

State of California  
The Resources Agency

DEPARTMENT OF WATER RESOURCES  
Division of Operations and Maintenance

# **STATE WATER PROJECT ANNUAL REPORT OF OPERATIONS 1990**

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State of California

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## Abbreviations And Units

The following names, terms, and units commonly used throughout this report are defined here and when first used in the text.

AF	acre-feet
CVP	Central Valley Project
cfs	cubic feet per second
DOI	Delta Outflow Index
DWR	Department of Water Resources
DO	dissolved oxygen
EC	electrical conductivity
ft	feet
California Aqueduct	Governor Edmund G. Brown California Aqueduct
Banks	Harvey O. Banks Delta Pumping Plant
Kv	kilovolt
KW	kilowatt
KWh	kilowatt-hour
LADWP	Los Angeles Department of Water and Power
MAF	million acre-feet
MW	megawatt
MWh	megawatt-hour
MWDSC	Metropolitan Water District of Southern California
µg/L	micro grams per liter
mg/L	milli grams per liter
mmhos/cm	milli mhos (Siemens) per centimeter
PGE	Pacific Gas and Electric Company
SCE	Southern California Edison
SDWA	South Delta Water Agency
SRI	Sacramento River Index
SWP	State Water Project
SWRCB	State Water Resources Control Board
USBR	United States Bureau of Reclamation
D-1485	Water Rights Decision 1485

## *Introduction*

The 1990 Annual Report of Operations for the SWP is divided into eight parts. The first two parts, "Highlights of 1990 Operation" and "Project Status in 1990," cover conditions and events of statewide significance. The following four sections cover water quality, water conditions, water operations, and energy operations in 1990. The seventh part, "Sacramento-San Joaquin Delta Operations," gives special emphasis to Delta operations, a key aspect of the SWP. The last part, "Project Operations By Field Division," provides further detail on operational conditions and activities for each field division as outlined on Map 1.

The report also includes two appendices, tabulating and depicting Project operations in 1990. Appendix A covers operations of the Aqueduct. Appendix B covers various types of water quality measurement analyses for selected stations throughout the Project.

## *Highlights of 1990 Operation*

The fourth year of drought had a great impact on the people of California. Conservation measures, both mandatory and voluntary, affected many users, while reduced agricultural and hydroelectric production resulted in increased costs. The drought also adversely affected fish, game, waterfowl, and forests. Both the Central Valley Project and the SWP reduced deliveries for the second time in their histories. This is the third drought of this century in Northern California and the second longest.

Snow water content reached its maximum about March 1, a full month earlier than normal. All regions had below average snowpack during the year. Snow conditions were similar to those of 1976 through April. Statewide snow water content on May 1, 1976 was 35 percent of average, whereas the snowpack on May 1, 1990 was 10 percent of average conditions.

Precipitation during the 1989-90 water year started out well and was above average for many stations in October. November through April was unusually dry for most regions of the State. May was wet and resulted in the first increase in runoff forecasts (50% exceedence) since the start of the season. Statewide seasonal precipitation was approximately two-thirds of average. All regions were below average. The driest area, the Central Coast, had only slightly more than half its usual rainfall. The three wettest regions (Colorado River-Desert, the North Coast, and the Sacramento Region) had about three-quarters of average precipitation.

Statewide seasonal runoff was less than half of average (45 percent) and varied from just under half of average runoff in the Sacramento Region to a trickle (9 percent) along the Central Coast. Coastal streams from San Francisco Bay southward had less than a quarter of their usual seasonal runoff. The SRI for the 1989-90 water year was 9.23 MAF. This categorized 1990 as a "critical" water year.

Reservoir storage at year's end was about 60 percent of average. Storage figures were particularly low for the reservoirs of the Central Coast and the North Lahontan regions (less than a fifth of average). South Coast reservoirs, in contrast, were holding near average amounts, but these reservoirs are used mostly to regulate imported water supplies.

DWR and USBR declared balanced Delta water conditions four times during 1990: from January 1 through January 10, from February 1 through February 4, from March 20 through May 27, and from June 8 through December 31. This was the seventh consecutive year in which balanced water conditions were declared. During balanced water conditions, DWR and USBR adjust their reservoir storage releases and Delta exports to enable each agency to meet its share of in-basin uses and Delta outflow. Drought and in basin demands severely limited water available for export all year. In October SWP storage at San Luis dropped below its share of dead storage (41,000 AF). The storage continued downward to about 5,000 AF at the end of the year.

There are 19 plants along the SWP with pumping capabilities. These include two State-federal facilities, one federal facility, and 16 State facilities, which were used to pump water for the SWP, CVP and the city of Los Angeles. Plants used for federal pumping are Banks, Gianelli, and Dos Amigos. A detailed list of all project pumping is shown on Table 1.

Total State and federal water deliveries from the SWP in 1990 are shown in Table 2. Energy resources totaled 10,371,546 MWh, which includes 10,245,337 MWh of SWP energy generation and 126,209 MWh of federal energy generated at Gianelli. Project energy loads totaled 10,245,337 MWh including sales of 1,367,756 MWh, 8,541,306 MWh to pump water to SWP contractors, and 333,651 MWh of losses (see Figure 8).

Total State contractor deliveries in 1990 were 2,910,000 AF including 2,582,274 AF of entitlement water and 327,726 AF of other water and excluding

Joint-Use Facilities and prior water right deliveries. The breakdown of contract deliveries in 1990 is shown below.

Deliveries

<u>Entitlement Water</u>	<u>Other Water</u>
Municipal.....1,371,074	Federal Wheeling..... 74,784
Agricultural.....610,235	Purchased ..... 62,204
Municipal Groundwater .....257,858	General Wheeling ..... 8,705
Bypass .....195,996	Local Supply ..... 10,259
Carryover.....128,546	Recreation ..... 9,262
Transfer .....2,061	Transfer..... 11,492
Benicia ..... 11,243	Vallejo Permit ..... 749
Vallejo .....4,613	Unscheduled ..... 90
Agricultural Groundwater.....525	Groundwater Demonstration..... 150,000
Local.....123	Federal Recreation ..... 182

## *Project Status in 1990*

### *Project Facilities*

The SWP conserves water for distribution to much of California's population and to irrigated agriculture. It also provides flood control, water quality control, electrical power generation, recreational opportunities, and enhancement of sport fisheries and wildlife habitat.

The first SWP facilities to become operational were Frenchman Dam and Lake Davis in the Upper Feather River Division and the South Bay Aqueduct in the San Francisco Bay area in 1962. By 1973, construction of the initial facilities of the SWP had been completed, providing operation of the SWP from Plumas County in the north to Riverside County in the south. Additional facilities to the Project were: Warne Powerplant which began generation on November 17, 1982; Reid Gardner Unit No. 4 (a coal-fired unit owned jointly with Nevada Power Company) which began operation on July 26, 1983; Bottle Rock Powerplant (a geothermal plant) which began generation on February 26, 1985; and Alamo Powerplant which began operation on July 1, 1986. The switchyard for the new Cordelia Pumping Plant on the North Bay Aqueduct was activated for the first time on December 2, 1987. Barker Slough Pumping Plant switchyard was energized on December 4, 1987.

SWP facilities in operation during 1990 included: 28 water storage facilities with a gross capacity of 6,768,792 AF; 7 powerplants with a total output capacity of 1,686 MW, 16 pumping plants housing 112 units that use 2,768 MW; and 537 miles of aqueduct.

During 1990, water was delivered from SWP facilities to 48 agencies including 26 long-term water service contractors and 22 other agencies. In addition, joint-use facilities were used to deliver a total of 1,066,806 AF of federal water to USBR customers.

### *Outages and Limitations*

Major outages, construction, and operating limitations of SWP facilities during 1990 were:

#### *January*

- A leak at Pastoria Siphon was repaired.
- A leak in an exposed pipe joint at Mile 4.86 of the North Bay Aqueduct was repaired.

#### *February*

- The East Branch of the California Aqueduct downstream of Pearblossom Pumping Plant was reopened upon completion of enlargement construction.
- The scheduled shutdown on the North Bay Aqueduct to repair a leak and valve was completed on February 8, 1990.
- Installation of two new discharge lines to the outlet structure of Pearblossom Pumping Plant was completed.

#### *March*

- Drawdown of Pool 6 on the Coastal Branch in the San Joaquin Field Division for repairs of a leak. Repairs were completed by March 9.
- On March 16, the Perris Bypass Pipeline was isolated at the request of Metropolitan Water District of Southern California due to a suspected leak. The pipeline was dewatered while inspections and repairs were made.

#### *April*

- On April 19, drawdown at Mile 56 started in preparation for Pool 10 repair.
- Unit 7 at Edmonston Pumping Plant was scheduled out of service for impeller repair.

#### *May*

- Unit 1 at Warne Powerplant was out for the whole month to install new unions on turbine needle hydraulic supply and return lines.
- Due to water temperature problems, low lake levels, and unit vibration, load restrictions were initiated at Edward Hyatt Powerplant.

#### *June*

- On June 15, concrete placement started at Mile 56 (Pool 10). A waterproof membrane and concrete liner was installed by June 21.

#### *July*

- During the first week in July, Pools 10, 11, and 12 were drawn down in preparation for removal of earthen plugs at Mile 56. Normal operation of the California Aqueduct was resumed on July 10 after repairs were completed.

#### *August*

- Adjustment of Edward Hyatt Powerplant intake shutters continued for temperature control. One shutter remained in each intake. Load restrictions on the penstocks were lowered to 100 MW.
- Civil Maintenance and Engineering staff worked on Pool 6 of the Coastal Aqueduct. They repaired a leak at Mile 12.85 with 7,000 pounds of concrete compound pumped into voids to reduce the leakage.

### *September*

- Adjustments of Edward Hyatt Powerplant intake shutters continued to be made for temperature control. All shutters were removed from intakes 1 and 2 on September 13 and remained out for the rest of the year.
- Unit 2 at Dos Amigos Pumping Plant was out of service through the end of the year for motor shaft machining.

### *October*

- Temperatures at the Edward Hyatt Powerplant intake continued to be 2 to 3 degrees higher than normal. Divers placed air bubbler supply piping near the bottom of the intakes in an attempt to make some colder water rise to where it would be pulled into the intake. Water temperature tests continued throughout the month.

### *November*

- Temperatures at Edward Hyatt Powerplant intake (57 to 58 degrees) continued to be a problem early in the month. The desired maximum water temperature of 55 degrees was reached later in the month. The penstock load restrictions, which began in May, were lifted.
- In the San Joaquin Field Division, de-watering of Pools 5 and 6 of the Coastal Aqueduct enabled liner inspections and repairs. Refilling was completed by the end of the month and the Aqueduct returned to service.
- In the Southern Field Division, excessive leakage at the Pyramid Dam spillway radial gate required an outage from November 16 through November 27.

### *December*

- Seismic recorders detected several earthquakes with magnitudes between 3.5 and 4.5 throughout the State. Freezing temperatures in several parts of the State caused many water lines to rupture, valves to break, and pumps to fail. Inspections did not reveal any damage to SWP facilities.
- In the Delta Field Division, a shutdown of the South Bay Aqueduct was required for completion of the San Antonio turnout and repair of Dyer Altamont trash rack rake.
- Pumping at Edmonston Pumping Plant was suspended due to lack of water supply upstream of the Delta. Drought conditions in the State forced pumping schedules to go on a week-to-week basis.

## *Water Quality Standards*

SWP and Sacramento-San Joaquin Delta water quality conditions are summarized below. Other water quality information appears in Appendix E of Bulletin 132, DWR's monthly SWP Operations Data, and in this report under Sacramento-San Joaquin Delta Operations.

The SWP supplies all or part of the water for a large segment of California's population. Uses include recreation, agriculture, power generation, and municipal/urban use. The quality of the water for beneficial use is safeguarded through an extensive water quality monitoring program. Water quality objectives are set for existing or potential sources of drinking water under the authority of the State Water Resources Control Board and Department of Health Services. Additional water quality objectives are also set by contracts with Project water contractors.

Water quality in the Delta and Suisun Marsh is protected by SWRCB D-1485, which establishes water quality standards according to water year type through standards and operational constraints delimiting flow volume, salinity level, and export quantity. DWR's monitoring of Delta water quality and salinity, as required by SWRCB, directly influences SWP operations regarding the timing and quantity of reservoir releases and export pumping. Monitoring of the phytoplankton and benthic communities is also carried out under D-1485 to identify changes potentially related to SWP operations. Contained within D-1485 is a system of water year classifications based upon DWR's May 1 forecast of unimpaired water runoff to the Sacramento River. Values set for D-1485 standards differ for each year type classification. D-1485 standards for three Delta stations are illustrated on Figure 9. Under the SRI of D-1485, the 1989-90 water year was classified as "critical" both for fish and wildlife needs and for municipal and industrial needs.

DWR monitors water quality through an automated network of recorders, and by laboratory analysis of field samples collected at weekly, quarterly, monthly or annual intervals. Additional special studies may investigate water quality at potential problem sites or following unique events. During 1990, the best SWP water quality was found upstream of the Delta and in the four Southern California SWP lakes.

Water quality in the Delta is influenced by the volume of freshwater flow from the Sacramento and San Joaquin rivers, by water export and, by tidal influence, and by Delta consumptive use. The Delta Outflow Index is discussed in detail under the Sacramento-San

Joaquin Delta Operations section. The D-1485 Delta outflow and export standards ensure Delta water quality, benefit striped bass, enhance salmon migration, and assure Suisun Marsh protection. D-1485 standards limit Delta exports during May, June, and July.

Water quality in the Delta is primarily a balance between freshwater downstream flow and saltwater tidal intrusion. During periods of lower river flow, Delta inflow is augmented by water released from reservoirs of the SWP (Oroville) and the CVP (Shasta, Whiskeytown, and Folsom) to meet all Delta standards by balancing Delta outflow and pumping needs. The dual operational objectives of both the SWP and the CVP systems are to (1) conform to the requirements of water rights permits for the SWP and CVP (2) protect the environment through fully complying with all Delta standards and (3) conserve surplus water not needed for standards compliance. The releases from SWP and CVP reservoirs are coordinated to accomplish these objectives.

Hourly Delta water quality readings, forecasted tidal conditions, and weather are among data evaluated in the daily scheduling of project operations. Occasionally, because of unexpected and sudden changes in local climatological conditions, Delta tides may be higher than those forecasted, and Delta water quality conditions may rapidly deteriorate due to the large tidal influxes. Under such circumstances, the SWP and CVP systems may increase releases from project reservoirs or reduce Delta exports to improve Delta water quality. Reservoir releases require a carriage time of one to four days to reach the Delta.

During 1990 there were three short periods of exceedence of D-1485 water quality standards. These were (1) the agricultural standard at Emmaton, (2) the Suisun Marsh monthly mean high-tide standard for Beldon's Landing, and (3) the mean daily chloride standard at the Contra Costa Canal Intake. Specific information about each incident follows.

The agricultural standard at Emmaton (14-day mean electrical conductivity of not more than 2.78 mS/cm) was exceeded for seven days from May 14 through 20. As a remedy, upstream reservoir releases were increased by 1,300 cfs to 3,500 cfs and the Delta Cross Channel closed. This exceedence is illustrated on Figure 9.

The Suisun Marsh monthly mean high-tide standard for Beldon's Landing on Montezuma Slough (15.5 mS/cm) was exceeded by 0.1 mS/cm in November due

to failure of a gate cable at the Montezuma Slough Salinity Control Structure on October 30 and subsequent gate closure for 2 1/2 weeks for inspection and repair. Following repairs, gate operations expanded from daylight hours only to 24-hour operations to bring salinity levels back to compliance.

The mean daily chloride standard (maximum of 250 mg/L) at the Contra Costa Canal intake was exceeded for 11 days from February 18 through 29 due to rising tides and strong westerly winds earlier in the month. Upstream reservoir releases were increased, the Montezuma Slough Salinity Control Structure gates were operated fully opened, and export pumping was curtailed to counter high salinity levels.

### ***SWP Water Quality Outside the Delta***

DWR monitors water quality at approximately 30 locations throughout the SWP outside the Delta. Approximately 20 of these water quality stations are south of the Delta, and are found at the reservoirs, powerplants, branches, and in the main canal of the California Aqueduct. Other monitoring locations are at State reservoirs north of the Delta (Lake Oroville, Antelope Lake, and Frenchman Lake). Water samples are analyzed to determine levels of total dissolved solids; concentrations of chlorides, sulfates, sodium, and boron; and measures a few other parameters. These data are compared with monthly average water quality objectives in the water supply contracts (Article 19).

Except for infrequent local storm inflow, Delta exports are the sole source of water for SWP facilities and reservoirs south of the Delta. Most Delta water is exported south during the winter months when the greatest freshwater outflow occurs. Thus, reservoirs south of the Delta are usually supplied with the highest quality water. San Luis Reservoir, the only SWP conservation storage facility between the Delta and Southern California, is usually filled by May 1.

The contract objectives for average monthly hardness, totals of dissolved solids, sulfates, and boron were all met and the measured quality was well below objective limits. The SWP water supply contracts' Article 19 objective for the percentage of sodium to salt content was exceeded at points south of the Delta. The chloride objective was exceeded on several occasions in nearly all waters between the Delta and Pearblossom Pumping Plant, reflecting generally lower Delta outflow during drought conditions of 1990.

DWR also monitors water south of the Delta for levels of asbestos. Asbestos is found in natural geological formations next to the aqueduct. No asbestos beyond background levels was detected in 1990.

Information about water quality at nine important locations throughout the project, including the annual average water quality objectives, may be found in Appendix B of this report.

## *Water Supply Conditions*

The SWP monitors precipitation and calculates runoff to coordinate the operation of its complex system of dams and reservoirs. Information on those activities is based on the water supply conditions of the 1990 calendar year and the 1989-90 water year.

In a typical year, California receives about 193 MAF of water as rain or snow. Of the 193 MAF, about 75 percent falls in Northern California (although about 75 percent of water demand originates in highly populated Southern California).

Most of the water either soaks into the ground, is consumed by plants, or evaporates. However, some water flows off into streams or rivers and eventually flows into the Sacramento-San Joaquin Delta, the primary source of the SWP water supply.

Total runoff in the Sacramento River Basin in Northern California has ranged from as little as 5.1 MAF in 1977 to more than 38 MAF in 1983 (the 50-year average is about 18 MAF). This runoff constitutes the primary SWP water supply.

When planning and coordinating SWP operations, and meeting its contractual obligations, DWR carefully monitors and calculates that variable water supply in terms of precipitation and runoff and uses that information to determine the amount of water that can be delivered during the year. Those monitoring activities are conducted and recorded according to the water year. The data recorded throughout the water year is used by DWR to determine the amount of runoff that should be retained in storage should the coming year be "dry."

The total amount of precipitation recorded statewide for the 1989-90 water year was 70 percent of the average annual rainfall. The highest amount was recorded in the Colorado River Area, 75 percent, and the lowest in the Central and South Coast areas, 55 percent. The amount of precipitation recorded in the Sacramento Basin, which includes the Feather River drainage area was well below average. Even though twice the average amount of precipitation was recorded in October 1989, overall dry conditions continued, and December 1989 was listed as the driest December on record. Precipitation in May was three times average, however, the 1989-90 water year ended with the level of precipitation at only 75 percent of average in the Sacramento Basin.

During the water year, DWR calculates the amount of unimpaired runoff to streams in all hydrologic areas in California and forecasts the likely runoff for the snow melt season and the water year. Those amounts are reported in *Water Conditions in California (Bulletin 120)*, published by DWR in February, March, April, and May of each year. All forecasts of unimpaired runoff are considered by the SWP when planning operations. The operations of both the CVP and the SWP are regulated by D-1485 standards according to the water year classification of these forecasts. The May 1 forecast of the amount of unimpaired runoff to streams in the Sacramento River Basin is particularly significant since it establishes the year classification until the following winter.

The amount of unimpaired runoff to streams flowing into the Sacramento River for the 1989-90 water year was forecast to be 8.2 MAF or 43 percent of average. Although the actual amount of unimpaired runoff recorded for the 1989-90 water year was 9.2 MAF or 49 percent of average, that amount was not enough to warrant a change in the "critical" classification. CVP and SWP operations in the Sacramento-San Joaquin Delta were directly affected by the "critical" classification.

# Water Operations

## Reservoir Operations

Lake Oroville and San Luis Reservoir are the two conservation facilities for SWP water supplies. Table 8 and Table 13 summarize the operations of these reservoirs during the 1989 and 1990 calendar years.

Lake Oroville began 1990 with 195,735 AF more than it held at the beginning of 1989. Storage for January, February, and early March continued to be more than that of the same periods in 1989. However, lack of precipitation and runoff in late March and April brought 1990 storage well below 1989 levels. Storage in Lake Oroville peaked at 2,101,925 AF (59 percent of normal maximum operating capacity) on March 26 and dropped to 987,094 AF (28 percent of normal maximum operating capacity) by December 31. The net effect of operations and water conditions at Lake Oroville resulted in a storage change of -901,705 AF.

At the start of 1990, San Luis Reservoir held 42 percent of its normal maximum operating capacity, although the SWP share was only 23 percent of its maximum. By the end of 1990, SWP storage was only 5,555 AF (less than 1 percent of maximum State storage); federal storage was 473,923 AF for a total of 479,478 AF. The net effect of operations and water conditions at San Luis Reservoir resulted in a storage change of -748,746 AF.

At the beginning of 1990, Lake Del Valle held 28,486 AF of water (71 percent of normal maximum operating capacity). Pumping at Del Valle during the first six months of 1990 allowed storage at the lake to increase to 39,176 AF (98 percent of normal maximum operating capacity) by June 10. By December 31, storage in Lake Del Valle had dropped to 29,527 AF (74 percent of normal maximum operating capacity).

SWP southern reservoirs (Silverwood, Perris, Pyramid, Elderberry, and Castaic) held 78 percent of their combined normal maximum operating capacity at the beginning of the year and held 76 percent of their combined normal maximum operating capacity by December 31, 1990. The net effect of operations and water conditions at the SWP southern reservoirs resulted in a storage change of -14,793 AF.

## Aqueduct Operations and Water Deliveries

SWP deliveries for 1990 totaled 2,910,000 AF. A graph showing the highest and lowest annual totals is shown on Figure 3. Amounts are shown by field division on Map 2 and include entitlement water, permit water, local supply, recreation, purchases, wheeling, and water transfers. Totals by agency are shown in Table 2. Joint-Use Facilities deliveries to federal customers were the lowest in the last five years at 991,840 AF. Joint-Use Facilities include 102 miles

of aqueduct between O'Neill Forebay and Kettleman City.

The Risk Analysis for 1990 indicated that full requested municipal and industrial deliveries and 72 percent of the requested agricultural deliveries could be met with about 90 percent reliability.

Significant operational activities during 1990 were as follows:

### January

- Reduced pumping at the Edmonston Pumping Plant accommodated an East Branch outage. During this outage, the plant operated up to 10 units off-peak and occasionally 1 or 2 units on peak. All the water was delivered to the West Branch of the California Aqueduct. This operation continued until the completion of the East Branch outage.
- The California State Police reported 26 automobiles found in the East Branch of the California Aqueduct after the canal had been dewatered for inspection and maintenance. All of the vehicles were removed from the aqueduct.

### February

- Approval of 28 percent of the agricultural entitlement requests was deferred until the water supply outlook improved.

### March

- Approved deliveries for agriculture were cut from 72% to 50% on March 16.
- The completion of all repair work and the return of the East Branch to normal operation allowed pumping at the Edmonston pumping plant to operate at a much higher rate, 12 units off-peak and 5 units on-peak.
- Releases from the Oroville-Thermalito complex to the Feather River were increased in several steps beginning on March 20 to 5,000 cfs on March 27 for Delta water quality requirements. Releases had been at 1,700 cfs throughout February and most of March.

### April

- Releases from the Oroville-Thermalito complex to the Feather River were increased, again in several steps, bringing the total release to 7,500 cfs on April 6. Releases were reduced to approximately 850 cfs during the last week of April because of the aqueduct outage.
- SWP 1990 water deliveries through April were about 1.03 MAF. This is about 90,000 AF more than was delivered during the same period in 1989.

### *May*

- As defined in the SWRCB Water Right D-1485, the 1989-90 water year was officially classified as "critical." The median forecast on May 1 for the SRI was 8.2 MAF (43 percent of average), which is well below the upper limit specified in D-1485 for a "critical" water year classification for all standards.

### *June*

- Releases from the Oroville-Thermalito complex to the Feather River varied in response to needs for protecting Delta water quality and meeting planned exports. For most of June, releases were 900 cfs. From June 29 through July 3, the release was 1,400 cfs to counteract high salinity in the Delta.

### *July*

- Leakage repair at Mile 56 (Pool 10) on the California Aqueduct was completed and normal operations were resumed on July 10. The completion of repairs to Pool 10 allowed exports to increase to about 4,100 cfs. Exports were held to 300 cfs during the outage.

### *August*

- The low water level at Oroville caused closure of all boat launching ramps. The civil maintenance crew at Oroville cleared and graded a parking lot and an old construction road in the spillway area so the Department of Parks and Recreation could provide boat launching access to the lake for the general public. At the beginning of the month, the Oroville complex river release was at 2,500 cfs. During the first week of the month, it was increased to 6,000 cfs because of high tides in the Delta and the reduction in release at Folsom. During the last two weeks of the month, the Feather River releases were reduced in increments due to reduced agricultural diversions from the Sacramento River and the increased release from Folsom. On August 28, the Feather River release was 1,000 cfs.

### *September*

- An agreement for Oroville-Wyandotte Irrigation District to transfer up to 15,000 AF of water to Westlands Water District by using SWP wheeling, began on September 20. (As of June 30, 1991, 7,000 AF had been delivered to Westlands.)
- Bottle Rock powerplant unit was shut down on September 16 for annual preventive maintenance.

### *October*

- Because water supply temperatures to the fish hatchery were 2 to 3 degrees higher than desired, tests were conducted on an air bubbler system in an effort to draw cooler water into the Hyatt intake structure. The tests proved the system to be of no effect and were discontinued. Hyatt was limited to a maximum of 40 MW per penstock for temperature control.
- Preventive maintenance work on the Bottle Rock Powerplant unit continued. The outage was extended to November 2. It was uncertain at this time if the plant will again be placed in service. Preliminary negotiations were held for the sale of the facility to Northern California Power Agency.
- SWP deliveries through October 15 were about 3.43 MAF. This is about 515,000 AF less than was delivered during the same period in 1989. Approved deliveries are less than those of 1989 because of the continued drought. Only 50 percent of the requested amounts of agricultural water were approved.

### *November*

- The SWP started wheeling water for the Placer County-San Francisco transfer. Transfer water was released through Folsom Reservoir at the rate of 300 cfs; 70 percent of that release was pumped at Banks Pumping Plant. The remaining 30% flowed to the ocean as carriage water to prevent deterioration of Delta water quality as a result of the transfer. Delivery of the transfer water was made through the San Antonio Turnout on the South Bay Aqueduct.

### *December*

- Due to lower water temperatures, the 40 MW per penstock restriction at the Edward Hyatt Powerplant was lifted. Releases were increased in 500 cfs stages at twelve-hour intervals to bring the increase to 5,000 cfs. With the arrival of the increased release in the Delta, pumping over the Tehachapis was increased to 11 units off-peak and 8 units on peak at Edmonston Pumping Plant. This established a new high for the number of units on-peak pumping at Edmonston Pumping Plant.
- SWP water contractors received preliminary notices that initial approvals for 1991 delivery would be well below requests.

## *Energy Operations*

### *Energy Sources and Loads*

Energy generation from the SWP's seven hydroelectric plants (Edward Hyatt, Thermalito, Warne, Gianelli, William E. Warne, Castaic, Alamo, and Devil Canyon) during 1990, totaled 3,884,104 MWh, as illustrated in Figure 4.

Edward Hyatt and Thermalito Powerplants supplied 1,515,173 MWh in 1990, which is 21 percent below the amount generated in 1989. Generation at Edward Hyatt and Thermalito Powerplants is shown in Figure 5.

The combined energy generation at the SWP energy recovery plants (Gianelli, Warne, Castaic, Alamo, and Devil Canyon) totaled 2,368,931 MWh in 1990. This is a 27 percent increase over the amount generated in 1989.

Bottle Rock Powerplant supplied the SWP with a total of 57,531 MWh in 1990. This was a 49 percent decrease from the amount supplied in 1989. Reid Gardner Unit No. 4 supplied the SWP with 1,452,583 MWh of energy in 1990, a 15 percent decrease over the amount supplied in 1989. Energy supplied by Reid Gardner varies based on need and prevailing market rates. Lack of water for delivery caused Pine Flat Powerplant to furnish 80,062 MWh to the SWP in 1990, 28 percent below the power furnished in 1989. All SWP energy sources in 1990 are illustrated in Figure 4.

The SWP receives energy under contract from five small hydroelectric facilities (total capacity of 30 MW) owned and operated by MWDSC. In 1990, these plants furnished 205,272 MWh of energy to the SWP. DWR has exchange arrangements with Southern California Edison and the Los Angeles Department of Water and Power to provide transmission of this energy.

The DWR-SCE Power Contract has been in effect since April 1983. Under that contract, part of the Edward Hyatt and Thermalito Powerplants' generation and all the output of Devil Canyon Powerplant and Alamo Powerplant are delivered to SCE. The energy is generally delivered during on-peak periods, and a greater amount of energy is returned to DWR during off-peak periods. The difference between these two amounts (listed in Figure 6) is called "return additional." The SCE combined "return additional" to the SWP during 1990 was 2,187,076 MWh.

Long-term contracted energy purchases such as TERA Corp. and MWD Hydro are itemized separately in Table 3. Other purchases totaled 2,227,098 MWh

from various utilities such as Portland General Electric and Idaho Power Co. Energy Loads

SWP energy loads during 1990 totaled 10,245,337 MWh, approximately 10 percent more than the corresponding amount for 1989. This includes 8,541,306 MWh of SWP loads as shown by field division in Figure 7. Also included are losses, sales, and deviation adjustments as shown in Table 4. Repayment of transmission losses, through the major transmission networks to the SWP plants, is included as part of the annual SWP energy use at the SWP plants in Figure 8. Increased water deliveries to MWDSC, a large pump-back operation at the Hyatt-Thermalito facilities, and increased pumping at Gianelli Pumping-Generating Plant were the major reasons for higher SWP energy use in 1990. Energy losses on the major transmission line networks in California for the SWP pumping plants and powerplants were 333,651 MWh in 1990.

During 1990, SWP energy supplies (including substantial purchases under contractual obligations) exceeded SWP needs, and DWR sold the excess energy under power sale contracts to 15 utilities at current market rates. The total sale of energy during 1990 was 1,367,756 MWh. DWR considers projected SWP operations and changes in the power market as well as energy losses, transmission costs, and dispatching costs, in finding the most advantageous time to sell the power. Project energy loads in 1990 are illustrated in Figure 7.

Also in Figure 8 is a summary of DWR's power sales in 1990. Total energy sold to 15 utilities was just over 1.37 million MWh, for a revenue of \$29.11 million. DWR also received a total of \$12.86 million in revenues for peaking-capacity payments from Nevada Power Co., peaking-capacity-foregone payments from LADWP, interruptible transmission payments from SCE and the city of Vernon, and capacity payments from Northern California Power Agency, Turlock Irrigation District and the cities of Azusa, Anaheim, Riverside, Banning, Colton, and Vernon.

## *Sacramento - San Joaquin Delta Operations*

The Delta is an estuary subject to large daily tidal flows and water level fluctuations. Delta flows reverse direction twice daily from downstream to upstream in response to the immense tidal forces of the Pacific Ocean. SWP and CVP pumping plants are located in the south Delta, an area within these tidal influences. Banks Pumping Plant pumps water from Clifton Court Forebay, a 31,260 AF capacity reservoir, into the California Aqueduct.

All reservoir flood control operations affect the Delta in many ways. At Oroville, for example, operations conserve seasonal flows to the Delta by retaining portions of Feather River flows during spring runoff. Stored flows are later released to satisfy SWP export, meet Delta consumptive needs, and enhance Delta water quality. Flood control operations at Oroville occur during the flood season (October-April), thereby affecting the timing of floodwaters entering the Delta.

The Clifton Court control gates normally divert water daily from Old River into the forebay on a priority basis as specified in the 1986 South Delta Water Agency (SDWA) agreement. The SDWA agreement addressed the impact of SWP operations on south Delta water supply, water levels, and circulation. Most Clifton Court inflow occurs during the priority one condition, which is from one hour after low-high tide to one hour before low-low tide to maintain south Delta water levels sufficient for local agricultural pumping. Table 12 summarizes Clifton Court operations in 1990. A daily summary of operations (showing actual gate opening and closing times) is published in the monthly SWP Operations Data Report.

Delta flow patterns are altered by the operations of the SWP and CVP pumping plants. The magnitude and

timing of pumping impact is conditioned in part by specific D-1485 operational constraints that change with water-year type. When in operation, the SWP and CVP export pumps will not influence flows north of the San Joaquin River. Flows in the vicinity of Franks Tract and south toward the pumps may be affected by export pumping. A portion of the Sacramento River flows are diverted through the CVP's Delta Cross Channel gates and Georgiana Slough southward through the interior Delta. Sacramento River flows not diverted through the interior Delta continue westward to converge with the San Joaquin River west of Sherman Island. During operation of the export pumps, the inner north Delta channel network of sloughs and rivers often cannot carry the water volume for export and Delta consumptive use. When these conditions prevail, the net seaward flow of the San Joaquin River East of Chipps Island can reverse and be pulled southward with the Sacramento River water toward the export pumps. This is known as reverse flow. Under these conditions, export water supplies become more brackish as western Delta water under greater tidal influence is drawn southward toward the export pumps. To protect Delta water supplies during periods of reverse flow, additional water called "carriage water" is released from upstream storage to repel seawater intrusion from the Pacific Ocean. See Table 5 for a summary of Delta inflow, uses, and exports.

### *Delta Outflow Index*

Direct measurement of net Delta outflow is impractical because of huge tidal fluxes. However, since net outflow is one of the primary factors in controlling Delta water quality, a calculated value known as the Delta Outflow Index represents the approximate amount of outflow from the Delta to San Pablo Bay. The bypass flows (Yolo, Sutter, and Sacramento) and

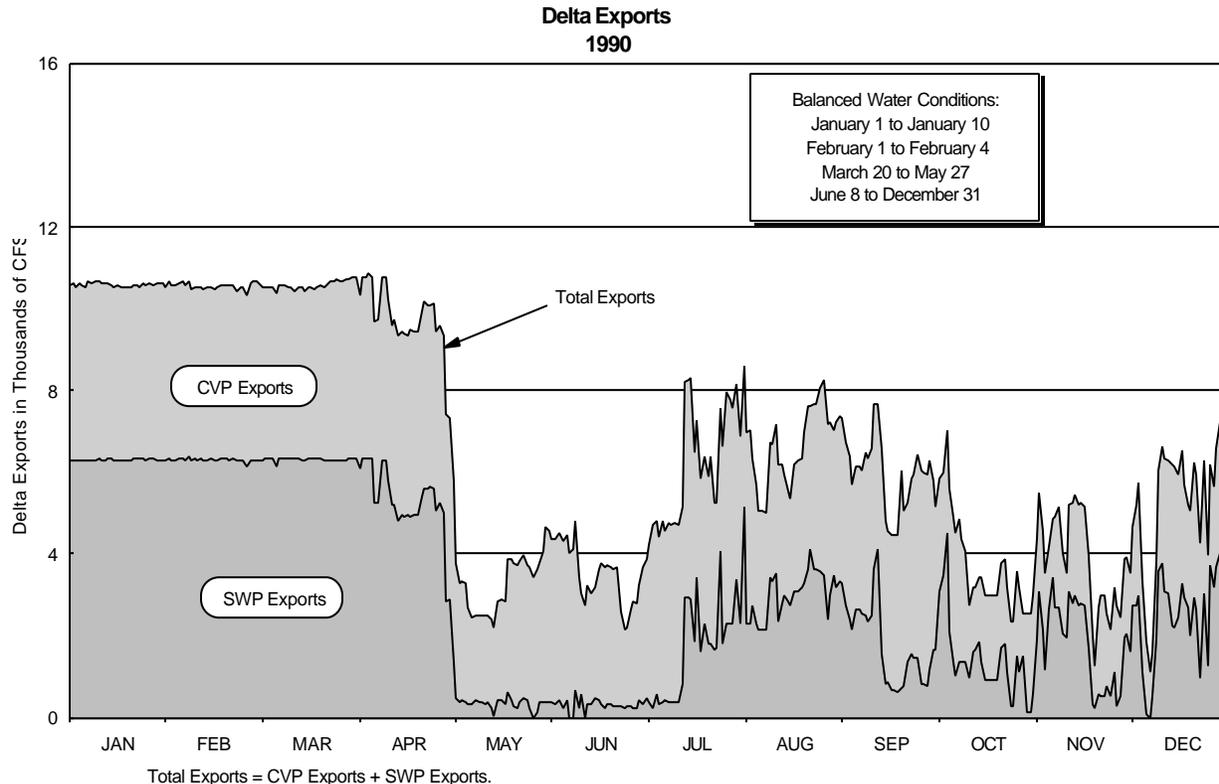
several surface inflows, notably the Cosumnes, Mokelumne, and Calaveras rivers, are not included in the calculation. The Delta consumptive use, an estimated value, is included in the computed DOI.

