California Department of Water Resources
Division of Operations and Maintenance
Water Quality Section

Water Quality Assessment of the State Water Project, 1994–1995

June 1997

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Governor
State of California

Douglas P. Wheeler
Secretary for Resources
The Resources Agency

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Abbreviations

af	acre-feet
Ag	silver
Al	aluminum
As	arsenic
B	boron
Ba	barium
Br	bromide
Ca	calcium
Cd	cadmium
cfs	cubic feet per second
Cl	chloride
CO_3	carbonate
Cr	chromium
Cu	copper
CVP	Central Valley Project
DHS	Department of Health Services
DMC	Delta-Mendota Canal
DWR	Department of Water Resources
EC	electrical conductivity
EPA	Environmental Protection Agency
F	fluoride
Fe	iron
Hg	mercury
K	potassium
MCL	maximum contaminant level
MFL	million fibers per liter
mg/l	milligrams per liter
Mg	magnesium
Mn	manganese
mp	mile-post
n	number
N	nitrogen
Na	sodium
NH_4	ammonia
NO_2	nitrite
NO_3	nitrate
P	phosphorous
Pb	lead
pH	negative log of the hydrogen ion activity
PO_4	phosphate
Se	selenium
SLC	San Luis Canal
SO_4	sulfate
SRI	Sacramento River Index
SWP	State Water Project
TDS	total dissolved solids
TOC	total organic carbon
TSS	total suspended solids
THM	trihalomethane
USBR	United States Bureau of Reclamation
µg/l	micrograms per liter
µmole/l	micromoles per liter
µS/cm	microseimens per centimeter
WQT	water quality threshold
Zn	zinc

I. Executive Summary

Water quality in the State Water Project varied greatly between the years 1994 and 1995. Because 1994 was a relatively dry year with below-normal rainfall in the Central Valley, less fresh water flowed into the Delta. Less runoff to the Delta resulted in higher mineral levels downstream in the SWP. The opposite occurred in 1995 when heavy runoff from above-normal rainfall lowered mineral concentrations throughout the SWP. Mineral parameters such as sulfate, total dissolved solids, and sodium increased in the California Aqueduct from ground water pump-ins and floodwater inflows during 1994 and 1995, respectively. During 1995, heavy rainfall produced total organic carbon spikes in the North Bay Aqueduct that more than tripled the formation potential of trihalomethanes. This report discusses these and other trends in detail.

Water Supply Conditions

Delta Inflows

Dry conditions prevailed in early 1994 when California received only about 55 percent of the historical average rainfall by February 1, followed by a very dry March. Total 1994 northern Sierra Nevada precipitation ended at only 70 percent of average and the mountain snowpack measured about 50 percent of average. Dry year conditions deteriorated into critical year conditions as the season progressed. The Sacramento River Index of unimpaired runoff for 1994 totaled 7.8 million af—down greatly from 22.2 million af the previous year.

Conversely, 1995 was the wettest year since 1983 and the second wettest year in the Sacramento Valley since 1922. Approximately 40 percent of the entire year's precipitation fell in the northern Sierra Nevada between January 4 to 15, 1995. A second series of major statewide storms followed in March. By the end of 1995, precipitation in the Sierra Nevada was 171 percent of average and the year was classified as wet. As a result, the SRI for 1995 was 35 million af.

Precipitation in the Central Valley ultimately determines the salinity of water taken from the Delta. High runoff flushes brackish water from the Delta's tidal prism and lowers the concentration of salts such as chloride, sulfate, and sodium. Higher flows also help to dilute discharges from agriculture, abandoned mines, and wastewater treatment plants. The reverse occurs during low-flow years when less runoff is available to prevent salinity intrusion and dilute in-stream discharges.

Non-Project Inflows

Non-Project inflows from groundwater pump-ins to the California Aqueduct totaled 100,000 af in 1994 and 7,500 af in 1995. Alternately, floodwater inflows totaled 600 af in 1994 and 26,000 af in 1995. Both inflows increased salt loading to the California Aqueduct, although concentration increases depended on discharge-to-flow ratios.

Non-Project inflows from local watershed runoff accounted for 5 percent of all Project and non-Project contributions into Pyramid and Castaic lakes during 1994 and 42 percent during 1995. At Pyramid Lake, local runoff totaled 17,550 af in 1994 and 105,500 af in 1995. At Castaic Lake, local runoff totaled 3,100 af in 1994 and 33,400 af in 1995. On the East Branch of the California Aqueduct, natural inflows to Silverwood Lake were 4,500 af in 1994 and 40,259 af in 1995.

Water Quality Assessment

Water quality was assessed at 11 representative SWP stations located on the California Aqueduct, North Bay Aqueduct, South Bay Aqueduct, Thermalito Afterbay below Lake Oroville, and the Delta Mendota Canal. Water quality constituents addressed in this report are listed in Table 1 along with their respective water quality thresholds.

Table 1
Water Quality Constituents Addressed in This Report

(All values in mg/l unless otherwise noted)

	DHS Drinking Water Standards[a]		Article 19 Objective
	Primary	Secondary	(monthly)
Minerals			
Specific conductance (µS/cm)		900 - 1600 - 2200[b]	
Anion/ cation balance			
Total dissolved solids		500 - 1000 - 1500[b]	440
Sodium			50[c]
Hardness			180
Chloride		250 - 500 - 600[b]	110
Sulfate		250 - 500 - 600[b]	110
Minor Elements			
Arsenic	0.05		0.05[d]
Selenium	0.05		0.01[d]
Trihalomethane-related			
Total organic carbon			
THM formation potential			
Bromide			
Organic Chemicals			
Insecticides, herbicides, volatile organics[e]			

a. California final (Jan. 1996)
b. Recommended - Upper - Short-term
c. Percent of the total cationic composition
d. Maximum
e. Refer to Table 3

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Minerals

Seasonal Trends: Mineral concentrations in the SWP were substantially lower in 1995 than 1994. At Banks Pumping Plant for instance, chloride averaged 87 mg/l in 1994 and 31 mg/l in 1995; a decline of 64 percent between years (Figure 1). At the same station, sodium averaged 59 mg/l in 1994 and 27 mg/l in 1995; a decline of 54 percent. Similar annual trends were observed for specific conductance, total dissolved solids, hardness, and sulfate throughout the entire length of the California Aqueduct to Devil Canyon Afterbay. These trends were also observed in the South Bay Aqueduct; however, mineral concentrations were not as disparate between years in the North Bay Aqueduct because NBA water quality is usually more affected by local runoff than by central Delta hydrodynamics. Therefore, annual mineral concentrations at most SWP stations during 1995 were influenced by the diluting effect of fresh water inflows to the Delta that consequently minimized salinity intrusion (see discussion above).

The effects of salinity intrusion in the Delta were illustrated by analysis of ionic equivalents. Chloride was the dominant anion in the California Aqueduct during 1994, but not 1995. Chloride composed 43-51 percent of the total anionic composition at all Aqueduct stations during 1994, but dropped to 20-39 percent during 1995. Chloride is the major anion in sea water while the dominant anion in fresh water is usually bicarbonate. The lower chloride percentages in 1995 combined with a higher bicarbonate percentage of the total anionic content (31-59 percent) during the same year reflects a diminished influence of salt water intrusion. The converse was true in 1994 as bicarbonate was only 28-36 percent of the total anionic composition. Similar trends were observed for sodium and calcium, which are dominant cations, respectively, in seawater and fresh water.

No appreciable change in mineral averages were observed between years at either Thermalito Afterbay or Castaic Lake. This was due, at Thermalito Afterbay, to its location within the watershed and the moderating effects of Oroville dam releases, and at Castaic Lake, to the moderating effects of lake volume, limnological cycles within the lake, and inflows from Pyramid Lake.

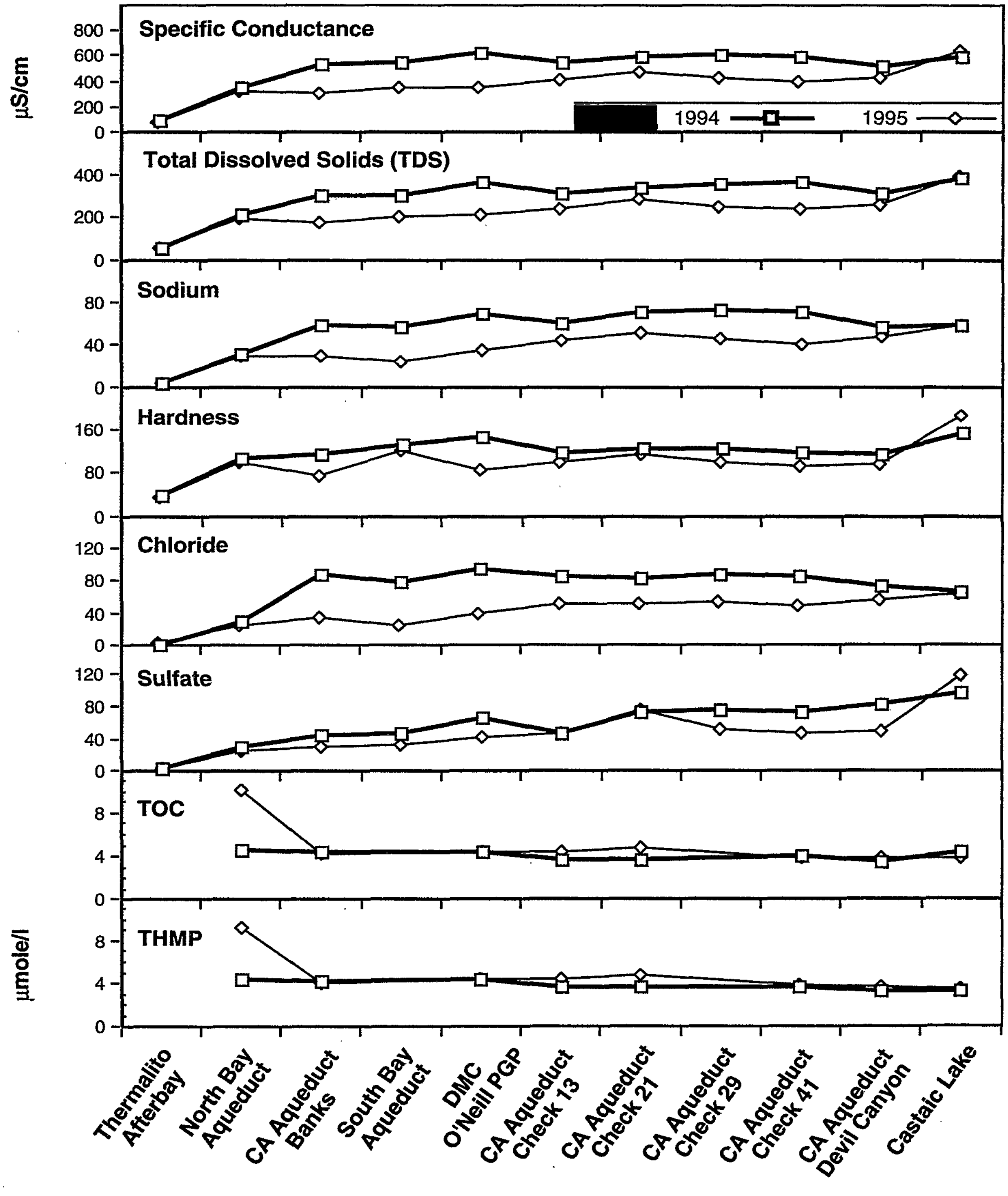
Station Comparisons: During both years, minerals increased in the California Aqueduct successively between Banks Pumping Plant and several downstream locations. During 1994, total dissolved solids averaged 297 mg/l at Banks Pumping Plant while at Checks 13, 21, 29, and 41, averages ranged from 304 to 361 mg/l; an increase of up to 22 percent. A more pronounced trend was observed during 1995 when TDS increased from an annual average of 166 mg/l at Banks Pumping Plant to between 226 and 273 mg/l at Checks 13, 21, 29, and 41; an increase of as much as 64 percent. Similar trends were observed for specific conductance, chloride (only in 1995), sodium, hardness, and sulfate. The observed mineral increases were caused by several factors including inflows to O'Neill Forebay from the Delta-Mendota Canal, non-Project inflows from pump-ins and floodwaters, in-channel evaporation, and possibly San Luis Reservoir releases.

An increase in mineral levels occurred between Banks Pumping Plant and Check 13 during 1995 due to DMC inflows to O'Neill Forebay and, possibly, releases from San Luis Reservoir. For instance, annual specific conductance was 283 µS/cm at Banks Pumping Plant and 399 µS/cm at Check 13; an increase of 41 percent. Specific conductance in the DMC averaged 332 µS/cm the same year, which was 67 µS/cm lower than the Check 13 average and, therefore, was not entirely responsible for the higher levels detected there. Chloride during 1995 averaged 31 mg/l at Banks Pumping Plant and 50 mg/l at Check 13; an increase of 61 percent between stations. The DMC average of 37 mg/l was only slightly higher than that observed at Banks Pumping Plant and could not have been solely responsible for the increase. Similar trends were observed for total dissolved solids, sodium, hardness, and sulfate. Other than DMC inflows, the only major source that could have influenced water quality at Check 13 were releases from San Luis Reservoir.

Figure 1

Mean Annual Water Quality at Selected Stations

Units = mg/l unless otherwise noted



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On the California Aqueduct, the greatest station-to-station increase occurred between Check 13 and Check 21 where a majority of non-Project inputs are located. During 1994 for instance, annual sulfate averaged 47 mg/l at Check 13 and 72 mg/l at Check 21; a 53 percent increase between stations. A similar increase was observed during 1995 when sulfate averaged 45 mg/l at Check 13 and 74 mg/l at Check 21. These trends were also observed, to varying degrees, for specific conductance, total dissolved solids, hardness, and sulfate, but not chloride. Mineral increases between Checks 13 and 21 corresponded with non-Project inputs from groundwater pump-ins and/or floodwater inflows. Previous studies have shown that both inputs increase salt loading to the California Aqueduct and can measurably affect water quality.

Figure 2 shows monthly mineral concentrations at Checks 13 and 21 and the ratio of pump-in volumes to SLC outflows (in percent) at Check 21. Measurable increases were observed during the first half of 1994 when pump-ins amounted to less than 7 percent of the California Aqueduct. A more substantial increase in mineral concentrations began in September 1994 when pump-ins exceeded 10 percent of flows and specific conductance increased from 613 μS/cm at Check 13 to 682 μS/cm at Check 21; an increase of 69 μS/cm between stations. During the same month, sulfate was 28 mg/l at Check 13 and 80 mg/l at Check 21; an increase of 52 mg/l or 186 percent. The differential became greater through the rest of 1994 and into the first month of 1995 when pump-ins composed 16 to 30 percent of Check 21 outflows. Similar trends were observed for total dissolved solids, sodium, and to a small extent, hardness, but not chloride.

The widest concentration differential between Checks 13 and 21 was observed in January 1995 when pump-ins and floodwaters, together, comprised more than 25 percent of the California Aqueduct (Figure 2). For instance, the total dissolved solids concentration that month was 289 mg/l at Check 13 and 495 mg/l at Check 21; an increase of 206 mg/l or 71 percent. Although pump-ins during the rest of 1995 were minor compared to Check 21 outflows, floodwater inflows amounted to more than 20,000 af in March 1995 and increased total dissolved solids between stations by over 200 mg/l. Similar trends were observed that same month for specific conductance, hardness, sulfate, and to a small extent, sodium, but not chloride. March pump-ins totaled only 4 af.

Total Organic Carbon and Total Trihalomethane Formation Potential

Seasonal Trends: Total organic carbon and total trihalomethane formation potential concentrations were relatively similar between 1994 and 1995 at most stations. At Banks Pumping Plant, for instance, TOC averaged 4.3 mg/l in 1994 and 4.2 mg/l in 1995, a difference of 0.1 mg/l (Figure 1). At all but two monitoring stations, annual average TOC concentrations differed by 0.1 to 0.6 mg/l between years. Nearly identical trends were also observed for annual TTHMFP averages. At Banks Pumping Plant, for instance, TTHMFP was 4.19 μmoles/l in 1994 and 4.07 μmoles/l in 1995; a difference of 0.12 μmoles/l. The exception was at NBA's Barker Slough Pumping Plant where the annual average TOC was more than twice as high in 1995 (10.1 mg/l) than 1994 (4.5 mg/l). At the same station, TTHMFP levels also more than doubled from 4.3 μmoles/l in 1994 to 9.3 μmoles/l in 1995.

The large difference in annual TOC averages at Barker Slough Pumping Plant was directly related to precipitation totals. Figure 3 shows monthly TOC concentrations at Barker Slough Pumping Plant and monthly rainfall at the City of Fairfield. TOC increased from 5.3 mg/l in December 1994, to more than 21 mg/l in January 1995—the same month when 17 inches of rainfall was recorded. TOC remained elevated during the first half of 1995 but steadily declined from 17.6 mg/l in February to 9.1 mg/l in May with continued on-and-off rainfall. In contrast, TOC peaked at 5.5 mg/l in February 1994—a year with below-normal rainfall that totaled 10 inches for the entire year. A nearly identical seasonal trend was observed for TTHMFP whereupon concentrations went from 4.8 μmoles/l in December 1994, to 17 μmoles/l in January 1995. The peak concentration of 17 μmoles/l in 1995 contrasted with a maximum monthly concentration of 6 μmoles/l detected the previous year. Preliminary investigations indicate that heavy or sustained rainfall

Figure 2

Minerals in the California Aqueduct at Checks 13 and 21 and the Relative Percentage of Pump-ins and Floodwater Inflows to Check 21 Outflows, 1994-95

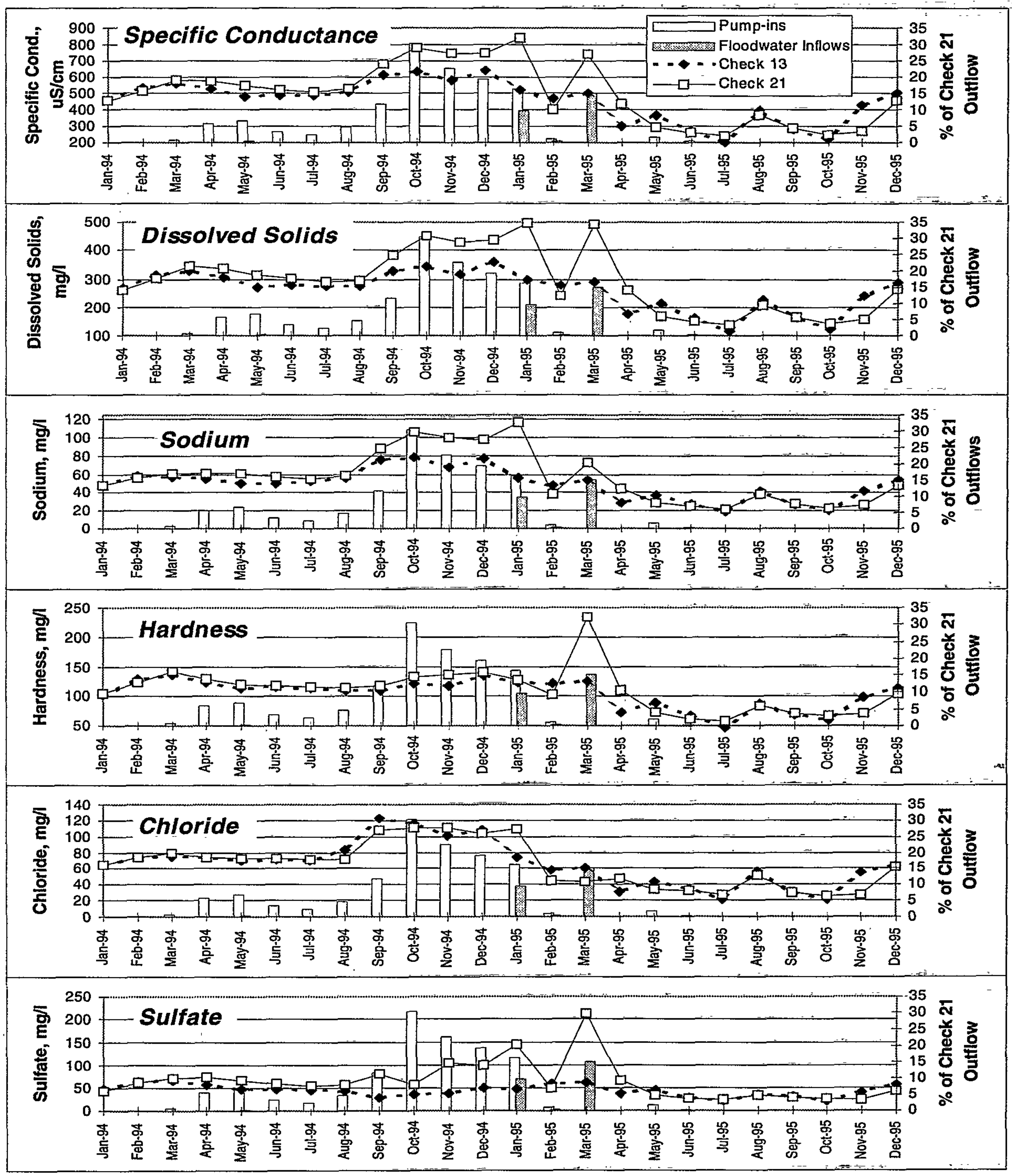

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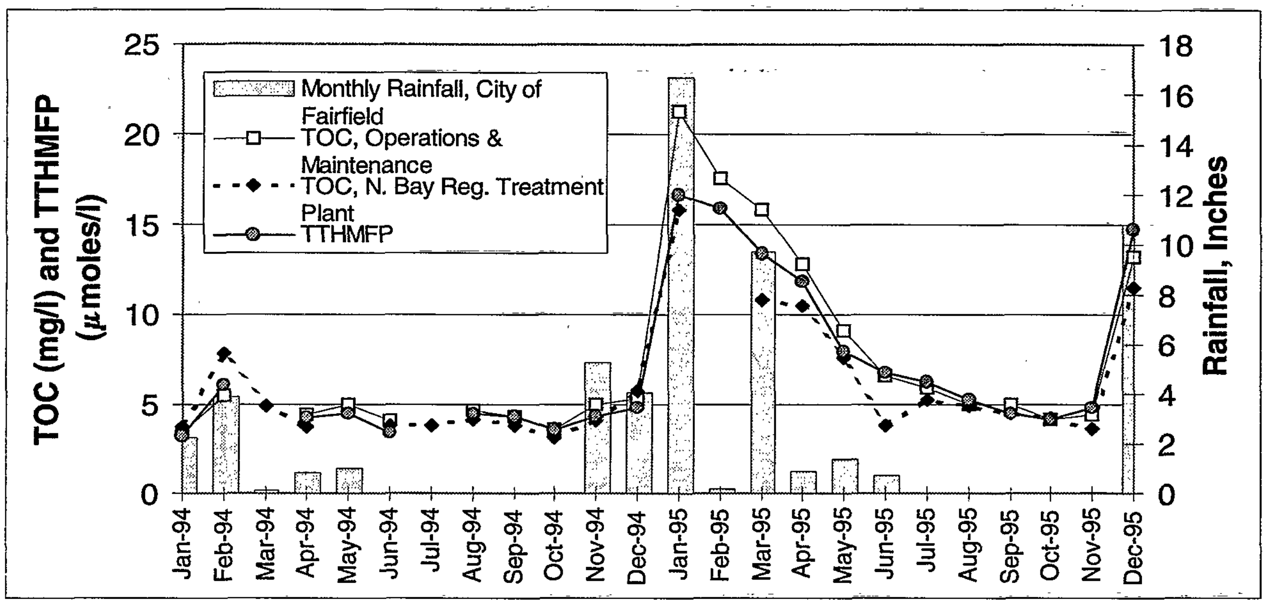
Figure 3
Monthly Average Total Organic Carbon (TOC) and Total Trihalomethane Formation Potential (TTHMFP) in the North Bay Aqueduct and Total Monthly Rainfall at the City of Fairfield



generates runoff in the upstream Barker Slough watershed, causing TOC and TTHMFP concentrations at Barker Slough Pumping Plant to increase.

Although seasonal increases of TOC and TTHMFP also occurred in the California Aqueduct during the winter, they were less dramatic than those observed at Barker Slough Pumping Plant. For instance, during 1994 at Banks Pumping Plant, TOC peaked at 6 mg/l in February and steadily declined throughout the year to 3 mg/l by November. The following year at the same station, TOC peaked at 7 mg/l in January and February and steadily declined throughout the year to a minimum monthly concentration of 3 mg/l by the end of December. Similar trends were observed at most California Aqueduct stations for both TOC and TTHMFP. Therefore, TOC and TTHMFP increased in the Delta during the rainy season of both years and these increases persisted down the California Aqueduct. However, no strong seasonal trends emerged for these compounds at SWP lakes in Southern California.

Station Comparisons: Annual TOC averages during both years were relatively similar between stations. Averages ranged from 3.5 mg/l to 5.0 mg/l during 1994 at all stations and 3.9 to 4.9 mg/l during 1995 at all stations except Barker Slough Pumping Plant where the annual average that year was 10 mg/l (see discussion above in Seasonal Trends). Similar trends were observed for TTHMFP levels.

Peak monthly TOC concentrations ranged between 4.4 to 7.1 mg/l throughout the California Aqueduct during 1994. During 1995, peak levels ranged between 7.3 and 8.6 mg/l from Banks Pumping Plant to Check 41 and between 4.4 and 5.5 mg/l at stations south of Check 41.

Pesticides

Organic chemicals were detected at low levels in the SWP during 1994 and 1995; most were either insecticides or herbicides. Of the 17 chemicals detected, six were found more than once during the two-year period examined.

Diuron, a preemergent herbicide, was detected throughout the Project twice in 1994 and once in 1995 at concentrations up to 4.7 µg/l. Most detections occurred during February, March, or May. Dacthal was the most frequently detected chemical (36 times), ranging in concentration from 0.01 to 1.09 µg/l and was found throughout the Project at least once each year. Simazine was also routinely detected at concentrations ranging from 0.09-0.2 µg/l at all stations in May 1994 and almost all stations in March 1995 (0.07-0.81 µg/l). Most positive detections of the herbicide, 2,4-D, were observed at Banks Pumping Plant at concentrations ranging from 0.18 to 0.7 µg/l.

Of the two insecticides detected in the SWP, diazinon was the most common (four positive detections). Diazinon ranged in concentration from 0.02-0.18 µg/l and was detected throughout the Project once during May 1994. Other detections were scattered sporadically at various stations during both years.

Minor Elements

Other water quality parameters of concern include the minor elements, arsenic and selenium. Approximately 99 percent of all 1994-95 samples analyzed contained arsenic levels of 0.003 mg/l or less. A maximum arsenic value of 0.004 mg/l was detected once in 1994 at both Check 21 and Devil Canyon Afterbay. More than 94 percent of the 287 selenium samples collected during 1994-95 were below the reporting limit of <0.001 mg/l. The remainder ranged largely between 0.001 and 0.004 mg/l with a maximum concentration of 0.005 mg/l detected once at Check 21 during 1995.

Special Investigations

Crude Oil Release to Arroyo Pasajero: During March 1995, approximately 4,400 barrels of crude oil flowed into the Arroyo Pasajero ponding basin from a ruptured conveyance pipe. Several petroleum hydrocarbons were found in the Aqueduct after floodwaters breached the ponding basin's containment dike. Benzene, toluene, ethylbenzene, and xylene were detected in a 90-mile stretch of the Aqueduct below Check 21 but had dissipated four days later to levels at, or just above, the reporting limits. The oil pipeline was re-routed to prevent future ruptures and oiled surfaces in the Arroyo Pasajero watershed were cleaned.

Diesel Spill in the Feather River Watershed: A rock slide in the North Fork Feather River derailed a westbound train and sent a locomotive down the river embankment. A fuel tank ruptured and spilled approximately 5,000 gallons of diesel into the river. Diesel fuel was initially detected in the North Fork Feather River arm of Oroville Lake but was undetected three days later.

Sediment in the Aqueduct: In 1995, 26,000 af of Diablo Range runoff flowed into the SLC, carrying with tons of sediment. Composed largely of fines—clay and silt-sized particles—the sediment was easily suspended in the Aqueduct. Suspended sediment is a concern because it must be removed during the water treatment process. Greater coagulent dosages are needed to flocculate the suspended particles and the resulting floc quickly clogs filters. This necessitates more frequent backwashing to keep the filters in operation and ultimately increases the cost of sludge handling and disposal. High suspended sediments in raw water can also interfere with the disinfection process.

Approximately 133 to 146 thousand cubic yards of sediment were discharged to the Aqueduct by floodwaters in 1995. A subsequent analysis of bottom sediment showed that more than 95 percent was comprised of fines which were easily suspended in the water column and transported downstream. Although suspended sediment in the Aqueduct increased during and just after the period of highest flooding in March 1995, the greatest increase was observed from June to August 1995, when monthly flow-volume in the SLC increased above 185,000 af. Increases in total suspended solids from increased flows were observed in a 130-mile stretch below the SLC at checks 21, 29, and 41. Peak values were detected in July when monthly flow-volume in the SLC reached 302,000 af and concentrations ranged from 173 mg/l at Check 21 to almost 500 mg/l at Check 29. TSS declined at all stations as flow-volumes receeded to 109,000 af in October 1995. Although similar flow-volumes were sent down the Aqueduct during the previous year, TSS never exceeded 50 mg/l.

Impacts from floodwaters were confirmed with turbidity measurements above and below floodwater sources. Turbidity increased with increased pumping at Dos Amigos Pumping Plant at checks 21and 41 located downstream in the SLC, while turbidity remained generally stable regardless of pumping rate upstream at Check 13. Therefore, sediment deposited in the Aqueduct from floodwaters during winter was resuspended later as flows increased through the summer. Most sediment moving down the Aqueduct likely settles out in one of the SWP's Southern California lakes, is removed from delivered water, or is removed from the Aqueduct by dredging.

II. Introduction

Objectives

The Water Quality Section of the Division of Operations and Maintenance oversees water quality activities in the State Water Project. These activities include assessing the physical, chemical, and biological properties of water collected at 34 stations in and around the State Water Project. Assessments are made on a variety of organic and inorganic constituents such as metals, minerals, and pesticides. The objectives of this monitoring are to:

1. assess the influence of hydrological conditions and water operations on SWP water quality,
2. document long-term changes in SWP water quality,
3. provide SWP contractors with water quality data to assess water treatment plant operational needs,
4. identify, monitor, and respond to water quality emergencies and determine impacts to the SWP,
5. assess the relative quality of SWP water by comparing concentration data to Article 19 Objectives, and State and federal Drinking Water Standards, and
6. conduct special investigations to address water quality issues of particular concern.

Background

Water quality monitoring in the SWP began after the California Aqueduct was completed in 1968. The monitoring strategy was periodically expanded to keep up with the expansion of the SWP. Currently, water quality monitoring is conducted in the Feather River watershed, North Bay Aqueduct, South Bay Aqueduct, Coastal Branch, and the California Aqueduct—including its four terminus lakes. Water samples are collected by field staff from five field divisions—Oroville, Delta, San Luis, San Joaquin, and Southern field divisions. Sampling frequency ranges from weekly to annually depending on station and parameter. Routine laboratory analyses include minerals, nutrients, trace metals, and pesticides, as well as the conventional parameters—temperature, specific conductance, pH, dissolved oxygen, and turbidity. In addition, certain conventional parameters are electronically monitored at 17 locations around the Project and provide real-time measurements hourly.

This report is the third general water quality assessment of the SWP. Earlier water quality assessments were documented in DWR 1992 and DWR 1995A. These reports discuss the general water quality trends related to seasonal and hydrological variations that occurred within a two-year period and attempts to define the influence of non-Project inflows and water operations on SWP water quality. Special water quality investigations were completed for floodwater inflows (DWR 1995B), groundwater pump-ins (DWR 1991A, DWR 1994), and SWP lakes in Southern California (DWR 1996A).

Monitoring Strategy Updates

Several changes were made to O&M's water quality monitoring strategy in 1994 and 1995.

SWP Pathogen Monitoring Program

Routine pathogen monitoring was initiated in May 1995, at Banks Pumping Plant, Delta Medota Canal, and Arroyo Valle Creek inflow to Lake Del Valle. Samples are collected monthly and analyzed for *Giardia* cysts and *Cryptosporidium* oocysts and reported as number per 100 milliliters. Total and fecal coliforms are also analyzed.

Operations and Maintenance Water Quality Home Page

Up-to-date water quality information is now available on the internet at "http://wwwomhq.ca.gov/wq". Grab sample data from key SWP stations are updated monthly. Real-time data from three automated monitoring stations are updated daily and include specific conductance, temperature, and turbidity. Also found on the home page is a description of O&M's monitoring program, pathogen and coliform data, as well as the detection of zebra mussels in vessels trailered into California.

Automated Stations

Automated monitoring stations were newly installed at Del Valle Check 7 on the South Bay Aqueduct and at the Devil Canyon Headworks on Silverwood Lake. Real-time parameters include specific conductance, temperature, turbidity, and pH.

III. Methods

Sampling Locations and Methodology

Water quality in the SWP aqueducts and reservoirs is monitored at 33 stations (Figure 4). Stations are distributed over a distance of more than 500 miles (805 km) from the upper Feather River reservoirs in Plumas County to Lake Perris in Riverside County. This report focuses on 10 major SWP stations (and one station on the DMC) where monitoring is more detailed both in terms of frequency and parameters (Figure 4).

Types of samples collected at each station, sampling frequency, and a description of the stations is provided in Table 2. Sampling is usually done on the third Wednesday of every month. Pesticide samples are collected in March, June, and September at nine stations.

SWP sampling methods are presented in the *SWP Water Quality Field Manual* (DWR 1996). Usually, subsurface water quality samples are collected mid-channel using a Van Dorn sampler, bucket, or bailer. Samples requiring filtration are filtered immediately after collection with a 0.45 micron filter. Samples are transported to DWR's Bryte Chemical Laboratory within 24 hours of collection. Further details of sample handling and preservation can be found in the report mentioned above.

Chemical Constituents

Table 3 shows the water quality constituents by category and the methods used for analysis. Over 60 constituents are analyzed routinely at the Bryte Laboratory in West Sacramento. This number does not include all the components covered in organic pesticide analysis. Analytical methods follow those of the U.S. Environmental Protection Agency (U.S. EPA 1983), U.S. Geological Survey (USGS 1985), and *Standard Methods for the Examination of Water and Wastewater* (APHA et al. 1994).

Laboratory Quality Assurance

As required for environmental laboratory accreditation in California, the Bryte Chemical Laboratory filed a Quality Assurance Plan with the Department of Health Services. The plan covers items required by EPA, such as organization and responsibility, laboratory sample procedures and identification, analytical methods, internal quality control, and corrective action. Internal quality control checks include duplicates, spikes, check standards, reference standards, and control charts.

In addition, blanks are processed and submitted by the field divisions to determine the potential for contamination during sample collection and processing. Although there were a few incidences of contamination, environmental samples did not appear to be significantly affected. Data of questionable quality were excluded from the report.

Automated Stations

The 17 SWP automated sampling stations provide real-time data by continuously monitoring several important water quality constituents. The parameters monitored include specific conductance, temperature, turbidity, fluorometry, and pH (Table 4, Figure 5).

Figure 4

SWP Water Quality Monitoring Stations

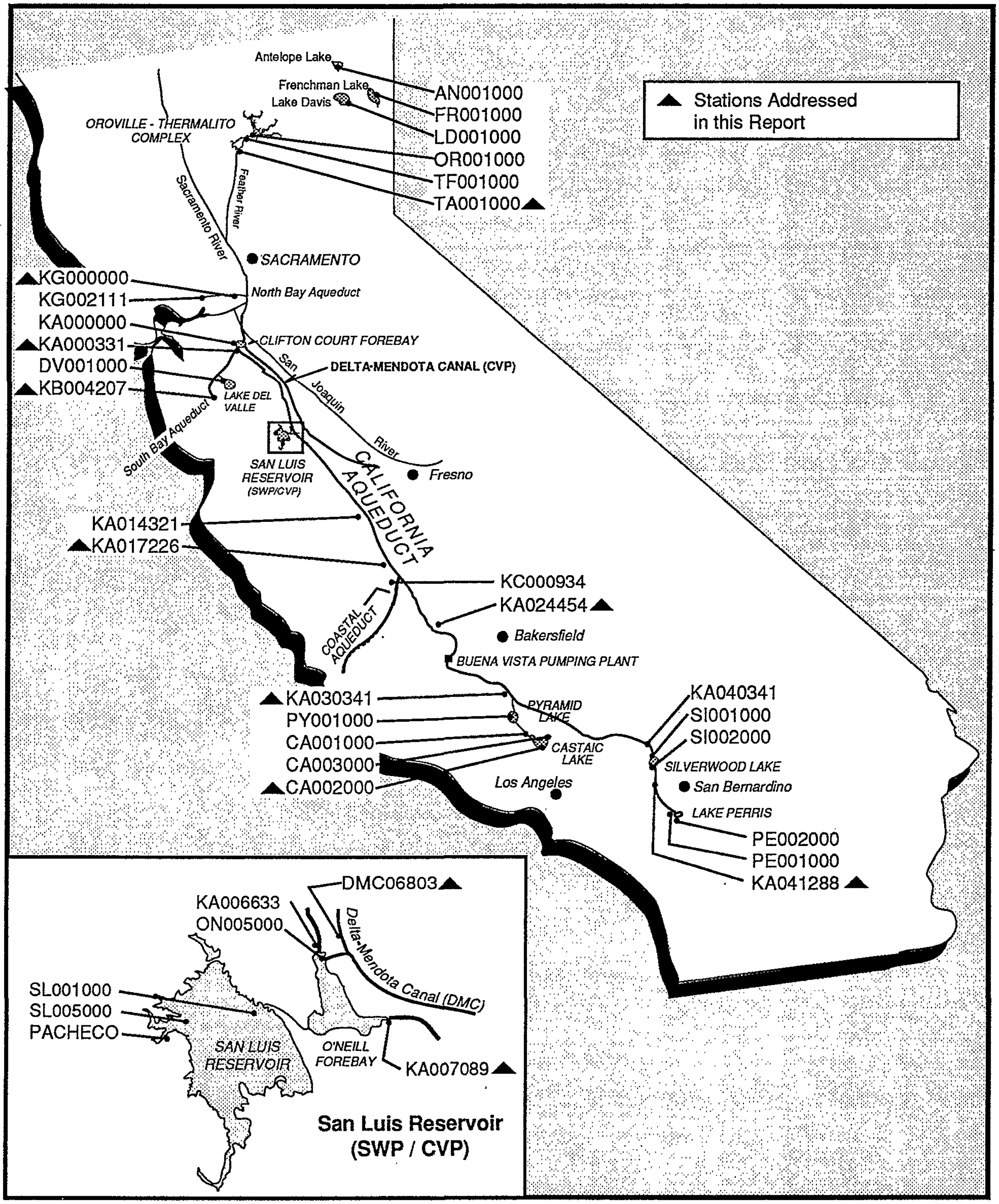


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Table 2

Water Quality Sampling Program

Station	[1] Minerals	[2] Nutrients	[4] Chlorinated Organics	[5] Organo-Phosphorus Pesticides	[6] Herbicides	[7] Purgeable Organics	[9] Carbamates	[8] Trihalomethane Pot.	Phytoplankton	[17] Iron & [20] Manganese	[36] Bromide	[56] Suspended Solids	[66] Total Organic Carbon	[68] †Project Standard	[68a] ‡Project Additional	[ASB] Asbestos	Reservoir Profiles	Automated Station
Oroville Field Division																		
LD001000		A							A§	M				A			A§	
FR001000		A							A					A			A	
AN001000		A							A					A			A	
OR001000		M							M								M	
TF001000														Q	Q			
▲ TA001000		M							M			Q		M				t
Delta Field Division																		
▲ KG000000		M	T	T	T	T	T	M	M		M	Q	M	M	M			Ec,t,fl,ntu,pH
KG002111											Q			Q	Q			Ec,t
KA000000	Q																	Ec,t,fl,ntu,pH
▲ KA000331		M	T	T	T	T	T	M	M		M	M	M	M	M	M		Ec,t,fl,ntu,pH,O
DV001000		M							M								M	
KB001638																		Ec,t,fl,ntu,pH
▲ KB004207									M		Q[1]			Q[1]	Q[1]			Ec,t,fl,ntu
San Luis Field Division																		
KA006633	Q							Q					Q					Ec,t
▲ DMC06803			T	T	T	T	T	M					M	M	M			
SL001000		M							M								M	
SL005000		M							M					M	M		M	Ec,t
PACHECO																		Ec,t,fl,ntu
▲ KA007089			T	T	T	T	T	M					M	M	M	M		Ec,t,fl,ntu
KA014321																		Ec,t,fl,ntu
▲ KA017226			T	T	T	T	T	Q				M	Q	M	M	M		Ec,t,ntu
San Joaquin Field Division																		
KC000934														Q				Ec,t,fl,ntu
▲ KA024454			T	T	T	T	T					M		M	M			Ec,t,ntu
Southern Field Division																		
▲ KA030341		M	T	T	T	T	T	M				M	M	M	M	M		Ec,t,ntu
KA040341		M						Q					Q	Q		M		Ec,t (out of service)
SI001000									W								W	
SI002000		M							W					Q	Q		W	
▲ KA041288		M	T	T	T	T	T	M				Q	M	M	M			Ec,t,ntu, pH
PE001000									W								W	
PE002000		M							W					Q	Q		W	
PY001000		M							W					Q	Q		W	
CA001000									W								W	
▲ CA002000	Q	M						Q	W				Q	Q	Q		W	
CA003000								W									W	

Sampling frequency: **A** — Annually **Q** — Quarterly (Feb, May, Aug, Nov) **T** — Mar, Jun, and Sep
M — Monthly **Q**[1] — Feb, May, Aug, Sep - Dec **W** — Weekly & Bi-weekly

▲—Denotes Principal Water Quality Station §— Monthly sampling during June through October

†Project Standard : arsenic, chromium, copper, iron, lead, manganese, selenium, zinc, calcium, magnesium, sodium, alkalinity, sulfate, chloride, fluoride, bromide, boron, nitrate, dissolved solids, and conductivity.

‡Project Additional: barium, cadmium, aluminum, mercury, and silver.

