9 Economic Analysis – Flood Damage Reduction Costs and Benefits

Overview

Project 1 provides some flood reduction benefits to the Tulare Lake Basin Region as described in this Attachment 9. None of the other Projects include flood damage reduction benefits.

9.1 Project 1 – Cross Valley Canal to Calloway Canal Intertie

North Kern Water Storage District (North Kern) and Cawelo Water District (Cawelo) are proposing to construct a bi-directional water conveyance connection or intertie, identified as the *Cross Valley to Calloway Canal Intertie* (Project), and these districts are requesting a grant under Proposition 84 to assist with funding. In addition to water supply, water quality and other benefits described in Attachments 7 and 8, this Project will provide Flood Damage Reduction Benefits by reducing the volume of flood water that would flow into Tulare Lake bed. Tulare lake bed is located at the confluence of many streams in the Southern San Joaquin Valley, including the Kings, Kaweah, Tule and Kern among others. During wet years, the lake bottom lands are flooded and cannot be farmed. To the extent flood waters can be reduced, a commensurate amount of land is kept in production.

By interconnecting the Calloway Canal to the CVC, Kern River water can be diverted beyond the present capability of the North Kern Water Storage District and Cawelo Water District to absorb flood water from the Kern River by 340 cfs. This increased diversion during flood events can be accomplished using the new connection from the CVC to the Calloway Canal. Presently, between the two districts, absorption is limited to about 660 cfs to recharge off of the Kern River. The present point of diversion is upstream of the location of this CVC Canal to Calloway Canal Intertie. The current conveyance capacity in the Calloway Canal is about 1,000 cfs; the new Intertie will allow utilization of the full Calloway Canal capacity up to the 1,000 cfs during flood events, allowing the CVC to deliver more water to the west of the Intertie. The result of this new Intertie is that it provides a path to use the difference between 1,000 cfs and the 660 cfs, which is 340 cfs that would be available to divert into the CVC. Once in the CVC the water can be conveyed to recharge ponds on the Kern Water Bank that cannot otherwise receive Kern River water directly, west of the Metropolitan Bakersfield Urban area, and conveyed into the California Aqueduct to help meet SWP demands. Taking the additional 340 cfs off the Kern River can also help relieve pressure on the existing Kern River levee system through Bakersfield. The levees have the capacity of conveying the 100-year flood of 10,000 cfs, taking 340 cfs off the

channel into the Calloway and CVC can help relieve some of the flow, especially if it is a long term event.

If Friant-Kern Canal flood flows are occurring at times when the Kern River is not, the Project adds about 60 cfs of connectivity between North Kern's system and the Friant-Kern Canal, thus allowing the conserved water to be recharged instead of flooding Tulare Lake Basin. Friant-Kern flood flows can consist of San Joaquin River, Kings River, Kaweah River or Tule River water which has historically been conveyed using the Friant-Kern Canal and dumped in to the Kern River channel at the terminus of the Friant-Kern in Bakersfield. Once in the Kern River channel, the water would flow downstream to Tulare Lake bed, adding to flooding of the area.

9.1.1 Project 1 Costs

The Project as defined in Attachment 7 will also provide flood damage reduction benefits. As shown in more detail on Table 7 – Project 1, the Project costs are estimated to be $10,787,200. Project implementation will occur over 15 months, with 40% during the first year and 60% during the second year. However, since the Project is built primarily for its water supply benefits, the Project Capital Costs are not included in the Flood Damage Reduction Benefits analysis. However, annual administration, operations and maintenance costs will be different than defined in water supply benefits analysis because of the direction of flow, but are otherwise not expected to increase with implementation of the project. The total present value of the administration, operations and maintenance costs over the useful life of the project is $1,395,746 as shown in Table 17 – Project 1.

9.1.2 Flood Damage Reduction Benefits

9.1.2.1 Avoided Physical Damage

Based on historic flooding of Tulare Lake Bed, in 1969 about 227,000 acre-feet of snowmelt flooding covered more than 50,000 acres (*USACE Isabella Lake Reservoir Regulation Manual*, May 1953-Revised January 1978 (Isabella, 1978)). The depth and duration of flooding was sufficient to prevent use of the lands for farming for the entire year. Typical crops grown in the Tulare Lake Basin have been annual row crops such as cotton and vegetables. In more recent years higher value crops such as tomatoes have been planted. Based on the value of crops damaged, it is estimated that about $600/acre in damages would occur. This value is supported by "*Economic Impacts of the 1992 Drought Year, An Analysis of Economic Costs in Kern County*", Prepared for Kern County Water Agency by Northwest Economics Associates, December 1994 (Appendix 9.1-1). Using the relationship of acreage flooded in past events from *Isabella, 1978*, a depth of water of about 4.3 feet will flood an acre on Tulare Lake bed. Therefore, for every 10,000 acre-feet diverted away from the Tulare Lake bed about 2,300 acres will continue to be farmed. Excerpts from the *Isabella,*

1978 report and the *KCWA Water Supply Report* are provided as Appendix 9.1-2, Flood Damage Analysis.

Based on the diversion capabilities of the Project, 680 acre-feet per day can be diverted off the Kern River into the Cross Valley Canal. A repeat of the 1969 snow melt flood, which had a duration of about 3-months, 90 days, beyond what could be stored in Isabella Lake, would result in about diversion of 61,200 acre-feet. This would prevent about 14,000 acres of farm land from being flooded, resulting in prevention of about $8,400,000 in farm losses.

While an extensive frequency analysis was not done for the Project, flood flows of the 1969 magnitude and duration have occurred in 1906, 1909, 1916, 1952, 1967, 1969, 1978, 1980, 1983, 1986, 1995 and 1998 (Table 5 of KCWA 1999 Water Supply Report, May 2003), Appendix 9.1-2. About 12 years out of 116 years of record had sufficient flows to flood Tulare Lake bed, based on post Isabella Dam operations, about one in ten years. The expected annual avoided damage benefit is $840,000. The present worth benefit over the life of the Project totals $13,036,800 (Table 19 – Project 1).

Similarly the ability to convey 60 cfs of Friant Kern Flood flow into the Poso Creek region will reduce flooding in Tulare Lake bed by about 120 acre-feet per day. For 90 days that amounts to 10,800 acre-feet. This reduces flooding on about 2,300 acres which provides a benefit of $1,380,000 per event. The frequency of these events is similar to the high flow Kern River events of one in ten years, resulting in average annual benefits of $138,000 over the 50-year life of the Project. The present worth benefit over the life of the Project is $2,141,760.

The total avoided physical damage benefit is the sum of the above benefits at $15,178,560.

Note that a detailed flood frequency analysis was not completed for the Project, therefore Table 18 is not included in the referenced tables.

9.1.2.2 Avoided Direct and Indirect Net Income Loss

Job losses are also a factor to consider. Based on the study "*Measuring the Employment Impact of Water Reductions"* by Howitt et al, Sept 28, 2009, job losses were estimated at 21,000 as a result of lost acreage due to drought and Delta regulation impacts. The report goes on to simplify the calculation to 30 jobs lost per every million dollars in lost revenue. Therefore, at $8.4 million for Kern River flood damage reduction and $1.4 million for Friant-Kern flood damage reduction, a total of $9.8 million in lost revenue could occur. Therefore, with each event, about 294 jobs are lost. Implementation of the Project for flood damage reduction will therefore prevent about 294 job losses each event.

9.1.3 Distribution of Benefits and Identification of Beneficiaries

The beneficiaries of the flood related benefits of the Project are the growers in the Tulare Lake bed and the associated workforce and farm industry dependent on the acreage farmed each year.

9.1.4 Benefits Timeline

Benefits will begin with the first flood year after 2014. The estimated life if the Project is 50 years.

9.1.5 Uncertainty of Benefits

The uncertainty related to a repeat of historic hydrology translates in to some uncertainty in the benefits. However experience tells us that these large hydrologic events have occurred and climate change analyses are indicating that snow line elevations may be increasing resulting in filling existing reservoirs earlier in the year. This would increase the likely hood of flows occurring above reservoir capacity and would relate to more frequent flooding than analyzed herein.

9.1.6 Potential Adverse Effects

Temporary impacts associate with construction will be fully mitigated. Otherwise no adverse impacts are anticipated.

9.1.7 Summary of Findings

The primary flood damage reduction benefit of the Project is the reduced flooded area in Tulare Lake bed. The present value of protecting that land and allowing farming to continue is $15,178,560.

9.1.8 Appendices

Appendix 9.1-1	Economic Impacts of 1992 Drought
Appendix 9.1-2	Flood Damage Analysis

9.1.9 Tables

Table 17 – Project 1	Annual Cost of Project
Table 18	(Not Included)
Table 19 – Project 1	Present Value of Expected Annual Damage Benefits

Appendix 9.1-1
Flood Damage Reduction Benefit

Economic Impacts of the 1992 Drought Year

An Analysis of Economic Costs in Kern County

Prepared for

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Draft: October 1993
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Overview and Highlights

Background

California's six year hydrologic drought, extending from 1987 through 1992, formally ended in 1993 when heavy rains early in the year pushed measured snow-pack and subsequent run-off to pre-drought levels. Although 1993 was officially recorded as a wet year, low rainfall and snowpack levels in 1994 again saw the return of critical shortages in surface water supplies.

Agricultural producers in California's San Joaquin Valley are dependent on surface water for nearly 75% of their crop water requirements. Local surface water supplies account for 35% of water use while imported supplies account for an additional 40%;. groundwater makes up the remaining water requirements. Imported surface water supplies are delivered primarily to the valley's westside via the federal Central Valley Project and California's State Water Project. Normal deliveries from these projects to agricultural growers in the San Joaquin Valley average 5.9 million acre-feet annually. During the recent drought however, significant reductions occurred in delivered water supplies, resulting in considerable economic hardship for many farmers throughout the valley.[1]

Growers in Kern County take deliveries of both imported and local surface water supplies for irrigated production. During normal water years surface water accounts for approximately two-thirds of agricultural water requirements with imported water accounting for the largest share of this use. Drought-related restrictions in project water deliveries in 1990, 1991, and

[1] / The economic impacts of the 1991 and 1992 California droughts on San Joaquin Valley agriculture are presented in the following reports prepared by Northwest Economic Associates: *Economic Impacts of the 1991 California Drought on San Joaquin Valley Agriculture and Related Industries*; and *Economic Impacts of the 1992 California Drought and Regulatory Reductions on the San Joaquin Valley Agriculture Industry*.

1992 and reduced availability of local surface water have resulted in farm income losses for most growers in the county.

The most significant reductions in available water supplies have occurred on the state water system. The Kern County Water Agency is the largest agricultural water contractor to the State Water Project, with an annual firm water supply entitlement of 1,130,000 acre-feet (AF). The largest share of this, nearly 90%, is accounted for by agricultural water while the remaining represents municipal contracts. In 1992, water deliveries to agricultural contractors on the State Water Project were restricted for the third consecutive year. Deliveries of only 45% of entitlement in 1992 were preceded by a 100% shortage in 1991 and a 50% shortage in 1990. Agricultural member units of the Kern County Water Agency received a 1992 entitlement of only 334,200 AF compared to a contracted full firm entitlement of 1,015,000 acre-feet.

The accumulated results of limited water supplies and higher water costs have led to some restructuring of Kern County agriculture. Permanent crop acreage has declined somewhat since 1989, with most of the reduction occurring in the KCWA westside service area. Land values have also declined in many parts of the county, reflecting the increased uncertainty of imported surface water supplies.

Irrigation water districts in Kern County have likewise seen significant changes in response to the extended period of drought. Fiscal reserves built up over the past twenty-five years have been depleted in many districts, increasing the financial risk faced by growers in an era of uncertain water supplies and increasing water costs. In some cases, water districts have begun significant investments in a dual water system designed to increase groundwater pumping capacities to meet district water demands.

This report documents the economic impacts of the 1992 drought on agricultural producers in Kern County. The effects of limited water supplies on planted acreage are examined as are the cost impacts associated with the acquisition of alternative water supplies. Economic impacts are measured in terms of income and job losses incurred both on the farm and throughout the county.

Study Highlights

Kern County Crop Production

- Kern County irrigated crop acreage for 1992 was 762,500 acres, ranking the county third among the eight San Joaquin Valley counties for land in irrigated production. About two-thirds of the acreage was planted in annual crops, while the remaining one-third was utilized for permanent crops (grapes, tree nuts, and tree fruits).

- 1992 Kern County crop production was valued at $1.6 billion and accounted for 21% of total value of crop production for the eight county San Joaquin Valley region, and nearly 12% of California's $13.5 billion crop production industry

Shortages in Surface Water Supplies

- Surface water supplies available for Kern County agriculture in 1992 amounted to just over 890,000 acre-feet. This is considerably less than the 2.2 million acre-feet of surface water available under normal supply conditions.

- Limited surface water deliveries were received from all Kern County water sources: i) deliveries from the State Water Project were 45% of full entitlement, ii) deliveries on the federal Central Valley Project were 75% of Class I entitlements, and iii) local Kern River supplies were only 49% of normal.

Grower's Response to Water Shortage

- The economic impacts of the 1992 drought in Kern County agriculture have been primarily two-fold: 1) a decline in gross crop revenues and net farm income caused by acreage idled because of insufficient water supplies, and 2) an increase in water costs resulting from higher average unit rates on the state project, higher costs associated with water purchased to replace the state supplies unavailable for delivery, and increased groundwater pumping.

Drought-Related Reductions in Planted Crop Acreage

- According to Kern County growers and water district managers, 44,600 acres of irrigated cropland were not planted in 1992 as a results of the drought-related reductions in water supply. All but 700 acres of the reduction occurred in the westside service area of the KCWA. The acreage not planted was predominantly cotton but also included vegetables, grains, and alfalfa hay.

- An additional 18,200 acres of cotton and alfalfa hay placed into production suffered yield losses of 20% as a result of reduced water applications. All of this Acreage was located in the westside service area of the KCWA.

Some Crop Acreage Permanently Abandoned

- Since 1990, 14,500 acres of productive Kern County cropland has been permanently abandoned as a result of increasing uncertainty regarding available water supplies and the high costs associated with available supplies. The permanently idled land includes 10,500 acres of perennial orchards and vineyards and 4,000 acres of vegetables and alfalfa hay.

- The permanently idled acreage includes 1,200 acres of vegetables and 4,800 acres of perennial crops abandoned in 1992. This acreage is in addition to the 44,600 acres of cropland temporarily idled as a result of the drought.

Economic Losses Related to Acreage Reductions

- When productive acreage is fallowed or suffers yield declines, losses in crop revenues, farm income, and farm employment result. It is estimated that the 50,600 acres not planted or abandoned in 1992 along with the yield losses on an additional 18,200 acres led to a direct on-farm loss of $66.5 million in crop revenues including an income loss of $27.5 million and a reduction of 800 farm jobs.

- Additional losses occurred throughout the Kern County economy as a consequence of the economic linkages between agriculture and other manufacturing, trade, and service industries in the region. The total economic losses related to idled cropland were comprised of county-wide revenue losses of $133.4 million, including income losses of $57.2 million. Approximately 2,000 jobs were lost including the 800 on-farm jobs.

- The 10,500 acres of cropland permanently idled as a result of the drought will sustain economic losses into the future. It is estimated that the present value of crop revenues lost over the remaining life of the abandoned perennial orchards is $240 million while the present value of lost annual crop revenues is estimated to be $150 million. The abandoned revenue streams include future farm income losses of almost $102 million.

Growers Shifted to Groundwater Utilization Where Possible

- Growers with access to groundwater resources significantly increased their utilization of this water source in 1992 in order to compensate for critical reductions in surface water deliveries. It is estimated that groundwater pumping for irrigation purposes increased to over 1.5 million acre-feet, more than doubling normal pumping levels of about 740,000 acre-feet.

