4.0 *Water Quality*

4.1 *Introduction*

This chapter describes the existing water quality conditions in the Sacramento-San Joaquin River Delta, and evaluates the consequences of the proposed Interim South Delta Project on water quality within the Delta, on the quality of water exported for use throughout the State from the Delta, and on the quality of water withdrawn from the Delta for local use. It is organized as follows. Section 4.2 provides a description of existing Delta water quality in sufficient detail to provide a basis for evaluating potential project-related consequences. Section 4.3 provides analysis and discussion of the consequences associated with the construction and operation of the project. Section 4.4 provides mitigation measures for significant adverse consequences. Section 4.5 concludes the chapter with analysis of the water quality consequences of project alternatives.

4.2 *Environmental Setting/Affected Environment*

Water in the Delta is a mixture of tidally-introduced saline water from the Pacific Ocean and fresh water from the Sacramento River, San Joaquin River, and other source streams. The relative contribution of each source and the resulting pattern of mixing is governed by Delta hydrodynamics, which is discussed in the project description. Each of the sources of water to the Delta has a distinct chemical composition and contains pollutants from both point and non-point sources. This section utilizes field and laboratory analytical data to describe the characteristics of each of these sources of Delta water quality variations.

4.2.1 Water Quality Monitoring Programs

There are several historical and ongoing water quality studies and monitoring programs pertaining to the Delta. The results of these field studies and programs are used to describe the affected environment in this chapter. Descriptions of some of the more comprehensive programs follows.

DWR and Reclamation are jointly responsible for monitoring water quality conditions in the Delta under the provisions of the SWRCB's Decision 1485 (D1485) (SWRCB, 1978). Monitoring stations extend throughout the Delta, from Courtland on the Sacramento River, near Vernalis on the San Joaquin River, and from Suisun Bay to San Pablo Bay. Electrical conductivity, chloride (both measures of salinity), Delta outflow, and export rates are monitored.

The Interagency Ecological Study Program of the Sacramento-San Joaquin Estuary was initiated in 1970 by DWR, Reclamation, CDFG, and the USFWS to provide information on the effects of CVP and SWP exports on fish and wildlife in the Bay-Delta estuary. Water quality parameters measured include salinity and algal productivity.

The Municipal Water Quality Investigation Program, formerly the Interagency Delta Health Aspects Monitoring Program, was initiated in 1983 to provide a comprehensive source of water quality data for judging the suitability of the Delta as a source of drinking water. Issues of particular concern included sodium, asbestos, and trihalomethane formation potential.

DWR is investigating the quality of Delta agricultural return water through the Delta Island Drainage Investigation. The investigation has identified and mapped discharge points of agricultural return water.

4.2.2 Delta Water Quality

The discussion of existing water quality considers both Delta water sources and specific issues of concern. The section first describes the water quality in the two main sources of freshwater inflow to the Delta, the Sacramento and San Joaquin Rivers. Next, salinity within the Delta is described by data collected from 1978 to 1991 from five monitoring stations. The section then describes the following water quality concerns: 1) point-source discharges; 2) downstream waste discharges; 3) agricultural drainage in the Delta; 4) urban runoff; 5) trace metals; 6) trihalomethane formation potential; and 7) water quality effects of dredging. The section concludes with a description of Delta groundwater quality.

- *Sacramento River Water Quality*

The Sacramento River contributes approximately 76 percent of the freshwater inflow to the Delta. Water quality in the Sacramento River is generally good, although there are concerns related to agricultural and mine drainage, as described in the following.

Agricultural drainage may constitute up to 30 percent of the Sacramento River flow in May and June (Gunther *et al.* 1987). Monitoring from 1986 to 1989 consistently demonstrated that in May and June water in the Colusa Drain is potentially toxic, and the rice-field pesticides carbofuran, methyl parathion and malathion have been measured in the Sacramento River as far south as Rio Vista (Foe and Connor 1989). Between 1977 and 1979 the Sacramento Valley rice industry shifted from long- to short-stem rice cultivation, with a resultant increase in the number of acres of rice cultivated and the number and pounds of pesticides applied (SLC 1991). Although their use has been banned or significantly reduced, chlorinated pesticides have been detected in fish collected from the lower Sacramento River. DDT, toxaphene, hexachlorobenzene and chlordane in fish collected near Hood sometimes exceed the guideline concentration recommended by the National Academy of Science (SLC 1991).

Acidic drainage from mines located in the upper Sacramento River is a significant source of metals, particularly in the area from Lake Keswick to Red Bluff (SWRCB 1990). Mine drainage contributes cadmium, copper and chromium to the lower Sacramento River and the Delta (SWRCB 1990). Chromium, cadmium, copper, nickel and zinc have been found in fish collected near Keswick, and cadmium and chromium have been measured in fish collected in the Sacramento River near Hood (SWRCB 1990).

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- *San Joaquin River Water Quality*

The San Joaquin River contributes approximately 15 percent of the freshwater inflow to the Delta. The river is more saline than the Sacramento River and carries higher concentrations of several constituents, including nitrates, selenium, nickel, manganese and boron. The concentration of these constituents is highest just downstream of the confluence of Salt and Mud Sloughs (major sources of subsurface agricultural drainage) with the San Joaquin River; concentrations decrease upstream and downstream of this area (RWQCB 1991).