Automated stations : Ec = electrical conductivity; t = temperature; fl = fluorometry; ntu = turbidity; pH ; O = dissolved oxygen

revised 09/96

Table 3

Methods for Water Quality Analysis

Constituent	Method [a]	Reference	
MINERAL			
Calcium	AA, flame	EPA	215.1
Magnesium	AA, flame	EPA	242.1
● Hardness	*Calculated from calcium and magnesium*	Std. Met.	
● Sodium	AA, flame	EPA	273.1
Potassium	AA, flame	EPA	258.1
Alkalinity	Titrimetric	EPA	310.1
pH	Electrometric	EPA	150.1
● Sulfate	Colorimetric, Automated MTB	EPA	375.2
● Chloride	Colorimetric, Automated	EPA	325.2
Nitrate	Colorimetric, Automated Cd reduction	EPA	353.2
Fluoride	Potentiometric ISE	EPA	340.2
Boron	Colorimetric, Automated, Azomethine	USGS	I-2115-85
Turbidity	Nephelometric	EPA	180.1
● Dissolved Solids	Gravimetric, 180°C	EPA	160.1
● Specific Conductance	Wheatstone Bridge	EPA	120.1
Silica	Colorimetric, Molybdate Blue	USGS	I-1700-85
METALS			
Aluminum	AA, direct & furnace, Zeeman	EPA	202.1, 202.2
● Arsenic	AA, hydride	EPA	206.3
Barium	AA, direct	EPA	208.1
Cadmium	AA, furnace, Zeeman	EPA	213.2
Chromium	AA, furnace, Zeeman	EPA	218.2
Chromium (+6)	AA, furnace, Zeeman	EPA	218.5
Colbalt	AA, furnace, Zeeman	EPA	219.2
Copper	AA, direct & furnace, Zeeman	EPA	220.1, 220.2
Iron	AA, direct & furnace, Zeeman	EPA	236.1, 236.2
Lead	AA, furnace, Zeeman	EPA	239.2
Lithium	AA, direct	USGS	I-1425-85
Manganese	AA, furnace, Zeeman	EPA	243.1, 243.2
Mercury	AA, cold vapor	EPA	245.1
Molybdenum	AA, furnace, Zeeman	EPA	246.2
Nickel	AA, direct & furnace, Zeeman	EPA	249.1, 249.2
● Selenium	AA, hydride	EPA	270.3
Silver	AA, Zeeman	EPA	272.2
Strontium	AA, direct	USGS	I-1800-85
Zinc	AA, direct & furnace, Zeeman	EPA	289.1, 289.2
Barium	AA, furnace, Zeeman	EPA	208.2
Vanadium	AA, furnace, Zeeman	EPA	286.2

[a] ***Abbreviations:***
AA — Atomic Absorption
GC — Gas Chromatography
HPLC — High Performance Liquid Chromotography

● *Indicates constituents discussed in this report.*

Table 3 (Continued)

Methods for Water Quality Analysis

Constituent	Method [a]	Reference	
NUTRIENTS			
Ammonia	Colorimetric, Automated Phenate	EPA	350.1
Ammonia + Organic N	Colorimetric, Semi-Automated	EPA	351.2
Nitrate	Colorimetric, Auto Cd Reduction	EPA	353.2
Nitrite	Colorimetric, Auto Cd Reduction	EPA	353.2
Nitrate + Nitrite	Colorimetric, Auto Cd Reduction	EPA	353.2
Phosphate	Colorimetric, Ascorbic acid	EPA	365.1
Phosphorus	Colorimetric, Semi-Automated	EPA	365.4
MISCELLANEOUS			
Settleable Solids	Volumetric, Imhoff	EPA	160.5
Suspended Solids	Gravimetric, 105°C	EPA	160.2
Color, True	Colorimetric, Pt-Co	EPA	110.2
Methylene Blue Act Sub.	Colorimetric	EPA	425.1
COD	Titrimetric, low level	EPA	410.2
Tannin & Lignin	Colorimetric	Std. Met.	5550B
Oil & Grease	Gravimetric, extraction	EPA	413.1
Cyanide	Titrimetric, Spectrophotometric	EPA	335.1
Phenols	Spectrophotometric, Distillation	EPA	420.1
BOD	Incubation 20°C	EPA	405.1
● Organic Carbon	Wet Oxidation, IR, Auto	EPA	415.1
Volatile Suspended Solids	550°C	EPA	160.4
● Bromide	Ion Chromatography	Std. Met	4110B
ORGANICS			
● THM Formation Potential	GC	EPA	502.2
Chloroform			
Bromodichloromethane			
Dibromochloromethane			
Bromoform			
● Chlorinated Organics	GC	EPA	608
Pesticides			
Diuron	Reporting Limits in µg/l: 0.05		
BHC, alpha	0.01		
Chlopropham	0.02		
Dichloran	0.01		
Simazine	0.02		
BHC, gamma	0.01		

[a] ***Abbreviations:***
AA — Atomic Absorption
GC — Gas Chromatography
HPLC — High Performance Liquid Chromotography
● *Indicates constituents discussed in this report.*

Table 3 (Continued)
Methods for Water Quality Analysis

Constituent	Method [a]		Reference	
ORGANICS (Continued)				
● Chlorinated Organic Pesticides (Cont'd)	GC		EPA	614
BHC, beta	Reporting Limits in µg/l:	0.01		
Atrazine		0.02		
PCNB		0.01		
BHC, delta		0.01		
Chlorothalonil		0.01		
Alachlor		0.05		
Heptachlor		0.01		
Thiobencarb		0.02		
Chlorpyrifos		0.01		
Aldrin		0.01		
DCPA		0.01		
Captan		0.02		
Heptachlor Epoxide		0.01		
Chlordane		0.05		
Endosulfan I		0.01		
Dieldrin		0.01		
DDE		0.01		
Endrin		0.01		
Endosulfan II		0.01		
Endrin Aldehyde		0.01		
DDD		0.01		
Endosulfan Sulfate		0.01		
DDT		0.01		
Methoxychlor		0.01		
Dicofol		0.01		
Toxaphene		0.20		
PCB-1016		0.10		
PCB-1221		0.10		
PCB-1232		0.10		
PCB-1248		0.10		
PCB-1254		0.10		
PCB-1260		0.10		
Metolachlor		0.20		
Oxyfluorfen		0.20		

[a] ***Abbreviations:***
AA — Atomic Absorption
GC — Gas Chromatography
HPLC — High Performance Liquid Chromotography

● *Indicates constituents discussed in this report.*

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Table 3 (Continued)

Methods for Water Quality Analysis

Constituent	Method [a]		Reference	
ORGANICS (Continued)				
● Organic Phosphorus Pesticides	GC		EPA	614
Mevinphos	Reporting Limits in µg/l:	0.01		
Demeton		0.02		
Naled		0.02		
Phorate		0.01		
Dimethoate		0.01		
Diazinon		0.01		
Disulfoton		0.01		
Methyl Parathion		0.01		
Malathion		0.01		
Chlorpyrifos		0.01		
Parathion		0.01		
Methidathion		0.02		
Profenofos		0.01		
s,s,s-Tributyl Phosphorotrithioate (DEF)		0.01		
Ethion		0.01		
Carbophenothion (Trithion)		0.02		
Phosmet		0.02		
Phosalone		0.02		
Azinphosmethyl		0.05		
Bromacil		1.0		
Cyanazine		0.01		
Naproazmide		5.0		
Norflurazon		5.0		
Pendimethalin		5.0		
Prometryn		0.1		
Propetamphos		0.05		
Trifluralin		0.05		
Benfluralin		0.05		
● Chlorinated Phenoxy Acid Herbicides	GC		EPA	615
Dicamba	Reporting Limits in µg/l:	0.1		
MCPP		0.1		
Pentachlorophenol (PCP)		0.1		
Dichlororop		0.1		
2,4, -D		0.1		
MCPA		0.1		
2,4,5 -TP		0.1		
2,4,5 -T		0.1		
2,4, -DB		0.1		
Picloram		0.1		
Triclophr		0.1		

[a] ***Abbreviations:***
AA — Atomic Absorption
GC — Gas Chromatography
HPLC — High Performance Liquid Chromotography

● *Indicates constituents discussed in this report.*

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Table 3 (Continued)

Methods for Water Quality Analysis

Constituent	Method [a]	Reference
ORGANICS (Continued)		
● Purgeable Organics	GC	EPA 614
Dichlorodifluoromethane	Reporting Limits in µg/l: 0.5	
Chloromethane	0.5	
Vinyl chloride	0.5	
Bromomethane	0.5	
Chloroethane	0.5	
Trichlorofluoromethane	0.5	
1,1-Dichloroethene	0.5	
Methylene chloride	0.5	
trans- 1,2-Dichloroethene	0.5	
1,1-Dichloroethane	0.5	
2,2-Dichloropropane	0.5	
cis- 1,2-Dichloroethene	0.5	
Chloroform	0.5	
Bromochloromethane	0.5	
1,1,1- Trichloroethane	0.5	
1,1-Dichloropropene	0.5	
Carbon tetrachloride	0.5	
Benzene	0.5	
1,2-Dichloroethane	0.5	
Trichloroethene	0.5	
1,2-Dichloropropane	0.5	
Bromodichloromethane	0.5	
Dibromomethane	0.5	
cis-1,3-Dichloropropene	0.5	
Tolune	0.5	
trans-1, 3-Dichloropropene	0.5	
1,1,2-Trichloroethane	0.5	
1,3-Dichloropropane	0.5	
Tetrachloroethene	0.5	
Dibromochloromethane	0.5	
1,2-Dibromoethane	0.5	
Chlorobenzene	0.5	
Ethyl benzene	0.5	
1,1,1,2-Tetrachloroethane	0.5	
m-Xylene	0.5	
p-Xylene	0.5	
o-Xylene	0.5	
Styrene	0.5	
Isopropyl benzene	0.5	
Bromoform	0.5	

[a] ***Abbreviations:***
AA — Atomic Absorption
GC — Gas Chromatography
HPLC — High Performance Liquid Chromotography

● *Indicates constituents discussed in this report.*

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Table 3 (Continued)

Methods for Water Quality Analysis

Constituent	Method [a]		Reference	
ORGANICS (Continued)				
● Purgeable Organics (cont'd)	GC		EPA	614
1,1,2,2-Tetrachloroethane	Reporting Limits in µg/l:	0.5		
1,2,3-Trichloropropane		0.5		
n-Propyl benzene		0.5		
Bromobenzene		0.5		
1,3,5-Trimethylbenzene		0.5		
2-Chlorotoluene		0.5		
4-Chlorotoluene		0.5		
tert-Butylbenzene		0.5		
1,2,4-Trimethylbenzene		0.5		
sec-Butylbenzene		0.5		
4-Isopropyltoluene		0.5		
1,3-Dichlorobenzene		0.5		
1,4-Dichlorobenzene		0.5		
n-Butylbenzene		0.5		
1,2-Dichlorobenzene		0.5		
1,2-Dibromo-3-chloropropane		0.5		
1,2,4-Trichlorobenzene		0.5		
Hexachlorobutadiene		0.5		
Napthalene		0.5		
1,2,3- Trichlorobenzene		0.5		
● Carbamates	HPLC		EPA	531.1
Aldicarb Sulfoxide	Reporting Limits in µg/l:	2		
Aldicarb Sulfone		2		
Oxamyl		2		
Methomyl		2		
3-Hydroxycarbofuran		2		
Aldicarb		2		
Carbofuran		2		
Carbaryl		2		
1-Naphthol		4		
Methiocarb		4		
Formetanate Hydrochloride		100		
● Miscellaneous Pesticides	HPLC		EPA	531.1
Glyphosate	Reporting Limits in µg/l:	100		
Aminomethylphosphonic Acid		100		
Propargite		1		

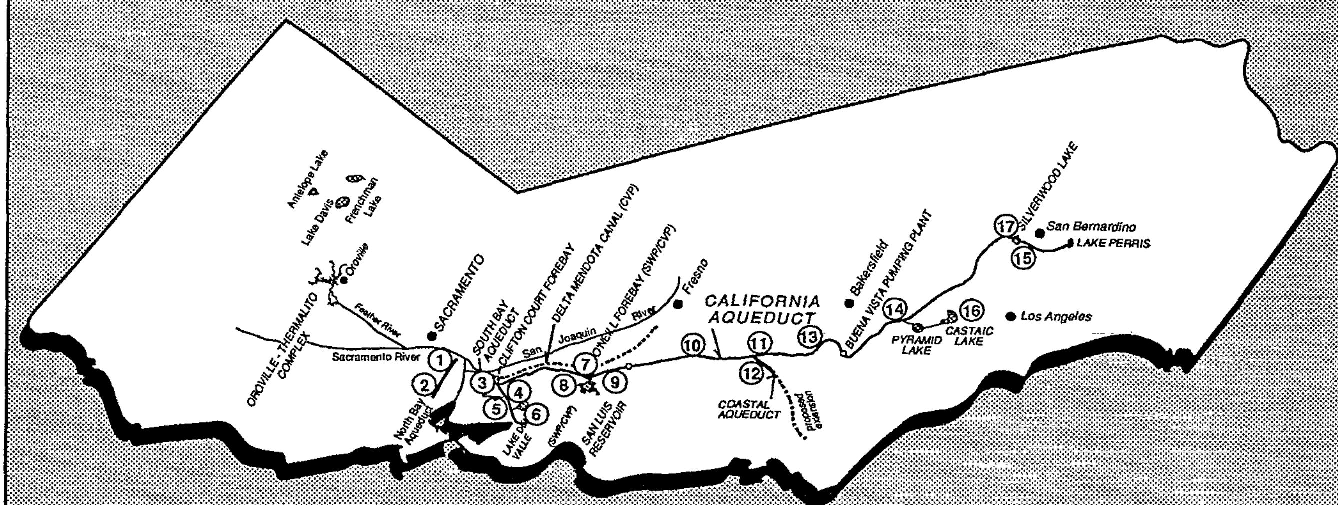
[a] ***Abbreviations:***
AA — Atomic Absorption
GC — Gas Chromatography
HPLC — High Performance Liquid Chromotography

● *Indicates constituents discussed in this report.*

Table 4
SWP Automated Water Quality Stations

Map Key	Station	Description	Conductivity	Temperature	Turbidity	Fluorometry	Oxygen	pH
1	KG000000	North Bay Aqueduct at Barker Slough Pumping Plant	●	●	●	●		●
2	KG002111	North Bay Aqueduct at Cordelia Pumping Plant	●	●	●			
3	KA000000	Clifton Court	●	●	●	●		●
4	KA000331	Harvey O. Banks Pumping Plant	●	●	●	●	●	●
5	KB004207	South Bay Aqueduct at Santa Clara Terminal Tank	●	●	●	●		
6	KB001638	South Bay Aqueduct at Del Valle	●	●	●	●		●
7	KA006633	Ca Aqueduct at Inlet to O'Neill Forebay (Check 12)	●	●				
8	PACHECO	San Luis Reservoir — Pacheco Pumping Plant	●	●	●	●		
9	KA007089	Ca Aqueduct at Outlet to O'Neill Forebay (Check 13)	●	●	●	●		
10	KA014321	Ca Aqueduct near Coalinga (Check 18)	●	●	●	●		
11	KA017226	Ca Aqueduct near Kettleman City (Check 21)	●	●	●			
12	KC000934	Coastal Aqueduct (Check 4)	●	●	●	●		
13	KA024454	Ca Aqueduct near Hwy. 119 (Check 29)	●	●	●			
14	KA030341	Ca Aqueduct at Tehachapi Afterbay (Check 41)	●	●	●			
15	RIP000000	Rialto Pipeline at Devil Canyon Afterbay	●	●	●			●
16	CAS00000	MWD Pipeline at Castaic Lake	●	●	●			●
17	DCHDWRKS	Devil Canyon Headworks	●	●	●		●	●

Figure 5
Map of SWP Automated Water Quality Stations



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E-026703

Specific conductance and temperature are continuously monitored at all automated stations. Specific conductance is used to estimate salinity and concentrations of minerals such as sodium and chloride, hardness, and alkalinity. Nephelometers, used to measure turbidity levels, are installed at 16 locations. Fluorometers provide information on relative changes in algal biomass and are installed at nine Project stations.

Data are collected and stored using OmniData Easy Loggers. The loggers scan all recorder signals at five-minute intervals. These data are averaged and only the hourly mean value is stored into computer memory.

Water Quality Thresholds

California Drinking Water Standards

Primary Drinking Water Standards, or Maximum Contaminant Levels, are the maximum permissible levels of contaminants in water that can enter the distribution system of a public water supply (Table 5). These standards are for treated water and are included for comparison, since the SWP is a raw-water supply and does not have to meet the MCLs. However, since some contaminants cannot be removed with conventional treatment processes, it is useful to know their levels in source water.

MCLs are enforceable primary drinking water standards which must be met by public drinking water supply systems to which they apply. These standards were adopted into regulation under the Safe Drinking Water Act. The California Department of Health Services arrives at the values based on comprehensive risk assessment, exposure levels, analytical detection limits, and feasibility of removal and removal costs.

Secondary Drinking Water Standards or MCLs are consumer acceptance standards designed to protect taste, odor, color, and other aesthetic aspects of drinking water that do not present a health risk. Treated drinking water with constituents above Secondary MCLs may be objectionable to an appreciable number of people. Table 6 lists Secondary MCLs in California.

Article 19 Objectives

These objectives are standard provisions of DWR's water supply contracts. Article 19 requires the collection and analysis of water quality samples in the SWP and the compilation of records. Article 19(a) states:

> "It shall be the objective of the State and the State shall take all reasonable measures to make available, at all delivery structures for the delivery of Project water to the District, Project water of such quality that the following constituents do not exceed the concentrations stated." (Table 7).

Table 5
Primary Drinking Water Standards [a]
Maximum Contaminant Level (MCL)

All values in mg /l unless otherwise noted

● Indicates chemicals discussed in this report

ORGANICS	MCL
Synthetics	
● Atrazine	0.003
Bentazon	0.018
● Benzene	0.001
Carbon Tetrachloride	0.0005
Carbofuran	0.018
Chlordane	0.0001
1,2-Dibromo-3-chloropropane (DBCP)	0.0002
1,4-Dichlorobenzene	0.005
1,1-Dichlorethane	0.005
1,2-Dichlorethane	0.0005
cis-1,2-Dichloroethylene	0.006
trans-1,2-Dichloroethylene	0.01
1,1-Dichloroethylene	0.006
1-2-Dichloropropane	0.005
1-3-Dichloropropene	0.0005
Di(2-ethylhexyl)phthalate	0.004
Ethylbenzene	0.7
Ethylene Dibromide (EDP)	0.00005
Glyphosate	0.7
Heptachlor	0.00001
Heptachlor Epoxide	0.00001
Molinate	0.02
Monochlorobenzene	0.07
● Simazine	0.004
1,1,2,2-Tetrachloroethane	0.001
Tetrachloroethylene	0.005
Thiobencarb [b]	0.07
● 1,1,1-Trichloroethane	0.2
1,1,2-Trichloroethane	0.005
● Trichloroethylene	0.005
Trichlorofluoromethane	0.15
1,1,2-Trichloro-1,2,2-Trifluoroethane	1.2
Vinyl Chloride	0.0005
Xylene	1.750

Chlorinated Hydrocarbons	MCL
Endrin	0.002
Lindane	0.0002
Methoxychlor	0.04
Toxaphene	0.003
Chlorophenoxys	
● 2, 4-D	0.07
2, 4, 5-TP (Silvex)	0.05
INORGANICS	
Aluminum	1
Asbestos	7 MFL [c]
● Arsenic	0.05
Barium	1
Cadmium	0.005
Chromium	0.05
Mercury	0.002
Nitrate (as NO_3)	45
● Selenium	0.05
TOTAL TRIHALOMETHANES (sum of bromodichloromethane, dibromochloromethane, bromoform, and chloroform) *(not to be confused with THM formation potential - see text for further discussion)*	0.1 [d]
FLUORIDE	
≤53.7 Degrees Fahrenheit	2.4
53.8 to 58.3	2.2
58.4 to 63.8	2.0
63.9 to 70.6	1.8
70.7 to 79.2	1.6
79.3 to 90.5	1.4

[a] California Final (Jan. 1996). Exlcudes bacteria and radioactivity.
[b] Also listed as a Secondary Drinking Water Standard with MCL of 0.01 mg/l
[c] MFL = million fibers per liter for fiber length greater than 10 µm (adopted 7/92)
[d] Federal MCL

Table 6

Secondary Drinking Water Standards [a]

All values in mg/l unless otherwise noted

● Discussed in this report

	Constituent	MCL
	Aluminum	0.2
●	Chloride	250 - 500 - 600 [b]
	Color	15 units
	Copper	1
	Corrosivity	Non-corrosive
	Foaming Agents (MBAS)	0.5
	Iron	0.3
	Manganese	0.05
	Odor —Threshold	3 units
	Silver	0.1
●	Specific Conductance (micromhos)	900 - 1600 - 2200 [b]
●	Sulfate	250 - 500 - 600 [b]
	Thiobencarb (Bolero)	0.001 [c]
●	Total Dissolved Solids	500 - 1000 - 1500 [b]
	Turbidity	5 units
	Zinc	5.0

a California Final (96 Jan.)
b Recommended — Upper — Short- term
c Also listed as a Primary Drinking Water Standard with MCL of 0.07 mg/l

Table 7

Article 19 Water Quality Objectives and MCLs

All values in mg/l unless otherwise noted

● Discussed in this report

Constituent	ARTICLE 19			MCL (recommended)
	Monthly Average	Avg for any 10 yr period	Maximum	
● Total Dissolved Solids	440	220		500
● Total Hardness	180	110		
● Chlorides	110	55		250
● Sulfates	110	20		250
Boron	0.6			
● Sodium (Percentage)	50	40		
Fluoride			1.5	1.4-2.4
Lead			0.1	0.05
● Selenium			0.05	0.01
Hexavalent Chromium			0.05	0.05
● Arsenic			0.05	0.05
Iron + Manganese			0.3	
Magnesium			125.0	
Copper			3.0	1.0
Zinc			15.	5.0
Phenol			0.001	

IV. Water Operations of the State Water Project

This chapter describes water supply conditions and water operations in the SWP during 1994-95. More detailed information on SWP operation and management can be found in DWR Bulletin 132-95, *Management of the California State Water Project.*

Water Supply Conditions

During 1994, precipitation in the Sacramento River Basin was only 64 percent of average compared with 140 percent the previous year. California began 1994 with about 55 percent of average rainfall by February 1. This was followed by a very dry March. At the end of December 1994, northern Sierra Nevada seasonal precipitation was 70 percent of average and the mountain snowpack measured about 50 percent of average. The Sacramento River Index of unimpaired runoff was 7.8 million af, down greatly from the 22.2 million af in 1993.

Conversely, 1995 was the wettest year since 1983 and the second wettest year in the Sacramento Valley since 1922. Approximately 40 percent of the entire year's average precipitation fell in the northern Sierra Nevada between January 4 and 15, 1995. A second series of major statewide storms followed in March. Precipitation in the Sierra Nevada was 171 percent of average by the end of 1995. That year was classified as wet based on criteria defined by the Delta's Water Quality Control Plan.

Water Operations

Background

Water quality in the California Aqueduct is affected by the day-to-day operations of SWP facilities. Operations such as pump schedules and dam releases are adjusted on a daily basis for water supply, flood control, environmental requirements, water quality, Delta outflow, and water rights requirements.

Delta water quality is affected by natural runoff; tidal fluctuations; Delta island agricultural discharges; cross-Delta flow; upstream municipal, industrial, inactive mine, and agricultural discharges; and upstream reservoir operations. Generally, the best quality water is available for export when Sacramento River and cross-Delta flows are high. When these flows are low and agricultural discharges are high, the quality of water available for SWP export declines. The salinity of exported water may increase when the Delta Cross Channel gates are closed. Gate closure combined with Delta pumping can cause reverse flows, whereby the Sacramento River flows into brackish water near River Mile 1, then comes around Sherman Island and up the San Joaquin River. Reverse flows intermix with saline water from San Francisco Bay before becoming entrained within the southbound pumping regime at Banks Pumping Plant.

Exports from the Delta at Banks Pumping Plant are constrained by the State Water Resources Control Board D-1485 restrictions, endangered species protection, and the availability of export water. D-1485 limits the mean monthly export rate of Delta water in May and June to 3,000 cfs and 4,600 cfs during July. San Luis Reservoir is generally filled by May 1 each year to use better quality water associated with high winter and spring outflows. Clifton Court Forebay is used to regulate daily tidal effects that influence the quality of Delta export water. Water diverted at the CVP Tracy Plant is more influenced by the San Joaquin River outflows than is the SWP (Figures 6 and 7).

Figure 6

SWP Water Operations Overview

General SWP Operations

1 Water stored in Lake Oroville during run-off periods
2 Delta water conveyed by H.O. Banks Delta Pumping Plant into the California Aqueduct
3 San Luis Reservoir (Joint CVP/SWP)
  a SWP Delta water conveyed to O'Neill Forebay via Check 12
  b CVP Delta water conveyed through Delta-Mendota Canal (DMC)
  c CVP share enters O'Neill Forebay via O'Neill Pumping-Generating Plant
  d Combined waters either stored in San Luis Reservoir or
  e Released downstream through Check 13 or
  f Released into the DMC

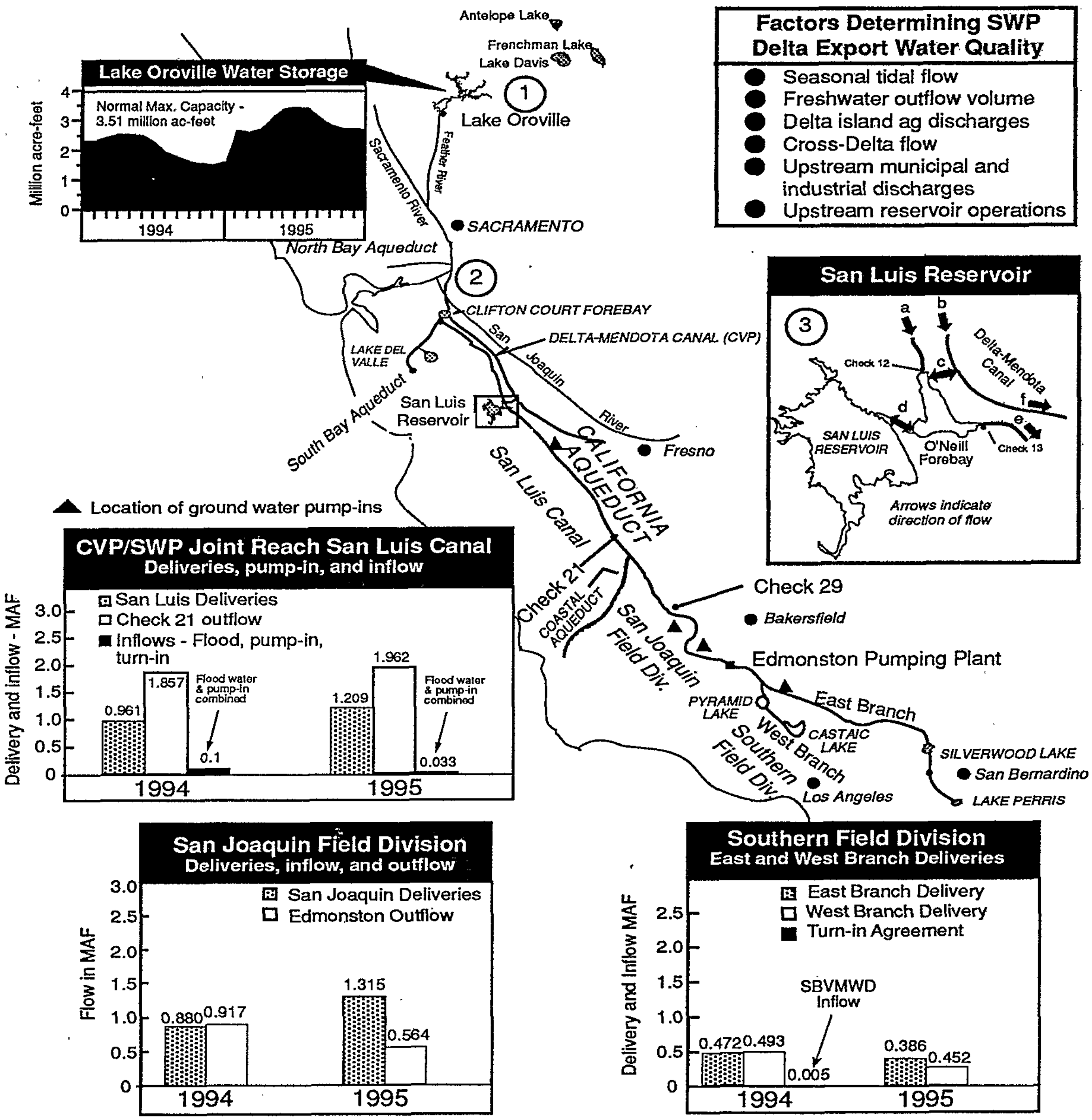

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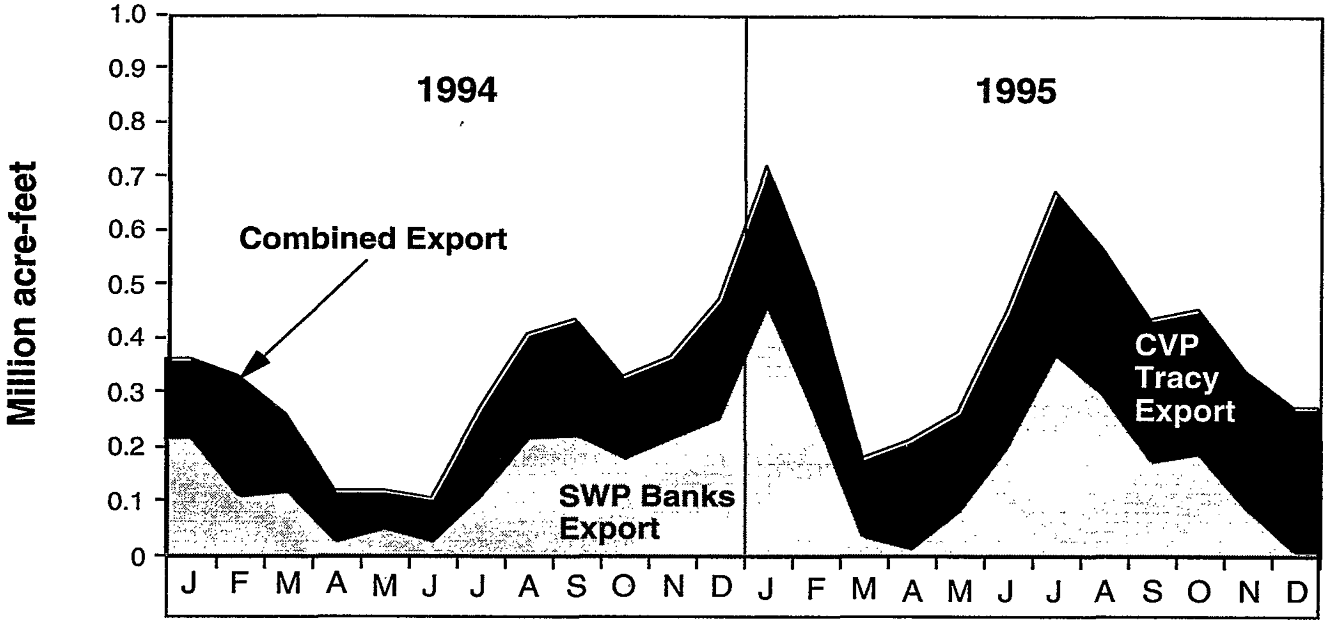
Figure 7

Mean Monthly SWP and CVP Sacramento/ San Joaquin Delta Export Volume, 1994-1995



Total Deliveries

The total amount of water conveyed through the SWP was 2.98 million af in 1994 and 2.96 million af in 1995. This included entitlement, recreation, and nonentitlement water delivered to contractors and non-Project water conveyed to other agencies. DWR met 100 percent of all entitlement water requests during both 1994 and 1995.

Groundwater Pump-ins

Beginning in 1990, SWP and CVP contractors entered into groundwater "pump-in" agreements with several water districts along the California Aqueduct. The term "pump-in" is used to define pumping groundwater into the California Aqueduct in return for an equal amount of SWP water returned at another time and place than the original pump-in. Pump-in water is wheeled as credit for future use as a means of managing and distributing scarce water supplies. Pump-ins are allowed to mitigate for supply deficiencies imposed on water contractors.

Pump-ins that discharge to the San Luis Canal in San Luis Field Division originate from the Westlands, Panoche, and San Luis water districts and the Mendota Pool Group. Water districts in San Joaquin Field Division such as the Kern County Water Agency, Wheeler Ridge-Maricopa Water Storage District, West Kern Water District, and Henry Miller Water District participated in the past, but did not discharge in either 1994 or 1995. Pump-ins to the California Aqueduct from the San Bernardino Valley Municipal Water District in Southern Field Division were relatively small in 1995 and nonexistent in 1994.

The total volume of pump-in water discharged to the California Aqueduct in 1994 was 104,602 af and 7,473 af in 1995. Detailed background information regarding pump-ins can be found in the DWR report titled *Analysis of Water Quality Impacts from Ground Water Pump-in on the State Water Project* (DWR 1994).

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Floodwater Inflows

Rainfall runoff from the Diablo Range intersects the San Luis Canal, or Joint-Use Stretch, and is accepted into the California Aqueduct when the capacity of ponding areas or bypass structures (overchutes, evacuation culverts) are exceeded. Floodwater inflows are typified by elevated salinity, suspended solids, and pesticides, which can alter SLC water quality during heavy rainfall. Detailed background information on floodwater inflows can be found in the DWR report titled *Water Quality Assessment of Floodwater Inflows in the San Luis Canal, California Aqueduct* (DWR 1995B).

Inflows during 1994 were relatively small at 600 af. During 1995, heavy rainfall in January and March resulted in the second highest annual inflow volume in 23 years (25,970 af) (Figure 8). These inflows caused major water quality problems for Project contractors primarily from high sediment loading. Floodwaters also breached the California Aqueduct at several locations causing extensive damage to the levee and liner.

Sixty-two percent of the 600 af of floodwaters discharged in 1994 occurred during May (Figure 9, left graph). Pumpage accounted for 68 percent of the May total followed by Cantua Creek with 18 percent. During 1995, approximately 77 percent of the years' inflows occurred in March and Cantua Creek was the highest contributor with 5,967 af, followed by breaches or breaks (5,010 af), and Arroyo Pasajero drain inlets at Gale Avenue with 4,144 af (Figure 9, right graph). January was the second highest month of inflows during 1995 with 5,384 af; Cantua Creek was the dominant source (63 percent).

During 1995, floodwaters overtopped the canal levee at several locations and contributed more than 5,000 af of uncontrolled inflows to the SLC. Floodwaters breached the SLC at mileposts 135.96 and 138 and accounted for 99 and 50 af, respectively, of inflows on March 10. The following day, floodwaters breached the levee at Cantua Creek between mileposts 134.92 and 135.15 and discharged 2,227 af. That same day, a break developed in the containment dike for the Arroyo Pasajero ponding basin. Inflows from this break totaled 2,635 af. These incidents accounted for a substantial amount of sediment loading to the California Aqueduct as well as the detection of several petroleum hydrocarbons from an oil spill in the watershed (see Chapter VI).

Rainfall near the town of Panoche was assessed and compared to floodwater inflows. The Panoche station was chosen because it is representative of Diablo Range precipitation[1]. Annual precipitation totals from December-March of each year between 1992 and 1995 were summed and converted to percentiles for analysis. Percentiles represent the probabilities of rain less than the associated value occurring in any given year.

During the 72-year period, the 50th percentile, or median annual rainfall, was 5.1 inches and the 80th percentile was 8.4 inches (Figure 10, top graph). Therefore, rainfall totals of 5.1 inches or less are expected about half the time or, in any given year, there is a 50 percent chance of less than 5.1 inches of rainfall at Panoche between December-March. This statistic is useful in determining the frequency and volume of floodwater inflows to the SLC.

An attempt was made to predict the frequency and volume of floodwater inflows by relating inflows to annual rainfall. This relationship exhibited an r-squared of 0.82 and is shown in Figure 10 (bottom graph).

[1] Rainfall data from the town of Panoche at the Panoche 2W station is representative because it is centrally located in elevation and longitude in the stretch of Diablo Range draining to the SLC. Precipitation totals in the Diablo Range increase with an increase in both longitude and altitude. Panoche is also located near the major contributing watershed—Cantua Creek.

Figure 8
Annual Floodwater Inflows to the San Luis Canal, 1973-1995

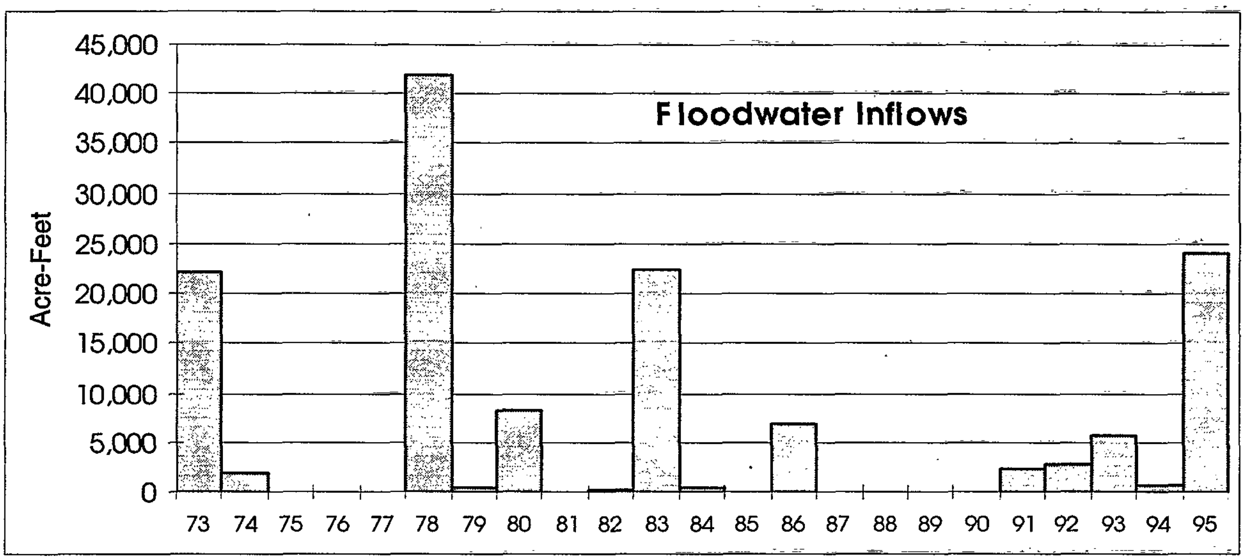
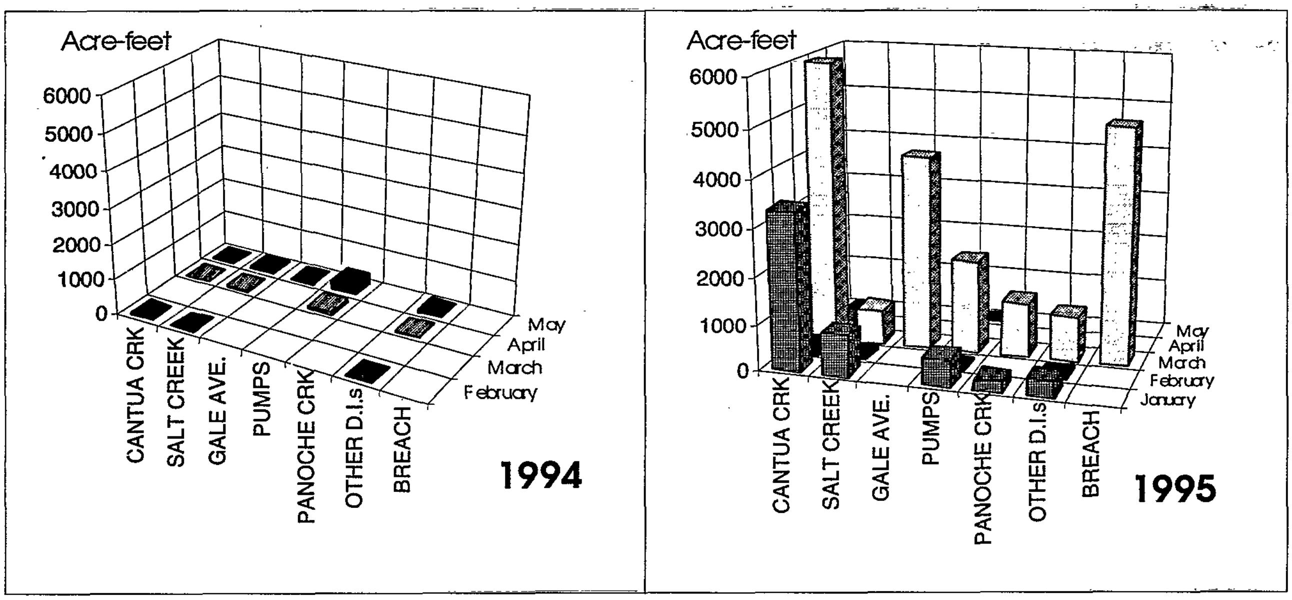


Figure 9
Monthly Floodwater Inflows to the San Luis Canal by Drain Inlet, 1994 and 1995



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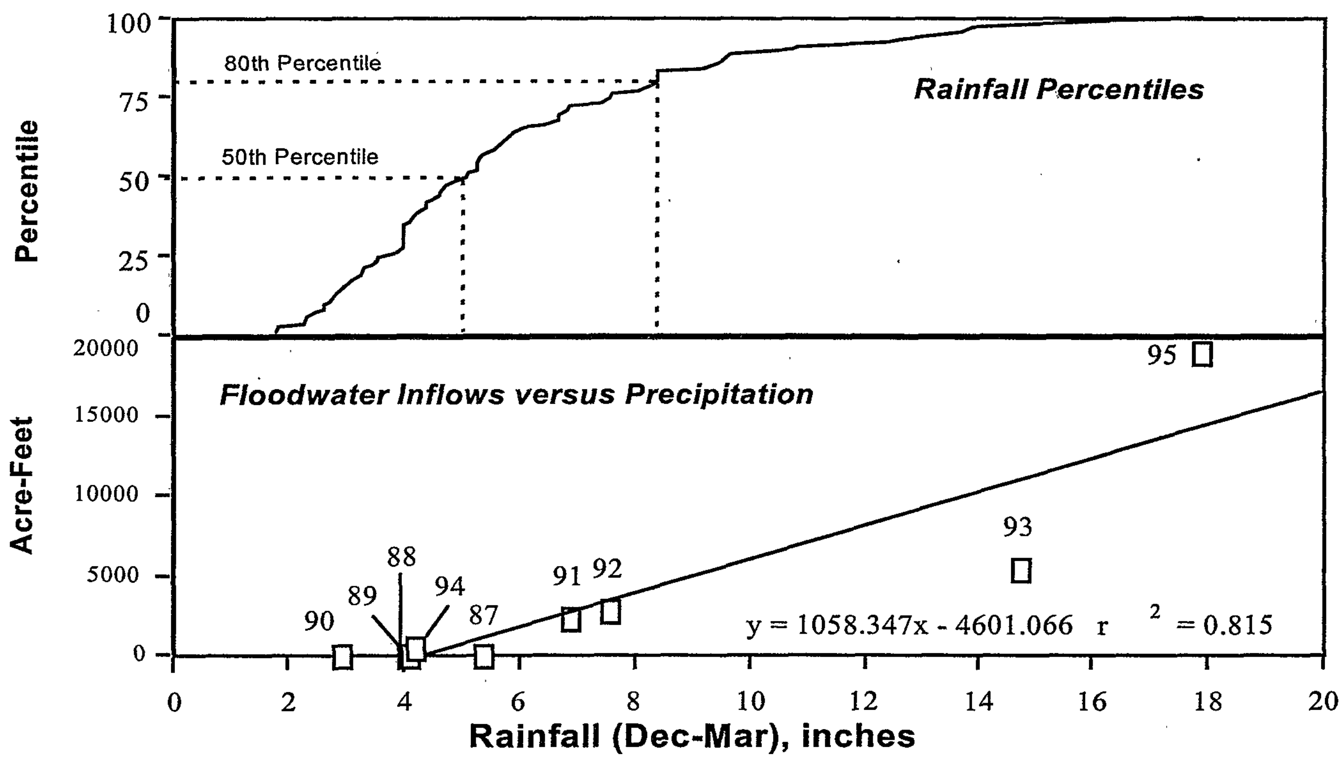
Values prior to 1987 were excluded due to expansion of the ponding basin in Arroyo Pasajero[2]. Although the relationship was not strong for high inflows, a majority of the points were clustered around low rainfall totals and indicate a relatively narrow cutoff point for floodwater inflows. The cutoff point is where the line intersects the x-axis and, in Figure 10, little or no inflows are predicted when December-March rainfall is 4.3 inches or less. The actual cutoff point ranged from 2.9 to 5.3 inches and encompased the median historical total of 5.1 inches discussed above. Although this situation occurred approximately half the time for the period between 1987 to 1995 as predicted (i.e., rainfall in 1987, 1988, 1989, 1990, and 1994 totaled between 2.9 and 5.3 inches and subsequent inflows were nominal or nonexistant), it occurred during the first four years of a six-year drought that California experienced between 1987 and 1992, and rainfall amounts were lower than expected. Therefore, more data are needed to accurately predict inflows.

Historical records back to 1923 indicate that rainfall at Panoche has been unusually heavy in recent times. Eleven of the highest 20 precipitation totals over the last 73 years have occurred between 1969 and 1995 (Figure 11). The highest December-March total on record was during 1995 when 17.9 inches of rainfall fell

Figure 10

Annual Rainfall Percentiles from 1923 to 1995 (top graph). The Bottom Graph Shows the Relationship Between Annual Rainfall and SLC Inflows



[2] Although inflow data exists from 1973, only 1987-95 data was plotted because rainfall/inflow relationships from 1986 and earlier would not be the same. During that year, operational procedures were modified to increase the holding capacity in Arroyo Pasajero, thereby decreasing overall inflow potential.

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at Panoche and its corresponding frequency was about 2 percent. The second wettest year at that station was 1978 when inflows to the SLC were also high. Rainfall during 1993 (14.7 inches) was also uncommonly high and was the third highest December-March total on record. The probability of this much rainfall in any given year was less than 5 percent. Therefore, some of the highest recorded rainfall totals have occurred in recent times and have generally been greater than normal since the construction of the Aqueduct.

DWR and the U.S. Army Corps of Engineers have been involved in completing a feasibility study to control floodwaters in the Arroyo Pasajero watershed. Solutions for the Cantua Stream group are also being investigated and include upstream dams, enlarged ponding capacity at the Aqueduct, and routing floodwaters over or under the Aqueduct. Plans to install three telemetered rain gauges and two stream gauges in the Cantua group watershed have been developed to provide greater advance warning on floodflows headed for the Aqueduct.

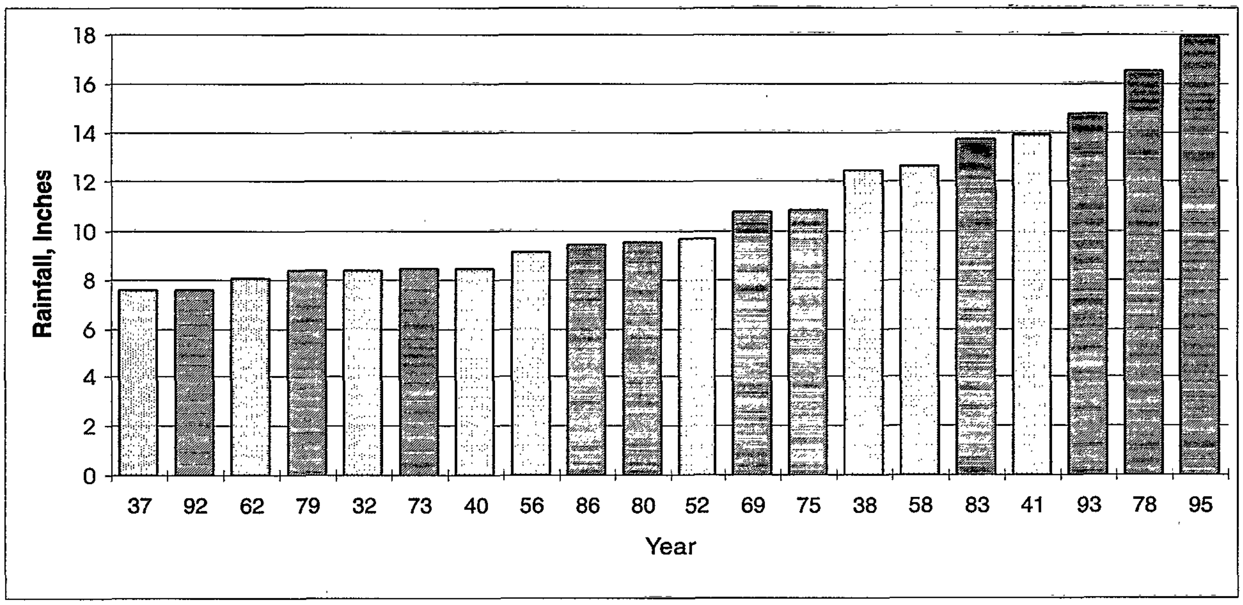
Delta Field Division

North Bay Aqueduct: Water is pumped from Barker Slough into the North Bay Aqueduct via the SWP's Barker Slough Pumping Plant to Napa and Solano county contractors. North Bay Aqueduct deliveries totaled 42,959 af in 1994 and 27,435 af in 1995.

South Bay Aqueduct: The South Bay Aqueduct is immediately south of Banks Pumping Plant and conveys SWP water primarily to Alameda and Santa Clara counties. Lake Del Valle, located off the South Bay Aqueduct, is filled during the winter and spring for water conservation and summer recreation. During fall, water is released from Del Valle to the South Bay Aqueduct for water supply. This release allows reservoir

Figure 11

Twenty Highest December-March Rainfall Totals Between 1923 and 1995. Light Shaded Bars Represent Pre-Project Rainfall and the Darker Bars Represent Post-Project Rainfall



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storage for local flood control. Within the reservoir's watershed, heavy rains provide some non-Project inflows from natural runoff. SWP deliveries to the South Bay Aqueduct totaled 130,191 af in 1994 and 66,295 af in 1995.

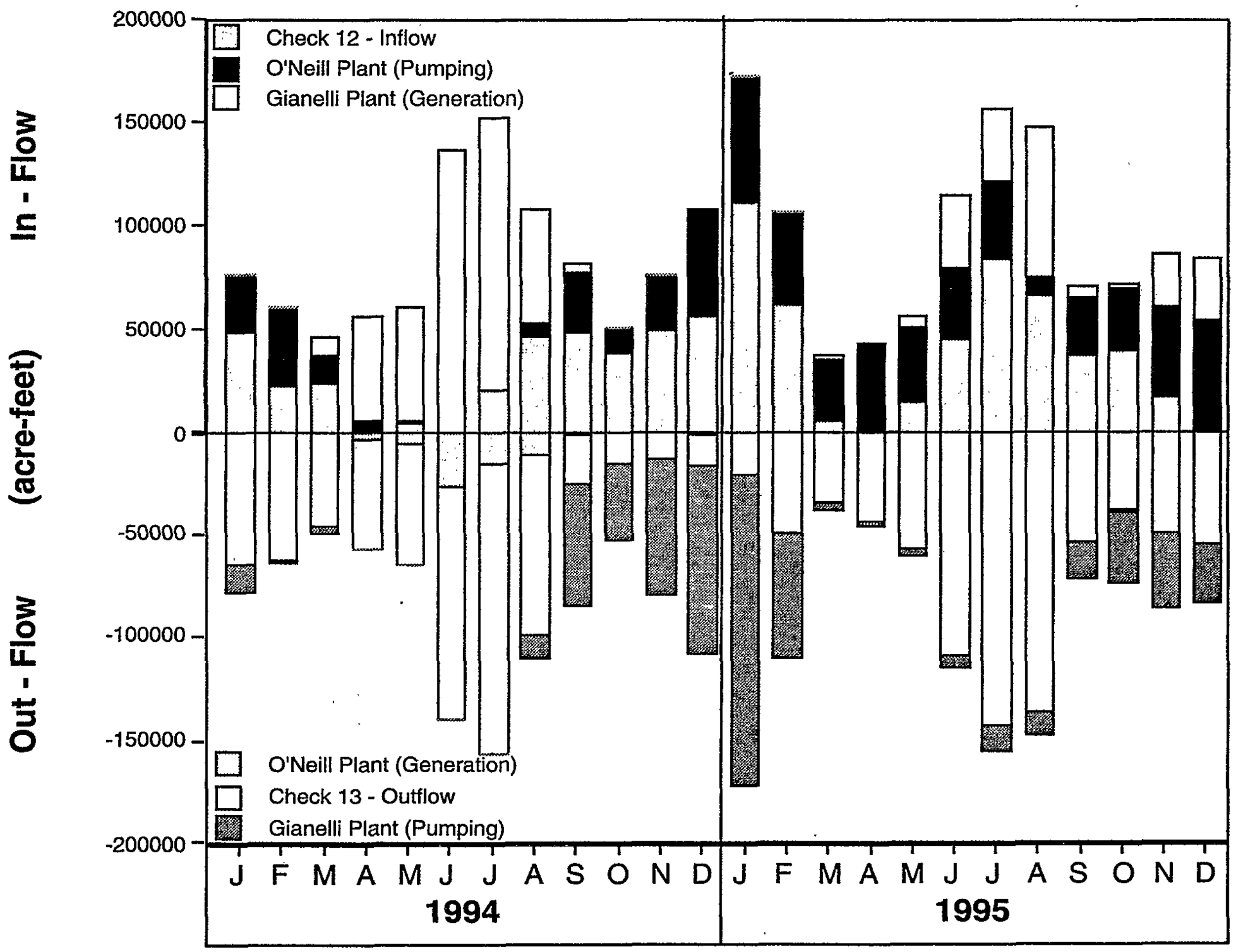
San Luis Field Division

O'Neill Forebay, San Luis Reservoir, and the California Aqueduct between Checks 13 and 21 are Joint-Use (SWP and CVP) facilities. The California Aqueduct conveys Delta water to O'Neill Forebay through Check 12. CVP water enters the forebay from the Delta-Mendota Canal via the CVP O'Neill Pumping-Generating Plant. Water from both projects can be stored in the San Luis Reservoir via the Gianelli San Luis Pumping-Generating Plant, released into the SLC at Check 13, or returned to the Delta-Mendota Canal through O'Neill Pumping-Generating Plant (Figure 12). Water stored in San Luis Reservoir is released down the SLC during late spring and summer to coincide with the agricultural irrigation season. During these months, inflows to O'Neill Forebay at Check 12 generally pass through the Forebay and into the SLC at Check 13 without diversion into San Luis Reservoir. The storage capacity of San Luis Reservoir is about 2.028 million af; the SWP share is about 1.062 million af and the CVP share is about 0.966 million af.