- The most significant increases in groundwater use was accounted for by growers within the service areas of the KCWA were usage increased from normal levels of about 200,000 acre-feet to estimated withdrawals of about 900,000 acre-feet, an increase of 450%.

Significant Increases in Water Costs

- Growers utilizing additional groundwater in 1992 were able to avoid acreage reductions but incurred significantly higher water costs. It is estimated that the increased costs related to additional groundwater pumping in 1992 were $47.3 million, based on increased withdrawals of 776,000 acre-feet. These increased water costs can be viewed as a direct decline in grower income.

- Additional groundwater costs were incurred by all pumpers as a result of the accelerated drawdown of the groundwater basin. Increased pumping during the drought caused the depth to water to increase more rapidly for all growers, resulting in increased pumping costs for each acre-foot withdrawn from the basin. It is estimated that the increased costs associated with accelerated drawdown amounted to $1.1 million in 1992.

- Costs for available surface water supplies also increased significantly as a result of the drought. In the KCWA westside service areas (without access to groundwater) many growers were able to replace water supplies normally received with more expensive water resources. Costs for these additional supplies averaged $86 per acre-foot but ranged to over $200 per acre-foot.

- The effective costs for actual deliveries of imported project water also increased in 1992. Although full entitlement deliveries were not made, KCWA districts receiving state project water were required to cover their full fixed cost obligation. This caused the average unit rates for water actually received to be substantially greater than average rates under full entitlement. Average district water costs increased from $40 per acre-foot to $76 per acre-foot.

- It is estimated that the costs for surface water actually delivered to Kern County growers increased by $25.3 million in 1992. Most of these costs were incurred by growers in the KCWA westside service areas.

Total Economic Costs Related to the 1992 Drought

- Kern County crop revenues declined by $66.5 million in 1992 as a result of drought-related reductions in planted acreage and crop yields. This included a $27.5 million in farm income and an associated loss of 800 farm jobs. The drought-related increases in surface and groundwater costs led to additional farm income losses of $73.7 million, resulting in total farm income losses of $101.2 million.

- Average county-wide income losses were nearly $130 per planted acre in 1992. However, in the KCWA service area average income losses in the westside water districts were nearly $300 per acre while losses in the groundwater districts were approximately $150 per acre.

- Kern County agricultural support industries also saw a decline in 1992 business revenues and earned income as a result of the drought. It is estimated that $254 million in county-wide revenues, including on-farm revenues, were lost. Approximately $133 million of this loss was related to idled crop acreage while the remaining $121 million decline in revenues can be linked to the reduction in farm income caused by increased water costs.

- The reduction in county-wide revenues also includes a $191 million income loss including wages and salaries and returns to business ownership and management for agriculture and its support industries. Most of the income losses were tied to the effects of the drought on farm-level water costs. Over $134 million of the income losses were related to water costs while the remaining $57 million was linked to idled crop acreage.

- It is estimated that the combined impacts of the drought on water costs and planted crop acreage led to a decline of 4,900 Kern County jobs, including 800 on-farm jobs.

Long-Term Effects of the Drought

- As environmental needs place increasing demands on limited water supplies, Kern County growers are likely to face a future of permanent water shortages. Farm-level adjustments made during the recent drought provide important insights into the potential impacts of these long-term shortages on irrigated agriculture.

- The extended period of drought focused attention on those regions within the KCWA service area which are most vulnerable to drought. Growers without access to groundwater and with only limited access to affordable alternative water supplies were most adversely impact by shortage. Implementation of permanent project water supply reductions which take into account the localized effects of shortage will help to minimize the overall costs of meeting the expanded water requirements for protecting environmental resources.

- During the drought growers overlying the groundwater basin indicated that they completely offset reduced surface water deliveries through increased groundwater pumping. As permanent water shortages are put into place, questions regarding long-term groundwater management may need to be evaluated . The extent to which the new pattern of drawdown and recharge will be sustainable over the long-run must be determined.

- Empirical evidence from the drought has also shown that the availability of affordable water transfers can mitigate the impacts of water shortages. In areas without alternative water supplies, water transfers provide the only opportunity to maintain production on lands that otherwise would be fallowed.

Organization of the Report

The economic impacts measured for both the surface water and groundwater areas of Kern County are presented in the sections that follow. First, a brief discussion of county-wide agricultural production in 1992 is presented. This is followed by a presentation of irrigation water supply and utilization for 3 major water district groupings (based on primary water source). The next two sections document the economic costs of the drought in Kern County including the effects on planted acreage and irrigation water costs. A discussion of the long-term impacts of the drought is also presented.

Kern County Agriculture

Irrigated Crop Acreage

Kern County's irrigated crop acreage for 1992 was estimated at 762,500 acres, about 15% of the total crop acreage for the San Joaquin Valley, and nearly 11% of California's total crop acreage. Among San Joaquin Valley counties, Kern was ranked third in total irrigated crop acreage; Fresno and Tulare counties were ranked first and second, respectively (see Table 1).

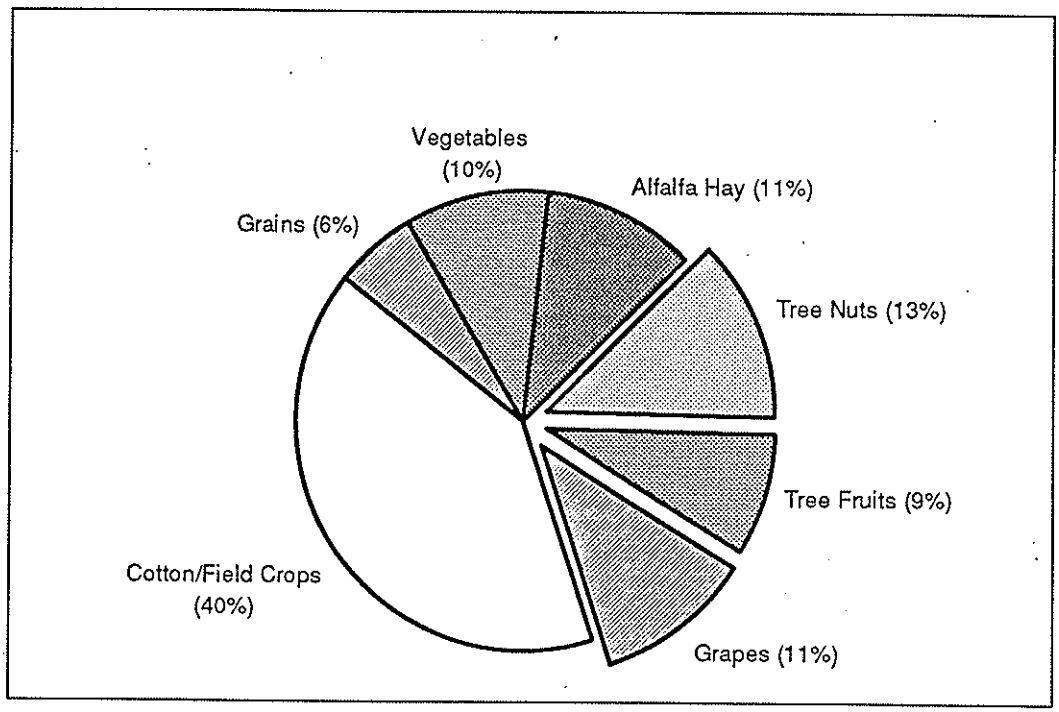
Table 1
1992 San Joaquin Valley Crop Acreage

San Joaquin Valley County	Crop Acreage
Fresno	1,151,670
Tulare	780,976
Kern	**762,506**
Merced	546,043
Kings	534,113
San Joaquin	486,430
Stanislaus	455,650
Madera	336,710

Source: *1992 County Agricultural Commissioners Reports and Kern County Water Agency*

The largest portion (40%) of Kern County crop acreage was devoted to cotton and field crops. The remainder was fairly evenly distributed among crop types, as shown in Figure 1. About two thirds of the acreage was planted in annual crops, while the remaining third was utilized for permanent crops (grapes, tree nuts, and tree fruits).

Figure 1
Distribution of 1992 Kern County Acreage



Source: *Kern County Water Agency*

Total permanent crop acreage in Kern County has remained fairly constant since 1986. However, the composition of the acreage has shifted over time. Grape and almond plantings declined by 18,000 acres between 1986 and 1990 while pistachio and citrus acreage increased by nearly 15,000 acres. Recent trends in permanent crop acreage are presented in Table 2 and Figure 2.

Annual crop acreage in Kern County has shown more variation than permanent crop acreage in recent years, due in large part to drought-related reductions in available water supplies (see Table 3 and Figure 3).

Table 2
Kern County Permanent Crop Acreage, 1986-1993

	Tree Nuts	Tree Fruits	Grapes/Vines	Permanent Crop Total
1986	104,600	50,900	92,400	247,900
1987	103,200	52,800	90,700	246,700
1988	104,800	55,000	90,300	250,100
1989	103,700	56,900	87,400	248,000
1990	104,600	60,000	89,300	253,900
1991	103,100	63,900	85,400	252,400
1992	98,700	65,300	85,700	249,700
1993	99,900	62,800	84,300	247,000

Source: *Kern County Water Agency*

Figure 2
Kern County Permanent Crop Acreage, 1986-1993

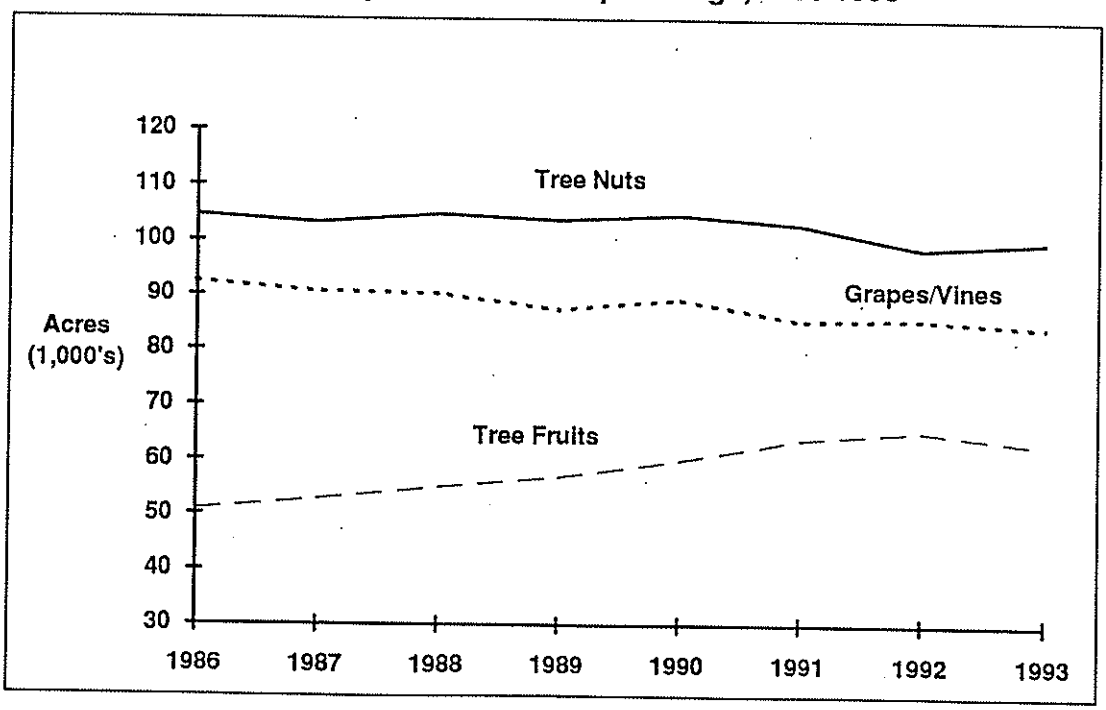
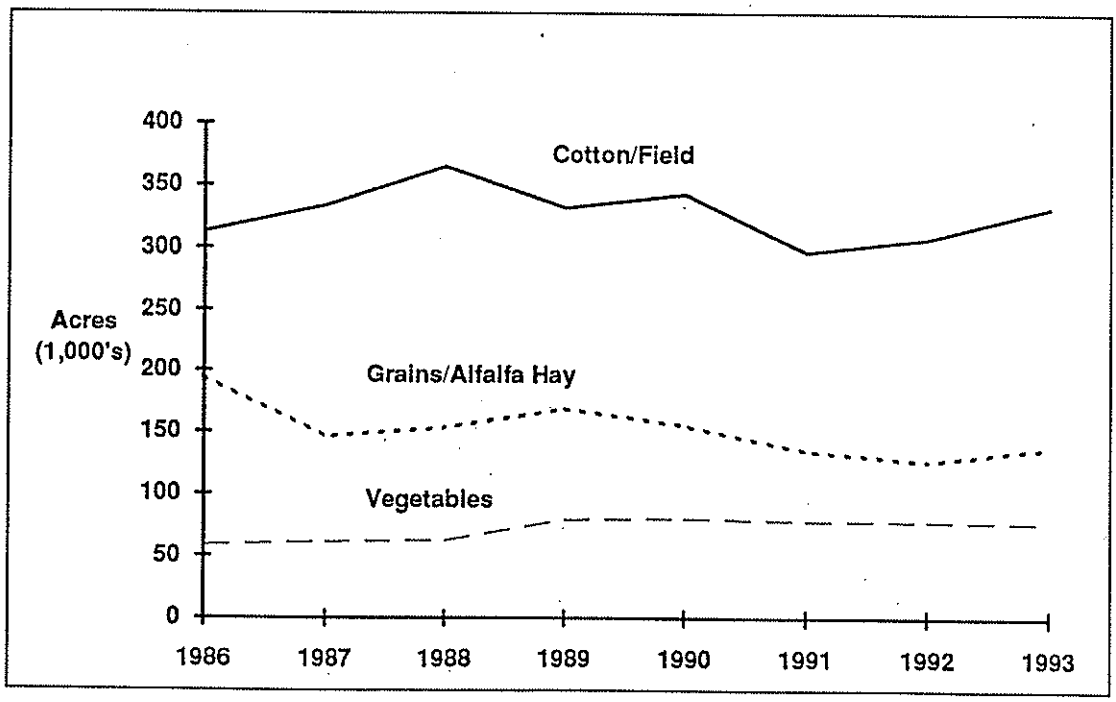


Table 3
Kern County Annual Crop Acreage, 1986-1993

	Cotton/ Field Crops	Grains/ Alfalfa Hay	Vegetables	Annual Crop Total
1986	313,200	194,100	58,800	566,100
1987	333,800	146,100	61,300	541,200
1988	364,900	154,500	62,500	581,900
1989	332,200	169,000	79,500	580,700
1990	343,300	155,600	80,800	579,700
1991	297,000	135,100	78,400	510,500
1992	308,000	123,400	78,300	509,700
1993	332,600	137,400	76,800	546,800

Source: *Kern County Water Agency*

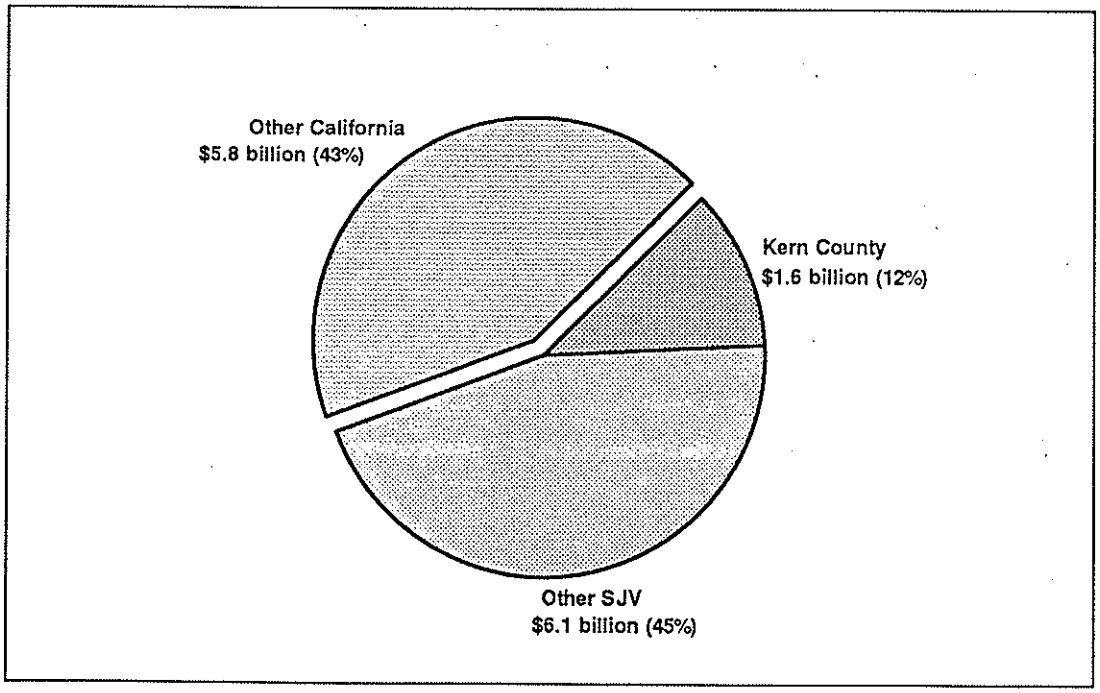
Figure 3
Kern County Annual Crop Acreage, 1986-1993



Value of Production

In 1992, agricultural commodities valued at nearly $1.7 billion were produced in Kern County. Nearly all of this, $1.6 billion, was attributable to irrigated crop production with cotton, grapes, almonds, carrots, and pistachios ranking as the county's five leading commodities. The value of Kern County crop production, measured by gross crop receipts, accounted for 21% of total value of crop production for the entire eight county San Joaquin Valley region, and nearly 12% of California's $13.5 billion crop production industry (see Figure 4). For 1992, Kern County was ranked fourth in the state based on the total value of agriculture production (both crops and livestock). The county was ranked third among San Joaquin Valley counties for total agriculture production, and second for crop production only.