Agricultural drainage comprises a significant portion of San Joaquin River flow during the irrigation season and, occasionally, in January, February, and March following flushing of agricultural water from duck clubs (SWRCB 1990). Bioassays have found periodic toxicity in the river (SWRCB 1990), sometimes with high mortality over many miles (Foe 1989; 1990a,b). Analysis performed in April 1990 showed diazinon exceeded EPA's recommended criteria by a factor of 82-170 and carbofuran exceeded the Central Valley regional Water Quality Control Board's performance goal by a factor of 1-2 over a 36 mile reach of the San Joaquin River (Foe 1990b).

The regularly-collected D-1485 monitoring data do not show that the San Joaquin River is significantly higher in pesticide concentrations than the Sacramento River. Pesticide concentrations in water samples from all streams measured were below established drinking water limits. Selenium data collected by DWR and the USGS demonstrate that the San Joaquin River is not significantly degrading Delta water supplies.

- *Salinity Within The Delta*

Salinity data (electrical conductivity and chlorides) collected as part of the D-1485 monitoring program from 1978 through 1991 describe the range and variability of salinity in the Delta. The salinity at a particular location depends strongly on the tidal cycle, and for this reason minimum, maximum, and average values of salinity are presented. The salinity monitoring stations discussed (Figure 4-1) and the rationale for their selection are as follows: 1) Sacramento River at Freeport, representing inflow to the Delta; 2) San Joaquin River at Vernalis, representing inflow to the Delta; 3) Chipps Island, representing Delta outflow; 4) Clifton Court Forebay Intake, representing salinity objectives for municipal and industrial uses; 5) San Joaquin River at Jersey Point, representing salinity standards for agricultural uses; and 6) Sacramento River at Collinsville representing salinity standards for fish and wildlife uses. The water quality objectives for salinity are taken from the May 1995 Water Quality Control Plan for the San Francisco Bay/Sacramento-San Joaquin Delta Estuary (SWRCB 1995a), and are summarized in Table 4-1.

<u>Sacramento River at Greens Landing</u>. The monitoring station at Greens Landing represents the salinity of the Sacramento River as it enters the Delta (Figure 4-2). Average electrical conductivity (EC, a measure of salinity) ranges from approximately 90 µmhos/cm in 1981 to 240 µmhos/cm in 1984. These are the lowest salinities of any station presented in this section, and reflect the relatively high quality of Sacramento River water.