Furthermore, the Delta consumptive use variable used in the calculation is based on daily increments of long-term averages, whereas daily inflow estimates are based on either the daily mean of hourly measurements or on an instantaneous flow measurement that represents the entire day. The DOI is calculated daily from the sum of Sacramento River inflow, San Joaquin River inflow, and Sacramento Treatment Plant discharge minus the Delta consumptive use estimates and the water exported by the SWP, CVP, and Contra Costa Canal.

The 1990 daily DOI averaged only 5,356 cfs for the year, about 60 percent of the 1989 average. The greatest mean monthly DOI occurred during January at 10,752 cfs. Maximum daily DOI occurred on January 17 at 29,562 cfs. Minimum daily DOI occurred on September 24 and was only 550 cfs. With the exception of one day in February, the two brief storm periods of January and late May and early June were the only flow periods containing daily means over 10,000 cfs for a total of 21 days. These periods of maximum and minimum DOI are illustrated in Figure 13.

All daily DOI values are summarized in Table 6. D-1485 establishes minimum DOI and river flow standards. All DOI and river flow standards were met in 1990.

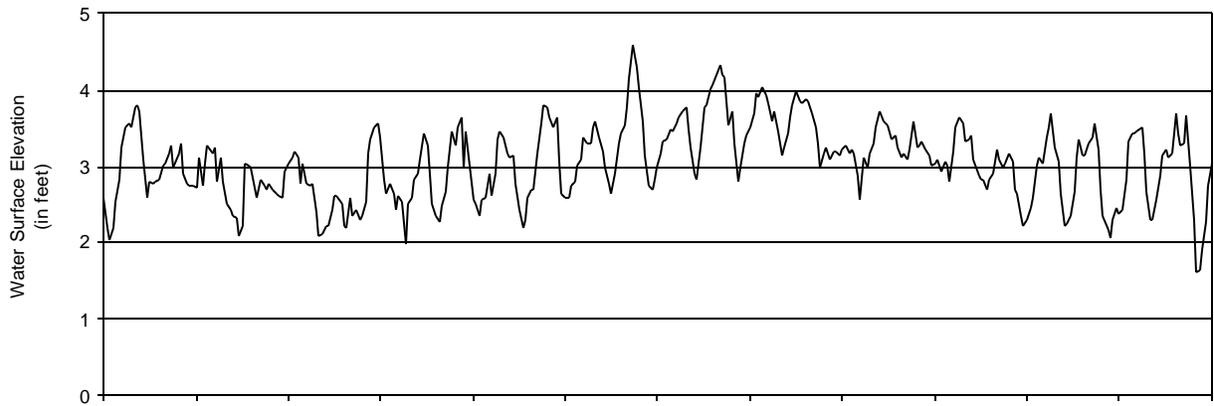
**Figure 12. Coordinated Delta Operations**



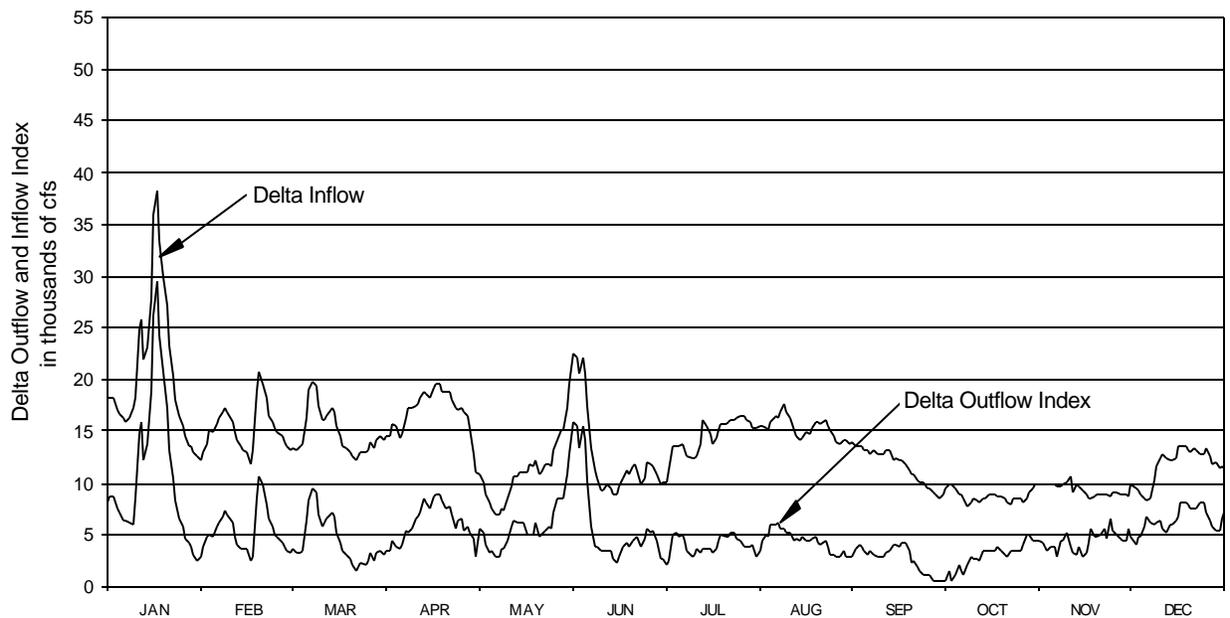
SWP operations either augmented the DOI primarily through reservoir releases or reduced it by retention of upstream inflow at Lake Oroville and exports at Banks. Mean monthly augmentation of the DOI occurred during May, July, August, and December and was largest in May (1,235 cfs) as exports dropped to very low levels or ceased at Banks due to SWP downstream repairs. The greatest daily augmentation also

occurred during May (4,094 on May 13). The largest DOI reductions occurred during January, February, and March as export pumping at Banks was maximized in anticipation of later aqueduct shutdowns. The highest monthly mean flow reduction occurred during March (-8,770 cfs); the largest daily DOI reduction occurred on January 16 (-15,345 cfs). The yearly balance showed a reduction of -1,905 cfs.

**Figure 13.**  
**Antioch High-High Tide**  
**1990**



**Delta Inflow and Outflow Index**  
**1990**



# *Project Operations by Field Division*

## *Oroville Field Division*

### *Water Storage*

SWP water storage facilities north of the Delta include Lake Oroville, Thermalito Forebay and Afterbay (Oroville-Thermalito complex), and upper Feather River reservoirs (Lake Davis, Frenchman Lake, and Antelope Lake). Lake Oroville operations store winter and spring runoff for later SWP uses, including power generation, flood control, recreation, and fish and wildlife enhancement along with water supply.

The upper Feather River reservoirs have a combined capacity of 162,000 AF. None of these reservoirs spilled in 1990. Monthly operations for the three upper Feather River reservoirs are presented in Table 7. The table below compares storage capacity with the largest end-of-month storage for each reservoir for the last five years:

	Antelope	Frenchman (all values in AF)	Davis
Capacity	22,566	55,477	84,371
1990	(May) 20,007	(Apr.) 28,207	(Apr.) 55,713
1989	(May) 23,125	(Apr.) 37,031	(Apr.) 61,015
1988	(Apr.) 16,344	(Apr.) 32,002	(Jan.) 55,043
1987	(May) 19,285	(Apr.) 41,909	(Apr.) 69,815
1986	(Mar.) 23,886	(Mar.) 57,344	(Mar.) 84,250

Lake Oroville's computed inflow is tabulated in Table 8 and plotted along with releases and diversions on Figure 14 which clearly shows which months required withdrawals from storage. A ten-year historical summary of Lake Oroville's storage and inflow is illustrated on Figure 15.

During 1990, inflow into Lake Oroville was insufficient to cause the actual storage to approach the lake's "Required Flood Control Reservation" space (see Figure 16). The lake was not operated for flood control, and no water was released from the Oroville Dam spillway.

Water temperature on and below the lake's surface is monitored very closely throughout the year at various locations around the lake. The two intake structures to the plant have shutters that control the depth from which water enters the plant. The temperature of water entering the fish hatchery can then be controlled by adding or removing shutters as necessary. A complete illustration of water temperature and intake structure operation is shown on Figure 17.

High water temperatures were a problem in 1990, especially during the last four months of the year. Solutions and results relating to this problem are discussed earlier in this report in the "Project Status" section.

### *Water Deliveries*

Project water stored in the Upper Feather River Area lakes (Antelope, Frenchman, and Davis) flows into Lake Oroville through the North and Middle Forks of the Feather River. Contract deliveries were made from Frenchman and Davis totaling 7,594 AF to Last Chance Creek Water District and Plumas County FC&WCD. Non-project deliveries (prior water rights), totaling 1,642 AF, were made out of Lake Davis only.

Water stored in Lake Oroville is released into the Thermalito Diversion Dam Pool, from which specified quantities are released into both the Feather River and the Thermalito Power Canal. The Power Canal supplies water first to Thermalito Forebay and then to Thermalito Afterbay. From Thermalito Afterbay, additional water is released to the Feather River and several local distribution systems used to deliver water to holders of prior water rights. Prior water right holders are Plumas Mutual Water Company, Garden Highway Mutual Water Company, Tudor Mutual Water Company, Inc., Oswald Water District, Joint Water Districts Board, and Western Canal Water District. Deliveries are collectively called the Feather River Service Area diversions and flow through the Sutter-Butte, P.G. and E., Western, Richvale, Sunset Pumps, and Palermo Canal outlets. FRSA diversions are not considered SWP benefits as they predate the SWP construction and would have occurred without the SWP to the limit of available natural river flows. Nearly all FRSA diversions are for agricultural uses, and totaled 858,901 AF in 1990 as shown below:

Sutter Butte	509,370
P.G. and E.	3,668
Richvale	90,619
Sunset Pumps	1,750
Western Canal	245,840
Palermo Canal	7,654
<b>TOTAL IN AF</b>	<b>858,901</b>

A comparison of 1990 and 1989 Diversion Dam, Forebay, and Afterbay water surface elevations and storages is presented on Tables 9 and 10.

## Delta Field Division

### Water Storage

The Delta Field Division consists of the North Bay, South Bay, and California Aqueducts from Clifton Court Forebay to Check 8. Along these waterways, storage change data are maintained for Clifton Court Forebay, Bethany Reservoir, Travis and Napa Terminal Tanks, California Aqueduct, and Lake Del Valle. South Bay Aqueduct storage changes are assumed to be zero for operational purposes.

Lake Del Valle, as an off-stream storage facility, received inflows from the South Bay Aqueduct totaling 11,582 AF. Release to the Aqueduct from Del Valle totaled 7,712 AF and is detailed in Table 11 below. Inflow and storage changes for the last ten years at Lake Del Valle are shown on Figure 18.

Project water flows from the Delta into Clifton Court Forebay through the Clifton Court control gates. Total inflow through the gates was 2,457,147 AF. Monthly inflows to Clifton Court Forebay along with corresponding storage changes are shown in Table 12.

### Water Deliveries

The Delta Field Division delivered only 5 percent of all Project deliveries; 223,562 AF for 1990. Approximately 183,000 AF of that went to Entitlement. Under Vallejo's water right claim, 748 AF of non-SWP water was conveyed to the city of Vallejo's delivery structure. Napa County Flood Control and Water Conservation District took 6,373 AF of non-SWP Yuba County Water Agency (YCWA) water wheeled

through the aqueduct. DWR purchased 28,962 AF of YCWA water and delivered it to Santa Clara Valley Water District. These and other deliveries are summarized in Table 2.

### Pumping Plants

Delta Field Division plants pumped 2.68 MAF. These plants include Barker Slough and Cordelia Pumping Plants on the North Bay Aqueduct, Banks on the California Aqueduct, and South Bay and Del Valle Pumping Plants on the South Bay Aqueduct. Monthly pumping data is summarized for the year in Table 1.

The 1990 SWP export of Delta water through Banks totaled 2.4 MAF, only 62 percent of requested deliveries (compared to typically around 90 percent) due to downstream aqueduct repairs and agricultural delivery reductions. After April 30 through mid-July, all Banks pumping was limited to meeting only South Bay Aqueduct needs; all deliveries south of the Delta were made from San Luis Reservoir. There was 205,208 AF of federal pumping at Banks in 1990. Below is a five-year summary of federal, State, and total pumping at Banks in AF:

PUMPING AT HARVEY O. BANKS DELTA P.P.			
Year	Federal	State	Total
1990	205,208	2,210,756	2,415,964
1989	373,209	3,409,326	3,782,535
1988	488,027	2,166,266	2,654,293
1987	337,069	1,857,714	2,194,783
1986	25,647	696,131	721,778

**Table 11. Lake Del Valle Monthly Operation  
1990**

(in acre-feet except as noted)

Month	Water* Surface Elevation (in feet)	Storage*	Storage Change	Inflow		Outflow					Precipitation (inches)
				Natural	South Bay Aqueduct	South Bay Aqueduct	Recreation 1/	Arroyo Valle 2/	Evaporation	Total	
JAN	685.82	28,931	445	98	690	282	7	0	54	343	1.91
FEB	694.00	33,862	4,931	484	4,516	0	6	0	63	69	2.58
MAR	697.54	36,167	2,305	148	2,293	0	6	0	130	136	1.06
APR	698.78	36,998	831	-16	1,091	32	7	0	205	244	0.25
MAY	700.86	38,418	1,420	-12	1,754	9	19	0	294	322	1.81
JUN	701.50	38,862	444	-151	973	0	10	0	368	378	0.00
JUL	700.80	38,377	-485	-30	0	0	23	0	432	455	0.00
AUG	700.11	37,903	-474	-72	28	0	24	0	406	430	0.00
SEP	696.00	35,150	-2,753	-19	0	2,390	21	0	323	2,734	0.10
OCT	692.76	33,080	-2,070	96	0	1,042	24	0	1,100	2,166	0.19
NOV	688.33	30,384	-2,696	224	0	2,748	15	0	157	2,920	0.48
DEC	686.86	29,527	-857	199	237	1,209	6	0	78	1,293	1.52
TOTAL			1,041	949	11,582	7,712	168	0	3,610	11,490	9.90

\*At end of month

1/ To East Bay Regional Park District.

## San Luis Field Division

### Water Storage

San Luis Reservoir total storage reached its maximum of the year, 1,975,719 AF, on April 29. Maximum operating storage capacity is 2,027,835 AF. Drawdown to the minimum total storage for the year, 326,772 AF, occurred on November 23. The State's share of San Luis Reservoir storage reached the maximum of 1,156,044 AF on April 28, while the minimum of 1,137 AF was reached on December 14. Table 13 (below) and Figure 19 show San Luis Reservoir operations during 1990. Table 14 shows the monthly operation of O'Neill Forebay during 1990.

### Pumping and Generating Plants

Total pumping in 1990 at William R. Gianelli Pumping-Generating Plant was 1,252,249 AF. Total water released from San Luis Reservoir to O'Neill Forebay for generation was 1,824,405 AF. Total pumping at Dos Amigos Pumping Plant in 1990 was 3,700,507 AF. Table 15 summarizes Joint-Use plant activity on a monthly basis.

### Water Deliveries

SWP water deliveries in the San Luis Field Division during 1990 totaled 1,003,157 AF. This includes 991,840 AF of deliveries to federal contractors, 8,900 AF of transfer water, 2,020 AF of wheeling, and 397 AF of State and federal deliveries to the DFG and the Department of Parks and Recreation. The following tabulation details the components of the recreation deliveries:

O'Neill Forebay (Reach 3)			
	DPR	DFG	Total
State	70	102	172
Federal	57	84	141
Sub-total	127	186	313
Pools 16, 17, and 18 (Reach 5)			
	DPR	DFG	Total
State	0	43	43
Federal	0	41	41
Sub-total	0	84	84

**Table 13. San Luis Reservoir Monthly Operation  
1990**

(In acre-feet except as noted)

Month	Reservoir Storage			Inflow	Outflow				Gain (+) Loss (-)	Evaporation	Precipitation (in inches)
	Water Surface Elevation (in feet)	Storage	Storage Change	Gianelli P-G Plant Pumping	Gianelli P-G Plant Generation	Pacheco Tunnel	Spill				
JAN	504.09	1,554,851	326,627	341,156	0	3,992	0	-10,537	1,416	1.13	
FEB	513.04	1,659,787	104,936	131,833	20,281	3,297	0	-3,319	2,251	1.29	
MAR	527.87	1,838,781	178,994	197,303	0	4,451	0	-13,858	4,649	0.57	
APR	538.55	1,971,565	132,784	171,446	6,048	12,046	0	-20,568	8,317	0.04	
MAY	514.08	1,672,133	-299,432	833	291,320	9,532	0	587	10,219	1.59	
JUN	471.67	1,194,771	-477,362	10300	476,929	9,168	0	-1,565	11,399	0.00	
JUL	422.09	709,258	-485,513	0	477,065	12,934	0	4,486	11,681	0.00	
AUG	395.91	490,766	-218,492	26,372	232,026	11,685	0	-1,153	8,555	0.00	
SEP	395.57	488,128	-2,638	104,777	91,828	8,055	0	-7,532	6,423	0.08	
OCT	375.26	340,198	-147,930	16,333	154,701	7,529	0	-2,033	4,299	0.02	
NOV	375.95	344,850	4,652	68,993	51,553	6,230	0	-6,558	1,956	0.13	
DEC	394.45	479,478	134,628	182,903	22,654	9,567	0	-16,054	567	0.43	
TOTAL			-748,746	1,252,249	1,824,405	98,486	0	-78,104	71,732	5.28	

## ***San Joaquin Field Division***

### ***Water Deliveries***

A total of 1,075,913 AF of deliveries were made in the San Joaquin Field Division in 1990. There were six SWP water service contractors who took delivery of 1,001,167 AF. Water types include entitlement water, groundwater demonstration, carryover entitlement, purchases, and transfer water. Kern County Water Agency represented 85 percent of the total SWP water delivered within the Field Division.

Besides SWP deliveries, 74,746 AF of federal water was wheeled through SWP facilities to KCWA's Cross Valley Canal to be delivered to Cross Valley Canal contractors. The table below itemizes total wheeling:

<b>FEDERAL WHEELING</b>	
<b>Agency</b>	<b>Agency Total</b>
Cawelo Water District	1,824
Fresno County	1,500
Green Valley Water District	164
Hills Valley Irrigation District	3,465
Kern-Tulare Water District	20,000
Lower Tule River	15,551
Pixley Irrigation District	15,551
Rag Gulch Water District	6,650
Tri-Valley Water District	1,187
Tulare County	2,654
USBR (CVP)	6,200
<b>TOTAL FEDERAL WHEELING</b>	<b>74,746</b>

Green Valley Water District, shown in the above wheeling table, is not a one of the Cross Valley Canal contractors.

Map 2 and Table 2 break down water deliveries by agency and water type with totals.

The San Joaquin Field Division is the only field division in the SWP where there are no water storage facilities. All deliveries are made from the aqueduct and are summarized in Appendix A, Table 21.

### ***Pumping Plants***

Pumping plants in the San Joaquin Field Division include Las Perillas and Badger Hill on the Coastal Aqueduct, and Buena Vista, Teerink, Chrisman, and Edmonston on the California Aqueduct. A complete monthly summary of amounts pumped at all of these plants is shown in Table 1. A summary of energy used to pump at each plant is shown in Table 4.

Just over 2.7 MAF (2,708,807 AF State inflow and 74,746 AF federal inflow) of project water flowed past Check 21 into San Joaquin Field Division during 1990. Approximately 1.6 MAF was pumped south at Edmonston Pumping Plant.

## ***Southern Field Division***

### ***Water Storage***

There are five storage reservoirs in the Southern Field Division with a combined capacity of 717,251 AF. Combined storage at the beginning of the year was 568,136 AF. End of year combined storage was 553,343 AF. Complete monthly operation tables for all five reservoirs along with historical inflow and storage data for the last ten years is summarized on pages 47 through 55.

### ***Water Deliveries***

SWP deliveries in the Southern Field Division totaled 1,588,468 AF. Twelve agencies received the water, which was nearly all entitlement water. The only exception was 8,879 AF of recreation water to the California Department of Parks and Recreation. MWDSC received the largest single total delivery for 1990 from the SWP at 1,396,423 AF.

### ***Pumping and Generating Plants***

Pumping plants in the Southern Field Division include Oso and Castaic on the West Branch and Pearblossom on the East Branch. Just over 1.6 MAF of SWP water was pumped into the Southern Field Division in 1990. A complete monthly summary of amounts pumped is shown on Table 1. A summary of energy used to pump and station service energy at each plant is shown on Table 4.

Generating plants include William E. Warne and Castaic on the West Branch, and Alamo and Devil Canyon on the East Branch. Energy available from each generating plant is summarized in Table 3. Combined generation at all four plants totaled 2,129,412 MWh.

**Table 1. Project Pumping by Plant**  
**1990**  
(in acre-feet)

PUMPING PLANTS	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTALS
Hyatt*	39,507	71,535	47,356	0	43,944	64,425	32,952	0	0	0	0	0	299,719
Thermalito*	40,413	73,638	52,729	0	47,716	90,351	45,577	0	0	0	0	0	350,424
Barker Slough	1,638	1,236	1,599	2,435	2,547	3,387	3,792	3,845	3,799	3,339	3,680	2,532	33,829
Cordelia	1,614	1,194	1,553	2,243	2,402	3,307	3,598	3,609	3,380	2,715	2,250	2,023	29,888
South Bay	11,937	15,336	17,681	17,080	17,681	16,715	17,738	17,737	14,657	14,278	14,826	15,078	190,744
Del Valle	690	4,516	2,293	1,091	1,754	973	0	28	0	0	0	237	11,582
Banks													
State	388,580	350,802	388,755	308,902	21,232	18,339	113,810	186,428	110,300	77,710	108,844	137,054	2,210,756
Federal	0	0	0	0	0	0	35,692	21,921	36,950	61,089	20,778	28,778	205,208
Total	388,580	350,802	388,755	308,902	21,232	18,339	149,502	208,349	147,250	138,799	129,622	165,832	2,415,964
Gianelli* 1/													
State	180,291	131,833	147,956	95,487	833	114	0	445	733	236	2,460	36,083	596,471
Federal	160,865	0	49,347	75,959	0	10,186	0	25,927	104,044	16,097	66,533	146,820	655,778
Total	341,156	131,833	197,303	171,446	833	10,300	0	26,372	104,777	16,333	68,993	182,903	1,252,249
O'Neill* 2/													
State	0	0	0	0	0	0	0	0	0	0	0	0	0
Federal	226,176	139,578	155,004	144,788	54,274	41,749	14,170	30,641	97,485	1,444	65,719	137,752	1,108,780
Total	226,176	139,578	155,004	144,788	54,274	41,749	14,170	30,641	97,485	1,444	65,719	137,752	1,108,780
Dos Amigos 1/													
State	138,244	220,685	259,896	206,668	218,347	288,838	376,312	302,275	206,817	197,284	149,392	124,779	2,689,537
Federal	117,354	136,402	68,141	77,069	104,362	174,532	192,385	91,000	10,968	11,994	14,283	12,480	1,010,970
Total	255,598	357,087	328,037	283,737	322,709	463,370	568,697	393,275	217,785	209,278	163,675	137,259	3,700,507
Las Perillas													
State	1,552	5,518	9,406	12,419	18,994	20,977	23,820	15,055	6,309	6,554	3,491	7,445	131,540
Federal	0	948	0	0	0	0	0	0	0	0	0	0	948
Total	1,552	6,466	9,406	12,419	18,994	20,977	23,820	15,055	6,309	6,554	3,491	7,445	132,488
Badger Hill	1,506	6,335	9,408	12,419	18,994	20,977	23,820	15,055	6,309	6,554	3,491	7,445	132,313
Buena Vista	107,730	159,134	182,285	149,985	135,697	145,615	182,954	191,569	170,500	165,726	125,553	94,018	1,810,766
John R. Teerink													
Wheeler Ridge	107,000	147,354	167,822	143,351	124,201	123,353	156,620	172,215	167,989	164,597	124,366	89,156	1,688,024
Ira J. Chrisman													
Wind Gap	105,875	146,316	163,094	139,041	118,129	117,226	149,407	166,923	164,349	160,778	122,490	87,838	1,641,466
A.D. Edmonston	105,552	144,728	161,456	136,667	115,322	115,057	145,412	163,669	161,871	158,384	121,066	86,390	1,615,574
Oso	103,605	79,084	102,320	57,403	43,800	35,824	60,269	82,212	86,103	88,935	49,592	35,301	824,448
Castaic* 3/	30,998	30,439	8,143	22,131	36,236	99,700	84,342	24,187	74,867	61,847	64,481	84,880	622,251
Pearblossom	0	64,909	57,348	77,009	68,634	74,306	79,187	75,881	71,718	68,164	72,064	49,607	758,827

1/ Joint State-federal facility.

2/ O'Neill Pumping Plant is a federal facility.

3/ Pumping at Castaic Pumping Plant is by and for the City of Los Angeles.

\* Pumping-generating plants. This table includes only the pumping portion of operations of these plants.

## Table 2. Water Deliveries, 1962 - 1990

(in acre-feet)

AGENCY	1962-1985	1986	1987	1988	1989	1990	TOTALS
<b>OROVILLE FIELD DIVISION</b>							
LAST CHANCE CREEK WD	142,262	14,379	9,444	6,988	11,487	7,046	191,606
PLUMAS CO. FC & WCD	5,406	317	452	523	486	548	7,732
PALERMO CANAL	136,621	7,970	8,612	8,374	7,546	7,654	176,777
COUNTY OF BUTTE	4,557	313	459	385	300	380	6,394
THERMALITO I.D.	12,710	2,051	2,338	2,417	2,152	2,272	23,940
FEATHER RIVER SERVICE AREA DIVERSION: 1/	14,059,925	786,489	825,905	822,164	801,091	851,247	18,146,821
UPPER FEATHER RIVER LAKES	110,913	2,041	2,203	2,248	1,821	1,642	120,868
YUBA CITY	170	328	88	303	403	494	1,786
<b>DELTA FIELD DIVISION</b>							
NAPA CO. FC & WCD	83,342	3,519	7,693	7,038	10,153	13,313	125,058
ALAMEDA CO. WD	395,414	21,170	25,475	33,464	26,042	31,703	533,288
ALAMEDA CO. FLOOD CONTROL & WCD, ZONE 7	307,668	23,468	26,397	27,252	28,185	33,975	446,945
PLEASANTON TOWNSHIP WD	674	0	0	0	0	0	674
SANTA CLARA VALLEY WD	1,048,427	90,595	94,949	87,961	107,085	120,962	1,549,979
MARIN WD	4,594	0	0	0	0	0	4,594
SAN FRANCISCO WD	4,345	0	0	0	0	332	4,677
SKYLONDA M.WD	10	0	0	0	0	0	10
OAK FLAT WD	103,525	5,354	5,880	4,412	6,391	3,212	128,774
MUSTANG WD	4,256	0	0	0	0	0	4,256
GRANITE CONSTRUCTION	120	0	0	0	0	0	120
LAKE DEL VALLE ( EBRPD)	1,273	130	137	142	152	168	2,002
ORESTIMBA CREEK	100	0	0	0	0	0	100
TRACY GOLF & COUNTRY CLUB (CVP Water)	2,788	454	491	590	466	6	4,795
V.A.CEMETERY (CVP Water)	0	0	0	0	0	20	20
MUSCO OLIVE (CVP Water)	28	9	19	30	7	12	105
SOLANO CO. FCWCD	0	1,400	1,550	13,452	17,364	19,879	53,645
<b>SAN LUIS FIELD DIVISION</b>							
DEPT. PARKS & REC. ( STATE )	556	10	8	7	64	70	715
DEPT. FISH & GAME ( STATE )	4,442	440	590	380	429	145	6,426
FEDERAL (FROM AQUEDUCT, INCL. REC.)	17,611,448	1,371,722	1,462,359	1,421,166	1,303,249	992,022	24,161,966
USBR ( MISC. )	89,059	0	9,335	149,192	0	0	247,586
WESTLANDS WATER DISTRICT	0	0	0	0	0	10,900 12/	10,900
<b>SAN JOAQUIN FIELD DIVISION</b>							
TULARE LAKE BASIN WSD	1,927,288	92,143	144,290	94,316 8/	181,963	90,312	2,530,312
EMPIRE WEST SIDE ID	61,896	2,300	4,401	3,475 9/	3,000	3,310	78,382
COUNTY OF KINGS	34,200	3,700	4,000	4,000	4,000	2,000	51,900
HACIENDA WD	75,895	0	0	0	0	0	75,895
KERN CO. WA	12,556,990	929,278 4/	1,028,124	1,009,520	1,146,062	862,448 13/	17,532,422
KERN WATER BANK	0	0	7,501 6/	0	0	0	7,501
DUDLEY RIDGE WD	993,858	51,152	46,288	47,994	57,049 11/	36,657	1,232,998
DEVIL'S DEN WD	274,947	17,271	14,394	11,534	14,645	6,440	339,231
J.G. BOSWELL	117,430	0	0	0	0	0	117,430
SHELL CAL PROD.	84,311	1,603	0	0	0	0	85,914
GREEN VALLEY WD	11,054	0	0	0	0	0	11,054
FEDERAL WHEELING	554,175	17,050 5/	137,289	153,211 10/	172,656	74,746	1,109,127
WHEELER RIDGE WSD	92	0	0	0	0	0	92
<b>SOUTHERN FIELD DIVISION</b>							
ANTELOPE VALLEY EAST KERN WA	479,916	32,449	34,089	34,079	45,280	47,206	673,019
METROPOLITAN WATER DISTRICT	6,480,123	708,840	712,424	902,564	1,156,698	1,396,423	11,357,072
LITTLEROCK CREEK ID	4,839	163	1,085	419	971	1,747	9,224
MOJAVE WA	57,589	0	17	9	200	0	57,815
DESERT WA	204,300	29,000	31,500	34,000	36,500	38,100	373,400
COACHILLA VALLEY WD	130,566	18,210	19,431	20,652	21,873	23,100	233,832
CRESTLINE-LAKE ARROWHEAD W.A.	14,380	1,506	1,849	2,006	2,170	1,950	23,861
SAN GABRIEL VALLEY M.WD	59,911	9,454	10,630	8,948	12,839	16,649	118,431
SAN BERNARDINO VALLEY M.WD	155,844	6,421	19,075 7/	21,386	20,782	18,831	242,339
DEPT. OF PARKS 7 REC., L.A. CO. REC. DEPT.	18,357	3,285	6,937	4,360	7,490	8,879	49,308
PIRU CREEK FISH ENHANCEMENT	2,915	0	0	0	0	0	2,915
CASTAIC LAKE WA	49,848	13,928	16,167	18,904	21,719	22,139	142,705
PALMDALE WD	1,558	3,096	5,379	1,770	9,009	8,608	29,420
UNITED WATER CD	0	998	0	0	0	0	998
VENTURA CO. FCD	0	0	0	0	0	4,836	4,836
LILICO PICTURES	0	0	0	0	10	0	10
<b>TOTALS</b>	<b>58,486,915</b>	<b>4,274,006</b>	<b>4,729,254</b>	<b>4,961,635</b>	<b>5,239,789</b>	<b>4,762,383</b>	<b>82,453,982</b>

1/ Prior water right entitlement, see page 30.

2/ Hacienda Water District was annexed by Tulare Lake Basin W.S.D. in 1981.

3/ Repayment of preconsolidation water.

4/ Includes 1,703 AF transferred to Tulare Lake Basin W.S.D.

5/ Includes 6,500 AF to KCWD, 6,500 AF to Lakeside I.WD, 4,000 AF to Kern National Wildlife Refuge, and 50 AF to Green Valley WD

6/ Advance storage of ground water, by agreement between K.C.WA and D.W.R.

7/ Includes 324 AF of Local-Out.

8/ Includes 1,550 AF transferred to Westlands WD (Federal).

9/ Includes 300 AF transferred to Tulare Lake B.W.S.D. as Entitlement.

10/ Includes 3,000 AF transferred to Westlands WD (Federal).

11/ Includes 2,500 AF of transferred Entitlement water.

12/ Includes 2,000 AF of General Wheeling for Oroville-Wyondotte I.D..

13/ Includes 150,000 AF of 1990 Kern Ground Water Demo.

**Table 3. Total Energy Resources  
1990**

(in megawatt-hours)

RESOURCE	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTALS
Hyatt-Thermalito 1/	117,732	84,179	107,931	260,023	176,892	134,446	189,071	174,741	54,550	46,763	44,906	123,939	1,515,173
Bottle Rock	6,327	6,371	9,482	8,011	6,269	6,780	6,060	5,913	2,318	0	0	0	57,531
William R. Gianelli													
State	0	5/ - 76	0	1,654	54,057	67,009	56,824	19,994	13,301	17,475	6,455	2,826	239,671
Federal	0	5,284	0	0	22,693	43,573	34,533	16,767	0	3,359	0	0	126,209
Total	0	5,208	0	1,654	76,750	110,582	91,357	36,761	13,301	20,834	6,455	2,826	365,728
William E. Warne 2/	57,497	45,823	57,348	33,485	27,044	22,576	34,892	47,404	48,546	51,319	27,859	20,128	473,921
Castaic (State Share)	99,960	73,848	98,208	55,140	39,408	32,400	56,952	82,296	80,736	78,984	43,416	32,760	774,108
Alamo	0	2,513	2,783	2,910	2,534	1,821	2,528	2,691	2,551	2,949	2,876	1,893	28,049
Devil Canyon	0	54,737	71,198	85,887	79,184	79,707	91,895	83,211	80,628	87,952	77,996	60,939	853,334
Tera Corp.	41	81	270	415	435	673	618	458	492	164	86	27	3,760
MWD Hydro	11,087	12,849	18,300	15,874	19,633	20,177	18,335	17,786	17,982	18,086	16,772	18,391	205,272
Reid Gardner	125,647	131,627	159,950	0	0	90,414	170,070	149,137	162,557	149,500	143,041	170,640	1,452,583
Pine Flat	0	0	3,903	3,035	852	50,288	21,984	0	0	0	0	0	80,062
Purchases 3/	34,586	144,966	185,777	279,856	169,663	229,073	192,967	201,725	230,129	274,830	200,785	82,741	2,227,098
Other Sources/ Exchanges 4/	23,206	19,197	7,923	1,225	23,898	35,771	17,295	8,103	1,363	4,572	2,948	2,350	147,851
SCE Return Additional	358,968	329,676	302,519	95,138	137,762	50,687	88,683	132,960	164,512	100,301	90,077	335,793	2,187,076

1/ Includes Table Mountain and Hyatt out adjusted to Tesla.

2/ Includes station-service energy.

3/ Includes Salt River Project, Portland General Electric, British Columbia Hydro Authority, El Paso Electric, Seattle City Light, Bonneville Power Authority, Pacific Gas and Electric, Washington Water & Power Co., Montana Power Company, Idaho Power Co., Arizona Public Service Co., Pacific Power & Light, Puget Sound Power and Light, Western Area Lower Colorado, Eugene Water and Electric Board, Los Angeles Dept. of Water and Power, and Northern California Power Agency.

4/ Includes Southern California Edison, Western Area Mid-Pacific, Los Angeles Dept. of Water and Power, Bonneville Power Authority, Northern California Power Authority, and Pacific Gas and Electric.

5/ Negative values in SWP columns indicate a mismatch of scheduled CVP energy and actual pumping; adjustments to SWP water shares are made to balance the mismatch.