Figure 4
1992 Value of Crop Production in Kern County, San Joaquin Valley, and California



Source: *1992 California Agriculture Statistical Review*

Water District Organization

The water-using areas of the San Joaquin Valley portion of Kern County, with the exception of about 27,000 acres of irrigated lands, are included within the organized areas of 23 public water districts. These districts are generally contiguous and overlapping, with just a few exceptions. The districts receive surface water deliveries from three major sources: I) the State Water Project, ii) the Central Valley Project, and iii) the Kern River.

The service area of the Kern County Water Agency encompasses the entire valley area of Kern County as well as less developed mountain and desert areas, including the Tehachapi-Cummings County Water District and Tejon-Castac Water District. The agency was formed primarily to provide a county-wide authority to contract with the State of California for water, then wholesale that water to retailing member districts within the county.

Fourteen of the county's irrigation water districts are member units of the Kern County Water Agency and receive direct deliveries of state project water. Ten of the member units overly the groundwater basin and are able to supplement surface water deliveries with groundwater pumping. For the remaining four districts however, state project water deliveries provide the only available water supplies. These districts are located primarily along the westside of the KCWA service area and generally do not overly the groundwater basin.

Local Kern River supplies are utilized by ten of the county's irrigation districts, including five districts that also take deliveries from the State Water Project. Deliveries from the federal Central Valley Project are supplied to six Kern County districts, two of which also receive Kern River deliveries.

The twenty-three Kern County agricultural water districts utilizing imported and local surface water supplies are presented in Table 4.

Table 4
Kern County Water District Organization

Water District	Surface Water Supplies
KCWA Member Water Districts	
Westside Water Districts	
Belridge Water Storage District	SWP
Berrenda Mesa Water District	SWP
Lost Hills Water District	SWP
Wheeler Ridge-Maricopa Water Storage District	SWP
Groundwater Area Water Districts	
Buena Vista Water Storage District	SWP, Kern River*
Buttonwillow Improvement District	SWP
Cawelo Water District	SWP*, Kern River
Henry Miller Water District	SWP*, Kern River
Improvement District No. 4	SWP
Kern Delta Water District	SWP, Kern River*
Pond-Poso Improvement District	SWP
Rosedale-Rio Bravo Water Storage District	SWP*, Kern River
Semitropic Water Storage District	SWP
West Kern County Water District	SWP
Non-Member Water Districts	
Arvin-Edison Water Storage District	CVP
Delano-Earlimart Irrigation District	CVP
Kern-Tulare Water District	CVP, Kern River*
North Kern Water Storage District	Kern River
Rosedale Ranch Improvement District	Kern River
Olcese Water District	Kern River
Rag Gulch Water District	CVP*, Kern River
Shafter-Wasco Irrigation District	CVP
Southern San Joaquin Municipal Utility District	CVP

* Denotes primary surface water supply.

Source: *Kern County Water Agency.*

Irrigation Water Supply and Utilization for 1992

Available Irrigation Surface Water Supplies

Limited water supply availability in 1992 marked the sixth consecutive year of drought in California and the San Joaquin Valley. Water deliveries on both the State Water Project and the federal Central Valley Project were cut for the third year in a row and available local water supplies were at levels significantly below normal. Once again, farmers found it necessary to increase their utilization of groundwater and to seek out alternative, and more costly, sources of surface water supply in order to maintain crop production. Where alternative water sources were unavailable, cropland was idled and production was lost.

State Water Project Deliveries

In 1992, agricultural contractors on the State Water Project were allocated only 45% of their firm entitlement. Deliveries of 1992 SWP firm entitlement to the KCWA irrigation member districts amounted to just under 334,200 AF. After taking into account carry-overs, transfers, and exchanges, state project deliveries totaled nearly 385,800 AF, significantly less than the full firm entitlement of 1,015,000 AF.[2] Actual 1992 SWP agricultural water deliveries to the KCWA member units are displayed in Table 5.

The KCWA westside surface water districts have firm entitlement contracts for annual delivery of 696,400 acre-feet of state project water. State project deliveries to the westside member units measured only 271,300 acre-feet in 1992. Miscellaneous transfers and exchanges

2/ Actual deliveries in 1992 exclude 57,171 acre-feet of entitlement returned to DWR under the 1990 Demonstration Programs and 40,156 acre-feet of 1992 entitlement delivered in 1993.

augmented delivery of state water to these districts to 286,600 acre-feet. The net result was a reduction of nearly 60% in available SWP surface water supplies.

Table 5
1992 SWP Irrigation Deliveries to KCWA Member Districts

Member Unit	Firm Entitlement	Actual Deliveries	Delivery Shortage[1]
	Acre-Feet	Acre-Feet	Percentage
Westside Districts	**696,424**	**286,600**	**59%**
Belridge WSD	148,000	53,830	64%
Berrenda Mesa WD	155,100	73,750	52%
Lost Hills WD	140,400	51,990	63%
Wheeler Ridge WSD	252,924	107,030	58%
Groundwater Districts	**318,676**	**99,200**	**69%**
Buena Vista WSD[2]	21,300	35,440	
Buttonwillow ID	83,000	14,610	82%
Cawelo WD	38,200	5,550	85%
Henry Miller WD	35,500	15,360	57%
ID No.4 - Agriculture	10,276	3,440	69%
Kern Delta WD[2]	25,500		
Pond Poso ID	67,000	12,070	82%
Rosedale-Rio Bravo WSD	29,900	10,030	66%
Semitropic WSD	8,000	2,030	75%
West Kern WD[2]	0	670	
Total Member Districts	**1,015,100**	**385,800**	**62%**

1/ Net delivery shortages to individual member districts vary significantly due to various exchange agreements and repayment obligations under past programs.

2/ Deliveries to Buena Vista WSD include Kern Delta and West Kern entitlement deliveries via a long term agreement.

Source: *1992 Water Supply Report*, Kern County Water Agency, December 1993.

State Water Project 1992 entitlement deliveries to the KCWA groundwater member units summed to nearly 63,000 acre-feet. Miscellaneous transfers and exchanges increased delivery

of state water to 99,200 acre-feet. With full firm entitlement contracts for 318,700 acre-feet annually, the state project-related surface water deliveries to the groundwater member units were reduced by nearly 70% in 1992.

Other Surface Water Supplies to KCWA Member Districts

In addition to deliveries of state water, miscellaneous other supplies of surface water were utilized by growers within the KCWA service area. At the outset of 1992, when only a 20% SWP allocation was expected, plans for a two-part Emergency Water Supply Program were developed by the agency. The program consisted of continuation of the 1991 Emergency Groundwater Supply Program and continued participation in the State's Emergency Water Bank. When the final allocation of 45% was announced for SWP supplies, the KCWA Emergency Program was scaled back to only include participation in the 1992 State Water Bank.

Purchases from the water bank by all KCWA member units amounted to 13,900 acre-feet, at an average cost of $147/AF. Over 90% of these purchases were made by growers in the westside districts.

Five of the fourteen KCWA member units receive annual deliveries of Kern River water through either direct entitlements or long-term contracts. These districts included Kern Delta WD, Buena Vista WSD, Cawelo WD, ID No. 4, and Rosedale-Rio Bravo WSD. Six consecutive low water years were recorded between 1987 and 1992, with annual deliveries ranging from 39% to 70% of median regulated flows of 564,600 acre-feet. Total deliveries of Kern River water to the KCWA districts amounted to 200,430 acre-feet in 1992.

In addition to local surface water supplies, several of the KCWA districts also facilitated the transfer of well water from one landowner to another. District conveyance facilities were used to transfer 32,100 acre-feet of groundwater in 1992. The transfers included both within district and between district exchanges.

The allocation of KCWA water district purchases of surface water from sources other than the State Water Project is presented in Table 6.

Total Surface Water Supplies to KCWA Member Districts

Total surface water deliveries to the KCWA member units from all sources amounted to 632,250 acre-feet. Of this amount, 309,720 acre-feet, or 49%, was delivered to the westside districts while the remainder was delivered to the districts overlying the groundwater basin. Total deliveries are presented in Table 6.

Table 6
Total 1992 Surface Water Supplies for the KCWA Member Districts

Member Unit	State Water Bank	Kern River Deliveries	District Provided Groundwater[1]	Total Water Supply[2]
	Acre-Feet	Acre-Feet	Acre-Feet	Acre-Feet
Westside Districts	**12,700**	**0**	**10,420**	**309,720**
Belridge WSD	430	0	2,320	56,580
Berrenda Mesa WD	4,380[a]	0	0	78,130
Lost Hills WD	7,890[a]	0	50	59,930
Wheeler Ridge WSD		0	8,050	115,080
Groundwater Districts	**1,200**	**200,430**	**21,700**	**322,530**
Buena Vista WSD	500	14,490	3,540	53,970
Buttonwillow ID	190		0	14,800
Cawelo WD		24,050	16,620	46,220
Henry Miller WD			1,540	16,900
ID No.4 - Ag		10,100	0	13,540
Kern Delta WD		150,670	0	150,670
Pond Poso ID	270		0	12,340
Rosedale-Rio Bravo WSD		1,120	0	11,150
Semitropic WSD	240		0	2,270
West Kern WD			0	670
Member District Total	**13,900**	**200,430**	**32,120**	**632,250**

1/ District facilitated transfers of groundwater from one landowner to another.

2/ Total includes 1992 actual SWP deliveries reported in Table 8.

a/ Includes carry-over of 1991 State Water Bank water.

Source: *1992 Water Supply Report*, Kern County Water Agency, December 1993.

Surface Water Deliveries to Non-Member Districts

In addition to the fourteen member districts of the Kern County Water Agency, ten other water districts provide irrigation water to growers in the San Joaquin Valley portion of the county.

These districts have entitlements to federal project water or rights to Kern River supplies or, in some cases, access to both sources.

Six of the ten non-member districts received deliveries through the federal Central Valley Project. The primary source of CVP water in the Kern County service area is delivered through the Friant Unit which stores and deliveries water from the central Sierra watersheds via the Friant-Kern Canal.[3] Water supplies within the unit were about 75% of normal in 1992. Total deliveries to the KCWA non-member districts amounted to 56,900 acre-feet.

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Deliveries of federal project water and Kern River water supplies to the non-member districts in 1992 is presented in Table 7.

Table 7
1992 Surface Water Deliveries to KCWA Non-Member Districts

Non-Member District	CVP Deliveries	Kern River Deliveries	Total Surface Water Deliveries
	Acre-Feet	Acre-Feet	Acre-Feet
Arvin-Edison WSD	38,360	2,040	40,400
Delano Earlimart WD	12,660		12,660
Kern Tulare WD	16,920	10,070	26,990
North Kern WSD		42,080	42,080
Olcese WD		1,220	1,220
Rag Gulch WD	6,360	1,510	7,870
Shafter-Wasco WD	43,460		43,460
So. San Joaquin MUD	84,240		84,240
Non-Member District Total	**202,000**	**56,920**	**258,920**

Source: *1992 Water Supply Report*, Kern County Water Agency, December 1993.

3/ Two of the districts, Rag Gulch and Kern Tulare, hold water rights agreements with the Bureau of Reclamation for water stored in Shasta Reservoir. Through the Cross Valley Canal Exchange Agreement the Shasta water is delivered through the California Aqueduct to Arvin Edison WSD. In exchange, Arvin-Edison makes available a portion of its water supply delivered through the Friant Kern Canal.

Total Surface Water Supplies Available for Irrigation

Utilization of surface water for irrigation purposes in Kern County amounted to just over 890,000 acre-feet in 1992. This is considerably less than the amount of surface water available under full supply conditions where an estimated 2.2 million acre-feet would be available. Member districts of the Kern County Water Agency accounted for 70 percent of the 1992 deliveries while the non-member districts accounted for the remaining 30 percent of surface water deliveries. The distribution of total irrigation surface water supplies is presented in Table 8.

Table 8
Total 1992 Kern County Irrigation Surface Water Supplies

Water Source	KCWA Member Districts	KCWA Non-Member Districts	All Kern County Water Districts
	Acre-Feet	Acre-Feet	Acre-Feet
State Water Project	385,800		385,800
State Water Bank	13,900		13,900
Central Valley Project		202,000	202,000
Kern River	200,430	56,920	257,350
Other	32,120		32,120
Total Water Supply	**632,250**	**258,920**	**891,170**

Irrigation Water Demand

Crop acreage in Kern County was measured at 762,500 acres in 1992. This was about 15% of the total crop acreage for the San Joaquin Valley, and nearly 11% of California's total crop acreage. In the five year period prior to 1991's severe water shortage, Kern County crop production averaged 825,000 acres, reaching a high of 856,000 acres in 1989. Surface water shortages in 1992 caused a significant portion of Kern County's productive acreage to lay idle during the growing season. The distribution of 1992 crop acreage by crop and water district grouping is presented in Table 9.

Table 9
1992 Kern County Crop Acreage

Crop Group	KCWA Member Districts		Non-Member Districts	Kern County Total Acreage
	Westside	Groundwater		
Annual Crops	**82,432**	**280,175**	**150,142**	**512,749**
Cotton/Field Crops	53,058	188,145	66,809	308,012
Alfalfa/Hay	3,786	52,972	24,534	81,292
Grains	6,942	25,516	12,669	45,127
Vegetables	18,646	13,542	46,130	78,318
Permanent Crops	**69,734**	**51,375**	**128,648**	**249,757**
Tree Nuts	37,592	19,539	41,578	98,709
Tree Fruits	16,610	14,382	34,340	65,332
Grapes/Vines	15,532	17,454	52,730	85,716
Total Acreage	**152,166**	**331,550**	**278,790**	**762,506**

Source: *Kern County Water Agency*

Permanent crops accounted for approximately one-third of total county crop acreage in 1992, with annual crops accounting for the remaining two-thirds. This contrasts with normal water years where annual crops account for 70 to 75 percent of total acreage.