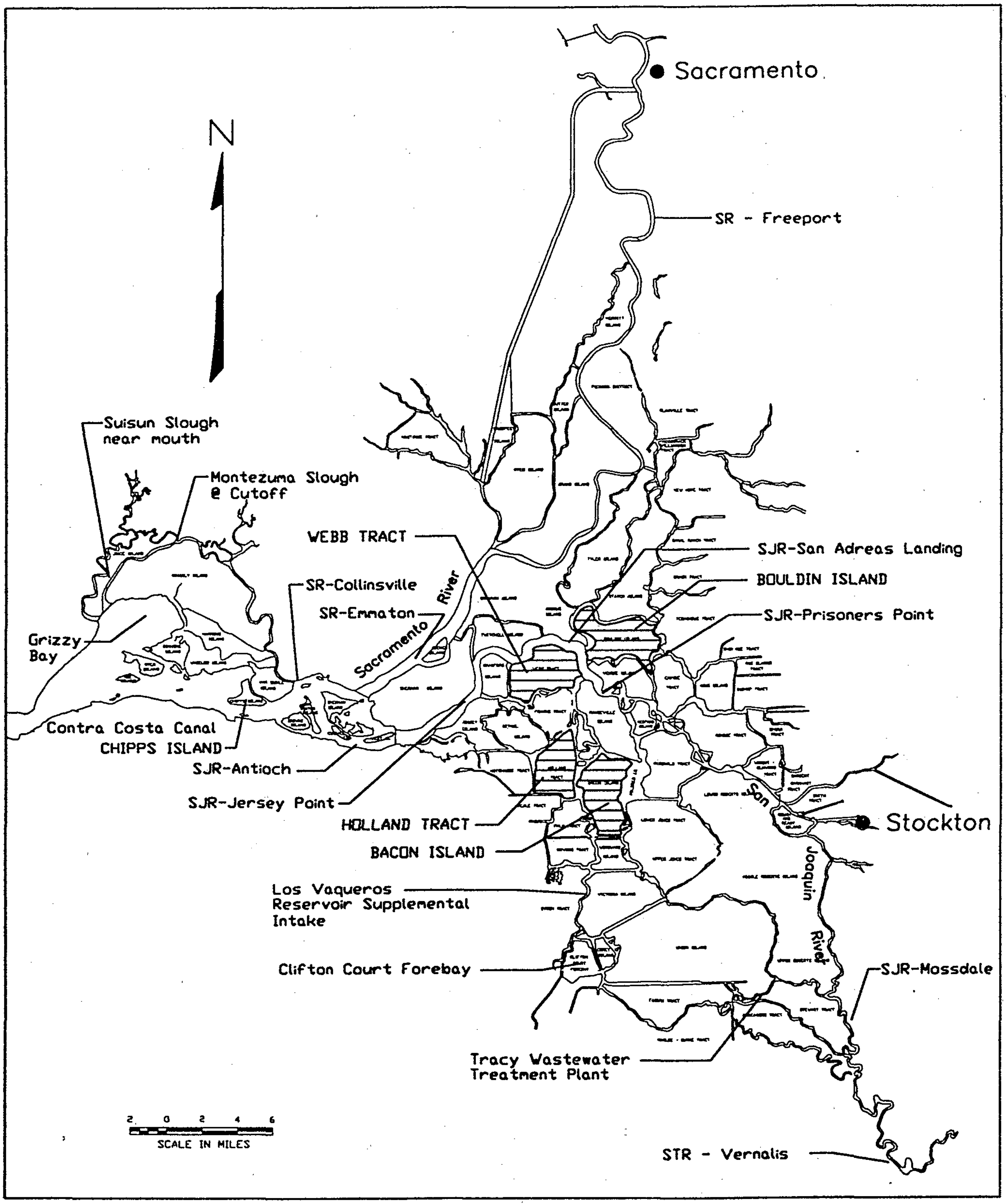

Figure 4-1. Water Quality Monitoring/Modeling Locations.

Table 4-1 Numeric Water Quality Objectives for Salinity in the Delta and Suisun Marsh*

Beneficial Use and Compliance Location	Year Type	Month	Value
MUNICIPAL AND INDUSTRIAL			
Contra Costa Canal Intake at Pumping Plant No. 1	All	All	250 mg/1 Chlorides
Clifton Court Forebay Intake at West Canal	All	All	250 mg/1 Chlorides†
Delta Mendota Canal at Tracy Pumping Plant	All	All	250 mg/1 Chlorides
Barker Slough at North Bay Aqueduct	All	All	250 mg/1 Chlorides
Cache Slough at City of Vallejo Intake	All	All	250 mg/1 Chlorides
Contra cost aCanal Intake at Pumping Plant No. 1 or San Joaquin River at Antioch Water Works Intake		Number of Days Each Calendar Year Less than 150 mg/1 Chloride	
	Wet	240 (66%)	
	Above Normal	190 (52%)	
	Below Normal	175 (48%)	
	Dry	165 (45%)	
	Critical	155 (42%)	
AGRICULTURAL			
Sacramento River at Emmaton		April 1 to August 15	0.45 EC‡
	Above Normal	April 1 to July 1	0.45 EC
		July 1 to August 15	0.63 EC
	Below Normal	April 1 to June 1	0.45 EC
		June 1 to August 15	1.14 EC
	Dry	April 1 to June 20	0.45 EC
		June 20 to August 15	1.67 EC
	Critical	April 1 to August 15	1.78 EC
SanJoaquin River at Jersey Point	Wet	April 1 to August 15	0.45 EC
	Above Normal	April 1 to August 15	0.45 EC
	Below Normal	April 1 to August 15	0.45 EC
		June 20 to August 15	0.74 EC
	Dry	April 1 to June 15	0.45 EC
		June 15 to August 15	1.35 EC
	Critical		2.20 EC
South Fork of Mokelumme River at Terminous	Wet	April 1 to August 15	0.45 EC
	Above Normal	April 1 to August 15	0.45 EC
	Below Normal	April 1 to August 15	0.45 EC
	Dry	April 1 to August 15	0.45 EC
	Critical	April 1 to August 15	0.54 EC
San Joaquin River at San Andreas Landing	Wet	April 1 to August 15	0.45 EC
	Above Normal	April 1 to August 15	0.45 EC
	Below Normal	April 1 to August 15	0.45 EC
	Dry	April 1 to June 25	0.45 EC
	Critical	June 25 to August 1	0.58 EC
		April 1 to August 15	0.87 EC

*Based on the Water Quality Control Plan for the San Francisco Bay/Sacramento-San Joaquin Delta Estuary dated May 1995.
†State Water Project objective for Clifton Court Forebay salinity is 100 mg/1 Chlorides.
‡EC - Electrical Conductivity is reported as maximum 14-day average in mmhos/cm.