State: 10,245,489

Federal: 126,209

Total Project: 10,371,698

**Table 4. Total Energy Loads  
1990**

(in megawatt-hours)

SOURCE	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTALS
Hyatt-Thermalito Pumpback and Station Service	30,118	54,541	37,412	26	34,728	53,897	26,938	110	148	186	203	106	238,413
North Bay 1/	0	0	0	1,344	2,976	1,488	580	1,152	1,440	1,586	2,880	2,976	16,422
South Bay	10,038	13,126	15,148	14,969	15,435	14,240	15,050	15,083	12,427	11,440	12,745	12,571	162,271
Del Valle	39	265	138	64	104	59	6	8	6	5	5	22	719
Banks													
State	116,070	104,727	115,830	92,211	6,821	6,268	34,569	55,817	33,231	23,682	33,062	41,473	663,761
Federal	0	0	0	0	0	0	10,600	6,510	10,974	18,144	6,171	8,547	60,946
Bottle Rock 2/	16	1	26	34	7	26	12	4	193	179	158	188	844
Wm. R. Gianelli													
State	59,578	46,807	55,602	38,311	855	284	266	700	650	725	1,271	7,787	212,836
Federal	51,621	0	18,648	29,788	0	3,407	0	5,472	21,672	3,180	12,462	28,242	174,492
Dos Amigos													
State	26,107	26,819	29,846	27,916	28,282	40,825	52,659	40,214	27,779	26,591	19,744	16,733	363,515
Federal	8,937	22,848	14,316	10,494	15,327	22,533	26,022	12,414	891	945	1,980	1,980	138,687
Pine Flat 2/	253	224	118	111	205	0	52	169	191	162	222	252	1,959
Las Perillas													
State	134	406	677	893	1,383	1,530	1,752	1,095	464	483	262	556	9,635
Federal	0	71	0	0	0	0	0	0	0	0	0	0	71
Badger Hill	285	1,223	1,779	2,363	3,737	4,181	4,740	2,893	1,193	1,260	660	1,443	25,757
Buena Vista	26,519	39,003	44,483	36,632	33,215	35,589	44,689	46,730	41,639	40,434	30,512	23,013	442,458
Teerink	29,788	40,808	46,414	39,370	34,127	34,209	43,198	47,445	46,369	45,430	34,388	25,174	466,720
Chrisman	68,279	93,718	104,192	88,705	75,279	74,886	95,346	106,934	105,305	102,290	78,466	56,528	1,049,928
Edmonston	241,397	331,476	369,003	311,844	262,672	260,968	331,824	372,684	369,753	362,000	276,203	197,717	3,687,541
Oso	28,012	21,332	27,548	15,366	12,005	9,773	16,274	21,990	23,053	23,779	13,402	9,722	222,256
Pearblossom	301	43,809	38,828	51,650	45,853	49,738	52,902	50,722	47,895	45,769	48,396	33,453	509,316
Warne 2/	0	1	0	27	1	1	5	4	1	0	46	97	183
Sales	138,877	33,383	60,599	48,625	117,710	169,196	159,826	89,734	79,524	63,910	39,142	367,230	1,367,756
Other Project													
Loads 3/	41,200	33,695	39,943	38,165	38,332	45,216	40,747	37,824	33,283	48,776	35,824	33,769	466,774
Actual Deviation	731	67	858	477	80	-961	-232	-151	1,277	899	-178	-243	2,624
Losses	17,309	20,439	37,148	33,475	23,824	20,409	26,971	35,257	33,844	33,312	29,802	21,862	333,652

1/ Includes Barker Slough, Cordelia, and Cordelia Interim Pumping Plants.

2/ Station Service only.

3/ Includes sales and exchange agreements with Southern California Edison, Bonneville Power Authority, City of Vernon, Pacific Gas and Electric, Nevada Power Company, Project Emergency Service, and Deviation Adjustment for Pacific Gas and Electric.

Total State: 10,245,340

Total Federal: 374,196

Total Project: 10,619,536

**Table 5. Sacramento Basin and Sacramento-San Joaquin Delta Operations  
1990**

(in thousands of acre-feet except as noted)

Month	Upstream Reservoir Releases To River			Sacramento River In-Basin Use 2/	Delta Inflow			Consumptive	Delta Uses		Delta Exports		
	Keswick 1/	Oroville 1/	Nimbus		Sacramento River at Sacramento 3/	San Joaquin River at Vernalis 4/	Total 5/		Total	Outflow Index		Total	DWR
				Average CFS									
JAN	210	186	81	686	1,162	36	1,258	-56	660	10,726	652	389	263
FEB	176	100	71	432	772	36	856	-37	306	5,501	587	351	236
MAR	204	161	62	415	795	53	912	-10	271	4,411	651	389	262
APR	483	394	108	-27	908	38	1,003	63	363	6,106	572	308	264
MAY	556	127	53	-145	641	39	710	121	377	6,139	205	21	184
JUN	508	55	162	15	625	36	730	191	328	5,521	209	18	191
JUL	667	156	360	-340	830	35	904	268	249	4,041	389	114	275
AUG	672	219	156	-200	853	32	932	252	266	4,332	408	186	222
SEP	406	65	87	25	600	26	673	174	143	2,401	350	110	240
OCT	309	70	72	28	469	30	542	118	202	3,288	219	78	141
NOV	250	59	54	104	467	36	553	55	265	4,456	233	109	124
DEC	248	247	55	145	672	30	738	2	414	6,731	315	137	178
<b>TOTAL</b>	<b>4,689</b>	<b>1,839</b>	<b>1,321</b>	<b>1,138</b>	<b>8,794</b>	<b>427</b>	<b>9,811</b>	<b>1,141</b>	<b>3,844</b>	<b>---</b>	<b>4,790</b>	<b>2,210</b>	<b>2,580</b>

- 1/ Time lagged values (Keswick: 5 days; Oroville: 2 days).
- 2/ Positive values are accretions; negative values are depletions.
- 3/ These values are a measured daily average taken from the Sacramento River at Freeport.
- 4/ These values are based on daily 6 a.m. readings.
- 5/ Includes Sacramento County Regional Waste Treatment Plant.

**Table 6. Calculated Delta Outflow Index  
1990**

(in cfs-days except as noted)

DATE	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	8,177	3,792	3,258	3,398	5,577	15,481	2,426	5,014	3,827	1,115	3,968	5,781
2	8,694	4,748	3,649	3,563	5,404	13,365	5,123	4,841	3,589	2,134	3,842	6,821
3	8,767	5,121	3,235	4,332	4,099	15,457	5,147	6,023	3,149	1,580	2,948	6,169
4	7,716	4,894	3,240	3,784	3,325	14,065	4,785	6,047	3,524	1,104	4,517	6,060
5	7,239	5,842	3,497	3,672	3,499	10,293	5,121	6,191	3,117	2,081	4,463	6,251
6	6,378	6,258	6,476	4,096	2,934	5,698	4,340	5,580	3,046	2,846	5,273	6,488
7	6,393	6,870	8,352	5,491	2,921	3,992	3,380	5,648	3,000	2,730	3,857	5,558
8	6,353	7,399	9,543	5,403	3,742	3,996	2,966	5,209	2,836	2,672	3,219	5,232
9	5,995	6,999	9,226	5,595	3,649	3,487	3,098	5,260	3,238	2,529	3,087	5,982
10	8,438	6,177	6,931	6,691	4,539	3,372	3,742	4,561	3,421	3,575	4,004	5,989
11	14,708	4,974	5,802	6,806	5,946	3,542	3,334	4,611	4,137	3,551	3,075	6,490
12	15,873	4,079	6,255	7,209	6,399	3,427	3,712	4,461	4,161	3,567	3,223	6,875
13	12,241	3,650	6,604	8,426	6,267	2,746	3,758	4,960	4,013	3,602	4,191	8,159
14	13,819	3,670	7,222	8,164	6,345	2,279	3,653	4,500	4,224	3,545	5,677	8,044
15	18,689	3,650	6,888	7,666	6,350	2,922	3,258	4,471	4,274	3,824	4,966	8,000
16	26,080	2,449	5,308	8,791	5,125	3,957	3,702	4,673	3,385	3,574	4,918	7,607
17	29,562	2,947	4,271	8,880	5,084	4,263	4,430	4,936	2,379	3,083	5,004	7,577
18	24,342	8,666	3,569	8,927	5,048	3,792	5,031	4,223	2,436	3,061	5,616	7,508
19	20,733	10,714	3,088	8,345	6,202	4,544	4,941	4,077	1,854	3,573	4,650	8,098
20	17,204	9,788	2,719	7,677	4,967	4,669	4,856	4,478	1,556	3,563	6,528	8,024
21	13,305	7,936	2,089	7,737	5,037	4,986	5,134	3,909	1,114	3,524	5,496	7,077
22	10,352	6,685	1,701	6,968	5,455	4,007	5,236	3,201	1,284	3,446	5,048	6,418
23	8,289	5,756	1,965	5,606	5,768	4,656	4,668	3,111	1,139	4,064	4,595	5,913
24	6,576	5,129	2,324	6,362	5,626	5,612	4,576	3,058	550	5,056	4,482	5,476
25	5,839	4,965	2,176	6,722	7,264	5,213	3,951	2,954	596	5,000	4,559	5,430
26	4,698	4,179	2,471	5,525	8,497	5,472	3,988	3,516	625	4,572	5,591	6,510
27	4,173	3,806	3,270	5,680	8,491	4,420	3,775	2,931	705	4,365	4,807	7,140
28	3,948	3,523	2,528	5,199	8,466	2,681	4,146	2,887	639	4,539	4,109	7,518
29	3,153		3,241	4,708	10,747	2,802	2,945	3,057	1,471	4,274	4,869	8,128
30	2,667		3,503	2,975	12,843	2,047	3,453	3,667	600	3,825	4,936	6,917
31	2,920		3,127		15,897		4,435	4,084		3,574		6,670
<b>TOTAL</b>	<b>333,321</b>	<b>154,666</b>	<b>137,528</b>	<b>184,398</b>	<b>191,513</b>	<b>167,243</b>	<b>127,110</b>	<b>136,139</b>	<b>73,889</b>	<b>103,548</b>	<b>135,518</b>	<b>209,910</b>
<b>AVE.</b>	<b>10,752</b>	<b>5,524</b>	<b>4,436</b>	<b>6,147</b>	<b>6,178</b>	<b>5,575</b>	<b>4,100</b>	<b>4,392</b>	<b>2,463</b>	<b>3,340</b>	<b>4,517</b>	<b>6,771</b>
<b>MAX.</b>	<b>29,562</b>	<b>10,714</b>	<b>9,543</b>	<b>8,927</b>	<b>15,897</b>	<b>15,481</b>	<b>5,236</b>	<b>6,191</b>	<b>4,274</b>	<b>5,056</b>	<b>6,528</b>	<b>8,159</b>
<b>MIN.</b>	<b>2,667</b>	<b>2,449</b>	<b>1,701</b>	<b>2,975</b>	<b>2,921</b>	<b>2,047</b>	<b>2,426</b>	<b>2,887</b>	<b>550</b>	<b>1,104</b>	<b>2,948</b>	<b>5,232</b>
<b>TOTAL IN AF</b>	<b>661,142</b>	<b>306,780</b>	<b>272,787</b>	<b>365,753</b>	<b>379,866</b>	<b>331,726</b>	<b>252,123</b>	<b>270,032</b>	<b>146,559</b>	<b>205,387</b>	<b>268,800</b>	<b>416,356</b>

Average daily DOI = 5,356  
 Highest daily DOI = 29,562  
 Highest monthly average = 10,752  
 Lowest daily DOI = 550

Annual Total= 1,954,783 cfs days  
 or 3,877,312 acre-feet

**Table 7. Upper Feather Area Lakes Monthly Operation  
1990**

(in acre-feet except as noted)

Month	Lake Storage			Outflow							Inflow
	Water Surface Elevation (in feet)	Storage*	Storage Change	Regulated Release				Spill	Estimated Evaporation And Seepage	Total Outflow	Computed Or Estimated
				Stream-Flow Maint.	Water Supply Contract	Prior Water Rights	Total Regulated Release				

**Antelope Lake Capacity 22,566 AF**

JAN	4992.36	14,609	158	684	0	0	684	0	50	734	892
FEB	4992.61	14,789	180	555	0	0	555	0	58	613	793
MAR	4995.76	17,181	2,392	615	0	0	615	0	90	705	3,097
APR	4998.89	19,773	2,592	595	0	0	595	0	226	821	3,413
MAY	4999.16	20,007	234	615	0	0	615	0	259	874	1,108
JUN	4999.12	19,972	-35	595	0	0	595	0	481	1,076	1,041
JUL	4997.89	18,921	-1,051	615	0	0	615	0	666	1,281	230
AUG	4996.62	17,871	-1,050	615	0	0	615	0	512	1,127	77
SEP	4995.62	17,070	-801	555	0	0	555	0	360	915	114
OCT	4994.66	16,321	-749	615	0	0	615	0	266	881	132
NOV	4994.03	15,841	-480	595	0	0	595	0	122	717	237
DEC	4993.45	15,406	-435	615	0	0	615	0	83	698	263
TOTAL	---	---	955	7,269	0	0	7,269	0	3,173	10,442	11,397

**Frenchman Lake Capacity 55,477 AF**

JAN	5563.63	24,812	334	123	0	0	123	0	67	190	524
FEB	5564.13	25,294	482	111	0	0	111	0	67	178	660
MAR	5566.12	27,267	1,973	123	0	0	123	0	119	242	2,215
APR	5567.04	28,207	940	119	0	0	119	0	276	395	1,335
MAY	5564.65	25,802	-2,405	6	2,495	0	2,501	0	402	2,903	498
JUN	5562.76	23,986	-1,816	0	1,442	0	1,442	0	625	2,067	251
JUL	5560.42	21,844	-2,142	0	1,743	0	1,743	0	712	2,455	313
AUG	5558.98	20,584	-1,260	0	710	0	710	0	580	1,290	30
SEP	5558.22	19,938	-646	0	432	0	432	0	339	771	125
OCT	5557.74	19,536	-402	0	186	0	186	0	268	454	52
NOV	5557.46	19,304	-232	113	38	0	151	0	132	283	51
DEC	5557.46	19,304	0	148	0	0	148	0	91	239	239
TOTAL	---	---	-5,174	743	7,046	0	7,789	0	3,678	11,467	6,293

**Lake Davis Capacity 84,371 AF**

JAN	5765.48	50,729	453	615	12	0	627	0	212	839	1,292
FEB	5765.73	51,490	761	555	16	0	571	0	203	774	1,535
MAR	5766.77	54,726	3,236	615	5	0	620	0	371	991	4,227
APR	5767.08	55,713	987	595	26	0	621	0	639	1,260	2,247
MAY	5766.84	54,947	-766	424	54	190	668	0	1,428	2,096	1,330
JUN	5766.24	53,056	-1,891	238	81	357	676	0	1,334	2,010	119
JUL	5765.44	50,608	-2,448	246	105	369	720	0	1,638	2,358	-90
AUG	5764.69	48,307	-2,301	246	98	369	713	0	1,491	2,204	-97
SEP	5764.09	46,613	-1,694	238	61	357	656	0	1,292	1,948	254
OCT	5763.54	45,040	-1,573	615	32	0	647	0	1,075	1,722	149
NOV	5763.26	44,256	-784	595	23	0	618	0	566	1,184	400
DEC	5763.08	43,749	-507	615	35	0	650	0	307	957	450
TOTAL	---	---	-6,527	5,597	548	1,642	7,787	0	10,556	18,343	11,816

\* At end of month.

**Table 8. Lake Oroville Monthly Operation**

(in acre-feet except as noted)

Capacity 3,537,577 acre-feet

Month	Year	Water Surface Elevation (in feet)	Storage	End Of Month Storage Change	Outflow						Hyatt Pumpback	Computed Inflow 3/
					Hyatt Generation 1/	Palermo Canal	Spillway Leakage 2/	Evaporation	Spill	Total Outflow		
JAN	1990	772.37	1,895,501	6,702	210,354	205	0	652	0	211,211	39,507	178,406
	1989	752.37	1,699,766	39,500	123,728	202	0	809	0	124,739	61,408	102,831
FEB	1990	776.26	1,935,355	39,854	149,189	114	0	1,023	0	150,326	71,535	118,645
	1989	754.14	1,716,489	16,723	182,385	182	0	1,009	0	183,576	25,271	175,028
MAR	1990	791.00	2,091,865	156,510	187,092	81	0	2,000	0	189,173	47,356	298,327
	1989	854.35	2,867,122	1,150,633	118,712	202	107	1,521	0	120,542	45,836	1,225,339
APR	1990	766.99	1,841,358	-250,507	451,613	646	0	2,920	0	455,179	0	204,672
	1989	887.50	3,343,930	476,808	98,069	284	635	4,510	0	103,498	33,852	546,454
MAY	1990	755.31	1,727,608	-113,750	318,113	849	0	3,361	0	322,323	43,944	164,629
	1989	883.18	3,278,807	-65,123	280,510	1,019	785	6,940	0	289,254	2,482	221,649
JUN	1990	751.61	1,692,620	-34,988	239,926	817	0	4,662	0	245,405	64,425	145,992
	1989	870.49	3,092,775	-186,032	317,675	1,190	653	7,185	0	326,703	5,333	135,338
JUL	1990	723.90	1,446,234	-246,386	350,907	1,010	0	5,602	0	357,519	32,952	78,181
	1989	836.25	2,628,087	-464,688	558,326	1,180	357	9,188	0	569,051	0	104,363
AUG	1990	691.02	1,187,386	-258,848	346,810	1,100	0	4,580	0	352,490	0	93,642
	1989	808.02	2,283,529	-344,558	466,441	1,166	14	7,001	0	474,622	15,841	114,223
SEP	1990	687.71	1,163,259	-24,127	113,895	1,170	0	3,577	0	118,642	0	94,515
	1989	796.30	2,150,283	-133,246	251,139	1,040	0	4,646	0	256,825	36,049	87,530
OCT	1990	689.08	1,173,203	9,944	98,987	1,070	0	2,945	0	103,002	0	112,946
	1989	795.89	2,145,723	-4,560	190,376	456	0	2,726	0	193,558	29,609	159,389
NOV	1990	686.64	1,155,535	-17,668	93,327	422	0	1,123	0	94,872	0	77,204
	1989	794.02	2,125,012	-20,711	188,651	328	0	1,654	0	190,633	7,229	162,693
DEC	1990	661.95	987,094	-168,441	257,633	226	0	575	0	258,434	0	89,993
	1989	771.71	1,888,799	-236,213	377,625	297	0	832	0	378,754	171	142,370
TOTAL	1990	---	---	-901,705	2,817,846	7,710	0	33,020	0	2,858,576	299,719	1,657,152
	1989	---	---	228,533	3,153,637	7,546	2,551	48,021	0	3,211,755	263,081	3,177,207

1/ Includes bypass flows

2/ Only occurs when Lake water elevation is greater than or equal to 813.00 and there is no spill.

3/ Does not include pumpback.

**Table 9. Thermalito Forebay Monthly Operation**

Including Diversion Pool and Power Canal

(In acre-feet except as noted)

Month	Year	End Of Month Storage 1/	Storage Change	Inflow			Outflow					Losses (-) And Gains (+)
				Lake Oroville Releases 2/	Kelly Ridge Generation	Thermalito Pumpback	Thermalito Generation	Butte County	Thermalito Irrigation District	Releases To River 3/	Hyatt Pumpback	
JAN	1990	23,295	-171	210,354	14,090	40,413	186,252	27	87	39,496	39,507	341
	1989	22,480	-1,378	123,728	14,800	66,154	93,948	14	96	39,410	61,408	-11,184
FEB	1990	24,268	973	149,189	6,722	73,638	125,724	66	82	35,750	71,535	4,581
	1989	23,751	1,271	182,385	13,110	28,495	148,031	6	95	35,667	25,271	-13,649
MAR	1990	23,201	-1,067	187,092	7,516	52,729	163,853	172	108	39,306	52,729	7,764
	1989	23,412	-339	118,819	14,680	58,047	104,803	177	89	39,360	45,836	-1,620
APR	1990	22,752	-449	451,613	12,167	0	426,278	17	179	38,133	0	378
	1989	22,154	-1,258	98,704	14,470	45,175	78,093	89	137	38,179	33,852	-9,257
MAY	1990	23,456	704	318,113	9,650	47,716	293,768	19	207	38,480	43,944	1,643
	1989	23,765	1,611	281,295	14,970	3,978	239,723	0	274	38,240	2,482	-17,913
JUN	1990	23,446	-10	239,926	14,440	90,351	236,970	5	268	37,260	64,425	-5,799
	1989	23,349	-416	318,332	14,310	6,773	272,954	0	284	59,422	5,333	-1,838
JUL	1990	23,576	130	350,907	14,770	45,577	335,540	9	318	38,920	32,952	-3,385
	1989	23,836	487	558,683	14,660	0	521,868	0	327	38,145	0	-12,516
AUG	1990	23,980	404	346,810	14,910	0	321,552	9	302	38,110	0	-1,343
	1989	22,971	-865	466,441	14,530	16,464	436,087	0	313	38,027	15,841	-8,032
SEP	1990	22,857	-1,123	113,895	9,050	0	81,872	19	251	36,480	0	-5,446
	1989	22,975	4	251,139	8,860	33,750	210,891	0	209	36,767	36,049	-9,829
OCT	1990	24,645	1,788	98,987	793	0	63,488	0	225	37,923	0	3,644
	1989	23,502	527	190,376	12,450	28,995	164,165	14	132	38,298	29,609	924
NOV	1990	24,905	260	93,327	14,400	0	71,480	6	128	37,084	0	1,230
	1989	23,681	179	188,651	8,140	7,721	160,316	0	100	37,625	7,229	937
DEC	1990	24,340	-565	257,633	4,873	0	231,149	31	117	38,345	0	6,571
	1989	23,466	-215	377,625	14,670	265	346,666	0	93	39,111	171	-6,734
TOTAL	1990		874	2,817,846	123,382	350,424	2,537,926	380	2,272	455,287	305,092	10,179
	1989		-392	3,156,178	159,650	295,817	2,777,545	300	2,149	478,251	263,081	-80,532

1/ Sum of Thermalito Forebay and Diversion Pool.

2/ Sum of releases from Lake Oroville through Hyatt plant, spill, and spillway leakage.

3/ Sum of Diversion Dam generation plus hatchery.

**Table 10. Thermalito Afterbay Monthly Operation**

(In acre-feet except as noted)

Month	Year	Water Surface Elevation (in feet)	End Of Month Storage	Storage Change	Inflow		Outflow					Losses (-) And Gains (+)
					Thermalito Generation 1/	Sutter Butte Canal	Western Canal Lateral	Richvale Canal	Western Canal	River Outlet	Thermalito Pumpback	
JAN	1990	130.95	35,382	3,330	186,252	1,770	8	179	1,080	147,500	40,413	8,028
	1989	132.92	42,538	3,382	93,948	1,593	0	466	0	36,700	66,154	14,347
FEB	1990	130.55	34,004	-1,378	125,724	0	0	0	0	67,260	73,638	13,796
	1989	133.01	42,880	342	148,031	0	0	0	0	131,700	28,495	12,506
MAR	1990	128.88	28,531	-5,473	163,853	1,100	0	0	0	123,500	52,729	8,003
	1989	133.15	43,414	534	104,803	0	0	0	0	58,870	58,047	12,648
APR	1990	125.66	19,273	-9,258	426,278	54,570	374	5,820	13,830	353,600	0	-7,342
	1989	129.14	29,353	-14,061	78,093	14,300	98	3,126	2,448	35,870	45,175	8,863
MAY	1990	131.95	38,938	19,665	293,768	84,440	554	14,040	48,110	90,040	47,716	10,797
	1989	128.35	26,889	-2,464	239,723	94,350	863	14,870	46,400	102,500	3,978	20,774
JUN	1990	129.90	31,820	-7,118	236,970	81,240	834	17,350	43,380	20,070	90,351	9,138
	1989	132.06	39,339	12,450	272,954	88,540	823	16,713	46,750	108,200	6,773	7,295
JUL	1990	132.08	39,412	7,592	335,540	99,690	962	20,200	55,550	120,900	45,577	14,931
	1989	129.25	29,705	-9,634	521,868	97,510	918	19,010	55,600	357,100	0	-1,364
AUG	1990	131.06	35,765	-3,647	321,552	86,180	556	15,900	42,090	179,600	0	-873
	1989	134.82	50,005	20,300	436,087	93,180	731	16,230	44,720	251,100	16,464	6,638
SEP	1990	132.55	41,148	5,383	81,872	38,810	46	4,010	8,920	28,840	0	4,137
	1989	133.78	45,854	-4,151	210,891	45,670	68	5,334	11,760	130,200	33,750	11,740
OCT	1990	128.21	26,464	-14,684	63,488	33,100	0	2,590	13,800	33,240	0	4,558
	1989	124.20	15,628	-30,226	164,165	19,090	0	4,000	5,860	138,900	28,995	2,454
NOV	1990	133.31	44,028	17,564	71,480	15,230	254	6,160	11,010	24,650	0	3,388
	1989	132.55	41,148	25,520	160,316	14,070	0	3,120	10,940	109,100	7,721	10,155
DEC	1990	130.28	33,088	-10,940	231,149	13,240	80	4,370	8,070	198,800	0	-17,529
	1989	129.97	32,052	-9,096	346,666	13,750	209	1,880	6,030	315,900	265	-17,728
TOTAL	1990			1,036	2,537,926	509,370	3,668	90,619	245,840	1,388,001	350,424	51,032
	1989			-7,104	2,777,545	482,053	3,710	84,749	230,508	1,776,140	295,817	88,328

1/ Includes bypass flows.

**Table 11: Lake Del Valle Monthly Operation**

**1990**

(in acre-feet except as noted)

Month	Water Surface Elevation (in feet)	Storage*	Storage Change	Inflow		Outflow					Precipitation (inches)
				Natural	South Bay Aqueduct	South Bay Aqueduct	Recreation 1/	Arroyo Valle	Evaporation 2/	Total	
JAN	685.82	28,931	445	98	690	282	7	0	54	343	1.91
FEB	694.00	33,862	4,931	484	4,516	0	6	0	63	69	2.58
MAR	697.54	36,167	2,305	148	2,293	0	6	0	130	136	1.06
APR	698.78	36,998	831	-16	1,091	32	7	0	205	244	0.25
MAY	700.86	38,418	1,420	-12	1,754	9	19	0	294	322	1.81
JUN	701.50	38,862	444	-151	973	0	10	0	368	378	0.00
JUL	700.80	38,377	-485	-30	0	0	23	0	432	455	0.00
AUG	700.11	37,903	-474	-72	28	0	24	0	406	430	0.00
SEP	696.00	35,150	-2,753	-19	0	2,390	21	0	323	2,734	0.10
OCT	692.76	33,080	-2,070	96	0	1,042	24	0	1,100	2,166	0.19
NOV	688.33	30,384	-2,696	224	0	2,748	15	0	157	2,920	0.48
DEC	686.86	29,527	-857	199	237	1,209	6	0	78	1,293	1.52
TOTAL	---	---	1,041	949	11,582	7,712	168	0	3,610	11,490	9.90

\*At end of month.

1/ To East Bay Regional Park District.

2/ Includes 2 AF loss from Del Valle Tunnel on July 13 for inspection and gate maintenance.

**Table 12. Clifton Court Forebay Monthly Operation**

(elevation in feet, storage in acre-feet)

Month	Year	End-of-Month Water Surface Elevation (ft)	End-of-Month Storage (AF)	Storage Change (AF)	Inflow (AF)
JAN	1990	0.32	18,952	1,657	390,237
	1989	-1.41	15,231	-22	361,187
FEB	1990	0.15	18,586	-366	350,691
	1989	-1.10	15,897	666	220,368
MAR	1990	-0.60	16,972	-1,614	391,238
	1989	-1.21	15,661	-236	370,378
APR	1990	-0.03	18,199	1,227	314,685
	1989	-0.90	16,327	666	381,261
MAY	1990	1.76	22,060	3,861	30,768
	1989	-0.19	17,854	1,527	191,881
JUN	1990	1.25	20,958	-1,102	22,926
	1989	0.57	19,491	1,637	128,131
JUL	1990	-1.17	15,747	-5,211	149,662
	1989	-0.11	18,026	-1,465	284,921
AUG	1990	-0.46	17,273	1,526	215,310
	1989	-0.07	18,112	86	396,673
SEP	1990	0.17	18,629	1,356	153,339
	1989	-0.73	16,692	-1,420	367,180
OCT	1990	0.15	18,586	-43	141,116
	1989	0.63	19,621	2,929	378,057
NOV	1990	-1.45	15,145	-3,441	126,242
	1989	0.38	19,082	-539	360,540
DEC	1990	0.92	20,246	5,101	170,933
	1989	-0.45	17,295	-1,787	380,235
TOTAL	1990	---	---	2,951	2,457,147
	1989	---	---	2,042	3,820,812

**TABLE 13. San Luis Reservoir Montly Operation**

(in acre-feet except as noted)

Month	Year	Water Surface Elevation (in feet)	Storage 1/	Monthly Storage Change	Inflow	Outflow			Gain (+) Loss (-)	Evaporation	Precipitation (in inches)
					Gianelli P-G Plant Pumping	Gianelli P-G Plant Generation	Pacheco Tunnel	Spill			
JAN	1990	504.09	1,554,851	326,627	341,156	0	3,992	0	-10,537	1,416	1.13
	1989	470.35	1,180,796	326,743	350,688	0	11,508	0	-12,437	1,119	0.55
FEB	1990	513.04	1,659,787	104,936	131,833	20,281	3,297	0	-3,319	2,251	1.29
	1989	473.02	1,209,118	28,322	117,370	79,574	5,971	0	-3,503	1,656	1.15
MAR	1990	527.87	1,838,781	178,994	197,303	0	4,451	0	-13,858	4,649	0.57
	1989	498.59	1,491,534	282,416	300,618	2,662	5,368	0	-10,172	3,723	0.70
APR	1990	538.55	1,971,565	132,784	171,446	6,048	12,046	0	-20,568	8,317	0.04
	1989	501.94	1,529,993	38,459	124,846	65,694	15,805	0	-4,888	7,268	0.03
MAY	1990	514.08	1,672,133	-299,432	833	291,320	9,532	0	587	10,219	1.59
	1989	479.27	1,276,306	-253,687	0	230,789	19,540	0	-3,358	9,703	0.00
JUN	1990	471.67	1,194,771	-477,362	10,300	476,929	9,168	0	-1,565	11,399	0.00
	1989	417.79	671,333	-604,973	0	595,475	17,775	0	8,277	10,507	0.00
JUL	1990	422.09	709,258	-485,513	0	477,065	12,934	0	4,486	11,681	0.00
	1989	364.10	268,174	-403,159	0	385,804	18,787	0	1,432	9,840	0.00
AUG	1990	395.91	490,766	-218,492	26,372	232,026	11,685	0	-1,153	8,555	0.00
	1989	350.28	188,453	-79,721	30,643	95,613	12,580	0	-2,171	5,655	0.03
SEP	1990	395.57	488,128	-2,638	104,777	91,828	8,055	0	-7,532	6,423	0.08
	1989	378.81	364,771	176,318	197,818	0	9,495	0	-12,005	4,007	1.47
OCT	1990	375.26	340,198	-147,930	16,333	154,701	7,529	0	-2,033	4,299	0.02
	1989	410.15	605,895	241,124	270,605	0	6,249	0	-23,232	3,180	0.40
NOV	1990	375.95	344,850	4,652	68,993	51,553	6,230	0	-6,558	1,956	0.13
	1989	439.50	870,050	264,155	269,945	0	2,434	0	-3,356	1,682	0.39
DEC	1990	394.45	479,478	134,628	182,903	22,654	9,567	0	-16,054	567	0.43
	1989	474.81	1,228,224	358,174	382,914	294	13,821	0	-10,625	692	0.17
TOTAL	1990	---	---	-748,746	1,252,249	1,824,405	98,486	0	-78,104	71,732	5.28
	1989	---	---	374,171	2,045,447	1,455,905	139,333	0	-76,038	59,032	4.89

1/ At end of month.

**Table 14. O'Neill Forebay Monthly Operation**

(in acre-feet except as noted)

Month	Year	End-of-Month Water Surface Elevation (in feet)	End-of-Month Storage	End-of-Month Storage Change	Inflow			Outflow				Gain ( + ) Loss ( - )
					O'Neill P-G Plant Pumping	Gianelli P-G Plant Generation	Flow Past Check 12	O'Neill P-G Plant Generation	Gianelli P-G Plant Pumping	Dos Amigos Pumping	Deliveries	
JAN	1990	221.52	47,125	1,600	226,176	0	372,752	0	341,156	255,598	425	-149
	1989	218.53	39,398	-11,381	218,957	0	349,256	0	350,688	228,316	429	-161
FEB	1990	221.08	45,970	-1,155	139,578	20,281	332,338	0	131,833	357,087	2,238	-2,194
	1989	221.98	48,334	8,936	137,746	79,574	205,938	0	117,370	295,322	2,225	595
MAR	1990	220.97	45,682	-288	155,004	0	366,940	0	197,303	328,037	2,161	5,269
	1989	221.62	47,388	-946	157,534	2,662	350,457	0	300,618	212,216	1,037	2,272
APR	1990	219.30	41,349	-4,333	144,788	6,048	290,931	0	171,446	283,737	1,900	10,983
	1989	221.17	46,206	-1,182	63,803	65,694	353,044	656	124,846	351,908	3,262	-3,051
MAY	1990	221.87	48,045	6,696	54,274	291,320	0	10,031	833	322,709	2,524	-2,801
	1989	220.11	43,437	-2,769	2,693	230,789	164,955	27,801	0	368,661	3,663	-1,081
JUN	1990	221.25	46,416	-1,629	41,749	476,929	0	41,825	10,300	463,370	2,986	-1,826
	1989	222.64	50,086	6,649	295	595,475	99,490	69,343	0	608,848	4,485	-5,935
JUL	1990	222.28	49,128	2,712	14,170	477,065	129,295	38,455	0	568,697	4,923	-5,743
	1989	220.75	45,106	-4,980	11,829	385,804	256,508	8,457	0	640,246	5,309	-5,109
AUG	1990	221.12	46,075	-3,053	30,641	232,026	188,798	35,856	26,372	393,275	3,346	4,331
	1989	220.29	43,905	-1,201	51,699	95,613	367,040	1,741	30,643	471,151	4,806	-7,212
SEP	1990	221.65	47,467	1,392	97,485	91,828	132,098	0	104,777	217,785	1,560	4,103
	1989	220.88	45,446	1,541	119,572	0	351,708	0	197,818	279,547	1,464	9,090
OCT	1990	221.41	46,836	-631	1,444	154,701	123,912	62,032	16,333	209,278	334	7,289
	1989	219.20	41,093	-4,353	142,123	0	358,755	0	270,605	249,128	779	15,281
NOV	1990	222.29	49,155	2,319	65,719	51,553	115,212	1,599	68,993	163,675	369	4,471
	1989	221.08	45,970	4,877	184,904	0	348,758	0	269,945	253,883	524	-4,433
DEC	1990	222.53	49,793	638	137,752	22,654	150,928	0	182,903	137,259	188	9,654
	1989	220.91	45,525	-445	212,825	294	365,748	0	382,914	199,780	661	4,043
TOTAL	1990	---	---	4,268	1,108,780	1,824,405	2,203,204	189,798	1,252,249	3,700,507	22,954	33,387
	1989	---	---	-5,254	1,303,980	1,455,905	3,571,657	107,998	2,045,447	4,159,006	28,644	4,299

**Table 15. Monthly Operations Summary, State-Federal San Luis Joint-Use Facilities  
1990**

(In acre-feet except as noted)

	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	TOTAL
Check 12													
State	372,752	332,338	366,940	290,931	0	0	93,600	166,877	95,148	62,823	94,434	122,150	1,997,993
Federal	0	0	0	0	0	0	35,692	21,921	36,950	61,089	20,778	28,778	205,208
Total	372,752	332,338	366,940	290,931	0	0	129,292	188,798	132,098	123,912	115,212	150,928	2,203,201
O'Neill P-G Plant													
Amount Pumped													
State	0	0	0	0	0	0	0	0	0	0	0	0	0
Federal	226,176	139,578	155,004	144,788	54,274	41,749	14,170	30,641	97,485	1,444	65,719	137,752	1,108,780
Total	226,176	139,578	155,004	144,788	54,274	41,749	14,170	30,641	97,485	1,444	65,719	137,752	1,108,780
Released for Gen.													
Federal	0	0	0	0	10,031	41,825	38,455	35,856	0	62,032	1,599	0	189,798
O'Neill Forebay													
End-Of-Month Storage													
State	81,906	52,221	11,206	12,071	5,535	10,621	19,587	13,412	22,896	24,537	26,632	23,884	---
Federal	-34,781	-6,251	34,476	29,278	42,510	35,795	29,541	32,663	24,571	22,299	22,523	25,909	---
Total	47,125	45,970	45,682	41,349	48,045	46,416	49,128	46,075	47,467	46,836	49,155	49,793	---
San Luis Reservoir													
End-Of-Month Storage													
State	790,497	928,802	1,072,136	1,150,263	935,234	638,444	346,077	218,602	100,365	7,155	8,956	5,555	---
Federal	764,354	730,985	766,645	821,302	736,899	556,327	363,181	272,164	387,763	333,043	335,895	473,923	---
Total	1,554,851	1,659,787	1,838,781	1,971,565	1,672,133	1,194,771	709,258	490,766	488,128	340,198	344,851	479,478	---
Gianelli P-G Plant													
Amount Pumped													
State	180,291	131,833	147,956	95,487	833	114	0	445	733	236	2,460	36,083	596,471
Federal	160,865	0	49,347	75,959	0	10,186	0	25,927	104,044	16,097	66,533	146,820	655,778
Total	341,156	131,833	197,303	171,446	833	10,300	0	26,372	104,777	16,333	68,993	182,903	1,252,249
Released for Gen.													
State	0	1/ -298	0	6,048	205,185	287,043	294,834	127,286	91,828	130,327	51,553	22,654	1,217,056
Federal	0	20,579	0	0	86,135	189,886	182,231	104,740	0	24,374	0	0	607,945
Total	0	20,281	0	6,048	291,320	476,929	477,065	232,026	91,828	154,701	51,553	22,654	1,824,405
San Felipe Project													
Federal	3,992	3,297	4,451	12,046	9,532	9,168	12,934	11,685	8,055	7,529	6,230	9,567	98,486
Dos Amigos P.P.													
Amount Pumped													
State	138,244	220,685	259,896	206,668	218,348	288,838	376,312	302,275	206,817	197,284	149,392	124,779	2,689,538
Federal	117,354	136,402	68,141	77,069	104,361	174,532	192,385	91,000	10,968	11,994	14,283	12,480	1,010,969
Total	255,598	357,087	328,037	283,737	322,709	463,370	568,697	393,275	217,785	209,278	163,675	137,259	3,700,507

1/ Negative values in State generation indicate a mismatch of scheduled CVP energy and actual energy; adjustments to SWP water shares are made to balance the mismatch.