The KCWA service area accounts for two-thirds of total crop production in Kern County, nearly 484,000 acres in 1992. Of this, the westside districts account for approximately 35% of production in a normal water year. In 1992, the westside share of KCWA crop acreage fell to just 30% of acreage in production. Annual crops predominate the KCWA service area, with

nearly all of the acreage planted to cotton or vegetable rotations. Permanent crops, accounting for 25% of acreage in the KCWA service area, are predominated by almond, pistachio, and grape production.

Applied Water Requirements

Estimates of per acre applied water requirements were developed using crop specific consumptive water use data and average irrigation efficiencies. The applied water use data were obtained from the Kern County Water Agency. Because of the significant shortage of water in the westside service areas, many growers were forced to cut water applications below consumptive requirements. This in turn led to crop stress and lower yields for many annual and permanent crops. Estimates of the drought-related reductions in per acre water applications were obtained from district managers and growers in the westside service areas.

Water application rates for the groundwater and westside growing areas are presented in Table 10.[4] The actual applied water rates for the various crops differ significantly over the valley, and are dependent on soil characteristics, topography, microclimates, irrigation system types, and cultural practices. The application rates in Table 10 represent the typical range of water use. It was generally found that

Total estimated water demand for 1992 was calculated using the average applied water rates presented in Table 10 and the planted crop acreages presented in Table 9. Irrigation water demand for 1992 was estimated to be 2.4 million acre-feet. The westside districts utilized 384,000 acre-feet, or 16% of total demand. The groundwater areas utilized the remaining 84 % of water demand, just over 2.0 million acre-feet. Total 1992 applied water requirements for the westside and groundwater service areas of Kern County are presented in Table 11.

4/ It should be noted that the annual effective precipitation rate for Kern County, 0.2 acre-feet/acre, was netted out of the applied water rate estimate.

Table 10
Average 1992 Applied Water Requirements

Crop Group	Westside Districts	Groundwater Districts
	Acre-feet/Acre	Acre-feet/Acre
Cotton/Field Crops	2.2 - 3.0	3.5
Alfalfa/Hay	4.0[a]	4.5
Grains	0.0 - 1.6	2.5
Vegetables	1.5	1.7
Tree Nuts	2.2 - 3.3	3.8
Tree Fruits	2.2 - 3.3	3.6
Grapes/Vines	2.2 - 2.7	2.7

Source: *1992 Water Supply Report*, Kern County Water Agency, December 1993, and personal communications with growers and water district managers.

Table 11
1992 Kern County Crop Water Requirements

Crop Group	KCWA Member Districts		Non-Member Districts	Kern County Total[1]
	Westside	Groundwater		
	Acre-Feet	Acre-Feet	Acre-Feet	Acre-Feet
Cotton/Field Crops	138,200	657,300	233,400	1,028,900
Alfalfa/Hay	14,500	235,900	109,300	359,700
Grains	0	62,900	31,200	94,200
Vegetables	31,200	22,700	77,300	131,100
Tree Nuts	112,100	74,200	158,000	344,300
Tree Fruits	47,700	51,100	121,900	220,700
Grapes/Vines	40,700	46,700	141,100	228,500
Total Acreage	**384,400**	**1,150,800**	**872,200**	**2,407,400**

1/ Some totals may not add due to rounding.

Estimated Groundwater Pumping

Surface water deliveries to the KCWA westside districts totaled 310,000 acre-feet in 1992. In three of the four water districts these limited deliveries were fully utilized to meet applied water requirements on a reduced acreage base. In Wheeler Ridge surface water deliveries were enhanced by limited groundwater pumping, estimated as the difference between applied water use and surface water deliveries, or 74,000 acre-feet.[5]

In the groundwater areas, 1992 deliveries to the KCWA member districts were 323,000 acre-feet and applied water requirements were 1,151,000 acre-feet. Groundwater pumping for these districts, estimated as the difference between deliveries and utilization, was 828,000 acre-feet. Non-member districts are estimated to have pumped 613,000 acre-feet in order to meet applied water requirements in their service areas. Irrigation water supply and utilization, including estimates of groundwater pumping, are presented in Table 12.

Based on surface water deliveries of 891,000 acre-feet and applied water requirements of just over 2.4 million acre-feet, groundwater pumping for irrigation purposes in Kern County was estimated to be 1,516,000 acre-feet in 1992.

5/ A small section of the Wheeler Ridge service area has limited access to groundwater. In normal water years, groundwater pumping is generally in the range of 20,000 to 30,000 acre-feet.

Table 12
Irrigation Water Supply and Utilization
Including Estimated Groundwater Pumping

Water District	Surface Water Supplies	Applied Water Use	Groundwater Pumping[1,2]
	Acre-Feet	Acre-Feet	Acre-Feet
KCWA Member Districts	632,000	1,535,000	903,000
Westside Districts[3]	310,000	384,000	74,000
Groundwater Districts	323,000	1,151,000	828,000
Non-member Districts	259,000	872,000	613,000
Kern County Total	**891,000**	**2,407,000**	**1,516,000**

1/ Groundwater pumping is estimated as the difference between applied water use and surface water deliveries.

2/ Some totals may not add due to rounding.

3/ Groundwater pumping occurs in some portions of the Wheeler Ridge service area.

Drought-Related Acreage Impacts

Farm-Level Adjustments to Water Shortage

The economic costs of water shortages, measured by losses in jobs, income, and gross revenues in agriculture and its support industries, are directly related to the magnitude and duration of reductions in water supply. For agricultural producers without access to alternative water supplies, the short-run response to water shortages is to remove relatively lower-valued crops from production. Depending on the severity of shortage, higher-valued crops may also be affected. Economic impacts become increasingly more significant as the magnitude of water shortage increases. Water is a necessary input for crop production; when deliveries are not made crops cannot be grown.

For growers with access to supplementary water supplies, reductions in surface water entitlement deliveries can be offset by increased groundwater pumping (where available) or through purchases on non-entitlement surface water supplies. Although net water use by these growers may remain unchanged, water costs increase substantially because of significantly higher per unit costs. Generally, growers are unable to recover increased water costs through higher output prices. As a result, farm income is adversely affected.

Reductions in water supply can also affect growers without contracts for entitlement deliveries. As growers who normally receive surface water deliveries become increasingly dependent on groundwater, problems of overdraft become more severe and pumping depths increase throughout the basin. This affects all growers utilizing groundwater.

In order to measure the economic impacts of the 1992 drought on agricultural producers in Kern County, growers and water districts were contacted mail surveys and direct interviews to document grower responses to the shortage in surface water deliveries. Water districts and producers in areas with and without access to alternative water supplies were contacted. As

outlined above, the primary drought-related economic effects identified by the growers and water managers were caused by:

- Drought-related reductions in planted acreage;
- Reductions in yields on water stressed crops; and
- Increased water costs for growers able to acquire supplemental water supplies.

Estimates on the economic costs of the 1992 drought to growers in Kern County are presented below.

Drought Related Acreage Reductions

Kern County irrigated crop acreage totaled 762,500 acres in 1992, with 249,760 acres (33%) in permanent crops (tree nuts, tree fruits, and grapes) and 512,750 acres in annual crops. The estimated value of 1992 crop production was $1.6 billion. Approximately 152,200 of the productive acres were located in the KCWA westside service areas and the remainder were located in the groundwater areas. Nearly 48% of the acreage in the westside area was planted to permanent crops compared to 29% in the groundwater areas.

Based on discussions with Kern County growers and water district managers, it was determined that 44,600 acres were not planted as a result of drought-related reductions in available surface water supplies. All but 700 acres of this reduction occurred within the service areas of the westside water districts.

In some cases growers found it necessary to abandon acreage that had been previously planted. The abandoned acreage included 1,200 acres of vegetables and 4,840 acres of permanent crops. Abandoned vegetable lands were first planted and then idled when anticipated water deliveries were unavailable. Decisions to abandon permanent crop acreage took into account the cumulative effects of water shortages in previous years and the anticipated reliability of future deliveries.

Croplands lost to production in 1992 as a result of the drought amounted 50,640 acres, including acreages not planted, abandoned, or idled. The drought-impacted acreages are presented in Table 13. Acreage is identified by crop type and water district service areas. The reduction in cropped acreage in turn led to a loss in crop revenues, farm income, and regional jobs.

Table 13
Kern County Crop Acreage Impacted by the 1992 Drought

	Westside Water Districts	Groundwater Districts	Kern County Total
Acreage Idled or Not Planted	**43,900**	**700**	**44,600**
Cotton/Field Crops	35,800	700	36,500
Alfalfa Hay	400		400
Grains	4,600		4,600
Vegetables	3,100		3,100
Abandoned Acreage	**5,740**	**300**	**6,040**
Vegetables	1,200		1,200
Tree Nuts	3,000	300	3,300
Tree Fruits	400		400
Grapes	1,140		1,140
Total Not Planted/Abandoned	**49,460**	**1,000**	**50,640**
Cotton/Field Crops	35,800	700	36,500
Alfalfa Hay	400		400
Grains	4,600		4,600
Vegetables	4,300		4,300
Tree Nuts	3,000	300	3,300
Tree Fruits	400		400
Grapes	1,140		1,140

Acreage with Drought-Related Yield Reductions

Water supplies were sufficient in some areas of the westside to place land into production but were insufficient to provide a full water supply to meet applied water requirements Where this occurred, yields fell below normal levels. Growers identified 18,240 acres of cotton and alfalfa as having lower yields as a result of reduced water applications. All of this acreage was located in the westside areas. Cotton yields on the affected acreage were estimated to have declined by 15% while alfalfa yield were estimated to have fallen by 20%.

Farm-Level Economic Losses Related to Acreage Impacts

When productive acreage is fallowed or shows yield reductions, losses in crop revenues, farm income, and farm employment result. It is estimated that the 50,640 acres not planted or abandoned resulted in a direct loss of $63.6 million in gross crop revenues. An additional loss of $2.9 million in crop revenues resulted from drought-related yield reductions on 18,000 acres of cotton and alfalfa. Direct crop revenue losses related to the 1992 drought, including yield reductions and acreage not planted, amounted to $66.5 million. Permanent crops accounted for $10.4 million (15%) of the crop revenue loss with the remaining $53.2 million linked to annual crops, primarily cotton.

The direct farm revenue loss of $66.5 million includes nearly $27.5 million in lost farm income. Farm income losses include wage and salary payments to farm workers and returns to farm proprietors. While only 15% of direct revenue losses can be attributed to reductions in permanent crop acreage, over 21% of farm income losses are related to permanent crops. This is because of the relatively higher labor intensity associated with permanent crop production.

When crop acreage is idled as a result of limited water supplies, there is an associated reduction in farm labor requirements. It is estimated that approximately 800 farm-level jobs were lost as a result of the 50,600 acre reduction in 1992 crop acreage.

Direct crop revenue losses along with farm income and employment losses are presented in Table 14.

Table 14
Economic Losses Associated with Drought-Related Acreage Impacts

	Westside Water Districts	Groundwater Districts	Kern County Total
Acreage Impacts			
Not Planted or Abandoned	49,640	1,000	50,640
Permanent Crops	4,540	300	4,840
Annual Crops	45,100	700	45,800
Yield Reductions[1]	18,420	0	18,420
Revenue Losses ($1,000)	**$130,703**	**$2,700**	**$133,403**
On-Farm Losses	$65,281	$1,235	$66,516
Permanent Crops	$9,938	$476	$10,414
Annual Crops	$55,343	$759	$56,102
Support Industry Losses	$68,422	$1,465	$66,887
Income Losses ($1,000)	**$56,099**	**$1,082**	**$57,181**
On-Farm Losses	$27,057	$428	$27,485
Permanent Crops	$5,616	$186	$5,802
Annual Crops	$21,441	$242	$21,683
Support Industry Losses	$29,042	$654	$29,696
Employment Losses (jobs)			**2,000**
On-Farm Losses			800
Support Industry Losses			1,200

1/ Documented yield reductions occurred only on annual acreage.

Economic Losses to Related Industries

As growers face reductions in crop revenues and declines in net farm returns to ownership, labor, and management, other business and industries in the local economy are also affected. Firms providing production inputs and support services were also affected by the drought-related reductions in acreage and yields. Revenue losses incurred by other farm-related businesses in Kern County were estimated to be $66.9 million for a total economy-wide revenue loss of $133.4 million. Approximately 85% of these losses can be attributed to reductions in annual crop acreage.

The county-wide total revenue losses of $133.4 million include regional income losses of $57.2 million. In addition to the on-farm loss of $27.5 million, over $29.7 million in lost income was distributed throughout the Kern County regional economy. In addition to the 800 farm jobs that were lost, 1,200 jobs are estimated to have been lost county-wide as result of the indirect revenue losses to farm-related business. The total drought-related employment loss in Kern County reached 2,000 jobs in 1992. County-wide losses are also presented in Table 14.

Permanently Abandoned Crop Acreage

Permanent crop acreages in Kern County have declined significantly since 1990. This reduction has been due primarily to increased uncertainty regarding available water supplies, along with the resulting higher water costs. Some reductions in annual crop acreages have also occurred as a result of increasing water uncertainty. These acreage reductions have occurred in areas with limited or no access to supplemental groundwater resources. Based on discussions with growers it is estimated that permanent crop acreage has declined by 10,535 acres while annual cropland has declined by 4,000 acres.

When land is permanently idled, crop revenues are lost and an associated decline in farm jobs and farm income results. It is estimated that the present value of crop revenues lost over the remaining life of abandoned perennial orchards is $240 million. The present value of lost annual crop revenues is estimated to be $150 million. The associated losses in support industry revenues is $368 million, for a county-wide loss of over $750 million in future business revenues. These lost future revenues include an estimated future income loss of almost $220 million. The foregone income is comprised of $102 million in on-farm losses and $117 million in losses to agricultural support industries. A permanent loss of nearly 600 on-farm jobs is associated with the permanently idled acreage along with an additional loss of 500 jobs throughout the Kern County economy.

The economic losses resulting from permanently abandoning nearly 15,000 acres of productive crop acreage are presented in Table 15.

Table 15
Lost Value of Permanently Abandoned Crop Acreage

	Westside Water Districts	Groundwater Districts	Kern County Total
Abandoned Acreage	**13,335**	**1,200**	**14,535**
Permanent Crops	9,335	1,200	10,535
Almonds	*5,600*	*1,200*	*6,800*
Pistachios	*200*		*200*
Olives	*400*		*400*
Grapes	*3,135*		*3,135*
Annual Crops	4,000		4,000
Alfalfa Hay	*2,800*		*2,800*
Vegetables	*1,200*		*1,200*
Revenue Losses ($1,000)[1]	**$711,600**	**$47,500**	**$759,100**
On-Farm Losses	$370,100	$20,600	$390,700
Permanent Crops	$219,800	$20,600	$240,400
Annual Crops	$150,300	$0	$150,300
Support Industry Losses	$341,500	$26,900	$368,400
Income Losses ($1,000)[1]	**$204,200**	**$14,700**	**$218,900**
On-Farm Losses	$96,400	$5,700	$102,100
Permanent Crops	$61,600	$5,700	$67,300
Annual Crops	$34,800	$0	$34,800
Support Industry Losses	$107,800	$9,000	$116,800
Employment Losses (jobs)	**1,000**	**100**	**1,100**
On-Farm Losses	550	50	600
Permanent Crops	450	50	500
Annual Crops	100	0	100
Support Industry Losses	450	50	500

1/ Figures represent present value of losses over the remaining life of the orchards.