Table 4-1 Numeric Water Quality Objectives for Salinity in the Delta and Suisun Marsh§ - continued

Beneficial Use and Compliance Location	Year Type	Month	Value
San Joaquin River at Airport Way Bridge, Vernails and San Joaquin River at Brandt Bridge and Old River near Middle River and Old River at Racy Road Bridge	All	April through August September through March	0.7** 1.0
Clifton Court Forebay Intake at West Canal and Delta Mendota Canal at Tracy Pumping Plant	All	All	1.0††
FISH AND WILDLIFE			
San Joaquin River at and between Jersey Point and Prisoners Point	Wet Above Normal, Below Normal and Dry	April and May	0.44 EC‡‡
Sacramento River at Collinsville and Montezuma Slough at National Steel and Montezuma Slough near Beldon Landing	All	October November January February and March April and May	19.0§§ 15.5 12.5 8.0 11.0
Chadbourne Slough at Sunrise Duck Club and Suisun Slough 300 ft. south of Volanti Slough and Cordelia Slough at Ibis Club and Goodyear Slough at Morrow Island Clubhouse and Water Supply intakes on Van Sickle and Chipps Is.	All (but deficiency period)	October November December January February and March April and May	19.0§§ 16.5 15.5 12.5 8.0 11.0
	Deficiency Period***	October November December through March April May	19.0 16.5 15.6 14.0 12.5
Brackish Tidal Marshes of Suisun Bay	Water quality conditions sufficient to support a natural gradient in species composition and wildlife habitat characteristics of a brackish marsh through all elevations of the tidal marshes bordering Suisun Bay must be maintained. Water quality conditions shall be maintained so that none of the following occurs: 1) loss of diversity; 2) conversion of brackish marsh to salt marsh; 3) for animals decreased population abundance of those species vulnerable to increased mortality and loss of habitat from increased water salinity; or 4) for plants, significant reduction in stature or percent cover from increased water or soil salinity of other water quality parameters.		

§Based on the Water Quality Control Plan for the San Francisco Bay/Sacramento-San Joaquin Delta Estuary dated May 1995.
**If a three-party contract has been implemented among the DWR, USBR, and SDWA, that contract will be reviewed prior to implementation of these objectives compliance/monitoring stations. The needs of other beneficial uses will also be considered prior to implementation. If implemented, values shall be reported as maximum 30-day running average of mean daily EC in mmhos/cm.
††Report as maximum monthly average of mean daily EC in mmhoscm.
‡‡EC - Electrical Conductivity is reported as maximum 14-day average in mmhos/cm.
§§Report as maximum monthly averge of both daily high tide EC values (mmhos/cm), or demonstrate that equivalent or better protection will be provided at the location.
***Deficiency period is defined as 1) the second consecutive dry water year following a critical year, 2) a dry water year following a year in which the Sacramento River Index was less than 11.35; or 3) a critical water year following a dry or critical water year.