**Table 16. Pyramid Lake Monthly Operation  
1990**

(in acre-feet except as noted)

Month	End-of month Water Surface Elevation (in feet)	End Of Month Storage	Natural Inflow Storage Shares	Storage Change	Inflow			Outflow				Computed Losses (-) Gains (+)
					Natural	Project		Project		To Piru Creek		
						Warne Power- plant	Castaic Powerplant Pumpback	Castaic Powerplant Generation	Recreation Deliveries (metered water)	Pyramid Diversion 1/	Deliveries 2/	
JAN	2571.33	161,433	445	4,307	740	102,709	30,998	125,300	1	340	0	-4,499
FEB	2570.57	160,486	306	-947	528	79,834	30,439	105,132	2	667	0	-5,947
MAR	2569.20	158,788	-38	-1,698	580	102,261	8,143	108,377	4	924	0	-3,377
APR	2571.66	161,845	-165	3,057	362	57,381	22,131	74,032	4	489	0	-2,292
MAY	2573.75	164,472	0	2,627	244	43,648	36,236	75,362	579	79	0	-1,481
JUN	2569.36	158,986	0	-5,486	151	36,536	99,700	136,791	605	151	0	-4,326
JUL	2572.22	162,546	0	3,560	107	59,449	84,342	133,910	782	107	0	-5,539
AUG	2566.34	155,281	0	-7,265	107	82,643	24,187	107,813	737	107	0	-5,545
SEP	2572.28	162,622	0	7,341	115	85,017	74,867	146,037	663	115	0	-5,843
OCT	2574.44	165,346	0	2,724	167	90,679	61,847	144,572	534	167	0	-4,696
NOV	2567.90	157,188	69	-8,158	276	48,609	64,481	115,686	160	42	2,633	-3,003
DEC	2572.97	163,489	318	6,301	306	35,112	84,880	110,064	1	57	2,203	-1,672
TOTAL	---	---	---	6,363	3,683	823,878	622,251	1,383,076	4,072	3,245	4,836	-48,220

1/ Stream flow releases, portions of which may be used to satisfy the fishery enhancement agreement.

2/ Deliveries to Ventura County Flood Control District.

**Table 17. Elderberry Forebay Monthly Operation  
1990**

(in acre-feet except as noted)

Month	Water Surface Elevation (in feet)	Storage	Storage Change	Inflow		Outflow			Computed Losses (-) Gains (+)
				Castaic Powerplant Generation	Natural	To Castaic Lake		Pumpback To Pyramid Lake 1/	
						Natural	Project		
JAN	1504.45	17,468	-10,134	125,300	0	0	104,945	30,998	509
FEB	1516.46	22,094	4,626	105,132	13	13	71,018	30,439	951
MAR	1524.94	25,690	3,596	108,377	6	6	96,814	8,143	176
APR	1530.96	28,428	2,738	74,032	1	1	49,313	22,131	150
MAY	1519.50	23,349	-5,079	75,362	0	0	44,388	36,236	183
JUN	1529.80	27,889	4,540	136,791	0	0	34,683	99,700	2,132
JUL	1511.70	20,201	-7,688	133,910	0	0	58,925	84,342	1,669
AUG	1519.38	23,299	3,098	107,813	0	0	80,536	24,187	8
SEP	1518.80	23,057	-242	146,037	0	0	72,258	74,867	846
OCT	1509.68	19,422	-3,635	144,572	0	0	86,513	61,847	153
NOV	1526.69	26,470	7,048	115,686	0	0	44,240	64,481	83
DEC	1518.00	22,725	-3,745	110,064	0	0	29,003	84,880	74
TOTAL	---	---	-4,877	1,383,076	20	20	772,636	622,251	6,934

1/ Pumpback by Los Angeles Department of Water and Power (LADWP) through Castaic Power Plant.

**Table 18. Castaic Lake Monthly Operation  
1990**

(in acre-feet except as noted)

Month	Water Surface Elevation (in feet)	End-of-Month Storage	Natural Inflow Storage Shares	Storage Change	Inflow			Outflow		Computed Losses (-) Gains (+)	Castaic Lagoon Release of Natural Inflow
					Natural	From Elderbery Forebay		Deliveries	Released to Castaic Lagoon		
						Natural	Project				
JAN	1485.01	260,680	0	43,910	40	0	104,945	61,835	0	760	60
FEB	1495.90	282,650	169	21,970	273	13	71,018	52,320	174	3,160	117
MAR	1510.69	314,150	97	31,500	87	6	96,814	64,150	660	-597	165
APR	1511.76	316,505	0	2,355	67	1	49,313	46,074	619	-333	165
MAY	1501.17	293,650	0	-22,855	21	0	44,388	66,948	534	218	21
JUN	1491.47	273,595	0	-20,055	4	0	34,683	53,286	199	-1,257	4
JUL	1484.20	259,084	0	-14,511	0	0	58,925	74,358	787	1,709	0
AUG	1488.74	268,099	0	9,015	0	0	80,536	73,672	0	2,151	0
SEP	1488.76	268,140	0	41	0	0	72,258	72,639	755	1,177	0
OCT	1493.57	277,866	0	9,726	0	0	86,513	76,976	0	189	0
NOV	1478.79	248,560	0	-29,306	0	0	44,240	73,259	0	-287	0
DEC	1455.90	206,580	0	-41,980	11	0	29,003	71,184	0	190	0

**Table 19. Silverwood Lake Monthly Operation**

**1990**

(in acre-feet except as noted)

Month	Water Surface Elevation (in feet)	End-of-Month Storage	Natural Inflow Storage Shares	Storage Change	Inflow		Outflow			Computed Losses (-) Gains (+)	Natural Inflow Exchanged or Released 1/
					Natural	Project	San Bernardino Tunnel	CLAWA Turnout	Release of Natural Inflow To Mojave River		
JAN	3334.80	56,643	341	252	170	0	43	153	10	288	10
FEB	3352.17	72,235	566	15,592	958	63,180	46,322	169	336	-1,719	733
MAR	3348.13	68,428	558	-3,807	772	55,700	59,698	155	12	-414	780
APR	3347.72	68,048	74	-380	182	75,290	74,260	103	11	-1,478	666
MAY	3345.69	66,182	56	-1,866	86	67,440	67,551	140	11	-1,690	104
JUN	3349.55	69,753	-16	3,571	18	73,428	67,886	149	10	-1,830	90
JUL	3345.16	65,700	-59	-4,053	0	78,780	81,655	219	10	-949	43
AUG	3347.75	68,076	-69	2,376	0	75,403	72,041	230	10	-746	10
SEP	3346.54	66,960	-79	-1,116	0	71,120	70,618	212	10	-1,396	10
OCT	3335.04	56,845	-89	-10,115	0	67,503	77,753	183	10	328	10
NOV	3336.26	57,877	-97	1,032	0	70,870	69,465	178	8	-187	8
DEC	3332.74	54,924	-105	-2,953	0	49,210	51,529	166	8	-460	8
TOTAL	---	---	---	-1,467	2,186	747,924	738,821	2,057	446	-10,253	2,472

1/ Total releases made from Mojave Siphon to Las Flores Ranch Co., in exchange for natural inflow stored in lake, and from Silverwood Lake to Mojave River from outlet for Mojave W.W. The difference between this total column and the natural inflow released to Mojave River equals the Las Flores Ranch portion.

**Table 20. Lake Perris Monthly Operation  
1990**

(in acre-feet except as noted)

Month	Water Surface Elevation (in feet)	End Of Month Storage	Storage Change	Inflow	Outflow	Computed Losses (-) Gains (+)
JAN	1578.69	106,182	-4,065	0	3,232	-833
FEB	1587.70	126,155	19,973	21,359	390	-996
MAR	1587.55	125,811	-344	1,954	1,578	-720
APR	1587.41	125,492	-319	393	531	-181
MAY	1584.86	119,721	-5,771	333	6,045	-59
JUN	1587.40	125,469	5,748	7,144	568	-828
JUL	1586.75	123,987	-1,482	1,219	564	-2,137
AUG	1583.62	116,953	-7,034	1,117	6,441	-1,710
SEP	1581.17	111,555	-5,398	1,045	4,387	-2,056
OCT	1579.68	108,317	-3,238	1,685	3,321	-1,602
NOV	1579.34	107,582	-735	1,001	970	-766
DEC	1578.43	105,625	-1,957	8,837	9,228	-1,566
TOTAL	---	---	-4,622	46,087	37,255	-13,454

**Figure 1. Mean Daily Chloride Levels at Delta Stations  
1990**

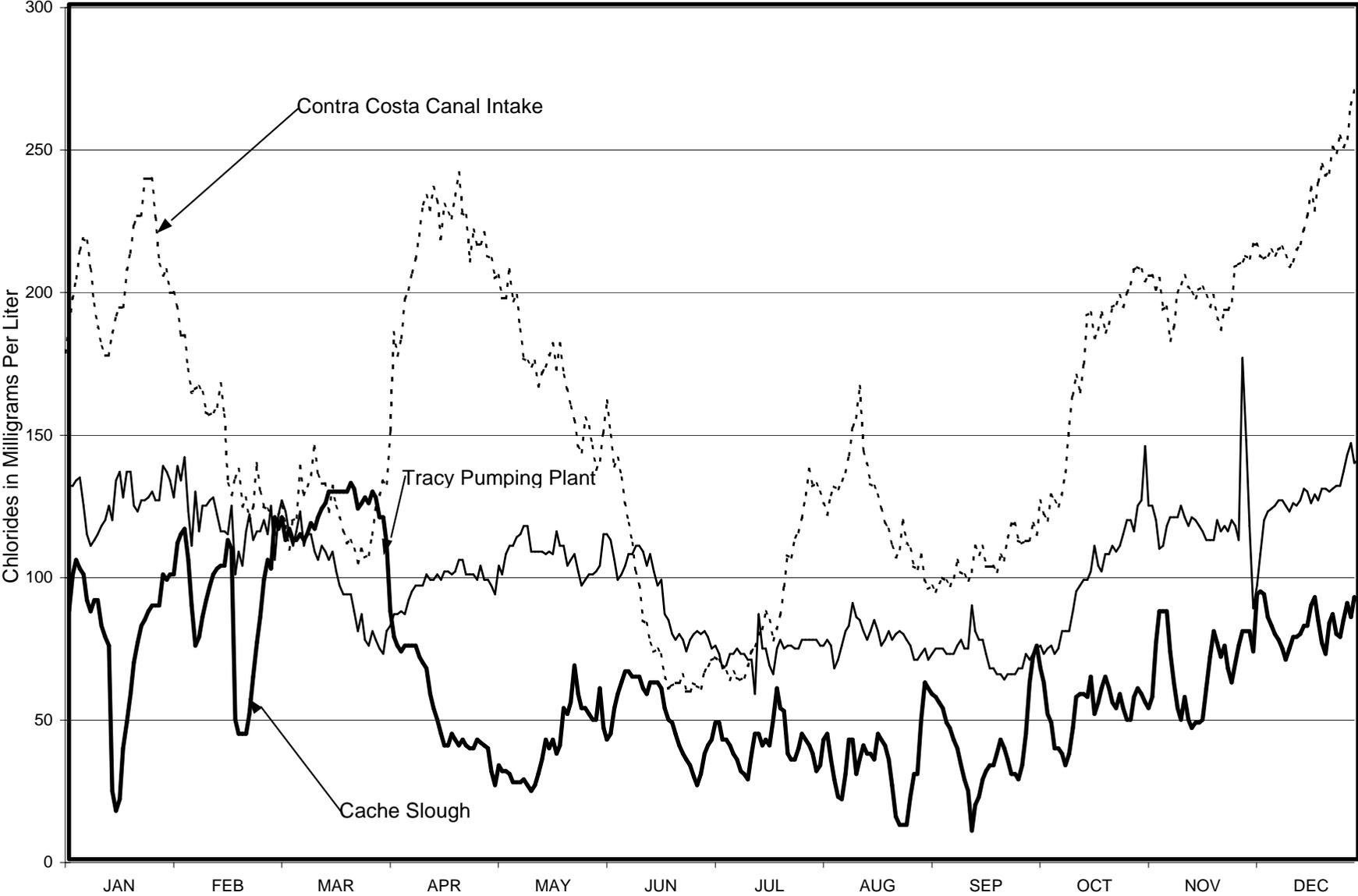
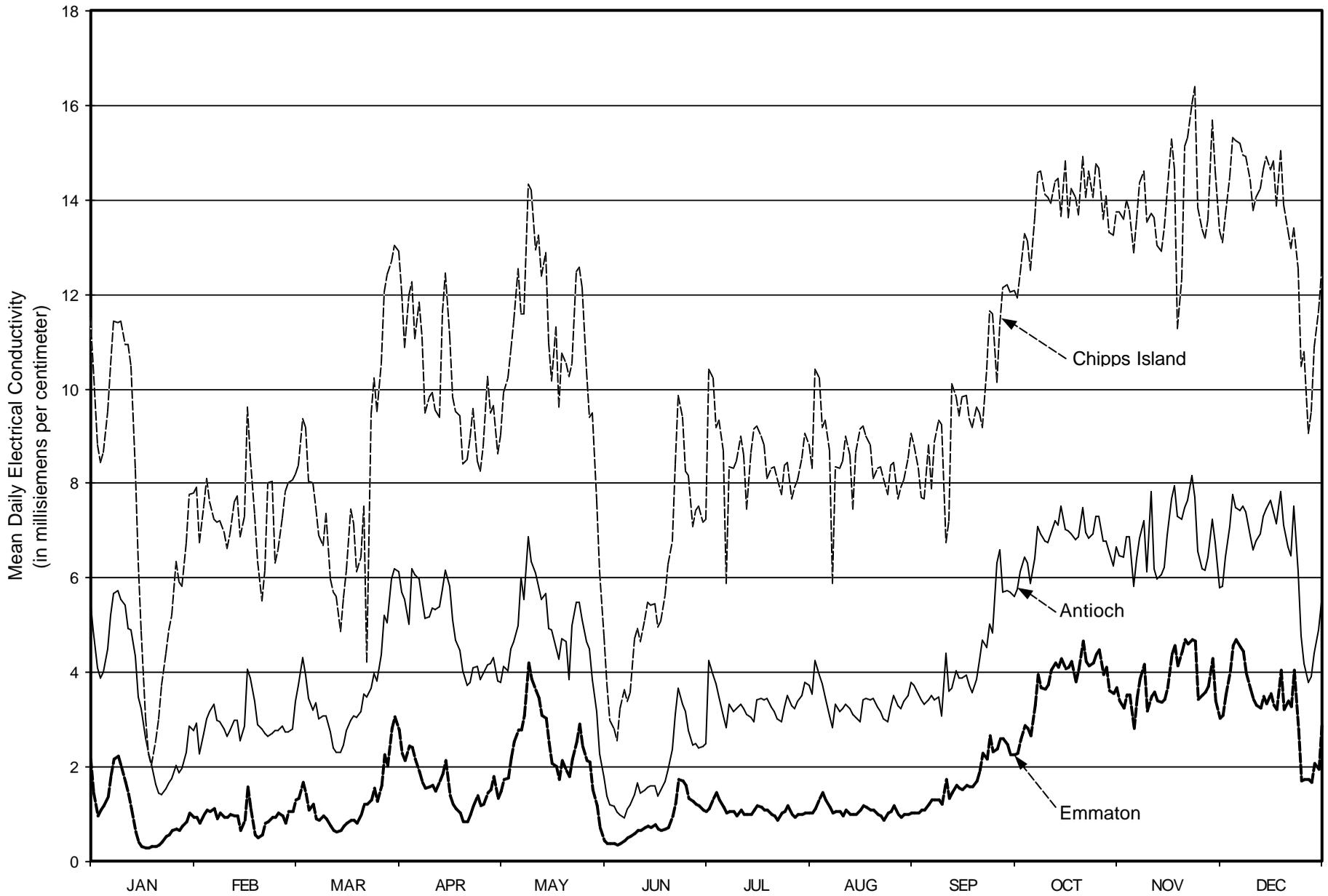
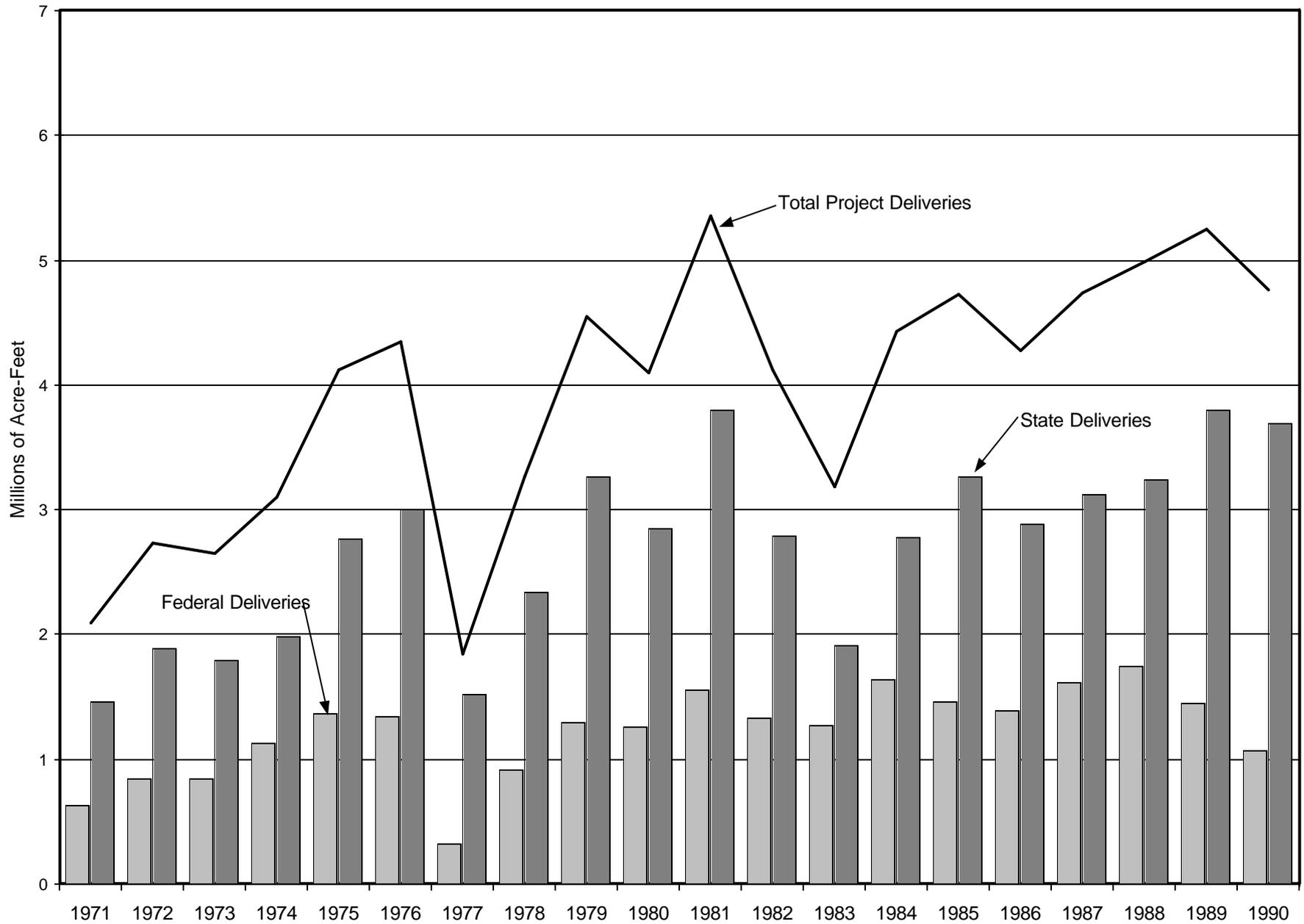


Figure 2. Mean Daily Electrical Conductivity at Delta Stations  
1990



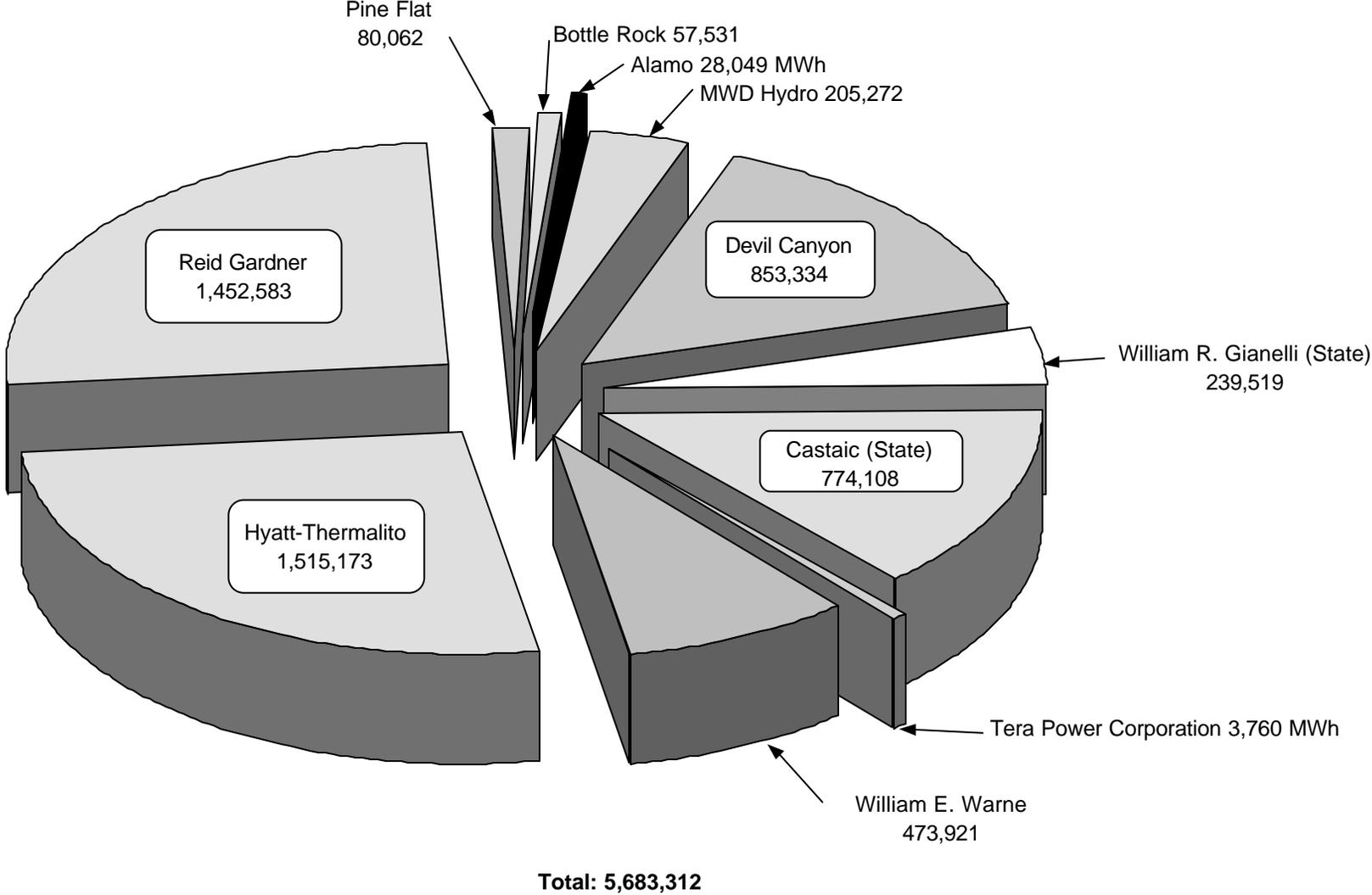
**Figure 3. Total Deliveries from SWP Facilities**

Annual Totals



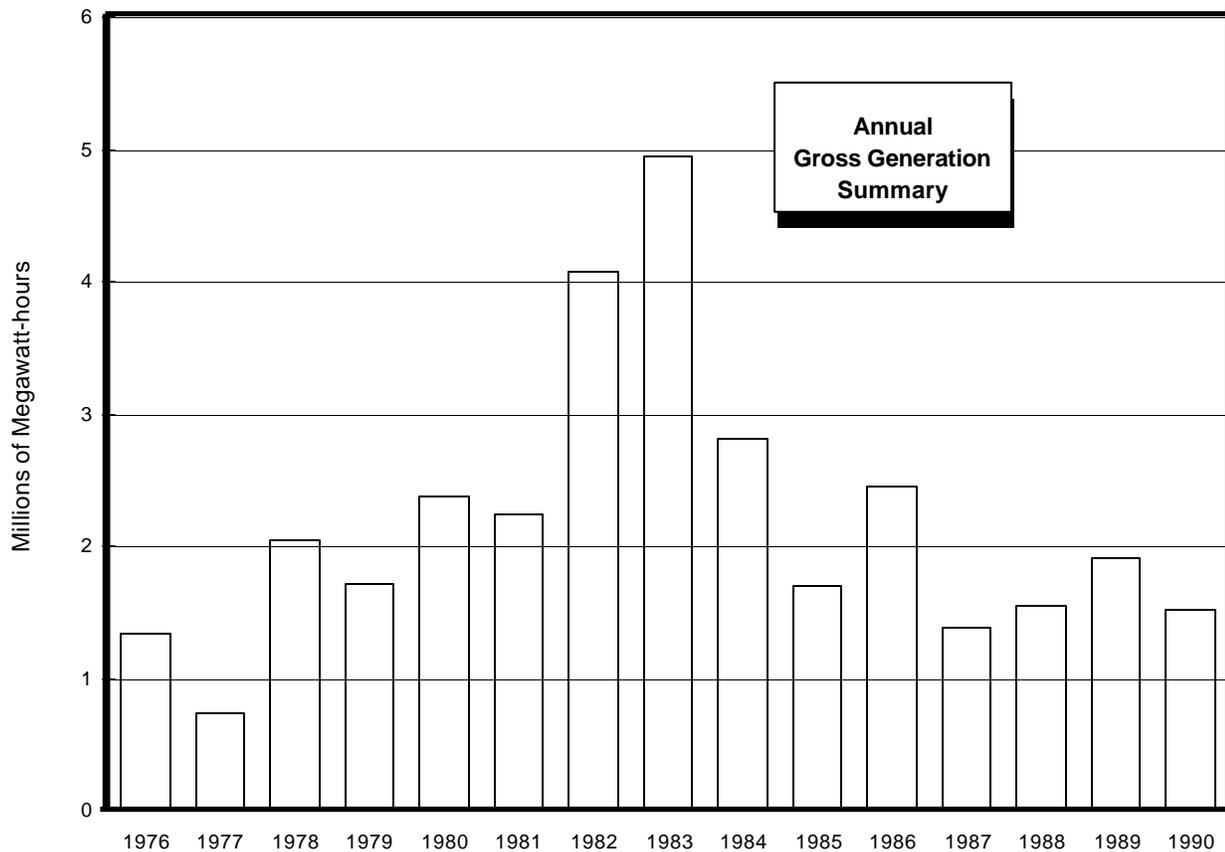
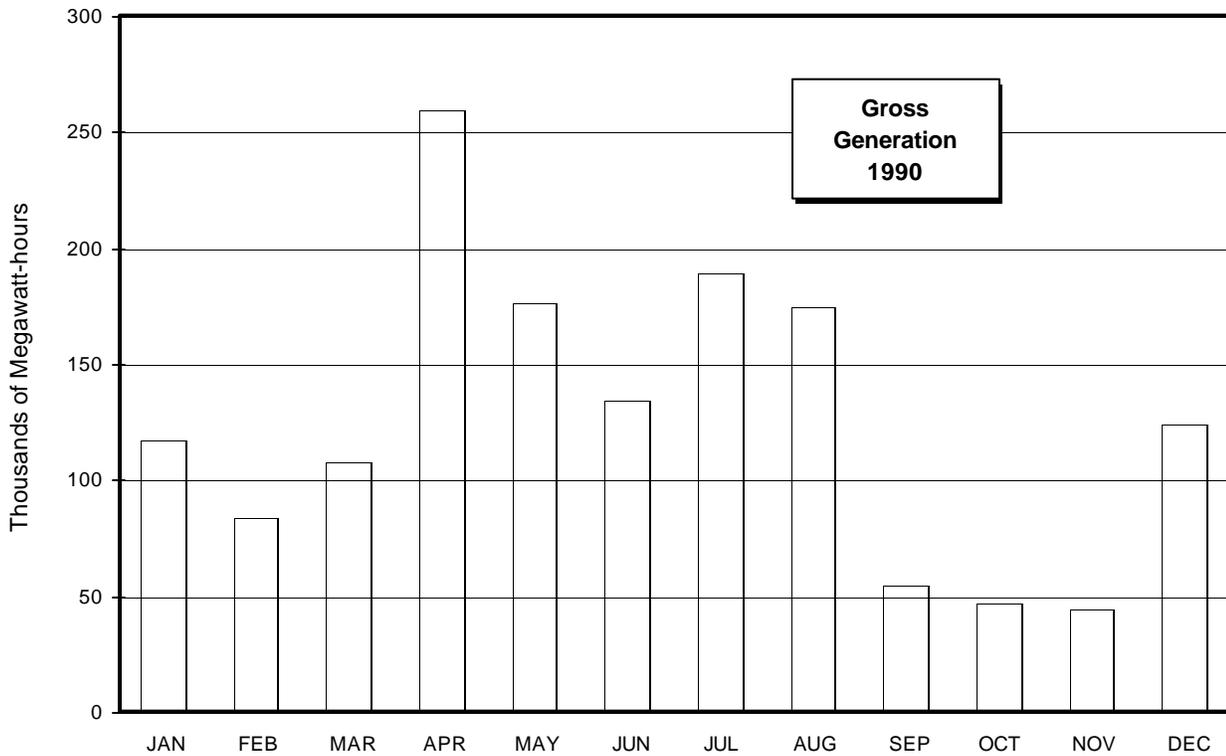
**Figure 4. SWP Energy Resources**

(in MWh)  
**1990**



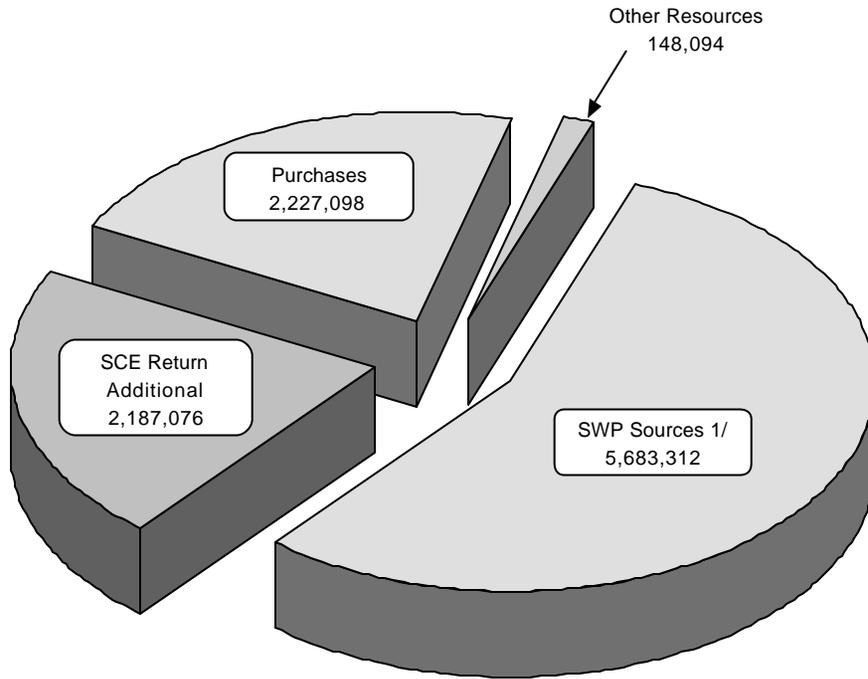
Note: Purchases, Other Sources, and SCE Return Additional are not shown here. All values are metered readings at plants and are not adjusted for transmission losses.

**Figure 5. Operation of Edward Hyatt and Thermalito Powerplants**



**Figure 6. Total Energy Resources**

(in MWh)  
**1990**



Total: 10,245,580

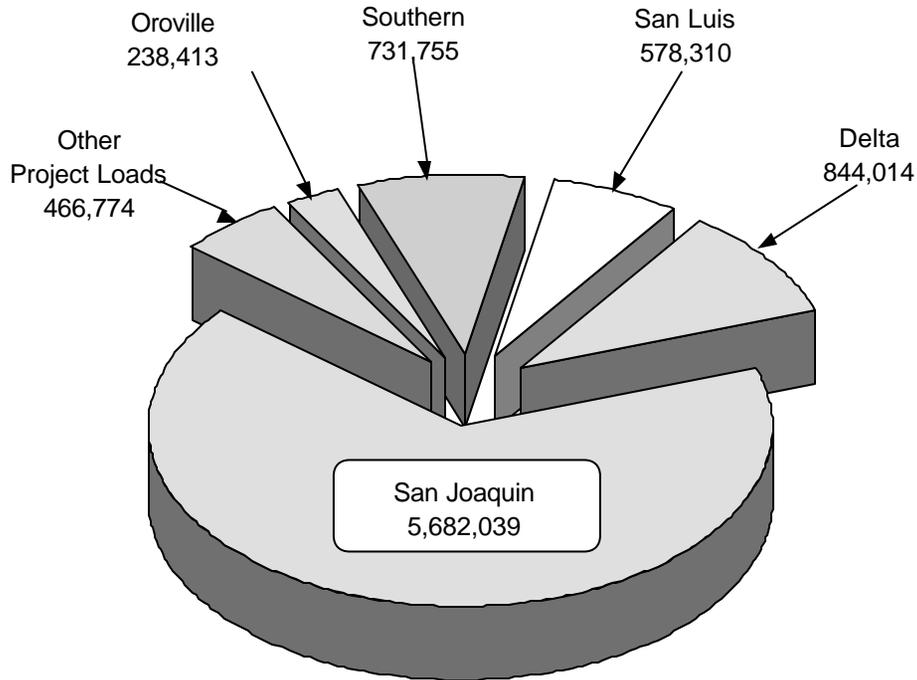
1/ See Figure 4 for a breakdown of this source.