Drought-Related Increases in 1992 Water Costs

1992 Surface Water Costs

Limited surface water deliveries from the State Water Project, the Central Valley Project, and the Kern River led to significantly higher water costs for all growers in Kern County. Two major reasons accounted for the drought-related increases in 1992 water costs. First, to replace the water supplies normally received, many growers and districts found it necessary to utilize more expensive water resources. The KCWA west-side member districts, generally without access to groundwater, implemented a variety of water transfer programs in order to augment the limited deliveries from the State system. In the groundwater areas, growers were able to supplement restricted surface water deliveries with increased groundwater pumping.

In some cases, growers were unable to obtain the necessary replacement water for irrigation. This led to the reduction in 1992 planted acreage discussed in the previous sections.

The second reason for higher water costs in 1992 was the effective increase in the average unit rate paid by Kern County water districts for actual contract deliveries from the state and federal projects. Although less than full entitlement deliveries were made, KCWA member districts receiving state project water were required to make full payment on their fixed cost obligation. Therefore, the full SWP fixed payment was allocated over a smaller delivered water base, substantially increasing average unit rates for the water that was received. Similarly, growers in water districts with Central Valley Project and Kern River entitlements also paid higher average unit rates for surface water deliveries available in 1992.

Surface water deliveries to Kern County growers, from all sources, amounted to 891,100 acre-feet. Expected total cost for this water, estimated using normal year unit rates, would have been $34.4 million; actual costs reached $59.7 million. The drought-related net increase in surface water costs for growers in Kern County amounted to $25.3 million. Nearly all of these costs were borne by growers within the KCWA service area, particularly those producers in

the westside water districts. A majority of the cost increase was tied to increased unit rates for state project entitlement deliveries. Many growers outside the KCWA service area also paid higher costs for limited deliveries of CVP and Kern River deliveries. Average district water costs throughout Kern County increased from $39 per acre-foot to $54 per acre-foot, an increase of 75%.

Expected and actual unit rates for 1992 surface water deliveries to growers in Kern County are presented in Table 16. The estimated net increase in total water costs for actual deliveries is also presented. A more detailed discussion of water costs for various water district groupings is presented below.

Water Costs for KCWA Member Districts

Growers within the Kern County Water Agency service area utilize water supplies from three primary sources: imported surface water supplies from the State Water Project, local surface water supplies from the Kern River, and, where available, groundwater.[6] Total 1992 surface water deliveries to the member districts amounted to 632,200 acre-feet. Drought-related cost increases were associated with all of the water sources.[7] It is estimated that the net increase in water costs for districts within the KCWA service area amounted to $23.2 million, with average unit rates for all surface water sources increasing from $40 to $76 per acre-foot.

SWP Entitlement Deliveries

The effective average unit rates ($/AF) for actual deliveries of state project entitlement water doubled in 1992 for most KCWA member districts. If full entitlement had been available, the member units would have paid an average of $53 per acre-foot; actual unit rates averaged $106 per acre-foot. The 1992 SWP deliveries of 385,800 acre-feet are estimated to have cost the KCWA member districts an additional $20.5 million as a result of the higher effective unit rates. These increased water costs were passed along to district producers. For many growers, state project costs increased even further as additional payments for fixed in-district assessments were spread over less delivered water.[8]

6/ Effective precipitation for irrigation purposes generally averages less than 0.2 acre-feet per acre annually in Kern County.

7/ Cost increases associated with groundwater are discussed in a later section.

8/ These additional net cost increases were not quantified for this study. However, an earlier district water rate survey conducted by the Kern County Water Agency showed that many of the water districts pass along infrastructure costs through fixed assessments.

Table 16
1992 Increased Water Costs for Kern County Growers[a]

Water District	Water Deliveries	Expected Cost	Actual Cost	Increased Water Costs
	AF	Cost/AF	Cost/AF	($1,000s)
KCWA Member Districts	**632,200**	**$40**	**$76**	**$23,160**
State Project Supplies	431,800	$52	$104	$22,158
SWP Entitlement	*385,800*	*$53*	*$106*	*$20,492*
State Water Bank	*13,900*	*$55*	*$148*	*$1,290*
District Programs	*32,100*	*$47*	*$59*	*$377*
Kern River Deliveries	200,400	$13	$18	$1,002
Westside Districts	**309,700**	**$56**	**$115**	**$18,167**
State Project Supplies	309,700	$56	$115	$18,167
SWP Entitlement	*286,600*	*$56*	*$114*	*$16,6234*
State Water Bank	*12,700*	*$56*	*$153*	*$1,232*
District Programs	*10,400*	*$56*	*$86*	*$312*
Groundwater Districts	**322,500**	**$24**	**$40**	**$4,994**
State Project Supplies	121,900	$43	$76	$3,992
SWP Entitlement	*99,200*	*$43*	*$82*	*$3,869*
State Water Bank	*1,200*	*$43*	*$91*	*$58*
District Programs	*21,700*	*$43*	*$46*	*$65*
Kern River Deliveries	200,400	$13	$18	$1,002
Non-Member Districts	**258,900**	**$36**	**$44**	**$2,148**
CVP Deliveries	202,000	$40	$45	$1,010
Kern River Deliveries	56,900	$20	$40	$1,138
Total All Water Districts	**891,100**	**$39**	**$54**	**$25,308**

a/ Some totals may not add due to rounding.

Westside Water Districts

If full entitlement deliveries had been available in 1992, the average price paid for water by the westside water districts would have been $56 per acre-foot. Actual deliveries in 1992 were 45% of normal, resulting in higher unit rates for the state water that was received. State water costs averaged $114 per acre-foot, an increase of $58 per acre foot over expected costs with full entitlement. It is estimated that the net increase in 1992 SWP water costs paid by the four surface water districts for deliveries actually made was $16.6 million.

Groundwater Districts

With full entitlement, the average price paid for water by the groundwater districts in 1992 would have been $43 per acre-foot. Limited deliveries to these districts also resulted in higher unit rates for the state water that was received. State water costs averaged $82 per acre foot, an increase of $39 per unit over expected costs with full entitlement. It is estimated that the net increase in 1992 SWP water costs paid by the groundwater districts for deliveries actually made was $3.9 million.

Other Imported Water Supplies

Districts and landowners in the KCWA service area were able to develop an additional 46,000 acre-feet of surface water in 1992 through State Water Bank purchases and carry-overs, imported water transfers, and local district projects. Purchases by the westside districts included transfers from the State Bank and a local groundwater program developed by Wheeler Ridge WSD. Under the program, groundwater was developed by local growers and transferred via district facilities to other landowners within the district. Groundwater programs also comprised the majority of other surface water purchases in the groundwater districts.

Average unit rates for these surface water supplies and groundwater programs ranged from $30 per acre-foot to over $200 per acre-foot, with a weighted average cost of $86. Based on actual costs for the purchases of other imported surface water supplies, it is estimated that the total cost for the additional water was $3.9 million, an increase of $1.7 million over expected costs.

Kern River Deliveries

Four of the KCWA member districts in the groundwater area also have entitlements to the local Kern River surface water supply. Six consecutive low water years for the river were recorded between 1987 and 1992, with annual deliveries ranging from 39% to 70% of median regulated flows of 564,600 acre-feet. Deliveries of 275,000 acre-feet in 1992 averaged only

49% of median flows. Allocations of available supplies to the individual districts is based on a historical priority system, resulting in a wide variation in supply shortages among the districts. Total deliveries to water districts in the KCWA service area amounted to 200,400 acre-feet. Average unit rates for these deliveries increased from $13 to $18 per acre-foot, resulting in a net water cost increase of $1 million.

Water Costs for Non-Member Districts

Modest increases in 1992 surface water costs were also incurred by growers outside the KCWA service area. Average unit rates for CVP deliveries increased from an expected $40 per acre-foot to actual costs of $45 per acre-foot. Costs for Kern River deliveries increased from an expected average rate of $20 per acre-foot to actual costs of $40 per acre-foot.[9] The net result was an increased water cost of $2.1 million to growers in these areas.

1992 Groundwater Costs

In order to compensate for the shortage not only in SWP surface water deliveries but also in CVP and Kern River supplies, Kern County growers were forced to significantly increase their use of groundwater. For most growers, groundwater costs per acre-foot are higher than costs for delivered project water. Therefore, the result of the increased groundwater reliance was a net increase in on-farm water costs, which in turn led to a decline in net farm income. Significant capital outlays were also necessary for the production of new wells and the rehabilitation of existing wells.

The drought-related impacts affecting grower pumping costs derive from two sources. First, as higher cost groundwater is substituted for unavailable surface water supplies applied water costs increased. Secondly, acceleration in the drawdown of the county's underground aquifers occurred as a result of increased groundwater pumping by growers. This led to additional increased pumping depths for groundwater normally pumped by all growers utilizing the groundwater basin.

9/ Variations in water rate schedules for the Kern River districts resulted in different average unit rates for districts outside the KCWA service area than for those districts within the service area boundaries. The reader is referred to Tables 6 and 7 for a listing of the individual water districts in each of these regions.

Groundwater Substitution

Applied water demand by all Kern County growers amounted to 2,407,000 acre-feet in 1992. Under normal water conditions 70% of this demand, or 1,667,000 acre-feet would have been met by surface water supplies from the SWP, the CVP, and the Kern River. Groundwater pumping would have accounted for 740,000 acre-feet of applied water use. However, diminished surface water supplies in 1992 resulted in a much larger proportion of applied water requirements made up by groundwater. It is estimated that 1,516,000 acre-feet of groundwater was pumped, an increase of 776,000 acre-feet. Actual deliveries of surface water accounted for only 35% of total water use.

The most significant increase in groundwater use was accounted for by member districts of the Kern County Water Agency where usage increased from normal levels of 200,000 acre-feet to just over 900,000 acre-feet, an increase of 450%. Groundwater pumping by the non-member districts increased from expected normal levels of 537,000 acre-feet to actual withdrawals of 613,00 acre-feet in 1992.

Results from the water district and grower surveys indicated that average pumping depths in Kern County are approximately 400 feet, although some variation exists throughout the region.[10] Pumping costs at this depth are estimated at about $71 per acre-foot. Because the fixed charges for surface water must be paid regardless of what quantity of water is actually delivered, the net increase in water costs related to groundwater substitution are measured as the difference between pumping costs and the variable cost of delivered surface water. Discussions with water district managers indicate that variable costs for surface water average approximately $10/acre-foot throughout the county. Therefore, increased costs related to the additional drought-related pumping in 1992 were calculated to be $47.3 million, based on increased withdrawals of 776,000 acre-feet.

Expected and actual groundwater usage for 1992 are presented in Table 17, along with the net increase in water costs related to groundwater substitution.

10/ Average pumping depths of 400 feet is consistent with information collected by the Kern County Water Agency.

Table 17
Increased Costs Related to Groundwater Substitution

	KCWA Member Districts	Non-Member Districts	Total
	Acre-feet	Acre-feet	Acre-feet
Applied Water Use	**1,535,000**	**872,000**	**2,407,000**
Normal Year Water Supply	**1,535,000**	**872,000**	**2,407,000**
Surface Water Deliveries	1,332,000	335,000	1,667,000
Groundwater Pumping	203,000	537,000	740,000
1992 Drought Water Supply	**1,535,000**	**872,000**	**2,407,000**
Surface Water Deliveries	632,000	259,000	891,000
Groundwater Pumping	903,000	613,000	1,516,000
Net Increase in 1992 Groundwater Pumping	**700,000**	**76,000**	**776,000**
Increased Costs for Groundwater Substitution *($1,000s)*	**$42,700**	**$4,600**	**$47,300**

Groundwater Drawdown

Additional groundwater costs were also incurred by growers as a result of the acceleration in drawdown of the groundwater aquifer. With increased utilization of groundwater during the 1992 production season, pumping depths increased more rapidly for all growers which in turn led to increased pumping costs for each acre-foot of water withdrawn from the basin. The Kern County Water Agency has developed a rule of thumb which indicates that pumping lifts increase one foot for every 100,000 acre-feet of overdraft. Using this rule, it is estimated that average Kern County pumping depths have increased by eight feet between 1991 and 1992, at an average costs of about $1.50 for each acre-foot withdrawn. This translates to an increased cost of $1.1 million for the estimated 740,000 AF that is normally pumped for irrigation use; approximately $305,000 was lost by growers within the KCWA service area while the remaining $805,000 was lost by growers in the non-member districts. These regional estimates are based on normal levels of groundwater pumping in the two areas (see Table 17).

Additional Groundwater Costs

Groundwater pumping capacity throughout Kern County was developed with the expectation that full entitlement deliveries of surface water would generally be available. The significant reductions in surface water deliveries between 1990 and 1992 led many growers and water districts to increase pumping capacity through investments in new wells. It was estimated by the Kern County Water Agency that fifty-one new wells were reported in 1992, including 16 district wells and 35 on-farm wells. At an average cost of $110,000 per well, Kern County growers invested $5.6 million to make up for surface water shortages related to the drought.[11] In addition to the capital costs of developing the wells, growers also incurred (and will continue to incur) the annual operations and maintenance costs which are estimated at $3,000 per year.

Summary of Increased Water Costs

It is estimated that total water costs paid by Kern County growers in 1992 increased by $73.7 million as a result of the drought-related reductions in surface water supplies available for irrigation. This figure includes $48.4 million in increased groundwater pumping costs and $25.3 million for increased costs related to surface water deliveries. These costs reflect direct losses in net farm income and are additive to the farm income losses which were incurred as a result of reductions in planted acreage and crop yields.

A summary of these costs are presented in Table 18.

The Economic Impacts of Increased Water Costs

The drought-related increases in agricultural water costs generated significant economic impacts throughout Kern County. These are in addition to the impacts generated by drought-related reductions in planted acreage and crop yields. The increased water costs are reflected in the farm operation as incremental to all other production costs, including water costs expected under normal water supply conditions. There is no offset to these costs through increased crop revenues. Therefore, the increased water costs result in a direct reduction in net farm income.

[11] / Average well costs based on information collected from water district surveys.

Table 18
Summary of Drought-Related Increases in 1992 Water Costs[a]

	Increased Water Costs Related to		
	Surface Water	Groundwater	Total
	($1,000s)	($1,000s)	($1,000s)
KCWA Member Districts	**$23,160**	**$43,000**	**$66,160**
Westside Districts	$18,167		$18,167
Groundwater Districts	$4,994	$43,000	$47,994
Non-Member Districts	**$2,148**	**$5,400**	**$7,548**
All Water Districts	**$25,308**	**$48,400**	**$73,708**

a/ Some totals may not add due to rounding.

In order to estimate the economic impacts associated with the increased costs, it was assumed that the loss in net farm income had a two-fold effect on the farming operation: 1) with less business income available, farm investments were delayed or withheld; and 2) with lower returns to land, management, and capital, less money was available to the farm household. Therefore, one-half of the net farm income change was assumed to have generated economic impacts through the effects on household income and the consequent reduction in household expenditures. The remaining portion of the change in farm income was assumed to have generated economic impacts through reduced purchases of farm machinery and equipment.

The direct loss of $73.7 on on-farm income is estimated to have generated additional income losses of $59.8 million to support businesses and industries throughout the economy resulting in a total income loss of $133.5 million to Kern County growers and residents. These income losses, along with the associated reduction in the production of goods and services, led to a reduction in Kern County employment, estimated at 2,900 jobs.

A Summary of Total Economic Losses Related to the 1992 Drought

Measured Economic Losses

A summary of the economic losses in Kern County related to the 1992 drought is presented in Table 19. The loss summary includes impacts related to reductions in planted crop acreage, crop yield losses, abandoned crop acreage, increased surface water costs, and increased groundwater costs related to increased pumping and accelerated drawdown of the aquifer. Measures of economic loss include changes in the total value of on-farm and support industry production (revenue losses), changes in wage and salary earnings and returns to management and ownership (income losses), and changes to regional employment.[12] Where possible losses are identified by water district grouping and are allocated to on-farm and support industries.

