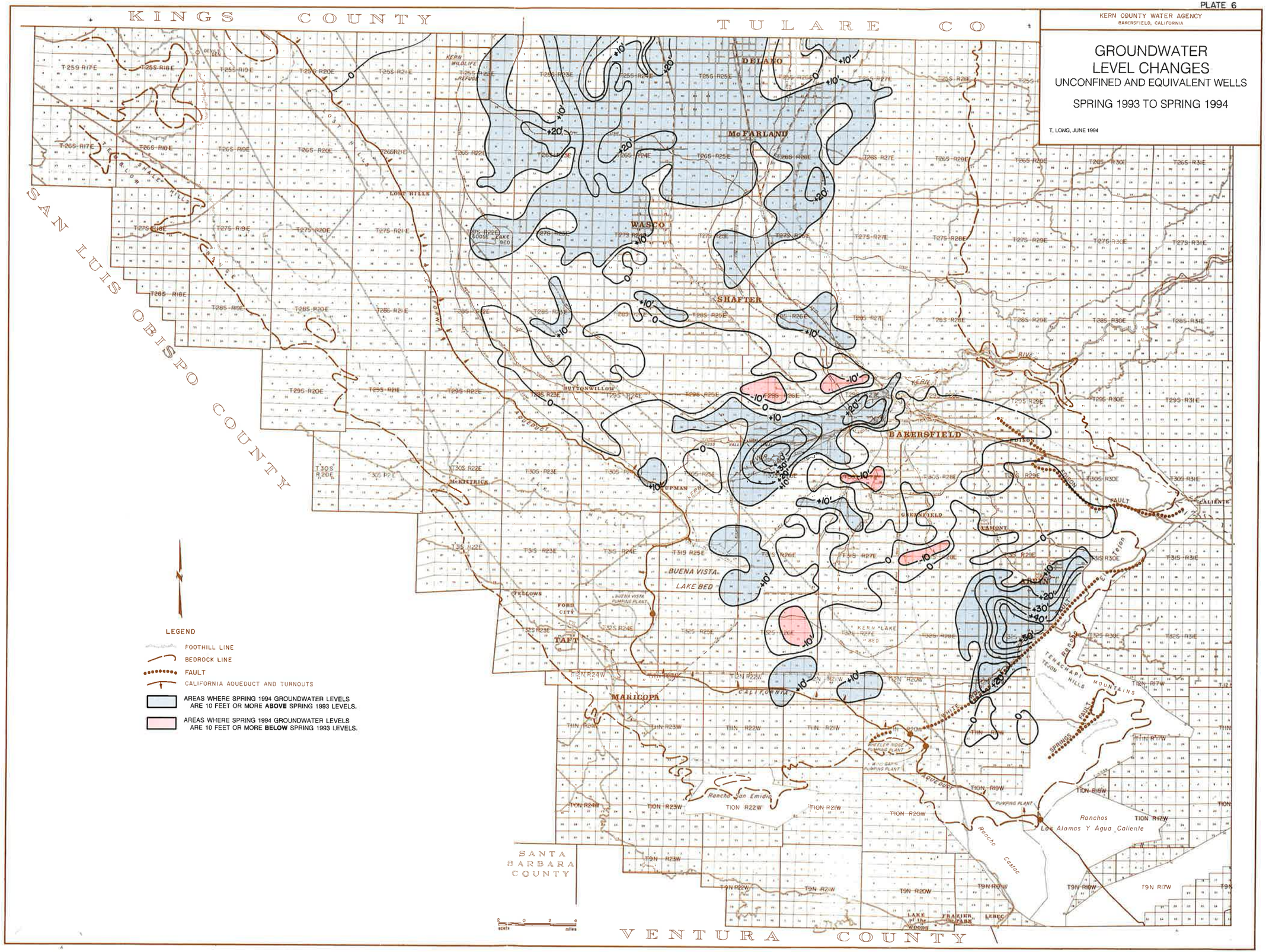

PLATE 7

KERN COUNTY WATER AGENCY
BAKERSFIELD, CALIFORNIA

INDIAN WELLS VALLEY
DEPTH TO GROUNDWATER
UNCONFINED WELLS

SPRING 1994

K. TURNER, MAY 1994