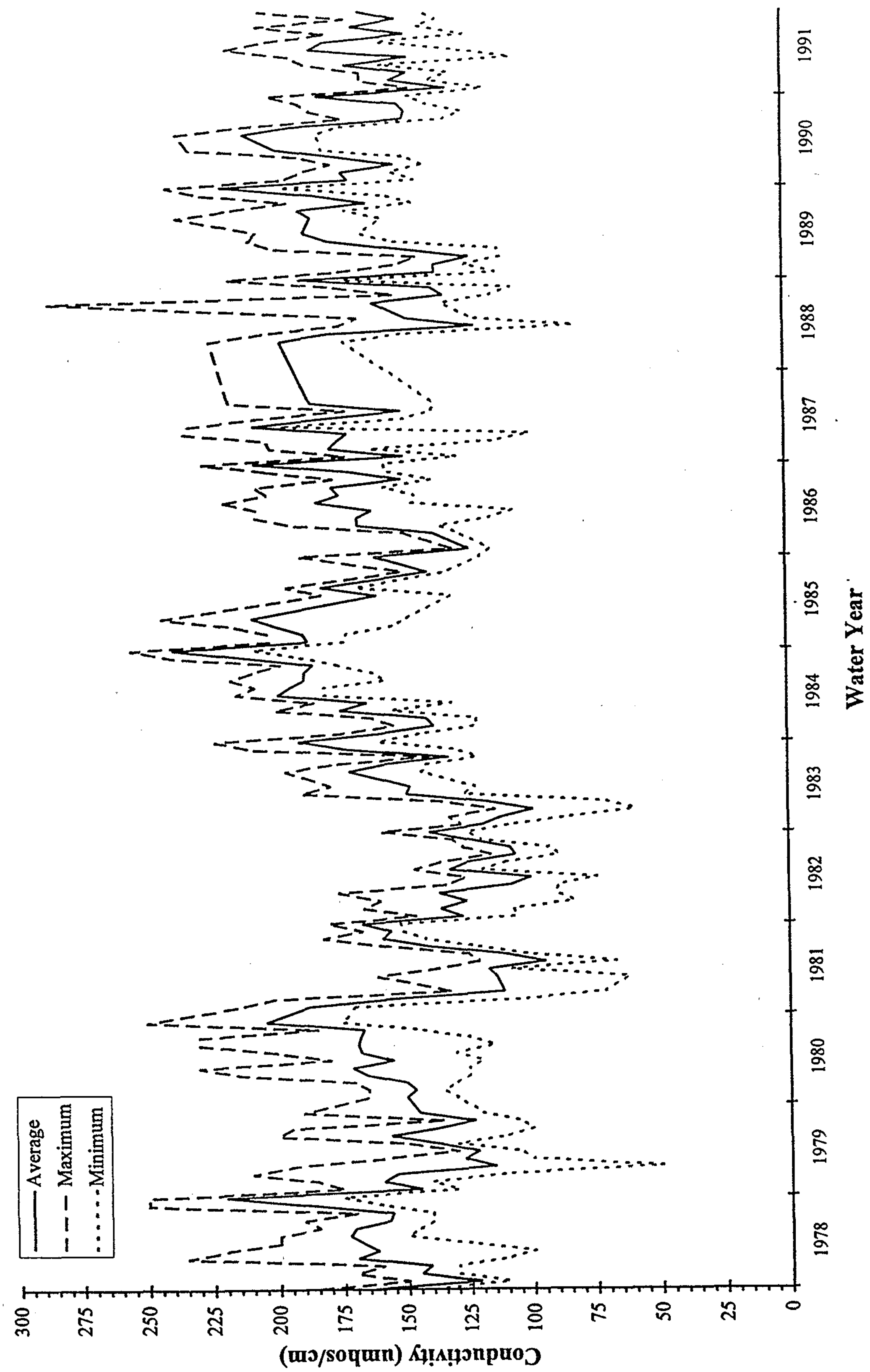

Figure 4-2. **Monthly Electrical Conductivity, Sacramento River at Greens Landing 1978-1991.**

San Joaquin River at Vernalis. The monitoring station at Vernalis represents the salinity of the San Joaquin River as it enters the Delta (Figure 4-3). Average EC ranges from approximately 120 µmhos/cm in 1981 and 1982 to 1260 µmhos/cm in 1987. The salinity of the San Joaquin River can be significantly higher than that of the Sacramento River.

Chipps Island. The monitoring station located at Chipps Island, considered the western end of the Delta, represents the salinity of Delta outflow (Figure 4-4). Salinity is much higher than the upstream stations owing to tidally-induced salt water intrusion. During the 14-year period from and critical years 1989 through 1991.

Clifton Court Forebay. The salinity data for Clifton Court Forebay indicate compliance with objectives for municipal water supplies. During all months of all year types, the 1995 Water Quality Control Plan salinity objective is 250 mg/l chloride (1150 µmhos/cm, according to DWR conversion) at the intake (Table 4-1); the SWP objective is 100 mg/l (560 µmhos/cm). Average EC values range from 125 µmhos/cm in 1982 to 850 µmhos/cm in 1990 (Figure 4-5). The minimum and maximum EC values vary greatly during the critical years 1989 through 1991, peaking at 2300 µmhos/cm.

San Joaquin River at Jersey Point. Salinity standards at this location are set to protect agricultural beneficial uses and vary depending on year type (Table 4-1). Objectives are set from April through mid-August, ranging from 91 mg/l chlorides (approximately 450 µmhos/cm EC) during wet years to 582 mg/l chloride (2200 µmhos/cm) during critical years. Monthly average EC for the period 1978-1991 (Figure 4-6) range from approximately 150 µmhos/cm during 1982 to 2500 µmhos/cm in 1987.

Sacramento River at Collinsville. Salinity standards at this location are set to protect fish and wildlife beneficial uses (Table 4-1). For each month from October through May during all year types the salinity objective ranges from 3457 mg/l chloride (11000 µmhos/cm) in May to 6021 mg/l chloride (19000 µmhos/cm) in October. Average monthly EC for the 14-year period varies from approximately 100 µmhos/cm in 1982 to 10500 µmhos/cm in 1991 (Figure 4-7).

- *Other Water Quality Concerns*

There are several water quality issues besides inflow and salinity that are of concern in the Delta. The following water quality issues are described as they pertain to the Delta: 1) point-source discharges; 2) downstream waste discharges; 3) Delta agricultural drainage; 4) urban runoff; 5) trace metals; 6) trihalomethane formation potential; and 7) water quality effects of dredging.

Point-Source Discharges. The primary point-source discharges in the Delta are listed in Table 4-2. Sewage treatment plants, industrial facilities and manufacturing facilities discharge water to the Delta. Between 1984 and 1986, the Sacramento Regional Waste Treatment Plant contributed 25 percent of the lead discharged to the Delta by the eight largest publicly owned treatment plants, and was a significant source of copper, chromium, and silver (Gunther *et al.*, 1987).