On-Farm Economic Losses

Kern County crop revenues declined by $66.5 million in 1992 as a result of drought-related reductions in planted acreage and crop yields. This included a $27.5 million in farm income and an associated loss of 800 farm jobs. The drought-related increases in surface and groundwater costs led to additional farm income losses of $73.7 million, resulting in total farm income losses of $101.2 million.

[12] / It should be noted that the income losses are not additive to the revenue losses. A portion of any industries product revenue is used to cover wage and salary payments as well as returns to management and ownership.

Table 19
Summary of Economic Losses Related to the 1992 Drought[a,b]

	Economic Impacts Related to		
	Crop Acreage	Water Costs	Total
On-Farm Revenue Losses ($1,000s)	**$66,516**		**$66,516**
KCWA Member Districts	$66,516		$66,516
Westside Districts	$65,281		$65,281
Groundwater Districts	$1,235		$1,235
Non-Member Districts			
Total Revenue Losses ($1,000s)	**$133,403**	**$120,623**	**$254,026**
KCWA Member Districts	$133,403	$108,271	$241,674
Westside Districts	$130,703	$29,730	$160,433
Groundwater Districts	$2,700	$78,542	$81,242
Non-Member Districts		$12,352	$12,352
On-Farm Income Losses ($1,000s)	**$27,485**	**$73,708**	**$101,193**
KCWA Member Districts	$27,485	$66,160	$93,645
Westside Districts	$27,057	$18,167	$45,224
Groundwater Districts	$428	$47,994	$48,422
Non-Member Districts		$7,548	$7,548
Total Income Losses ($1,000s)	**$57,181**	**$133,485**	**$190,666**
KCWA Member Districts	$57,181	$119,816	$176,997
Westside Districts	$56,099	$32,900	$88,999
Groundwater Districts	$1,082	$86,917	$87,999
Non-Member Districts		$13,669	$13,669
Total Employment Losses (jobs)	**2,000**	**2,900**	**4,900**
On-Farm Job Losses	800		800

a/ Total losses include on-farm and support industry losses.

b/ Some totals may not add due to rounding.

The relative value of these losses becomes more apparent when measured on a per acre basis. Average county-wide income losses related to the 1992 drought were nearly $130 per planted acre in 1992. However, in the KCWA service area these losses were much more significant. Average income losses in the westside water districts were nearly $300 per acre while average losses in the groundwater districts were approximately $150 per acre. Losses in the non-member district service areas averaged $30 per acre.

The farm job losses result from the 50,64 0 acres of cropland idled as a result of the drought, primarily in the KCWA westside district service areas.

County-Wide Economic Losses

Kern County agricultural support industries also saw a decline in 1992 business revenues and earned income as a result of the drought. It is estimated that $254 million in county-wide revenues, including on-farm revenues, were lost. Approximately $133 million of this loss was related to idled crop acreage while the remaining $121 million decline in revenues can be linked to the reduction in farm income caused by increased water costs.

The reduction in county-wide revenues also includes a $191 million income loss including wages and salaries and returns to business ownership and management for agriculture and its support industries. Most of the income losses were tied to the effects of the drought on farm-level water costs. Over $134 million of the income losses were related to water costs while the remaining $57 million was linked to idled crop acreage.

It is estimated that the combined impacts of the drought on water costs and planted crop acreage led to a decline of 4,900 Kern County jobs, including 800 on-farm jobs.

Long-Term Issues Raised by the Drought

As environmental needs place increasing demands on limited water supplies, Kern County growers are likely to face a future of permanent water shortages. Farm-level adjustments made by growers during the recent drought should provide water managers and policymakers with important insights into the potential impacts of these long-term shortages on irrigated agriculture. Although the drought represented temporary rather than permanent water shortages, grower actions during that time are likely to be indicative of the initial adjustments that will be required in the face of limited water supplies. Production responses by growers during the recent drought generally included land fallowing, increased groundwater pumping, and increased water transfers. Opportunities for reduced water applications were not

widespread and did not result in significant water savings.[13] In the face of permanent water shortages additional adjustments may also be made by growers. These include shifts in cropping patterns and crop mixes or investments in new water application technology. However, these longer-term adjustments are not likely to provide significant mitigation for the adverse impact of water shortages on irrigated agriculture.

The extended period of drought also focused attention on those regions within the KCWA service area which are most vulnerable to water shortages. Growers in the westside service area, without access to groundwater and with only limited access to affordable alternative water supplies, were most adversely affected by shortages in State Water Project deliveries. The empirical evidence gained during the drought on the localized impacts of water shortages should provide valuable information as the implementation of long-term reductions in project water supplies become a reality. Implementation measures which are developed to minimize the adverse impacts in areas most vulnerable to water shortage will help to minimize the overall costs of meeting the expanded water requirements for protection of environmental resources.

Water shortage, whether temporary or permanent, leads to increased reliance by growers on groundwater resources. During the drought growers overlying the groundwater basin indicated that they completely offset reduced surface water deliveries through increased groundwater pumping. As permanent water shortages are put into place, questions regarding long-term groundwater management may need to be evaluated . The extent to which the new pattern of drawdown and recharge will be sustainable over the long-run must be determined. Increased reliance on groundwater may also to lead to continued water quality degradation and increased land subsidence.

Empirical evidence from the drought has also shown that the availability of affordable water transfers can mitigate the impacts of water shortages. In areas without alternative water supplies, water transfers provide the only opportunity to maintain production on lands that otherwise would be fallowed. Mechanisms to improve water trading opportunities while still protecting third-party impacts and avoiding adverse environmental effects will be an important factor in determining the overall impacts of permanent water shortages.

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[13] / Irrigation efficiencies in Kern County's waster short areas are generally among the highest in the San Joaquin Valley. Therefore, opportunities for significant improvements in water application efficiencies are not available to growers in these areas.

Appendix A: Kern County Crop Acreage Impacted by the 1992 Drought

1992 KERN COUNTY CROP ACREAGE IMPACTED BY THE DROUGHT

	Cotton/ Field Crops	Alfalfa	Grains	Vegetables	Almonds/ Tree Nuts	Pistachios	Tree Fruits	Grapes	Total
SURFACE WATER DISTRICTS									
Belridge Water Storage District									
Total Acres	26,910	2,420	2,390	3,850			5,420	300	41,290
Not Planted	14,000			1,200					15,200
Abandoned									
Reduced Yield/Maintained	4,300	2,420							6,720
Potential Tree/Vine Kill									
Actual Acreage	12,910	2,420	2,390	2,650			5,420	300	26,090
Berrenda Mesa Water District									
Total Acres				1,200	13,623	9,825	427	4,174	29,249
Not Planted									
Abandoned				1,200	3,000			850	5,050
Reduced Yield/Maintained									
Potential Tree/Vine Kill									
Actual Acreage					10,623	9,825	427	3,324	24,199
Lost Hills Water District									
Total Acres	21,379	160	4,552	1,100	2,659	7,585	2,110	2,315	41,860
Not Planted	8,100			1,100					9,200
Abandoned									
Reduced Yield/Maintained	3,700						400	40	440
Potential Tree/Vine Kill									3,700
Actual Acreage	13,279	160	4,552		2,659	7,585	1,710	2,275	32,220
Wheeler Ridge-Maricopa WSD									
Total Acres	40,569	1,606	4,600	16,796	5,865	1,035	9,053	9,883	89,407
Not Planted	13,700	400	4,600	800					19,500
Abandoned								250	250
Reduced Yield/Maintained	8,000								8,000
Potential Tree/Vine Kill									
Actual Acreage	26,869	1,206		15,996	5,865	1,035	9,053	9,633	69,657
All Surface Water Districts									
Total Acres	88,858	4,186	11,542	22,946	22,147	18,445	17,010	16,672	201,806
Not Planted	35,800	400	4,600	3,100					43,900
Abandoned				1,200	3,000		400	1,140	5,740
Reduced Yield/Maintained	16,000	2,420							18,420
Potential Tree/Vine Kill									
Actual Acreage	53,058	3,786	6,942	18,646	19,147	18,445	16,610	15,532	152,166

1992 KERN COUNTY CROP ACREAGE IMPACTED BY THE DROUGHT

	Cotton/ Field Crops	Alfalfa	Grains	Vegetables	Almonds/ Tree Nuts	Pistachios	Tree Fruits	Grapes	Total
GROUNDWATER DISTRICTS									
Buena Vista WSD									
Total Acres	33,630	3,185	1,590				89		38,494
Not Planted									
Abandoned									
Reduced Yield/Maintained									
Potential Tree/Vine Kill									
Actual Acreage	33,630	3,185	1,590				89		38,494
Buttonwillow ID									
Total Acres	32,404	11,780	2,739	1,667	5,967	67	48	227	54,899
Not Planted									
Abandoned									
Reduced Yield/Maintained									
Potential Tree/Vine Kill									
Actual Acreage	32,404	11,780	2,739	1,667	5,967	67	48	227	54,899
Cawelo Water District									
Total Acres	2,926	432	153	746	5,361	3,324	12,165	10,942	36,049
Not Planted	700								700
Abandoned					300				300
Reduced Yield/Maintained									
Potential Tree/Vine Kill									
Actual Acreage	2,226	432	153	746	5,061	3,324	12,165	10,942	35,049
Henry Miller Water District									
Total Acres	15,983		3,007						18,990
Not Planted									
Abandoned									
Reduced Yield/Maintained									
Potential Tree/Vine Kill									
Actual Acreage	15,983		3,007						18,990
I.D. #4									
Total Acres	2,796	1,170	650	410	550	7		8	5,591
Not Planted									
Abandoned									
Reduced Yield/Maintained									
Potential Tree/Vine Kill									
Actual Acreage	2,796	1,170	650	410	550	7		8	5,591

1992 KERN COUNTY CROP ACREAGE IMPACTED BY THE DROUGHT

	Cotton/ Field Crops	Alfalfa	Grains	Vegetables	Almonds/ Tree Nuts	Pistachios	Tree Fruits	Grapes	Total
Kern Delta Water District									
Total Acres	46,368	17,043	11,676	5,245			851	4,795	85,978
Not Planted									
Abandoned									
Reduced Yield/Maintained									
Potential Tree/Vine Kill									
Actual Acreage	46,368	17,043	11,676	5,245			851	4,795	85,978
Pond Poso ID									
Total Acres	32,558	12,437	4,185	2,057	4,526	18	272	1,482	57,535
Not Planted									
Abandoned									
Reduced Yield/Maintained									
Potential Tree/Vine Kill									
Actual Acreage	32,558	12,437	4,185	2,057	4,526	18	272	1,482	57,535
Rosedale-Rio Bravo WSD									
Total Acres	17,313	6,012	1,236	3,417			957		28,935
Not Planted									
Abandoned									
Reduced Yield/Maintained									
Potential Tree/Vine Kill									
Actual Acreage	17,313	6,012	1,236	3,417			957		28,935
SemiTropic WSD									
Total Acres	4,695	606	280		19				5,600
Not Planted									
Abandoned									
Reduced Yield/Maintained									
Potential Tree/Vine Kill									
Actual Acreage	4,695	606	280		19				5,600
West Kern Water District									
Total Acres	172	307							479
Not Planted									
Abandoned									
Reduced Yield/Maintained									
Potential Tree/Vine Kill									
Actual Acreage	172	307							479

1992 KERN COUNTY CROP ACREAGE IMPACTED BY THE DROUGHT

	Cotton/ Field Crops	Alfalfa	Grains	Vegetables	Almonds/ Tree Nuts	Pistachios	Tree Fruits	Grapes	Total
All Groundwater Districts									
Total Acres	188,845	52,972	25,516	13,542	16,423	3,416	14,382	17,454	332,550
Not Planted	700								700
Abandoned					300				300
Reduced Yield/Maintained									
Potential Tree/Vine Kill									
Actual Acreage	188,145	52,972	25,516	13,542	16,123	3,416	14,382	17,454	331,550
TOTAL ALL DISTRICTS									
Total Acres	277,703	57,158	37,058	36,488	38,570	21,861	31,392	34,126	534,356
Not Planted	36,500	400	4,600	3,100					44,600
Abandoned				1,200	3,300		400	1,140	6,040
Reduced Yield/Maintained	16,000	2,420							18,420
Potential Tree/Vine Kill									
Actual Acreage	241,203	56,758	32,458	32,188	35,270	21,861	30,992	32,986	483,716

Source: Survey of Kern County Water Disitricts, 1993.

Not Planted:	Irrigated land that is typically planted but idled in 1992 because of lack of water.
Abandoned:	Acreage of perennial field crops and/or annual crops that were planted and established but abandoned due to lack of water.
Reduced Yield/Maintained:	Acreage receiving partial water but not enough to reach full yield potential.
Potential Tree/Vine Kill:	Acreage of fruits, nuts, and grapes that might die because of inadequate water.

Geotechnical
Environmental
Water Resources
Ecological

GEI Consultants

Memorandum

To: Files (073230) Appendix 9.1-2

From: Rick Iger

Re: Cross Valley Canal to Calloway Canal Intertie
Flood Damage Reduction Benefits

Based on a review of the US Army Corps of Engineers Reservoir Regulation Manual for Isabella Lake, Revised January 1978, flood damages to Tulare Lake bed were analyzed. In addition a summary of historic Kern River flows and Kern River-California Aqueduct flows were reviewed to determine the frequency of flood events that might reach Tulare lake bed. The following documents are provided as Exhibits.

Two excerpts from reports:
US Army Corps of Engineers, Reservoir Regulation Manual for Isabella Lake, Revised January– Exhibit 1;
Kern County Water Agency, 1999 Water Supply Report – Exhibit 2.

GEI Consultants, Inc.
5100 California Avenue, Suite 227, Bakersfield, CA 93309
661.327.7601 fax: 661.327.0173
www.geiconsultants.com

App 9.1-2
Exhibit 1 20

ISABELLA LAKE

Kern River, California

RESERVOIR REGULATION MANUAL

May 1953

Rev. January 1978

DEPARTMENT OF THE ARMY
SACRAMENTO DISTRICT, CORPS OF ENGINEERS
SACRAMENTO, CALIFORNIA

and the only outlet is across the ridge to the north (at elevation 207 feet) into San Joaquin River. Farming of the lakebed has been facilitated by a network of levees designed to confine floodwaters to the smallest practicable area.

f. During "Operation Foresight", in anticipation of the 1969 snowmelt runoff, two spreading basins were built by the Corps of Engineers in cooperation with local interests to prevent excess water from reaching Tulare Lakebed. One was the Sand Ridge Detention Basin on the Kern River Flood Channel, just south of Tulare Lake. The project stored some 63,000 acre-feet of Kern River floodwaters with a flooded area of 15,000 acres. The other Operation Foresight project was along Jerry Slough (about six miles downstream from Bakersfield) where about 800 acres of percolation ponds were constructed. The Jerry Slough project and numerous ancillary features prevented about 37,000 acre-feet of floodwater from reaching Tulare Lakebed during the 1969 snowmelt flood. The storage and percolation capabilities of both these projects remain in place. However, new flowage easements would have to be obtained in order to use these projects again, because the original easements were purchased by local interests for one season only. In addition, the Cross Valley Canal presently blocks the inlet to the Jerry Slough project.

g. Present population of Tulare Basin is about 600,000, with the largest center of population (approximately 200,000) in Metropolitan Bakersfield. The economy of the region is orientated around the agriculture and petroleum industries. A large part of California's field crops, fruits, nuts, livestock, and dairy products are produced here and more than one-fourth of the state's total oil production occurs in this region. The main line of the Atchison, Topeka and Santa Fe Railroad and the valley route of the Southern Pacific Railroad between San Francisco and Los Angeles pass through the basin. Branch lines serve important agricultural and petroleum centers within the area. Shops and yards of both lines are located in Bakersfield. Interstate 5 crosses Kern River about fifteen miles southwest of Bakersfield and U.S.Highway 99 crosses the Kern River at Bakersfield. Numerous state highways and an extensive system of county roads also serve the area.

h. Four hydroelectric plants are located on Kern River. All of these plants were operated on unregulated stream flow prior to the construction of Isabella Dam. One of the plants (Kern Canyon Power House) is owned by the Pacific Gas and Electric Company and the other three are owned by Southern California Edison Company. The power market of the former company serves northern California, while the latter supplies most of its power to the Los Angeles metropolitan area.