Figure 12

O'Neill Forebay Operations, 1994 - 1995

Mean weekly flows into and out of O'Neill Forebay



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Floodwater inflows to the SLC totaled 600 af in 1994 and 25,970 af in 1995. More information regarding floodwater inflows in these years can be found in the section on floodwater inflows.

A total 99,568 af of pump-in water entered the SLC between pool 15 and pool 21 during 1994. Pump-in volumes the following year decreased to 7,473 af.

San Joaquin Field Division

The California Aqueduct in the San Joaquin Field Division separates from the SWP/CVP Joint-Use stretch at Check 21 and continues to Edmonston Pumping Plant at the foot of the Tehachapi Mountains. The Coastal Branch diverts water westward from the California Aqueduct through the Las Perillas Pumping Plant. Coastal Branch deliveries totaled 101,214 af in 1994 and 101,522 af in 1995. There were no pump-ins to the California Aqueduct in the San Joaquin Field Division during either 1994 or 1995.

During seasonal flood events, local surface inflows may enter the Aqueduct through the Kern River Intertie. Water can also be diverted out of the Aqueduct and into the Kern River through the same gated conveyance structure. Approximately 11,850 af were released from the California Aqueduct and into the Kern River Intertie during March 1995 to accomodate high floodwater inflows upstream in the SLC.

Southern Field Division

Water enters Southern Field Division at Check 41 just upstream of the West and East branch bifurcation. The terminal point of both branches of the California Aqueduct are several small SWP reservoirs in Southern California. The larger of these reservoirs are Pyramid and Castaic lakes on the West Branch, and Silverwood Lake and Lake Perris on the East Branch.

West Branch: The 31-mile long West Branch diverges at Check 41 and continues through Quail Lake, down the Peace Valley Pipeline, and into Pyramid Lake. From Pyramid Lake, flows continue through the Angeles Tunnel and terminate at Castaic Lake.

SWP water delivered to terminal lakes on the West Branch totaled 420,469 af in 1994 and 194,976 af in 1995. Non-Project inflows from local watersheds also contributed inflows to these lakes. Watershed runoff to Castaic Lake was 3,094 af in 1994 and 33,366 af in 1995. Watershed runoff to Pyramid Lake was also high in 1995 and totaled 105,454 af. Project and non-Project water entering Pyramid Lake mixes together within the lake and then enters Castaic Lake. Therefore, watershed runoff to Pyramid and Castaic lakes accounted for 42 percent of the water entering the West Branch from Project deliveries and non-Project inflows. This compares to approximately 5 percent the previous year.

East Branch: The East Branch of the California Aqueduct passes through a series of pumping and generating plants, as well as Silverwood Lake before terminating in Lake Perris near San Bernardino.

Deliveries to East Branch contractors totaled 496,458 af in 1994 and 368,641 af in 1995. Natural inflows to Silverwood Lake were estimated at 4,511 af in 1994 and 40,259 af in 1995. The San Bernardino Valley Municipal Water District contributed 5,034 af of pump-in water during 1994 and none in 1995.

V. Water Quality in the State Water Project

This chapter assesses water quality trends in the SWP during 1994 and 1995. Parameters include specific conductance, total dissolved solids, sodium, hardness, chloride, sulfate, arsenic, selenium, trihalomethane formation potential, bromide, total organic carbon, pesticides, and ionic composition. Data used to generate the following graphs and tables are reported in Appendix A, Tables A-1 through A-5.

Specific Conductance

Specific conductance is an expression of salinity and is reported as microseimens per centimeter.

Seasonal Trends

Specific conductance at most SWP stations was generally higher in 1994 than 1995. During 1994, specific conductance at Banks Pumping Plant ranged from 430 to 648 µS/cm and averaged 529 µS/cm for the year (Figures 13, 14, and 15). At the same station in 1995, values ranged from 162 to 463 µS/cm and averaged 284 µS/cm for the year; 245 µS/cm lower than the previous year's average. The wide difference between years was due to below-normal precipitation in 1994, greater salinity intrusion in the Delta, and subsequently, higher specific conductance. The opposite occurred in 1995 when higher runoff volumes from above-normal rainfall lowered specific conductance levels at Banks Pumping Plant.

Water pumped from the Delta to the North Bay Aqueduct at Barker Slough Pumping Plant exhibited an annual specific conductance of 352 µS/cm in 1994 and 305 µS/cm in 1995; a difference of 47 µS/cm. The smaller annual differential at this station compared to Banks Pumping Plant reflects the relative influence that Delta water quality has on these two stations. Water quality at Barker Slough Pumping Plant is affected by local inflows while at Banks Pumping Plant, hydrodynamics in the Delta is the major determinant of salinity.

Specific conductance was also generally higher in 1994 than 1995 at other SWP stations. During 1994 for instance, specific conductance at Check 13 ranged between 437 and 678 µS/cm with an annual average of 542 µS/cm. During 1995, values there ranged from 199 to 528 µS/cm and averaged 399 µS/cm for the year; 143 µS/cm lower than the previous year's average. A similar trend was observed at other stations on the California Aqueduct where specific conductance averaged 102 to 209 µS/cm higher in 1994 than 1995 at Check 21, Check 29, Check 41, and Devil Canyon Afterbay. With the exception of Check 13, the cause of the higher 1994 specific conductance levels at these stations was due to the influence of both Delta water quality and pump-ins to the San Luis Canal. Pump-ins contain elevated levels of several salts and have been shown to increase specific conductance in the California Aqueduct below Check 13. Pump-ins totaled 100,000 af in 1994 (compared to 7,500 af in 1995) and measurably increased specific conductance in the California Aqueduct that year. In 1995, pump-ins measureably influenced specific conductance for approximately one month.

The greatest change in the average specific conductance between years (a decline of about 300 µS/cm) was observed for the Delta-Mendota Canal. The only station with no substantial change between years was Thermalito Afterbay, which is influenced by Lake Oroville dam releases. Although annual specific conductance increased between years at Castaic Lake from 586 µS/cm in 1994 to 628 µS/cm in 1995, a difference of 42 µS/cm, a similar increase was not observed for dissolved solids, chloride, or sulfate, indicating a possible artifact of one or more outliers instead a reflection of actual conditions.

Figure 13

Specific Conductance (µS/cm)

Mean Monthly Values at Stations from Thermalito Afterbay to Check 13

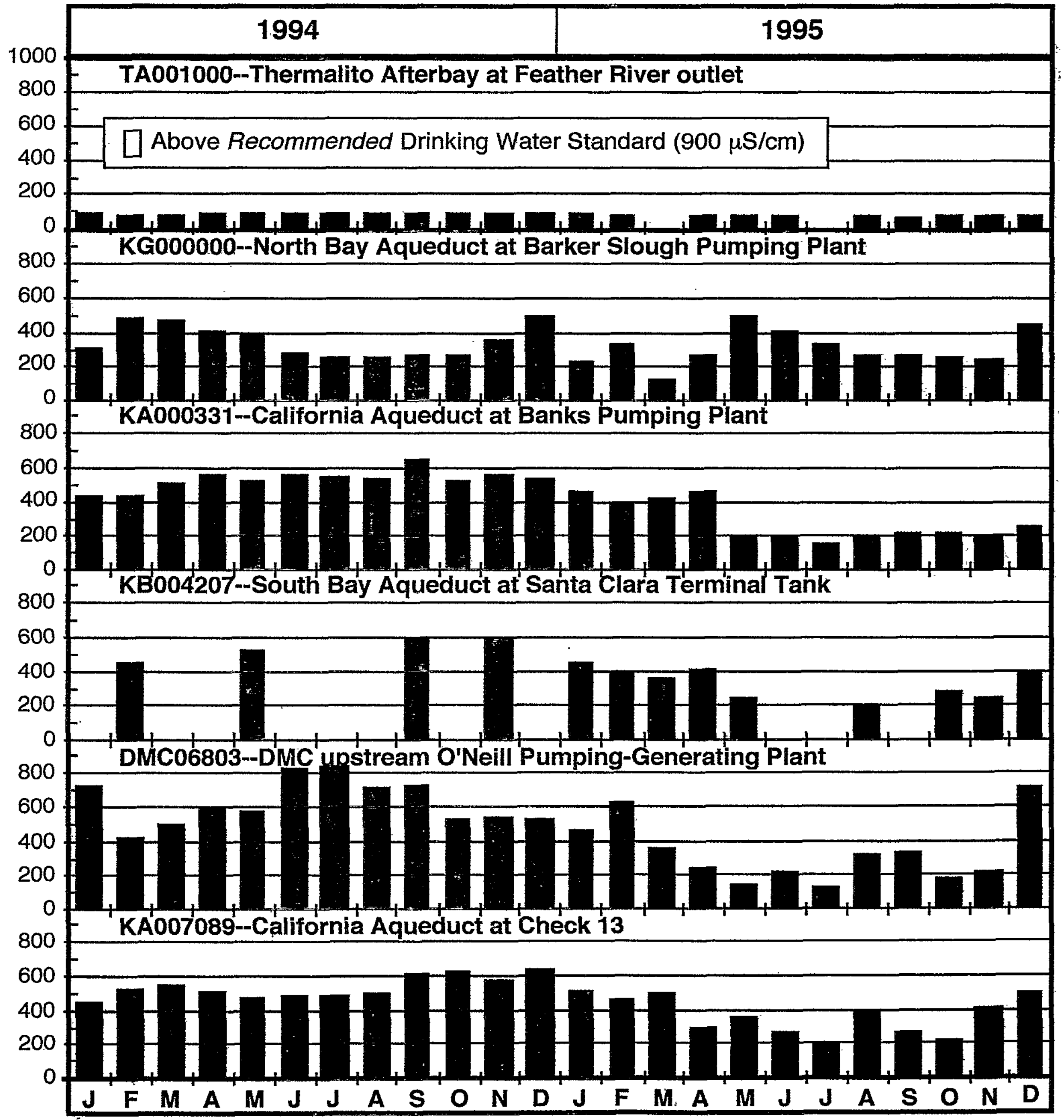

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Figure 14

Specific Conductance (µS/cm)

Mean Monthly Values at Stations from Check 21 to Castaic Lake

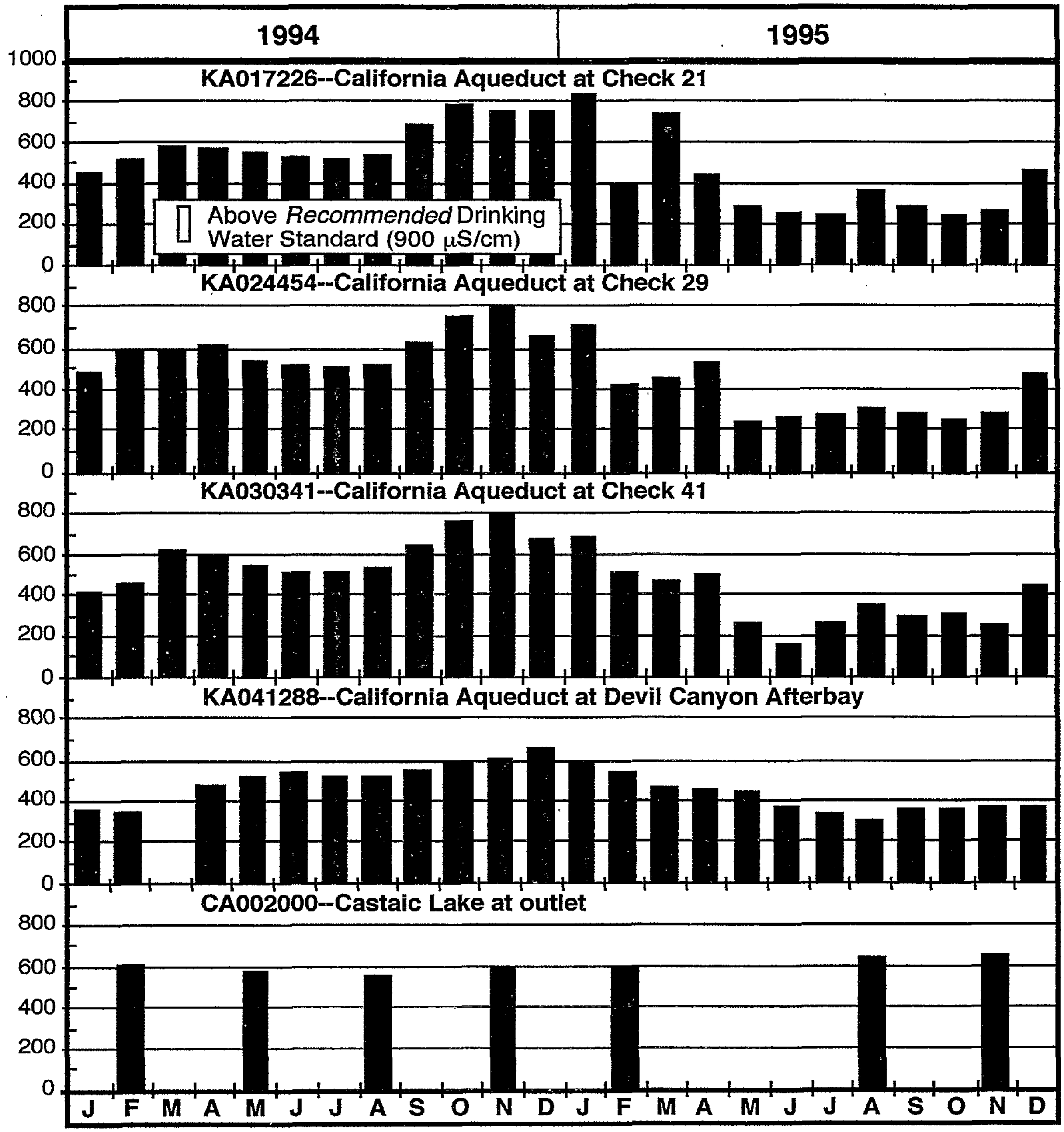

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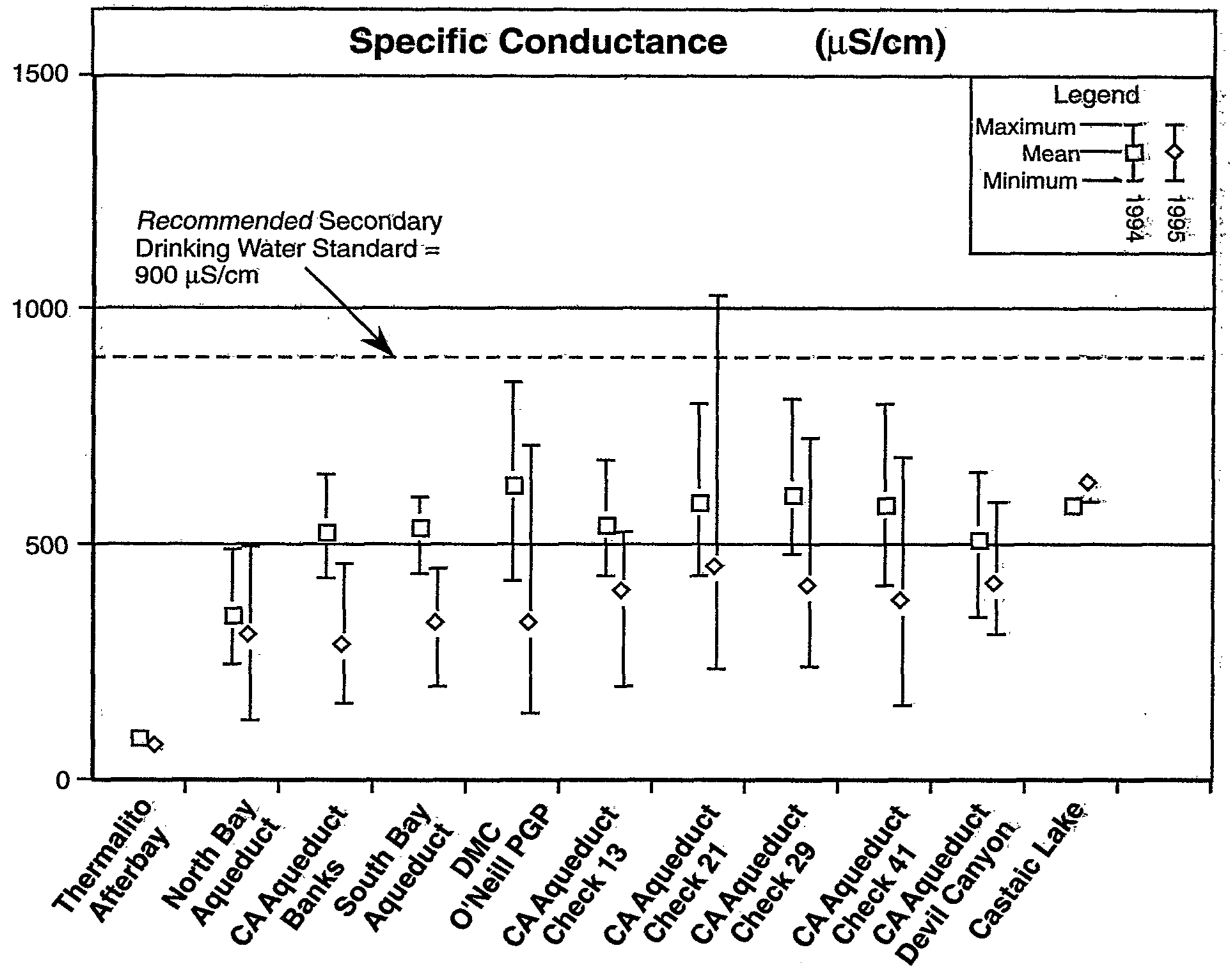
Figure 15

Mean Annual Specific Conductance, 1994-1995
Maximum and Minimum Monthly Values Shown



Station Comparisons

During both years, specific conductance generally increased in the California Aqueduct between Banks Pumping Plant and several downstream locations. During 1994, specific conductance averaged 529 µS/cm at Banks Pumping Plant while at Checks 13, 21, 29, and 41, the averages ranged from 542 to 606 µS/cm; an increase of up to 77 µS/cm. A similar trend was observed during 1995 when specific conductance increased from an annual average of 284 µS/cm at Banks Pumping Plant to between 375 and 452 µS/cm at Checks 13, 21, 29, and 41; an increase of as much as 168 µS/cm. These increases were due to several possible factors including inflows from the DMC, non-Project inflows from pump-ins and floodwaters, and San Luis Reservoir releases.

During 1994, a slight increase in annual specific conductance was observed between Banks Pumping Plant and Check 13 (respectively, from 529 to 543 µS/cm) and was due, in part, to DMC inflows, which exhibited an annual average of 627 µS/cm. During 1995, specific conductance increased from 283 µS/cm at Banks Pumping Plant to 399 µS/cm at Check 13, an increase of 116 µS/cm. However, the increase was not entirely related to salinity in the DMC, which averaged 332 µS/cm for the year. The only other major source that could influence water quality at Check 13 are releases from San Luis Reservoir.

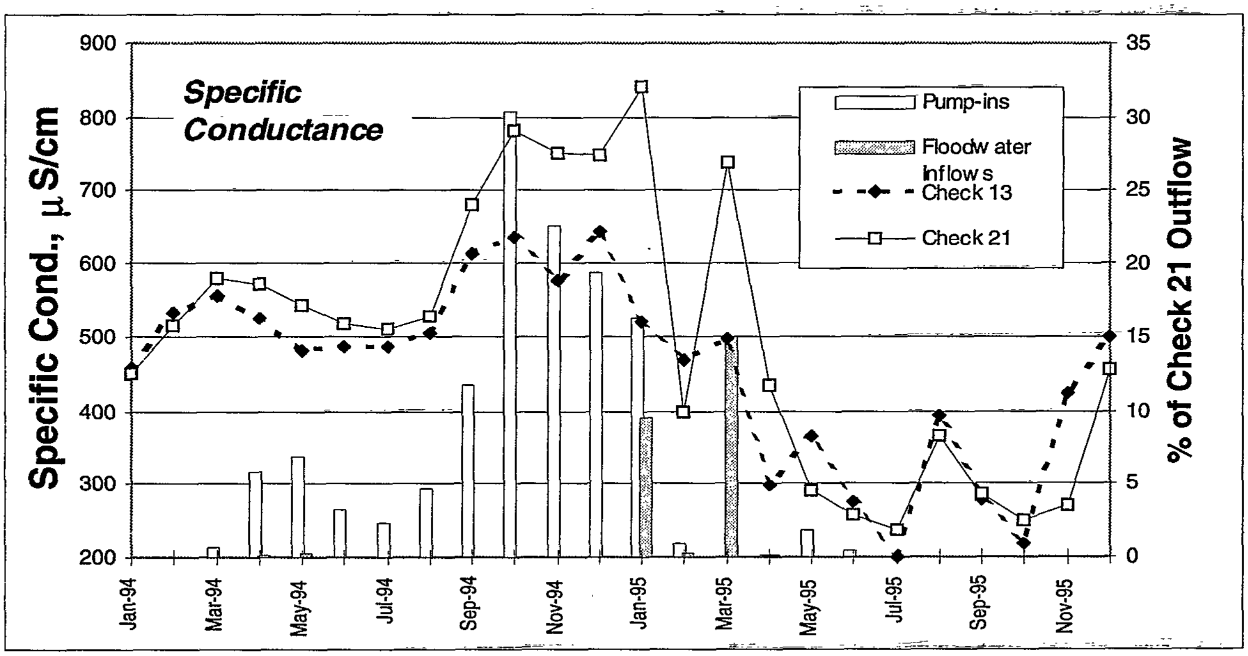
The greatest station-to-station increase on the California Aqueduct occurred between Check 13 and Check 21 where several non-Project inputs are located. During 1994, annual specific conductance averaged 542 µS/cm at Check 13 and 590 µS/cm at Check 21; a 50 µS/cm increase between stations. A similar increase was observed in 1995 when specific conductance averaged 399 µS/cm at Check 13 and 452 µS/cm at Check 21. The increases corresponded with non-Project inputs from groundwater pump-ins and/or floodwater inflows. Previous studies have documented that increases in SWP specific conductance from these highly mineralized inputs are proportionate with the discharge/flow ratio in the California Aqueduct.

Figure 16 shows monthly specific conductance at Checks 13 and 21 and the percentage of pump-in volumes to SLC outflows at Check 21. In September 1994, pump-ins exceeded 10 percent of the SLC and specific conductance increased from 613 µS/cm at Check 13 to 682 µS/cm at Check 21; an increase of 69 µS/cm. That differential between stations increased through the rest of 1994 to between 104 and 171 µS/cm with pump-in volumes composing 16 to 30 percent of SLC outflows. Prior to September 1994, specific conductance increases were also observed when monthly pump-in volumes accounted for 1 to 7 percent of outflows.

The widest differential in specific conductance between Checks 13 to 21 was observed in January 1995, when combined volume of pump-ins and floodwaters comprised 26 percent of the California Aqueduct (Figure 16). Specific conductance that month was 521 µS/cm at Check 13 and 840 µS/cm at Check 21; an increase of 319 µS/cm. Although pump-ins during the rest of 1995 were minor compared to Check 21 outflows, floodwater inflows amounted to more than 20,000 af in March 1995 and increased monthly specific conductance between stations by over 250 µS/cm. In the same month, pump-ins totaled only 4 af.

Figure 16

Specific Conductance in the California Aqueduct at Checks 13 and 21 and the Relative Volume of Pump-ins and Floodwater Inflows



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Comparison to Water Quality Thresholds

All 1994-1995 mean monthly specific conductance values were below the DHS recommended Secondary MCL of 900 µS/cm. One sample used to calculate the March 1995 monthly average at Check 21 exhibited a specific conductance of 1,030 µS/cm when floodwater inflows were unusually high.

Ionic Salinity as Equivalent Percentages

Table 8 presents the relative ionic composition of SWP waters reported as equivalent percentages. Major cations include the positively charged analytes calcium, magnesium, sodium, and potassium. Major anions include the negatively charged analytes bicarbonate, sulfate, and chloride. Equivalents can be used to compare the relative dominance of individual analytes. With this information, specific waters of unusual mineral composition can be identified. For instance, chloride dominates the anionic composition of ocean waters, whereas, bicarbonate or sulfate is usually dominant in fresh waters. Therefore, an increase in the chloride percentage in proportion to other anions would reflect a greater influence from salt water.

Water pumped from the south Delta contained a lower relative proportion of chloride in 1995 than 1994. During 1994, chloride composed from 43 to 51 percent of the total anionic composition at Banks Pumping Plant, South Bay Aqueduct, Check 13, Check 21, Check 29, Check 41, as well as, the Delta-Mendota Canal. The annual average chloride composition was substantially less in 1995 and ranged from 20 to 39 percent at the same stations. This decrease between years corresponded with a decrease in the mean annual specific conductance and a general increase in the proportion of sulfate and bicarbonate. At Banks Pumping Plant for instance, sulfate composed 19 percent of the total anions in 1994 and increased to 25 percent in 1995. The percentage of bicarbonate at that station also increased from 31 percent in 1994 to 40 percent in 1995. These trends indicate that saltwater from San Francisco Bay influenced SWP water more in 1994 than in 1995.

During 1994, the anionic composition of water monitored at Devil Canyon Afterbay and Castaic Lake was not dominated by any one ion but was more evenly distributed between chloride, bicarbonate, and sulfate. This even distribution was also observed at all stations on the California Aqueduct during the entire year of 1995. During both years, bicarbonate was the dominant anion at Thermalito Afterbay (89-90 percent) and Barker Slough Pumping Plant (58-63 percent).

During both 1994 and 1995, sodium made up the greatest proportion of cations (40-56 percent) in the California Aqueduct. The cationic composition of calcium at all stations ranged from 21 to 36 percent and was nearly identical to magnesium. Potassium made up only 1 or 2 percent of the cations at stations where it was monitored—Check 41, Devil Canyon Afterbay, and Castaic Lake.

Total Dissolved Solids

Total dissolved solids are a measure of the solids in water that pass through a 0.45 micron filter and provides another expression of salinity. TDS mostly includes the same minerals that influence specific conductance and make up the anionic/cationic composition.

Seasonal Trends

Similar to conductance, TDS at most SWP stations were generally lower in 1995 than 1994 and was largely due to water quality in the Delta (see discussion for specific conductance). At Banks Pumping Plant, TDS ranged from 252 mg/l to 351 mg/l during 1994 and averaged 297 mg/l for the year (Figures 17, 18, and 19). At the same station in 1995, values ranged from 97 mg/l to 239 mg/l and averaged 166 mg/l for the year; 131 mg/l lower than the previous year's average. Although similar annual trends were observed at Barker Slough Pumping Plant, the difference between years was not as great. TDS there averaged 205 mg/l in 1994 and 185 mg/l in 1995; a difference of 20 mg/l.

Table 8
Mean Annual Ionic Salinity as Equivalents Percentages

	Cations				Anions			
	Calcium (%)	Magnesium (%)	Sodium (%)	Potassium (%)	Bicarb. (%)	Sulfate (%)	Chloride (%)	EC µS/cm
Thermalito Afterbay								
1994	47	35	18	NA	90	5	4	92
1995	46	37	17	NA	89	6	5	71
North Bay Aqueduct								
1994	25	37	38	NA	58	18	25	352
1995	24	38	38	NA	63	16	20	305
California Aqueduct at Banks Pumping Plant								
1994	22	25	53	NA	31	19	51	529
1995	28	26	45	NA	40	25	35	284
South Bay Aqueduct								
1994	24	28	48	NA	36	19	45	541
1995	36	35	29	NA	59	21	20	331
DMC Upstream O'Neill Pumping-Generating Plant								
1994	24	25	51	NA	30	24	46	627
1995	29	24	47	NA	36	29	35	332
California Aqueduct at Check 13								
1994	22	25	53	NA	31	20	49	542
1995	27	25	48	NA	34	26	39	399
California Aqueduct at Check 21								
1994	22	23	55	NA	28	28	44	566
1995	27	23	49	NA	31	37	33	452
California Aqueduct at Check 29								
1994	21	22	56	NA	28	28	44	606
1995	27	24	50	NA	33	28	38	361
California Aqueduct at Check 41								
1994	22	22	55	2	29	28	43	584
1995	27	23	48	2	36	27	37	375
California Aqueduct at Devil Canyon Afterbay								
1994	23	23	52	2	30	33	37	471
1995	25	22	51	2	34	27	39	412
Castaic Lake								
1994	31	24	44	2	32	35	33	586
1995	34	24	40	1	34	39	27	628

Figure 17

Total Dissolved Solids — TDS (mg/l)

Mean Monthly Values at Stations from Thermalito Afterbay to Check 13

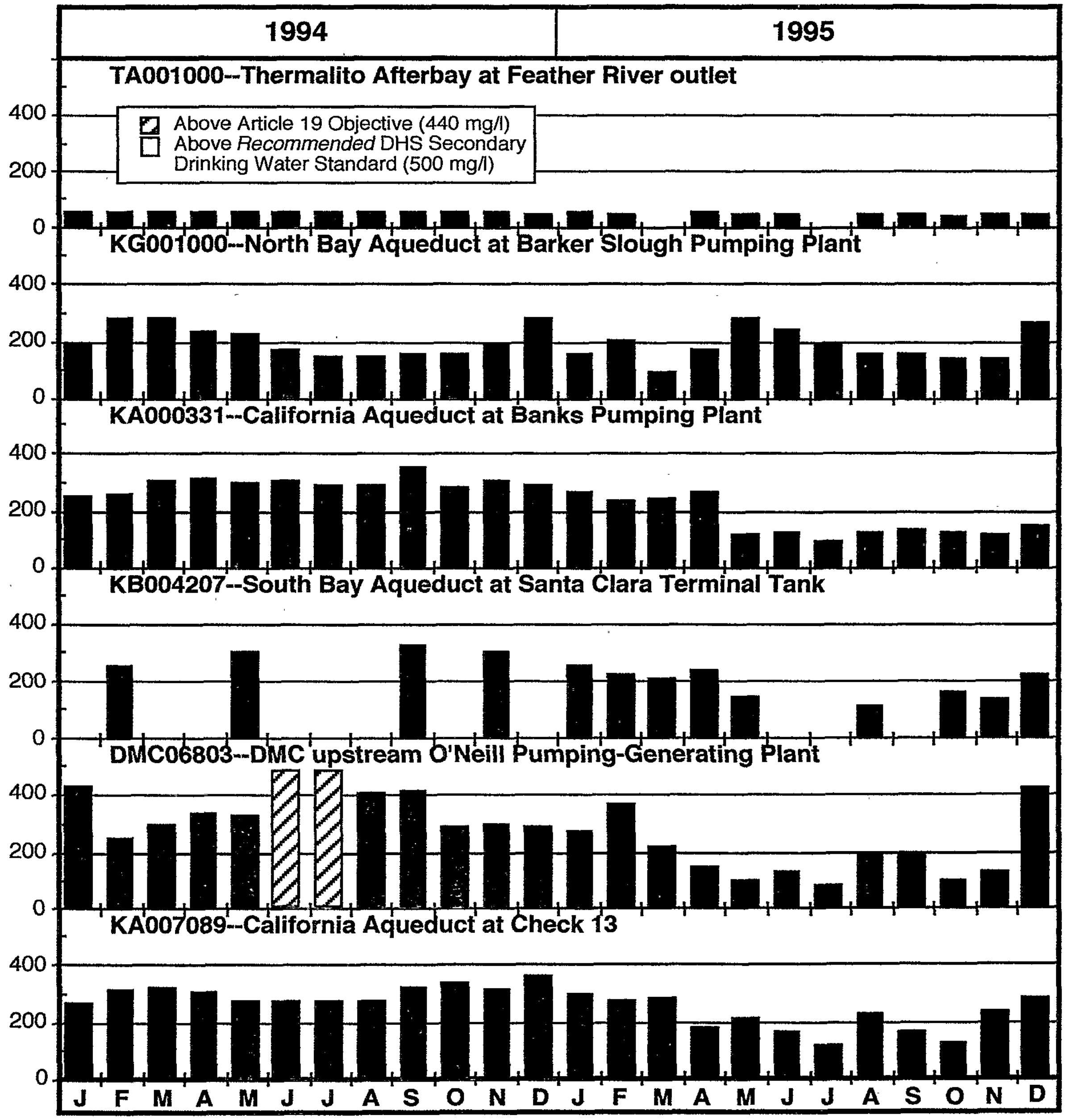

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Figure 18

Total Dissolved Solids —— TDS (mg/l)

Mean Monthly Values at Stations from Check 21 to Castaic Lake

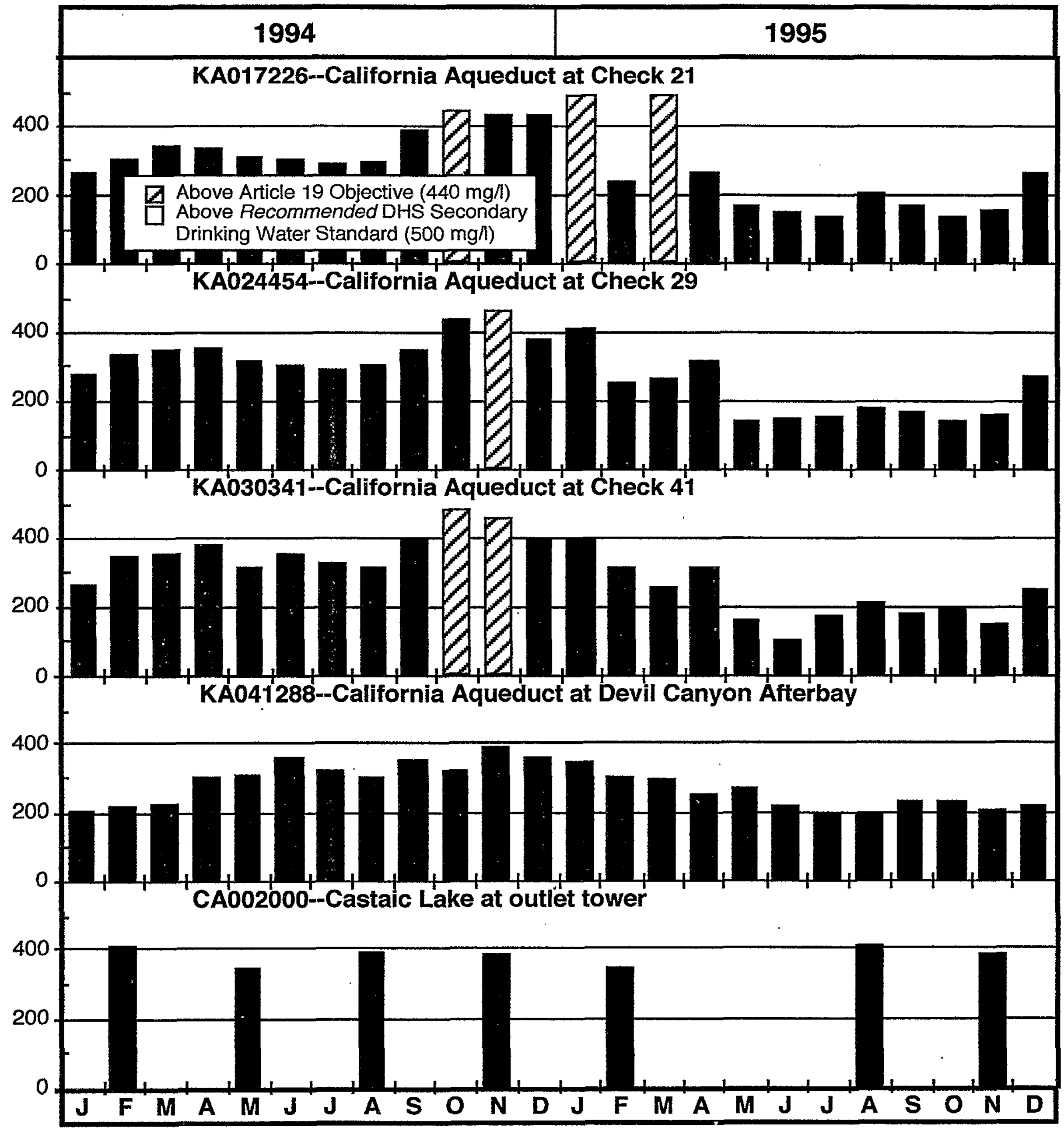

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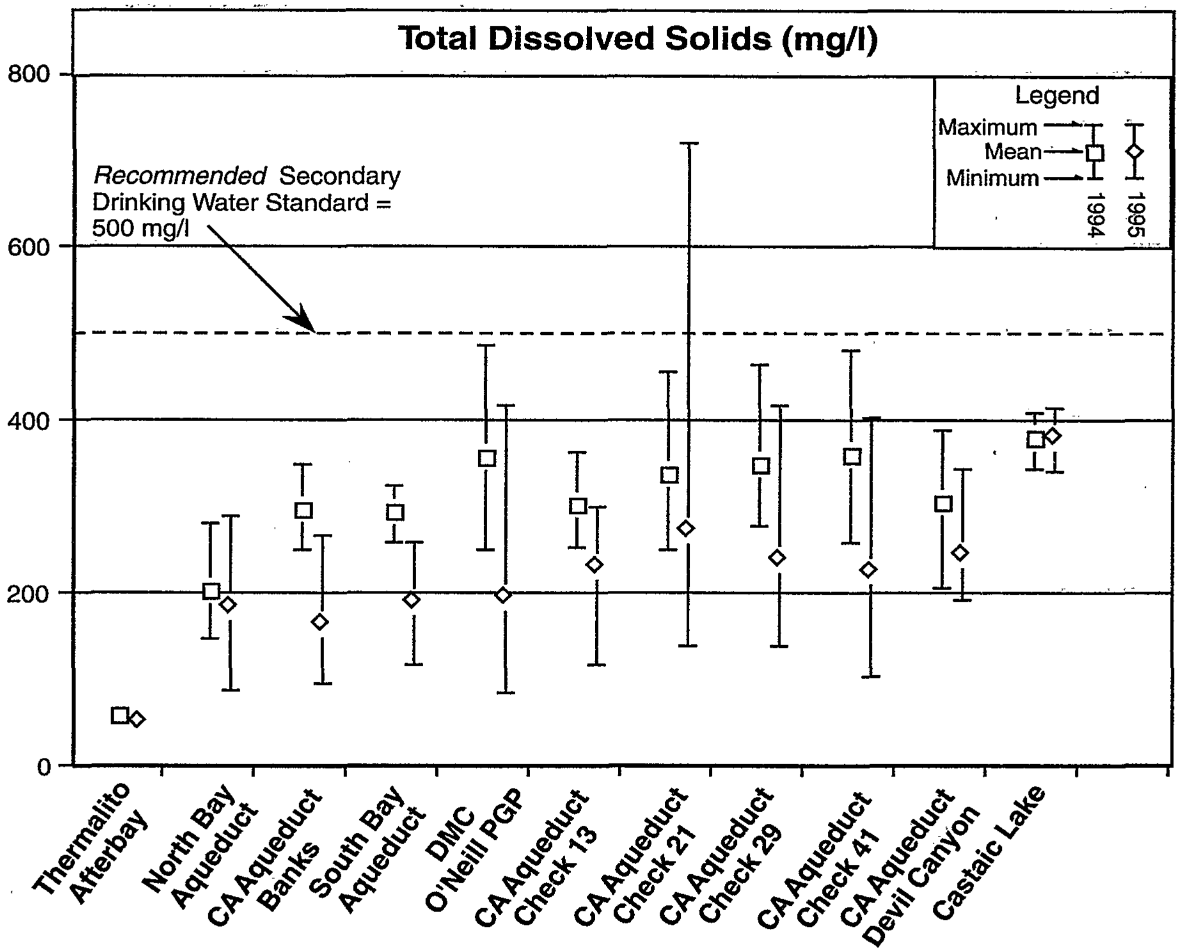
Figure 19

Mean Annual TDS, 1994-1995
Maximum and Minimum Monthly Values Shown



TDS were also generally higher in 1994 than 1995 at other SWP stations. During 1994 for instance, TDS at Check 13 ranged between 254 and 364 mg/l with an annual average of 305 mg/l. During 1995, values there ranged from 117 to 301 mg/l and averaged 232 mg/l for the year; 73 mg/l lower than the previous year's average. Similarly at Check 21, Check 29, Check 41, and Devil Canyon Afterbay, TDS averaged 67 to 135 mg/l lower in 1995 than 1994. With the exception of Check 13, TDS at these stations were influenced by both Delta water quality and pump-ins to the San Luis Canal. Pump-ins contain elevated levels of several salts and have been shown to increase TDS in the California Aqueduct below Check 13. During 1994, pump-ins totaled 100,000 af and measurably increased TDS in the California Aqueduct throughout most of the year. Pump-ins totaled 7,500 af the following year and measureably influenced TDS for one month.

The greatest change in the average TDS between years (a decline of 163 mg/l) was observed for the Delta-Mendota Canal. The only stations with no substantial change between years was at Thermalito Afterbay, which is influenced by dam releases from Lake Oroville and Castaic Lake, which is the terminal point of the West Branch. Conditions at Castaic Lake may not reflect those observed at the upstream stations because lake

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quality is also influenced by local watershed runoff, limnological dynamics within the lake, and the moderating effects from upstream Pyramid Lake.

Station Comparisons

TDS generally increased in the California Aqueduct between Banks Pumping Plant and several downstream locations. During 1994, TDS averaged 297 mg/l at Banks Pumping Plant and at Checks 13, 21, 29, and 41, TDS averaged from 304 to 361 mg/l; an increase of up to 64 mg/l. A more apparent trend was observed during 1995 when TDS increased from an annual average of 166 mg/l at Banks Pumping Plant to between 226 to 273 at Checks 13, 21, 29, and 41; an increase of as much as 107 mg/l. These increases were due to several possible factors including inflows from the DMC, non-Project inflows from pump-ins and floodwaters, and San Luis Reservoir releases.

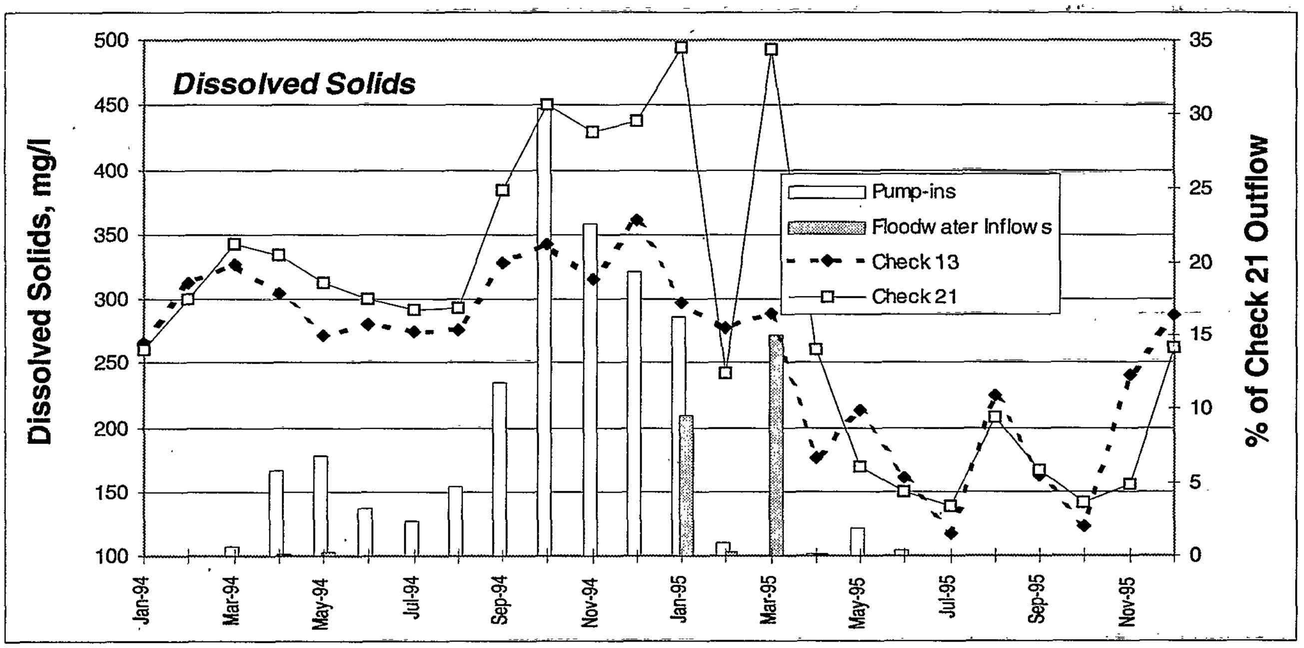
Although annual TDS averages were similar between Banks Pumping Plant and Check 13 during 1994, a pronounced difference was observed in 1995 when the average increased from 166 to 231 mg/l between stations. This trend was not entirely caused by salinity in the DMC, which averaged 196 mg/l for the year. The only other major source that could influence water at Check 13 are releases from San Luis Reservoir.

The greatest station-to-station increase in TDS on the California Aqueduct occurred between Check 13 and Check 21 where several non-Project inputs are located. During 1994, annual TDS averaged 305 mg/l at Check 13 and 340 mg/l at Check 21; a 35 mg/l increase between stations. A similar increase was observed during 1995 when TDS averaged 231 mg/l at Check 13 and 273 mg/l at Check 21; a 42 mg/l increase. Both increases corresponded with non-Project inputs from groundwater pump-ins and/or floodwater inflows. Previous studies documented that these highly mineralized inputs can increase SWP TDS in proportion to the discharge/flow ratio in the California Aqueduct.