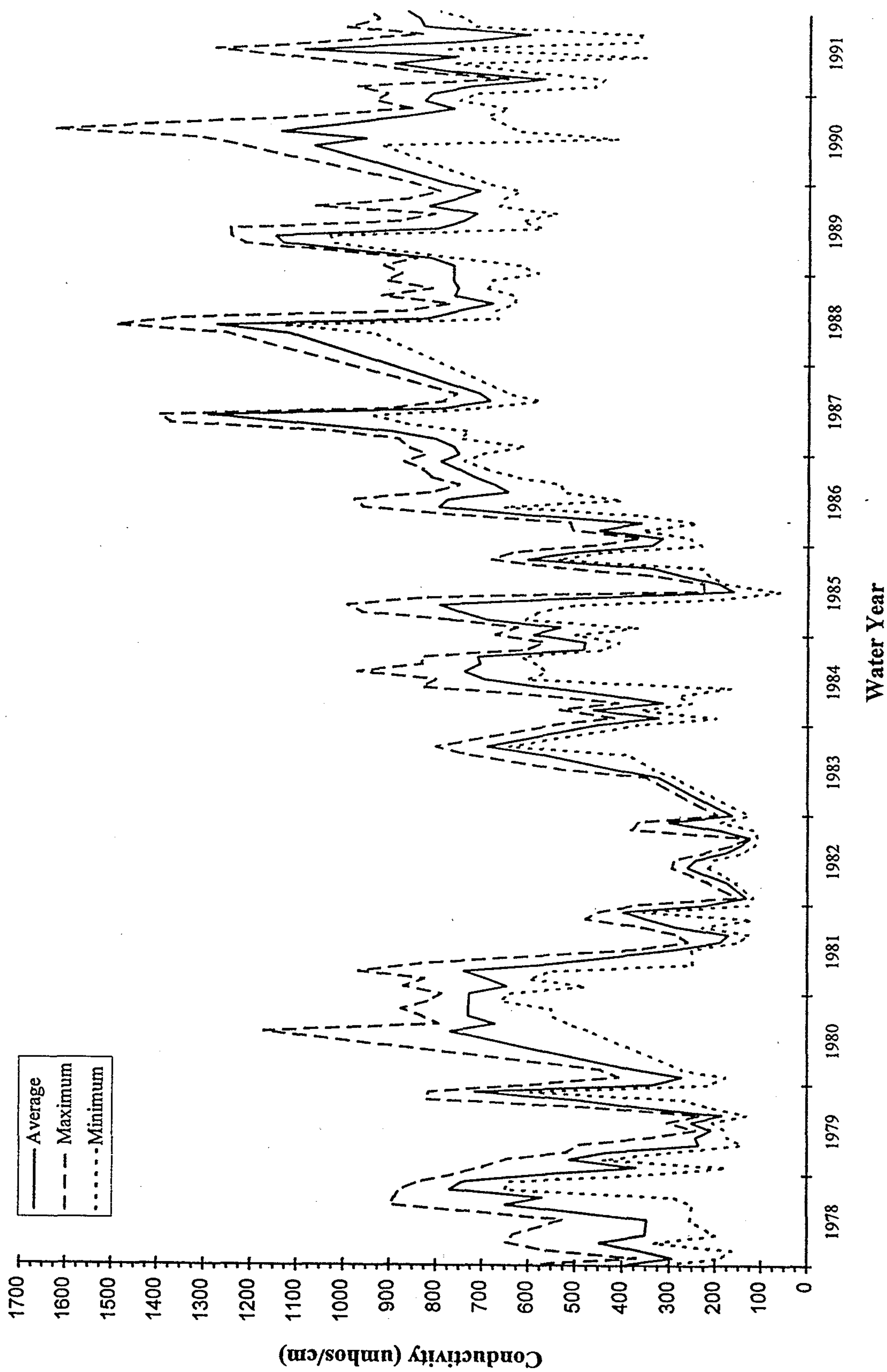

Figure 4-3. Monthly Electrical Conductivity, San Joaquin River at Vernalis 1978-1991.