5. CLIMATE

a. Normal seasonal precipitation varies from about 6 inches at the edge of the valley floor to a maximum of 45 inches in the main Kern River area. About 90 percent of the runoff-producing precipitation occurs during the winter months of November through April, as demonstrated in the monthly precipitation averages at key stations as follow:

channel from the sedimentation basin to the State Aqueduct and an emergency bypass channel from the sedimentation basin to the Buena Vista Outlet Canal. A general plan is shown on chart 15.

21. RELEASE REQUIREMENTS

a. It has been a practice to maintain a minimum release of approximately 5 c.f.s. for fish enhancement. No official requirement has been established for the action.

b. Releases for purposes other than flood control are initiated on the Watermaster's request. Such requests should be coordinated with downstream interests by the Watermaster.

22. DOWNSTREAM CHANNEL CAPACITIES AND FLOW CHARACTERISTICS

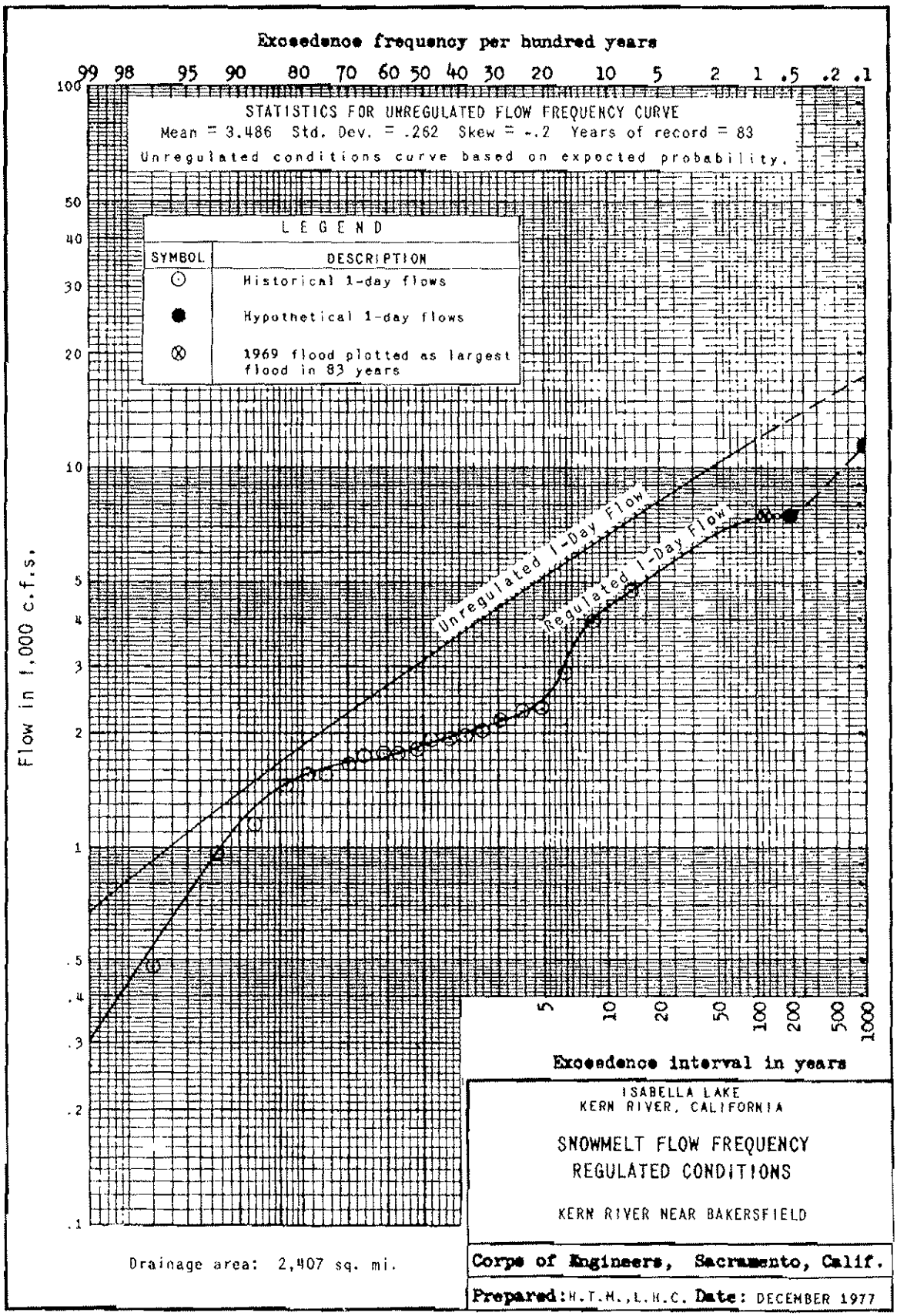
a. The maximum non-damaging capacities of downstream channels of Kern River and its distributaries are estimated as shown on chart A-6. The controlling capacity for reservoir operation purposes is the combined capacity of the river channel and bypass system below Pioneer Turnout, which is 4,600 cubic feet per second. The travel time from Isabella Lake to Pioneer Turnout is a minimum of 18 hours.

b. In the Bakersfield area flows of about 8,000 c.f.s. will cause some damage to industrial areas, however, levees protect the urban areas from flows to approximately 20,000 c.f.s.

23. FLOOD DAMAGES UNDER PROJECT CONDITIONS

a. Since completion of Isabella Lake, the largest rainflood of record (1893-1977) occurred in December 1966 and the largest snowmelt flood of record occurred in 1969. Releases from Isabella Lake during the 1966 flood were nominal and caused no damage downstream. In 1969, measures were taken by both the Federal government and local interests to spread the excess snowmelt flow, but in spite of these measures, it is estimated that 227,000 acre-feet of water from Kern River reached Tulare Lake. However, flows in the Kern River below Isabella Lake were kept at or below channel capacity during the 1969 flood, and the Kern River Intertie is expected to divert all or a portion of future snowmelt flood releases to Tulare Lake.

b. The December 1966 flood was followed by a snowmelt flood in the spring, and throughout the entire flood season it is estimated that Isabella Lake prevented about $50,000,000 in flood damage to the Bakersfield-Oildale area and about $1,300,000 in flood damage to Tulare Lake. Similarly, the 1969 snowmelt flood was preceded by a rainflood. During the entire 1969 flood season Isabella Lake prevented approximately $6,000,000 in flood damage to the Bakersfield-Oildale area and $2,100,000 flood damage in Tulare Lake.



Drainage area: 2,407 sq. mi.

ISABELLA LAKE
KERN RIVER, CALIFORNIA

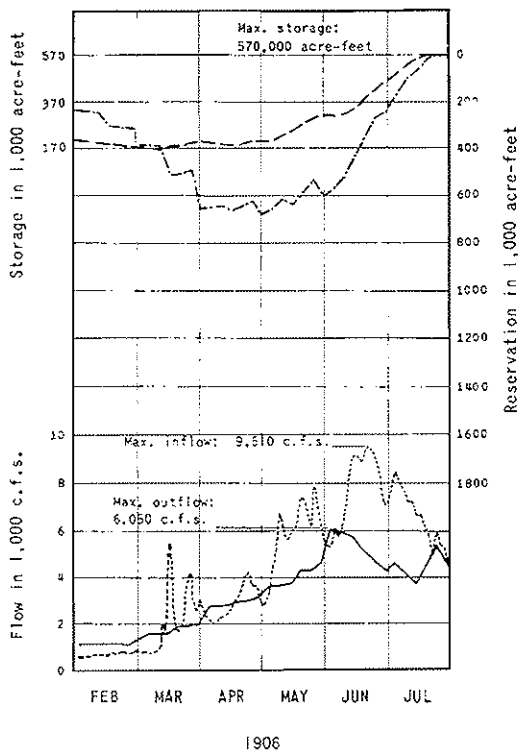
SNOWMELT FLOW FREQUENCY
REGULATED CONDITIONS

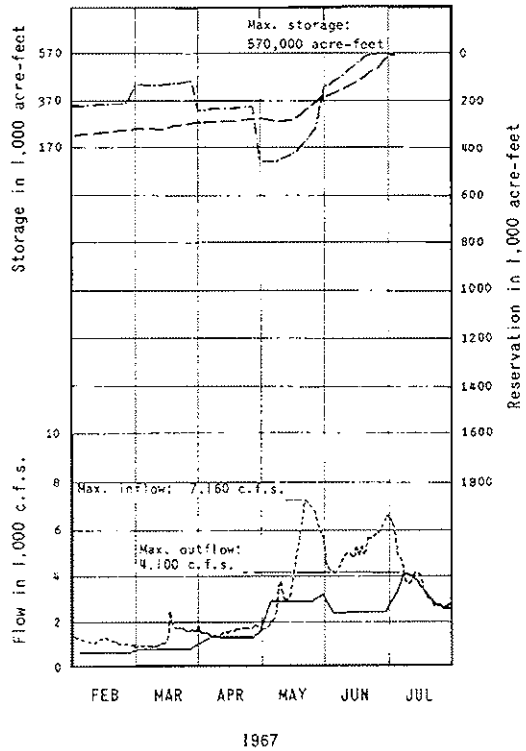
KERN RIVER NEAR BAKERSFIELD

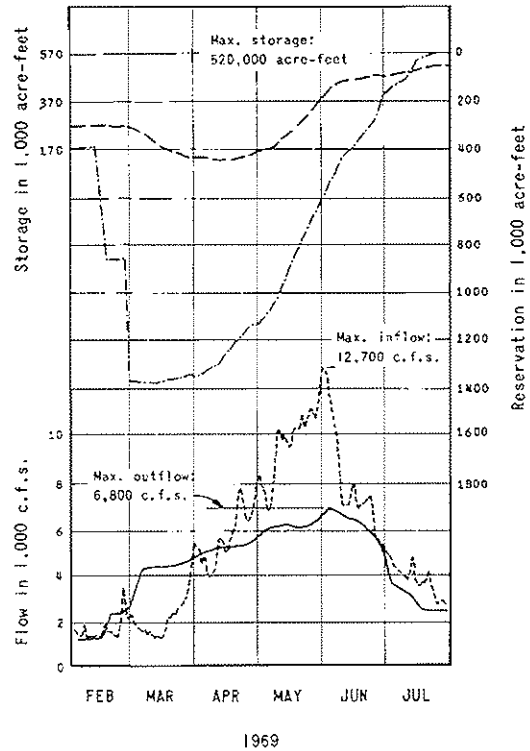
Corps of Engineers, Sacramento, Calif.

Prepared: H.T.M., L.H.C. **Date:** DECEMBER 1977

Chart 11







LEGEND	
SYMBOL	DESCRIPTION
- - - - - -	Inflow
————	Release
— — — —	Storage
—·—·—	Required Reservation

NOTE:

The 1967 and 1969 flood routings were based on forecasts published by the State of California. The forecasts for the 1906 flood routings were estimated from historic precipitation using current techniques.

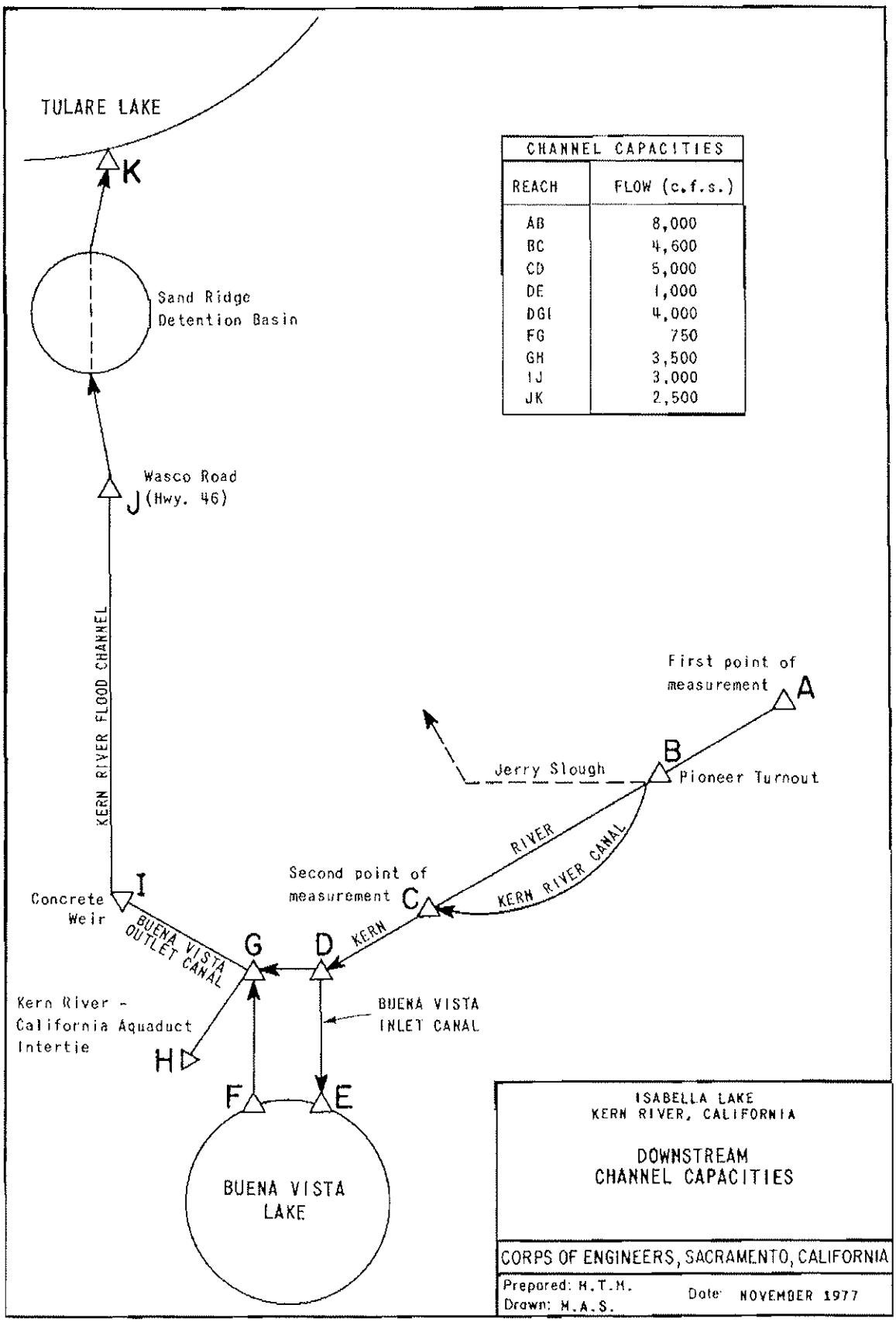
ISABELLA LAKE
KERN RIVER, CALIFORNIA

HYPOTHETICAL ROUTINGS
OF HISTORICAL
SNOWMELT FLOODS

CORPS OF ENGINEERS, SACRAMENTO, CALIFORNIA

Prepared R.T.M.
Drawn L.H.C.
Date NOVEMBER 1977

Chart 13



CHANNEL CAPACITIES	
REACH	FLOW (c.f.s.)
AB	8,000
BC	4,600
CD	5,000
DE	1,000
DGI	4,000
FG	750
GH	3,500
IJ	3,000
JK	2,500

ISABELLA LAKE
KERN RIVER, CALIFORNIA

DOWNSTREAM
CHANNEL CAPACITIES

CORPS OF ENGINEERS, SACRAMENTO, CALIFORNIA

Prepared: H.T.M.
Drawn: M.A.S.
Date: NOVEMBER 1977

GPO 789-127/028

Chart A-6

App 9.1-2
Exhibit 2

KERN COUNTY WATER AGENCY

WATER SUPPLY REPORT 1999

THOMAS N. CLARK
GENERAL MANAGER

MAY 2003

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

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

(1) Regulated flows do not include deliveries above First Point.