Figure 20 shows monthly TDS at Checks 13 and 21 and the percentage of pump-in volumes to SLC outflows at Check 21. In September 1994, the proportion of pump-ins exceeded 10 percent of the flow in the California

Figure 20

Dissolved Solids in the California Aqueduct at Checks 13 and 21 and Relative Volume of Pump-ins and Floodwater Inflows



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Aqueduct and TDS increased from 329 mg/l at Check 13 to 384 mg/l at Check 21; an increase of 53 mg/l. That differential between stations increased through the rest of 1994 to between 76 and 113 mg/l with pump-in volumes composing 16 to 30 percent of SLC outflows. Prior to September 1994, TDS increases were also observed when monthly pump-in volumes accounted for 1 to 7 percent of outflows.

The widest differential in TDS levels between Checks 13 to 21was observed in January 1995, when combined pump-ins and floodwaters comprised more than 25 percent of the California Aqueduct (Figure 20). TDS that month was 289 mg/l at Check 13 and 495 mg/l at Check 21; an increase of 206 mg/l. Although pump-ins during the rest of 1995 were minor compared to Check 21 outflows, floodwater inflows amounted to more than 20,000 af in March 1995 and increased monthly TDS between stations by over 200 mg/l. In the same month, pump-ins totaled only 4 af.

Comparison to Water Quality Thresholds

Monthly TDS values never exceeded the DHS MCL during either 1994 or 1995. However, one of two samples used to calculate the monthly averages at Check 21 was greater than the recommended Secondary MCL of 500 mg/l. TDS was 722 mg/l at Check 21 in March, 1995—the same month of unusually high floodwater inflows.

The Article 19 Objective of 440 mg/l was exceeded in the Delta-Mendota Canal (not a SWP station) in June and July, 1994. At stations downstream of Check 13, mean monthly TDS were higher than the objective on six occasions: three at Check 21, one at Check 29, and two at Check 41.

Sodium

Sodium is the major cation in seawater, as such, its concentration in the SWP increases with greater salinity intrusion in the Delta.

Seasonal Trends

Similar to conductance, sodium at most SWP stations was generally lower in 1995 than 1994 and was largely due to water quality in the Delta (see discussion for specific conductance). At Banks Pumping Plant during 1994, sodium ranged from 40 to 87 mg/l and averaged 59 mg/l for the year (Figures 21, 22, and 23). At that same station in 1995, values ranged from 15 to 50 mg/l and averaged 27 mg/l for the year; 32 mg/l lower than the previous year's average. Although a similar trend was observed at Barker Slough Pumping Plant, the difference between years was not as great. Sodium there averaged 31 mg/l in 1994 and 27 mg/l in 1995; a difference of 4 mg/l.

Sodium was also generally lower in 1995 than 1994 at other SWP stations. During 1994 for instance, sodium at Check 13 ranged between 45 and 85 mg/l with an annual average of 60 mg/l. During 1995, values ranged from 19 to 58 mg/l and averaged 41 mg/l for the year; 21 mg/l lower than the previous average. Similarly at Check 21, Check 29, and Check 41, sodium averaged 22 to 23 mg/l lower in 1995 than 1994. With the exception of Check 13, sodium at these stations was influenced by both Delta water quality and pump-ins to the San Luis Canal. Pump-ins contain elevated levels of several salts and demonstrate increased sodium in the California Aqueduct below Check 13. During 1994, pump-ins totaled 100,000 af (compared to 7,500 af in 1995) and measurably increased sodium in the California Aqueduct. The following year, pump-ins measureably influenced sodium for one month.

The greatest decrease in sodium between years (35 mg/l) was observed for the Delta-Mendota Canal. The only stations with no substantial change between years was Thermalito Afterbay, which is influenced by dam releases from Lake Oroville, and Castaic Lake, which is on the West Branch of the California Aqueduct. Water quality at Castaic Lake may not reflect that observed at upstream stations due to the influence of local

Figure 21

Sodium (mg/l)

Mean Monthly Values at Stations from Thermalito Afterbay to Check 13

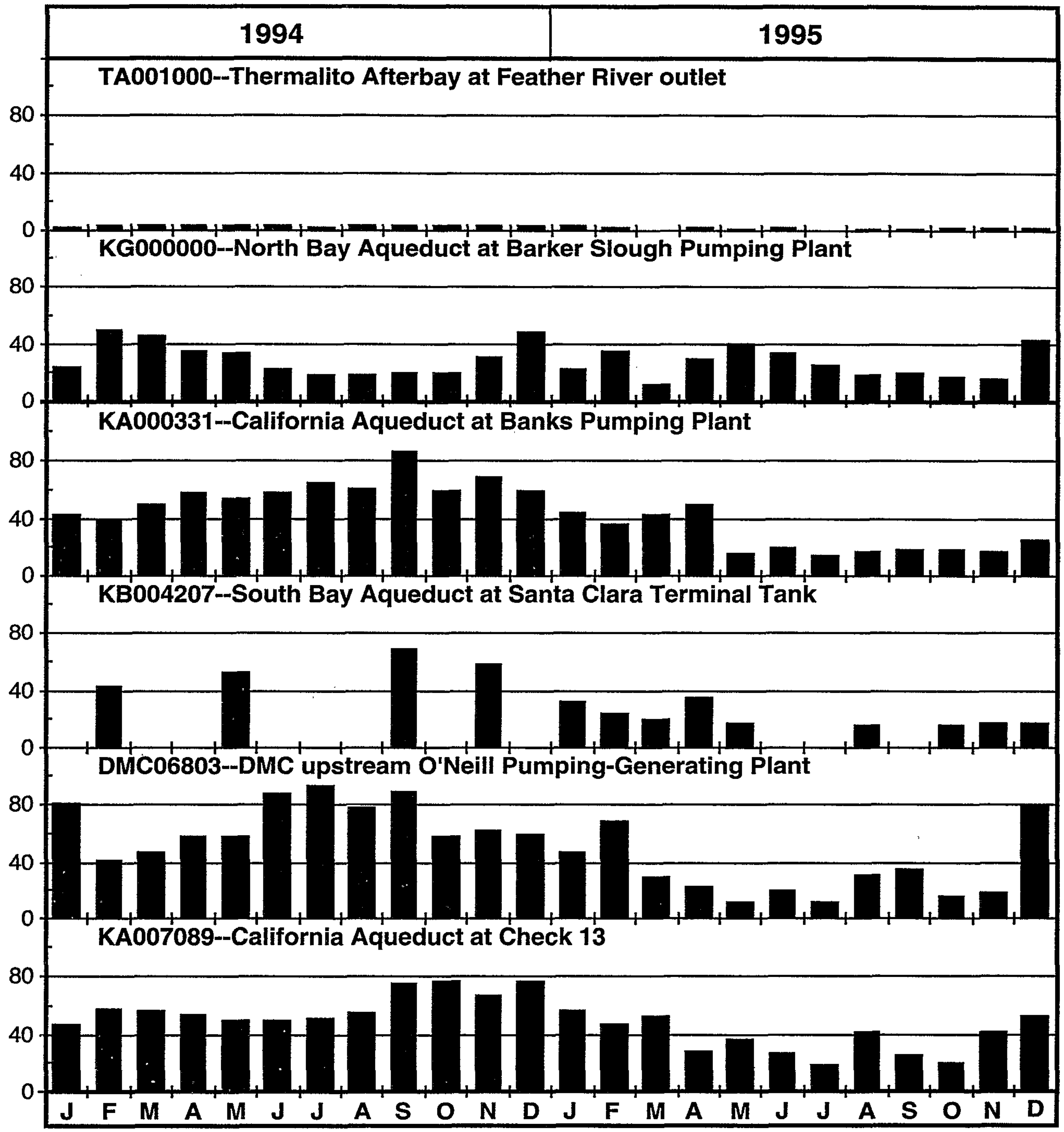

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Figure 22

Sodium (mg/l)

Mean Monthly Values at Stations from Check 21 to Castaic Lake

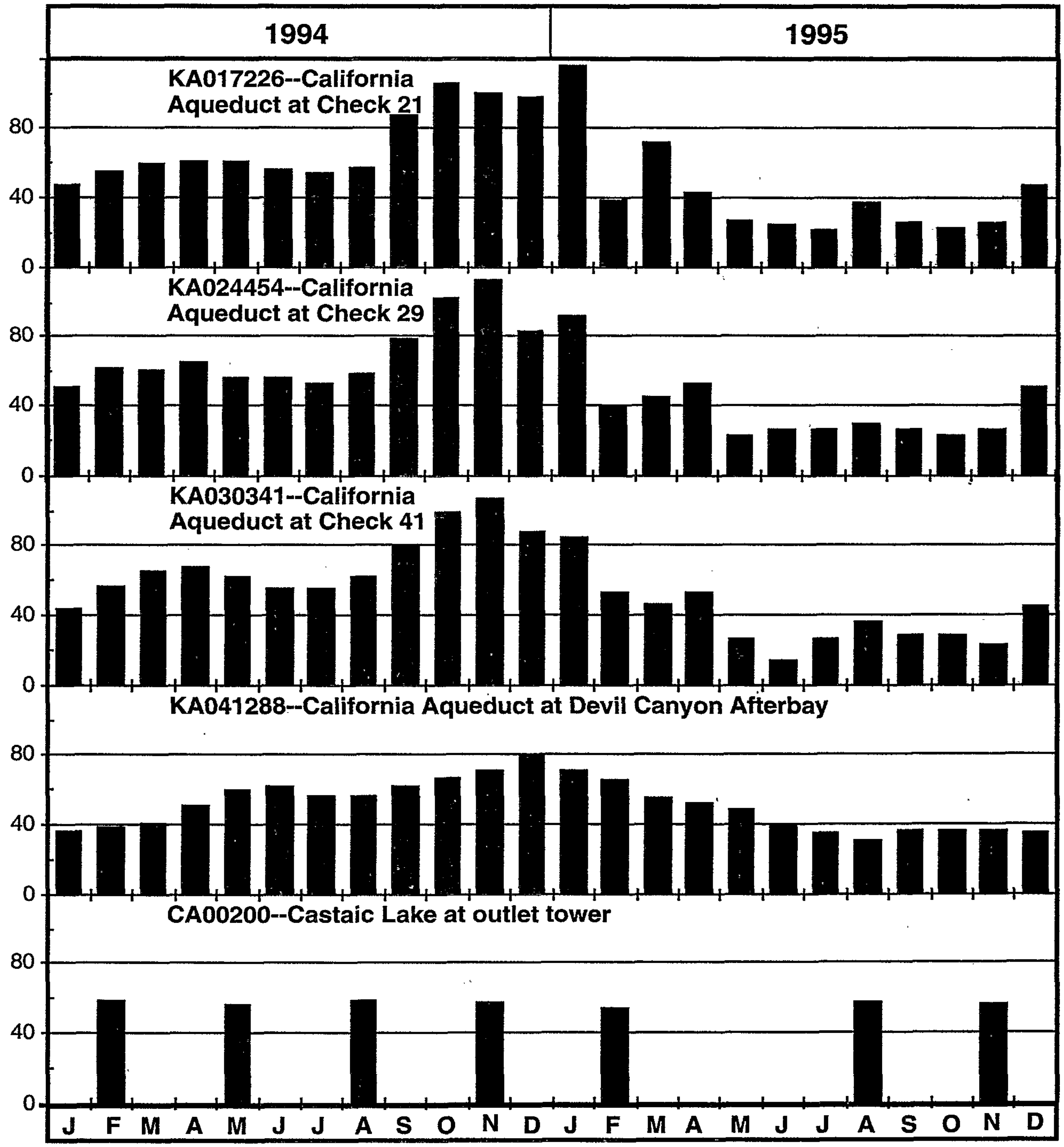

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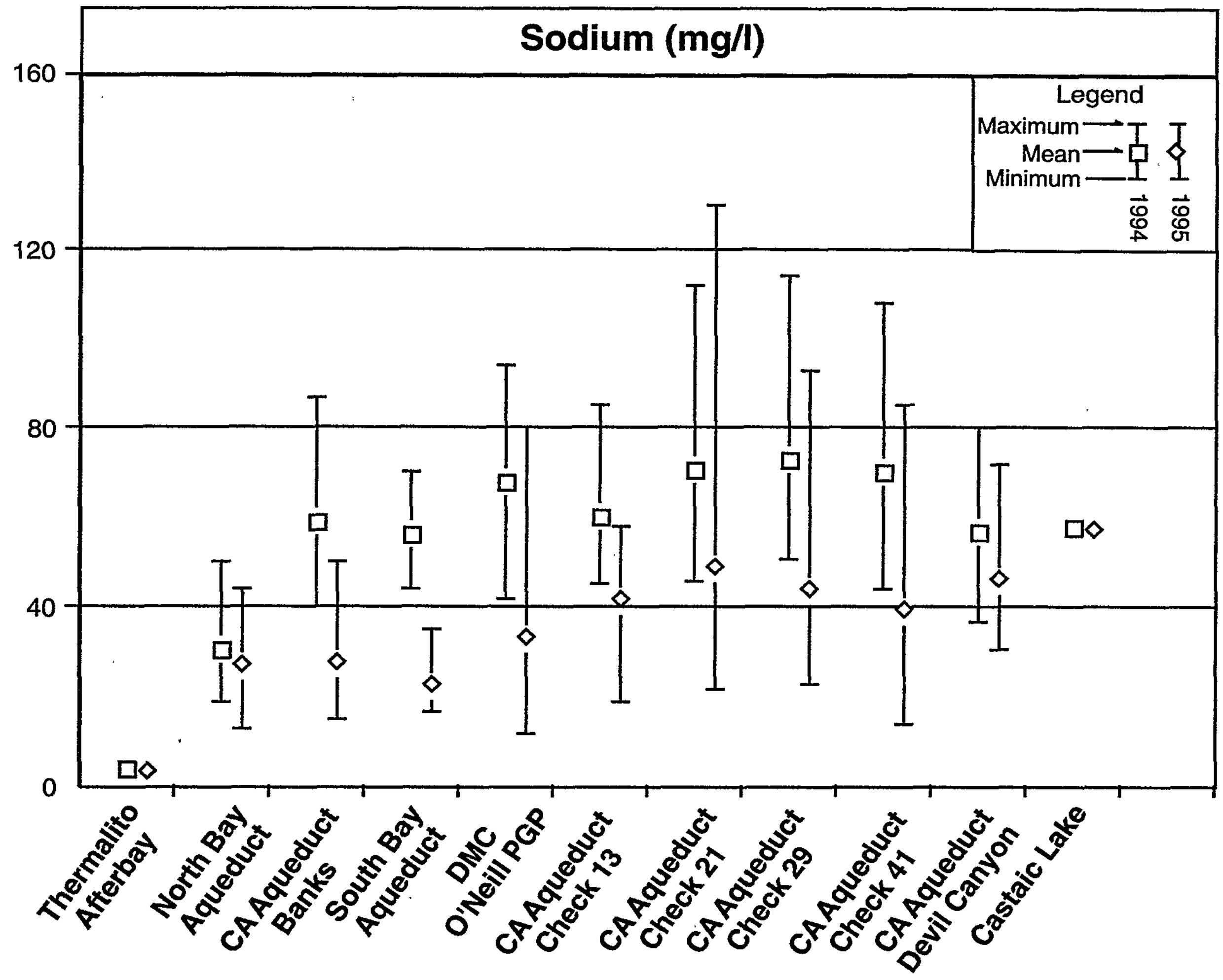
Figure 23
Mean Annual Sodium Concentrations, 1994-1995
Maximum and Minimum Monthly Values Shown



watershed runoff, limnological dynamics within the lake, and the moderating effects of Pyramid Lake, immediately upstream.

Station Comparisons

Sodium generally increased in the California Aqueduct between Banks Pumping Plant and several downstream locations. During 1994, the increase was nominal to slight when sodium averaged 59 mg/l at Banks Pumping Plant and ranged from 60 to 73 mg/l at Checks 21, 29, and 41; an increase of up to 14 mg/l. A more apparent trend was observed during 1995 when sodium increased from an annual average of 27 mg/l at Banks Pumping Plant to between 39 and 49 mg/l at Checks 13, 21, 29, and 41; an increase of as much as 31 mg/l. These increases were due to several possible factors including inflows from the DMC, non-Project inflows from pump-ins and floodwaters, and San Luis Reservoir releases.

Although annual sodium averages were similar between Banks Pumping Plant and Check 13 during 1994, a pronounced difference was observed in 1995 when the average increased from 27 to 41 mg/l between sta-

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E-026732

tions. This trend was not entirely caused by salinity in the DMC, which averaged 33 mg/l for the year. The only other major source that could influence water at Check 13 is releases from San Luis Reservoir.

Sodium in the California Aqueduct also increased between Check 13 and Check 21 where a majority of non-Project inputs are located. During 1994, annual sodium averaged 60 mg/l at Check 13 and 71 mg/l at Check 21; an 11 mg/l increase between stations. A smaller increase was observed in 1995 when sodium averaged 41 mg/l at Check 13 and 48 mg/l at Check 21. These increases corresponded with non-Project inputs from groundwater pump-ins and/or floodwater inflows. Previous studies documented that these highly mineralized inputs can increase SWP sodium in proportion to the discharge/flow ratio in the California Aqueduct.

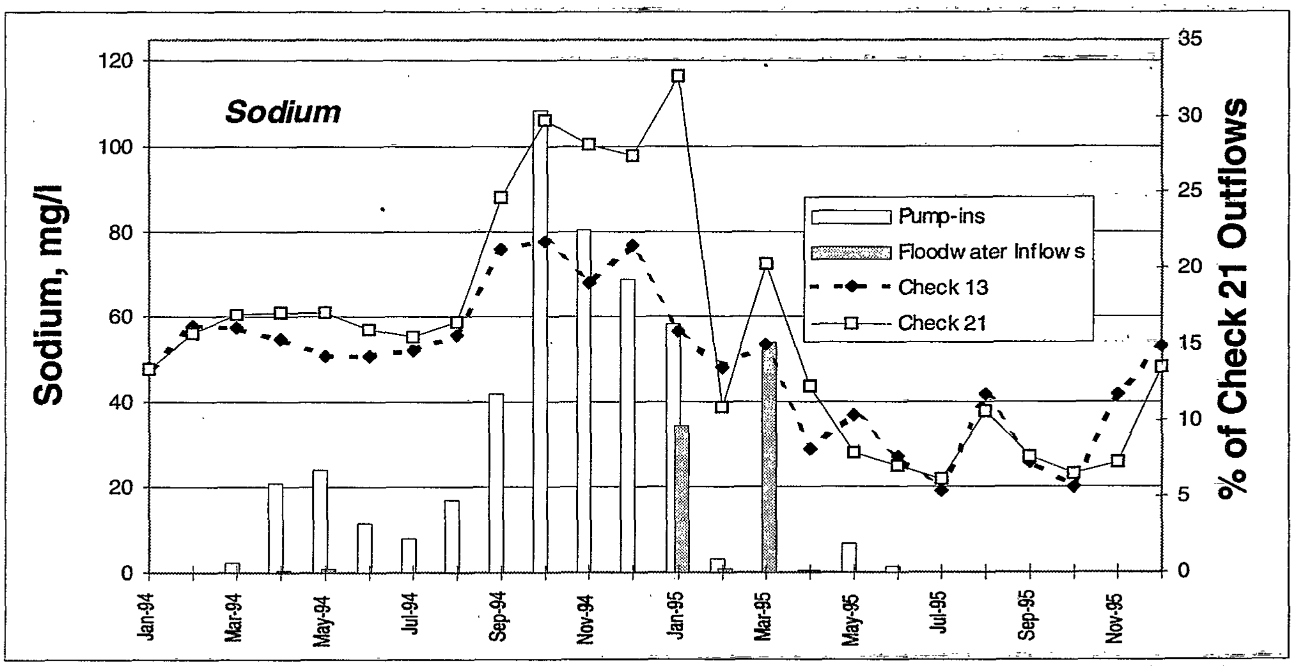
Figure 24 shows monthly sodium at Checks 13 and 21 along with pump-in volumes relative to outflows at Check 21. In September 1994, pump-ins exceeded 10 percent of the California Aqueduct and sodium increased from 76 mg/l at Check 13 to 88 mg/l at Check 21; an increase of 12 mg/l. That differential between stations increased through the rest of 1994 to between 21 to 33 mg/l with pump-in volumes composing 16 to 30 percent of Check 21 outflows. Prior to September 1994, sodium increases were also observed when monthly pump-in volumes accounted for 1 to 7 percent of Check 21 outflows.

The widest differential in monthly sodium levels between Checks 13 and 21 was observed in January 1995, when combined pump-ins and floodwaters comprised 26 percent of the California Aqueduct (Figure 24). Sodium that month was 57 mg/l at Check 13 and 117 mg/l at Check 21; an increase of 60 mg/l. Although pump-ins during the rest of 1995 were minor compared to Check 21 outflows, floodwater inflows amounted to more than 20,000 af in March 1995 and increased monthly sodium between stations by 20 mg/l. In the same month, pump-ins totaled only 4 af.

Comparison to Water Quality Thresholds

During 1994, mean annual sodium percentages were above the Article 19 Objective of 50 percent (percent of total cationic composition) at seven stations. In that year, sodium comprised 51 to 56 percent of the cationic

Figure 24
Sodium in the California Aqueduct at Checks 13 and 21 and Relative Volume of Pump-ins and Floodwater Inflows



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composition at seven stations between Banks Pumping Plant and Devil Canyon Afterbay (Table 8). The following year, sodium made up 50-51 percent of all cations at Check 29 and Devil Canyon Afterbay and its composition ranged from 45 to 49 percent at most other Aqueduct stations including the Delta-Mendota Canal. At Barker Slough Pumping Plant, the mean annual sodium composition was 38 percent both years.

Hardness

Hardness is largely a measure of the combined concentration of calcium and magnesium available to participate in secondary precipitation processes and is reported as milligrams per liter of calcium carbonate.

Seasonal Trends

Similar to specific conductance, hardness at most SWP stations was generally lower in 1995 than 1994 and was largely due to water quality in the Delta (see discussion for specific conductance). During 1994, hardness ranged from 102 mg/l to 131 mg/l at Banks Pumping Plant and averaged 114 mg/l for the year (Figures 25, 26, and 27). At that same station in 1995, values ranged from 40 mg/l to 118 mg/l and averaged 72 mg/l for the year; 42 mg/l lower than the previous average. Although similar annual trends were observed at Barker Slough Pumping Plant, the difference between years was not as great. Hardness there averaged 108 mg/l in 1994 and 95 mg/l in 1995; a difference of 13 mg/l.

Hardness was also generally lower in 1995 than 1994 at other SWP stations. During 1994 for instance, hardness at Check 13 ranged between 102 and 145 mg/l with an annual average of 119 mg/l. During 1995, values there ranged from 46 to 132 mg/l and averaged 97 mg/l for the year; 22 mg/l lower than the previous average. Similarly at Check 21, Check 29, and Check 41, hardness averaged 16 to 28 mg/l lower in 1995 than 1994. With the exception of Check 13, hardness at these stations was influenced by both Delta water quality and pump-ins to the San Luis Canal. Pump-ins contain elevated levels of several salts and can increase hardness in the California Aqueduct below Check 13. During 1994, pump-ins totaled 100,000 af and measurably increased sodium in the California Aqueduct. In 1995, pump-ins totaled 7,500 af and measureably influenced sodium for one month.

The greatest decrease in hardness between years (61mg/l) was observed for the Delta-Mendota Canal. Hardness at Thermalito Afterbay averaged 38 mg/l in 1994 and 30 mg/l in 1995. At Castaic Lake, hardness actually increased from 155 mg/l in 1994 to 182 mg/l in 1995 and was likely due to local watershed runoff that is known to affect lake quality.

Station Comparisons

Hardness generally increased in the California Aqueduct between Banks Pumping Plant and several downstream locations. During 1994, the increase was nominal to slight when hardness averaged 114 mg/l at Banks Pumping Plant and between 118 and 124 mg/l at Checks 13, 21, 29, and 41; an increase of up to 10 mg/l. A greater increase was observed during 1995 when hardness averaged 72 mg/l at Banks Pumping Plant and increased by as much as 28 mg/l at Checks 21, 29, and 41 where the annual averages ranged from 90 to 108 mg/l. These increases were due to several possible factors including inflows from the DMC, non-Project inflows from pump-ins and floodwaters, and San Luis Reservoir releases.

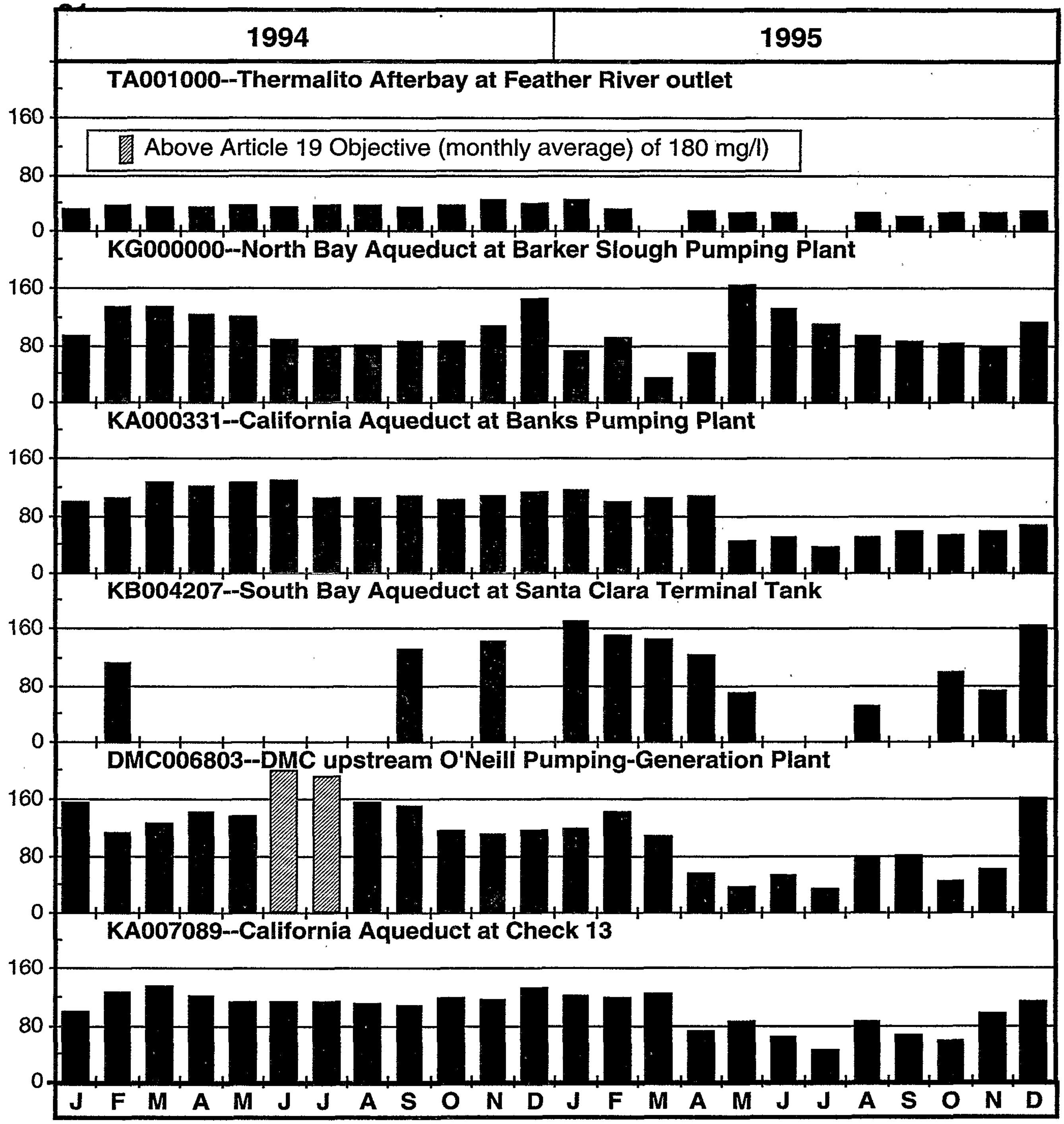
Although annual hardness averages were similar between Banks Pumping Plant and Check 13 during 1994, differences were measureable in 1995 when the annual average increased from 72 to 97 mg/l between stations. This trend was not entirely caused by hardness in the DMC, which averaged 82 mg/l for the year. The only other major source that could influence water at Check 13 is releases from San Luis Reservoir.

During 1994, a nominal increase in hardness was observed between Checks 13 and 21 when annual hardness averaged 118 mg/l at Check 13 and 124 mg/l at Check 21. During 1995, the increase was greater when annual

Figure 25

Hardness (mg/l)

Mean Monthly Values at Stations from Thermalito Afterbay to Check 13



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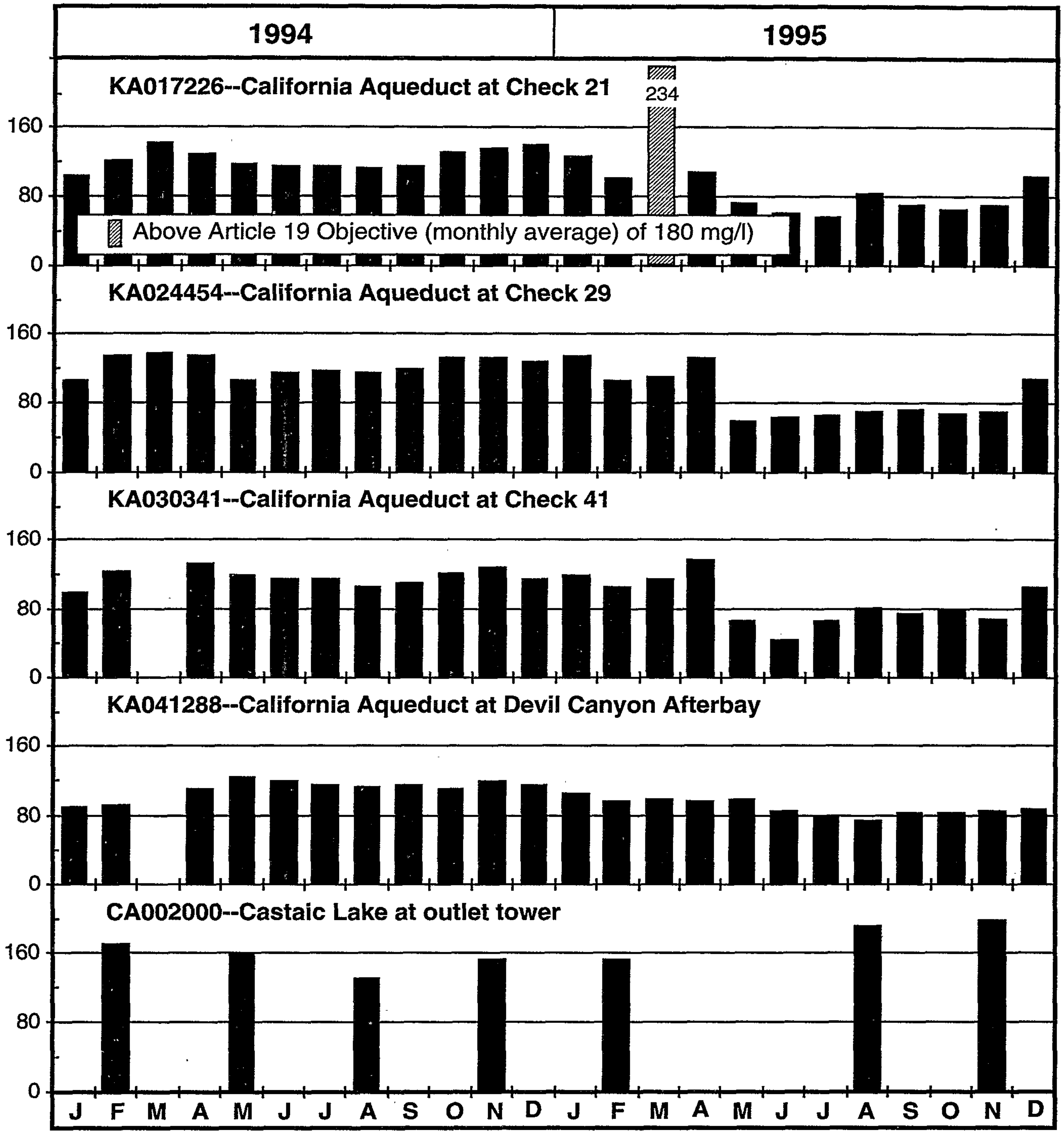
E-026735

Figure 26
Hardness (mg/l)
Mean Monthly Values at Stations from Check 21 to Castaic Lake

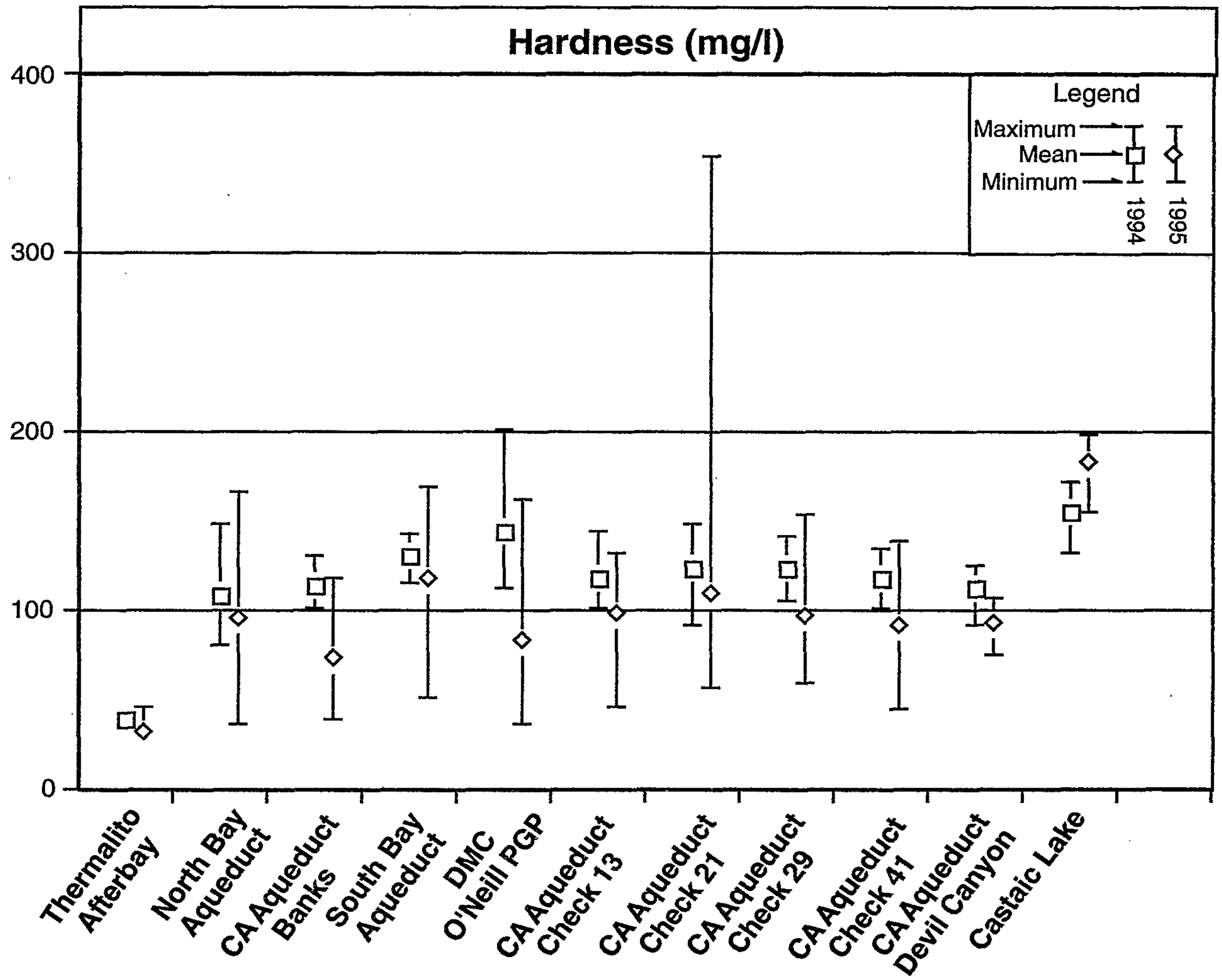


E —0 2 6 7 3 6

E-026736

Figure 27

Mean Annual Hardness, 1994-1995
Maximum and Minimum Monthly Values Shown

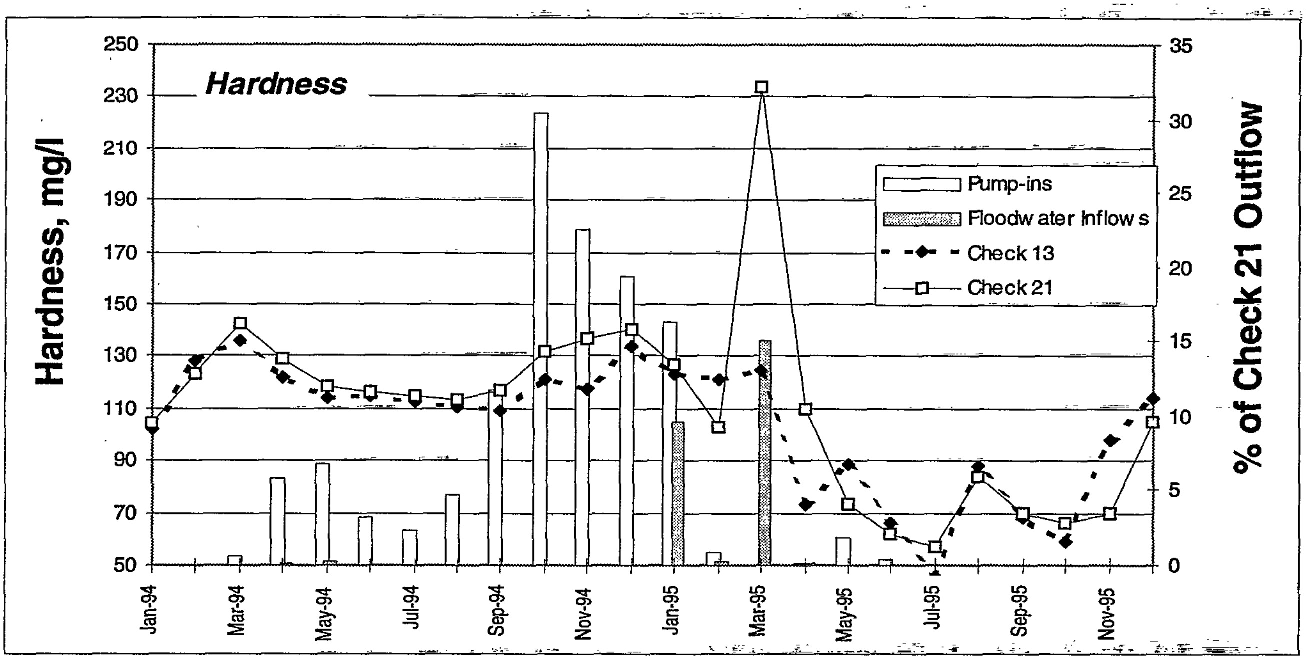


hardness went from 97 mg/l at Check 13 to 108 mg/l at Check 21; an increase of 11 mg/l. This increase between stations during 1995 was largely due to to an elevated sample collected in March 1995, during a period of peak floodwater inflows that increased the annual average at Check 21.

Figure 28 shows monthly hardness at Checks 13 and 21 along with pump-in volumes relative to outflows at Check 21. In September 1994, pump-ins exceeded 10 percent of the California Aqueduct and hardness increased from 110 mg/l at Check 13 to 117 mg/l at Check 21; a difference of 7 mg/l. During the rest of the year, that differential increased to a maximum of 19 mg/l in November 1994 with pump-in volumes composing 23 percent of Check 21 outflows. Prior to September 1994, hardness measurably increased between stations to a lesser degree when pump-ins amounted to 1 to 7 percent of Check 21 outflows.

The widest differential in hardness levels between Checks 13 and 21 was observed in March 1995, when floodwater inflows amounted to more than 20,000 af and increased monthly hardness from 124 mg/l at Check 13 to 234 mg/l at Check 21; an increase of 110 mg/l (Figure 28). In the same month, pump-ins totaled only 4 af.

Figure 28
Hardness in the California Aqueduct at Checks 13 and 21 and Relative Volume of Pump-ins and Floodwater Inflows



Comparison to Water Quality Thresholds

Mean monthly hardness levels exceeded the Article 19 Objective of 180 mg/l three times over the two-year period. In the DMC (not part of the SWP), hardness was 201 mg/l and 192 mg/l, respectively, in June and July, 1994. In March 1995, hardness averaged 234 mg/l at Check 21.

Chloride

Chloride is the major anion in sea water; as such, its concentration in the SWP increases with increased salinity intrusion in the Delta.

Seasonal Trends

Similar to specific conductance, chloride was generally lower in 1995 than 1994, largely due to water quality in the Delta (see discussion for specific conductance). At Banks Pumping Plant, chloride ranged from 59 to 137 mg/l during 1994 with an annual average of 87 mg/l (Figures 29, 30, and 31). At the same station in 1995, chloride ranged from 14 to 63 mg/l with an annual average of 31 mg/l; 56 mg/l lower than the 1994 average. Similar declines were observed in the South Bay Aqueduct and the Delta-Mendota Canal where annual chloride averages were 55 to 57 mg/l lower in 1995 than 1994; a decline of 60 to 71 percent between years. In the California Aqueduct, annual averages declined by 35 to 37 mg/l between years at Checks 13, 21, 29, and 41. The relative decline in annual choride was less at Barker Slough Pumping Plant where chloride averaged 30 mg/l in 1994 and 22 mg/l in 1995; a slight decline of 8 mg/l between years.

The greatest change in average chloride between years (a decline of 57 mg/l) was observed for the Delta Mendota Canal. The only stations with little or no substantial change between years were Thermalito Afterbay, which is influenced by dam releases from Lake Oroville, and Castaic Lake, which is located at the end of

Figure 29

Chloride (mg/l)

Mean Monthly Values at Stations from North Bay Aqueduct to Check 13

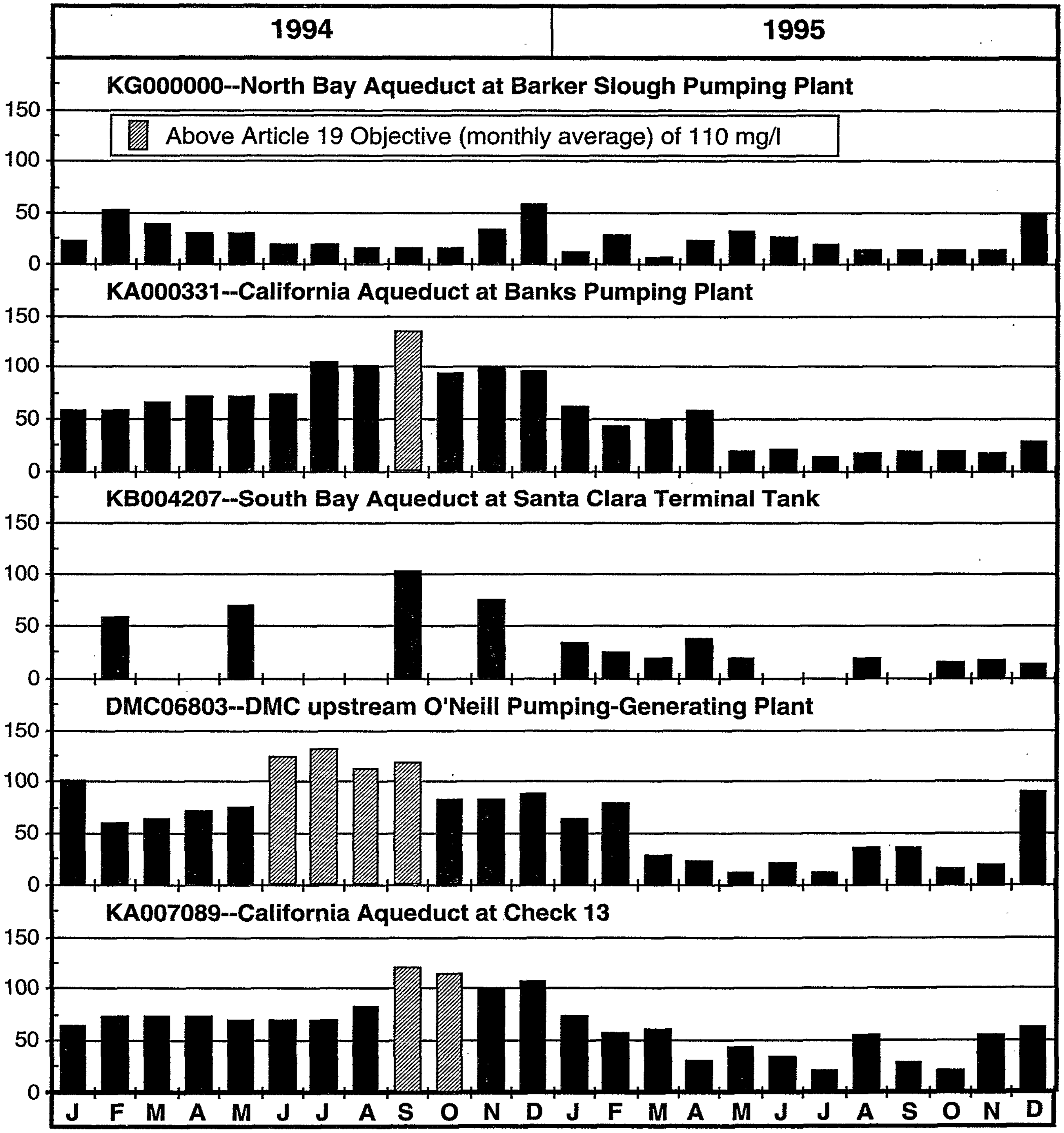


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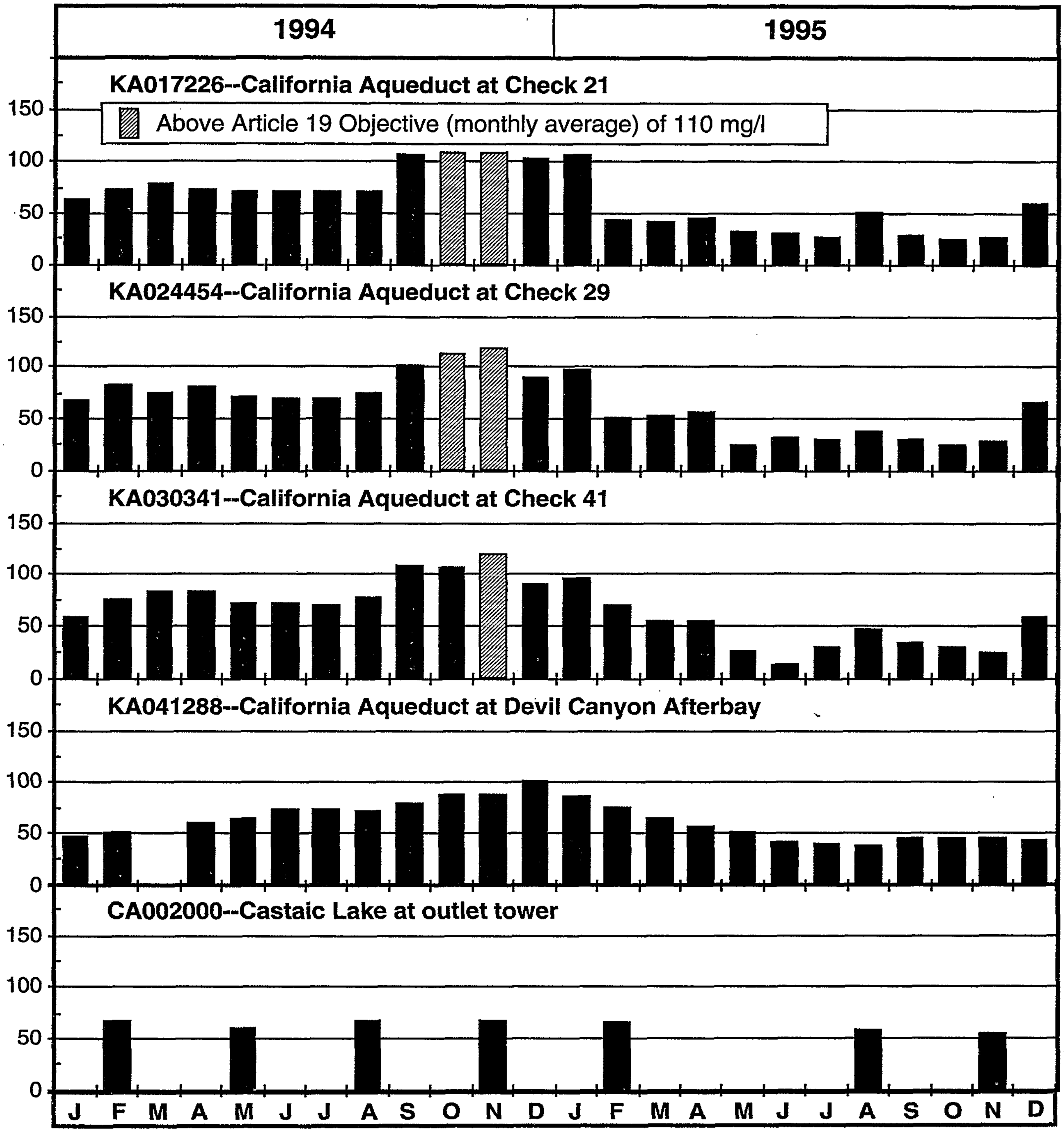
Figure 30

Chloride (mg/l)

Mean Monthly Values at Stations from Check 21 to Castaic Lake



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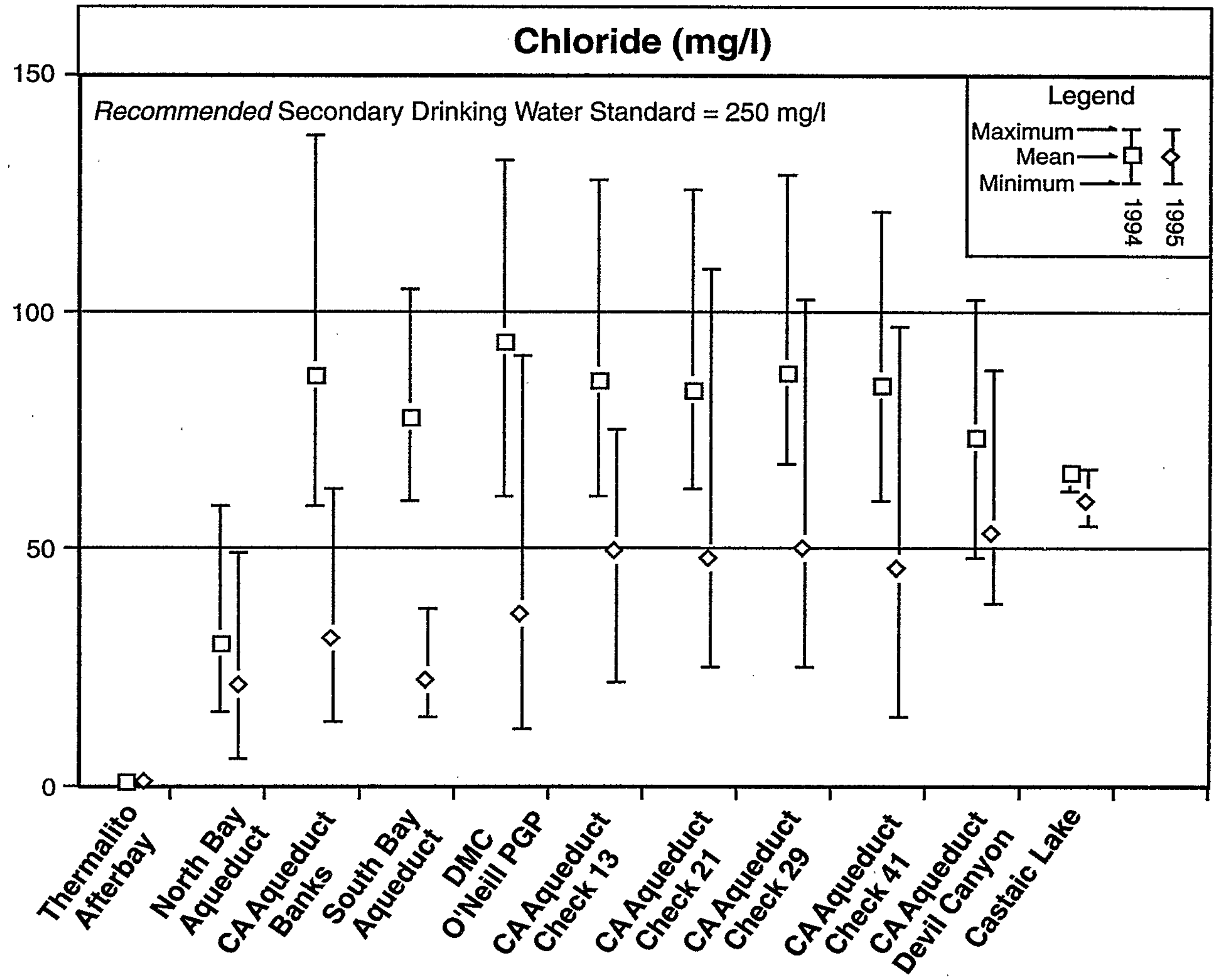
E-026740

Figure 31

Mean Annual Chloride Concentrations, 1994-1995
Maximum and Minimum Monthly Values Shown



the West Branch. Conditions at Castaic Lake may not reflect those observed in the California Aqueduct because water quality in Castaic Lake is also influenced by local watershed runoff, limnological dynamics within the lake, and inflows from the upstream Pyramid Lake.