<u>Purchases</u>	
Bonneville Power Authority	575,884
British Columbia Hydro Authority	508,491
Washington Water and Power Co.	424,735
Salt River Project	249,280
Montana Power Company	88,390
Pacific Gas and Electric	86,794
Pacific Power and Light	83,198
Portland General Electric	61,082
Arizona Public Service Co.	50,945
Puget Sound Power and Light	35,872
Western Area Lower Colorado	27,330
Seattle City Light	22,514
Idaho Power Company	6,022
Northern California Power Agency	2,545
Eugene Water and Electric Board	1,611
Los Angeles Dept. of Water and Power	1,540
El Paso Electric	865
	<hr/>
	2,227,098
<u>Other Resources</u>	
Southern California Edison	120,230
Bonneville Power Authority	10,186
Los Angeles Dept. of Water and Power	7,155
Pacific Gas and Electric	6,946
Western Area Mid Pacific	2,962
Northern California Power Agency	615
	<hr/>
	148,094
<u>SCE Return Additional</u>	
Total Received From SCE	3,866,856
SCE Hyatt-Thermalito Entitlement	-593,125
SCE Devil Canyon Entitlement	-853,334
SCE Alamo Entitlement	-28,049
MWD Hydro Entitlement	-205,272
	<hr/>
	2,187,076

**Figure 7. SWP Energy Loads**

(in MWh)

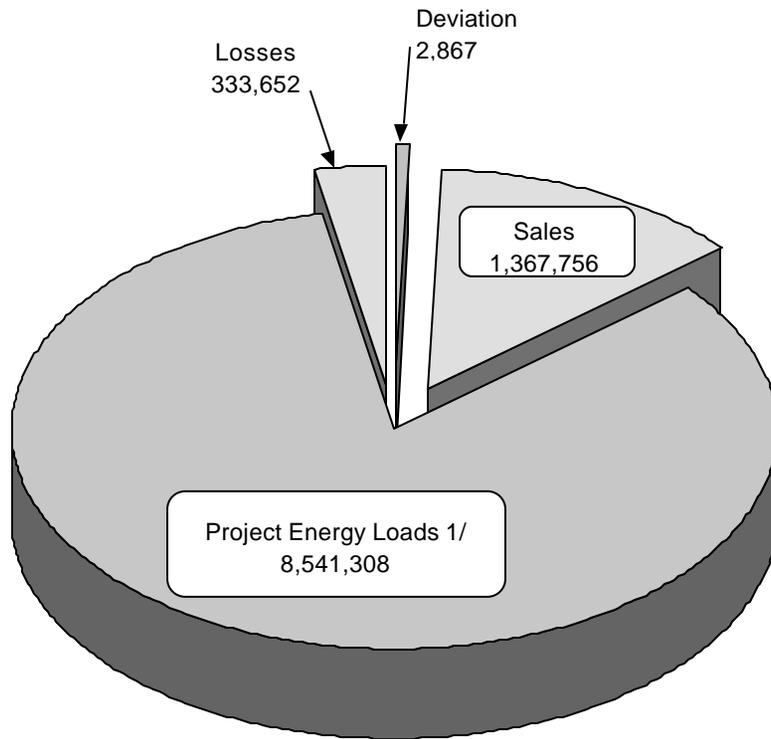
**1990**



Total: 8,541,305

<u>Oroville Field Division</u>	
Hyatt-Thermalito Complex (Pumpback and Station Service)	238,413
<u>Delta Field Division</u>	
North Bay	16,422
South Bay	162,271
Del Valle	719
Harvey O. Banks Delta	663,758
Bottle Rock (Station Service)	844
<u>San Luis Field Division</u>	
William R. Gianelli	212,836
Dos Amigos	363,515
Pine Flat (Station Service)	1,959
<u>San Joaquin Field Division</u>	
Las Perillas	9,635
Badger Hill	25,757
Buena Vista	442,458
Wheeler Ridge	466,720
Wind Gap	1,049,928
A.D.Edmonston	3,687,541
<u>Southern Field Division</u>	
Oso	222,256
Pearblossom	509,316
William E. Warne (Station Service)	183
<u>Other Project Loads</u>	
Southern California Edison	418,184
Nevada Power	25,921
Bonneville Power Authority	10,186
Pacific Gas and Electric	7,022
Northern Calif. Power Agency	2,726
City of Vernon	2,560
South Bay Station Service	175

**Figure 8. Total Energy Loads**  
(in MWh)  
**1990**

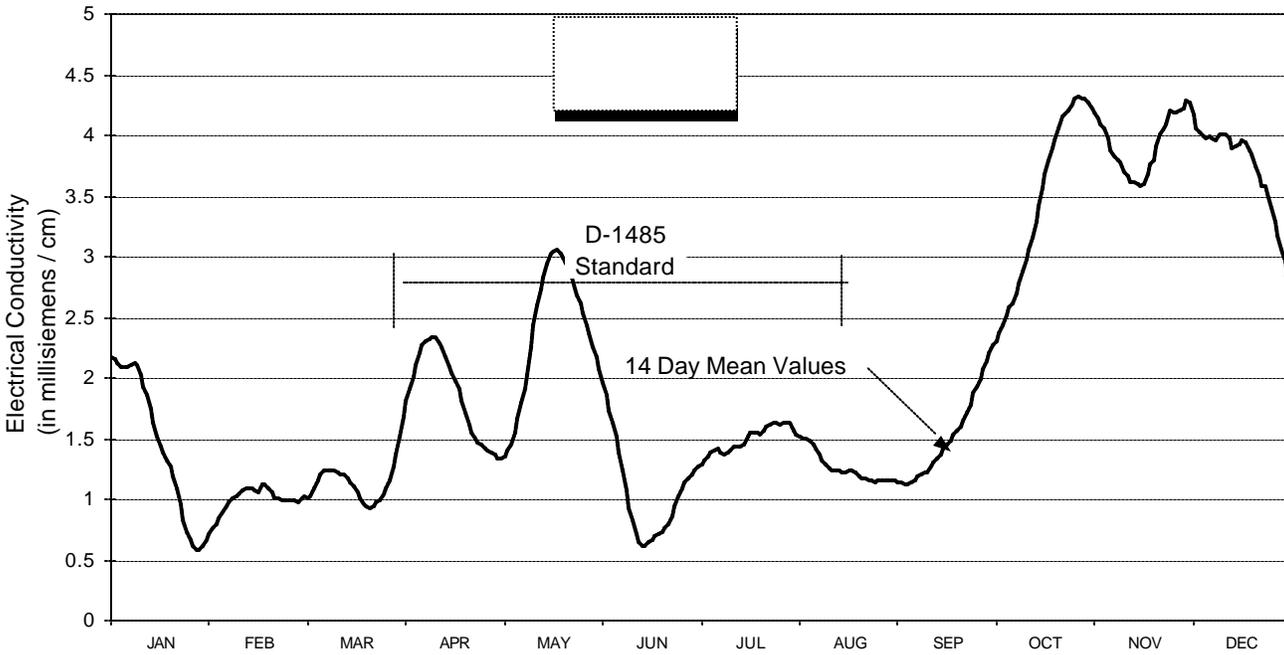
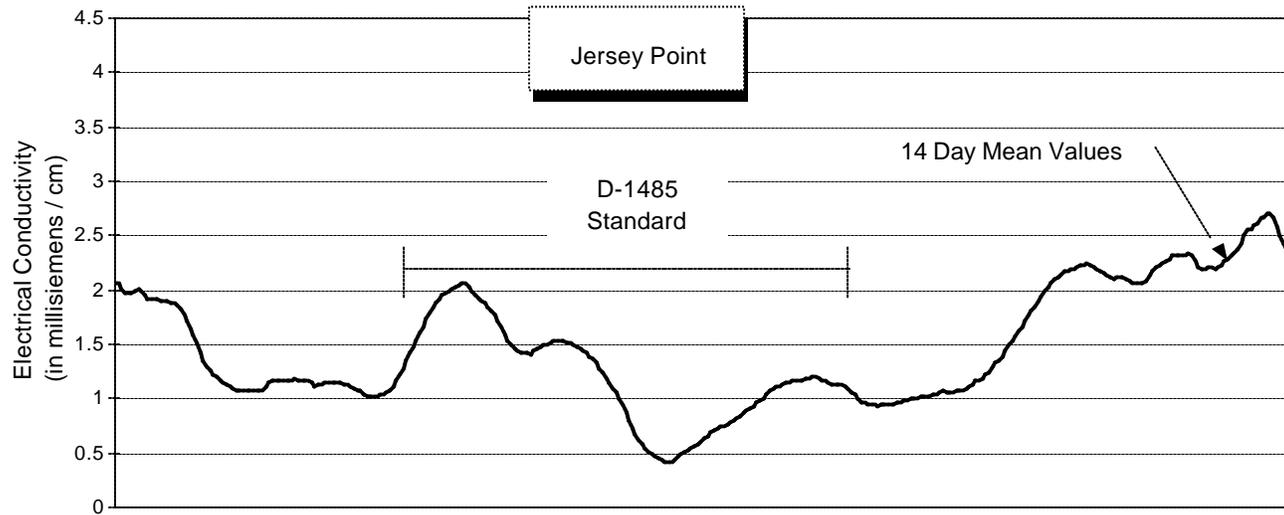
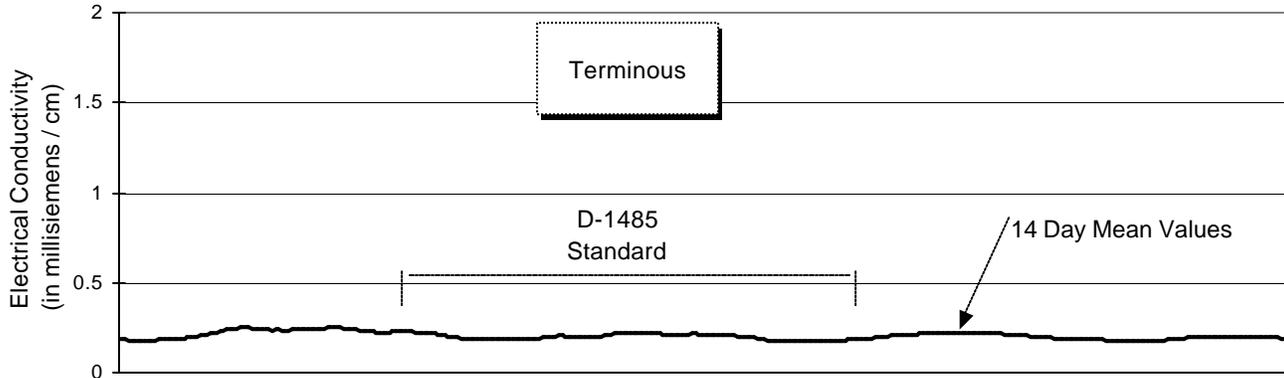


<u>Sales</u>	
City of Vernon	302,778
Modesto Irrigation District	245,161
Turlock Irrigation District	171,064
Nevada Power	164,707
Southern California Edison	157,033
Pacific Gas and Electric	110,031
Sacramento Municipal Utility District	59,049
City of Anaheim	36,199
City of Riverside	26,024
Azusa, Banning, Colton, Riverside	25,920
Northern California Power Agency	17,538
Puget Sound Power Authority	15,107
City of Colton	14,373
City of Azusa	12,750
Salt River Project	5,660
City of Banning	2,912
Portland General Electric	1,200
San Diego Gas and Electric	250

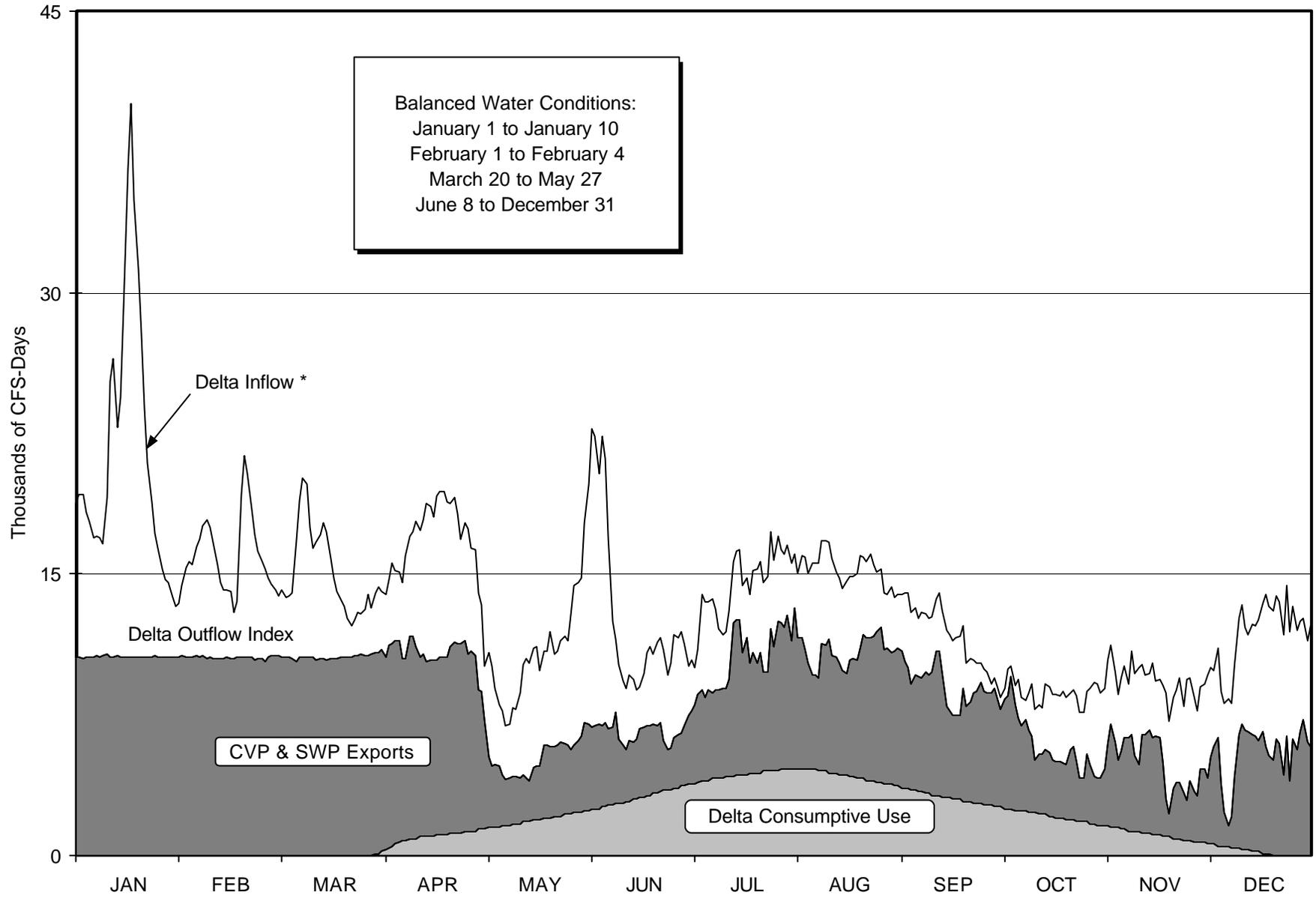
Total: 10,245,340

1/ See Figure 7 for breakdown of Project Energy Loads.

**Figure 9. Water Quality Conditions at Selected Delta Stations  
1990**

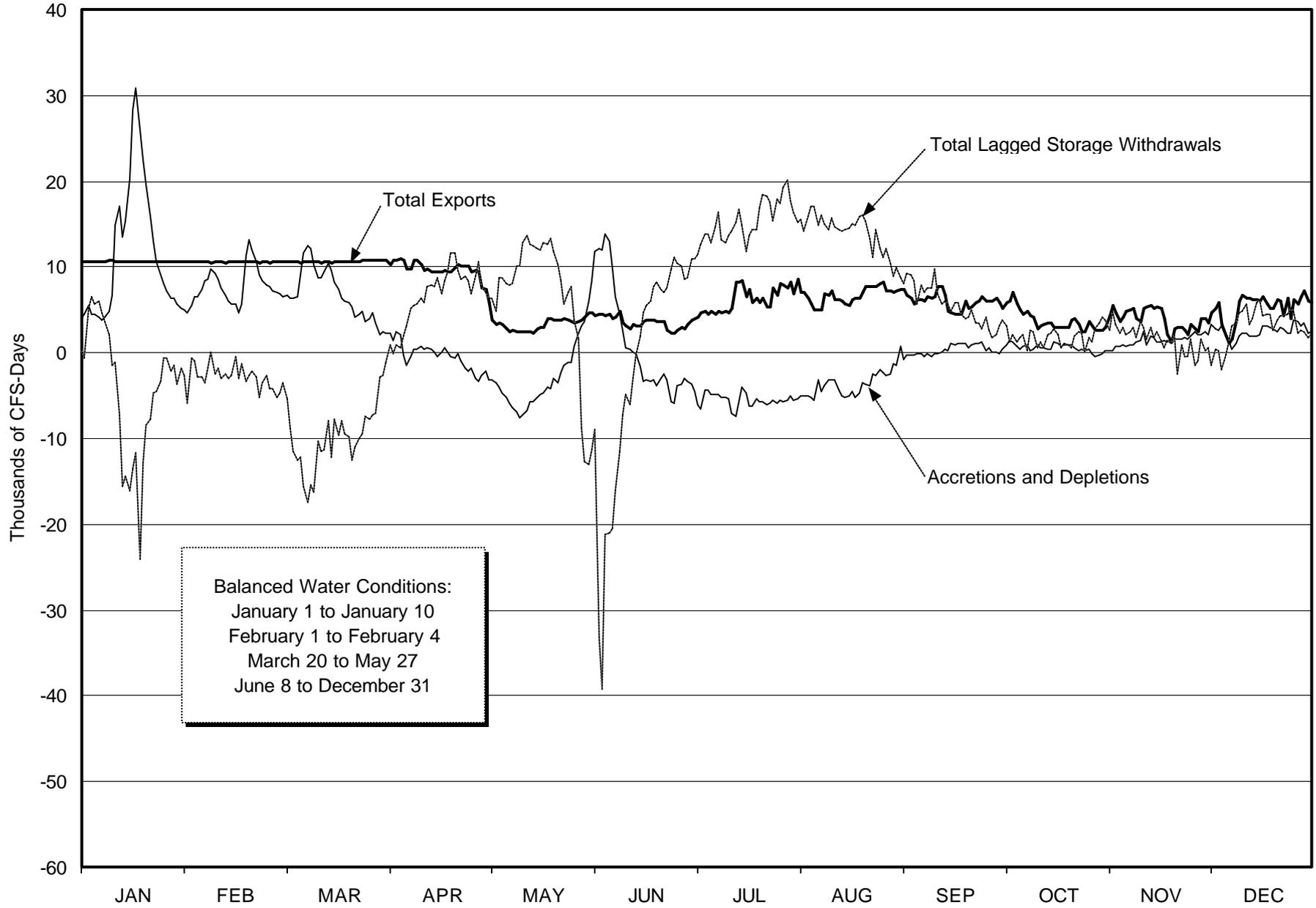


**Figure 10. Coordinated Delta Operations  
1990**

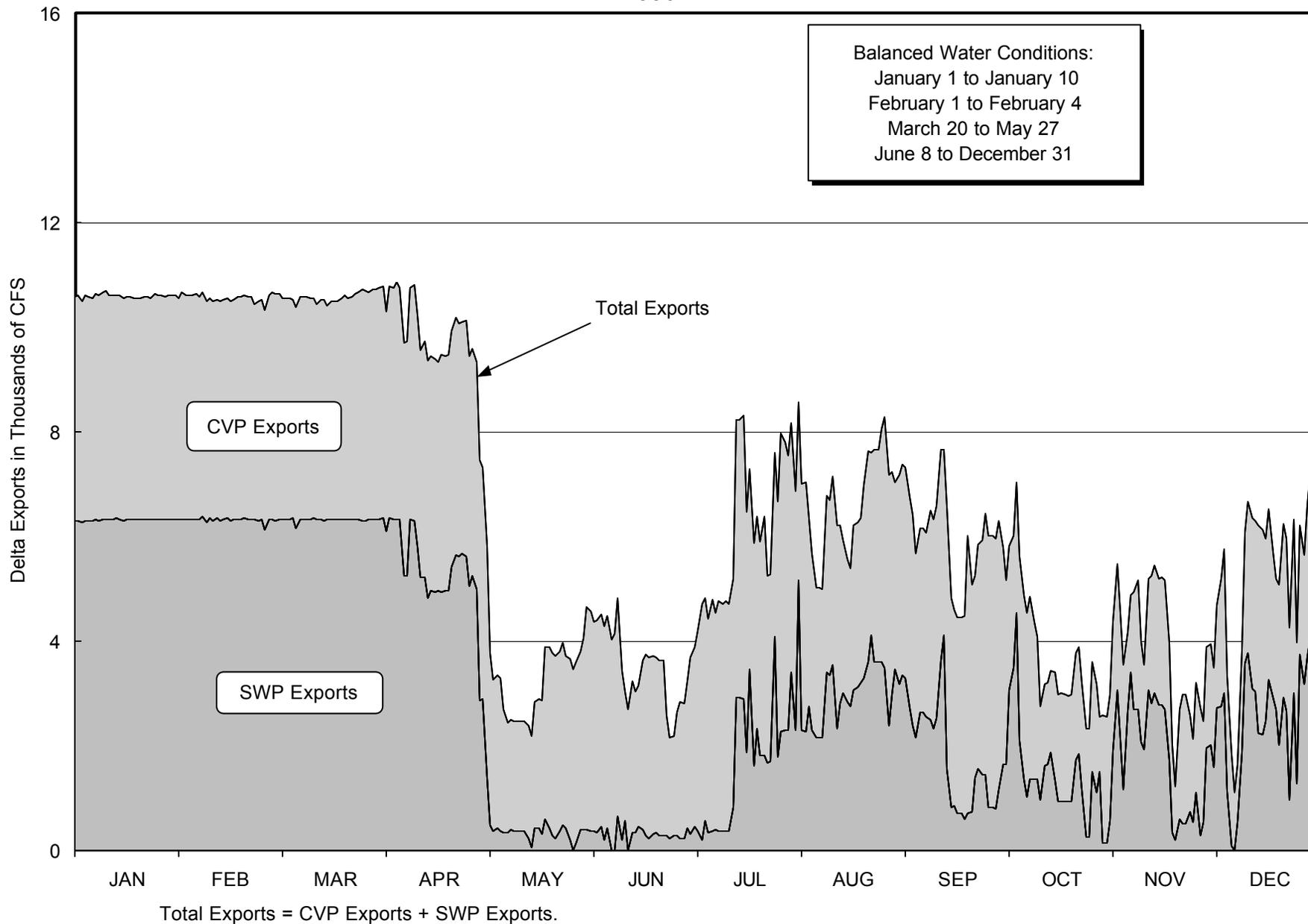


\* Delta inflow = Exports + Outflow + Consumptive use.

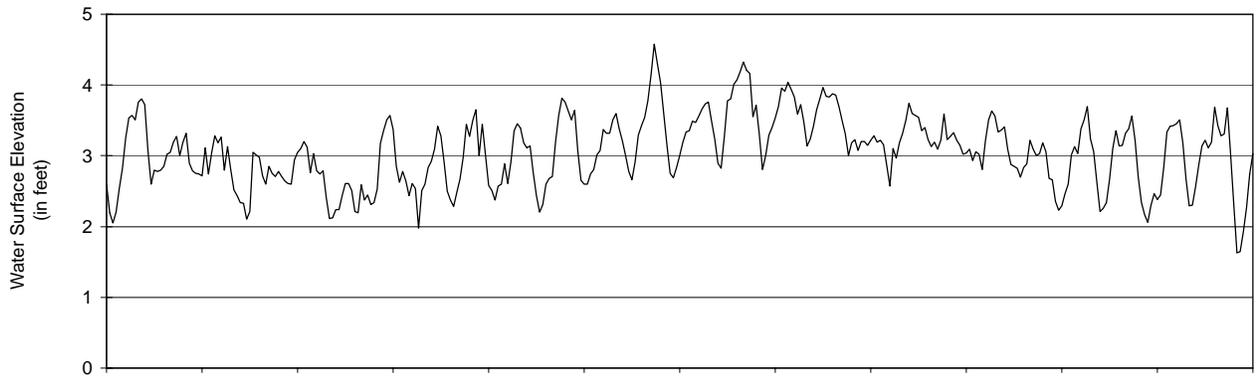
**Figure 11. Coordinated Delta Operations  
Lagged Storage Withdrawals  
1990**



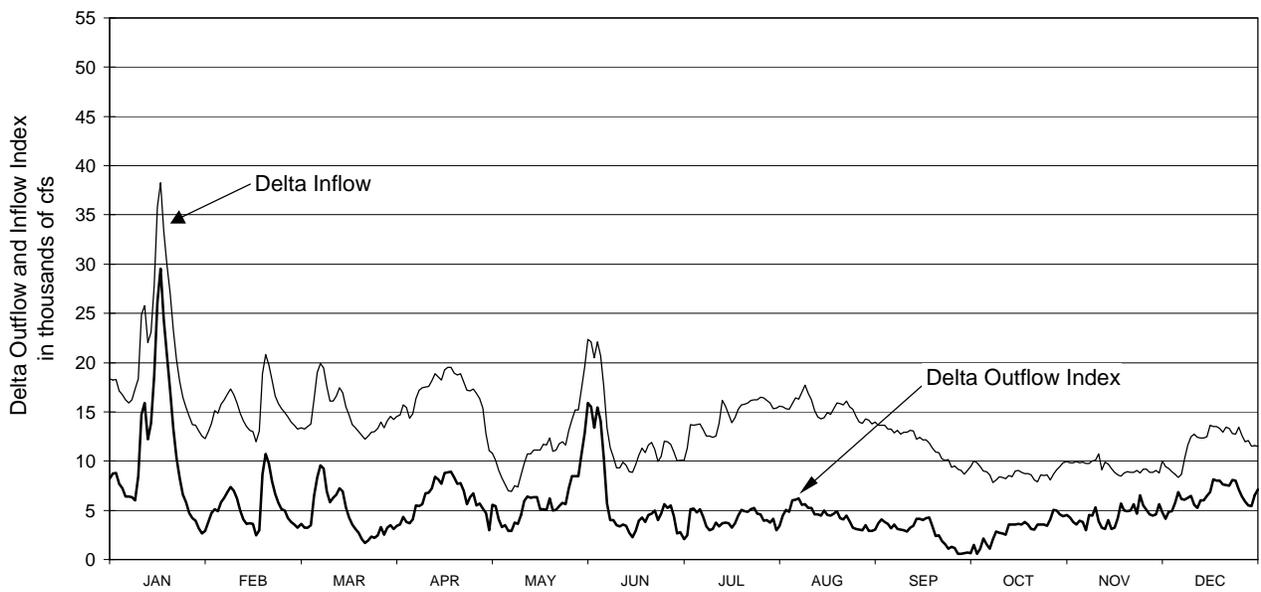
**Figure 12. Coordinated Delta Operations**  
**Delta Exports**  
**1990**



**Figure 13.**  
**Antioch High-High Tide**  
**1990**

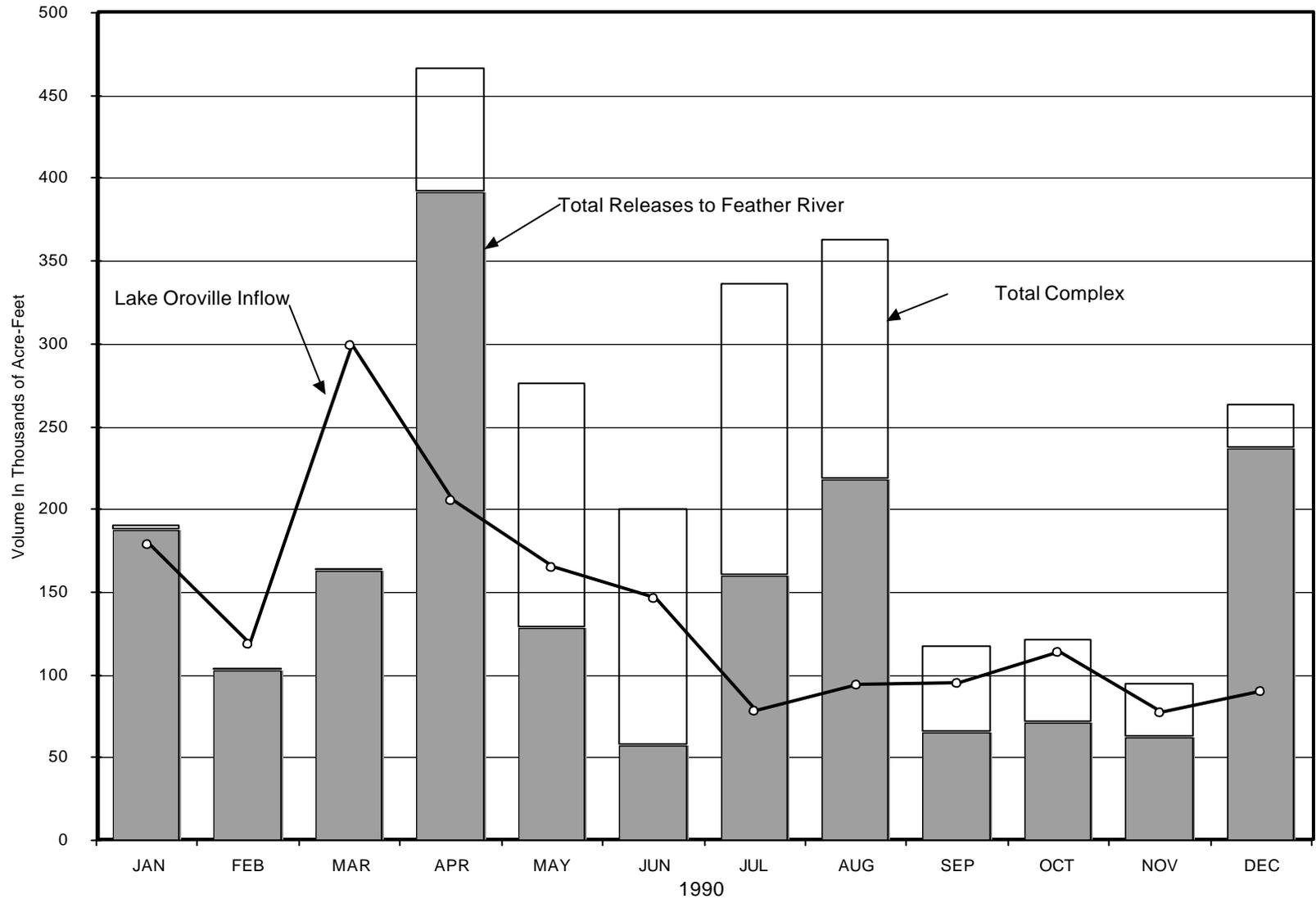


**Delta Inflow and Outflow Index**  
**1990**



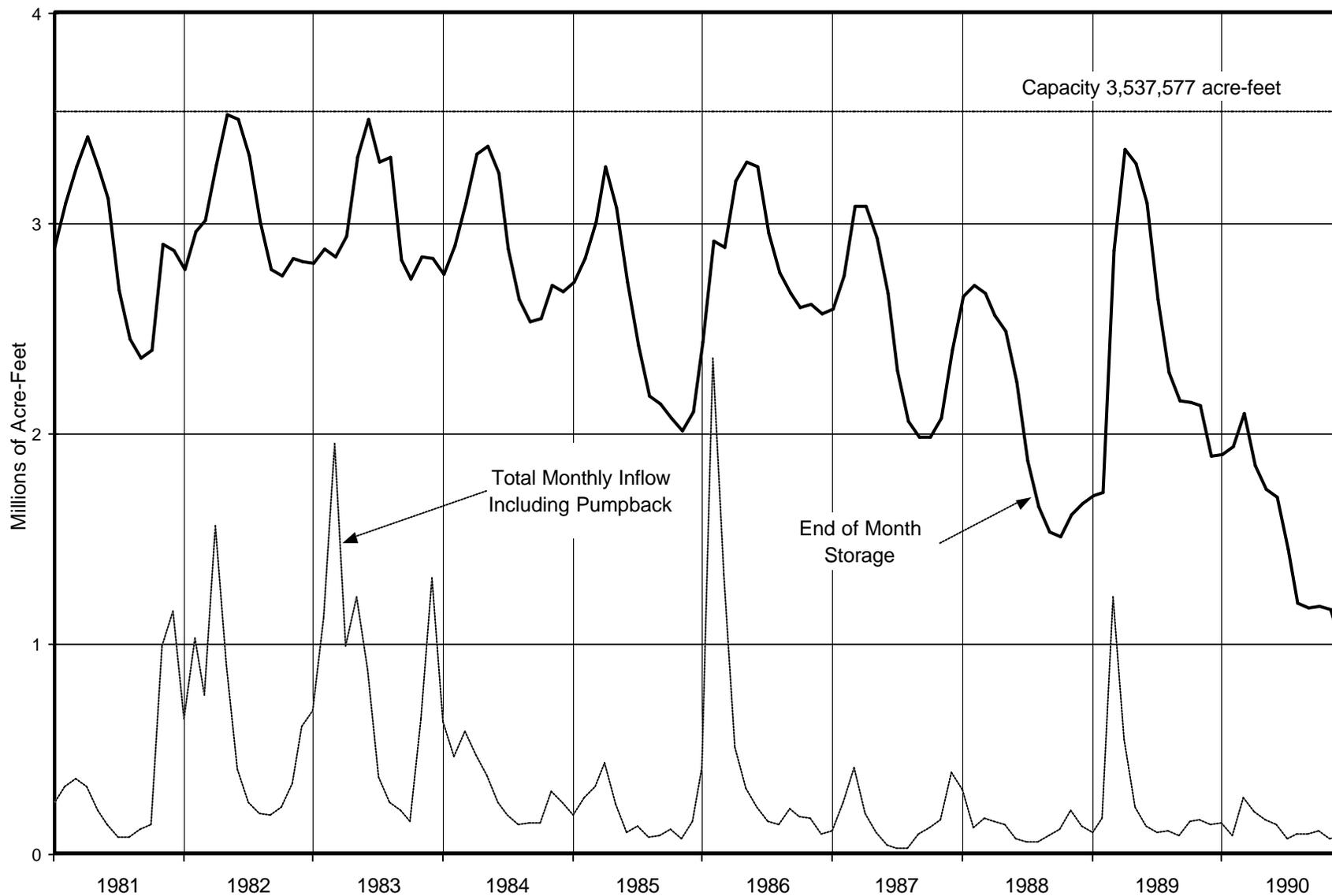
### Figure 14: Oroville-Thermalito Complex

Inflow, Releases, and Diversions

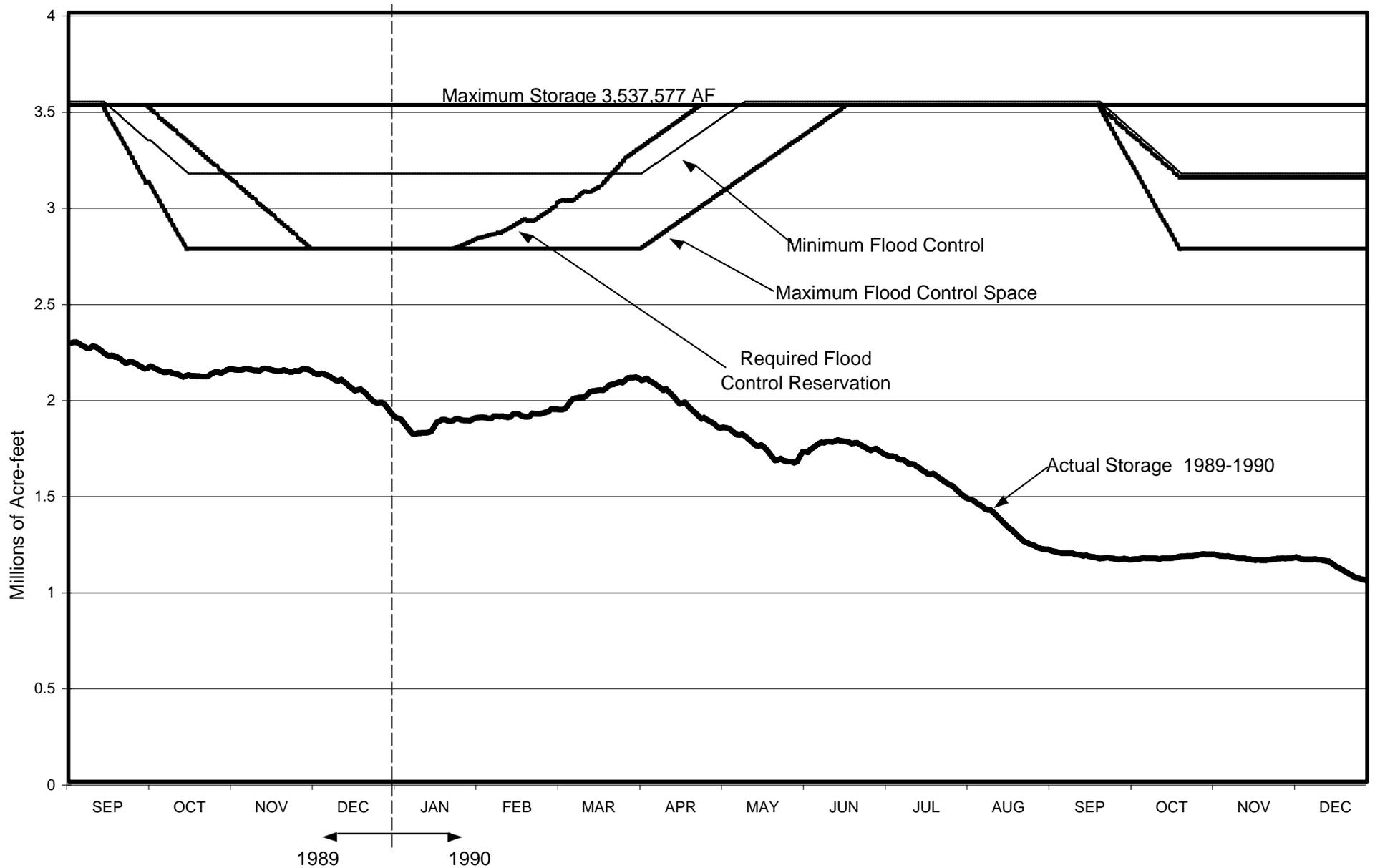


Note: Releases include flows at fish barrier dam, fish hatchery, and Afterbay river outlet. Diversions include Butte County, Thermalito Irrigation District, Sutter Butte Canal, Western Lateral, Richvale Canal, Sunset Pumps, and Western

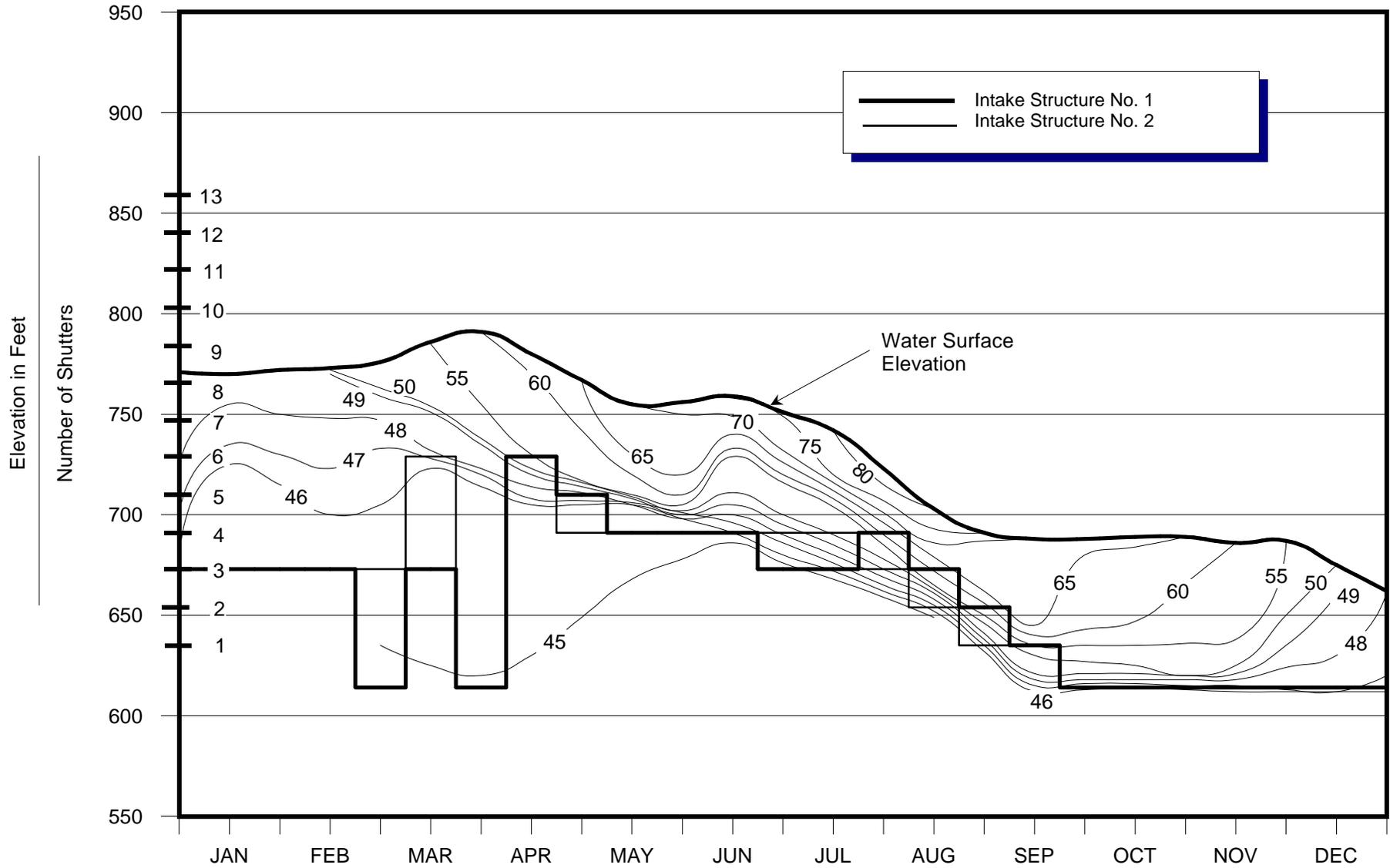
Figure 15. Lake Oroville Operation



**Figure 16. Operation of Lake Oroville for Flood Control  
1989 -1990**



**Figure 17. Lake Oroville Temperatures  
1990**  
(Isotherms in degrees Fahrenheit)



Note: Temperature data is obtained once per month and averaged for the rest of the year.