(2) Isabella Dam in operation. All subsequent flows are controlled releases.

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

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

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

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

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

* A breakdown between sources was not available.

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

(2) The year 1995 is not included in totals.

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

Table 17 -Annual Cost of Project
(All costs should be in 2009 Dollars)
Project 1: CVC to Calloway Canal Intertie

Year	Initial Costs	Operations and Maintenance Costs [1]				Discounting Calculations	
	(a)	(b)	(c) & (d)	(f)	(g)	(h)	(i)
	Grand Total Cost from Table 7	Admin	Operations & Maintenance	Other	Total Costs	Discount Factor	Discounted Costs
2009					$ -	1.000	$ -
2010					$ -	0.943	$ -
2011					$ -	0.890	$ -
2012					$ -	0.840	$ -
2013	Friant-Kern Canal Flooding	$ 1,296	$ 4,536	$ 3,920	$ 9,752	0.792	$ 7,724
	Kern River Flooding	$ 7,344	$ 89,964	$ -	$ 97,308	0.792	$ 77,068
2014	Friant-Kern	$ 1,296	$ 4,536	$ 3,920	$ 9,752	0.747	$ 7,285
	Kern River	$ 7,344	$ 89,964	$ -	$ 97,308	0.747	$ 72,689
2015	Friant-Kern	$ 1,296	$ 4,536	$ 3,920	$ 9,752	0.705	$ 6,875
	Kern River	$ 7,344	$ 89,964	$ -	$ 97,308	0.705	$ 68,602
2016	Friant-Kern	$ 1,296	$ 4,536	$ 3,920	$ 9,752	0.665	$ 6,485
	Kern River	$ 7,344	$ 89,964	$ -	$ 97,308	0.665	$ 64,710
2017	Friant-Kern	$ 1,296	$ 4,536	$ 3,920	$ 9,752	0.627	$ 6,115
	Kern River	$ 7,344	$ 89,964	$ -	$ 97,308	0.627	$ 61,012
2018	Friant-Kern	$ 1,296	$ 4,536	$ 3,920	$ 9,752	0.592	$ 5,773
	Kern River	$ 7,344	$ 89,964	$ -	$ 97,308	0.592	$ 57,606
2019	Friant-Kern	$ 1,296	$ 4,536	$ 3,920	$ 9,752	0.558	$ 5,442
	Kern River	$ 7,344	$ 89,964	$ -	$ 97,308	0.558	$ 54,298
2020	Friant-Kern	$ 1,296	$ 4,536	$ 3,920	$ 9,752	0.527	$ 5,140
	Kern River	$ 7,344	$ 89,964	$ -	$ 97,308	0.527	$ 51,281

Table 17 -Annual Cost of Project
(All costs should be in 2009 Dollars)
Project 1: CVC to Calloway Canal Intertie

Year	Initial Costs	Operations and Maintenance Costs [1]				Discounting Calculations	
	(a)	(b)	(c) & (d)	(f)	(g)	(h)	(i)
	Grand Total Cost from Table 7	Admin	Operations & Maintenance	Other	Total Costs	Discount Factor	Discounted Costs
2021	Friant-Kern	$ 1,296	$ 4,536	$ 3,920	$ 9,752	0.497	$ 4,847
	Kern River	$ 7,344	$ 89,964	$ -	$ 97,308	0.497	$ 48,362
2022	Friant-Kern	$ 1,296	$ 4,536	$ 3,920	$ 9,752	0.469	$ 4,574
	Kern River	$ 7,344	$ 89,964	$ -	$ 97,308	0.469	$ 45,637
2023	Friant-Kern	$ 1,296	$ 4,536	$ 3,920	$ 9,752	0.442	$ 4,311
	Kern River	$ 7,344	$ 89,964	$ -	$ 97,308	0.442	$ 43,010
2024	Friant-Kern	$ 1,296	$ 4,536	$ 3,920	$ 9,752	0.417	$ 4,067
	Kern River	$ 7,344	$ 89,964	$ -	$ 97,308	0.417	$ 40,577
2025	Friant-Kern	$ 1,296	$ 4,536	$ 3,920	$ 9,752	0.394	$ 3,842
	Kern River	$ 7,344	$ 89,964	$ -	$ 97,308	0.394	$ 38,339
2026	Friant-Kern	$ 1,296	$ 4,536	$ 3,920	$ 9,752	0.371	$ 3,618
	Kern River	$ 7,344	$ 89,964	$ -	$ 97,308	0.371	$ 36,101
2027	Friant-Kern	$ 1,296	$ 4,536	$ 3,920	$ 9,752	0.350	$ 3,413
	Kern River	$ 7,344	$ 89,964	$ -	$ 97,308	0.350	$ 34,058
2028	Friant-Kern	$ 1,296	$ 4,536	$ 3,920	$ 9,752	0.331	$ 3,228
	Kern River	$ 7,344	$ 89,964	$ -	$ 97,308	0.331	$ 32,209
2029	Friant-Kern	$ 1,296	$ 4,536	$ 3,920	$ 9,752	0.312	$ 3,043
	Kern River	$ 7,344	$ 89,964	$ -	$ 97,308	0.312	$ 30,360
2030	Friant-Kern	$ 1,296	$ 4,536	$ 3,920	$ 9,752	0.294	$ 2,867
	Kern River	$ 7,344	$ 89,964	$ -	$ 97,308	0.294	$ 28,609
2031	Friant-Kern	$ 1,296	$ 4,536	$ 3,920	$ 9,752	0.278	$ 2,711
	Kern River	$ 7,344	$ 89,964	$ -	$ 97,308	0.278	$ 27,052
2032	Friant-Kern	$ 1,296	$ 4,536	$ 3,920	$ 9,752	0.262	$ 2,555
	Kern River	$ 7,344	$ 89,964	$ -	$ 97,308	0.262	$ 25,495

Table 17 -Annual Cost of Project
(All costs should be in 2009 Dollars)
Project 1: CVC to Calloway Canal Intertie

Year	Initial Costs	Operations and Maintenance Costs [1]				Discounting Calculations	
	(a)	(b)	(c) & (d)	(f)	(g)	(h)	(i)
	Grand Total Cost from Table 7	Admin	Operations & Maintenance	Other	Total Costs	Discount Factor	Discounted Costs
2033	Friant-Kern	$ 1,296	$ 4,536	$ 3,920	$ 9,752	0.247	$ 2,409
	Kern River	$ 7,344	$ 89,964	$ -	$ 97,308	0.247	$ 24,035
2034	Friant-Kern	$ 1,296	$ 4,536	$ 3,920	$ 9,752	0.233	$ 2,272
	Kern River	$ 7,344	$ 89,964	$ -	$ 97,308	0.233	$ 22,673
2035	Friant-Kern	$ 1,296	$ 4,536	$ 3,920	$ 9,752	0.220	$ 2,146
	Kern River	$ 7,344	$ 89,964	$ -	$ 97,308	0.220	$ 21,408
2036	Friant-Kern	$ 1,296	$ 4,536	$ 3,920	$ 9,752	0.207	$ 2,019
	Kern River	$ 7,344	$ 89,964	$ -	$ 97,308	0.207	$ 20,143
2037	Friant-Kern	$ 1,296	$ 4,536	$ 3,920	$ 9,752	0.196	$ 1,911
	Kern River	$ 7,344	$ 89,964	$ -	$ 97,308	0.196	$ 19,072
2038	Friant-Kern	$ 1,296	$ 4,536	$ 3,920	$ 9,752	0.185	$ 1,804
	Kern River	$ 7,344	$ 89,964	$ -	$ 97,308	0.185	$ 18,002
2039	Friant-Kern	$ 1,296	$ 4,536	$ 3,920	$ 9,752	0.174	$ 1,697
	Kern River	$ 7,344	$ 89,964	$ -	$ 97,308	0.174	$ 16,932
2040	Friant-Kern	$ 1,296	$ 4,536	$ 3,920	$ 9,752	0.164	$ 1,599
	Kern River	$ 7,344	$ 89,964	$ -	$ 97,308	0.164	$ 15,959
2041	Friant-Kern	$ 1,296	$ 4,536	$ 3,920	$ 9,752	0.155	$ 1,512
	Kern River	$ 7,344	$ 89,964	$ -	$ 97,308	0.155	$ 15,083
2042	Friant-Kern	$ 1,296	$ 4,536	$ 3,920	$ 9,752	0.146	$ 1,424
	Kern River	$ 7,344	$ 89,964	$ -	$ 97,308	0.146	$ 14,207
2043	Friant-Kern	$ 1,296	$ 4,536	$ 3,920	$ 9,752	0.138	$ 1,346
	Kern River	$ 7,344	$ 89,964	$ -	$ 97,308	0.138	$ 13,429
2044	Friant-Kern	$ 1,296	$ 4,536	$ 3,920	$ 9,752	0.130	$ 1,268
	Kern River	$ 7,344	$ 89,964	$ -	$ 97,308	0.130	$ 12,650

Table 17 -Annual Cost of Project
(All costs should be in 2009 Dollars)
Project 1: CVC to Calloway Canal Intertie

Year	Initial Costs	Operations and Maintenance Costs [1]				Discounting Calculations	
	(a)	(b)	(c) & (d)	(f)	(g)	(h)	(i)
	Grand Total Cost from Table 7	Admin	Operations & Maintenance	Other	Total Costs	Discount Factor	Discounted Costs
2045	Friant-Kern	$ 1,296	$ 4,536	$ 3,920	$ 9,752	0.123	$ 1,200
	Kern River	$ 7,344	$ 89,964	$ -	$ 97,308	0.123	$ 11,969
2046	Friant-Kern	$ 1,296	$ 4,536	$ 3,920	$ 9,752	0.116	$ 1,131
	Kern River	$ 7,344	$ 89,964	$ -	$ 97,308	0.116	$ 11,288
2047	Friant-Kern	$ 1,296	$ 4,536	$ 3,920	$ 9,752	0.109	$ 1,063
	Kern River	$ 7,344	$ 89,964	$ -	$ 97,308	0.109	$ 10,607
2048	Friant-Kern	$ 1,296	$ 4,536	$ 3,920	$ 9,752	0.103	$ 1,004
	Kern River	$ 7,344	$ 89,964	$ -	$ 97,308	0.103	$ 10,023
2049	Friant-Kern	$ 1,296	$ 4,536	$ 3,920	$ 9,752	0.097	$ 946
	Kern River	$ 7,344	$ 89,964	$ -	$ 97,308	0.097	$ 9,439
2050	Friant-Kern	$ 1,296	$ 4,536	$ 3,920	$ 9,752	0.092	$ 897
	Kern River	$ 7,344	$ 89,964	$ -	$ 97,308	0.092	$ 8,952
2051	Friant-Kern	$ 1,296	$ 4,536	$ 3,920	$ 9,752	0.087	$ 848
	Kern River	$ 7,344	$ 89,964	$ -	$ 97,308	0.087	$ 8,466
2052	Friant-Kern	$ 1,296	$ 4,536	$ 3,920	$ 9,752	0.082	$ 800
	Kern River	$ 7,344	$ 89,964	$ -	$ 97,308	0.082	$ 7,979
2053	Friant-Kern	$ 1,296	$ 4,536	$ 3,920	$ 9,752	0.077	$ 751
	Kern River	$ 7,344	$ 89,964	$ -	$ 97,308	0.077	$ 7,493
2054	Friant-Kern	$ 1,296	$ 4,536	$ 3,920	$ 9,752	0.073	$ 712
	Kern River	$ 7,344	$ 89,964	$ -	$ 97,308	0.073	$ 7,103
2055	Friant-Kern	$ 1,296	$ 4,536	$ 3,920	$ 9,752	0.069	$ 673
	Kern River	$ 7,344	$ 89,964	$ -	$ 97,308	0.069	$ 6,714
2056	Friant-Kern	$ 1,296	$ 4,536	$ 3,920	$ 9,752	0.065	$ 634
	Kern River	$ 7,344	$ 89,964	$ -	$ 97,308	0.065	$ 6,325

Table 17 -Annual Cost of Project
(All costs should be in 2009 Dollars)

Project 1: CVC to Calloway Canal Intertie

Year	Initial Costs	Operations and Maintenance Costs [1]				Discounting Calculations	
	(a)	(b)	(c) & (d)	(f)	(g)	(h)	(i)
	Grand Total Cost from Table 7	**Admin**	**Operations & Maintenance**	**Other**	**Total Costs**	**Discount Factor**	**Discounted Costs**
2057	Friant-Kern	$ 1,296	$ 4,536	$ 3,920	$ 9,752	0.061	$ 595
	Kern River	$ 7,344	$ 89,964	$ -	$ 97,308	0.061	$ 5,936
2058	Friant-Kern	$ 1,296	$ 4,536	$ 3,920	$ 9,752	0.058	$ 566
	Kern River	$ 7,344	$ 89,964	$ -	$ 97,308	0.058	$ 5,644
					Total Present Value of Discounted Costs		$ 1,395,746

Notes:
Category (e) not shown, as there are no Replacement costs associated with this project.
Costs shown in (b), (c), (d) and (f) are based on the cost per acre-foot applied to the estimated flood flow through the project:

Friant-Kern Canal Flooding (Friant-Kern)

Total Flood Water:		1,080	AF/Y
Administration:	$	1.20	/AF
Operations & Maintenance:	$	4.20	/AF
Other (Power):	$	3.63	/AF
Sum of Operation Costs for Friant-Kern Canal Flooding			$ 127,142

Kern River Flooding (Kern River)

Total Flood Water:		6,120	AF/Y
Administration:	$	1.20	/AF
Operations & Maintenance:	$	14.70	/AF
Other (Power):	$	-	/AF
Sum of Operation Costs for Kern River Flooding			$ 1,268,604

Table 19(a) - Present Value of Expected Annual Damage Benefits Project 1: CVC to Calloway Canal Intertie - Friant-Kern Canal Flooding Benefits			
(a)	Expected Annual Damage Without Project [1]		$ 138,000.00
(b)	Expected Annual Damage With Project [1]		$ -
(c)	Expected Annual Damage Benefit		$ 138,000.00
(d)	Present Value Coefficient [2]		15.52
(e)	Present Value of Future Benefits		$ 2,141,760

(1) This program assumes no population growth, thus EAD will be constant over analysis period
(2) 6% discount rate; 50-year analysis period (could vary depending upon life cycle of project).

Table 19(b) - Present Value of Expected Annual Damage Benefits Project 1: CVC to Calloway Canal Intertie - Kern River Flooding Benefits			
(a)	Expected Annual Damage Without Project [1]		$ 840,000.00
(b)	Expected Annual Damage With Project [1]		$ -
(c)	Expected Annual Damage Benefit		$ 840,000.00
(d)	Present Value Coefficient [2]		15.52
(e)	Present Value of Future Benefits		$ 13,036,800

(1) This program assumes no population growth, thus EAD will be constant over analysis period
(2) 6% discount rate; 50-year analysis period (could vary depending upon life cycle of project).

Total Present Value of Expected Annual Damage Benefits	$ 15,178,560