Station Comparisons

During 1994, annual chloride averages were relatively constant throughout the California Aqueduct and ranged between 83 and 87 mg/l from Banks Pumping Plant to Check 41. Conversely, during 1995, chloride averaged 31 mg/l at Banks Pumping Plant and from 46 to 50 mg/l at Checks 13, 21, 29, and 41; a 14 to 19 mg/l increase in chloride. The greatest station-to-station increase in annual chloride was observed between Banks Pumping Plant and Check 13.

Although annual chloride averages were similar between Banks Pumping Plant and Check 13 during 1994, differences were measureable in 1995 when the annual average increased from 31 to 50 mg/l; an increase of

19 mg/l between stations. This trend was not entirely caused by inflows from the Delta Mendota Canal, which averaged 37 mg/l for the year. The only other major source that could influence water at Check 13 is releases from San Luis Reservoir.

Annual chloride averages at stations in the California Aqueduct between checks 13 and 41were relatively constant and ranged from 84 to 93 mg/l in 1994 and from 45 to 50 mg/l in 1995. Unlike most stations, chloride averages were similar between years at Castaic Lake. During both 1994 and 1995, monthly chloride levels in the California Aqueduct between Checks 13 and 21 did not appear to be consistently affected by either pump-ins or floodwater inflows (Figure 32).

Comparison to Water Quality Thresholds

During 1994, chloride was elevated above the Objective of 110 mg/l on a total of 12 occasions in the CVP's Delta-Mendota Canal and in the California Aqueduct at Banks Pumping Plant and Checks 13, 21, 29, and 41. The elevated levels detected in the California Aqueduct were due to the effects of salinity intrusion in water pumped from the Delta at Banks Pumping Plant. No exceedances were observed in 1995.

Sulfate

Sulfate is a major anion in both fresh and salt waters.

Seasonal Trends

Sulfate was slightly lower in 1995 than 1994 at most SWP stations and was, to a certain extent, due to water quality in the Delta (see discussion for specific conductance). At Banks Pumping Plant, sulfate ranged from 28 to 64 mg/l with an annual average of 44 mg/l (Figures 33, 34, and 35). At the same station during 1995, values ranged from 16 to 54 mg/l with an annual average of 30 mg/l; 14 mg/l lower than the previous year's average. Similar, but less disparate, trends were observed in the North and South bay aqueducts.

Figure 32

Chloride in the California Aqueduct at Checks 13 and 21 and Relative Volume of Pump-ins and Floodwater Inflows

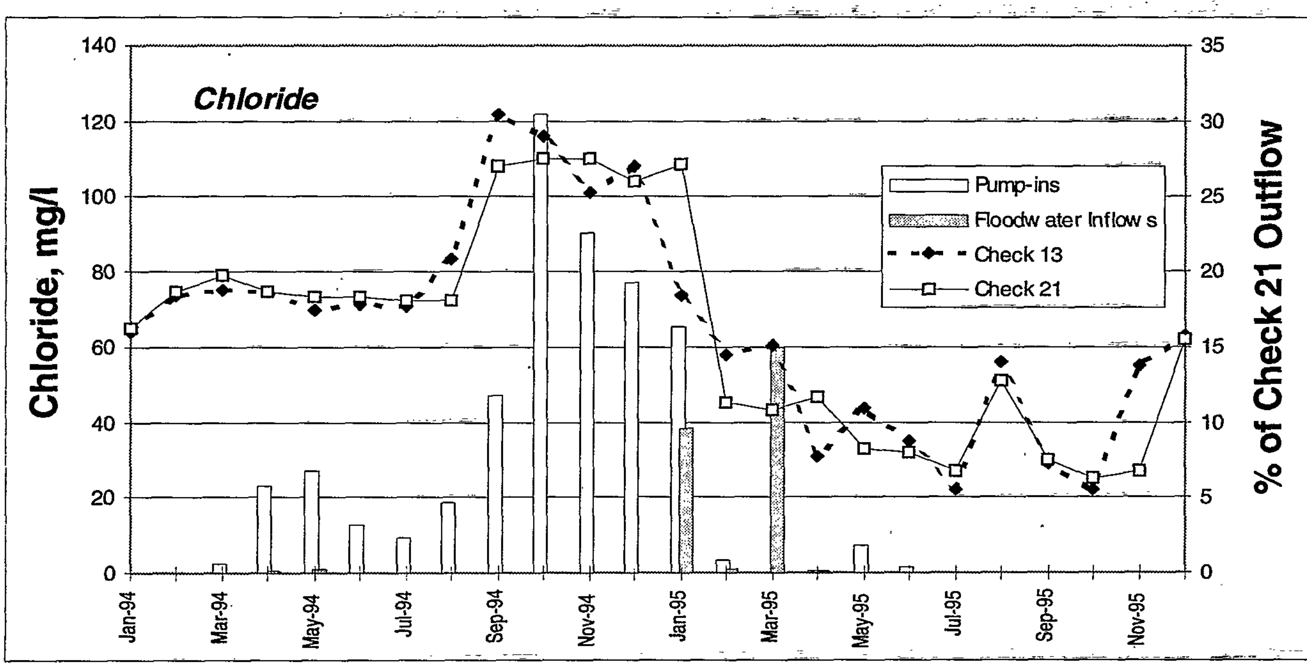


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Figure 33

Sulfate (mg/l)

Mean Monthly Values at Stations from North Bay Aqueduct to Check 13

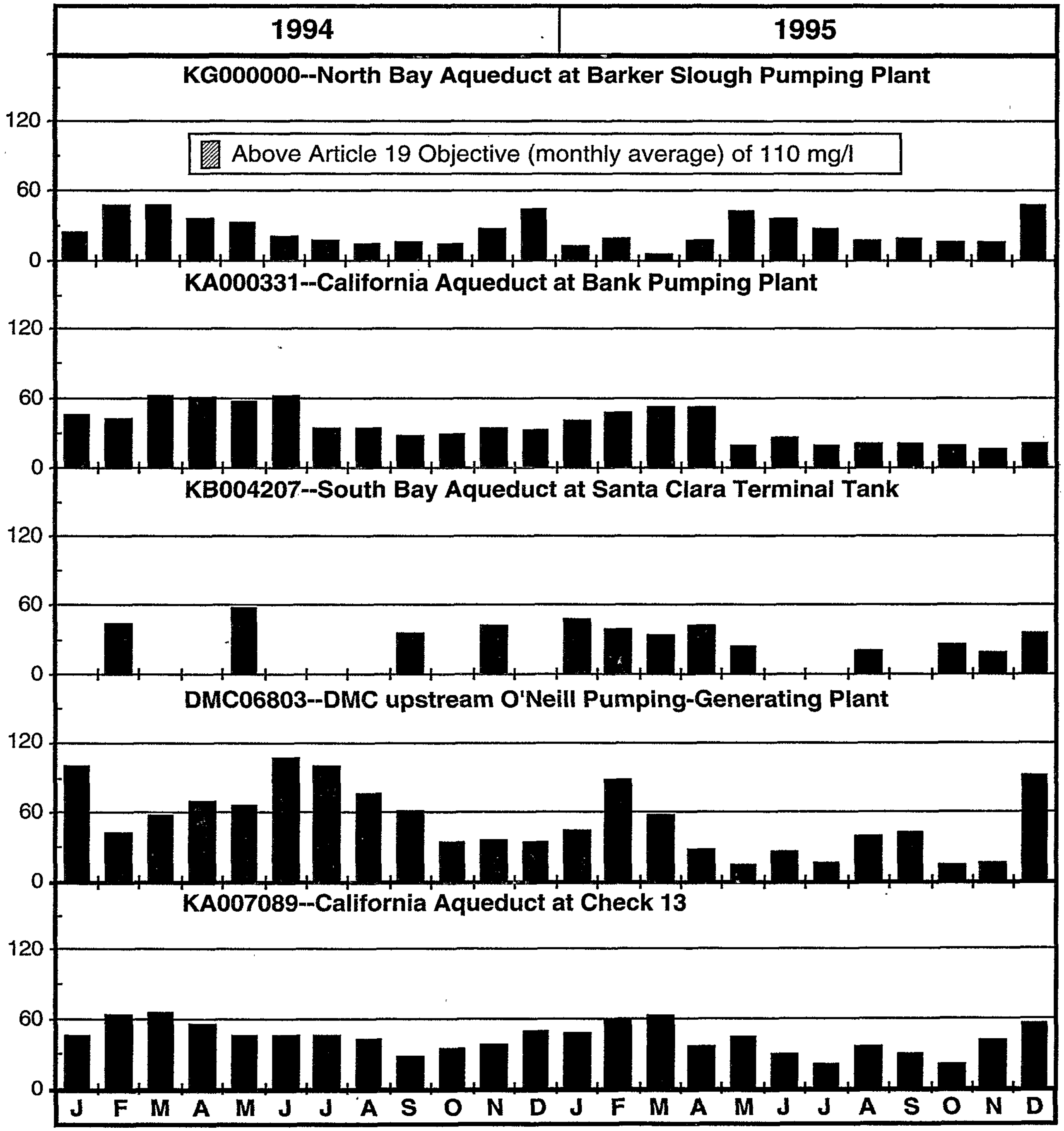

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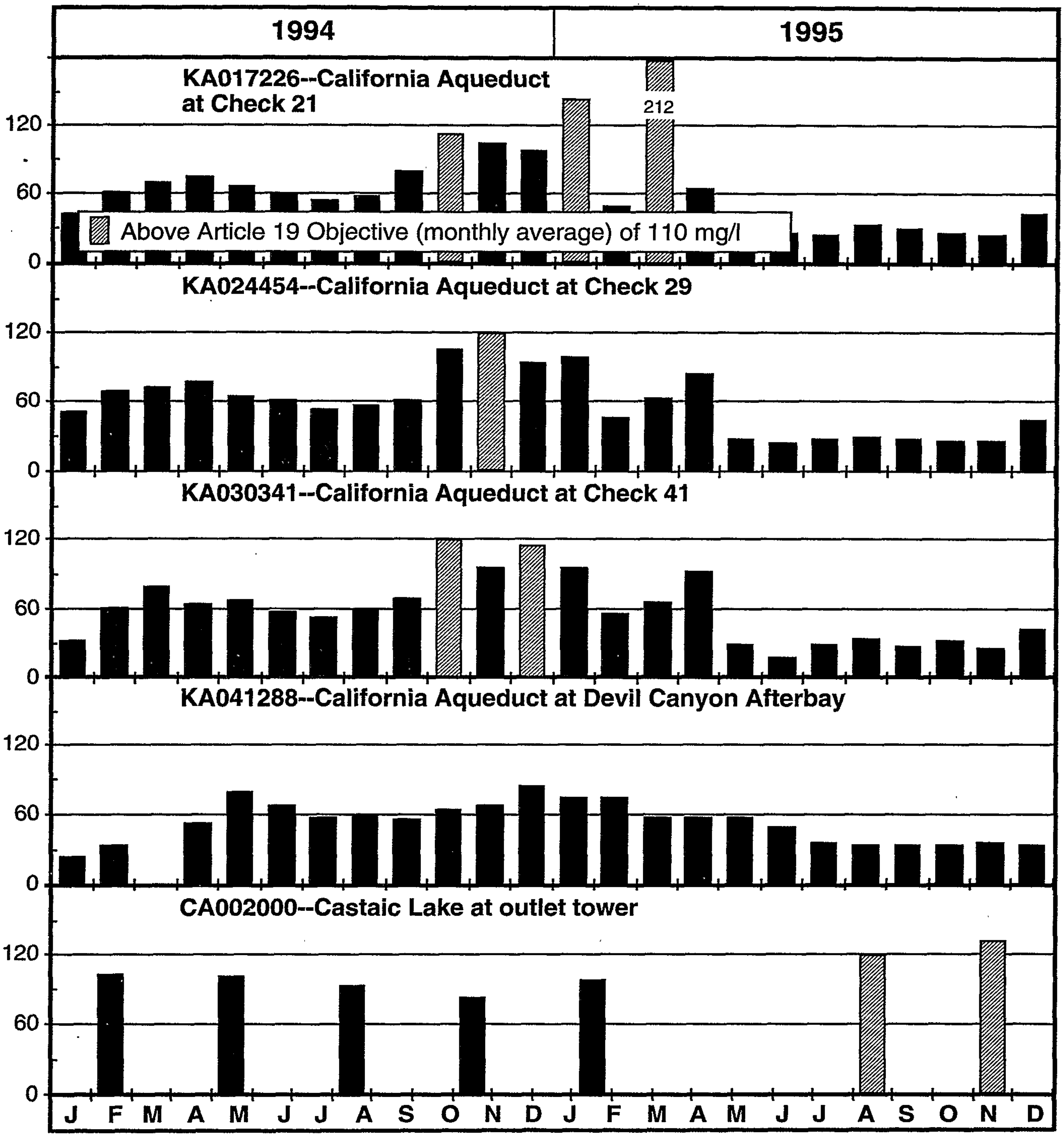
Figure 34

Sulfate (mg/l)

Mean Monthly Values at Stations from Check 21 to Castaic Lake

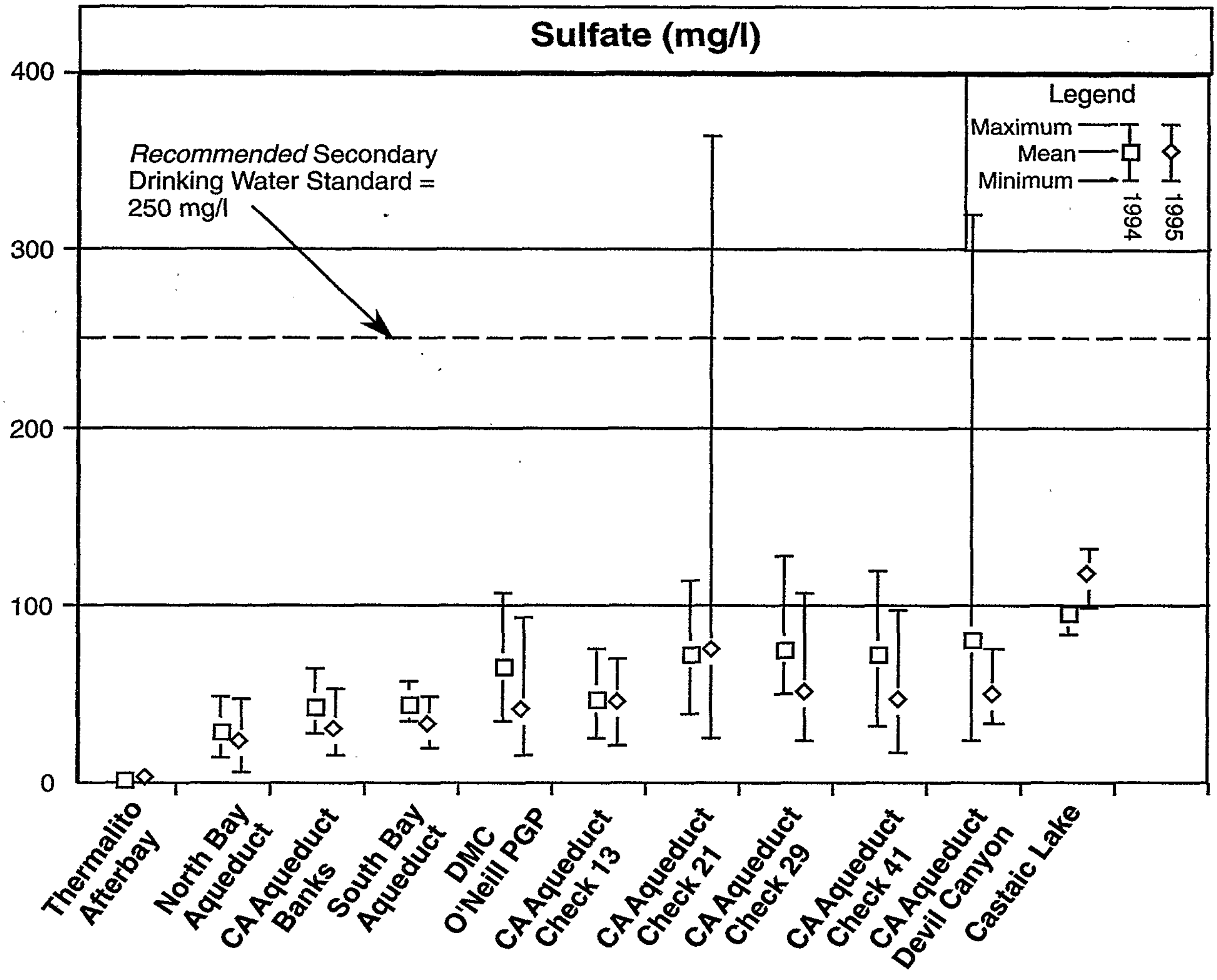


E —0 2 6 7 4 4

E-026744

Figure 35

Mean Annual Sulfate Concentrations, 1994-1995
Maximum and Minimum Monthly Values Shown



Within the California Aqueduct, sulfate averaged 25 to 32 mg/l lower in 1995 than 1994 at Check 29, Check 41, and Devil Canyon Afterbay, as well as in the Delta Mendota Canal. With the exception of the Delta Mendota Canal station, these trends were induced by both Delta water quality and pump-ins to the San Luis Canal. During 1994, pump-ins totaled 100,000 af and measurably increased sulfate in the California Aqueduct downstream from Check 13 throughout most of the year. The next year, pump-ins totaled 7,500 af and measurably increased sulfate in the California Aqueduct for one month. Stations that did not exhibit this same trend included Thermalito Afterbay, Castaic Lake, and Checks 13 and 21 on the California Aqueduct.

In the California Aqueduct at Check 21, annual sulfate trends were affected by both pump-ins and floodwaters discharged to the San Luis Canal. Both inputs contain elevated mineral levels that can measurably increase sulfate concentrations in the California Aqueduct. Floodwater inflows totaled 26,000 af in 1995 versus 600 af during 1994. Conversely, pump-in volumes were higher in 1994 than 1995 (see above paragraph). Therefore, pump-ins were largely responsible for elevated sulfate levels downstream from Check 13 during 1994, as well as the first month of 1995, and floodwater inflows affected water quality in the California Aqueduct primarily during 1995.

At Check 21, the annual sulfate average was similar between 1994 (76 mg/l) and 1995 (74 mg/l). Although pump-ins were much higher in 1994 and would normally have elevated sulfate over the 1995 value, an extremely high sulfate value of 364 mg/l measured in March 1995—the same month when 20,000 af of floodwater inflows were discharged—elevated the annual average such that it approximated the previous year's average.

While sulfate at Checks 29 and 41 increased temporarily from floodwaters, the increase was not as great as that observed at Check 21 and, therefore, the annual average was not as strongly biased (see discussion below in the Station Comparison section). Instead, pump-ins had a greater influence on sulfate levels at these stations. At Check 29, the annual sulfate average was 76 mg/l in 1994 and 51 mg/l in 1995; a difference of 15 mg/l. A similar difference of 17 mg/l was observed at Check 41.

An unusually elevated value of 320 mg/l was recorded at Devil Canyon Afterbay in March 1994. Although monthly sulfate concentrations were already elevated above 1995 levels from the effects of pump-ins, the high value increased the annual average disparity. It is possible that local watershed runoff influenced sulfate levels in the lake for a short period of time. One stream that drains to Silverwood Lake is Cleghorn Creek, which is known to be highly mineralized from ancient marine sediments typical of the area's geology.

Sulfate was relatively similar between years at Check 13 and averaged 44 mg/l in 1994 and 47 mg/l in 1995. This trend was dissimilar to several other parameters such as specific conductance, TDS, and chloride, which decreased in concentration between years at Check 13. It is possible that the annual similarity in sulfate concentrations was due to the moderating effects of San Luis Reservoir and O'Neill Forebay.

Within a reservoir environment, sulfate can participate in precipitation processes and become entrained within lake sediment. Further, the oxidation state of sulfate can be reduced in an anoxic hypolimnium and also become incorporated in the sediment. The reverse occurs under oxidizing conditions and sulfate may actually be released from the sediment. Therefore, depending on environmental conditions and operational procedures of the Joint-Use facilities (San Luis Reservoir, DMC, Check 13), sulfate concentrations may maintain equilibrium in reponse to a variety of physical and chemical mechanisms.

Station Comparisons

Sulfate generally increased in the California Aqueduct between Banks Pumping Plant and several downstream locations. During 1994, sulfate averaged 44 mg/l at Banks Pumping Plant and ranged from 47 to 76 mg/l at Checks 13, 21, 29, and 41; an increase of up to 32 mg/l. A more apparent trend was observed during 1995 when sulfate increased from an annual average of 30 mg/l at Banks Pumping Plant to between 45 and 74 mg/l at Checks 13, 21, 29, and 41; an increase of as much as 44 mg/l. These increases were due to several possible factors including inflows from the DMC, non-Project inflows from pump-ins and floodwaters, and San Luis Reservoir releases.

Although annual sulfate averages were similar between Banks Pumping Plant and Check 13 during 1994, a measureable increase was observed in 1995 when the average increased from 30 to 45 mg/l between stations. This trend was not entirely caused by salinity in the DMC, which averaged 41 mg/l for the year. The only other major source that could influence water at Check 13 is releases from San Luis Reservoir.

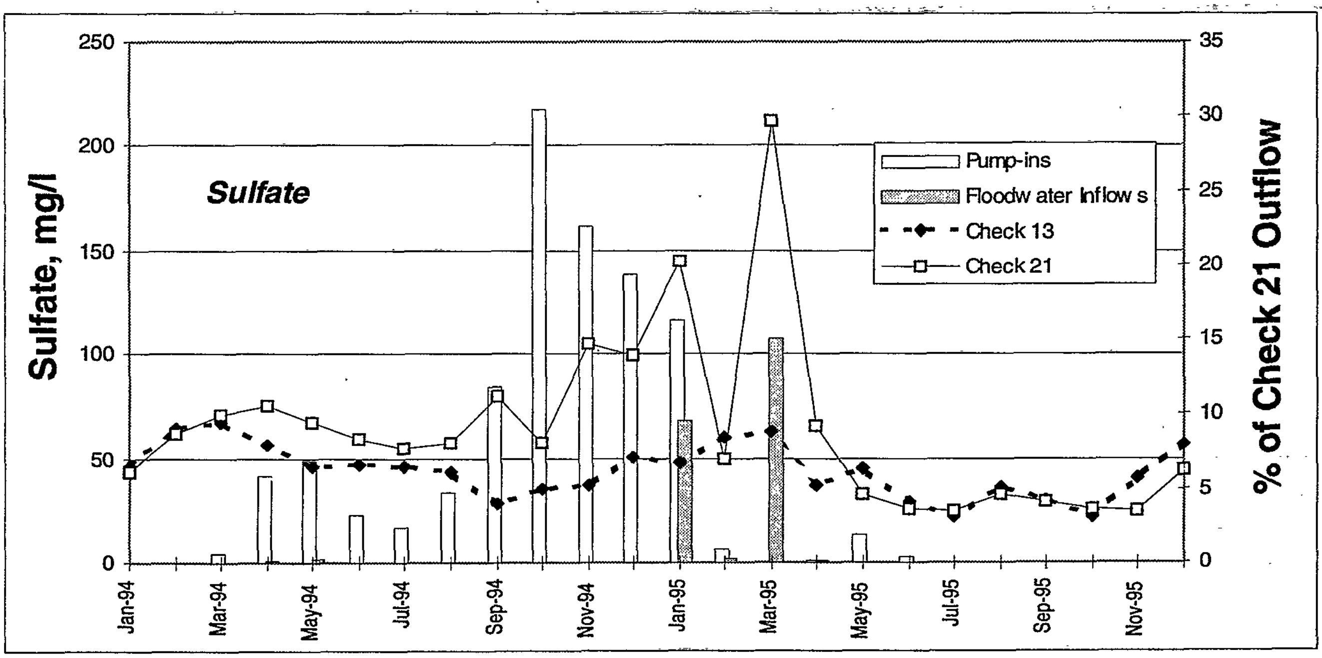
The greatest station-to-station increase in sulfate on the California Aqueduct occurred between Check 13 and Check 21 where several non-Project inputs are located. During 1994, annual sulfate averaged 47 mg/l at Check 13 and 72 mg/l at Check 21; a 25 mg/l increase between stations. A similar increase was observed in 1995 when sulfate averaged 45 mg/l at Check 13 and 74 mg/l at Check 21. Both increases corresponded with non-Project inputs from groundwater pump-ins and/or floodwater inflows. Previous studies documented that these highly mineralized inputs can increase SWP sulfate in proportion to the discharge/flow ratio in the California Aqueduct.

Figure 36 shows monthly sulfate at Checks 13 and 21 and the percentage of pump-in volumes to SLC outflows at Check 21. In September 1994, pump-ins exceeded 10 percent of the SLC and sulfate increased from 28 mg/l at Check 13 to 80 mg/l at Check 21; an increase of 52 mg/l. That differential between stations ranged between 22 and 67 mg/l through the rest of 1994 and corresponded with pump-in compositions of 19-30 percent. Prior to September 1994, sulfate increases were also observed when monthly pump-in volumes accounted for 1 to 7 percent of outflows. During months with no pump-ins, sulfate was similar between Checks 13 and 21.

The second widest differential in sulfate between checks 13 and 21 was observed in January 1995, when pump-ins and floodwaters, together comprised 26 percent of the California Aqueduct (Figure 36). Specific conductance that month was 48 mg/l at Check 13 and 145 mg/l at Check 21; an increase of 97 mg/l. Although pump-ins during the rest of 1995 were minor compared to Check 21 outflows, floodwater inflows amounted to more than 20,000 af in March 1995 and increased monthly sulfate from 63 to 212 mg/l between stations; an increase of 149 mg/l or 237 percent. In the same month, pump-ins totaled only 4 af.

During 1994, sulfate was relatively constant in the California Aqueduct between Check 21 and Devil Canyon Afterbay and averaged from 72 to 81 mg/l. A similar trend was observed in 1995 when sulfate averaged from

Figure 36
Sulfate in the California Aqueduct at Checks 13 and 21 and Relative Volume of Pump-ins and Floodwater Inflows



46 to 50 mg/l at the same stations except Check 21. At Check 21, one sample, collected when floodwaters peaked in March 1995, contained an unusually high sulfate concentration and biased the annual average upward. Downstream from Check 21 at checks 29 and 41, samples were also collected during the period of highest inflow in March 1995. However, floodwater inflows had not migrated far enough downstream to affect these samples and, therefore, sulfate concentrations were not elevated that month. By the time of the next collection date at Check 29 (April 1995), sulfate had been diluted and dispersed to a concentration of 107 mg/l—44 mg/l higher than the March value of 63 mg/l. A similar trend occurred further downstream at Check 41 where the effects of the floodwaters increased sulfate to 93 mg/l in late April—an increase of 27 mg/l from the previous month's concentration of 66 mg/l. The effects of short-term floodwater inflows and monthly sampling frequency resulted in similar trends for specific conductance, TDS, sodium, and hardness during 1995, but to a lesser degree than sulfate.

Comparison to Water Quality Thresholds

Mean monthly sulfate concentrations during 1994 and 1995 were above the Article 19 objective of 110 mg/l on nine occasions at five SWP stations. All elevated levels were observed at stations below Check 13 and included Checks 21 to 41, Devil Canyon Afterbay, and Castaic Lake due largely to floodwater inflows during 1995 and pump-ins during 1994.

Arsenic

Arsenic is a nonmetallic element that can be toxic in small amounts and is considered an impurity in water.

During 1994 and 1995, 287 samples were collected in the SWP and analyzed for arsenic. Mean monthly arsenic levels at all stations ranged from <0.001 mg/l to 0.004 mg/l (Table 9). During 1994, most samples (99 percent) contained arsenic levels of 0.003 mg/l or less. A majority of the samples (52 percent) exhibited an arsenic concentration of 0.002 mg/l followed by 0.003 mg/l with 32 percent. During that year, a maximum of 0.004 mg/l was observed at Check 21 and Devil Canyon Afterbay. During 1995, 75 percent of the samples exhibited a concentration of 0.002 mg/l followed by 0.001 mg/l with 13 percent. A SWP maximum of 0.003 mg/l was observed at Barker Slough Pumping Plant (four times), Check 29 (once), and Check 41 (once).

Comparison to Water Quality Thresholds

The primary MCL and Article 19 objective of 0.050 mg/l for arsenic was not exceeded in any of the 1994 or 1995 samples. The highest arsenic concentration observed in the SWP was 0.004 mg/l from two individual samples in the Aqueduct during 1994 (Table 9).

Selenium

Selenium is a nonmetallic element necessary for life in small amounts that can be toxic at higher concentrations and is considered an undesirable element in drinking water at excess concentrations.

Over 95 percent of the 157 selenium samples collected during 1994 were below the reporting limit of <0.001 mg/l (Table 10). The same year, selenium was 0.001 mg/l at three stations—the Delta-Mendota Canal, Check 29, and Check 41—and was detected once in the DMC at 0.002 mg/l. Of the 130 selenium samples analyzed in 1995, 120 contained selenium below the reporting limit of <0.001 mg/l, eight were at 0.001 mg/l, one was at 0.002 mg/l, and one at 0.005 mg/l.

Comparison to Water Quality Thresholds

The primary MCL of 0.01 mg/l selenium was not exceeded in any of the SWP samples examined. The highest single concentration observed was 0.005 mg/l at Check 21 in 1995.

Table 9

Frequency of Arsenic Concentrations
(Number of Samples are Listed)

	CONCENTRATION, MG/L								
	1994					**1995**			
	Reporting Limit					*Reporting Limit*			
	< 0.001	0.001	0.002	0.003	0.004	< 0.001	0.001	0.002	0.003
STA ID.#									
TA001000	12					10			
KG000000			7	5				8	4
KA000331			9	3			2	10	
KB004207	2		4				2	7	
DMC06803		1	8	3			4	8	
KA007089			17	7			4	13	
KA017226	1		12	11	1		1	17	
KA024454	3		9	10			2	12	1
KA030341	1	1	5	7			2	9	1
KA041288			7	4	1			12	
CA002000			4					3	
Total	19	2	82	50	2	10	17	99	6
% of Total	12.3	1.3	52.9	32.3	1.3	7.6	12.9	75.0	4.5

Total Organic Carbon

Total organic carbon is an estimate of all waterborne organic carbon including the THM precursors, humic and fulvic acids, and is important because it is well correlated with the formation of THMs. Information on TOC and THM covariation can be found in the O&M publications, DWR 1992 and 1995A.

Seasonal Trends

Annual TOC levels were similar between years at all but two SWP stations. At Banks Pumping Plant, TOC ranged from 2.5 to 6.0 mg/l during 1994 and averaged 4.3 for the year (Table 11 and Figure 37). During 1995, TOC at the same station ranged from 2.7 to 8.0 mg/l and averaged 4.2 mg/l for the year, a 0.1 mg/l difference from the previous year's average. Differences between 1994 and 1995 annual averages ranged from 0.1 to 0.6 mg/l at all other stations except Check 21 and Barker Slough Pumping Plant. At Check 21, annual TOC averaged 1.1 mg/l higher in 1995 than 1994 mainly because of a smaller than usual database that mathematically induced a higher 1995 average. At Barker Slough Pumping Plant, TOC averaged 4.5 mg/l during 1994 and 10.1 mg/l during 1995, an increase of 5.6 mg/l between years.

The disparity in annual TOC averages at Barker Slough Pumping Plant was the result of a dramatic rise in concentration between years from 5.3 mg/l in December 1994, to over 21 mg/l the next month. Although

Table 10

Frequency of Selenium Concentrations
(Number of Samples are Listed)

	CONCENTRATION, MG/L						
	1994			**1995**			
	Reporting Limit			*Reporting Limit*			
	< 0.001	**0.001**	**0.002**	**< 0.001**	**0.001**	**0.002**	**0.005**
STA ID.#							
TA001000	12			10			
KG000000	12			12			
KA000331	14			12			
KB004207	6			9			
DMC06803	9	2	1	9	3		
KA007089	24			15	2		
KA017226	25			14	1		1
KA024454	21	1		13	1	1	
KA030341	12	2		11	1		
KA041288	12			12			
CA002000	4			3			
Total	151	5	1	120	8	1	1
% of Total	96.2	3.2	0.6	92.3	6.2	0.8	0.8

elevated levels continued through the first half of 1995, they declined steadily from 18 mg/l in February 1995, to 13 mg/l in April. Concentrations leveled off at around 5 mg/l starting in August 1995. The maximum concentration of 21 mg/l detected in 1995 contrasted with a maximum of 5.5 mg/l the previous year. Higher TOC concentrations in 1995 coincided with a very wet rainy season when 28 inches of rainfall was recorded in a nearby watershed compared to 10 inches the previous year.

Figure 38 shows monthly TOC levels during 1994 and 1995 along with nearby monthly rainfall. In January 1995, rainfall for the month totaled 17 inches, the same month when an elevated TOC level of up to 21 mg/l was recorded. Conversely, rainfall in 1994 totaled 10 inches for the entire year and TOC peaked at 6 mg/l. A preliminary water quality assessment of the North Bay Aqueduct concluded that rainfall runoff to Barker Slough was influencing TOC levels at the pumping plant. During periods of heavy or sustained rainfall, TOC increased along with several other water quality parameters. TOC increases were first observed during the start of each rainy season either when seasonal rainfall totaled approximately 7 inches or when intense rainfall totaled about 1 inch within a three-day period prior to sampling (Draft Staff Report).

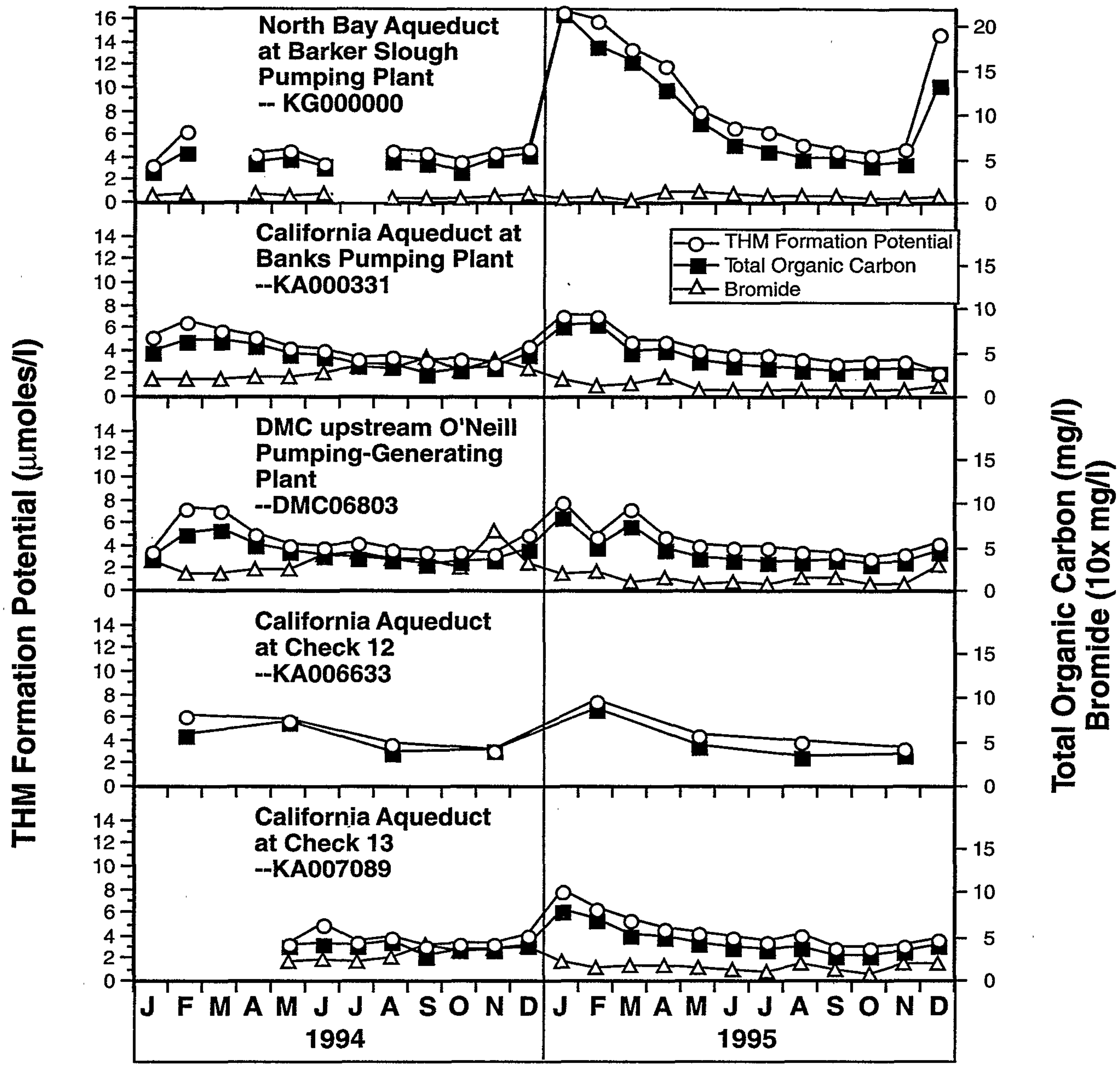
TOC increases during the rainy season were also observed at several stations on the California Aqueduct. During 1994, TOC was highest during February-March at all stations except Check 12 and several southerly stations where peak levels were detected in either August, April, or May, 1994. During 1995, peak levels occurred during either January and February at all stations except Check 66 where the highest monthly

Table 11
TOC and Trihalomethane Formation Potential at SWP Stations

Station	TOC (mg/l)			Trihalomethane Formation Potential (moles/l)	
	Year	Annual Mean	Max	Annual Mean	Max
North Bay Aqueduct at Barker Slough PP	1994	4.5	5.5 Feb	4.29	6.14 Feb
KG000000	1995	10.1	21.3 Jan	9.32	16.67 Jan
Aqueduct at Banks Pumping Plant	1994	4.3	6.0 Feb&Mar	4.19	6.37 Feb
KA000331	1995	4.2	8.0 Feb	4.07	6.97 Jan
DMC upstream O'Neill Pumping-Generating Plant	1994	4.3	6.8 Mar	4.41	7.13 Feb
DMC06803	1995	4.4	8.3 Jan	4.39	7.71 Jan
Aqueduct at Check 12	1994	5.0	7.1 May	4.58	6.04 Feb
KA006633	1995	4.9	8.5 Feb	4.65	7.28 Feb
Aqueduct at Check 13	1994	3.7	4.4 Aug	3.58	4.84 Jun
KA007089	1995	4.3	7.9 Jan	4.29	7.71 Jan
Aqueduct at Check 21	1994	3.7	4.9 Feb	3.66	5.40 Feb
KA017226	1995	4.8	8.6 Feb	4.68	7.64 Feb
Aqueduct at Check 41	1994	4.0	5.8 Mar	3.69	5.70 Mar
KA030341	1995	3.9	7.2 Feb	3.89	5.90 Feb
Aqueduct at Check 66	1994	4.2	4.8 Feb	3.64	4.66 Feb
KA040341	1995	4.0	4.6 Aug	3.55	4.68 Aug
Aqueduct at Devil Canyon Afterbay	1994	3.5	4.4 Apr	3.25	4.26 Apr
KA041288	1995	3.9	5.5 Feb	3.61	4.51 Mar
Lake Castaic at outlet tower	1994	4.4	6.9 Aug	3.31	4.25 Aug
CA002000	1995	3.9	4.4 Feb	3.39	3.54 Aug

Figure 37

Total Organic Carbon, Trihalomethane Formation Potential, and Bromide 1994-1995



E —0 2 6 7 5 2

E-026752

Figure 37 (Continued)

Total Organic Carbon, Trihalomethane Formation Potential, and Bromide 1994-1995

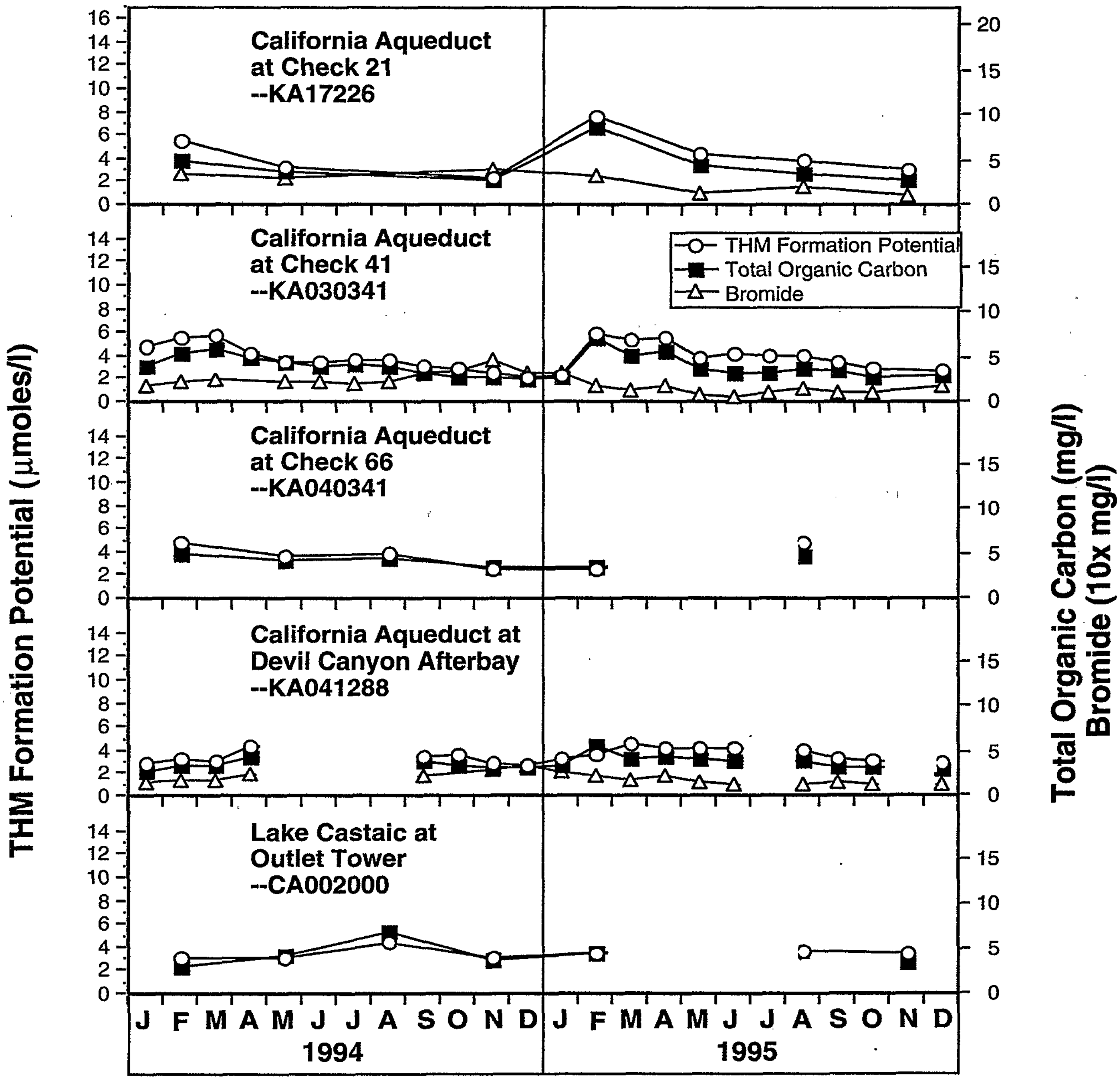


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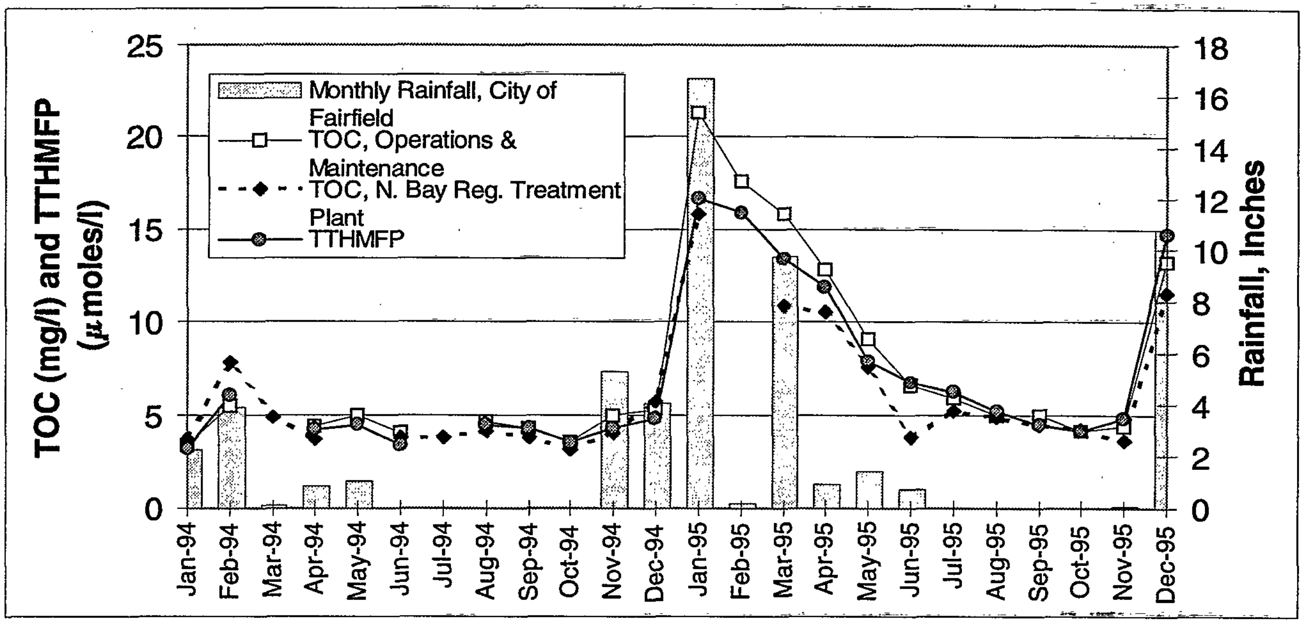
Figure 38
Monthly Average Total Organic Carbon (TOC) and Total Trihalomethane Formation Potential (TTHMFP) in the North Bay Aqueduct and Total Monthly Rainfall at the City of Fairfield



concentration was observed in August. At Banks Pumping Plant, TOC went from 4.7 mg/l in December 1994, to 8 mg/l in January and February 1995 (Figure 37). TOC steadily declined throughout the rest of 1995 at that station from 5 mg/l in March to approximately 3 mg/l between July and the rest of the year. TOC levels were also higher during the start of 1995 at all California Aqueduct stations from Check 12 to Check 41. Peak monthly concentrations during 1995 ranged from 4.4 to 8.6 mg/l at all stations except Barker Slough Pumping Plant and most were detected during either January or February. At Devil Canyon Afterbay, TOC levels were relatively invariable throughout both years and did not increase dramatically during the start of 1995 as was observed at most other stations.