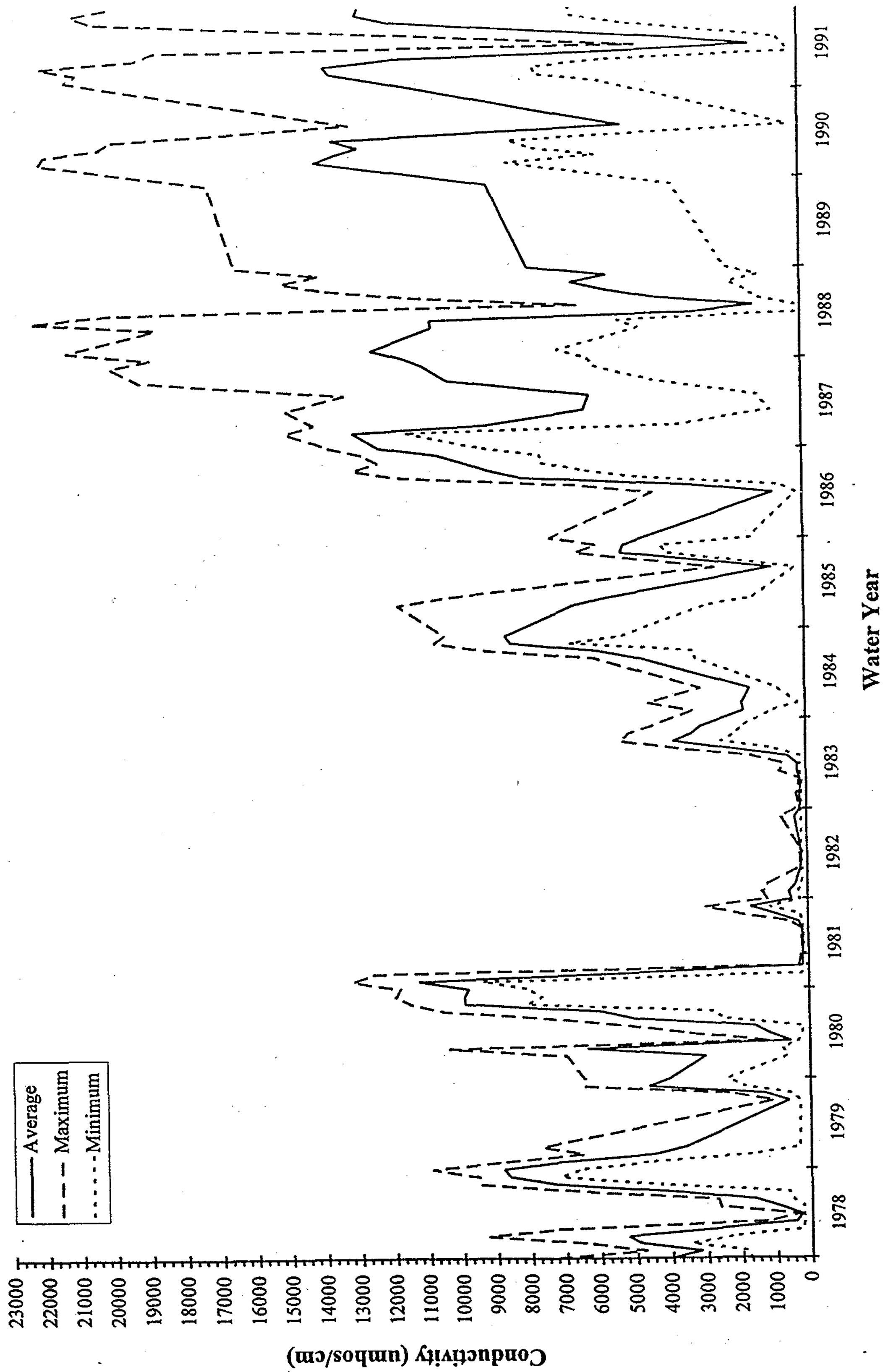

Figure 4-4. **Monthly Electrical Conductivity, Chipps Island 1978-1991.**

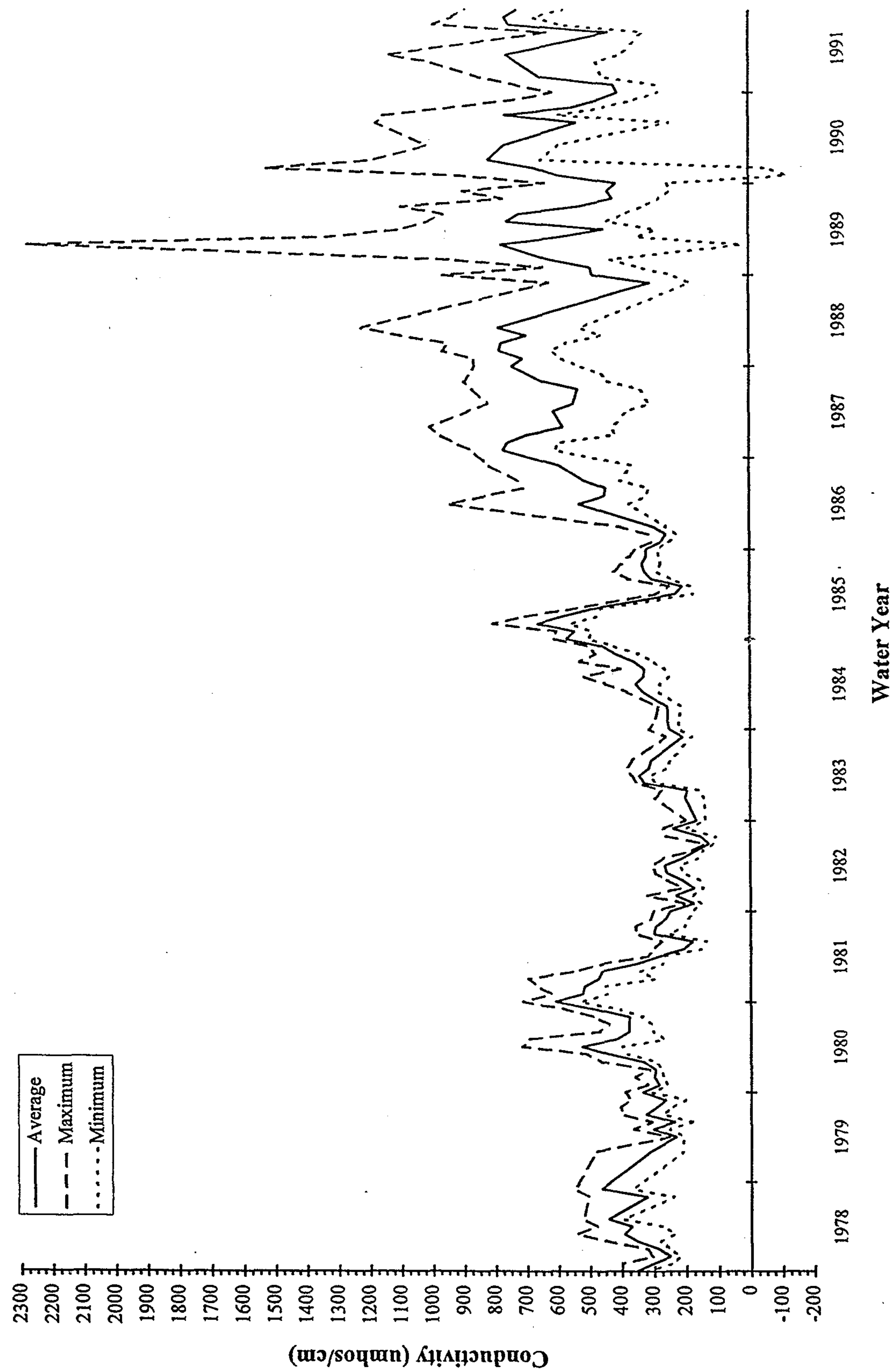

Figure 4-5. **Monthly Electrical Conductivity, Clifton Court Forebay 1978-1991.**