Figure 18. Lake Del Valle Operation

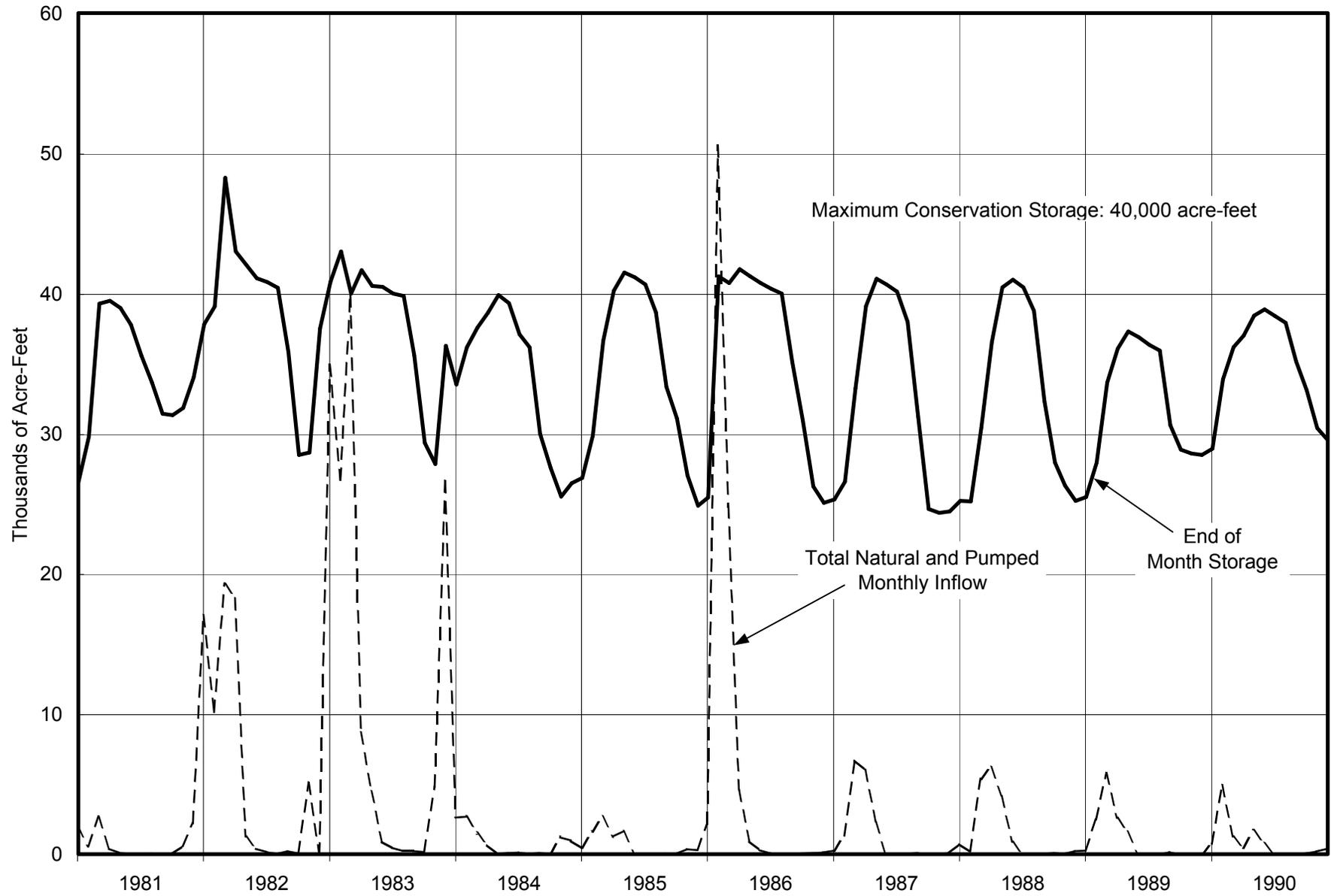


Figure 19. San Luis Reservoir Operation

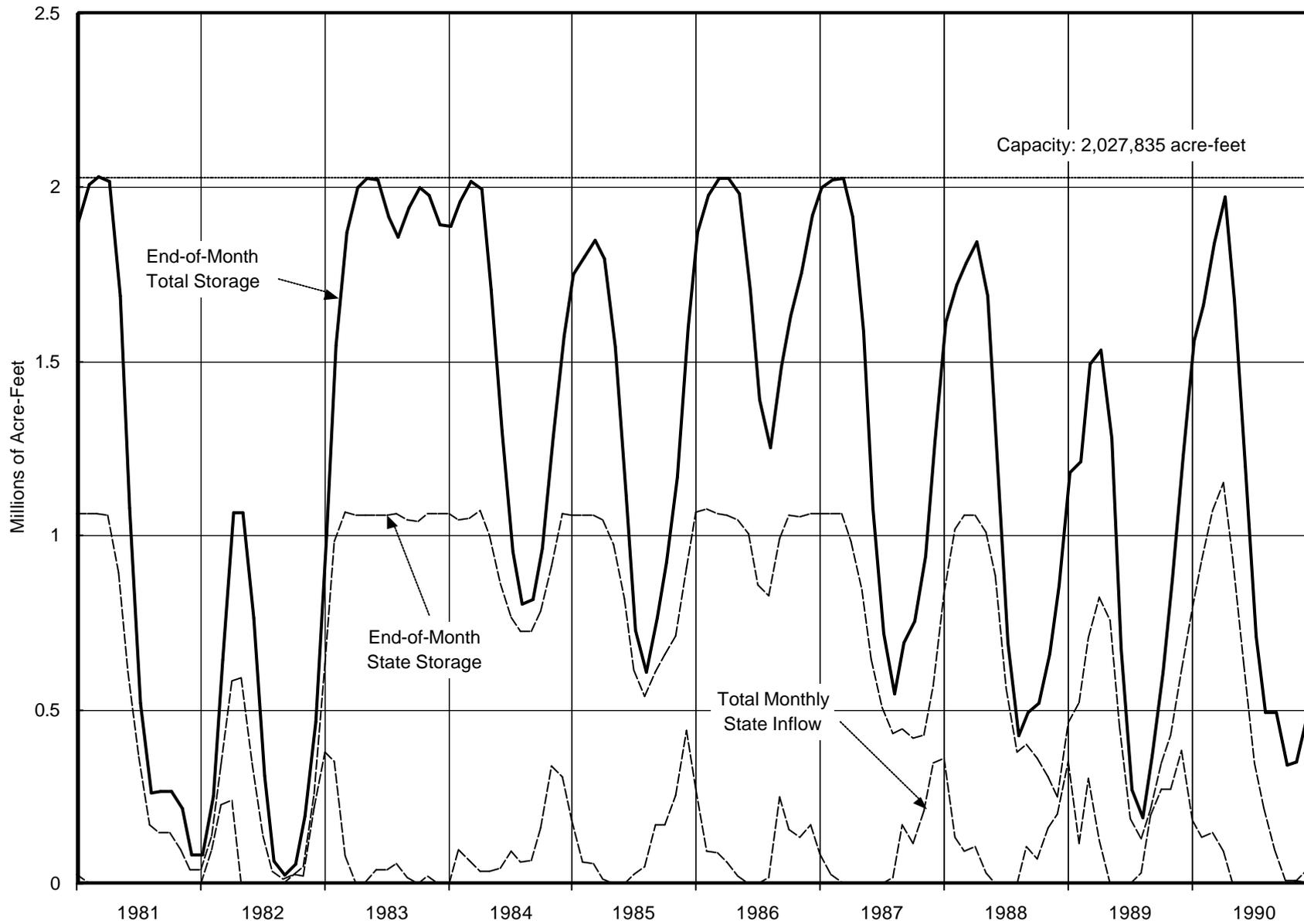
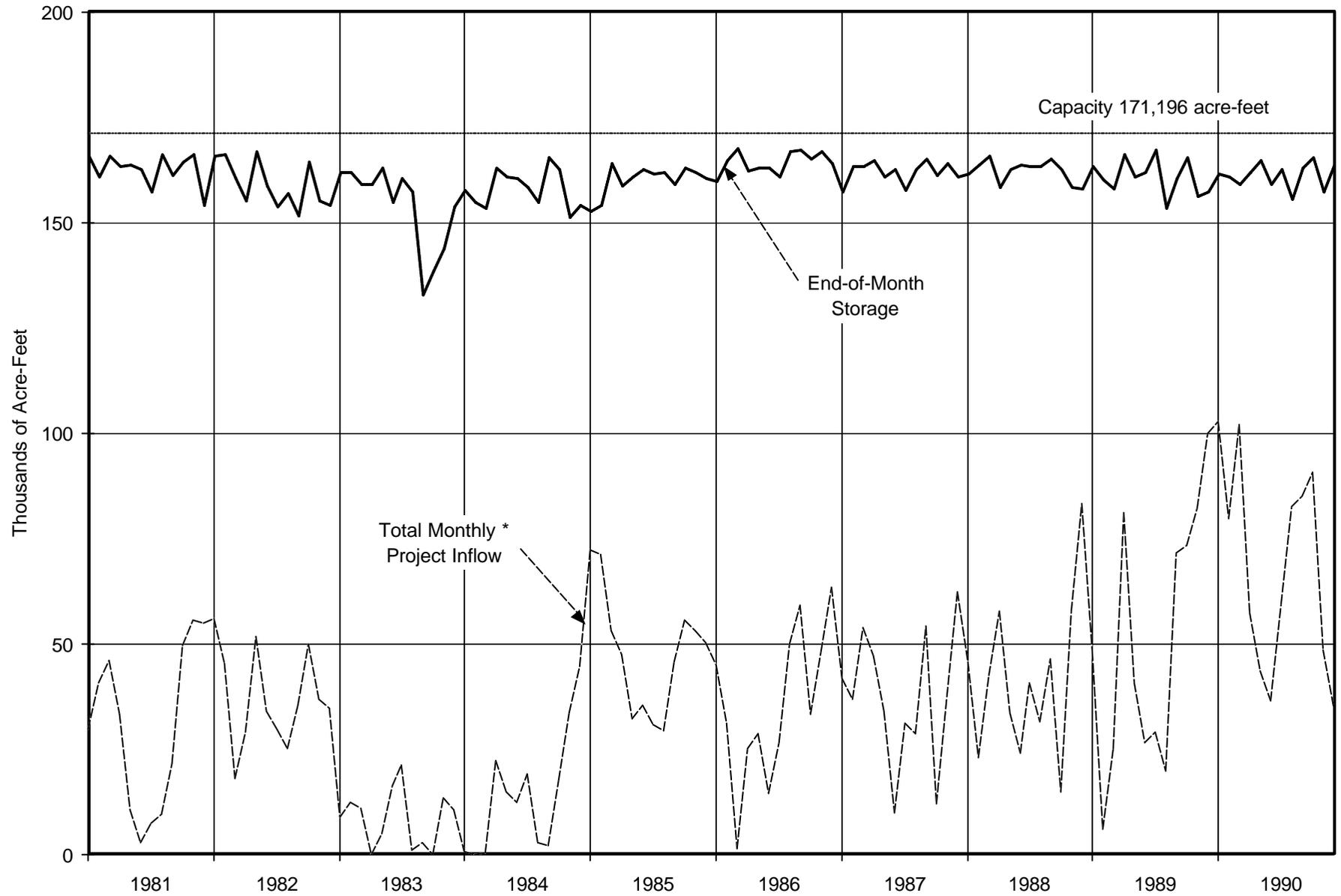


Figure 20. Pyramid Lake Operation



\* Excludes pumpback by LADWP through Castaic Powerplant.

Figure 21. Castaic Lake Operation

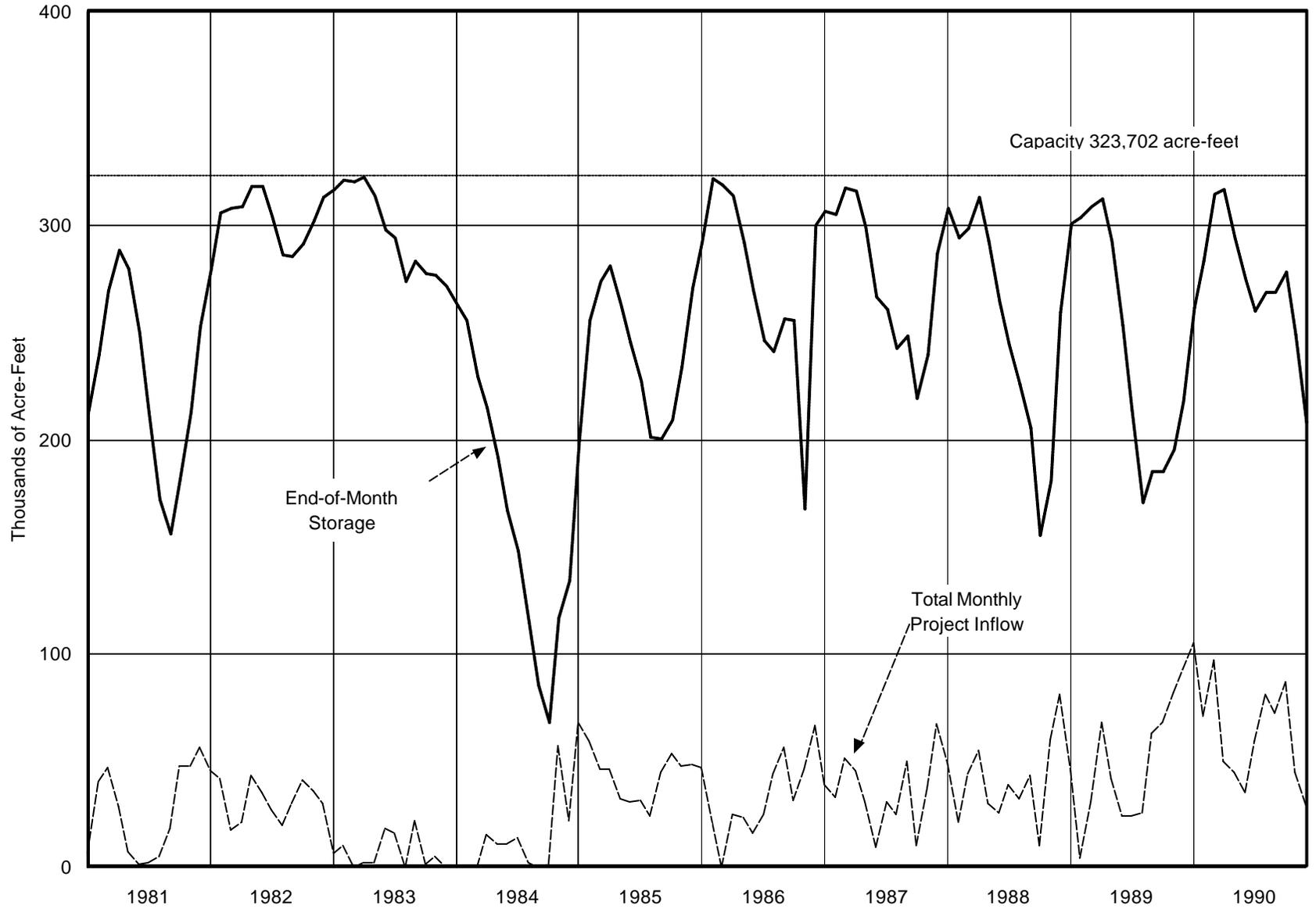


Figure 22. Silverwood Lake Operation

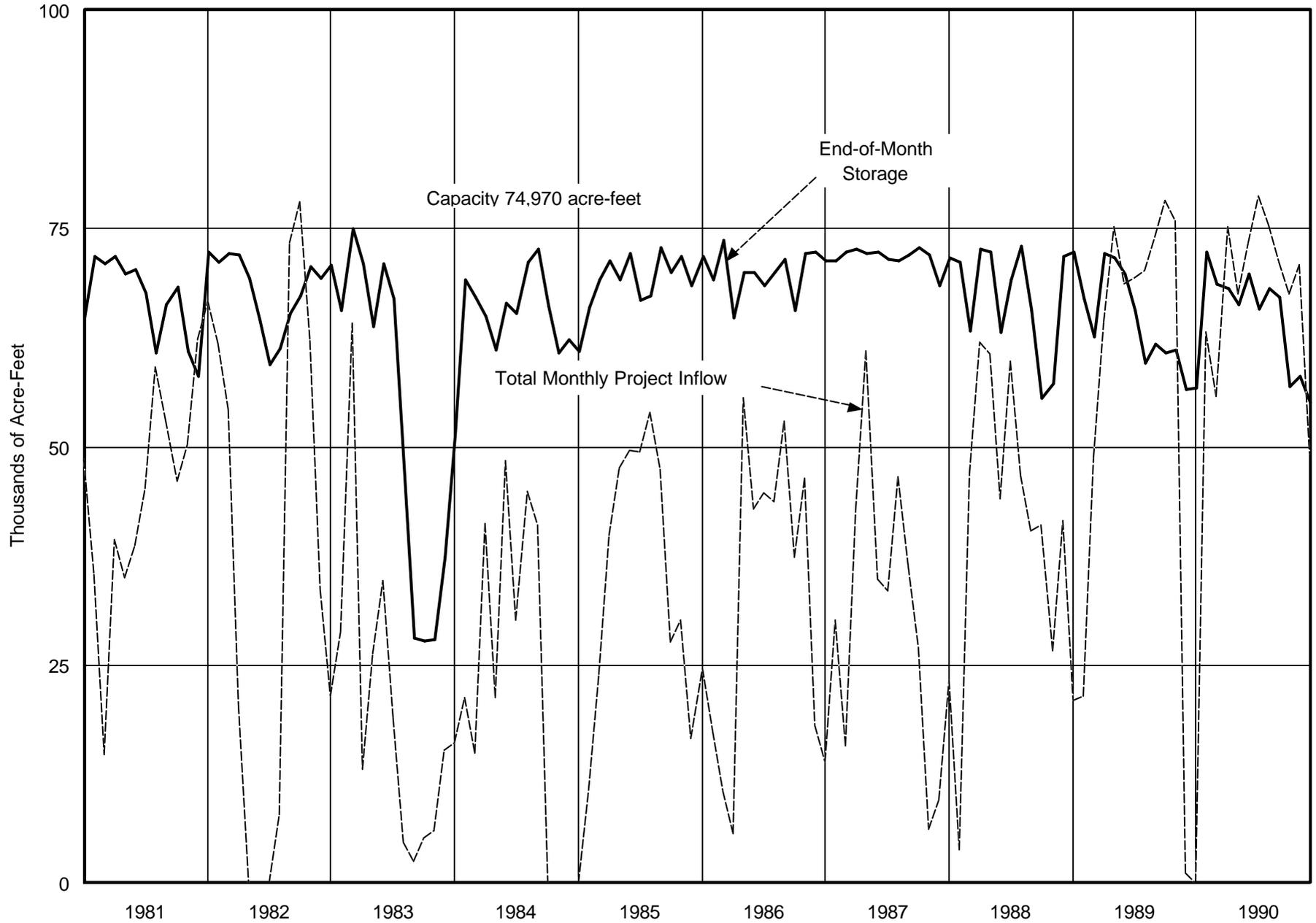
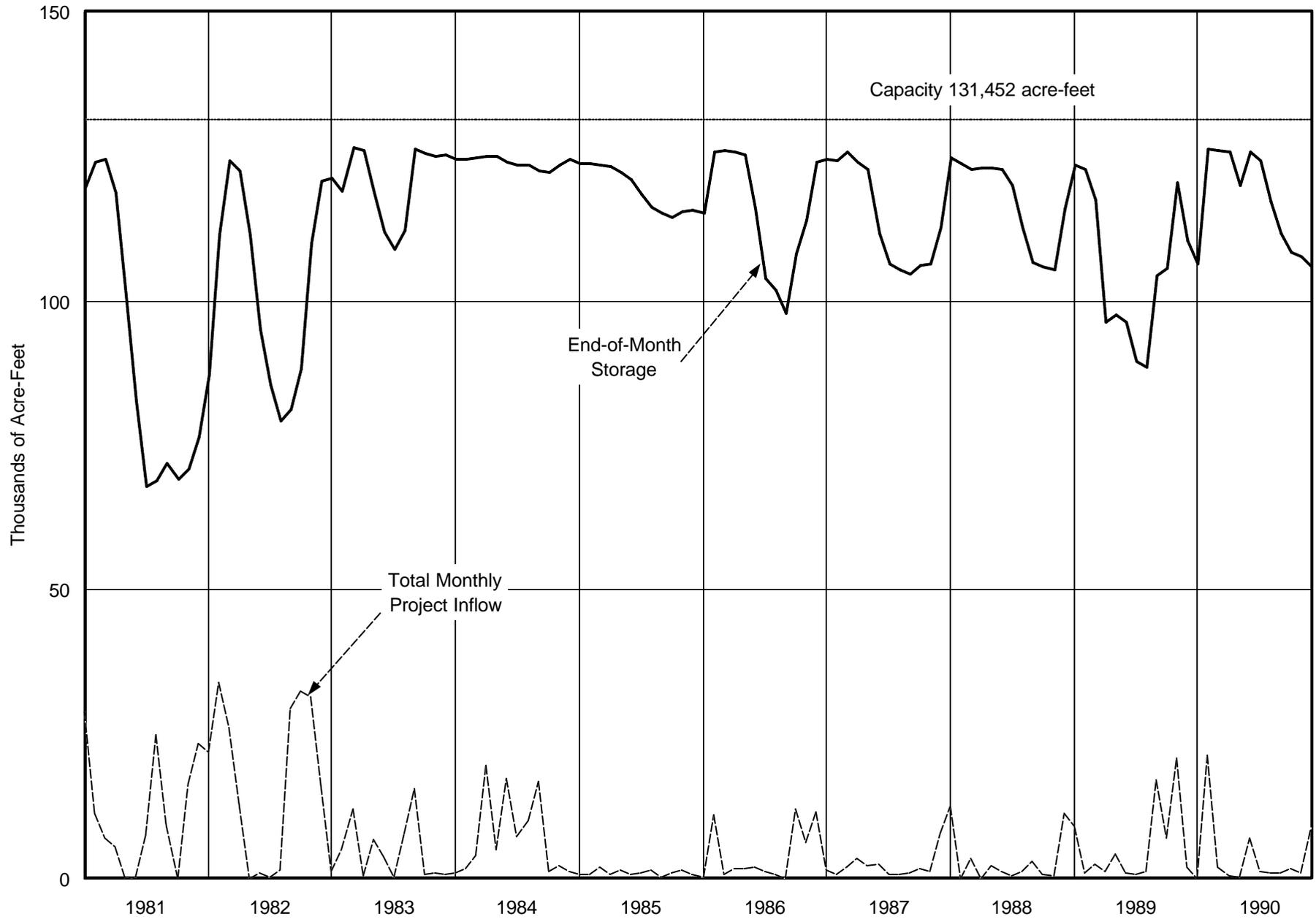
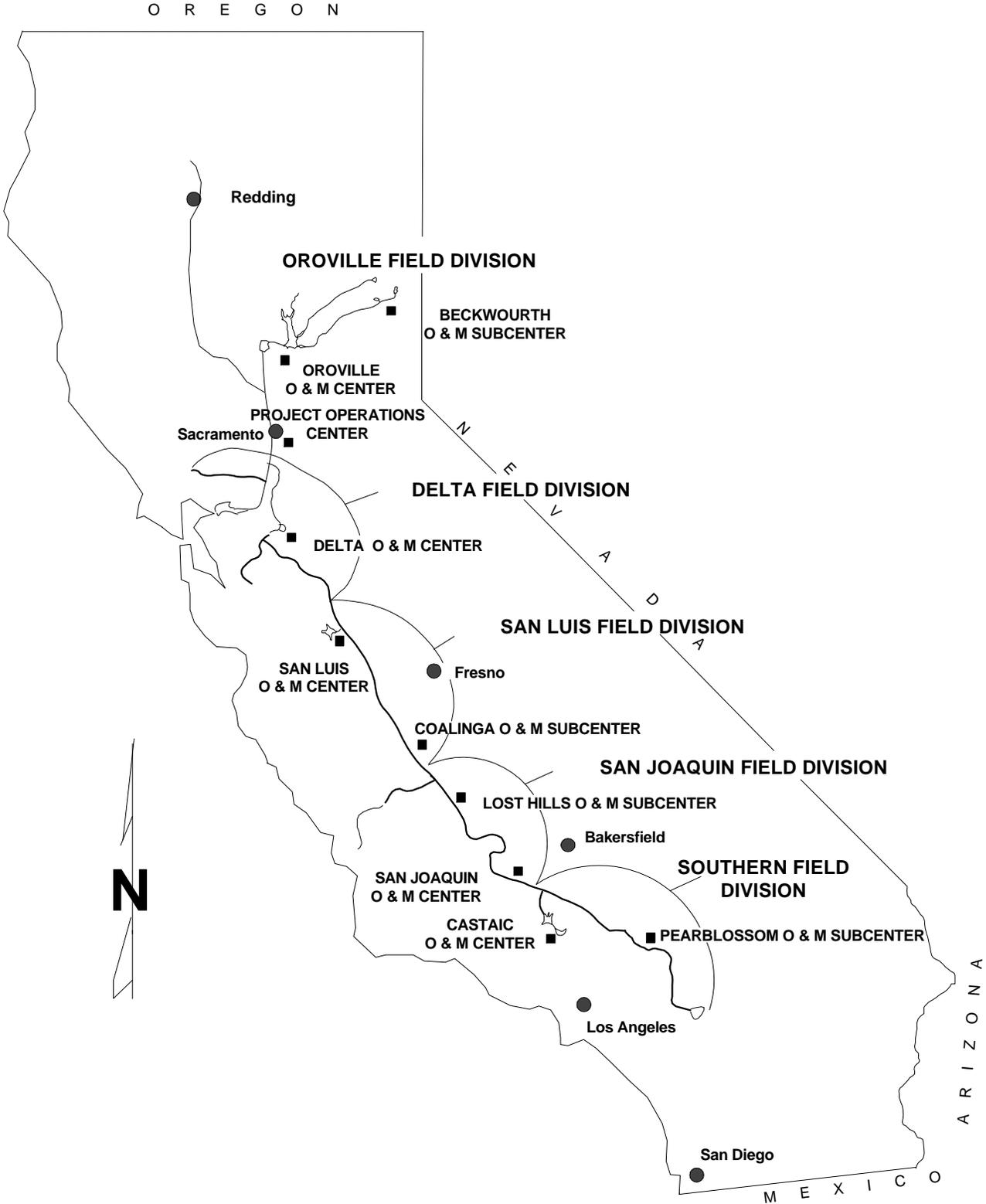


Figure 23. Lake Perris Operation

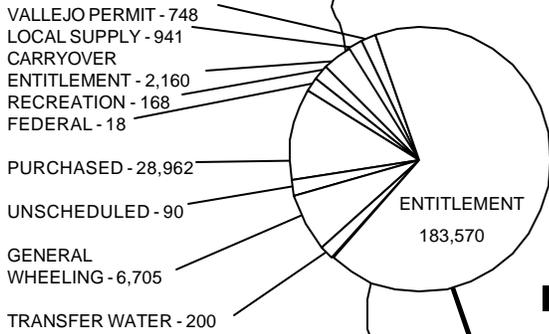


# Map 1 Field Division Boundaries

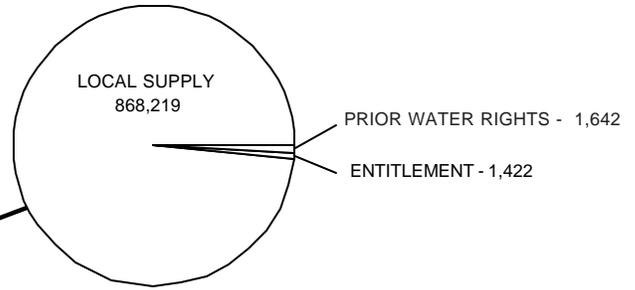


## Map 2 1990 Water Deliveries (in acre-feet)

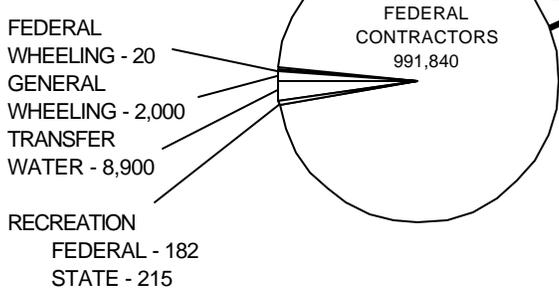
### DELTA FIELD DIVISION (TOTAL DELIVERIES - 223,562)



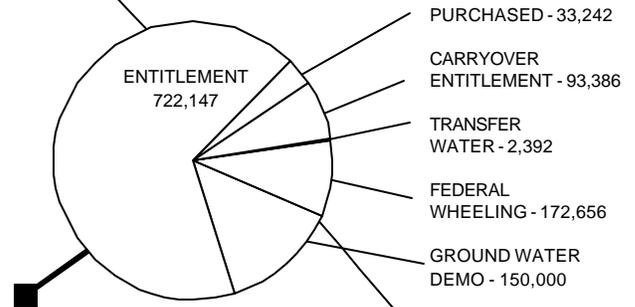
### OROVILLE FIELD DIVISION (TOTAL DELIVERIES - 871,283)



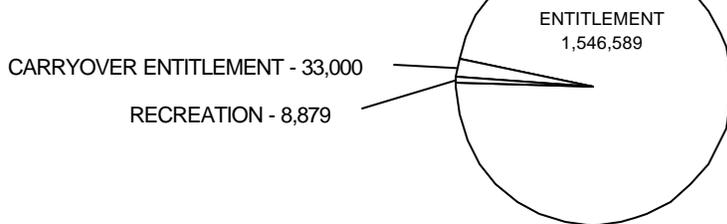
### SAN LUIS FIELD DIVISION (TOTAL DELIVERIES - 1,003,157)