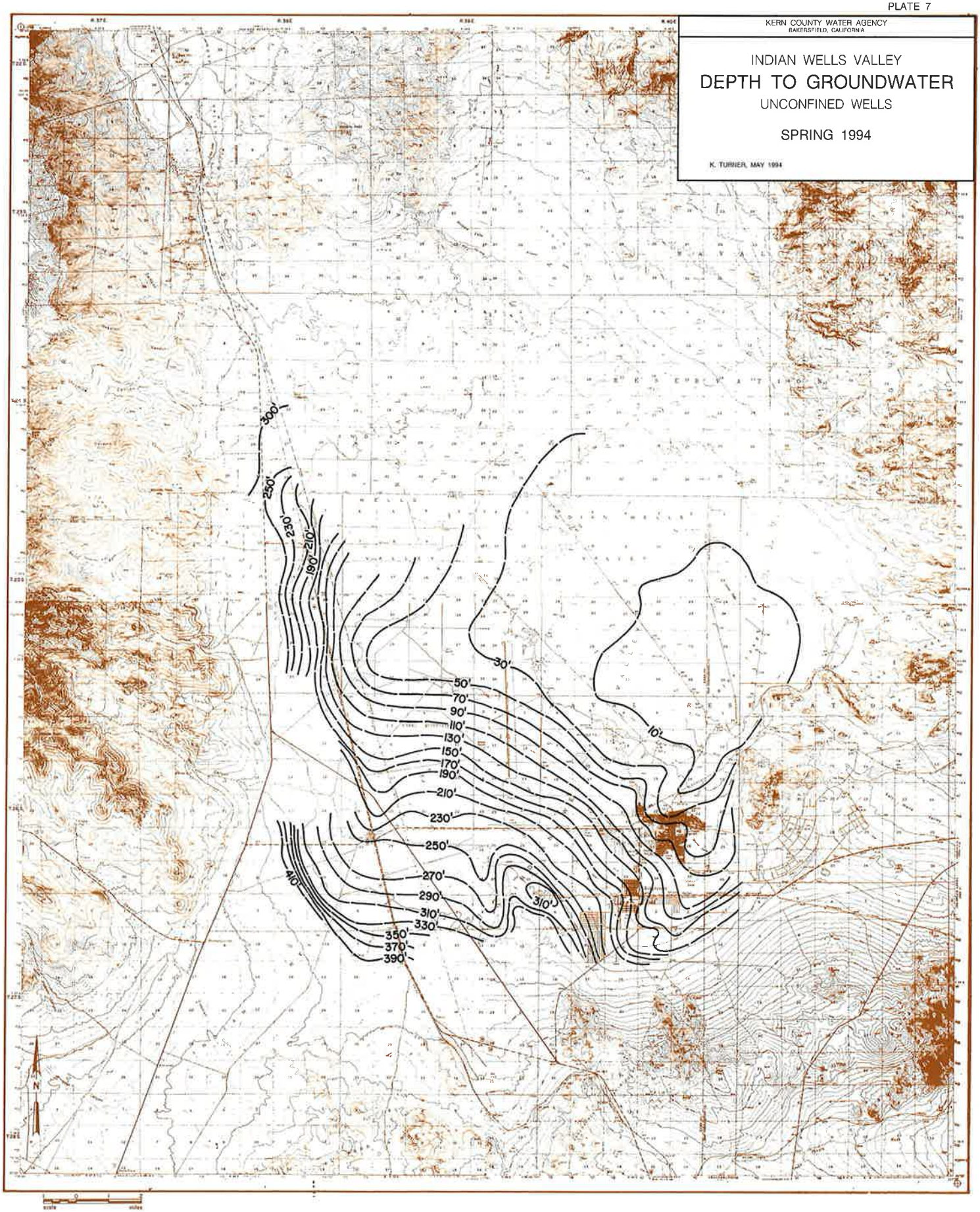

PLATE 8

KERN COUNTY WATER AGENCY
BAKERSFIELD, CALIFORNIA

INDIAN WELLS VALLEY
GROUNDWATER SURFACE ELEVATION MAP
UNCONFINED WELLS
SPRING 1994

K. TURNER, MAY 1994