Station Comparisons

During 1994, annual TOC averages were relatively similar throughout the SWP and ranged from 3.5 to 5.0 mg/l. Maximum values that year were just slightly higher, ranging from 4.4 to 7.1 mg/l. Similar annual averages were recorded during 1995 and ranged from 3.9 to 4.9 mg/l at all stations except at Barker Slough Pumping Plant where the annual average was 10 mg/l (see discussion above in Seasonal Trends). During 1995, peak monthly concentrations in the California Aqueduct ranged between 7.3 and 8.6 mg/l from Banks Pumping Plant to Check 41 and between 4.4 and 5.5 mg/l at stations south of Check 41.

Comparison to Water Quality Thresholds

There is no drinking water MCL or Objective for TOC.

Trihalomethane Formation Potential

Trihalomethane formation potential is a measure of the capacity for THMs to form when disinfectants are added during the water treatment process. THMs include chloroform, bromodichloromethane, dibromochloromethane, and bromoform. These compounds can form when naturally occurring organic matter is combined with oxidizing compounds, such as chloramine and chlorine, which are used to make drinking water potable by eliminating microorganisms. Bromide inadvertently enters the Project when seawater from San Francisco Bay mixes with freshwater in the Delta before reaching the Aqueduct. THMs pose a risk to human health and the existing regulatory limit may be made more stringent. THM formation potential is reported in micro-moles per liter (µmoles/l) to avoid confusion between total THM concentration reported in µg/l.

Seasonal Trends

As was observed for TOC, annual THM formation potential averages were similar between 1994 and 1995 at all but three stations. At Banks Pumping Plant, the 1994 annual average of 4.19 µmoles/l was 0.12 µmoles/l higher than the 1995 average of 4.07 (Table 11 and Figure 37). At most other stations, annual average differences ranged from 0.02 to 0.36 µmoles/l. The exceptions were Checks 13 and 21 where smaller sample sizes biased averages that were 0.71 to 1.02 µmoles/l higher in 1995 than 1994. The other exception was at Barker Slough Pumping Plant.

The greatest difference in annual THM formation potential levels was observed for Barker Slough Pumping Plant. At this station, the annual average THM formation potential more than doubled between years from 4.3 µmoles/l in 1994 to 9.3 µmoles/l in 1995; a difference of 5 µmoles/l. Similar to TOC, the dramatic increase was related to higher rainfall during 1995 and subsequent runoff from the upstream Barker Slough watershed (see discussion above for TOC). The similarity in TOC and THMFP trends are expected since both parameters were shown to be well correlated (DWR 1992 and 1995A).

Station Comparisons

During both years, annual THM formation potential averages were relatively similar between stations with the exception of Barker Slough Pumping Plant. During 1994 for instance, annual THM formation potential averaged 4.19 µmoles/l at Banks Pumping Plant compared to 3.64 to 4.58 µmoles/l at other California Aqueduct stations between Checks 12 and 66. A similar trend was observed during 1995.

Comparison to Water Quality Thresholds

There is no drinking water MCL or objective for THM formation potential. The EPA MCL of 100 µg/l is for total THM concentration and is not comparable to THM formation potential data.

Bromide

Bromide is a significant element in sea water with similar chemical behavior to chloride, but is less abundant.

Bromide at most SWP stations was generally higher in 1994 than 1995. Bromide in the SWP ranged from 0.05 mg/l to 0.27 mg/l in 1994 and from 0.05 to 0.16 mg/l in 1996 (Table 12 and Figure 37). At Banks Pumping Plant, for instance, bromide averaged 0.26 mg/l in 1994 and 0.09 mg/l in 1995, a decrease of 0.17 mg/l between years. The lowest mean monthly bromide levels there during 1994 occurred in January-March (0.17-0.18 mg/l) and the highest was observed in September (0.41 mg/l). At the same station the following year, mean monthly bromide levels were lowest between May-November (0.04-0.06 mg/l) and highest in April. Two other general trends were evident with respect to the mean annual bromide concentrations: 1) bromide concentrations were usually lower at Barker Slough Pumping Plant (annual average = 0.05 mg/l during both years) than other SWP stations; and 2) mean annual bromide concentrations were relatively invariable between stations at Check 13, Check 21, and Check 41 (0.26-0.27 mg/l in 1994 and 0.13-0.15 mg/l in 1995).

Table 12
Bromide Concentrations at SWP Stations

		Bromide (mg/l)				
Station	Year	Mean	Min	Max	Std. Dev.	Number
North Bay Aqueduct at Barker Slough Pumping Plant	1994	0.05	0.03	0.08	0.02	12
KG000000	1995	0.05	0.01	0.10	0.03	12
North Bay Aqueduct at Cordelia Pumping Plant	1994	0.06	0.03	0.08	0.02	4
KG002111	1995	0.05	0.04	0.07	0.01	4
Aqueduct at Banks Pumping Plant	1994	0.26	0.17	0.41	0.08	12
KA000331	1995	0.09	0.04	0.20	0.05	12
Aqueduct at Check 13	1994	0.26	0.18	0.38	0.07	12
KA007089	1995	0.13	0.06	0.20	0.04	12
Aqueduct at Check 21	1994	0.26	0.22	0.30	0.03	3
KA017226	1995	0.15	0.08	0.25	0.07	4
Aqueduct at Check 41	1994	0.27	0.18	0.46	0.08	11
KA030341	1995	0.13	0.04	0.32	0.07	12
Aqueduct at Devil Canyon Afterbay	1994	0.22	0.15	0.34	0.06	11
KA041288	1995	0.16	0.11	0.28	0.05	11

Insecticides, Herbicides, and Other Organic Chemicals

Seventeen chemicals were detected overall and six were detected more than once during the two years examined (Table 13). With the exception of volatile organics, all chemicals detected were insecticides or herbicides. The pesticides diuron, simazine, Dacthal, cyanazine, 2,4-D, and diazinon were detected between 8 and 18 times out of 36 sampling runs conducted during the two-year period.

Diuron, a preemergent herbicide, was detected in 16 of 36 samples. During February and May 1994, and March 1995, it was detected at all or most stations monitored. During March 1995, diuron levels ranged

Table 13

Insecticides, Herbicides, and Organic Chemicals *

Concentrations in µg/l

X — below detection		Reporting Limit	MCL	North Bay Aqueduct 94	North Bay Aqueduct 95	Banks Pumping Plant 94	Banks Pumping Plant 95	DMC O'Neill PGP 94	DMC O'Neill PGP 95	Check 21 94	Check 21 95	Check 41 94	Check 41 95	Devil Canyon Afterbay 94	Devil Canyon Afterbay 95	Number Detected	Total Samples
Diuron		0.05	—													16	36
	Feb			0.52		1.33		0.6		1.22		1.97		X			
	Mar				0.79		0.11		4.7		0.28		0.2		X		
	May			0.86		0.25		4.7		0.12		0.09		0.13			
	Jun				X		X		X		X		X		X		
	Sep			X	X	X	X	X	X	X	X	X	X	X	X		
2,4 - D		0.10	70													8	36
	Feb			0.18		X		X		X		X		X			
	Mar				X		0.39		X		X		X		X		
	May			X		X		X		X		X		X			
	Jun				X		0.18		X		X		X		X		
	Sep			X	X	0.7	0.2	0.4	X	X	0.2	X	0.1	X	X		
MCPA		0.10	—													1	36
	Feb			X		X		X		X		X		X			
	Mar				X		0.48		X		X		X		X		
	May			X		X		X		X		X		X			
	Jun				X		X		X		X		X		X		
	Sep			X	X	X	X	X	X	X	X	X	X	X	X		
Cyanazine		—	—													1	36
	Feb			X		X		X		X		X		X			
	Mar				X		X		X		X		X		X		
	May			X		X		X		X		X		X			
	Jun				0.22		X		X		X		X		X		
	Sep			X	X	X	X	X	X	X	X	X	X	X	X		
Simazine		0.02	4													17	36
	Feb			X		0.66		0.16		0.15		X		X			
	Mar				0.12		0.07		0.81		0.07		0.11		X		
	May			0.2		0.2		0.17		0.09		0.11		0.08			
	Jun				0.03		X		X		0.04		X		0.08		
	Sep			X	X	X	X	X	X	X	X	X	X	X	X		
Diazinon		0.01	—													12	36
	Feb			X		X		X		X		X		X			
	Mar				X		X		0.04		0.05		X		X		
	May			0.16		0.18		0.03		0.02		0.09		0.02			
	Jun				0.02		X		X		0.03		0.02		X		
	Sep			X	X	X	X	X	X	0.02	X	X	X	X	X		
DCPA (Dacthal)		0.01	—													18	36
	Feb			X		0.59		0.61		1.09		0.65		0.54			
	Mar				0.04		0.01		0.01		0.07		0.02		X		
	May			X		X		X		X		X		X			
	Jun				X		0.01		0.02		0.01		0.02		0.01		
	Sep			X	X	X	X	X	0.03	X	0.02	X	X	X	0.02		
Chlorpyrifos		0.01	—													4	36
	Feb			X		X		X		X		X		X			
	Mar				0.33		X		X		X		X		X		
	May			X		X		X		X		X		X			
	Jun				X		X		X		X		X		X		
	Sep			X	X	X	X	X	X	0.28	X	X	0.19	X	0.03		
Dimethoate		0.01	—													1	36
	Feb			X		X		X		X		X		X			
	Mar				0.08		X		X		X		X		X		
	May			X		X		X		X		X		X			
	Jun				X		X		X		X		X		X		
	Sep			X	X	X	X	X	X	X	X	X	X	X	X		

Table 13 (continued)

Insecticides, Herbicides, and Organic Chemicals *

Concentrations in µg/l

X — below detection	Reporting Limit	MCL	North Bay Aqueduct 94	North Bay Aqueduct 95	Banks Pumping Plant 94	Banks Pumping Plant 95	DMC O'Neill PGP 94	DMC O'Neill PGP 95	Check 21 94	Check 21 95	Check 41 94	Check 41 95	Devil Canyon Afterbay 94	Devil Canyon Afterbay 95	Number Detected	Total Samples
Benzene	0.50	5													1	36
Feb			X		X		X		X		X		X			
Mar				X		X		X		5.3		X		X		
May			X		X		X		X		X		X			
Jun				X		X		X		X		X		X		
Sep			X	X	X	X	X	X	X	X	X	X	X	X		
Toluene	0.50	1000													1	36
Feb			X		X		X		X		X		X			
Mar				X		X		X		14.4		X		X		
May			X		X		X		X		X		X			
Jun				X		X		X		X		X		X		
Sep			X	X	X	X	X	X	X	X	X	X	X	X		
o-Xylene	0.50	—													1	36
Feb			X		X		X		X		X		X			
Mar				X		X		X		7.7		X		X		
May			X		X		X		X		X		X			
Jun				X		X		X		X		X		X		
Sep			X	X	X	X	X	X	X	X	X	X	X	X		
Napthalene	0.50	—													1	36
Feb			X		X		X		X		X		X			
Mar				X		X		X		1.6		X		X		
May			X		X		X		X		X		X			
Jun				X		X		X		X		X		X		
Sep			X	X	X	X	X	X	X	X	X	X	X	X		
Isopropylbenzene	0.50	—													1	36
Feb			X		X		X		X		X		X			
Mar				X		X		X		0.5		X		X		
May			X		X		X		X		X		X			
Jun				X		X		X		X		X		X		
Sep			X	X	X	X	X	X	X	X	X	X	X	X		
Ethylbenzene	0.50	700													1	36
Feb			X		X		X		X		X		X			
Mar				X		X		X		2.8		X		X		
May			X		X		X		X		X		X			
Jun				X		X		X		X		X		X		
Sep			X	X	X	X	X	X	X	X	X	X	X	X		
n-Butylbenzene	0.50	—													1	36
Feb			X		X		X		X		X		X			
Mar				X		X		X		0.9		X		X		
May			X		X		X		X		X		X			
Jun				X		X		X		X		X		X		
Sep			X	X	X	X	X	X	X	X	X	X	X	X		
1,3,5-Trimethylbenzene	0.50	—													1	36
Feb			X		X		X		X		X		X			
Mar				X		X		X		0.8		X		X		
May			X		X		X		X		X		X			
Jun				X		X		X		X		X		X		
Sep			X	X	X	X	X	X	X	X	X	X	X	X		

* Unknown sulfur containing compound detected on 6/21/1995. The value is 12.5 µg/l.

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between 0.2 and 4.7 µg/l at all stations between the North Bay Aqueduct and Check 41. The single highest concentration of 4.7 µg/l was observed in the Delta-Mendota Canal. During February 1994, diuron was detected at concentrations ranging from 0.52 to 1.97 µg/l at all stations except Devil Canyon Afterbay. Three months later, in May, diuron was again detected (0.09-4.7 µg/l) at all stations monitored and was highest again in the DMC. Diuron was not detected at any station during September 1994, and June and September 1995.

The herbicide 2,4-D was detected above the <0.1 µg/l reporting limit three times in 1994 and five times in 1995. Four detections were observed at Banks Pumping Plant in March, June, and September 1995, and September 1994, and ranged in concentration between 0.18 and 0.7 µg/l. The remaining detections were observed individually at several other stations around the Project.

Simazine was detected in 17 of 36 samples collected during 1994 and 1995. This herbicide is commonly used on corn and orchards to control annual grasses and broadleaf weeds. During May 1994, simazine was detected at all stations at concentrations ranging from 0.09 to 0.2 µg/l. Simazine was observed at three or more stations during February and May 1994, and March and June 1995. No simazine was detected in September of either 1994 or 1995.

Diazinon was detected in 12 of 36 samples collected during 1994 and 1995. This insecticide is usually applied to stone fruit orchards during late winter and early spring to prevent bud predation. Late season storms often flush diazinon from Central Valley orchards and into Delta tributaries. Diazinon was observed at all stations in May 1995, ranging in concentration from 0.02 to 0.18 µg/l. It was also reported at various stations in September 1994, and May and June 1995. No diazinon was detected in February 1994.

The herbicide Dacthal, or DCPA, was the most frequently detected chemical (18 of 36 times). Most detections occurred during March, June, and September 1995. During February 1994, and March 1995, low levels of Dacthal were detected at all stations except North Bay Aqueduct. No Dacthal was detected during either May or September 1994.

The herbicides MCPA and Cyanazine were detected once each at Banks Pumping Plant (0.48 µg/l) and North Bay Aqueduct (0.22 µg/l), respectively. The insecticides dimethoate and chlorpyrphos were detected once (0.08 µg/l) and four times (0.03-0.37 µg/l), respectively.

Several monocyclic aromatic hydrocarbons were detected in the Aqueduct during March 1995. Concentrations ranged from 0.5 µg/l for isopropylbenzene to 14.4 µg/l for toluene. The detections occurred just after an oil pipeline ruptured in Arroyo Pasajero and subsequent floodwater inflows from that watershed (see discussion in Chapter VI). Petroleum hydrocarbons were also detected in Lake Oroville as a result of a train derailment in the North Fork Feather River Canyon. However, in both incidences, levels dissipated to below detection four days after the incident. No other hydrocarbons were detected in either 1994 or 1995.

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VI. Special Investigations

Oil Spill in Arroyo Pasajero

Background

Before noon on Saturday March 11, 1995, a Chevron pipeline ruptured in the Arroyo Pasajero watershed, approximately four miles upstream from the California Aqueduct (Figure 39). The rupture was caused by high velocity floodflows that undercut a pipeline buried beneath the stream channel. The amount of oil released and flushed into the ponding basin was initially estimated at 200 barrels. However, a mass balance estimate of oil remaining in the pipeline before repairs were made showed that 4,400 barrels of oil (180,000 gallons) had been released to Arroyo Pasajero. During the same day, water from the ponding basin began flowing into the SLC from a break in the basin's containment dike (Table 14). Approximately 5,000 acre-feet of ponded water flowed into the SLC before the breach was repaired. Floodwaters from Arroyo Pasajero were also admitted to the Aqueduct through the Gale Avenue drain inlet.

Chevron quickly established a command center to facilitate cleanup. Oil absorbent booms were first deployed at the Arroyo Pasajero evacuation culvert. In the SLC, triple oil containment booms were deployed immediately downstream of Gale Avenue (milepost 158) and further south at Plymouth Avenue (nine miles downstream of Gale Avenue). Water quality samples were collected in the Aqueduct to track hydrocarbon concentrations through time.

Water Quality Monitoring

One day after the pipeline break, DWR Surveillance Unit staff (SLFD) began monitoring the Aqueduct for various petroleum chemicals. Water samples were collected upstream of the breach and as far downstream as

Figure 39
Areal Location of the Containment Dike Breach and Oil Discharge in the Arroyo Pasajero Watershed

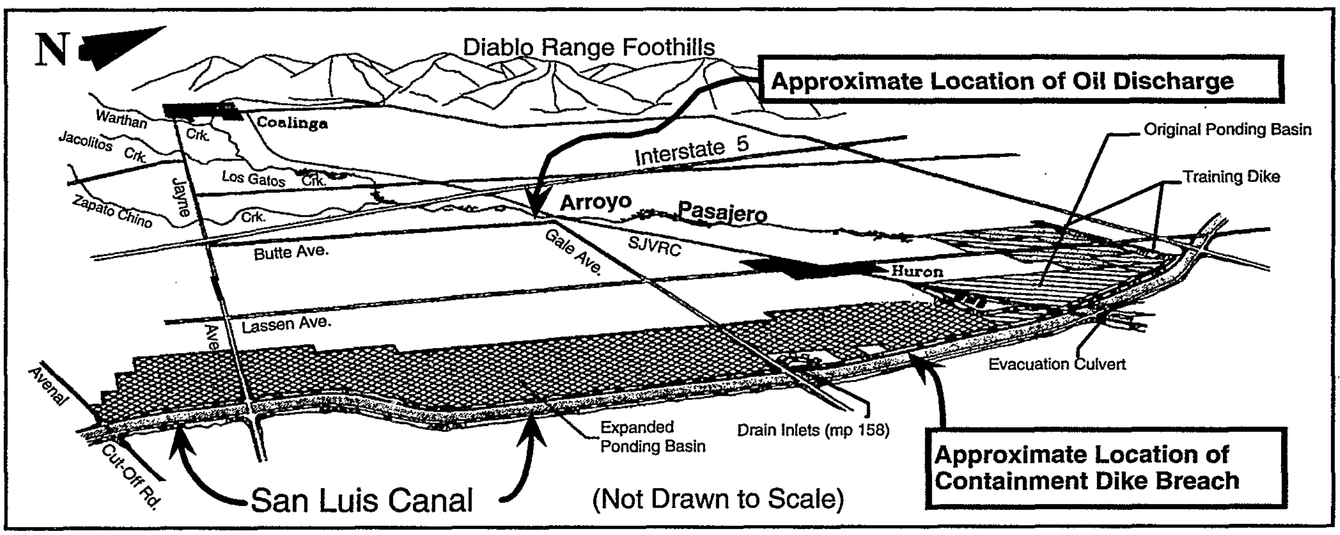

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Table 14
Chronology of Significant Events Surrounding the March 1995 Oil Discharge in Arroyo Pasajero

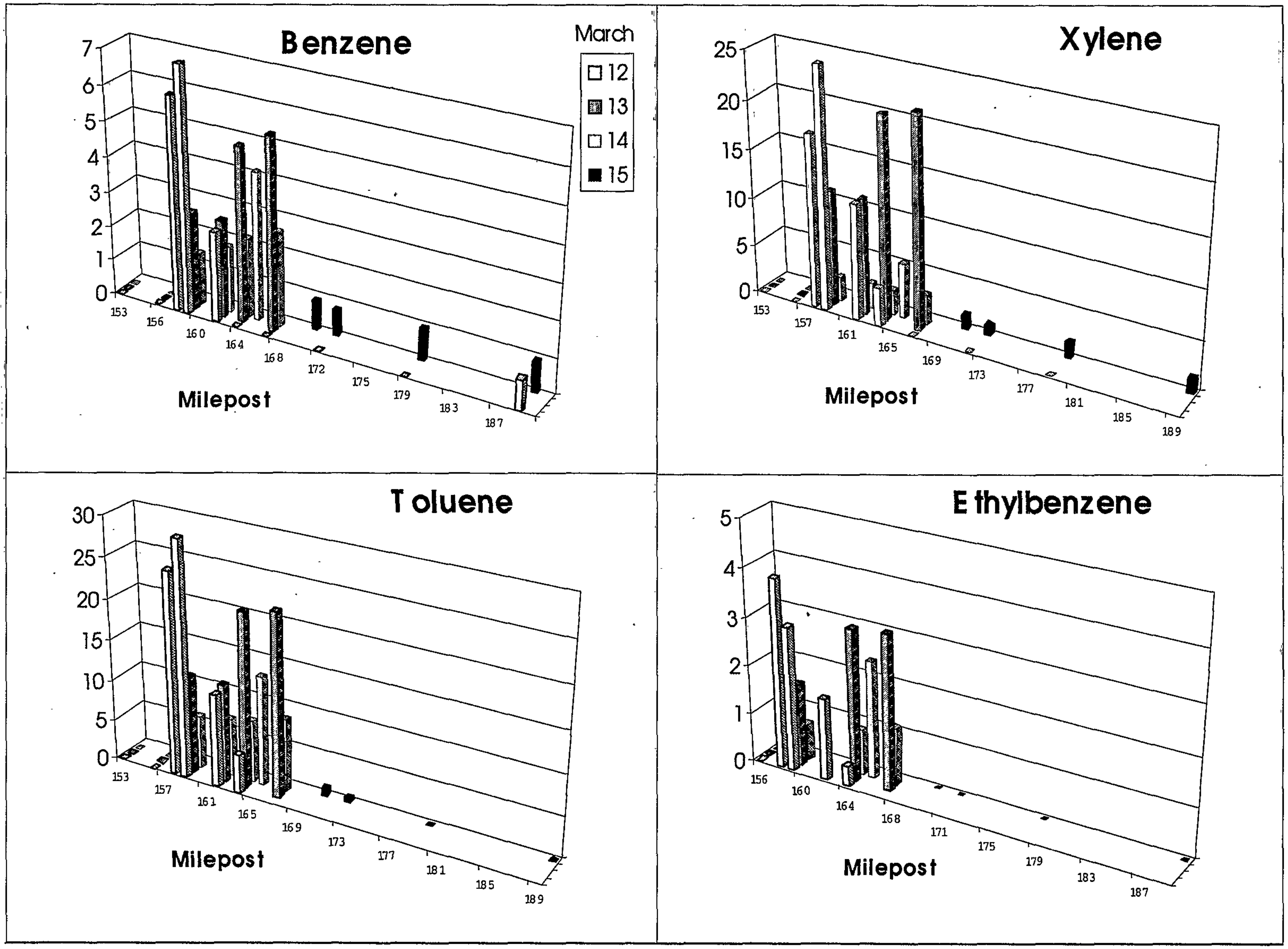
Day/Time	Date	Incident
Friday	**10**	
1306		Floodwaters crest Aqueduct levee at milepost 134.93 (Cantua Creek), causing extensive damage; 8 liner panels are sloughed into the Aqueduct and more are cracked and undercut from erosion at the top of the canal liner.
1200		Water treatment plant for Avenal shut down from a main break and high turbidities (2900 NTU [Sat], 500 NTU [Sun], 45 NTU [Mon]); boil order issued by city and continued through March 20.
Saturday	**11**	
155		Gale Ave drain inlet gates are open and releasing 1,500 cfs; evacuation culvert would not open due to power outage; generator requested.
302		Kern River Intertie gates opened.
500		Gale Ave floodwater inflows increased to 2,975 cfs.
610		Report of 15' x 2' breach impoundment dike at mp 157.42.
700		Evacuation culvert valve opened and releasing 1,000 cfs; flow through breach estimated at 400-500 cfs.
1220		Oil leak from Chevron pipeline reported by CalTrans at Butte and Gale aves. 93-4 miles from Aqueduct culvert; Chevron sets up control and containment command post; oil booms set up first at culvert then the impoundment breach.
2115		Gale Ave gates closed due to oil encroachment but complete closure blocked by 18" log; inflows continue; oil booms placed in the Aqueduct d/s the impoundment area.
2302		Oil observed entering Aqueduct through breach.
Sunday	**12**	
		Kern River Intertie flows decreased.
Monday	**13**	
2100		Repair begins on impoundment breach, which is now 50' x 11'; breach flows=300 cfs; evacuation culvert flows=300 cfs;
Tuesday	**14**	
		Impoundment breach fully repaired; uncontrolled inflows stop; work crews begin to remove oil soaked debris from ponding basin.
510		Kern River Intertie closed.
750		Evacuation culvert closed.
1415		Stop log placed in front of drain inlet gates; inflows continue.
1630		30 yards of rock dumped in front of gates; inflows continue.
1930		Larger rocks dumped in front of gates stop all inflows.

milepost 244.54 during March 12 through 15, 1995. Analyses included total petroleum hydrocarbons and purgeable organics including benzene, toluene, ethylbenzene, and xylene (collectively called BTEXs). Extensive monitoring was also conducted by Chevron at several Aqueduct locations.

Results from Chevron and Bryte laboratories show that BTEXs were detected at relatively low levels except benzene, which was detected above the primary MCL of 5 µg/l on March 12 at Gail Avenue Bridge (milepost 158.5; 6.1 and 7.1 µg/l) and on March 13 at mileposts 164 and 167 (5.5 and 5.4 µg/l, respectively) (Figure 40). TPHs were below the reporting limit of <1 mg/l in the Aqueduct at Check 21 (milepost 172.44) and Check 29 (mp 244.54) on March 14 and at Check 21 on March 15.

Figure 40

Concentrations (in µg/l) of Volatile Organic Chemicals in the San Luis Canal on March 12, 13, 14, and 15, 1995



Although BTEXs are somewhat soluble in water, they are also highly volatile and quickly dissipated in the Aqueduct from dilution and vaporization. Volatilization rates are largely controlled by air temperature, wind speed, and water depth. For instance, the half-life of benzene in a body of water 10 meters deep is calculated to be approximately 9 days at a temperature of 25 degrees C and a wind velocity of 3.4 miles per hour (based on model in Southworth 1979). The actual reduction of benzene in the Aqueduct was much greater. Benzene went from a high of 7.1 µg/l on the first day of sampling (March 12) to 1 µg/l or less on the fourth day of sampling. TPH concentrations in the Aqueduct were all <1 mg/l indicating that other petroleum-related chemicals were not present at detectable levels.

Although crude oil contains a complex mixture of organic compounds, volatile chemicals such as alkanes, cycloalkanes, and BTEXs make up the largest fraction. These compounds comprise approximately 50-95 percent of crude oil followed by resins, asphalts, and sulfur containing compounds (Bailar et al. 1978). Alkanes and cycloalkanes are similar in volatility and solubility to BTEXs and are further dissipated by other routes such as microbial breakdown. Chemicals comprising the heavier fraction of crude oil (e.g., resins, asphalts) are highly insoluble. Most insoluble components adhere to stationary objects such as soil and vegetation as was observed in the ponding basin north of the railroad tracks (Figure 41).

Corrective Actions

Chevron remediated the problems caused by the incident and took further action to prevent another occurence. Oiled surfaces in the basin were limited to the original ponding basin boundaries north of the railroad tracks (Figure 41) and much of the coated soil and vegetation was removed. Sediment in the basin was removed if the oil transferred with a swipe, otherwise it was disked in. Similar remediation criteria applied to live plants and plant debris. Any vegetation coated with oil was removed and disposed of off-site or disked in if there was no smell and did not transfer with a swipe. Floating debris within the Arroyo Pasajero decantation weir was also removed during the initial days of flooding.

A total of $400,000 was paid by Chevron for State response participation, penalties, and habitat restoration to offset the affected areas. Living brush and trees removed during the cleanup were replaced by wild sunflowers, safflower, and cottonwood and willow saplings. Water was purchased for irrigation to ensure that the plantings became established. Impacted seasonal ponding basins were re-excavated to enhance wildlife habitat.

The pipeline that crosses Arroyo Pasajero was realigned to prevent future breaks. The new pipeline was hydrodrilled approximately 75 feet below the ground surface and 35 feet below the streambed. The pipe resurfaces a minimum of 250 feet from the streambank.

Diesel Spill in the Feather River Canyon

At 9 A.M. on Friday, April 14, 1995, a train derailed in the North Fork Feather River canyon, approximately seven miles upstream Lake Oroville (Figure 42). The derailment was caused by a rock slide that sent the lead locomotive over an embankment. The locomotive slid 80 feet downhill and ruptured a fuel tank before coming to rest approximately 200 feet from the river. Diesel from the 5,000 gallon fuel tank spilled into a tributary creek creating a pink plume in the Feather River.

Several agencies responded to the spill. Absorbent material was placed in the diesel discharge to curtail the release. An attempt was made to install an absorbent boom across the Feather River with a kayak, immediately downstream the site, but flows were too high (7,000-8,000 cfs) for successful deployment. An absorbent boom was successfully deployed in the river below the Poe Powerhouse. Absorbent booms

Figure 41
Areas Affected by Crude Oil Spill in Arroyo Pasajero

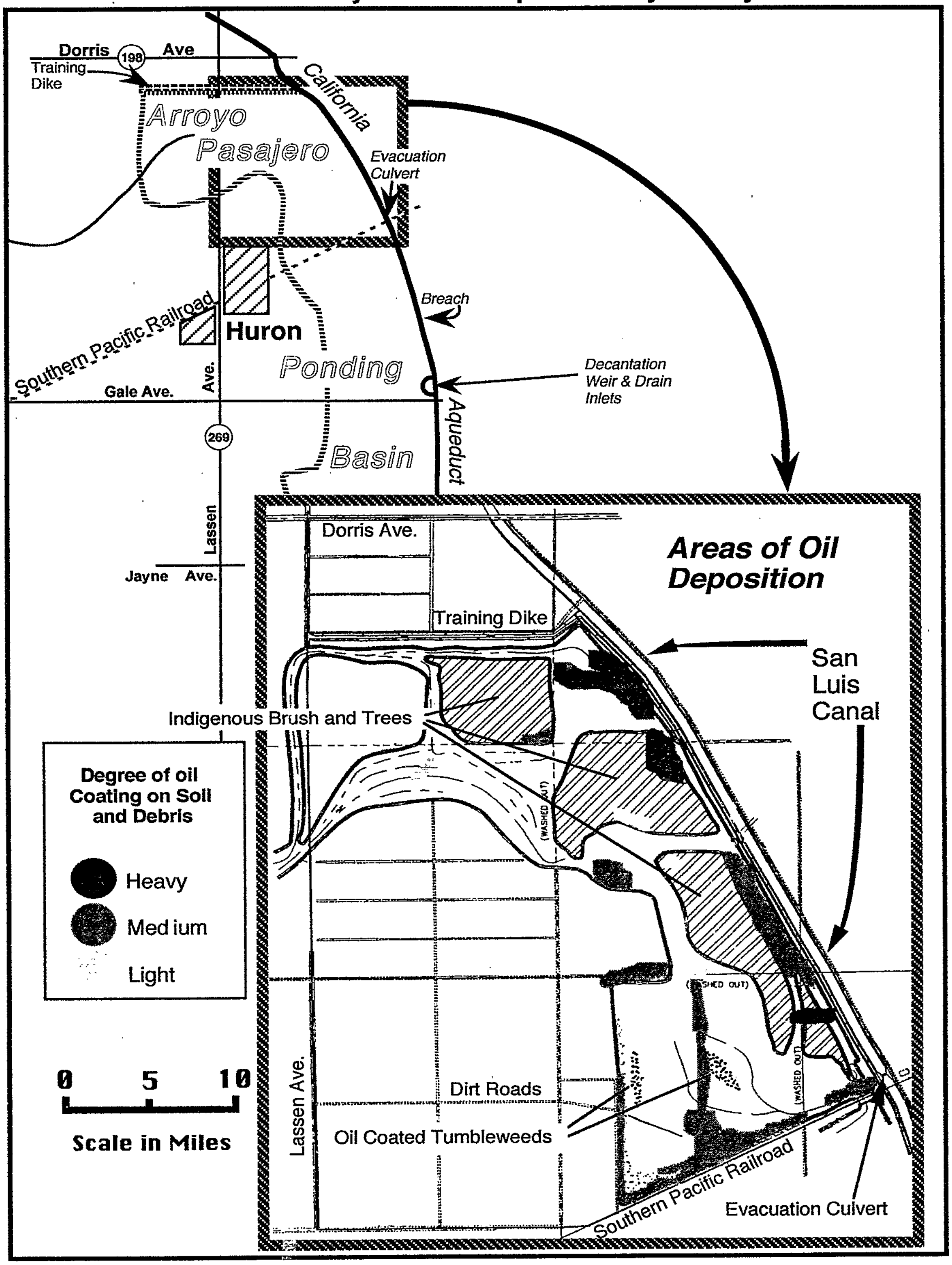


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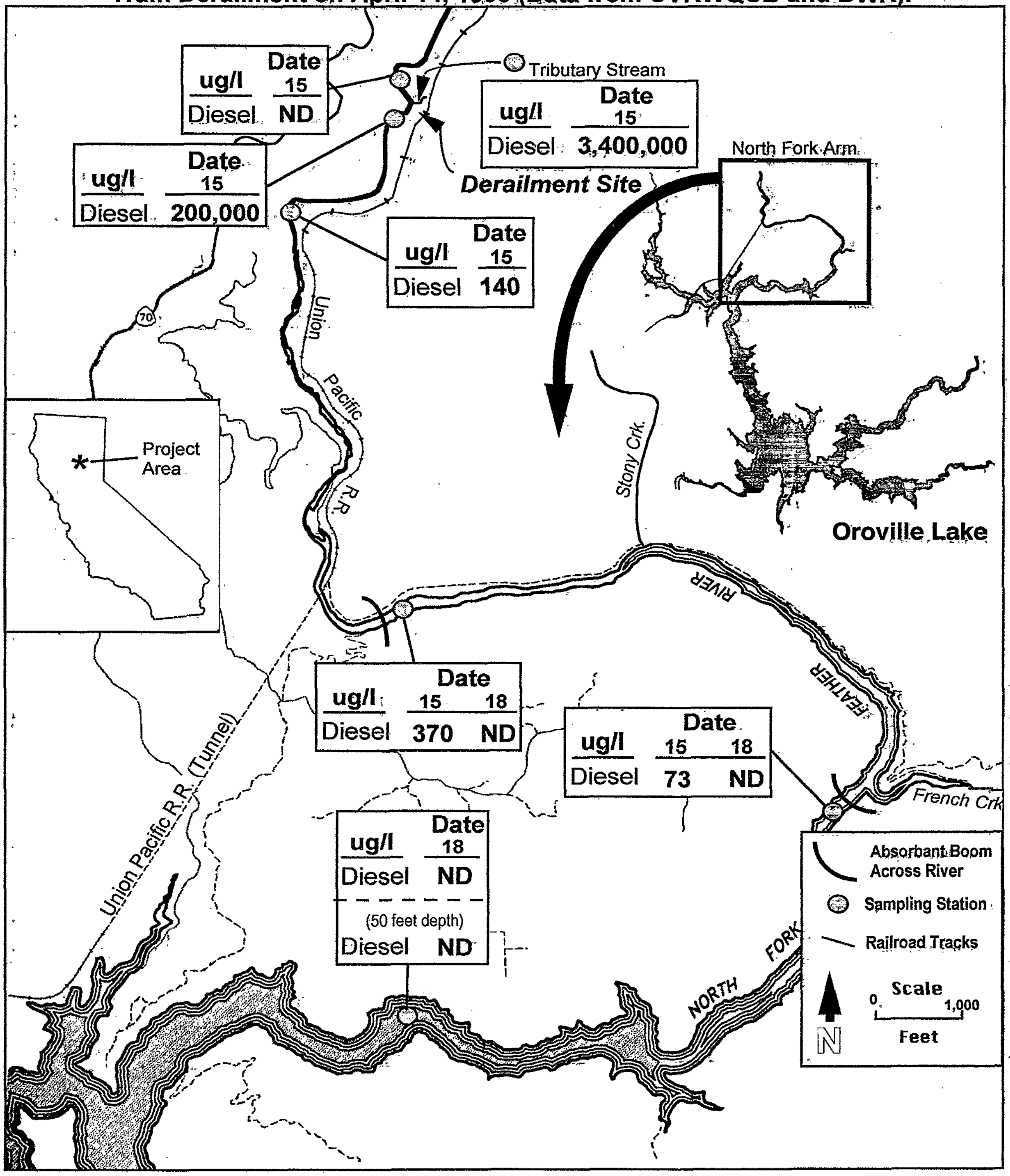
Figure 42
Diesel Fuel Concentrations in the North Fork Feather River and in Lake Oroville from Train Derailment on April 14, 1995 (Data from CVRWQCB and DWR).



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were also deployed in Lake Oroville just upstream Stony Creek at the lake/river confluence and just below the French Creek/Lake confluence (Figure 42).

Water samples were collected the next day by staff from the Central Valley Regional Water Quality Control Board, Redding Office. Diesel was most elevated in the river just below the site with a concentration of 3,400,000 µg/l (Figure 42). The concentration declined with downstream sample location from 200,000 to 140 ug/l. Levels in the lake were 370 µg/l and 73 µg/l at the first and second booms, respectively.

Soon after, on April 18, sampling by O&M staff showed diesel levels in the lake had declined to below detection. At the time of sampling, an iridescent sheen about 700 feet long was observed behind the second boom. At the furthermost sampling station on the Lake, water was collected 50 feet below the surface to determine if colder water from the river had moved under the warmer lake water. Diesel was not detected at any of the stations four days after the spill.

Remediation continued until the incident was officially closed. Absorbent booms in the lake were periodically replaced at the same time floating debris was collected and stockpiled for disposal. The derailment site was flushed and fuel was removed from the rinsate. Catch basins constructed below the site facilitated removal of fuel pushed through the embankment with the flushing operations. These activities continued until fuel levels were such that the site could be closed.

According to the Central Valley Regional Water Quality Control Board, six spill incidents were recorded in the Feather River Canyon between September 1993 and April 1995. The location, cause, and amount of diesel spilled varied between incidents:

Date	Mile	Diesel Release
9/6/93	225	Locomotive struck rock spilling 900 galllons to tracks and water
2/8/93	237.9	Rock derailment of locomotive and spillage of 2,500 gallons to tracks and water
2/5/94	244	Rock detailment of 3 locomotives spilling 4,000 gallons to embankment
4/3/94	305-311.5	Fuel line leakage from tank spilling 1,200 gallons along track
2/2/95	240-256.3	Locomotive struck rock spilling 1,500 gallons to tracks and water

Union Pacific Railroad Company periodically patrols the Feather River tracks in an attempt to discover rock slides before they cause train accidents.

Sediment in the Aqueduct

In 1995, 26,000 af of Diablo Range runoff flowed into the SLC, carrying with it tons of sediment. Composed largely composed of fines—clay and silt-sized particles—the sediment was easily suspended in the Aqueduct. Suspended sediment is a concern because it must be removed during the water treatment process. Greater coagulent dosages are needed to flocculate the suspended particles and the resulting floc quickly clogs filters. This necessitates more frequent backwashing to keep the filters in operation and ultimately increases the cost of sludge handling and disposal.

High suspended sediment levels in raw water can also interfere with the disinfection process. Particulates adhering to the surface of a bacterium's cell shield it from the oxidizing action of disinfecting agents, thereby reducing disinfecting efficiency and increasing chlorine demand. Other effects include the formation of chlorinated organic compounds such as trihalomethanes and haloacetic acids.

Total suspended solids and turbidity are two measures of suspended sediment. *Total suspended solids* is a measure of all material in the sample, such as clays, colloids, and organic compounds reported in mg/l. *Turbidity* is a related measure reported in nephelometric turbidity units (NTU) that quantifies the amount of light scattered by suspended particles. Depending on the source, turbidity can be the most variable water quality parameter measured in raw water and is often the key determinant in estimating appropriate water treatment dosages.

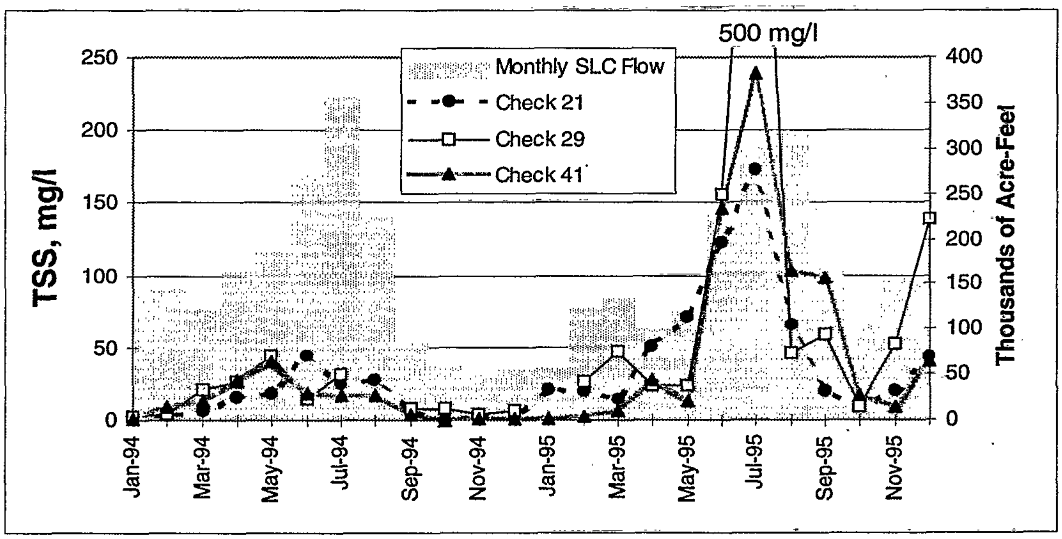
Suspended Sediment Concentrations

Past studies have shown that total suspended solids are very high in floodwater inflows. Two of the larger drain inlets, Salt and Cantua creeks, exhibit median TSS levels between 500 and 800 mg/l, although values as high as 13,000 mg/l have been recorded. This contrasts with median values ranging from 5 to 12 mg/l in the California Aqueduct, which equates to a one-to-five order of magnitude difference in TSS concentration between floodwaters and Aqueduct waters. Sediment in the Aqueduct is transported downstream either suspended in the water column or via bedload movement.