### SAN JOAQUIN FIELD DIVISION (TOTAL DELIVERIES - 1,075,913)

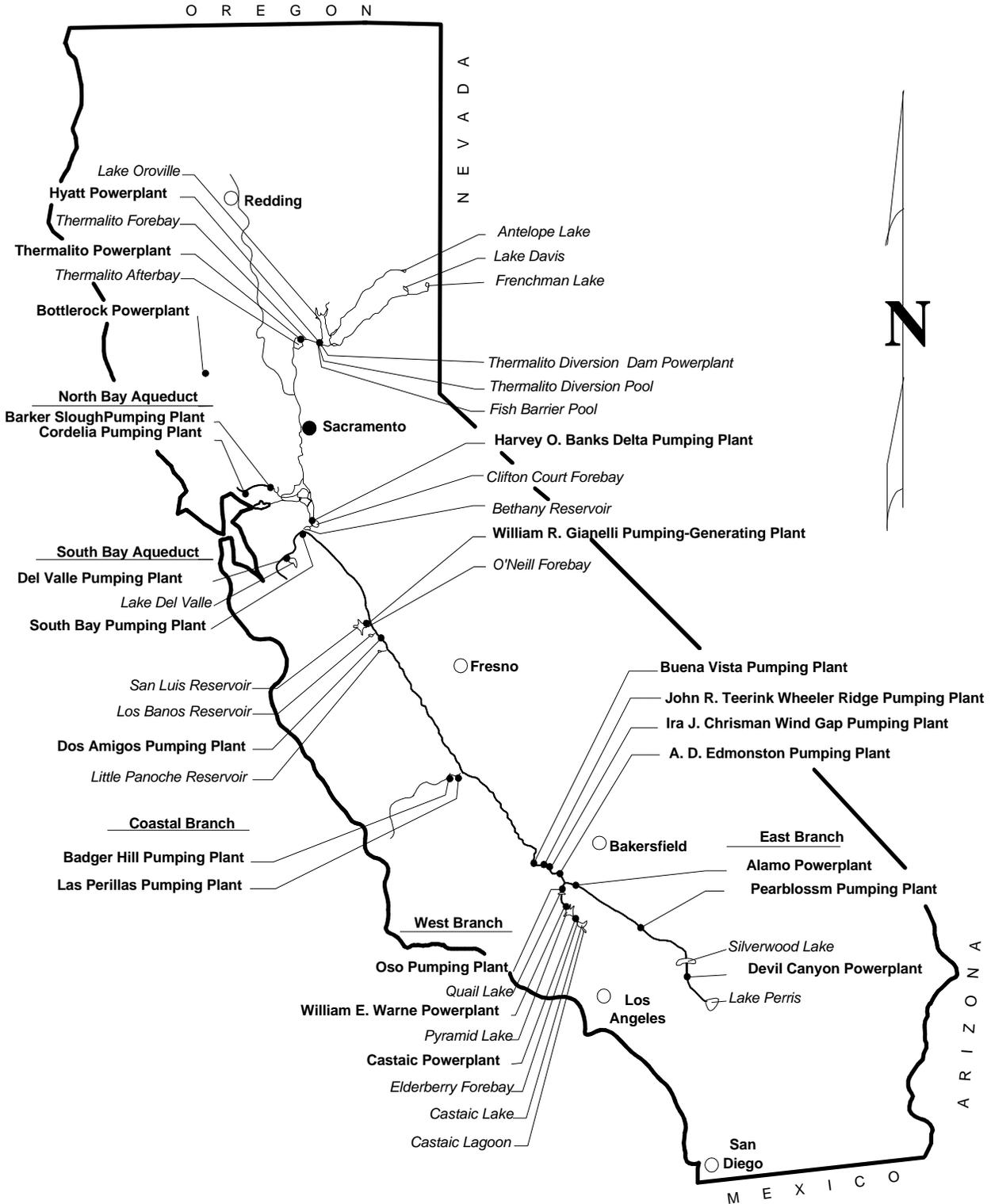


### SOUTHERN FIELD DIVISION (TOTAL DELIVERIES - 1,588,468)



**Total Deliveries  
4,762,383**

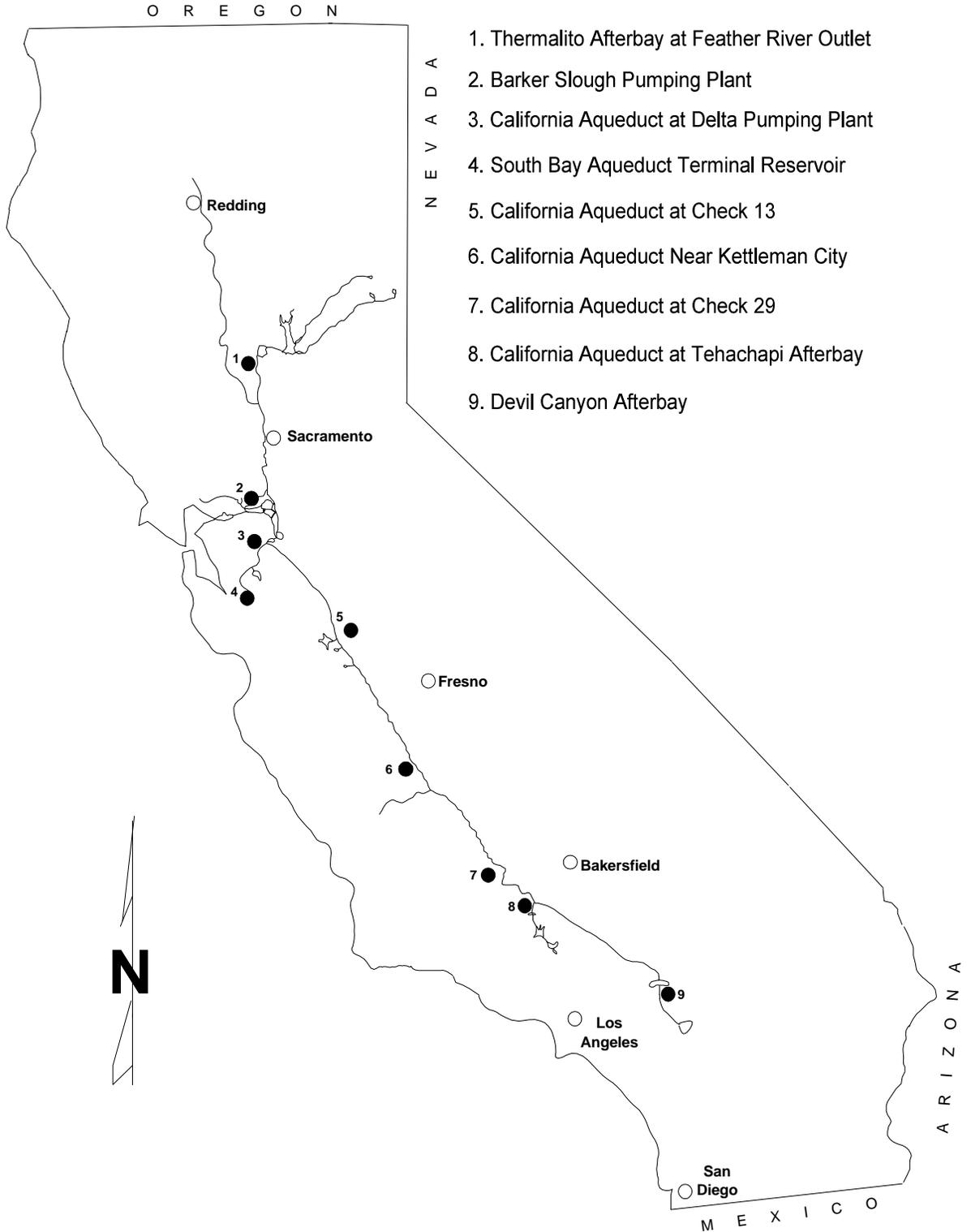
# Map 3 Project Facilities



# Map 4

## Water Quality Monitoring Stations

(as reported in Appendix B of this report)



**Table 21a. Summary of California Aqueduct Operation  
1990**

(in acre-feet)

DESCRIPTION	JAN	FEB	MAR	APR	MAY	JUN
<b>DELTA FIELD DIVISION</b>						
North Bay Aqueduct						
Pumped at Barker Slough Pumping Plant	1,638	1,236	1,599	2,435	2,547	3,387
Deliveries (Travis & Fairfield/Vacaville)	0	0	0	0	0	0
Pumped at Cordelia Pumping Plant	1,614	1,194	1,553	2,243	2,402	3,307
Deliveries (Benecia, Vallejo, A.C. 1&2, & Napa)	1,612	1,192	1,560	2,236	2,433	3,314
Change in Storage, Napa Terminal Tank	2	2	-7	7	-1	-7
Computed Losses (-), Gains (+)	-24	-42	-46	-192	-115	-80
California Aqueduct						
Pumped at Harvey O. Banks Delta Pumping Plant	388,580	350,802	388,755	308,902	21,232	18,339
Pumped at South Bay Pumping Plant	11,937	15,336	17,681	17,080	17,681	16,715
Delivered to Contracting Agencies	92	8	136	674	536	806
Change in Storage	321	-373	-29	-1,939	1,867	-643
Outflow at Check 12	372,752	332,338	366,940	290,931	0	0
Computed Losses (-), Gains (+)	-3,478	-3,493	-4,027	-2,156	-1,148	-1,461
South Bay Aqueduct						
Pumped at South Bay Pumping Plant	11,937	15,336	17,681	17,080	17,681	16,715
Lake Del Valle releases into S. Bay Aq.	282	0	0	32	9	0
Outflow (Pumped into Lake Del Valle)	690	4,516	2,293	1,091	1,754	973
Outflow, Deliveries	11,512	10,810	15,378	16,011	15,926	15,732
Computed Losses (-), Gains (+)	-17	-10	-10	-10	-10	-10
Lake Del Valle Operation:						
Natural Inflow	98	484	148	-16	-12	-151
Inflow from S. Bay Aq.	690	4,516	2,293	1,091	1,754	973
Releases to S. Bay Aq.	282	0	0	32	9	0
Delivered to EBRP District	7	6	6	7	19	10
End-of-Month Storage (State)	28,931	33,862	36,167	36,998	38,418	38,862
Change in Storage	445	4,931	2,305	831	1,420	444
Evaporation	-54	-63	-130	-205	-294	-368
<b>SAN LUIS FIELD DIVISION</b>						
O'Neill Forebay Operation						
End-of-Month Storage	47,125	45,970	45,682	41,349	48,045	46,416
Inflow, California Aqueduct	372,752	332,338	366,940	290,931	0	0
Inflow, O'Neill P.- G. Plant	226,176	139,578	155,004	144,788	54,274	41,749
Inflow, Gianelli P.- G. Plant	0	20,281	0	6,048	291,320	476,929
Delivered to Dept. of Fish and Game (State)	22	1	17	11	13	5
Delivered to Dept. of Fish and Game (Fed.)	0	0	0	0	0	0
Delivered to Dept. of Parks and Rec. (State)	1	0	3	10	6	11
Delivered to Dept. of Parks and Rec. (Fed.)	0	0	0	0	0	0
Delivered to Federal Customers	403	2,237	2,144	1,889	2,511	2,981
Outflow, O'Neill P.- G. Plant	0	0	0	0	10,031	41,825
Outflow, Gianelli P.- G. Plant	341,156	131,833	197,303	171,446	833	10,300
Outflow, Dos Amigos P.P.	255,598	357,087	328,037	283,737	322,709	463,370
Change in Storage	1,600	-1,155	-288	-4,333	6,696	-1,629
Computed Losses (-), Gains (+)	-149	-2,194	5,269	10,983	-2,801	-1,826
San Luis Reservoir Operation						
State End-of-Month Storage	790,497	928,802	1,072,136	1,150,263	935,234	638,444
Total End-of-Month Storage	1,554,851	1,659,787	1,838,781	1,971,565	1,672,133	1,194,771
Inflow, Gianelli P.- G. Plant	341,156	131,833	197,303	171,446	833	10,300
Outflow, Gianelli P.- G. Plant	0	20,281	0	6,048	291,320	476,929
Pacheco Tunnel Diversion	3,992	3,297	4,451	12,046	9,532	9,168
Change in Storage (Total)	326,627	104,936	178,994	132,784	-299,432	-477,362
Computed Losses (-), Gains (+)	-10,537	-3,319	-13,858	-20,568	587	-1,565

**Table 21b. Summary of California Aqueduct Operation  
1990**

(in acre-feet)

JUL	AUG	SEP	OCT	NOV	DEC	TOTAL	DESCRIPTION
<b>DELTA FIELD DIVISION</b>							
North Bay Aqueduct							
3,792	3,845	3,799	3,339	3,680	2,532	33,829	Pumped at Barker Slough Pumping Plant
8	240	357	539	1,543	588	3,275	Deliveries (Travis & Fairfield/Vacaville)
3,598	3,609	3,380	2,715	2,250	2,023	29,888	Pumped at Cordelia Pumping Plant
3,590	3,607	3,383	2,709	2,256	2,025	29,917	Deliveries (Benecia, Vallejo, A.C. 1&2, & Napa)
8	2	-3	6	-5	-1	3	Change in Storage, Napa Terminal Tank
-186	4	-62	-85	114	80	-634	Computed Losses (-), Gains (+)
California Aqueduct							
Pumped at Harvey O. Banks Delta Pumping Plant							
149,502	208,349	147,250	138,799	129,622	165,832	2,415,964	
17,738	17,737	14,657	14,278	14,826	15,078	190,744	Pumped at South Bay Pumping Plant
530	249	170	36	10	3	3,250	Delivered to Contracting Agencies
840	715	-252	92	-703	141	37	Change in Storage
129,292	188,798	132,098	123,912	115,212	150,928	2,203,201	Outflow at Check 12
-1,102	-850	-577	-481	-277	318	-18,732	Computed Losses (-), Gains (+)
South Bay Aqueduct							
17,738	17,737	14,657	14,278	14,826	15,078	190,744	Pumped at South Bay Pumping Plant
0	0	2,390	1,042	2,748	1,209	7,712	Lake Del Valle releases into S. Bay Aq.
0	28	0	0	0	237	11,582	Outflow (Pumped into Lake Del Valle)
17,728	17,699	17,037	15,307	17,564	16,040	186,744	Outflow, Deliveries
-10	-10	-10	-13	-10	-10	-130	Computed Losses (-), Gains (+)
Lake Del Valle Operation:							
-30	-72	-19	96	224	199	949	Natural Inflow
0	28	0	0	0	237	11,582	Inflow from S. Bay Aq.
0	0	2,390	1,042	2,748	1,209	7,712	Releases to S. Bay Aq.
23	24	21	24	15	6	168	Delivered to EBRP District
38,377	37,903	35,150	33,080	30,384	29,527	- - -	End-of-Month Storage (State)
-485	-474	-2,753	-2,070	-2,696	-857	1,041	Change in Storage
-432	-406	-323	-1,100	-157	-78	-3,610	Evaporation
<b>SAN LUIS FIELD DIVISION</b>							
O'Neill Forebay Operation							
49,128	46,075	47,467	46,836	49,155	49,793	- - -	End-of-Month Storage
129,292	188,798	132,098	123,912	115,212	150,928	2,203,201	Inflow, California Aqueduct
14,170	30,641	97,485	1,444	65,719	137,752	1,108,780	Inflow, O'Neill P.- G. Plant
477,065	232,026	91,828	154,701	51,553	22,654	1,824,405	Inflow, Gianelli P.- G. Plant
0	33	0	0	0	0	102	Delivered to Dept. of Fish and Game (State)
0	0	0	0	0	0	0	Delivered to Dept. of Fish and Game (Fed.)
10	15	5	8	0	1	70	Delivered to Dept. of Parks and Rec. (State)
0	0	0	0	0	0	0	Delivered to Dept. of Parks and Rec. (Fed.)
4,923	3,313	1,560	334	369	188	22,852	Delivered to Federal Customers
38,455	35,856	0	62,032	1,599	0	189,798	Outflow, O'Neill P.- G. Plant
0	26,372	104,777	16,333	68,993	182,903	1,252,249	Outflow, Gianelli P.- G. Plant
568,697	393,275	217,785	209,278	163,675	137,259	3,700,507	Outflow, Dos Amigos P.P.
2,712	-3,053	1,392	-631	2,319	638	4,268	Change in Storage
-5,740	4,331	4,103	7,289	4,471	9,654	33,390	Computed Losses (-), Gains (+)
San Luis Reservoir Operation							
346,077	218,602	100,365	7,155	8,956	5,555	- - -	State End-of-Month Storage
709,258	490,766	488,128	340,198	344,850	479,478	- - -	Total End-of-Month Storage
0	26,372	104,777	16,333	68,993	182,903	1,252,249	Inflow, Gianelli P.- G. Plant
477,065	232,026	91,828	154,701	51,553	22,654	1,824,405	Outflow, Gianelli P.- G. Plant
12,934	11,685	8,055	7,529	6,230	9,567	98,486	Pacheco Tunnel Diversion
-485,513	-218,492	-2,638	-147,930	4,652	134,628	-748,746	Change in Storage (Total)
4,486	-1,153	-7,532	-2,033	-6,558	-16,054	-78,104	Computed Losses (-), Gains (+)

**Table 21c. Summary of California Aqueduct Operation  
1990**

(in acre-feet)

DESCRIPTION	JAN	FEB	MAR	APR	MAY	JUN
<b>SAN LUIS FIELD DIVISION (Cont.)</b>						
California Aqueduct (Pools 14 thru 21)						
Inflow, Dos Amigos P.P.(State)	138,244	220,685	259,896	206,668	218,347	288,838
Inflow, Dos Amigos P.P.(Federal)	117,354	136,402	68,141	77,069	104,362	174,532
Flow into Aqueduct	0	0	0	0	0	86
Delivered to Federal Customers 1/	119,221	136,754	63,243	67,631	98,929	166,264
" to Dept. of Fish and Game (State)	0	0	0	0	0	0
" to Dept. of Fish and Game (Federal)	1	0	1	0	1	1
Outflow, Check 21 (State)	139,510	226,120	261,469	209,816	217,790	288,869
Outflow, Check 21 (Federal)	1,704	5,820	6,347	10,674	8,890	9,697
Change in Storage	510	2,109	200	-1,637	332	282
Evaporation	212	317	621	1,095	1,369	1,652
Computed Losses (-), Gains (+)	5,560	14,033	3,844	3,842	4,602	3,309
<b>SAN JOAQUIN FIELD DIVISION</b>						
California Aqueduct, Check 21 to Buena Vista Pumping Plant						
Inflow, Check 21 (state)	139,510	226,120	261,469	209,816	217,790	288,869
Inflow, Check 21 (Federal)	1,704	5,820	6,347	10,674	8,890	9,697
Delivered to Contracting State Agencies	25,858	53,647	62,204	40,515	56,767	111,789
Delivered to Federal Customers	1,662	5,710	6,347	10,674	8,890	9,697
Outflow, Buena Vista P.P.	107,730	159,134	182,285	149,985	135,697	145,615
Coastal Br. Diversion	1,552	6,466	9,406	12,419	18,994	20,977
Change in Storage	-295	-307	83	658	-413	199
Computed Losses (-), Gains (+)	-4,707	-7,290	-7,491	-6,239	-6,745	-10,289
California Aqueduct, Buena Vista P.P. to Wheeler Ridge P.P.						
Inflow, Buena Vista P.P.	107,730	159,134	182,285	149,985	135,697	145,615
Delivered to Contracting State Agencies	2,007	13,720	15,778	8,929	13,696	22,899
Outflow, Wheeler Ridge P.P.	107,000	147,354	167,822	143,351	124,201	123,353
Change in Storage	-132	-63	128	-217	83	29
Computed Losses (-), Gains (+)	1,145	1,877	1,443	2,078	2,283	666
California Aqueduct, Wheeler Ridge to Ira J. Chrisman Wind Gap P.P.						
Inflow, Wheeler Ridge P.P.	107,000	147,354	167,822	143,351	124,201	123,353
Delivered to Contracting State Agencies	688	630	3,913	2,444	4,892	5,493
Outflow, Ira J. Chrisman Wind Gap P.P.	105,875	146,316	163,094	139,041	118,129	117,226
Change in Storage	92	-43	0	-46	24	56
Computed Losses (-), Gains (+)	-345	-451	-815	-1,912	-1,156	-578
California Aqueduct, Ira J. Chrisman Wind Gap P.P. to A.D. Edmonston P.P.						
Inflow, Ira J. Chrisman Wind Gap P.P.	105,875	146,316	163,094	139,041	118,129	117,226
Delivered to Contracting State Agencies	79	65	757	1,248	1,396	1,875
Outflow, A.D. Edmonston P.P.	105,552	144,728	161,456	136,667	115,322	115,057
Change in Storage	-113	44	-11	17	-8	7
Computed Losses (-), Gains (+)	-357	-1,479	-892	-1,109	-1,419	-287
Coastal Branch, California Aqueduct						
Inflow, Las Perillas P.P. (State)	1,552	5,518	9,406	12,419	18,994	20,977
Inflow, Las Perillas P.P. (Federal)	0	948	0	0	0	0
Delivered to Contracting State Agencies	1,263	5,981	8,975	10,802	16,915	18,406
Delivered to Federal Customers	42	122	0	0	0	0
Change in Storage	2	29	-9	-4	9	3
Computed Losses (-), Gains (+)	-245	-334	-440	-1,621	-2,070	-2,568

1/ Total includes 1 AF of Phase I water in August; does not include 543 AF to the City of Avenal; does not include 147 AF to City of Dos Palos.

**Table 21d. Summary of California Aqueduct Operation  
1990**

(in acre-feet)

JUL	AUG	SEP	OCT	NOV	DEC	TOTAL	DESCRIPTION
							SAN LUIS FIELD DIVISION (Cont.)
							California Aqueduct (Pools 14 thru 21)
376,312	302,275	206,817	197,284	149,392	124,779	2,689,537	Inflow, Dos Amigos P.P.(State)
192,385	91,000	10,968	11,994	14,283	12,480	1,010,970	Inflow, Dos Amigos P.P.(Federal)
713	724	679	702	1,152	975	5,031	Flow into Aqueduct
186,280	86,210	13,096	9,668	11,336	11,296	969,928	Delivered to Federal Customers 1/
11	16	14	2	0	0	43	" to Dept. of Fish and Game (State)
8	14	13	1	0	0	40	" to Dept. of Fish and Game (Federal)
382,133	305,247	206,616	197,801	149,578	123,858	2,708,807	Outflow, Check 21 (State)
11,479	10,535	0	3,055	5,446	1,099	74,746	Outflow, Check 21 (Federal)
764	-192	403	378	-1,165	675	2,659	Change in Storage
1,968	1,730	1,359	964	472	139	11,898	Evaporation
13,233	9,561	3,037	1,889	840	-1,167	62,583	Computed Losses (-), Gains (+)
							SAN JOAQUIN FIELD DIVISION
							California Aqueduct, Check 21 to Buena Vista Pumping Plant
382,133	305,247	206,616	197,801	149,578	123,858	2,708,807	Inflow, Check 21 (state)
11,479	10,535	0	3,055	5,446	1,099	74,746	Inflow, Check 21 (Federal)
164,705	93,093	21,916	18,513	19,116	19,325	687,448	Delivered to Contracting State Agencies
11,479	8,535	0	3,055	2,146	999	69,194	Delivered to Federal Customers
182,954	191,569	170,500	165,726	125,553	94,018	1,810,766	Outflow, Buena Vista P.P.
23,820	15,055	6,309	6,554	3,491	7,445	132,488	Coastal Br. Diversion
-140	-66	465	-44	-97	23	68	Change in Storage
-10,794	-7,596	-7,426	-7,052	-4,815	-3,147	-83,591	Computed Losses (-), Gains (+)
							California Aqueduct, Buena Vista P.P. to Wheeler Ridge P.P.
182,954	191,569	170,500	165,726	125,553	94,018	1,810,766	Inflow, Buena Vista P.P.
27,771	22,215	5,407	3,732	2,510	4,081	142,745	Delivered to Contracting State Agencies
156,620	172,215	167,989	164,597	124,366	89,156	1,688,024	Outflow, Wheeler Ridge P.P.
22	45	77	-78	37	-101	-170	Change in Storage
1,459	2,906	2,973	2,525	1,360	-882	19,833	Computed Losses (-), Gains (+)
							California Aqueduct, Wheeler Ridge to Ira J. Chrisman Wind Gap P.P.
156,620	172,215	167,989	164,597	124,366	89,156	1,688,024	Inflow, Wheeler Ridge P.P.
6,273	4,528	2,116	2,424	905	2,047	36,353	Delivered to Contracting State Agencies
149,407	166,923	164,349	160,778	122,490	87,838	1,641,466	Outflow, Ira J. Chrisman Wind Gap P.P.
-83	27	-29	-26	66	3	41	Change in Storage
-1,023	-737	-1,553	-1,421	-905	732	-10,164	Computed Losses (-), Gains (+)
							California Aqueduct, Ira J. Chrisman Wind Gap P.P. to A.D. Edmonston P.P.
149,407	166,923	164,349	160,778	122,490	87,838	1,641,466	Inflow, Ira J. Chrisman Wind Gap P.P.
1,769	1,575	832	682	437	712	11,427	Delivered to Contracting State Agencies
145,412	163,669	161,871	158,384	121,066	86,390	1,615,574	Outflow, A.D. Edmonston P.P.
-12	-53	85	-78	88	-4	-38	Change in Storage
-2,238	-1,732	-1,561	-1,790	-899	-740	-14,503	Computed Losses (-), Gains (+)
							Coastal Branch, California Aqueduct
23,820	15,055	6,309	6,554	3,491	7,445	131,540	Inflow, Las Perillas P.P. (State)
0	0	0	0	0	0	948	Inflow, Las Perillas P.P. (Federal)
20,908	13,858	6,009	5,974	2,952	7,259	119,302	Delivered to Contracting State Agencies
0	0	0	0	0	0	164	Delivered to Federal Customers
-18	-5	19	-26	31	-21	10	Change in Storage
-2,930	-1,202	-281	-606	-508	-207	-13,012	Computed Losses (-), Gains (+)

**Table 21e. Summary of California Aqueduct Operation  
1990**

(in acre-feet)

DESCRIPTION	JAN	FEB	MAR	APR	MAY	JUN
<b>SOUTHERN FIELD DIVISION</b>						
California Aqueduct, A.D. Edmonston P.P. to Junction of West Branch						
Inflow, A.D. Edmonston P.P.	105,552	144,728	161,456	136,667	115,322	115,057
Outflow, West Branch	103,565	78,987	102,231	57,306	43,720	35,775
Outflow, East Branch	2,001	65,773	59,255	79,393	71,629	79,298
Change in Storage	5	4	-5	-1	-3	2
Computed Losses (-), Gains (+)	19	36	25	31	24	18
California Aqueduct, Junction of West Branch to Pearblossom P.P.						
Inflow (Aqueduct)	2,001	65,773	59,255	79,393	71,629	79,298
Delivered to Contracting Agencies	1,208	2,835	3,789	4,505	5,462	6,251
Outflow, Pearblossom P.P.	0	64,909	57,348	77,009	68,634	74,306
Change in Storage	2,180	698	-55	181	-720	110
Computed Losses (-), Gains (+)	1,387	2,669	1,827	2,302	1,747	1,369
California Aqueduct, Pearblossom P.P. to Silverwood Lake						
Inflow, Pearblossom P.P.	0	64,909	57,348	77,009	68,634	74,306
Deliveries (Exchange of Natural Inflow)	0	0	0	0	0	0
Los Flores T.O.	0	284	768	655	93	80
Outflow to Silverwood Lake	0	63,180	55,700	75,290	67,440	73,428
Change in Storage	0	1,075	794	81	-8	113
Computed Losses (-), Gains (+)	0	-370	-86	-983	-1,109	-685
Silverwood Lake Operation						
Inflow, Project	0	63,180	55,700	75,290	67,440	73,428
Inflow, Natural	170	958	772	182	86	18
Delivered to Contracting Agencies	153	169	155	103	140	149
Outflow, Natural Inflow Released	10	336	12	11	11	10
Outflow, Project Water at San Bernardino Tunnel	43	46,322	59,698	74,260	67,551	67,886
Change in storage	252	15,592	-3,807	-380	-1,866	3,571
Computed Losses (-), Gains (+)	288	-1,719	-414	-1,478	-1,690	-1,830
California Aqueduct, Silverwood Lake to Lake Perris						
Inflow, San Bernardino Tunnel	43	46,322	59,698	74,260	67,551	67,886
Delivered to Contracting Agencies	0	24,961	57,744	73,863	67,216	60,739
Outflow to Lake Perris	0	21,359	1,954	393	333	7,144
Change in Storage	43	1	-1	3	0	0
Operational Losses (-), Gains (+)	0	-1	-1	-1	-2	-3
Lake Perris Operation						
Inflow	0	21,359	1,954	393	333	7,144
Delivered to Contracting Agencies	3,232	390	1,578	531	6,045	568
Outflow	0	0	0	0	0	0
Change in Storage	-4,065	19,973	-344	-319	-5,771	5,748
Computed Losses (-), Gains (+)	-833	-996	-720	-181	-59	-828

**Table 21f. Summary of California Aqueduct Operation  
1990**

(in acre-feet)

JUL	AUG	SEP	OCT	NOV	DEC	TOTAL	DESCRIPTION
							SOUTHERN FIELD DIVISION
							California Aqueduct, A.D. Edmonston P.P. to Junction of West Branch
145,412	163,669	161,871	158,384	121,066	86,390	1,615,574	Inflow, A.D. Edmonston P.P.
60,145	82,128	85,958	88,818	49,498	35,205	823,336	Outflow, West Branch
85,307	81,569	75,960	69,604	71,599	51,216	792,604	Outflow, East Branch
-3	6	-4	1	2	-7	-3	Change in Storage
37	34	43	39	33	24	363	Computed Losses (-), Gains (+)
							California Aqueduct, Junction of West Branch to Pearblossom P.P.
85,307	81,569	75,960	69,604	71,599	51,216	792,604	Inflow (Aqueduct)
8,670	8,405	6,933	4,272	2,800	2,431	57,561	Delivered to Contracting Agencies
79,187	75,881	71,718	68,164	72,064	49,607	758,827	Outflow, Pearblossom P.P.
216	-197	506	25	-848	995	3,091	Change in Storage
2,766	2,520	3,197	2,857	2,417	1,817	26,875	Computed Losses (-), Gains (+)
							California Aqueduct, Pearblossom P.P. to Silverwood Lake
79,187	75,881	71,718	68,164	72,064	49,607	758,827	Inflow, Pearblossom P.P.
0	0	0	10	0	0	10	Deliveries (Exchange of Natural Inflow)
33	0	0	0	0	0	1,913	Los Flores T.O.
78,780	75,403	71,120	67,503	70,870	49,210	747,924	Outflow to Silverwood Lake
-74	-17	-81	-12	111	-111	1,871	Change in Storage
-448	-495	-679	-663	-1,083	-508	-7,109	Computed Losses (-), Gains (+)
							Silverwood Lake Operation
78,780	75,403	71,120	67,503	70,870	49,210	747,924	Inflow, Project
0	0	0	0	0	0	2,186	Inflow, Natural
219	230	212	183	178	166	2,057	Delivered to Contracting Agencies
10	10	10	10	8	8	446	Outflow, Natural Inflow Released
81,655	72,041	70,618	77,753	69,465	51,529	738,821	Outflow, Project Water at San Bernardino Tunnel
-4,053	2,376	-1,116	-10,115	1,032	-2,953	-1,467	Change in storage
-949	-746	-1,396	328	-187	-460	-10,253	Computed Losses (-), Gains (+)
							California Aqueduct, Silverwood Lake to Lake Perris
81,655	72,041	70,618	77,753	69,465	51,529	738,821	Inflow, San Bernardino Tunnel
80,433	70,922	69,564	76,067	68,460	42,691	692,660	Delivered to Contracting Agencies
1,219	1,117	1,045	1,685	1,001	8,837	46,087	Outflow to Lake Perris
0	-1	7	-1	2	0	53	Change in Storage
-3	-3	-2	-2	-2	-1	-21	Operational Losses (-), Gains (+)
							Lake Perris Operation
1,219	1,117	1,045	1,685	1,001	8,837	46,087	Inflow
564	6,441	4,387	3,321	970	9,228	37,255	Delivered to Contracting Agencies
0	0	0	0	0	0	0	Outflow
-1,482	-7,034	-5,398	-3,238	-735	-1,957	-4,622	Change in Storage
-2,137	-1,710	-2,056	-1,602	-766	-1,566	-13,454	Computed Losses (-), Gains (+)

**Table 21g. Summary of California Aqueduct Operation  
1990**

(in acre-feet)

DESCRIPTION	JAN	FEB	MAR	APR	MAY	JUN
<b>SOUTHERN FIELD DIVISION (Cont.)</b>						
West Branch California Aqueduct Tehachapi Afterbay to Oso P.P.						
Inflow	103,565	78,987	102,231	57,306	43,720	35,775
Outflow, Oso Pumping Plant	103,605	79,084	102,320	57,403	43,800	35,824
Change in Storage	17	13	-14	-2	-8	7
Computed Losses (-), Gains (+)	57	110	75	95	72	56
West Branch California Aqueduct Oso P.P. to Pyramid Lake						
Inflow, Oso P.P.	103,605	79,084	102,320	57,403	43,800	35,824
Outflow through William E. Warne P.P. to Pyramid Lake	102,709	79,834	102,261	57,381	43,648	36,536
Change in Storage	896	-390	57	-183	141	-712
Operational Losses (-), Gains (+)	0	360	-2	-205	-11	0
Pyramid Lake Operation						
Inflow, Project	102,709	79,834	102,261	57,381	43,648	36,536
Inflow, Natural	740	528	580	362	244	151
Pumpback from Elderberry Forebay	30,998	30,439	8,143	22,131	36,236	99,700
Deliveries	0	0	0	0	0	0
Deliveries to Dept. of Parks and Rec. (State)	1	2	4	4	579	605
Outflow, Pyramid Diversion	340	667	924	489	79	151
Outflow, Angeles Tunnel	125,300	105,132	108,377	74,032	75,362	136,791
Change in Storage	4,307	-947	-1,698	3,057	2,627	-5,486
Computed Losses (-), Gains (+)	-4,499	-5,947	-3,377	-2,292	-1,481	-4,326
Elderberry Forebay Operation						
Inflow, Project through Castaic P-G Plant	125,300	105,132	108,377	74,032	75,362	136,791
Inflow, Natural	0	13	6	1	0	0
Outflow, Pumpback to Pyramid Lake	30,998	30,439	8,143	22,131	36,236	99,700
Outflow, Project Water Released to Castaic Lake	104,945	71,031	96,820	49,314	44,388	34,683
Change in Storage	-10,134	4,626	3,596	2,738	-5,079	4,540
Computed Losses (-), Gains (+)	509	951	176	150	183	2,132
Castaic Lake Operation						
Inflow, Project	104,945	71,031	96,820	49,314	44,388	34,683
Inflow, Natural	40	273	87	67	21	4
Delivered to Contracting Agencies	61,835	52,320	64,150	46,074	66,948	53,286
Outflow, Castaic Lagoon	0	174	660	619	532	199
Change in Storage	43,910	21,970	31,500	2,355	-22,855	-20,055
Computed Losses (-), Gains (+)	760	3,160	-597	-333	216	-1,257
Castaic Lagoon Operation						
Inflow (Includes recreation inflow)	0	174	660	645	532	199
Outflow	60	117	165	165	21	4
Deliveries to Recreation (State)	94	39	47	108	389	321
Change in Storage	-154	18	448	372	122	-126
Computed Losses (-), Gains (+)	0	0	0	0	0	0

**Table 21h. Summary of California Aqueduct Operation  
1990**

(in acre-feet)

JUL	AUG	SEP	OCT	NOV	DEC	TOTAL	DESCRIPTION
							SOUTHERN FIELD DIVISION (Cont.)
							West Branch California Aqueduct Tehachapi Afterbay to Oso P.P.
60,145	82,128	85,958	88,818	49,498	35,205	823,336	Inflow
60,269	82,212	86,103	88,935	49,592	35,301	824,448	Outflow, Oso Pumping Plant
-10	20	-13	1	6	-21	-4	Change in Storage
114	104	132	118	100	75	1,108	Computed Losses (-), Gains (+)
							West Branch California Aqueduct Oso P.P. to Pyramid Lake
60,269	82,212	86,103	88,935	49,592	35,301	824,448	Inflow, Oso P.P.
59,449	82,643	85,017	90,679	48,609	35,112	823,878	Outflow through William E. Warne P.P. to Pyramid Lake
820	-431	1,082	-1,742	966	155	659	Change in Storage
0	0	-4	2	-17	-34	89	Operational Losses (-), Gains (+)
							Pyramid Lake Operation
59,449	82,643	85,017	90,679	48,609	35,112	823,878	Inflow, Project
107	107	115	167	276	306	3,683	Inflow, Natural
84,342	24,187	74,867	61,847	64,481	84,880	622,251	Pumpback from Elderberry Forebay
0	0	0	0	2,633	2,203	4,836	Deliveries
782	737	663	534	160	1	4,072	Deliveries to Dept. of Parks and Rec. (State)
107	107	115	167	42	57	3,245	Outflow, Pyramid Diversion
133,910	107,813	146,037	144,572	115,686	110,064	1,383,076	Outflow, Angeles Tunnel
3,560	-7,265	7,341	2,724	-8,158	6,301	6,363	Change in Storage
-5,539	-5,545	-5,843	-4,696	-3,003	-1,672	-48,220	Computed Losses (-), Gains (+)
							Elderberry Forebay Operation
133,910	107,813	146,037	144,572	115,686	110,064	1,383,076	Inflow, Project through Castaic P-G Plant
0	0	0	0	0	0	20	Inflow, Natural
84,342	24,187	74,867	61,847	64,481	84,880	622,251	Outflow, Pumpback to Pyramid Lake
58,925	80,536	72,258	86,513	44,240	29,003	772,656	Outflow, Project Water Released to Castaic Lake
-7,688	3,098	-242	-3,635	7,048	-3,745	-4,877	Change in Storage
1,669	8	846	153	83	74	6,934	Computed Losses (-), Gains (+)
							Castaic Lake Operation
58,925	80,536	72,258	86,513	44,240	29,003	772,656	Inflow, Project
0	0	0	0	0	11	503	Inflow, Natural
74,358	73,672	72,639	76,976	73,259	71,184	786,701	Delivered to Contracting Agencies
787	0	755	0	0	0	3,726	Outflow, Castaic Lagoon
-14,511	9,015	41	9,726	-29,306	-41,980	-10,190	Change in Storage
1,709	2,151	1,177	189	-287	190	7,078	Computed Losses (-), Gains (+)
							Castaic Lagoon Operation
787	0	755	0	0	0	3,752	Inflow (Includes recreation inflow)
0	0	0	0	0	0	532	Outflow
526	379	457	362	293	248	3,263	Deliveries to Recreation (State)
261	-379	298	-362	-293	-248	-43	Change in Storage
0	0	0	0	0	0	0	Computed Losses (-), Gains (+)

## Water Quality

**Table 22. Thermalito Afterbay At Feather River Outlet  
1990**

<b>Constituents</b>	<b>JAN</b>	<b>FEB</b>	<b>MAR</b>	<b>APR</b>	<b>MAY</b>	<b>JUN</b>	<b>JULY</b>	<b>AUG</b>	<b>SEP</b>	<b>OCT</b>	<b>NOV</b>	<b>DEC</b>	<b>Annual Average</b>
Total Dissolved Solids	56	59	60	58	62	65	64	60	68	63	68	70	63
Total Hardness	39	39	39	39	36	39	36	42	39	39	46	48	40
Chlorides	1	2	2	1	1	2	1	2	1	2	2	2	2
Sulfates	2	3	3	2	3	6	2	3	3	4	2	2	3
Sodium	3	4	4	4	3	4	4	4	4	4	5	5	4
% Sodium	14	14	18	10	15	18	12	13	11	12	14	14	14
EC *	86	94	94	92	92	93	93	97	95	98	108	111	96
Fluoride	NR	NR	NR	0.1	<0.1	<0.1	<0.1	0.1	<0.1	0.1	<0.1	<0.1	0.1
Lead **	NR	<0.01	NR	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
Selenium	NR	<.001	NR	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001
Total Chromium	NR	NR	NR	NR	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
Arsenic **	NR	<.01	NR	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001
Iron	NR	0.030	NR	0.014	0.021	0.066	0.015	0.020	0.021	0.039	0.017	0.014	0.026
Manganese	NR	NR	NR	<.005	<.005	0.011	0.008	<.005	<.005	0.020	<.005	<.005	0.008
Magnesium	4	4	4	4	4	4	4	4	4	4	5	5	4
Copper	NR	0.02	NR	<.005	<.005	0.009	<.005	<.005	0.006	<.005	<.005	<.005	0.007
Calcium	9	9	9	9	8	9	8	10	9	9	10	11	9
Zinc **	NR	<.01	NR	0.007	<.005	0.061	0.008	0.005	0.007	0.026	0.006	<.005	0.014
Phenol	NR	NR	NR	NR	NR	NR	NR						
Color Units	NR	NR	NR	NR	NR	NR	NR						
Sampling Date	01/17	02/21	03/21	04/18	05/16	06/20	07/18	08/15	09/18	10/17	11/14	12/19	

\*EC is in microsiemens/cm (microsiemens are equivalent to micromhos; to obtain millisiemens, divide by 1,000). All other constituents are in milligrams per liter except for pH.

\*\* January and February had higher detection limits due to less sensitive testing method

Water Quality

**Table 23. Barker Slough Pumping Plant  
1990**

<b>Constituents</b>	<b>JAN</b>	<b>FEB</b>	<b>MAR</b>	<b>APR</b>	<b>MAY</b>	<b>JUN</b>	<b>JULY</b>	<b>AUG</b>	<b>SEP</b>	<b>OCT</b>	<b>NOV</b>	<b>DEC</b>	<b>Annual Average</b>
Total Dissolved Solids	236	245	284	275	273	252	187	176	205	233	191	222	232
Total Hardness	123	126	144	120	139	130	101	96	109	121	103	116	119
Chlorides	31	33	44	40	39	35	22	20	25	31	23	29	31
Sulfates	34	36	51	52	45	37	27	21	27	33	25	31	35
Sodium	36	37	49	51	42	38	25	25	30	35	27	33	36
% Sodium	34	45	43	48	40	NR	24	24	25	25	24	25	32
EC *	395	409	492	481	457	423	311	291	342	389	317	370	390
Boron	0.2	0.2	0.3	0.3	0.3	0.2	0.2	0.2	0.1	0.2	0.1	0.1	0.2
Fluoride	<0.1	<0.1	0.2	0.2	0.1	<0.1	<0.1	0.2	<0.1	0.1	<0.1	<0.1	0.12
Lead	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
Selenium	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001
Total Chromium	NR	<.005	NR	NR	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
Arsenic	0.003	<.001	0.002	0.002	0.002	0.003	0.003	0.003	0.003	0.003	0.003	0.002	0.003
Iron	1.140	0.120	0.041	0.013	0.022	0.047	0.074	0.040	0.075	0.043	0.023	0.046	0.140
Manganese	0.059	0.012	0.019	0.007	0.007	0.006	0.008	0.008	0.006	0.019	0.005	0.014	0.014
Magnesium	16	12	21	20	19	15	13	12	12	15	12	14	15
Copper	0.033	0.008	<.005	<.005	<.005	<.005	0.006	<.005	<.005	0.009	<.005	<.005	0.008
Calcium	14	11	23	15	21	18	15	14	15	17	15	17	16
Zinc	0.04	0.018	0.014	0.01	<.005	0.012	0.029	NR	0.013	0.019	0.007	0.017	0.016
Phenol	NR	NR	NR	NR	NR	NR	NR						
Color Units	160	100	35	NR	NR	NR	NR	NR	NR	NR	NR	NR	98
Sampling Date	01/17	02/20	03/21	04/18	05/16	06/19	07/18	08/14	09/18	10/16	11/13	12/18	

\*EC is in microsiemens/cm (microsiemens are equivalent to micromhos; to obtain millisiemens, divide by 1,000). All other constituents are in milligrams per liter except for pH.

## Water Quality

**Table 24. California Aqueduct At Banks Pumping Plant****1990**

<b>Constituents</b>	<b>JAN</b>	<b>FEB</b>	<b>MAR</b>	<b>APR</b>	<b>MAY</b>	<b>JUN</b>	<b>JULY</b>	<b>AUG</b>	<b>SEP</b>	<b>OCT</b>	<b>NOV</b>	<b>DEC</b>	<b>Annual Average</b>
Total Dissolved Solids	411	264	300	411	407	379	305	272	266	343	435	475	356
Total Hardness	150	96	116	150	149	140	117	107	105	129	157	169	132
Chlorides	140	84	90	140	139	126	92	77	74	110	152	170	116
Sulfates	87	30	60	88	87	79	60	52	51	70	93	103	72
Sodium	92	52	62	92	91	83	63	54	52	73	99	109	77
% Sodium	57	54	54	57	57	56	31	30	30	32	33	34	44
EC *	721	478	522	722	715	664	531	472	461	599	765	836	624
pH	7.7	7.9	7.8	8.0	8.0	7.9	7.3	7.2	7.2	7.2	7.4	6.5	7.51
Fluoride	<0.1	<0.1	0.1	0.1	<0.1	<0.1	<0.1	0.2	<0.1	0.1	0.1	<0.1	0.1
Lead	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
Selenium	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001
Total Chromium	NR	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
Arsenic	0.001	0.001	0.002	0.002	0.002	0.002	0.003	0.003	0.003	0.002	0.002	0.002	0.002
Iron	0.038	0.036	0.036	0.016	0.037	0.040	0.047	0.042	0.034	0.013	0.019	0.045	0.034
Manganese	0.022	0.022	0.020	<.005	0.007	0.007	0.019	0.022	0.018	0.020	0.017	0.029	0.017
Magnesium	16	13	12	17	16	15	11	12	13	17	19	20	15
Copper	<.005	0.007	0.007	0.007	<.005	<.005	0.018	<.005	<.005	<.005	<.005	<.005	0.006
Calcium	18	17	17	18	18	19	15	15	18	19	23	25	19
Zinc	NR	NR	0.021	0.012	0.010	0.010	0.042	NR	0.019	0.019	0.021	0.032	0.021
Phenol	NR	0.005	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	0.005
Color Units	20	35	30	NR	NR	NR	NR	NR	NR	NR	NR	NR	28
Sampling Date	01/16	02/20	03/20	04/18	05/15	06/19	07/18	08/14	09/18	10/16	11/13	12/18	

\*EC is in microsiemens/cm (microsiemens are equivalent to micromhos; to obtain millisiemens, divide by 1,000). All other constituents are in milligrams per liter except for pH.

Water Quality

**Table 25. South Bay Aqueduct Terminal Reservoir 1/  
1990**

<b>Constituents</b>	<b>JAN</b>	<b>FEB</b>	<b>MAR</b>	<b>APR</b>	<b>MAY</b>	<b>JUN</b>	<b>JULY</b>	<b>AUG</b>	<b>SEP</b>	<b>OCT</b>	<b>NOV</b>	<b>DEC</b>	<b>Annual Average</b>
Total Dissolved Solids	351	276	251		386			258			286		301
Total Hardness	111	103	96		111			87			136		107
Chlorides	136	87	75		146			91			139		112
Sulfates	35	31	29		38			24			44		34
Sodium	81	56	50		86			58			89		70
% Sodium	N/R	N/R	N/R		N/R			N/R			N/R		N/R
EC	683	N/R	380		755			517			788		625
Boron	0.1	0.1	0.1		0.2			0.1			0.2		0.1
Fluoride	0.1	0.1	0.1		0.1			0.2			0.1		0.1
Lead	<.005	<.005	<.005		<.005			<.005			<.005		<.005
Selenium	<.001	<.001	<.001		<.001			<.001			<.001		<.001
Hexavalent Chromium	N/R	N/R	N/R		N/R			N/R			N/R		N/R
Arsenic	0.002	<.001	0.001		0.002			0.003			0.002		0.002
Iron	0.068	0.041	0.052		0.044			0.02			0.015		0.040
Manganese	0.016	0.026	0.014		0.014			0.065			0.011		0.024
Magnesium	16	14	13		16			12			19		15
Copper	<.005	0.009	<.005		0.05			0.006			<.005		0.006
Calcium	18	18	17		18			87			23		30
Zinc	N/R	N/R	N/R		N/R			N/R			0.01		0.01
Phenol	N/R	0.004	N/R		N/R			N/R			N/R		0.004
Color Units	20	35	25		N/R			N/R			N/R		27
Sampling Date	01/16	02/20	03/20		05/15			08/14			11/13		

\*EC is in microsiemens/cm (microsiemens are equivalent to micromhos; to obtain millisiemens, divide by 1,000). All other constituents are in milligrams per liter except for pH.

1/ After March 1990, W.Q. samples were collected quarterly at this station.

Water Quality

**Table 26. California Aqueduct At Check 13  
1990**

<b>Constituents</b>	<b>JAN</b>	<b>FEB</b>	<b>MAR</b>	<b>APR</b>	<b>MAY</b>	<b>JUN</b>	<b>JULY</b>	<b>AUG</b>	<b>SEP</b>	<b>OCT</b>	<b>NOV</b>	<b>DEC</b>	<b>Annual Average</b>
Total Dissolved Solids	405	362	301	367	369	375	350	294	252	371	384	384	351
Total Hardness	139	128	112	130	130	132	125	110	99	131	134	134	125
Chlorides	124	106	81	108	109	112	101	78	60	110	116	116	102
Sulfates	60	55	47	55	55	56	53	46	41	56	57	57	53
Sodium	83	73	58	74	75	76	69	55	45	74	78	78	70
% Sodium	56	55	53	31	56	56	30	29	28	31	31	31	41
EC *	716	638	525	647	651	662	616	512	434	654	678	678	618
Boron	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.1	0.2	0.2	0.2	0.19
Fluoride	<0.1	<0.1	0.1	0.2	<0.1	<0.1	<0.1	0.2	<0.1	0.1	<0.1	<0.1	0.12
Lead	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
Selenium	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001
Total Chromium	NR	<.005	NR	NR	NR	NR	<.005	<.005	<.005	<.005	<.005	<.005	<.005
Arsenic	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.003	0.003	0.002	0.002
Iron	0.080	0.058	0.090	0.025	0.008	0.006	0.013	0.007	0.021	0.013	0.018	0.055	0.033
Manganese	0.015	0.015	0.014	0.006	0.001	<.005	<.005	<.005	<.005	<.005	0.014	0.019	0.009
Magnesium	17	15	14	20	16	16	15	16	14	16	18	20	16
Copper	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	0.005	<.005	<.005	<.005
Calcium	22	22	20	20	24	21	20	21	19	21	23	26	22
Zinc	0.005	<.005	<.005	<.005	0.007	<.005	<.005	<.005	0.007	<.005	<.005	<.005	0.005
Phenol	NR	0.003	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	0.003
Color Units	20	30	25	NR	NR	NR	NR	NR	NR	NR	NR	NR	25
Sampling Date	01/17	02/21	03/21	04/18	05/16	06/20	07/18	08/15	09/19	10/17	11/14	12/19	

\*EC is in microsiemens/cm (microsiemens are equivalent to micromhos; to obtain millisiemens, divide by 1,000). All other constituents are in milligrams per liter except for pH.

Water Quality

**Table 27: California Aqueduct Near Kettleman City  
1990**

<b>Constituents</b>	<b>JAN</b>	<b>FEB</b>	<b>MAR</b>	<b>APR</b>	<b>MAY</b>	<b>JUN</b>	<b>JULY</b>	<b>AUG</b>	<b>SEP</b>	<b>OCT</b>	<b>NOV</b>	<b>DEC</b>	<b>Annual Average</b>
Total Dissolved Solids	406	381	312	351	370	386	365	323	260	305	378	442	357
Total Hardness	141	134	116	126	131	135	130	119	103	114	133	150	128
Chlorides	120	110	84	99	106	112	104	88	64	81	109	134	101
Sulfates	51	47	38	43	46	48	45	39	30	37	47	56	44
Sodium	83	77	60	70	74	77	73	62	47	58	76	91	71
% Sodium	56	55	53	55	55	NR	30	30	29	30	31	31	41
EC *	710	666	544	613	646	674	638	563	451	530	661	775	623
pH	7.5	7.8	7.9	7.4	8.2	8.2	7.7	7.9	7.4	8.2	7.7	6.9	7.73
Boron	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.1	0.2	0.2	0.2	0.192
Fluoride	<0.1	<0.1	0.2	0.2	<0.1	<0.1	<0.1	0.2	<0.1	0.1	0.1	<0.1	0.125
Lead	<005	<005	<005	<005	<005	<005	<005	<005	<005	<005	<005	<005	<.005
Selenium	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001
Total Chromium	NR	<.005	NR	NR	NR	NR	<.005	<.005	<.005	<.005	<.005	<.005	<.005
Arsenic	0.002	0.002	<.001	0.002	0.001	0.002	0.002	0.002	0.002	0.003	0.002	0.002	0.002
Iron	0.054	0.075	0.093	0.030	0.010	0.100	0.019	0.019	0.039	0.014	0.015	0.032	0.042
Manganese	0.019	0.013	0.010	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	0.007
Magnesium	18	16	15	20	16	16	15	15	13	16	18	20	17
Copper	<.005	0.014	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	0.006
Calcium	24	23	22	20	25	21	20	20	19	21	22	27	22
Zinc	0.006	0.007	<.005	<.005	0.014	0.007	0.024	NR	0.021	0.006	0.007	0.011	0.010
Phenol	NR	0.003	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	0.003
Color Units	15	25	20	NR	NR	NR	NR	NR	NR	NR	NR	NR	20
Sampling Date	1/16/90	2/20/90	3/21/90	4/17/90	5/16/90	6/20/90	7/18/90	8/15/90	9/19/90	10/17/90	11/14/90	12/18/90	

\*EC is in microsiemens/cm (microsiemens are equivalent to micromhos; to obtain millisiemens, divide by 1,000). All other constituents are in milligrams per liter except for pH.

Water Quality

**Table 28. California Aqueduct At Check 29  
1990**

<b>Constituents</b>	<b>JAN</b>	<b>FEB</b>	<b>MAR</b>	<b>APR</b>	<b>MAY</b>	<b>JUN</b>	<b>JULY</b>	<b>AUG</b>	<b>SEP</b>	<b>OCT</b>	<b>NOV</b>	<b>DEC</b>	<b>Annual Average</b>
Total Dissolved Solids	382	369	306	335	355	343	338	319	280	310	357	438	344
Total Hardness	139	135	116	125	131	127	125	120	108	117	131	156	128
Chlorides	110	105	81	92	100	95	93	86	70	82	101	133	96
Sulfates	66	64	52	58	61	59	58	55	47	53	62	76	59
Sodium	102	99	60	70	72	74	76	65	48	60	82	90	75
% Sodium	62	61	53	30	55	54	31	30	29	30	31	32	42
EC *	676	652	533	588	626	603	593	557	483	541	630	783	605
pH	7.9	8.0	7.7	7.2	NR	8.2	7.8	7.9	7.5	7.6	7.7	7.0	7.5
Boron	0.1	0.2	0.2	0.2	0.2	0.2	0.1	0.2	0.2	0.2	0.2	0.2	0.2
Fluoride	0.2	0.2	0.1	0.1	<0.1	<0.1	0.2	<0.1	0.1	<0.1	<0.1	<0.1	0.1
Lead **	<.01	<.01	NR	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
Selenium	<.001	<.001	NR	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001
Total Chromium	NR	NR	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
Arsenic **	<.01	<.01	0.002	0.002	0.002	0.002	0.002	0.002	0.003	0.002	0.006	0.002	0.003
Iron	0.04	0.04	0.07	0.032	0.016	0.058	0.018	0.023	0.030	0.026	0.025	0.032	0.034
Manganese	NR	NR	0.01	<.005	<.005	<.005	0.008	0.066	<.005	<.005	<.005	0.264	0.038
Magnesium	19	17	17	16	16	16	16	15	12	15	18	19	16
Copper	0.02	0.02	0.02	0.035	0.061	0.016	0.017	0.018	0.018	0.037	0.014	0.017	0.024
Calcium	25	25	22	21	21	22	22	20	18	19	22	26	22
Zinc	0.02	0.01	NR	0.02	0.064	0.034	0.053	0.021	0.021	0.064	0.026	0.031	0.033
Phenol	NR	NR	NR	NR	NR	NR	NR						
Color Units	NR	18	16	NR	NR	NR	NR	NR	NR	NR	NR	NR	17
Sampling Date	01/16	02/20	03/20	04/17	05/15	06/20	07/17	08/14	09/18	10/16	11/13	12/18	

\*EC is in microsiemens/cm (microsiemens are equivalent to micromhos; to obtain millisiemens, divide by 1,000). All other constituents are in milligrams per liter except for pH.

\*\* January and February had higher detection limits due to less sensitive testing method.

Water Quality

**Table 29. California Aqueduct At Tehachapi Afterbay  
1990**

<b>Constituents</b>	<b>JAN</b>	<b>FEB</b>	<b>MAR</b>	<b>APR</b>	<b>MAY</b>	<b>JUN</b>	<b>JULY</b>	<b>AUG</b>	<b>SEP</b>	<b>OCT</b>	<b>NOV</b>	<b>DEC</b>	<b>Annual Average</b>
Total Dissolved Solids	356	339	275	323	311	311	301	308	246	281	352	369	314
Total Hardness	129	124	106	120	116	116	113	109	98	108	128	132	117
Chlorides	102	96	70	90	84	85	80	74	59	73	101	108	85
Sulfates	63	60	48	57	55	55	53	50	42	49	63	66	55
Sodium	73	69	53	65	62	61	59	55	45	54	72	76	62
% Sodium	55	55	52	31	54	54	30	30	29	30	31	31	40
EC *	620	590	475	562	539	540	521	493	423	486	613	644	542
pH	7.8	7.8	8.1	8.1	7.6	7.6	7.5	7.2	7.6	7.5	7.5	NR	7.6
Boron	0.1	0.2	0.2	0.1	0.2	0.2	0.1	0.2	0.1	0.3	0.3	NR	0.2
Fluoride	0.1	0.2	0.1	0.1	0.1	0.2	0.2	0.2	0.1	0.1	0.1	NR	0.1
Lead **	<.01	<.01	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
Selenium	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001
Total Chromium	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
Arsenic **	<.01	<.01	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.003	0.003	0.002	0.004
Iron	0.01	0.03	0.013	0.016	0.012	0.015	0.016	0.006	0.039	0.008	0.006	0.017	0.016
Manganese	NR	NR	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
Magnesium	21	17	14	16	16	15	15	14	13	15	17	NR	16
Copper	0.01	0.02	<.005	0.007	<.005	<.005	<.005	<.005	0.005	<.005	<.005	0.006	0.007
Calcium	22	24	22	21	21	25	24	24	26	21	23	NR	23
Zinc **	NR	<.01	<.005	0.018	<.005	0.012	0.006	0.007	0.027	<.005	<.005	0.015	0.010
Phenol	NR	NR	NR	NR	NR	NR	NR						
Color Units	9	6	7	NR	NR	NR	NR	NR	NR	NR	NR	NR	7
Sampling Date	01/18	02/21	03/21	04/18	05/16	06/20	07/18	08/15	09/19	10/17	11/14	12/19	

\*EC is in microsiemens/cm (microsiemens are equivalent to micromhos; to obtain millisiemens, divide by 1,000). All other constituents are in milligrams per liter except for pH.

\*\* January and February had higher detection limits due to less sensitive testing method.

Water Quality  
**Table 30. Devil Canyon Afterbay  
 1990**

<b>Constituents</b>	<b>JAN</b>	<b>FEB</b>	<b>MAR</b>	<b>APR</b>	<b>MAY</b>	<b>JUN</b>	<b>JULY</b>	<b>AUG</b>	<b>SEP</b>	<b>OCT</b>	<b>NOV</b>	<b>DEC</b>	<b>Annual Average</b>
Total Dissolved Solids	NR	312	328	291	312	328	340	308	288	272	297	352	312
Total Hardness	NR	116	121	110	117	120	124	115	110	105	112	128	116
Chlorides	NR	85	92	77	85	91	97	84	76	69	79	102	85
Sulfates	NR	46	56	44	53	48	50	46	43	41	44	51	47
Sodium	NR	62	65	56	61	65	68	60	55	51	58	71	61
% Sodium	NR	54	54	53	54	54	31	30	30	29	30	31	41
EC *	NR	548	577	510	547	576	599	540	503	473	520	620	547
pH	NR	8.0	7.9	7.7	7.7	8.3	7.5	7.4	7.6	7.4	NR	NR	7.6
Boron	NR	0.2	0.2	0.1	0.1	0.2	0.1	0.1	0.1	0.3	NR	NR	0.2
Fluoride	NR	0.1	0.1	0.1	0.1	0.2	0.2	0.1	0.1	0.1	NR	NR	0.1
Lead **	NR	<.01	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
Selenium	NR	<.001	<.001	<.001	0.001	0.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001
Total Chromium	NR	NR	NR	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
Arsenic	NR	NR	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.003	0.003	0.002	0.002
Iron **	NR	<.01	0.016	0.010	0.006	0.009	<.005	<.005	0.006	0.011	<.005	0.005	0.008
Manganese	NR	NR	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	0.006	<.005	0.005
Magnesium	NR	16	15	16	17	16	15	15	15	14	NR	NR	15
Copper **	NR	<.01	<.005	0.008	<.005	0.007	<.005	<.005	<.005	<.005	<.005	0.008	0.006
Calcium	NR	22	25	22	21	25	26	25	20	20	NR	NR	23
Zinc	NR	0.01	0.006	0.006	<.005	0.009	0.018	<.005	0.015	0.005	<.005	0.015	0.009
Phenol	NR	NR	NR	NR	NR	NR	NR						
Color Units	NR	6	4	4	NR	NR	NR	NR	NR	NR	NR	NR	5
Sampling Date		02/21	03/21	04/18	05/16	06/20	07/18	08/15	09/19	10/17	11/14	12/19	

\*EC is in microsiemens/cm (microsiemens are equivalent to micromhos; to obtain millisiemens, divide by 1,000). All other constituents are in milligrams per liter except for pH.

\*\* January and February had higher detection limits due to less sensitive testing method.

**Table 31. Water Quality  
Minimum Detection Concentrations For Tested Substances**

	Reporting Limit m g/L		Reporting limit m g/L
<b>Carbamates</b>		<b>Misc. Pesticides (cont.)</b>	
1-Naphtol	4.00	Benfluralin	0.01
3-Hydroxycarbofuran	2.00	Glyphosate	100.00
Aldicarb	2.00	Propargite	1.00
Aldicarb Sulfone	2.00	Trifluralin	0.01
Aldicarb Sulfoxide	2.00	<b>Organic Phosphorus Pesticides</b>	
Cabaryl	2.00	Azinphosmethyl	0.05
Cabofuran	2.00	Carbophenothion (Trithion)	0.02
Methiocarb	4.00	Chlorpyrifos	0.01
Methomyl	2.00	Demeton	0.02
Oxamyl	2.00	Diazinon	0.01
<b>Chlorinated Hydrocarbons</b>		Dimethoate	0.01
Alachlor	0.05	Disulfoton	0.01
Aldrin	0.01	Ethion	0.01
Atrazine	0.02	Malathion	0.01
BHC (alpha, beta, delts, gamma)	0.01	Methidathion	0.02
Captan	0.02	Methyl Parathion	0.01
Chlordane	0.05	Mevinphos	0.01
Chlorothalonil	0.01	Naled	0.02
Chlorpropham	0.02	Parathion	0.01
Chlorpyrifos	0.01	Phorate	0.01
DCPA	0.01	Phosalone	0.02
DDD, DDE, DDT	0.01	Phosmet	0.02
Dichloran	0.01	Profenofos	0.01
Dicofol	0.01	s,s,s-Tributyl Phosphorotrithioate (DEF)	0.01
Dieldrin	0.01	<b>Purgeable Organics</b>	
Diuron	0.05	1,1,1-Trichloroethane	0.50
Endosulfan Sulfate	0.01	1,1,2-Trichloroethane	0.50
Endosulfan (I,II)	0.01	1,1-Dichloroethane	0.50
Endrin	0.01	1,1-Dichloroethylene	0.50
Endrin Aldehyde	0.01	1,2-Dichloroethane	0.50
Heptachlor	0.01	1,2-Dichlorobenzene	0.50
Heptachlor Epoxide	0.01	1,2-Dechloropropane	0.50
Methoxychlor	0.01	1,3-Dechlorobenzene	0.50
PCB (various isomers)	0.10	1,4-Dechlorobenzene	0.50
PCNB	0.01	Benzene	0.50
Simazine	0.02	Bromodichloromethane	0.50
Thiobencarb	0.02	Bromoform	0.50
Toxaphene	0.20	Carbon tetrachloride	0.50
<b>Herbicides</b>		Chlorobenzene	0.50
2,4, - D	0.10	Chloroform	0.50
2,4 - DB	0.10	cis-1,2-Dechloroethylene	0.50
2,4,5 - TP	0.10	Dibromochloromethane	0.50
2,4,5 - T	0.10	Ethytibenzene	0.50
Dicamba	0.10	Tetrachloroethylene	0.50
MCPA	0.10	Toluene	0.50
MCPP	0.10	trans-1,2-Dichloroethylene	0.50
Pentachlorophenol (PCP)	0.10	Trichloroethylene	0.50
<b>Misc. Pesticides</b>		Trichlorofluoromethane	0.50
Acephate	0.10	Vynil chloride	0.50
Aminomethylphosphonic	100.00	Xylene (s) 1	0.50

\*Listed are those pesticides that would be detected by lab scans currently used for pesticide analysis, and the minimum concentration at which these substances can be detected. Detected amounts from the quarterly sampling program are shown below

**Pesticides In The California Aqueduct**

	1990			
STATION	FEB	MAY	AUG	NOV
<b>Harvey O. Banks Delta Pumping Plant</b>				
Chlorinated Hydrocarbons	None Detected	None Detected	None Detected	
2,4-D				0.10
1,1,1 Tri-Chloroethane				0.50
<b>O'Neill Pumping Plant Discharge</b>				
Chlorinated Hydrocarbons	None Detected	None Detected	None Detected	
2,4-D				0.40
<b>Near Kettleman City (Check 21)</b>				
Chlorinated Hydrocarbons	None Detected	None Detected	None Detected	
2,4-D				0.60
<b>Tehachapi Afterbay</b>				
Chlorinated Hydrocarbons	None Detected	None Detected	No Results	
2,4-D				0.10

## Glossary

**accretion** - the water accumulated and retained within a service area.

**acre-foot (AF)** - a quantity or volume of water covering one acre to a depth of one foot; equal to 43,560 cubic feet or 325,851 gallons.

**active storage capacity** - the total usable reservoir capacity available for seasonal or cyclic water storage. It is gross reservoir capacity minus inactive storage capacity.

**afterbay** - a reservoir that regulates fluctuating discharges from a hydroelectric power plant or a pumping plant.

**alluvium** - a stratified bed of sand, gravel, silt, and clay deposited by flowing water.

**aquifer** - a geologic formation that stores and transmits water and yields significant quantities of water to wells and springs.

**average annual runoff** - the average value of annual runoff amounts for a specified area calculated for a selected period of record that represents average hydrologic conditions.

**balanced water conditions** - exist when upstream reservoir storage releases, plus other inflows, approximately equal the water supply needed to (1) satisfy Sacramento Valley and Sacramento-San Joaquin Delta in-basin needs, including Delta water quality requirements, and (2) meet export needs.

**benthic invertebrates** - aquatic animals without backbones that dwell on or in the bottom sediments of fresh or salt water. Examples: clams, crayfish, and a wide variety of worms.

**biota** - all living organisms of a region, as in a stream or other body of water.

**brackish water** - water containing dissolved minerals in amounts that exceed normally acceptable standards for municipal, domestic, and irrigation uses. Considerably less saline than sea water.

**carriage water** - the amount of water needed above an increased export so as to not increase salinity in the Delta.

**conjunctive use** - the operation of a ground water basin in combination with a surface water storage and conveyance system. Water is stored in the ground water basin for later use by intentionally recharging the basin during years of above-average water supply.

**Decision 1485 operating criteria** - standards for operating water project facilities under Water Rights Decision 1485 regarding the Sacramento-San Joaquin Delta and Suisun Marsh, adopted by the State Water Resources Control Board, August 1978.

**Delta consumptive use** - the sum of evapotranspiration and changes in soil moisture of Delta lands and evaporation from Delta channels.

**Delta outflow index** - a calculated approximation of this seaward freshwater outflow as it passes Chipps Island near Pittsburg, beyond the confluence of the Sacramento and San Joaquin Rivers.

**depletion** - the water consumed within a service area and no longer available as a source of supply.

**dissolved organic compounds** - carbon substances dissolved in water.

**drainage basin** - the area of land from which water drains into a river; for example, the Sacramento River Basin, in which all land area drains into the Sacramento River. Also called, "catchment area," "watershed," or "river basin."

**drought condition** - hydrologic conditions during a defined drought period during which rainfall and runoff are much less than average.

**ecology** - the study of the interrelationships of living organisms to one another and to their surroundings.

**ecosystem** - recognizable, relatively homogeneous units, including the organisms they contain, their environment, and all the interactions among them.

**effluent** - waste water or other liquid, partially or completely treated or in its natural state, flowing from a treatment plant.

**environment** - the sum of all external influences and conditions affecting the life and development of an organism or ecological community; the total social and cultural conditions.

**estuary** - the lower course of a river entering the sea influenced by tidal action where the tide meets the river current.

**evapotranspiration (ET)** - the quantity of water transpired (given off), retained in plant tissues, and evaporated from plant tissues and surrounding soil surfaces. Quantitatively, it is usually expressed in terms of depth of water per unit area during a specified period of time.

**evapotranspiration of applied water (ETAW)** - the portion of the total evapotranspiration which is provided by irrigation.

**forebay** - a reservoir or pond situated at the intake of a pumping plant or power plant to stabilize water levels; also a storage basin for regulating water for percolation into ground water basins.

**fry** - a recently hatched fish.

**gross reservoir capacity** - the total storage capacity available in a reservoir for all purposes, from the streambed to the normal maximum operating level. Includes dead (or inactive) storage, but excludes surcharge (water temporarily stored above the elevation of the top of the spillway).

**ground water** - water that occurs beneath the land surface and completely fills all pore spaces of the alluvium, soil or rock formation in which it is situated.

**ground water basin** - a ground water reservoir, defined by an overlying land surface and the underlying aquifers that contain water stored in the reservoir.

**ground water overdraft** - the condition of a ground water basin in which the amount of water withdrawn by pumping exceeds the amount of water that recharges the basin over a period of years during which water supply conditions approximate average.

**ground water recharge** - increases in ground water storage by natural conditions or by human activity.

**ground water table** - the upper surface of the zone of saturation, except where the surface is formed by an impermeable body.

**hydraulic barrier** - a barrier developed in the estuary by release of fresh water from upstream reservoirs to prevent intrusion of sea water into the body of fresh water.

**hydrologic balance** - an accounting of all water inflow to, water outflow from, and changes in water storage within a hydrologic unit over a specified period of time.

**hydrologic basin** - the complete drainage area upstream from a given point on a stream.

**hydrologic region** - a study area, consisting of one or more planning subareas.

**joint-use facilities** - specific pumping plants, power plants, canals, and reservoirs in which both State and federal agencies participated in the construction, use, and maintenance.

**land subsidence** - the lowering of the natural land surface in response to earth movements; lowering of fluid pressure (or lowering of ground water level); removal of underlying supporting materials by mining or solution of solids, either artificially or from natural causes; compaction caused by wetting (hydrocompaction); oxidation of organic matter in soils; or added load on the land surface.

**megawatt** - one million watts.

**milligrams per liter (mg/L)** - the weight in milligrams of any substance dissolved in one liter of liquid; nearly the same as parts per million.

**natural flow** - the flow past a specified point on a natural stream that is unaffected by stream diversion, storage, import, export, return flow, or change in use caused by modification in land use.

**percolation** - the downward movement of water throughout the soil or alluvium to a ground water table.

**permeability** - the capability of soil or other geologic formations to transmit water.

**phytoplankton** - minute plants, usually algae, that live suspended in bodies of water and that drift about because they cannot move by themselves or because they are too small or too weak to swim effectively against a current.

**pollution (of water)** - the alteration of the physical, chemical, or biological properties of water by the introduction of any substance into water that adversely affects any beneficial use of water.

**prior water right** - a water designation used for water delivered based on its use prior to SWP construction.

**pumping-generating plant** - a plant at which the turbine-driven generators can also be used as motor-driven pumps.

**recharge basin** - a surface facility, often a large pond, used to increase the percolation of surface water into a ground water basin.

**riparian vegetation** - vegetation growing on the banks of a stream or other body of water.

**runoff** - the total volume of surface flow from an area during a specified time.

**Sacramento River index** - the sum of the Sacramento Valley's unimpaired runoff at the following four locations: Sacramento River near Red Bluff; total Feather River inflow to Lake Oroville; Yuba River at Smartville; and total American River inflow to Folsom Lake.

**salinity** - generally, the concentration of mineral salts dissolved in water. Salinity may be measured by weight (total dissolved solids), electrical conductivity, or osmotic pressure. See **total dissolved solids**.

**salinity intrusion** - the movement of salt water into a body of fresh water. It can occur in either surface water or ground water bodies.

**salt-water barrier** - a physical facility or method of operation designed to prevent the intrusion of salt water into a body of fresh water.

**sediment** - soil or mineral material transported by water and deposited in streams or other bodies of water.

**seepage** - the gradual movement of a fluid into, through, or from a porous medium.

**service area** - the geographical land area served by a distribution system of a water agency.

**snow water content** - a calculated or measured amount of water contained in packed snow based on its depth and density.

**spawning** - the depositing and fertilizing of eggs (roe) by fish and other aquatic life.

**streamflow** - the rate of water flow past a specified point in a channel.

**surplus water** - developed water supplies in excess of contract entitlement or apportioned water.

**total dissolved solids (TDS)** - a quantitative measure of the residual minerals dissolved in water that remain after evaporation of a solution. Usually expressed in milligrams per liter. See **salinity**.

**transpiration** - an essential physiological process in which plant tissues give off water vapor to the atmosphere.

**unimpaired runoff** - represents the natural water production of a river basin, unaltered by upstream diversions, storage, or by export or import of water to or from other watersheds.

**waste water** - the water, liquid waste, or drainage from a community, industry, or institution.

**water conservation** - reduction in applied water due to more efficient water use.

**water quality** - used to describe the chemical, physical, and biological characteristics of water, usually in regard to its suitability for a particular purpose or use.

**water right** - a legally protected right to take possession of water occurring in a natural waterway and to divert that water for beneficial use.

**water table** - see **ground water table**.

**water year** - a continuous 12-month period for which hydrologic records are compiled and summarized. In California, it begins on October 1 and ends September 30 of the following year.

**watershed** - see **drainage basin**.