Figure 43 shows monthly suspended sediment concentrations in the California Aqueduct at checks 21, 29, and 41 during 1994 and 1995. Although values increased at Check 21 during and after the period of highest flooding—March and April 1995—the greatest increase was observed from June to August 1995 when monthly flow-volume in the SLC increased above 185,000 af. Similar increases in TSS were observed at checks 29 and 41 during the same months. Peak values were detected in July when monthly flow-volume in the SLC reached 302,000 af and concentrations ranged from 173 mg/l at Check 21 to almost 500 mg/l at Check 29. TSS declined at all stations as flow-volumes receeded to 109,000 af in October 1995. Although similar flow-volumes were sent down the Aqueduct the previous year, TSS never exceeded 50 mg/l.

Figure 43

Monthly Suspended Sediment Concentrations in California Aqueduct at Checks 21, 29, and 41 during 1994 and 1995



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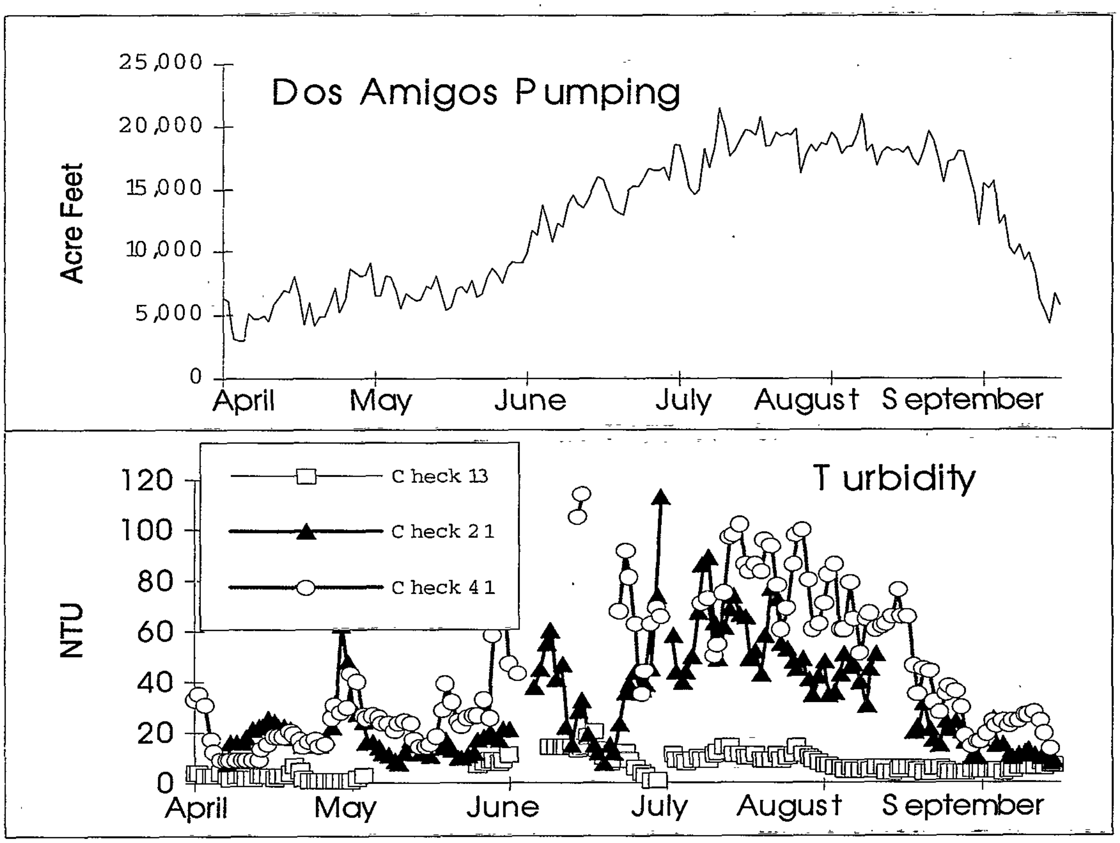
TSS increases from floodwater deposits were confirmed with turbidity measurements above and below the SLC. Figure 44 shows turbidity increased with increased pumping at Dos Amigos Pumping Plant at checks 21and 41 downstream in the SLC, while turbidity remained generally stable regardless of pumping rate upstream at Check 13. Therefore, sediment deposited in the Aqueduct from floodwaters was resuspended later as flows increased through the summer.

Sediment Loading

Past studies have shown sediment loading from floodwaters is significant compared to loading from the Delta. Between 1973 and 1993, floodwater inflows contributed 1 to 78 percent of the total monthly TSS loads compared to Delta inflows at BPP and the DMC (DWR 1995B). Half the monthly percentages were below 5 percent and a majority of the other half were above 20 percent. Although inflows are generally limited to winter months with greater than normal rainfall—approximately 14 of every 100 months—a substantial amount of sediment is discharged to the SLC over a short period of time.

Two methods were used to estimate the amount of sediment deposited in the Aqueduct from 1995 floodwaters. Assuming that the median floodwater inflow TSS value is adequately representative, a volume estimate can be obtained with flows and the strong correlation between TSS and total settleable solids, which is reported in ml/l. Using this method, the volume of sediment discharged during 1995 was estimated to be

Figure 44
Turbidity at Checks 13, 21, and 41 and Dos Amigos Pumping from April to September, 1995



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133,000 cubic yards. Another method using a weight-to-volume conversion developed by USGS (Strand and Pemberton 1982) provided an estimate of 146,000 cubic yards[1]. Regardless of the method used, sediment moving down the Aqueduct mainly settles out in one of the SWP's Southern California lakes, or is removed in delivered water or by dredging.

Physical Characteristics of Sediment in the Aqueduct

A survey was conducted five months after the March 1995 flood flows between August 22 and 25, 1995, to assess the physical characteristics of sediment in the Aqueduct. Sampling was conducted in a 38-mile stretch of the Aqueduct between mileposts 134.5 and 158.5. Sediment was collected at 18 stations with core and dredge-type samplers. The composition of sediment suspended in the water column was determined from 11 water samples collected from both 6 feet below the surface and 3 feet above the Aqueduct invert.

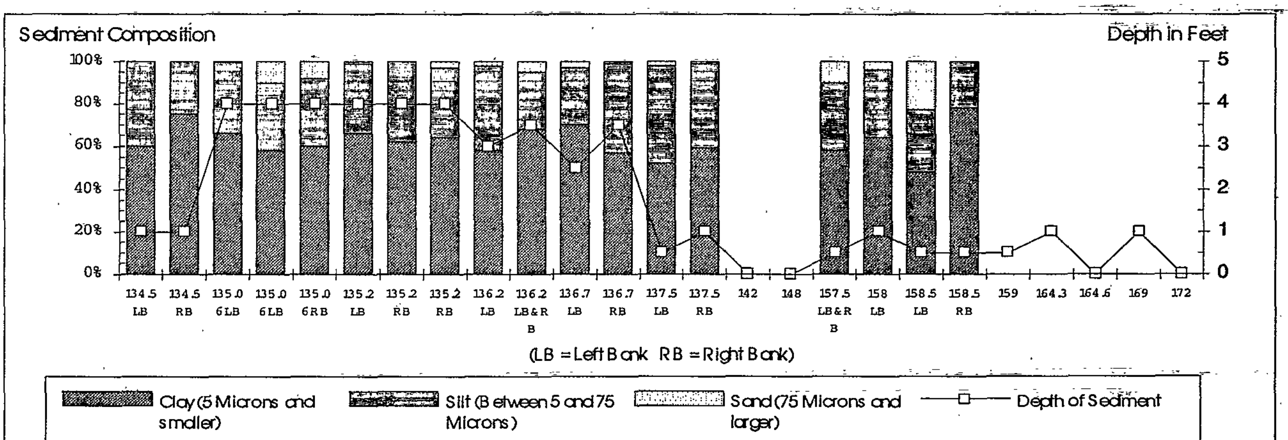
Sieve and hydrometer results show that the bottom sediment was composed primarily of fines, or clay- and silt-sized material. Material less than 5 microns (considered clay-size) accounted for 48 to 78 percent of the samples' composition (Figure 45). Silt-sized material was the second largest component, accounting for 25 to 46 percent of the material. Together, fines comprised more than 95 percent of all sediment composition. Clay-size particulates were the dominant component of suspended solids and comprised between 88 and 97 percent of the material in suspension.

Sediment Removal

Fathometer and hand sounding was conducted in the Aqueduct to determine how much sediment remained more than 6 months after the March 1995 flood flows. Three independent surveys estimated that 28,000 to 33,000 cubic yards were mounded in a 3-mile stretch of the Aqueduct. Subsequent dredging removed roughly 40,000 cubic yards the following year.

Figure 45

Relative Percent Composition of Sediment Deposited by Floodwater Inflows to the San Luis Canal, September 1995



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[1] For this method, loads were calculated from TSS data and pumping at Edmonston for a year and a half after the January flood flows, and then a similar loading estimate for a period of time when TSS was not as affected by floodwater sediment was subtracted from the 1995 value. The load could then be converted to volume by the USGS method and added to the amount of sediment dredged during 1996.

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TABLE A-1. MINERAL ANALYSES AT SELECTED SWP LOCATIONS

STATION NAME / STATION I.D.#	DATE	TIME	LAB pH	LAB EC	CONCENTRATION IN MG/L*, FILTERED: TDS	TOT. ALK. (as CaCO3)	HARD-NESS	Mg	Na	K	SO4	Cl	NO3	Fl	B
THERMALITO AFTERBAY AT FEATHER RIVER OUTLET															
TA001000	1/18/94	945	7.4	88	58	41	32	3	3		1	1	1.1	< 0.1	< 0.1
	2/16/94	910	7.4	84	58	38	39	4	4		3	1	< 0.1	< 0.1	< 0.1
	3/16/94	830	7.3	83	58	38	36	4	4		2	1	< 0.1	< 0.1	< 0.1
	4/20/94	930	7.4	91	62	42	36	4	4		2	2	< 0.1	< 0.1	< 0.1
	5/18/94	840	7.4	90	57	40	39	4	4		2	2	< 0.1	< 0.1	< 0.1
	6/15/94	850	7.5	92	61	42	36	4	5		2	1	< 0.1	< 0.1	< 0.1
	7/20/94	910	7.7	93	64	43	39	4	3		2	1	< 0.1	< 0.1	< 0.1
	8/17/94	915	7.7	96	64	45	39	4	4		3	1	< 0.1	< 0.1	< 0.1
	9/21/94	1015	7.4	97	64	45	36	4	4		3	2	< 0.1	< 0.1	< 0.1
	10/19/94	910	7.7	95	62	44	39	4	4		2	2	0.1	< 0.1	< 0.1
	11/16/94	910	7.5	97	63	44	46	5	4		5	2	< 0.1	< 0.1	< 0.1
	12/21/94	900	7.4	96	51	45	42	4	4		2	1	< 0.1	< 0.1	< 0.1
	1/18/95	1015	7.3	93	60	42	46	5	4		3	2	0.5	< 0.1	< 0.1
	2/15/95	815	7.2	77	52	34	34	4	3		2	2	0.2	< 0.1	< 0.1
	4/19/95	935	7.1	71	54	32	30	3	3		2	< 1	< 0.1	< 0.1	< 0.1
	5/17/95	820	7.0	66	48	31	28	3	2		2	1	< 0.1	< 0.1	< 0.1
	6/27/95	950	7.0	67	48	30	28	3	3		2	1	< 0.1	< 0.1	< 0.1
	8/16/95	950	7.2	68	50	32	28	3	2		1	1	< 0.1	< 0.1	< 0.1
	9/20/95	900	6.9	63	47	29	23	2	2		2	1	< 0.1	< 0.1	< 0.1
	10/18/95	915	7.1	66	44	31	28	3	3		2	1	< 0.1	< 0.1	< 0.1
	11/15/95	915	7.2	70	48	32	28	3	3		2	1	< 0.1	< 0.1	< 0.1
	12/20/95	925	7.0	72	50	31	30	3	3		2	1	0.1	< 0.1	< 0.1
NORTH BAY AQUEDUCT AT BARKER SLOUGH PUMPING PLANT															
KG000000	1/19/94	1420	7.9	308	181	93	96	13	25		25	23	1.5	0.1	0.2
	2/16/94	1400	8.0	493	283	117	137	21	50		49	54	0.9	0.1	0.2
	3/16/94	1455	8.0	475	276	125	135	20	46		49	41	2.4	0.1	0.3
	4/20/94	1230	8.0	407	238	120	124	18	35		36	32	1.4	0.1	0.3
	5/18/94	1315	7.8	390	225	114	122	18	34		33	32	1.8	0.1	0.2
	6/15/94	1230	7.9	284	168	88	91	13	23		21	20	2.0	0.1	0.2
	7/20/94	1300	7.8	254	153	79	80	11	19		18	19	1.9	< 0.1	0.1
	8/17/94	1330	7.8	246	148	79	82	12	19		15	17	1.0	0.1	0.1
	9/21/94	1315	7.7	265	158	91	88	13	21		16	16	0.6	0.1	0.1
	10/19/94	1320	7.9	259	154	88	87	12	20		15	17	0.8	< 0.1	0.1
	11/16/94	1355	7.9	347	198	92	109	16	31		28	35	1.0	< 0.1	0.1
	12/21/94	1400	7.8	494	283	113	148	22	49		45	59	1.9	0.1	0.2
	1/18/95	1410	7.3	231	158	77	74	10	23		13	13	1.1	0.1	0.2
	2/15/95	1400	7.3	334	206	99	92	14	36		20	30	0.4	0.1	0.2
	3/15/95	1405	7.0	126	88	48	36	5	13		6	6	0.7	< 0.1	0.1
	4/19/95	1230	7.6	277	174	79	70	11	30		18	23	0.8	0.1	0.2
	5/17/95	1400	7.9	495	289	163	166	25	41		44	33	< 0.1	0.2	0.4
	6/21/95	1310	7.9	407	242	128	132	20	34		36	28	0.4	0.2	0.4
	7/19/95	1345	7.8	328	196	108	111	16	26		28	19	1.1	0.1	0.2
	8/16/95	1400	7.8	269	160	92	95	14	19		18	14	1.1	0.1	0.2
	9/20/95	1300	7.6	268	160	88	88	13	20		19	15	0.7	0.1	0.2
	10/18/95	1310	7.6	248	140	82	84	12	18		16	14	0.8	0.1	0.1
	11/15/95	1400	7.7	240	137	76	78	11	17		16	14	1.5	< 0.1	0.1
	12/20/95	1345	7.2	438	264	86	114	18	44		48	49	2.9	0.1	0.2
HARVEY O. BANKS PUMPING PLANT															
KA000331	1/19/94	840	7.7	433	252	66	102	12	44		46	60	3.9	< 0.1	0.2
	2/16/94	800	7.7	430	256	70	106	13	40		43	59	4.1	0.1	0.2
	3/16/94	905	7.8	515	305	76	127	15	50		63	66	5.8	< 0.1	0.3
	4/20/94	900	8.0	550	322	90	122	15	58		62	72	4.1	0.1	0.4
	5/18/94	630	7.9	521	297	84	129	16	54		58	72	3.8	0.1	0.3
	6/15/94	700	7.9	556	308	84	131	16	59		64	74	1.6	0.1	0.3
	7/20/94	730	7.8	546	294	66	107	15	65		35	107	1.5	< 0.1	0.2
	8/17/94	740	7.8	528	294	64	105	14	61		34	102	0.8	< 0.1	0.2
	9/21/94	650	7.7	648	351	71	108	17	87		28	137	0.5	0.1	0.1
	10/19/94	810	7.9	519	286	77	103	14	60		29	95	1.5	< 0.1	0.2
	11/16/94	730	7.9	572	308	71	109	15	69		34	101	2.2	< 0.1	0.1
	12/21/94	825	7.6	529	294	70	114	15	60		33	96	4.1	< 0.1	0.2
	1/18/95	830	7.4	451	265	67	118	14	45		42	63	6.8	< 0.1	0.2
	2/15/95	735	7.4	393	236	60	102	12	37		48	45	6.1	< 0.1	0.2

TABLE A-1. MINERAL ANALYSES AT SELECTED SWP LOCATIONS

STATION NAME / STATION I.D.#	DATE	TIME	LAB pH	LAB EC	TDS	TOT. ALK. (as CaCO3)	HARD-NESS	Mg	Na	K	SO4	Cl	NO3	Fl	B
					CONCENTRATION IN MG/L*, FILTERED										
HARVEY O. BANKS PUMPING PLANT (continued)															
KA000331	3/15/95	810	7.6	419	242	64	105	12	43		54	50	5.0	< 0.1	0.3
	4/19/95	740	7.9	463	269	69	109	13	50		54	59	2.8	< 0.1	0.4
	5/22/95	630	7.2	198	114	39	46	5	17		20	19	1.2	< 0.1	0.1
	6/21/95	745	7.2	210	127	34	52	6	20		26	21	1.9	< 0.1	0.1
	7/19/95	745	7.0	162	97	29	39	4	15		20	14	1.4	< 0.1	< 0.1
	8/16/95	625	7.3	199	121	42	52	6	18		21	18	1.3	< 0.1	< 0.1
	9/20/95	650	7.4	222	134	53	59	7	19		21	20	1.0	< 0.1	0.1
	10/18/95	810	7.2	214	122	47	56	7	19		20	20	1.8	< 0.1	0.1
	11/15/95	740	7.4	209	118	51	59	7	18		16	18	2.9	< 0.1	< 0.1
	12/20/95	800	7.5	264	151	55	68	8	26		22	30	2.8	< 0.1	0.2
SOUTH BAY AQUEDUCT AT TERMINAL TANK															
KB004207	2/16/94	1045	7.8	441	259	72	115	14	44		45	60	4.5	< 0.1	0.2
	5/18/94	1000	7.9	521	298	84		16	53		58	70	3.8	0.1	0.3
	9/21/94	930	8	603	325	92	133	19	70		36	105	0.6	0.1	0.2
	11/16/94	1025	8.0	600	302	103	143	19	58		44	77	1.2	< 0.1	0.2
	1/18/95	1100	7.9	451	260	121	170	20	33		49	35	1.6	0.1	0.2
	2/15/95	1015	7.9	392	228	117	152	18	25		39	26	1.9	0.1	0.2
	3/15/95	1015	8.1	365	210	120	147	18	20		35	19	1.3	0.1	0.2
	4/19/95	930	8.0	408	239	95	124	15	35		43	38	2.2	0.1	0.3
	5/17/95	1015	7.7	247	146	64	70	8	18		24	19	1.4	< 0.1	0.2
	8/16/95	945	8.1	200	118	42	52	6	17		21	19	1.9	< 0.1	< 0.1
	10/17/95	930	7.8	286	160	87	100	12	17		27	17	1.1	< 0.1	0.1
	11/15/95	1015	7.7	247	136	65	74	9	18		20	18	2.1	< 0.1	0.1
	12/20/95	1035	8.1	385	225	138	167	20	18		36	15	0.5	0.1	0.2
O'NEILL P&G PLANT. DMC AT MCCABE ROAD BRIDGE. MI 68.03															
DMC06803	1/19/94	830	7.9	729	426	91	159	18	82		101	103	6.7	0.1	0.4
	2/16/94	810	7.8	425	250	73	113	14	42		44	61	4.3	< 0.1	0.2
	3/16/94	820	7.9	502	298	77	129	15	48		59	65	5.6	< 0.1	0.2
	4/20/94	635	8.0	584	338	90	143	17	58		72	72	5.2	0.1	0.3
	5/18/94	545	7.9	573	324	86	140	17	58		67	77	5.1	0.1	0.3
	6/15/94	630	8.1	833	487	109	201	24	88		107	125	5.7	0.1	0.5
	7/20/94	600	8.0	848	488	101	192	23	94		101	132	5.1	0.1	0.5
	8/17/94	650	7.9	713	409	92	158	19	79		77	114	3.8	0.1	0.4
	9/21/94	640	7.9	726	416	97	152	21	89		62	120	3.4	0.1	0.3
	10/19/94	730	7.9	523	290	82	117	15	59		36	83	2.3	< 0.1	0.2
	11/16/94	815	7.8	544	296	74	112	15	62		37	84	2.6	< 0.1	0.2
	12/21/94	740	7.7	527	292	71	117	15	60		36	90	4.8	< 0.1	0.2
	1/18/95	735	7.6	464	274	71	120	14	48		46	64	7.2	0.1	0.2
	2/15/95	810	7.6	625	364	76	144	16	70		90	80	6.3	< 0.1	0.4
	3/15/95	905	7.8	366	217	66	108	11	30		59	30	3.6	0.1	0.2
	4/19/95	715	7.3	246	147	43	57	6	23		29	24	1.9	< 0.1	0.2
	5/17/95	615	7.0	153	94	33	39	4	13		16	12	1.4	< 0.1	< 0.1
	6/21/95	900	7.3	216	130	39	54	6	20		26	21	2.3	< 0.1	0.1
	7/19/95	655	7.0	142	86	28	36	4	12		17	12	1.3	< 0.1	< 0.1
	8/16/95	855	7.5	320	189	51	80	9	31		41	36	3.3	< 0.1	0.2
	9/20/95	700	7.5	343	201	56	82	9	35		45	37	4.0	< 0.1	0.2
	10/18/95	735	7.3	181	106	39	46	5	16		16	17	2.2	< 0.1	< 0.1
	11/15/95	830	7.5	220	128	53	62	7	19		17	19	2.2	< 0.1	< 0.1
	12/20/95	950	7.9	713	419	98	162	18	80		94	91	8.1	0.1	0.4
CALIFORNIA AQUEDUCT OUTLET FROM O'NEILL FOREBAY (CHECK 13)															
KA007089	1/5/94	750	7.7	481	279	71	102	12	51		49	67	4.4	< 0.1	0.2
	1/19/94	800	7.7	437	254	67	102	12	45		44	61	4.6	< 0.1	0.2
	2/2/94	750	7.8	526	308	78	127	15	57		64	74	6.0	< 0.1	0.2
	2/16/94	905	7.8	542	318	79	129	15	59		65	73	6.4	0.1	0.3
	3/2/94	730	7.7	518	301	77	127	15	53		58	71	5.6	0.1	0.2
	3/16/94	855	8.0	597	353	83	145	17	62		76	79	6.4	< 0.1	0.3
	4/6/94	625	7.9	565	328	78	131	16	60		68	77	4.7	< 0.1	0.3
	4/20/94	700	7.9	486	280	74	113	14	49		46	72	3.7	< 0.1	0.2
	5/4/94	555	7.9	482	276	73	115	14	51		47	70	3.5	< 0.1	0.2
	5/18/94	750	7.9	480	267	73	113	14	50		46	70	3.6	< 0.1	0.2
	6/1/94	530	7.9	492	282	72	115	14	51		48	72	3.8	< 0.1	0.2
	6/15/94	605	7.9	484	278	75	115	14	50		46	70	3.6	< 0.1	0.2
	7/6/94	535	8.0	481	272	74	113	14	51		46	69	3.1	< 0.1	0.1

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TABLE A-1. MINERAL ANALYSES AT SELECTED SWP LOCATIONS

STATION NAME / STATION I.D.#	DATE	TIME	LAB pH	LAB EC	TDS	TOT. ALK. (as CaCO3)	HARD-NESS	Mg	Na	K	SO4	Cl	NO3	Fl	B
					CONCENTRATION IN MG/L*, FILTERED										
CALIFORNIA AQUEDUCT OUTLET FROM O'NEILL FOREBAY (CHECK 13) (continued)															
KA007089	7/20/94	645	8.1	492	276	77	113	14	53		46	72	2.3	0.1	0.2
	8/2/94	540	8.6	504	276	72	113	14	55		46	80	1.2	0.1	0.2
	8/17/94	745	8.4	504	275	72	108	14	56		41	87	0.6	0.1	0.2
	9/7/94	640	7.8	601	320	67	109	16	73		25	119	0.7	< 0.1	0.1
	9/21/94	725	7.8	624	337	73	110	17	79		31	125	0.8	< 0.1	0.1
	10/5/94	640	7.9	678	361	79	122	18	85		36	128	1.6	0.1	0.7
	10/19/94	650	8.0	595	325	82	120	17	71		35	104	1.8	0.1	0.2
	11/2/94	925	8.0	541	295	78	107	15	66		31	92	1.5	< 0.1	0.2
	11/16/94	800	7.9	614	336	79	128	17	70		44	110	2.6	< 0.1	0.2
	12/7/94	905	7.8	652	364	82	130	17	81		48	109	3.2	< 0.1	0.2
	12/21/94	805	7.8	634	357	82	138	17	73		53	107	5.0	< 0.1	0.2
	1/4/95	920	7.7	528	300	78	119	15	58		45	75	5.3	< 0.1	0.2
	1/18/95	800	7.6	513	295	77	127	15	55		50	72	7.0	0.1	0.2
	2/1/95	750	7.6	487	290	72	132	15	50		61	62	7.3	< 0.1	0.2
	2/15/95	730	7.5	449	266	64	110	12	46		60	54	5.9	< 0.1	0.3
	3/1/95	745	7.6	450	266	64	120	14	48		60	54	5.8	< 0.1	0.3
	3/14/95	950	7.8	518	300	72	127	15	56		70	63	6.0	< 0.1	0.3
	3/15/95	940	7.9	524	301	72	126	15	56		58	64	6.2	< 0.1	0.3
	4/19/95	825	7.5	298	177	49	73	8	29		37	31	2.0	< 0.1	0.2
	5/4/95	710	7.9	403	238	62	100	11	40		57	44	3.4	0.1	0.3
	5/17/95	715	7.4	327	188	52	77	9	34		33	43	2.2	< 0.1	0.2
	6/21/95	715	7.3	274	161	44	66	8	27		29	35	2.2	< 0.1	0.1
	7/19/95	715	7.1	199	117	35	46	5	19		22	22	1.7	< 0.1	0.1
	8/16/95	1000	7.6	393	225	60	88	11	42		36	56	2.9	< 0.1	0.1
	9/20/95	745	7.8	278	163	57	68	8	26		30	29	1.7	< 0.1	0.1
	10/18/95	635	7.4	219	123	45	59	7	20		22	22	2.1	< 0.1	0.1
	11/15/95	850	7.5	425	241	70	98	11	42		41	55	4.5	< 0.1	0.2
	12/20/95	1015	7.7	499	287	74	114	13	53		57	63	5.5	< 0.1	0.2
CALIFORNIA AQUEDUCT NEAR KETTLEMAN CITY (CHECK 21)															
KA017226	1/5/94	700	7.7	436	251	66	92	11	46		39	63	3.8	< 0.1	0.2
	1/19/94	700	7.7	465	269	69	117	12	49		48	67	4.9	< 0.1	0.2
	2/2/94	700	7.8	488	285	72	118	14	53		57	70	4.8	< 0.1	0.2
	2/16/94	700	7.8	544	316	80	129	15	59		67	79	5.5	0.1	0.3
	3/7/94	700	7.7	563	331	80	139	16	59		67	77	6.3	0.1	0.3
	3/16/94	700	7.9	598	355	83	145	17	62		75	81	6.7	0.1	0.3
	4/6/94	600	7.9	579	339	77	134	16	61		80	74	5.0	0.1	0.3
	4/20/94	600	8.0	564	330	78	124	15	61		70	75	3.7	0.1	0.3
	5/4/94	600	7.9	551	319	76	118	14	63		69	73	3.9	0.1	0.3
	5/18/94	600	8.0	538	307	74	119	15	59		66	73	3.5	0.1	0.2
	6/1/94	600	7.9	533	311	71	118	14	60		65	74	3.9	0.1	0.2
	6/15/94	600	8.0	505	290	75	115	14	54		54	72	3.7	< 0.1	0.2
	7/6/94	600	7.9	505	288	75	115	14	54		54	70	3.4	< 0.1	0.2
	7/20/94	600	8.0	515	294	78	115	14	56		56	74	2.7	0.1	0.2
	8/3/94	600	8.0	523	291	71	117	15	58		60	72	1.8	0.1	0.2
	8/17/94	600	8.2	533	296	72	110	14	59		56	72	1.1	0.1	0.2
	9/7/94	600	7.8	638	357	69	109	15	82		66	104	1.2	0.1	0.2
	9/21/94	600	7.8	725	410	72	125	17	94		94	112	1.7	0.1	0.3
	10/5/94	600	7.9	782	450	77	125	17	109		115	110	1.5	0.1	0.4
	10/19/94	600					139	18	104					0.1	0.4
	11/2/94	700	8.0	800	455	86	142	20	112		99	126	1.8	0.1	0.3
	11/16/94	800	8.0	698	403	84	131	16	89		111	94	2.0	0.1	0.3
	12/7/94	830	7.9	714	416	84	131	16	93		92	96	3.4	0.1	0.3
	12/21/94	800	7.9	780	458	85	149	18	103		107	112	3.6	0.1	0.4
	1/4/95	925	8.0	839	495	86	158	19	103		148	108	4.6	0.1	0.4
	1/18/95	800	7.8	841	495	82	95	11	130		141	109	4.1	0.2	0.5
	2/1/95	830	7.4	369	224	61	98	11	36		42	42	6.4	< 0.1	0.2
	2/15/95	830	7.4	427	260	66	107	12	41		57	48	7.7	< 0.1	0.2
	3/1/95	900	7.6	446	264	64	114	13	46		60	53	6.0	< 0.1	0.3
	3/14/95	1720	8.1	1030	722	106	354	35	99		364	33	8.8	0.3	0.5
	4/5/95	800	7.8	515	308	71	129	15	52		82	55	5.8	0.1	0.3
	4/19/95	800	7.6	357	212	57	91	10	35		49	38	2.6	< 0.1	0.2
	5/17/95	700	7.5	291	169	50	73	8	28		33	33	2.4	< 0.1	0.2
	6/21/95	630	7.4	258	149	43	62	7	25		26	32	2.0	< 0.1	0.1
	7/19/95	600	7.4	237	139	41	57	6	22		25	27	2.1	< 0.1	0.1

TABLE A-1. MINERAL ANALYSES AT SELECTED SWP LOCATIONS

STATION NAME / STATION I.D.#	DATE	TIME	LAB pH	LAB EC	TDS	ALK. (as CaCO3)	TOT. HARD-NESS (as CaCO3)	Mg	Na	K	SO4	Cl	NO3	Fl	B
					CONCENTRATION IN MG/L*, FILTERED										
CALIFORNIA AQUEDUCT NEAR KETTLEMAN CITY (CHECK 21) (continued)															
KA017226	8/16/95	400	7.5	365	208	57	84	10	38		33	51	2.6	< 0.1	0.1
	9/19/95	1410	7.6	285	166	57	70	8	27		29	30	2.2	< 0.1	0.1
	10/18/95	615	7.5	249	141	53	66	8	23		26	25	1.8	< 0.1	0.1
	11/15/95	830	7.4	270	156	62	70	8	26		25	27	3.5	< 0.1	0.1
	12/20/95	645	7.8	456	262	73	105	12	48		44	62	4.2	< 0.1	0.2
CALIFORNIA AQUEDUCT AT CHECK 29															
KA024454	1/18/94	1100	7.7	482	278	72	107	12	51		51	69	4.7	< 0.1	0.2
	2/15/94	1110	7.9	576	337	83	136	16	63		71	84	5.8	0.1	0.3
	3/15/94	930	7.9	584	346	82	139	16	61		74	76	6.8	< 0.1	0.3
	4/19/94	1020	7.9	612	357	82	136	16	66		78	82	4.5	0.1	0.3
	5/3/94	1210	7.6	528		77	106	13	52		64	71		0.1	0.2
	5/17/94	1030	7.8	552	316	76		15	62		67	75	4.1	0.1	0.3
	6/7/94	1010	8.0	528	307	77	118	14	58		65	68	3.5	< 0.1	0.3
	6/14/94	958	8.0	509	292	75	115	14	55		58	72	3.5	< 0.1	0.2
	7/5/94	930	7.7	505	286	76	118	14	54		54	70	3.1	< 0.1	0.2
	7/19/94	910	8.0	511	295	78	118	14	54		54	72	2.9	0.1	0.2
	8/2/94	1130	8.2	514	290	72	111	16	59		58	73	2.1	< 0.1	0.2
	8/16/94	915	8.1	525	310	74	119	15	60		56	79	1.5	0.1	0.2
	9/6/94	920	7.8	589	329	70	117	15	74		57	94	1.2	0.1	0.2
	9/20/94	1030	7.9	663	368	71	125	17	85		66	112	1.5	0.1	0.2
	10/4/94	1000	8.0	742	424	75	134	18	97		100	115	1.3	0.1	0.3
	10/18/94	1234	8.1	773	452	76	133	17	109		114	114	0.8	0.1	0.4
	11/1/94	1045	8.0	805	466	82	129	16	114		129	108	1.6	0.2	0.4
	11/15/94	1020	8.0	812	462	85	141	19	113		112	129	1.6	0.1	0.3
	12/6/94	1008	8.0	669	389	83	129	16	88		112	91	2.3	0.1	0.3
	12/20/94	1005	8.0	642	368	79	129	15	79		80	93	2.2	0.1	0.3
	1/3/95	1140	7.9	695	406	79	135	14	92		101	95	3.4	0.1	0.3
	1/17/95	1055	8.1	725	417	80	137	15	93		99	103	2.6	0.1	0.4
	2/7/95	1021	7.5	470	278	71	118	14	48		50	62	7.8	0.1	0.3
	2/14/95	1055	7.4	360	219	59	95	11	33		42	41	7.3	< 0.1	0.2
	3/14/95	945	7.7	452	263	64	111	13	46		63	53	5.8	< 0.1	0.3
	4/4/95	930	7.8	606	367	76	154	18	62		107	63	6.4	0.1	0.4
	4/18/95	1009	7.8	459	274	68	114	13	46		64	53	4.4	< 0.1	0.3
	5/16/95	1008	7.3	244	144	45	60	6	23		28	25	2.2	< 0.1	0.1
	6/20/95	1115	7.4	262	152	44	64	7	26		24	33	2.1	< 0.1	0.1
	7/18/95	1045	7.6	270	158	47	66	7	26		28	32	2.4	< 0.1	0.1
	8/15/95	1010	7.5	306	178	51	70	8	30		29	38	2.3	< 0.1	0.1
	9/19/95	1025	7.7	288	165	57	74	9	27		28	32	1.9	< 0.1	0.1
	10/17/95	1015	7.7	251	141	52	68	8	23		26	25	1.4	< 0.1	0.2
	11/14/95	920	7.6	277	160	59	70	8	26		26	30	3.5	< 0.1	0.1
	12/17/95	1300													
	12/17/95	1300													
	12/19/95	1100	7.9	477	270	74	109	13	51		45	67	4.1	< 0.1	0.2
CALIFORNIA AQUEDUCT AT CHECK 41															
KA030341	1/19/94	730	7.9	414	261	72	101	12	44	3.0	33	60	2.0	< 0.1	0.2
	2/16/94	730	8.1	460	345	80	126	14	57	3.6	61	76	5.8	< 0.1	0.3
	3/16/94	1100	8.1	614	352	87		17	66	4.9	80	84	6.7	< 0.1	0.4
	4/20/94	630	8.1	588	379	81	135	16	68	3.5	65	84	4.5	0.1	0.3
	5/3/94	900	7.8	538	311	76	122	15	59		66	73	3.6	0.1	0.2
	5/18/94	700	8.2	547	319	80	118	13	66	3.4	71	70	3.9	< 0.1	0.2
	6/15/94	900	8.1	514	353	76	117	14	56	3.3	59	72	3.6	0.1	0.2
	7/20/94	800	8.2	514	330	81	115	14	56	3.3	53	71	2.8	< 0.1	0.2
	8/17/94	615	8.4	532	310	77	107	13	62	3.5	60	78	1.5	< 0.1	0.2
	9/21/94	600	8.2	643	399	71	111	15	81	3.9	70	109	1.2	0.1	0.3
	10/19/94	640	8.5	756	481	78	123	16	100	3.6	120	108	1.1	0.1	0.4
	11/16/94	730	8.2	798	461	92	129	17	108	4.1	98	121	1.8	0.2	0.4
	12/21/94	730	8.2	672	398	85	117	13	88	3.6	116	92	2.0	0.1	0.3
	1/18/95	730	8.3	684	404	87	121	14	85	3.7	98	97	1.6	0.1	0.3
	2/15/95	730	7.8	511	314	78	108	13	53	5.0	56	71	7.0	0.1	0.2
	3/15/95	730	7.9	461	259	66	117	12	47	3.3	66	56	6.9	< 0.1	0.4
	4/19/95	730	8.1	506	313	78	139	15	53	3.9	93	56	4.9	0.1	0.3
	5/17/95	700	8.1	266	163	49	66	7	26	2.0	29	27	2.2	< 0.1	0.2
	6/21/95	630	7.8	160	103	38	44	4	14	1.4	18	15	1.3	< 0.1	0.1
	7/19/95	700	8.0	264	172	50	67	7	26	2.0	30	31	1.2	< 0.1	0.2

TABLE A-1. MINERAL ANALYSES AT SELECTED SWP LOCATIONS

STATION NAME					CONCENTRATION IN MG/L*, FILTERED										
STATION I.D.#	DATE	TIME	LAB pH	LAB EC	TDS	TOT. ALK. (as CaCO3)	HARD-NESS	Mg	Na	K	SO4	Cl	NO3	Fl	B
CALIFORNIA AQUEDUCT AT CHECK 41 (continued)															
KA030341	8/16/95	700	8.0	350	214	59	82	9	37	2.6	35	48	2.6	< 0.1	0.2
	9/20/95	700	8.2	293	178	59	76	9	29	2.1	28	34	1.7	< 0.1	0.1
	10/18/95	600	8.2	301	197	66	80	9	29	2.1	33	31	1.9	< 0.1	0.2
	11/15/95	730	8.1	256	147	57	69	8	23	1.9	27	26	1.3	< 0.1	0.2
	12/20/95	730	8.0	448	251	73	108	12	46	2.8	43	59	3.7	< 0.1	0.2
CALIFORNIA AQUEDUCT AT DEVIL CANYON															
KA041288	1/19/94	1100	7.9	357	206	76	92	10	37	2.7	24	48	2.4	< 0.1	0.1
	2/16/94	1130	8.3	346	217	68	93	10	39	2.7	34	51	2.4	< 0.1	0.2
	3/16/94	600	8.0		225	70		11	41	3.2	320		2.1	< 0.1	0.2
	4/20/94	1100	8.4	471	300	78	112	13	51	3.2	54	62	2.8	< 0.1	0.2
	5/18/94	600	8.7	516	306	79	125	14	60	3.3	81	65	2.4	< 0.1	0.3
	6/15/94	800	8.4	543	364	79	120	14	62	3.3	69	75	2.2	0.1	0.3
	7/20/94	600	8.2	519	322	81	115	14	57	3.4	58	74	2.7	< 0.1	0.2
	8/17/94	900	8.1	522	299	84	113	14	57	3.4	60	73	2.1	< 0.1	0.2
	9/21/94	800	8.2	550	354	79	115	14	62	3.6	57	79	1.4	< 0.1	0.2
	10/19/94	600	7.9	573	323	77	111	14	67	3.5	65	89	1.5	< 0.1	0.2
	11/16/94	700	8.0	604	390	79	121	15	71	3.7	68	90	2.4	0.2	0.3
	12/21/94	1030	8.1	653	365	81	115	15	80	4.0	85	103	1.4	0.1	0.3
	1/18/95	700	7.9	593	345	81	107	13	72	3.6	76	88	0.6	0.1	0.3
	2/15/95	900	8.0	538	299	73	99	12	66	3.6	75	77	1.9	0.1	0.3
	3/15/95	800	8.0	467	298	68	101	11	56	3.2	59	64	2.1	0.1	0.3
	4/19/95	900	8.4	456	253	70	98	11	52	3.2	59	58	1.7	0.1	0.2
	5/17/95	1200	8.2	446	265	69	101	11	49	3.1	59	52	2.3	0.1	0.3
	6/21/95	800	7.9	372	218	63	86	9	40	2.7	50	43	1.7	0.1	0.2
	7/26/95	700	7.8	333	193	58	80	9	35	2.5	37	40	2.6	< 0.1	0.2
	8/16/95	1030	7.9	309	192	54	75	8	31	2.3	34	39	2.4	< 0.1	0.2
	9/20/95	900	8.0	350	230	60	84	10	37	2.7	35	46	2.1	0.1	0.2
	10/18/95	700	7.9	350	227	63	85	10	37	2.7	35	46	2.4	< 0.1	0.1
	11/15/95	800	7.8	362	207	65	87	10	37	2.7	37	46	2.2	< 0.1	0.2
	12/20/95	930	7.9	364	215	68	90	10	36	2.7	34	44	2.2	< 0.1	0.2
CASTAIC LAKE AT OUTLET TOWER															
CA002000	2/14/94	900	8.2	610	411	96	172	17	59	3.4	104	68	1.8	0.3	0.3
	5/16/94	830	8.9	575	345	96	161	16	57	3.3	103	62	1.1	0.2	0.3
	8/15/94	1030	9.1	563	389	82	132	16	59	3.5	93	68	< 0.1	0.2	0.3
	11/14/94	830	7.9	595	384	92	155	17	58	3.5	84	68	2.7	0.3	0.3
	2/14/95	830	8.1	593	344	96	155	16	55	3.7	99	67	2.4	0.2	0.3
	8/14/95	1000	8.6	641	414	112	193	19	58	3.5	121	59	< 0.1	0.4	0.4
	11/13/95	830	8.2	649	385	107	199	20	57	3.3	132	55	0.7	0.3	0.4

*TDS = TOTAL DISSOLVED SOLIDS
HARDNESS = DISSOLVED HARDNESS
Mg = MAGNESIUM
Na = SODIUM
K = POTASSIUM
SO4 = SULFATE
Cl = CHLORIDE
NO3 = NITRATE
Fl = FLUORIDE
B = BORON

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TABLE A-2. MINOR ELEMENTS ANALYSES AT SELECTED SWP LOCATIONS

STATION NAME STATION I.D.#	DATE	TIME	As	Ba	Cd	Cr	Cu	Fe	Pb	Mn	Hg	Se	Ag	Zn	Al
			CONCENTRATION IN MG/L*, FILTERED												
THERMALITO AFTERBAY AT FEATHER RIVER OUTLET															
TA001000	1/18/94	945	< 0.001			< 0.005	< 0.005	0.010	< 0.005	< 0.005		< 0.001		< 0.005	
	2/16/94	910	< 0.001			< 0.005	< 0.005	0.030	< 0.005	< 0.005		< 0.001		< 0.005	
	3/16/94	830	< 0.001			< 0.005	< 0.005	0.024	< 0.005	0.005		< 0.001		0.005	
	4/20/94	930	< 0.001			< 0.005	< 0.005	0.007	< 0.005	< 0.005		< 0.001		0.012	
	5/18/94	840	< 0.001	< 0.050	< 0.005	< 0.005	< 0.005	0.023	< 0.005	< 0.005	< 0.001	< 0.001	< 0.005	< 0.005	0.027
	6/15/94	850	< 0.001			< 0.005	< 0.005	0.012	< 0.005	< 0.005	< 0.001	< 0.001		0.007	
	7/20/94	910	< 0.001			< 0.005	< 0.005	0.010	< 0.005	0.005		< 0.001		< 0.005	
	8/17/94	915	< 0.001			< 0.005	< 0.005	0.024	< 0.005	< 0.005		< 0.001		0.014	
	9/21/94	1015	< 0.001			< 0.005	< 0.005	0.025	< 0.005	< 0.005		< 0.001		0.008	
	10/19/94	910	< 0.001			< 0.005	< 0.005	0.008	< 0.005	< 0.005		< 0.001		< 0.005	
	11/16/94	910	< 0.001			< 0.005	< 0.005	0.020	< 0.005	0.011		< 0.001		0.006	
	12/21/94	900	< 0.001	< 0.050	< 0.005	< 0.005	< 0.005	0.017	< 0.005	< 0.005		< 0.001	< 0.005	< 0.005	
	1/18/95	1015	< 0.001			< 0.005	< 0.005	0.032	< 0.005	0.006		< 0.001		0.006	
	2/15/95	815	< 0.001	< 0.050	< 0.005	< 0.005	< 0.005	0.047	< 0.005	< 0.005		< 0.001	< 0.005	< 0.005	
	4/19/95	935	< 0.001	< 0.050	< 0.005	< 0.005	< 0.005	0.030	< 0.005	0.008	< 0.001	< 0.001	< 0.005	< 0.005	0.024
	5/17/95	820	< 0.001	< 0.050	< 0.005	< 0.005	< 0.005	0.019	< 0.005	< 0.005	< 0.001	< 0.001	< 0.005	0.005	< 0.010
	6/27/95	950	< 0.001	< 0.050	< 0.005	< 0.005	< 0.005	0.024	< 0.005	0.010		< 0.001	< 0.005	< 0.005	
	8/16/95	1234	< 0.001	< 0.050	< 0.005	< 0.005	< 0.005	0.012	< 0.005	< 0.005	< 0.001	< 0.001	< 0.005	< 0.005	0.012
	9/20/95	900	< 0.001			< 0.005	< 0.005	0.014	< 0.005	< 0.005		< 0.001		< 0.005	
	10/18/95	915	< 0.001			< 0.005	< 0.005	0.020	< 0.005	< 0.005		< 0.001		< 0.005	
	11/15/95	915	< 0.001			< 0.005	< 0.005	0.014	< 0.005	< 0.005		< 0.001		< 0.005	
	12/20/95	925	< 0.001			< 0.005	< 0.005	0.014	< 0.005	< 0.005		< 0.001		< 0.005	
NORTH BAY AQUEDUCT AT BARKER SLOUGH PUMPING PLANT															
KG000000	1/19/94	1420	0.002	0.064	< 0.005	< 0.005	< 0.005	0.022	< 0.005	0.038	< 0.001	< 0.001	< 0.005	0.007	0.019
	2/16/94	1400	0.002	0.060	< 0.005	< 0.005	< 0.005	0.064	< 0.005	0.095	< 0.001	< 0.001	< 0.005	0.005	0.051
	3/16/94	1455	0.002	0.118	< 0.005	< 0.005	< 0.005	0.052	< 0.005	0.040	< 0.001	< 0.001	< 0.005	< 0.005	0.042
	4/20/94	1230	0.002	0.079	< 0.005	< 0.005	< 0.005	0.018	< 0.005	0.018	< 0.001	< 0.001	< 0.005	0.007	0.013
	5/18/94	1315	0.003	0.083	< 0.005	< 0.005	< 0.005	0.026	< 0.005	0.019	< 0.001	< 0.001	< 0.005	< 0.005	0.050
	6/15/94	1230	0.003	< 0.050	< 0.005	< 0.005	< 0.005	0.061	< 0.005	0.035	< 0.001	< 0.001	< 0.005	0.009	0.020
	7/20/94	1330	0.002	< 0.050	< 0.005	< 0.005	< 0.005	0.242	< 0.005	0.036	< 0.001	< 0.001	< 0.005	0.010	0.051
	8/17/94	1330	0.003	< 0.050	< 0.005	< 0.005	< 0.005	0.098	< 0.005	0.011	< 0.001	< 0.001	< 0.005	0.005	0.055
	9/21/94	1315	0.003	< 0.050	< 0.005	< 0.005	< 0.005	0.020	< 0.005	0.011	< 0.001	< 0.001	< 0.005	0.007	0.017
	10/19/94	1320	0.003	< 0.050	< 0.005	< 0.005	< 0.005	0.051	< 0.005	0.016	< 0.001	< 0.001	< 0.005	0.009	0.044
	11/16/94	1355	0.002	0.056	< 0.005	< 0.005	< 0.005	0.059	< 0.005	0.026	< 0.001	< 0.001	< 0.005	< 0.005	0.021
	12/21/94	1400	0.002	< 0.050	< 0.005	< 0.005	< 0.005	0.060	< 0.005	0.023	< 0.001	< 0.001	< 0.005	< 0.005	0.054
	1/18/95	1410	0.002	< 0.050	< 0.005	< 0.005	0.005	0.200	< 0.005	0.110	< 0.001	< 0.001	< 0.005	< 0.005	0.073
	2/15/95	1400	0.003	< 0.050	< 0.005	< 0.005	< 0.005	0.120	< 0.005	0.093	< 0.001	< 0.001	< 0.005	< 0.005	< 0.010
	3/15/95	1405	0.002	< 0.050	< 0.005	< 0.005	< 0.005	0.270	< 0.005	0.011	< 0.001	< 0.001	< 0.005	0.009	0.160
	4/19/95	1230	0.002	< 0.050	< 0.005	< 0.005	< 0.005	0.086	< 0.005	0.030	< 0.001	< 0.001	< 0.005	< 0.005	0.015
	5/17/95	1400	0.002	0.082	< 0.005	< 0.005	< 0.005	0.011	< 0.005	0.015	< 0.001	< 0.001	< 0.005	< 0.005	< 0.010
	6/21/95	1310	0.002	0.066	< 0.005	< 0.005	< 0.005	0.008	< 0.005	0.026	< 0.001	< 0.001	< 0.005	< 0.005	< 0.010
	7/19/95	1345	0.003	< 0.050	< 0.005	< 0.005	< 0.005	0.007	< 0.005	0.018	< 0.001	< 0.001	< 0.005	< 0.005	< 0.010
	8/16/95	1400	0.003	< 0.050	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	0.009	< 0.001	< 0.001	< 0.005	< 0.005	< 0.010
	9/20/95	1300	0.003	< 0.050	< 0.005	< 0.005	< 0.005	0.008	< 0.005	0.009	< 0.001	< 0.001	< 0.005	< 0.005	< 0.010
	10/18/95	1310	0.002	< 0.050	< 0.005	< 0.005	< 0.005	0.013	< 0.005	0.015	< 0.001	< 0.001	< 0.005	< 0.005	< 0.010

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TABLE A-2. MINOR ELEMENTS ANALYSES AT SELECTED SWP LOCATIONS

CONCENTRATION IN MG/L*, FILTERED

STATION NAME / STATION I.D.#	DATE	TIME	As	Ba	Cd	Cr	Cu	Fe	Pb	Mn	Hg	Se	Ag	Zn	Al
NORTH BAY AQUEDUCT AT BARKER SLOUGH PUMPING PLANT (continued)															
KG000000	11/15/95	1400	0.002	< 0.050	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	0.006	< 0.001	< 0.001	< 0.005	< 0.005	< 0.010
	12/20/95	1345	0.002	< 0.050	< 0.005	< 0.005	< 0.005	0.086	< 0.005	0.030	< 0.001	< 0.001	< 0.005	< 0.005	< 0.010
HARVEY O. BANKS PUMPING PLANT															
KA000331	1/19/94	840	0.002	0.058	< 0.005	< 0.005	< 0.005	0.147	< 0.005	0.049	< 0.001	< 0.001	< 0.005	< 0.005	0.032
	2/16/94	800	0.002	< 0.050	< 0.005	< 0.005	< 0.005	0.160	< 0.005	0.067	< 0.001	< 0.001	< 0.005	< 0.005	0.041
	3/16/94	905	0.002	0.073	< 0.005	< 0.005	< 0.005	0.083	< 0.005	0.037	< 0.001	< 0.001	< 0.005	< 0.005	0.037
	4/20/94	900	0.002	< 0.050	< 0.005	< 0.005	< 0.005	0.027	< 0.005	0.030	< 0.001	< 0.001	< 0.005	< 0.005	0.020
	5/18/94	630	0.002	< 0.050	< 0.005	< 0.005	< 0.005	0.025	< 0.005	0.012	< 0.001	< 0.001	< 0.005	< 0.005	0.020
	6/15/94	700	0.002	0.059	< 0.005	< 0.005	< 0.005	0.035	< 0.005	0.005	< 0.001	< 0.001	< 0.005	< 0.005	0.034
	7/20/94	730	0.003	< 0.050	< 0.005	< 0.005	< 0.005	0.066	< 0.005	0.031	< 0.001	< 0.001	< 0.005	0.019	0.095
	8/8/94	750										< 0.001			
	8/17/94	740	0.003	< 0.050	< 0.005	< 0.005	< 0.005	0.024	< 0.005	0.019	< 0.001	< 0.001	< 0.005	0.009	0.020
	8/17/94	740										< 0.001			
	9/21/94	650	0.003	< 0.050	< 0.005	< 0.005	< 0.005	0.064	< 0.005	0.009	< 0.001	< 0.001	< 0.005	< 0.005	0.061
	10/19/94	810	0.002	< 0.050	< 0.005	< 0.005	< 0.005	0.093	< 0.005	0.017	< 0.001	< 0.001	< 0.005	< 0.005	0.082
	11/16/94	730	0.002	< 0.050	< 0.005	< 0.005	< 0.005	0.084	< 0.005	0.019	< 0.001	< 0.001	< 0.005	< 0.005	0.034
	12/21/94	825	0.002	< 0.050	< 0.005	< 0.005	< 0.005	0.100	< 0.005	0.025	< 0.001	< 0.001	< 0.005	< 0.005	0.064
	1/18/95	830	0.002	< 0.050	< 0.005	< 0.005	< 0.005	0.140	< 0.005	0.035	< 0.001	< 0.001	< 0.005	0.006	0.120
	2/15/95	735	0.002	< 0.005	< 0.005	< 0.005	0.005	0.190	< 0.005	0.057	< 0.001	< 0.001	< 0.005	0.008	0.190
	3/15/95	810	0.002	< 0.050	< 0.005	< 0.005	< 0.005	0.087	< 0.005	0.026	< 0.001	< 0.001	< 0.005	< 0.005	0.035
	4/19/95	740	0.002	< 0.050	< 0.005	< 0.005	< 0.005	0.045	< 0.005	0.016	< 0.001	< 0.001	< 0.005	< 0.005	0.030
	5/17/95	630	0.002	< 0.050	< 0.005	< 0.005	0.006	0.028	< 0.005	0.025	< 0.001	< 0.001	< 0.005	0.005	0.012
	6/21/95	745	0.001	< 0.050	< 0.005	< 0.005	< 0.005	0.026	< 0.005	0.031	< 0.001	< 0.001	< 0.005	< 0.005	< 0.010
	7/19/95	745	0.001	< 0.050	< 0.005	< 0.005	< 0.005	0.024	< 0.005	0.021	< 0.001	< 0.001	< 0.005	< 0.005	< 0.010
	8/16/95	625	0.002	< 0.050	< 0.005	< 0.005	< 0.005	0.024	< 0.005	0.011	< 0.001	< 0.001	< 0.005	< 0.005	< 0.010
	9/20/95	650	0.002	< 0.050	< 0.005	< 0.005	< 0.005	0.017	< 0.005	< 0.005	< 0.001	< 0.001	< 0.005	< 0.005	0.011
	10/18/95	810	0.002	< 0.050	< 0.005	< 0.005	< 0.005	0.020	< 0.005	0.015	< 0.001	< 0.001	< 0.005	< 0.005	< 0.010
	11/15/95	740	0.002	< 0.050	< 0.005	< 0.005	< 0.005	0.025	< 0.005	0.007	< 0.001	< 0.001	< 0.005	< 0.005	< 0.010
	12/20/95	800	0.002	< 0.050	< 0.005	< 0.005	< 0.005	0.008	< 0.005	< 0.005	< 0.001	< 0.001	< 0.005	0.006	< 0.010
SOUTH BAY AQUEDUCT AT TERMINAL TANK															
KB004207	2/16/94	1045	0.002	< 0.050	< 0.005	< 0.005	< 0.005	0.184	< 0.005	0.028	< 0.001	< 0.001	< 0.005	0.077	0.021
	2/16/94	1234	< 0.001	< 0.050	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.001	< 0.001	< 0.005	< 0.005	< 0.010
	2/16/94	1234	< 0.001	< 0.050	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.001	< 0.001	< 0.005	< 0.005	< 0.010
	5/18/94	1000	0.002	0.053	< 0.005	< 0.005	< 0.005	0.022	< 0.005	0.017	< 0.001	< 0.001	< 0.005	< 0.005	0.019
	9/21/94	930	0.002	< 0.050	< 0.005	< 0.005	< 0.005	0.035	< 0.005	0.007	< 0.001	< 0.001	< 0.005	< 0.005	0.025
	11/16/94	1025	0.002	0.074	< 0.005	< 0.005	< 0.005	0.051	< 0.005	0.013	< 0.001	< 0.001	< 0.005	0.054	0.022
	1/18/95	1100	0.002	0.057	< 0.005	< 0.005	< 0.005	0.040	< 0.005	0.130	< 0.001	< 0.001	< 0.005	0.007	0.029
	2/15/95	1015	0.002	0.057	< 0.005	< 0.005	0.042	0.029	< 0.005	0.010	< 0.001	< 0.001	< 0.005	0.035	< 0.010
	3/15/95	1015	0.001	0.053	< 0.005	< 0.005	< 0.005	0.039	< 0.005	0.010	< 0.001	< 0.001	< 0.005	0.010	< 0.010
	4/19/95	930	0.001	< 0.050	< 0.005	< 0.005	0.009	0.041	< 0.005	0.008	< 0.001	< 0.001	< 0.005	0.007	0.031
	5/17/95	1015	0.002	< 0.005	< 0.005	< 0.005	< 0.005	0.014	< 0.005	0.008	< 0.001	< 0.001	< 0.005	< 0.005	0.012
	8/16/95	945	0.002	< 0.050	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	0.007	< 0.001	< 0.001	< 0.005	< 0.005	< 0.010
	10/17/95	930	0.002	< 0.050	< 0.005	< 0.005	< 0.005	0.010	< 0.005	< 0.005	< 0.001	< 0.001	< 0.005	< 0.005	< 0.010

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TABLE A-2. MINOR ELEMENTS ANALYSES AT SELECTED SWP LOCATIONS

CONCENTRATION IN MG/L*, FILTERED

STATION NAME STATION I.D.#	DATE	TIME	As	Ba	Cd	Cr	Cu	Fe	Pb	Mn	Hg	Se	Ag	Zn	Al
SOUTH BAY AQUEDUCT AT TERMINAL TANK (continued)															
KB004207	11/15/95	1015	0.002	< 0.050	< 0.005	< 0.005	< 0.005	0.025	< 0.005	0.037	< 0.001	< 0.001	< 0.005	0.009	< 0.010
	12/20/95	1035	0.002	0.068	< 0.005	< 0.005	< 0.005	0.010	< 0.005	0.018	< 0.001	< 0.001	< 0.005	< 0.005	< 0.010
O'NEILL P&G PLANT. DMC AT MCCABE ROAD BRIDGE. MI 68.03															
DMC06803	1/19/94	830	0.001	< 0.050	< 0.005	< 0.005	< 0.005	0.044	< 0.005	0.020	< 0.001	0.001	< 0.005	< 0.005	0.030
	2/16/94	810	0.002	< 0.050	< 0.005	< 0.005	< 0.005	0.222	< 0.005	0.025	< 0.001	< 0.001	< 0.005	< 0.005	0.105
	3/16/94	820	0.002	< 0.050	< 0.005	< 0.005	< 0.005	0.154	< 0.005	0.016	< 0.001	< 0.001	< 0.005	< 0.005	0.085
	4/20/94	635	0.002	0.060	< 0.005	< 0.005	< 0.005	0.039	< 0.005	< 0.005	< 0.001	< 0.001	< 0.005	< 0.005	0.029
	5/18/94	545	0.002	0.057	< 0.005	< 0.005	< 0.005	0.066	< 0.005	0.007	< 0.001	< 0.001	< 0.005	< 0.005	0.064
	6/15/94	630	0.002	0.092	< 0.005	< 0.005	< 0.005	0.033	< 0.005	< 0.005	< 0.001	0.002	< 0.005	< 0.005	0.031
	7/20/94	600	0.003	0.070	< 0.005	< 0.005	< 0.005	0.060	< 0.005	< 0.005	< 0.001	< 0.001	< 0.005	< 0.005	0.044
	8/17/94	650	0.003	0.073	< 0.005	< 0.005	< 0.005	0.028	< 0.005	< 0.005	< 0.001	0.001	< 0.005	< 0.005	0.024
	9/21/94	640	0.003	< 0.050	< 0.005	< 0.005	< 0.005	0.037	< 0.005	< 0.005	< 0.001	< 0.001	< 0.005	< 0.005	0.053
	10/19/94	730	0.002	< 0.050	< 0.005	< 0.005	< 0.005	0.075	< 0.005	< 0.005	< 0.001	< 0.001	< 0.005	0.006	0.059
	11/16/94	815	0.002	0.055	< 0.005	< 0.005	< 0.005	0.065	< 0.005	< 0.005	< 0.001	< 0.001	< 0.005	0.010	0.032
	12/21/94	740	0.002	< 0.050	< 0.005	< 0.005	< 0.005	0.088	< 0.005	0.014	< 0.001	< 0.001	< 0.005	< 0.005	0.097
	1/18/95	735	0.002	< 0.050	< 0.005	< 0.005	< 0.005	0.140	< 0.005	0.013	< 0.001	< 0.001	< 0.005	< 0.005	0.062
	2/15/95	810	0.002	< 0.050	< 0.005	< 0.005	< 0.005	0.033	< 0.005	0.023	< 0.001	0.001	< 0.005	0.005	0.017
	3/15/95	905	0.002	< 0.050	< 0.005	< 0.005	0.010	0.049	< 0.005	< 0.005	< 0.001	< 0.001	< 0.005	0.009	0.018
	4/19/95	715	0.002	< 0.050	< 0.005	< 0.005	< 0.005	0.080	< 0.005	0.008	< 0.001	< 0.001	< 0.005	0.022	0.040
	5/17/95	615	0.002	< 0.050	< 0.005	< 0.005	< 0.005	0.043	< 0.005	0.007	< 0.001	< 0.001	< 0.005	< 0.005	0.014
	6/21/95	900	0.001	< 0.050	< 0.005	< 0.005	< 0.005	0.028	< 0.005	< 0.005	< 0.001	< 0.001	< 0.005	< 0.005	< 0.010
	7/19/95	655	0.001	< 0.050	< 0.005	< 0.005	< 0.005	0.014	< 0.005	< 0.005	< 0.001	< 0.001	< 0.005	< 0.005	< 0.010
	8/16/95	855	0.002	< 0.050	< 0.005	< 0.005	< 0.005	0.007	< 0.005	< 0.005	< 0.001	< 0.001	< 0.005	< 0.005	< 0.010
	9/20/95	700	0.002	< 0.050	< 0.005	< 0.005	< 0.005	0.008	< 0.005	< 0.005	< 0.001	0.001	< 0.005	< 0.005	< 0.010
	10/18/95	735	0.001	< 0.050	< 0.005	< 0.005	< 0.005	0.015	< 0.005	< 0.005	< 0.001	< 0.001	< 0.005	< 0.005	< 0.010
	11/15/95	830	0.001	< 0.050	< 0.005	< 0.005	< 0.005	0.026	< 0.005	< 0.005	< 0.001	< 0.001	< 0.005	< 0.005	< 0.010
	12/20/95	950	0.002	0.051	< 0.005	< 0.005	< 0.005	0.022	< 0.005	0.010	< 0.001	0.001	< 0.005	< 0.005	< 0.010
CALIFORNIA AQUEDUCT OUTLET FROM O'NEILL FOREBAY (CHECK 13)															
KA007089	1/5/94	750	0.002			< 0.005	< 0.005	0.082	< 0.005	0.034		< 0.001		0.007	
	1/19/94	800	0.002	< 0.050	< 0.005	< 0.005	< 0.005	0.127	< 0.005	0.027	< 0.001	< 0.001	< 0.005	< 0.005	0.082
	2/2/94	750	0.002			< 0.005	< 0.005	0.130	< 0.005	0.029		< 0.001		0.005	
	2/16/94	905	0.002	< 0.050	< 0.005	< 0.005	< 0.005	0.180	< 0.005	0.034	< 0.001	< 0.001	< 0.005	< 0.005	0.068
	3/2/94	730	0.002			< 0.005	< 0.005	0.203	< 0.005	0.029		< 0.001		0.005	
	3/16/94	855	0.002	< 0.050	< 0.005	< 0.005	< 0.005	0.138	< 0.005	0.017	< 0.001	< 0.001	< 0.005	< 0.005	0.118
	4/6/94	625	0.002			< 0.005	< 0.005	0.044	< 0.005	0.015		< 0.001		0.010	
	4/20/94	700	0.002	0.052	< 0.005	< 0.005	< 0.005	0.030	< 0.005	0.017	< 0.001	< 0.001	< 0.005	< 0.005	0.020
	5/4/94	555	0.002			< 0.005	< 0.005	0.018	< 0.005	0.017		< 0.001		< 0.005	
	5/18/94	750	0.002	< 0.050	< 0.005	< 0.005	< 0.005	0.020	< 0.005	0.013	< 0.001	< 0.001	< 0.005	< 0.005	0.027
	6/1/94	530	0.002			< 0.005	< 0.005	0.018	< 0.005	0.011		< 0.001		0.009	
	6/15/94	605	0.002	< 0.050	< 0.005	< 0.005	< 0.005	0.012	< 0.005	< 0.005	< 0.001	< 0.001	< 0.005	< 0.005	0.012
	7/6/94	535	0.003			< 0.005	< 0.005	0.013	< 0.005	0.008		< 0.001		0.011	
	7/20/94	645	0.003	< 0.050	< 0.005	< 0.005	< 0.005	0.045	< 0.005	0.006	< 0.001	< 0.001	< 0.005	< 0.005	0.031
	8/2/94	540	0.003			< 0.005	< 0.005	0.010	< 0.005	< 0.005		< 0.001		< 0.005	
	8/17/94	745	0.003	< 0.050	< 0.005	< 0.005	< 0.005	0.029	< 0.005	0.009	< 0.001	< 0.001	< 0.005	0.005	0.034

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TABLE A-2. MINOR ELEMENTS ANALYSES AT SELECTED SWP LOCATIONS

STATION NAME STATION I.D.#	DATE	TIME	As	Ba	Cd	Cr	Cu	Fe	Pb	Mn	Hg	Se	Ag	Zn	Al
			CONCENTRATION IN MG/L*, FILTERED												
CALIFORNIA AQUEDUCT OUTLET FROM O'NEILL FOREBAY (CHECK 13) (continued)															
KA007089	9/7/94	640	0.003			< 0.005	< 0.005	0.034	< 0.005	0.007		< 0.001		0.012	
	9/21/94	725	0.002	< 0.050	< 0.005	< 0.005	< 0.005	0.058	< 0.005	0.007	< 0.001	< 0.001	< 0.005	< 0.005	0.058
	10/5/94	640	0.003			< 0.005	< 0.005	0.075	< 0.005	0.021		< 0.001		0.021	
	10/19/94	650	0.003	< 0.050	< 0.005	< 0.005	< 0.005	0.073	< 0.005	0.019	< 0.001	< 0.001	< 0.005	0.007	0.035
	11/2/94	925	0.002			< 0.005	< 0.005	0.032	< 0.005	0.009		< 0.001		0.007	
	11/16/94	800	0.002	0.068	< 0.005	< 0.005	< 0.005	0.037	< 0.005	0.012	< 0.001	< 0.001	< 0.005	0.006	0.030
	12/7/94	905	0.002	< 0.050	< 0.005	< 0.005	< 0.005	0.029	< 0.005	0.009		< 0.001	< 0.005	< 0.005	
	12/21/94	805	0.002	< 0.050	< 0.005	< 0.005	< 0.005	0.061	< 0.005	0.015	< 0.001	< 0.001	< 0.005	< 0.005	0.051
	1/4/95	920	0.002			< 0.005	0.007	0.130	< 0.005	0.060		< 0.001		0.210	
	1/18/95	800	0.002	< 0.050	< 0.005	< 0.005	< 0.005	0.060	< 0.005	< 0.005	< 0.001	< 0.001	< 0.005	< 0.005	0.022
	2/1/95	750	0.002			< 0.005	0.006	0.069	< 0.005	< 0.005		< 0.001		0.007	
	2/15/95	730	0.002	< 0.050	< 0.005	< 0.005	< 0.005	0.120	< 0.005	0.029	< 0.001	< 0.001	< 0.005	< 0.005	0.060
	3/1/95	745	0.002			< 0.005	< 0.005	0.120	< 0.005	0.026		< 0.001		0.005	
	3/14/95	950	0.001	< 0.050	< 0.005	< 0.005	< 0.005	0.058	< 0.005	0.007	< 0.001	0.001	< 0.005	< 0.005	0.020
	3/15/95	940	0.001	< 0.050	< 0.005	< 0.005	< 0.005	0.094	< 0.005	< 0.005	< 0.001	0.001	< 0.005	< 0.005	0.050
	4/19/95	825	0.002	< 0.050	< 0.005	< 0.005	< 0.005	0.096	< 0.005	0.006	< 0.001	< 0.001	< 0.005	0.005	0.062
	5/4/95	710	0.002	< 0.050	< 0.005	< 0.005	< 0.005	0.026	< 0.005	0.006		< 0.001	< 0.005	0.013	
	5/17/95	715	0.002	< 0.050	< 0.005	< 0.005	< 0.005	0.023	< 0.005	0.011	< 0.001	< 0.001	< 0.005	< 0.005	0.010
	6/21/95	715	0.001	< 0.050	< 0.005	< 0.005	< 0.005	0.023	< 0.005	0.007	< 0.001	< 0.001	< 0.005	< 0.005	< 0.010
	7/19/95	715	0.001	< 0.050	< 0.005	< 0.005	< 0.005	0.025	< 0.005	< 0.005	< 0.001	< 0.001	< 0.005	< 0.005	< 0.010
	8/16/95	1000	0.002	< 0.050	< 0.005	< 0.005	< 0.005	0.011	< 0.005	0.007	< 0.001	< 0.001	< 0.005	< 0.005	0.010
	9/20/95	745	0.002	< 0.050	< 0.005	< 0.005	< 0.005	0.011	< 0.005	< 0.005	< 0.001	< 0.001	< 0.005	< 0.005	< 0.010
	10/18/95	635	0.002	< 0.050	< 0.005	< 0.005	< 0.005	0.018	< 0.005	< 0.005	< 0.001	< 0.001	< 0.005	< 0.005	< 0.010
	11/15/95	850	0.002	< 0.050	< 0.005	< 0.005	< 0.005	0.020	< 0.005	0.009	< 0.001	< 0.001	< 0.005	< 0.005	< 0.010
	12/20/95	1015	0.002	< 0.050	< 0.005	< 0.005	< 0.005	0.030	< 0.005	0.012	< 0.001	< 0.001	< 0.005	< 0.005	< 0.010
CALIFORNIA AQUEDUCT NEAR KETTLEMAN CITY (CHECK 21)															
KA017226	1/5/94	700	0.002			< 0.005	< 0.005	0.055	< 0.005	0.013		< 0.001		< 0.005	
	1/19/94	700	0.002	0.057	< 0.005	< 0.005	< 0.005	0.150	< 0.005	0.014	< 0.001	< 0.001	< 0.005	0.005	0.086
	2/2/94	700	0.002			< 0.005	< 0.005	0.102	< 0.005	0.016		< 0.001		< 0.005	
	2/16/94	700	< 0.001	< 0.050	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.001	< 0.001	< 0.005	< 0.005	< 0.010
	2/16/94	700	0.002	< 0.050	< 0.005	< 0.005	< 0.005	0.072	< 0.005	0.012	< 0.001	< 0.001	< 0.005	< 0.005	< 0.010
	3/2/94	700	0.002			< 0.005	0.007	0.079	< 0.005	0.021		< 0.001		0.011	
	3/16/94	700	0.002	0.084	< 0.005	< 0.005	< 0.005	0.075	< 0.005	0.006	< 0.001	< 0.001	< 0.005	< 0.005	0.018
	4/6/94	600	0.002			< 0.005	< 0.005	0.038	< 0.005	< 0.005		< 0.001		0.011	
	4/20/94	600	0.002	< 0.050	< 0.005	< 0.005	< 0.005	0.032	< 0.005	< 0.005	< 0.001	< 0.001	< 0.005	< 0.005	0.024
	5/4/94	600	0.003			< 0.005	< 0.005	< 0.005	< 0.005	0.010		< 0.001		< 0.005	0.002
	5/18/94	600	0.002	< 0.050	< 0.005	< 0.005	< 0.005	0.033	< 0.005	< 0.005	< 0.001	< 0.001	< 0.005	< 0.005	0.030
	6/1/94	600	0.002			< 0.005	< 0.005	0.036	< 0.005	< 0.005		< 0.001		< 0.005	
	6/15/94	600	0.002	< 0.050	< 0.005	< 0.005	< 0.005	0.012	< 0.005	0.005	< 0.001	< 0.001	< 0.005	< 0.005	0.011
	7/6/94	600	0.003			< 0.005	< 0.005	0.030	< 0.005	< 0.005		< 0.001		0.010	
	7/20/94	600	0.002	< 0.050	< 0.005	< 0.005	< 0.005	0.014	< 0.005	< 0.005	< 0.001	< 0.001	< 0.005	< 0.005	0.016
	8/3/94	600	0.003			< 0.005	< 0.005	0.024	< 0.005	< 0.005		< 0.001		0.007	
	8/17/94	600	0.003	< 0.050	< 0.005	< 0.005	< 0.005	0.014	< 0.005	0.054	< 0.001	< 0.001	< 0.005	< 0.005	< 0.010
	9/7/94	600	0.003			< 0.005	< 0.005	0.017	< 0.005	0.036		< 0.001		0.016	
	9/21/94	600	0.003	< 0.050	< 0.005	< 0.005	< 0.005	0.008	< 0.005	0.019	< 0.001	< 0.001	< 0.005	< 0.005	0.011

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TABLE A-2. MINOR ELEMENTS ANALYSES AT SELECTED SWP LOCATIONS

STATION NAME STATION I.D.#	DATE	TIME	As	Ba	Cd	Cr	Cu	Fe	Pb	Mn	Hg	Se	Ag	Zn	Al
			CONCENTRATION IN MG/L*, FILTERED												
CALIFORNIA AQUEDUCT NEAR KETTLEMAN CITY (CHECK 21) (continued)															
KA017226	10/5/94	600	0.003			< 0.005	< 0.005	0.010	< 0.005	< 0.005		< 0.001		< 0.005	
	10/19/94	600	0.004	< 0.050	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.001	< 0.001	< 0.005	< 0.005	< 0.010
	11/2/94	700	0.003			< 0.005	< 0.005	0.043	< 0.005	< 0.005		< 0.001		< 0.005	
	11/16/94	800	0.003	0.058	< 0.005	< 0.005	< 0.005	0.027	< 0.005	0.007	< 0.001	< 0.001	< 0.005	0.005	0.050
	12/7/94	830	0.003	< 0.050	< 0.005	< 0.005	< 0.005	0.019	< 0.005	< 0.005		< 0.001	< 0.005	0.008	
	12/21/94	800	0.003	< 0.050	< 0.005	< 0.005	< 0.005	0.025	< 0.005	< 0.005	< 0.001	< 0.001	< 0.005	< 0.005	0.027
	1/4/95	925	0.002			< 0.005	< 0.005	0.028	< 0.005	< 0.005		< 0.001		0.015	
	1/18/95	800	0.002	< 0.050	< 0.005	< 0.005	< 0.005	0.010	< 0.005	< 0.005	< 0.001	< 0.001	< 0.005	< 0.005	< 0.010
	2/1/95	830	0.002			< 0.005	0.005	0.069	< 0.005	0.022		< 0.001		0.008	
	2/15/95	830	0.002	< 0.050	< 0.005	< 0.005	0.007	0.046	< 0.005	0.014	< 0.001	< 0.001	< 0.005	< 0.005	0.024
	3/1/95	900	0.002			< 0.005	0.008	0.120	< 0.005	0.007		< 0.001		0.010	
	3/14/95	1720	0.002	0.054	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.001		< 0.005	0.009	0.013
	3/14/95	1720	0.002	0.054	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.001	0.005	< 0.005	0.009	0.013
	3/14/95	1720	0.002	0.054	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.001		< 0.005	0.009	0.013
	4/5/95	800	0.002	< 0.050	< 0.005	< 0.005	< 0.005	0.016	< 0.005	< 0.005		0.001	< 0.005	0.013	
	4/19/95	800	0.002	< 0.050	< 0.005	< 0.005	0.005	0.015	< 0.005	< 0.005	< 0.001	< 0.001	< 0.005	< 0.005	0.012
	5/17/95	700	0.002	< 0.050	< 0.005	< 0.005	< 0.005	0.010	< 0.005	< 0.005	< 0.001	< 0.001	< 0.005	< 0.005	< 0.010
	6/21/95	630	0.001	< 0.050	< 0.005	< 0.005	< 0.005	0.011	< 0.005	0.005	< 0.001	< 0.001	< 0.005	< 0.005	< 0.010
	7/19/95	600	0.002	< 0.050	< 0.005	< 0.005	< 0.005	0.059	< 0.005	0.010	< 0.001	< 0.001	< 0.005	< 0.005	0.033
	8/16/95	400	0.002	< 0.050	< 0.005	< 0.005	< 0.005	0.045	< 0.005	0.007	< 0.001	< 0.001	< 0.005	< 0.005	0.045
	9/19/95	1410	0.002	< 0.050	< 0.005	< 0.005	< 0.005	0.009	< 0.005	< 0.005	< 0.001	< 0.001	< 0.005	< 0.005	< 0.010
	10/18/95	615	0.002	< 0.050	< 0.005	< 0.005	< 0.005	0.058	< 0.005	< 0.005	< 0.001	< 0.001	< 0.005	< 0.005	0.050
	11/15/95	830	0.002	< 0.050	< 0.005	< 0.005	< 0.005	0.076	< 0.005	< 0.005	< 0.001	< 0.001	< 0.005	0.123	0.077
	12/20/95	645	0.002	< 0.050	< 0.005	< 0.005	< 0.005	0.035	< 0.005	0.008	< 0.001	< 0.001	< 0.005	< 0.005	0.028
CALIFORNIA AQUEDUCT AT CHECK 29															
KA024454	1/18/94	1100	0.002	0.054	< 0.005	< 0.005	< 0.005	0.100	< 0.005	0.006	< 0.001	< 0.001	< 0.005	0.014	0.077
	2/15/94	1110	0.002	< 0.050	< 0.005	< 0.005	< 0.005	0.105	< 0.005	0.010	< 0.001	< 0.001	< 0.005	0.014	0.051
	2/15/94	1134	< 0.001	< 0.050	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.001	< 0.001	< 0.005	< 0.005	< 0.010
	2/15/94	1135	< 0.001	< 0.050	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005		< 0.001	< 0.005	< 0.005	< 0.010
	3/15/94	930	0.002	0.094	< 0.005	< 0.005	0.013	0.156	< 0.005	0.008	< 0.001	< 0.001	< 0.005	0.007	0.076
	4/19/94	1020	0.002	0.064	< 0.005	< 0.005	0.013	0.024	< 0.005	0.012	< 0.001	0.001	< 0.005	0.035	0.035
	5/3/94	1210	0.002	0.066	< 0.005	< 0.005	< 0.005	0.015	< 0.005	0.020	< 0.001	< 0.001	< 0.005	0.023	0.031
	5/17/94	1030	0.003	0.062	< 0.005	< 0.005	< 0.005	0.033	< 0.005	< 0.005	< 0.001	< 0.001	< 0.005	0.024	0.054
	6/7/94	1010	0.002	< 0.050	< 0.005	< 0.005	0.010	0.039	< 0.005	0.006	< 0.001	< 0.001	< 0.005	0.012	0.022
	6/14/94	958	0.002	< 0.050	< 0.005	< 0.005	0.008	0.052	< 0.005	0.015	< 0.001	< 0.001	< 0.005	0.012	0.036
	7/5/94	930	0.002	< 0.050	< 0.005	< 0.005	< 0.005	0.009	< 0.005	< 0.005	< 0.001	< 0.001	< 0.005	< 0.005	0.010
	7/19/94	910	0.002	< 0.050	< 0.005	< 0.005	< 0.005	0.019	< 0.005	< 0.005	< 0.001	< 0.001	< 0.005	0.008	0.035
	8/2/94	1130	0.003	< 0.050	< 0.005	< 0.005	< 0.005	0.031	< 0.005	< 0.005	< 0.001	< 0.001	< 0.005	0.010	0.044
	8/16/94	915	0.003	< 0.050	< 0.005	< 0.005	< 0.005	0.016	< 0.005	< 0.005	< 0.001	< 0.001	< 0.005	0.006	0.057
	9/6/94	920	0.003	0.055	< 0.005	< 0.005	< 0.005	0.029	< 0.005	< 0.005	< 0.001	< 0.001	< 0.005	0.009	0.048
	9/20/94	1030	0.003	< 0.050	< 0.005	< 0.005	< 0.005	0.039	< 0.005	< 0.005	< 0.001	< 0.001	< 0.005	0.011	0.052
	10/4/94	1000	0.003	< 0.050	< 0.005	< 0.005	< 0.005	0.036	< 0.005	< 0.005	< 0.001	< 0.001	< 0.005	0.010	0.036
	10/18/94	940	0.003	< 0.050	< 0.005	< 0.005	< 0.005	0.022	< 0.005	< 0.005	< 0.001	< 0.001	< 0.005	0.007	0.027
	11/1/94	1045	0.003	< 0.050	< 0.005	< 0.005	< 0.005	0.017	< 0.005	< 0.005	< 0.001	< 0.001	< 0.005	0.006	0.024
	11/15/94	1020	0.003	0.063	< 0.005	< 0.005	< 0.005	0.025	< 0.005	< 0.005	< 0.001	< 0.001	< 0.005	0.014	0.038

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TABLE A-2. MINOR ELEMENTS ANALYSES AT SELECTED SWP LOCATIONS

CONCENTRATION IN MG/L*, FILTERED

STATION NAME STATION I.D.#	DATE	TIME	As	Ba	Cd	Cr	Cu	Fe	Pb	Mn	Hg	Se	Ag	Zn	Al
CALIFORNIA AQUEDUCT AT CHECK 29 (continued)															
KA024454	12/6/94	1008	0.003	< 0.050	< 0.005	< 0.005	< 0.005	0.009	< 0.005	< 0.005	< 0.001	< 0.001	< 0.005	< 0.005	0.021
	12/20/94	1005	< 0.001	< 0.050	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.001	< 0.001	< 0.005	< 0.005	< 0.010
	1/3/95	1140	0.003	< 0.050	< 0.005	< 0.005	< 0.005	0.013	< 0.005	< 0.005	< 0.001	< 0.001	< 0.005	< 0.005	< 0.010
	1/17/95	1055	0.002	< 0.050	< 0.005	< 0.005	< 0.005	0.017	< 0.005	< 0.005	< 0.001	< 0.001	< 0.005	< 0.005	< 0.010
	2/7/95	1021	0.002	< 0.050	< 0.005	< 0.005	< 0.005	0.048	< 0.005	< 0.005	< 0.001	< 0.001	< 0.005	0.010	0.012
	2/14/95	1055	0.002	< 0.050	< 0.005	< 0.005	0.010	0.048	< 0.005	< 0.005	< 0.001	< 0.001	< 0.005	0.009	0.011
	3/14/95	945	0.001	< 0.050	< 0.005	< 0.005	< 0.005	0.047	< 0.005	< 0.005	< 0.001	< 0.001	< 0.005	0.008	0.015
	4/4/95	930	0.002	< 0.050	< 0.005	< 0.005	< 0.005	0.010	< 0.005	< 0.005	< 0.001	0.002	< 0.005	< 0.005	0.019
	4/18/95	1009	0.002	< 0.050	< 0.005	< 0.005	< 0.005	0.012	< 0.005	< 0.005	< 0.001	0.001	< 0.005	0.007	< 0.010
	5/16/95	1008	0.001	< 0.050	< 0.005	< 0.005	< 0.005	0.023	< 0.005	< 0.005	< 0.001	< 0.001	< 0.005	0.006	< 0.010
	6/20/95	1115	0.002	< 0.050	< 0.005	< 0.005	< 0.005	0.031	< 0.005	< 0.005	< 0.001	< 0.001	< 0.005	< 0.005	0.034
	7/18/95	1045	0.002	< 0.050	< 0.005	< 0.005	< 0.005	0.073	< 0.005	< 0.005	< 0.001	< 0.001	< 0.005	< 0.005	0.034
	8/15/95	1010	0.002	< 0.050	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.001	< 0.001	< 0.005	< 0.005	< 0.010
	9/19/95	1234	0.002	< 0.050	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.001	< 0.001	< 0.005	< 0.005	< 0.010
	10/17/95	1015	0.002	< 0.050	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.001	< 0.001	< 0.005	< 0.005	< 0.010
	11/14/95	920	0.002	< 0.050	< 0.005	< 0.005	< 0.005	0.032	< 0.005	< 0.005	< 0.001	< 0.001	< 0.005	0.006	0.030
	12/19/95	1100	0.002	< 0.050	< 0.005	< 0.005	< 0.005	0.006	< 0.005	< 0.005	< 0.001	< 0.001	< 0.005	< 0.005	< 0.010
CALIFORNIA AQUEDUCT AT CHECK 41															
KA030341	1/19/94	730	0.001	< 0.050	< 0.005	< 0.005	< 0.005	0.095	< 0.005	< 0.005	< 0.001	< 0.001	< 0.005	< 0.005	0.042
	1/19/94	730	< 0.001	< 0.050	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.001	< 0.001	< 0.005	< 0.005	< 0.010
	2/16/94	730	0.002	0.072	< 0.005	< 0.005	< 0.005	0.067	< 0.005	< 0.005	< 0.001	< 0.001	< 0.005	< 0.005	0.033
	3/16/94	1100	0.002	0.077	< 0.005	< 0.005	< 0.005	0.047	< 0.005	< 0.005	< 0.001	0.001	< 0.005	< 0.005	0.043
	4/20/94	630	0.003	0.073	< 0.005	< 0.005	< 0.005	0.034	< 0.005	< 0.005	< 0.001	0.001	< 0.005	0.008	0.029
	5/3/94	900	0.002	0.054	< 0.005	< 0.005	< 0.005	0.025	< 0.005	< 0.005	< 0.001	< 0.001	< 0.005	< 0.005	0.020
	5/18/94	700	0.002	< 0.050	< 0.005	< 0.005	0.005	0.025	< 0.005	< 0.005	< 0.001	< 0.001	< 0.005	< 0.005	0.021
	6/15/94	900	0.002	0.060	< 0.005	< 0.005	< 0.005	0.025	< 0.005	< 0.005	< 0.001	< 0.001	< 0.005	0.007	0.019
	7/20/94	800	0.003	< 0.050	< 0.005	< 0.005	< 0.005	0.019	< 0.005	< 0.005	< 0.001	< 0.001	< 0.005	< 0.005	0.018
	8/17/94	615	0.003	< 0.050	< 0.005	< 0.005	< 0.005	0.042	< 0.005	< 0.005	< 0.001	< 0.001	< 0.005	0.008	0.024
	9/21/94	600	0.003	< 0.050	< 0.005	< 0.005	< 0.005	0.030	< 0.005	< 0.005	< 0.001	< 0.001	< 0.005	< 0.005	0.029
	10/19/94	640	0.003	< 0.050	< 0.005	< 0.005	< 0.005	0.023	< 0.005	< 0.005	< 0.001	< 0.001	< 0.005	< 0.005	0.020
	11/16/94	730	0.003	0.051	< 0.005	< 0.005	< 0.005	0.153	< 0.005	0.006	< 0.001	< 0.001	< 0.005	0.006	0.099
	12/21/94	830	0.003	< 0.050	< 0.005	< 0.005	< 0.005	0.010	< 0.005	< 0.005	< 0.001	< 0.001	< 0.005	< 0.005	0.100
	1/18/95	730	0.003			< 0.005	< 0.005	< 0.005	< 0.005	< 0.005		< 0.001		< 0.005	
	2/15/95	730	0.002	< 0.050	< 0.005	< 0.005	0.005	0.075	< 0.005	< 0.005	< 0.001	< 0.001	< 0.005	< 0.005	0.054
	3/15/95	730	0.002	< 0.050	< 0.005	< 0.005	< 0.005	0.095	< 0.005	< 0.005	< 0.001	< 0.001	< 0.005	< 0.005	0.056
	4/19/95	730	0.001	< 0.050	< 0.005	< 0.005	< 0.005	0.047	< 0.005	< 0.005	< 0.001	0.001	< 0.005	0.007	0.043
	5/17/95	700	0.001	< 0.050	< 0.005	< 0.005	< 0.005	0.018	< 0.005	< 0.005	< 0.001	< 0.001	< 0.005	0.007	0.012
	6/21/95	630	0.002	< 0.050	< 0.005	< 0.005	< 0.005	0.024	< 0.005	< 0.005	< 0.001	< 0.001	< 0.005	< 0.005	< 0.010
	7/19/95	700	0.002	< 0.050	< 0.005	< 0.005	< 0.005	0.028	< 0.005	< 0.005	< 0.001	< 0.001	< 0.005	< 0.005	0.012
	8/16/95	700	0.002	< 0.050	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.001	< 0.001	< 0.005	< 0.005	< 0.010
	9/20/95	700	0.002	< 0.050	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.001	< 0.001	< 0.005	< 0.005	< 0.010
	10/18/95	600	0.002	< 0.050	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.001	< 0.001	< 0.005	< 0.005	< 0.010
	11/15/95	730	0.002	< 0.050	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.001	< 0.001	< 0.005	< 0.005	< 0.010
	12/20/95	730	0.002	< 0.050	< 0.005	< 0.005	< 0.005	0.008	< 0.005	< 0.005	< 0.001	< 0.001	< 0.005	< 0.005	< 0.010

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TABLE A-2. MINOR ELEMENTS ANALYSES AT SELECTED SWP LOCATIONS

CONCENTRATION IN MG/L*, FILTERED

STATION NAME / STATION I.D.#	DATE	TIME	As	Ba	Cd	Cr	Cu	Fe	Pb	Mn	Hg	Se	Ag	Zn	Al
CALIFORNIA AQUEDUCT AT DEVIL CANYON															
KA041288	1/19/94	1100	0.002	< 0.050	< 0.005	< 0.005	< 0.005	0.017	< 0.005	0.006	< 0.001	< 0.001	< 0.005	< 0.005	0.027
	2/16/94	1130	0.002	< 0.050	< 0.005	< 0.005	0.005	0.014	< 0.005	< 0.005	< 0.001	< 0.001	< 0.005	< 0.005	0.013
	3/16/94	600	0.002	< 0.050	< 0.005	< 0.005	< 0.005	0.008	< 0.005	< 0.005	< 0.001	< 0.001	< 0.005	< 0.005	0.087
	4/20/94	1100	0.002	< 0.050	< 0.005	< 0.005	< 0.005	0.013	< 0.005	< 0.005	< 0.001	< 0.001	< 0.005	0.005	< 0.010
	5/18/94	600	0.002	0.052	< 0.005	< 0.005	< 0.005	0.012	< 0.005	< 0.005	< 0.001	< 0.001	< 0.005	0.006	< 0.010
	6/15/94	800	0.002	0.055	< 0.005	< 0.005	< 0.005	0.009	< 0.005	< 0.005	< 0.001	< 0.001	< 0.005	< 0.005	< 0.010
	7/20/94	600	0.002	< 0.050	< 0.005	< 0.005	< 0.005	0.013	< 0.005	< 0.005	< 0.001	< 0.001	< 0.005	< 0.005	0.023
	8/17/94	900	0.004	< 0.050	< 0.005	< 0.005	< 0.005	0.009	< 0.005	< 0.005	< 0.001	< 0.001	< 0.005	< 0.005	0.013
	9/21/94	800	0.003	< 0.050	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.001	< 0.001	< 0.005	< 0.005	< 0.010
	10/19/94	600	0.003	0.059	< 0.005	< 0.005	< 0.005	0.006	< 0.005	< 0.005	< 0.001	< 0.001	< 0.005	< 0.005	< 0.010
	11/16/94	700	0.003	0.051	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.001	< 0.001	< 0.005	< 0.005	0.015
	12/21/94	1030	0.003	< 0.050	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.001	< 0.001	< 0.005	< 0.005	0.010
	1/18/95	700	0.002			< 0.005	< 0.005	0.008	< 0.005	< 0.005		< 0.001		< 0.005	
	2/15/95	900	0.002	< 0.050	< 0.005	< 0.005	< 0.005	0.017	< 0.005	< 0.005	< 0.001	< 0.001	< 0.005	< 0.005	0.026
	3/15/95	800	0.002	< 0.050	< 0.005	< 0.005	0.005	0.015	< 0.005	< 0.005	< 0.001	< 0.001	< 0.005	0.006	0.024
	4/19/95	900	0.002	< 0.050	< 0.005	< 0.005	< 0.005	0.006	< 0.005	< 0.005	< 0.001	< 0.001	< 0.005	< 0.005	< 0.010
	5/17/95	1200	0.002	< 0.050	< 0.005	< 0.005	< 0.005	0.008	< 0.005	< 0.005	< 0.001	< 0.001	< 0.005	0.032	< 0.010
	6/21/95	800	0.002	< 0.050	< 0.005	< 0.005	< 0.005	0.024	< 0.005	< 0.005	< 0.001	< 0.001	< 0.005	< 0.005	0.019
	7/26/95	700	0.002	< 0.050	< 0.005	< 0.005	< 0.005	0.007	< 0.005	< 0.005	< 0.001	< 0.001	< 0.005	0.005	< 0.010
	8/16/95	1030	0.002	< 0.050	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	0.005	< 0.001	< 0.001	< 0.005	0.009	< 0.010
	9/20/95	900	0.002	< 0.050	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.001	< 0.001	< 0.005	< 0.005	< 0.010
	10/18/95	700	0.002	< 0.050	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	0.012	< 0.001	< 0.001	< 0.005	< 0.005	< 0.010
	11/15/95	800	0.002	< 0.050	< 0.005	< 0.005	< 0.005	0.017	< 0.005	0.013	< 0.001	< 0.001	< 0.005	< 0.005	0.032
	12/20/95	930	0.002	< 0.050	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.001	< 0.001	< 0.005	< 0.005	< 0.010
CASTAIC LAKE AT OUTLET TOWER															
CA002000	2/14/94	900	0.002	0.052	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.001	< 0.001	< 0.005	0.007	< 0.010
	5/16/94	830	0.002	< 0.050	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.001	< 0.001	< 0.005	< 0.005	< 0.010
	8/15/94	1030	0.002	< 0.050	< 0.005	< 0.005	0.005	< 0.005	< 0.005	< 0.005	< 0.001	< 0.001	< 0.005	0.006	< 0.010
	11/14/94	830	0.002	< 0.050	< 0.005	< 0.005	0.005	< 0.005	< 0.005	< 0.005	< 0.001	< 0.001	< 0.005	< 0.005	0.019
	2/14/95	830	0.002	< 0.050	< 0.005	< 0.005	0.005	0.009	< 0.005	< 0.005	< 0.001	< 0.001	< 0.005	< 0.005	0.013
	8/14/95	1000	0.002	< 0.050	< 0.005	< 0.005	0.010	< 0.005	< 0.005	< 0.005	< 0.001	< 0.001	< 0.005	< 0.005	< 0.010
	11/13/95	830	0.002	< 0.050	< 0.005	< 0.005	< 0.005	0.006	< 0.005	< 0.005	< 0.001	< 0.001	< 0.005	0.013	< 0.010

*As = ASENIC; Ba = BARIUM; Cd = CHLORIDE; Cr = CHROMIUM; Cu = COPPER; Fe = IRON; Pb = LEAD; Mn = MANGANESE; Hg = MERCURY; Se = SELENIUM; Ag = SILVER; Zn = ZINC; Al = ALUMINUM

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