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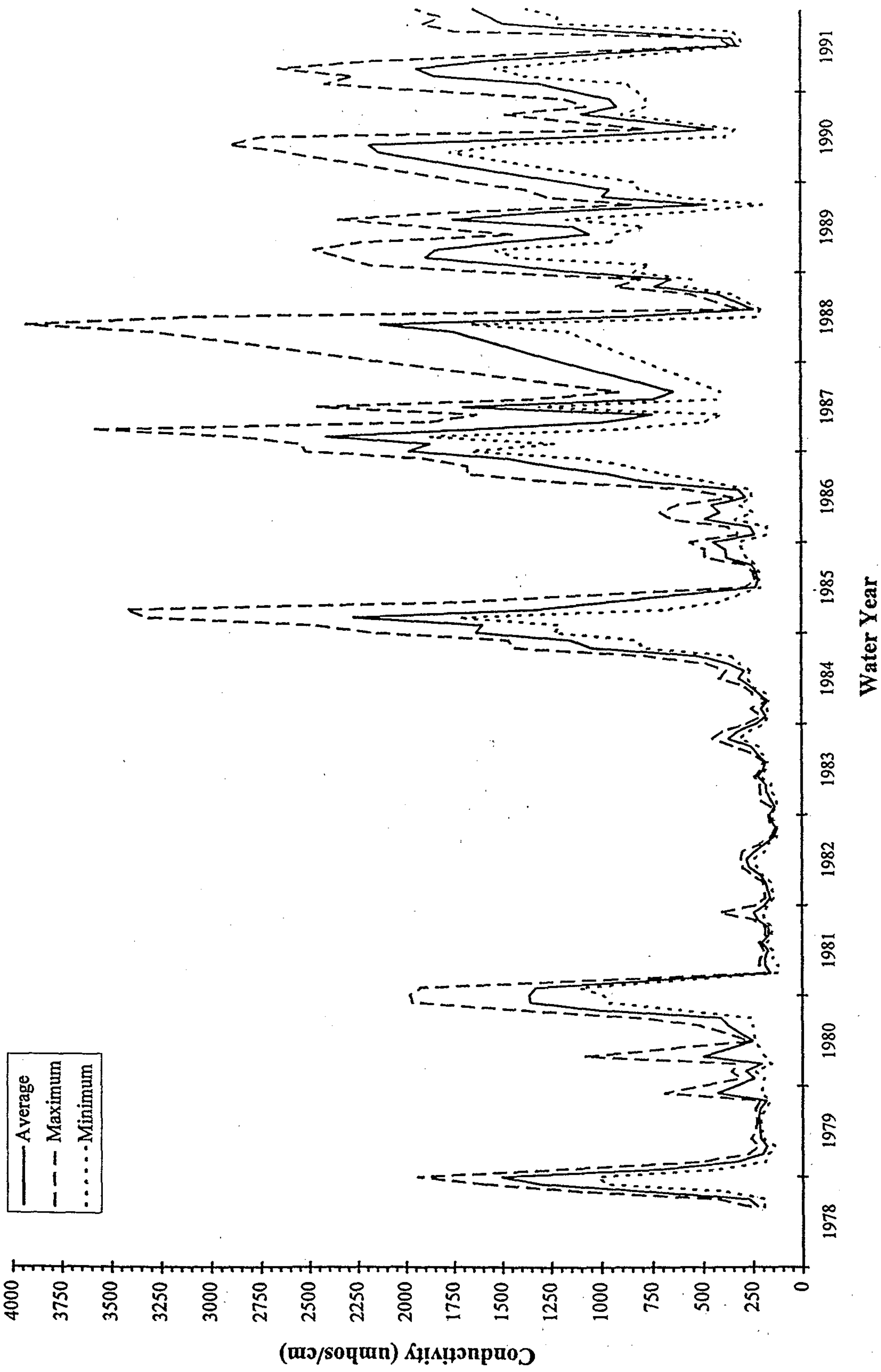

Figure 4-6. **Monthly Electrical Conductivity, San Joaquin River at Jersey Point 1978-1991.**

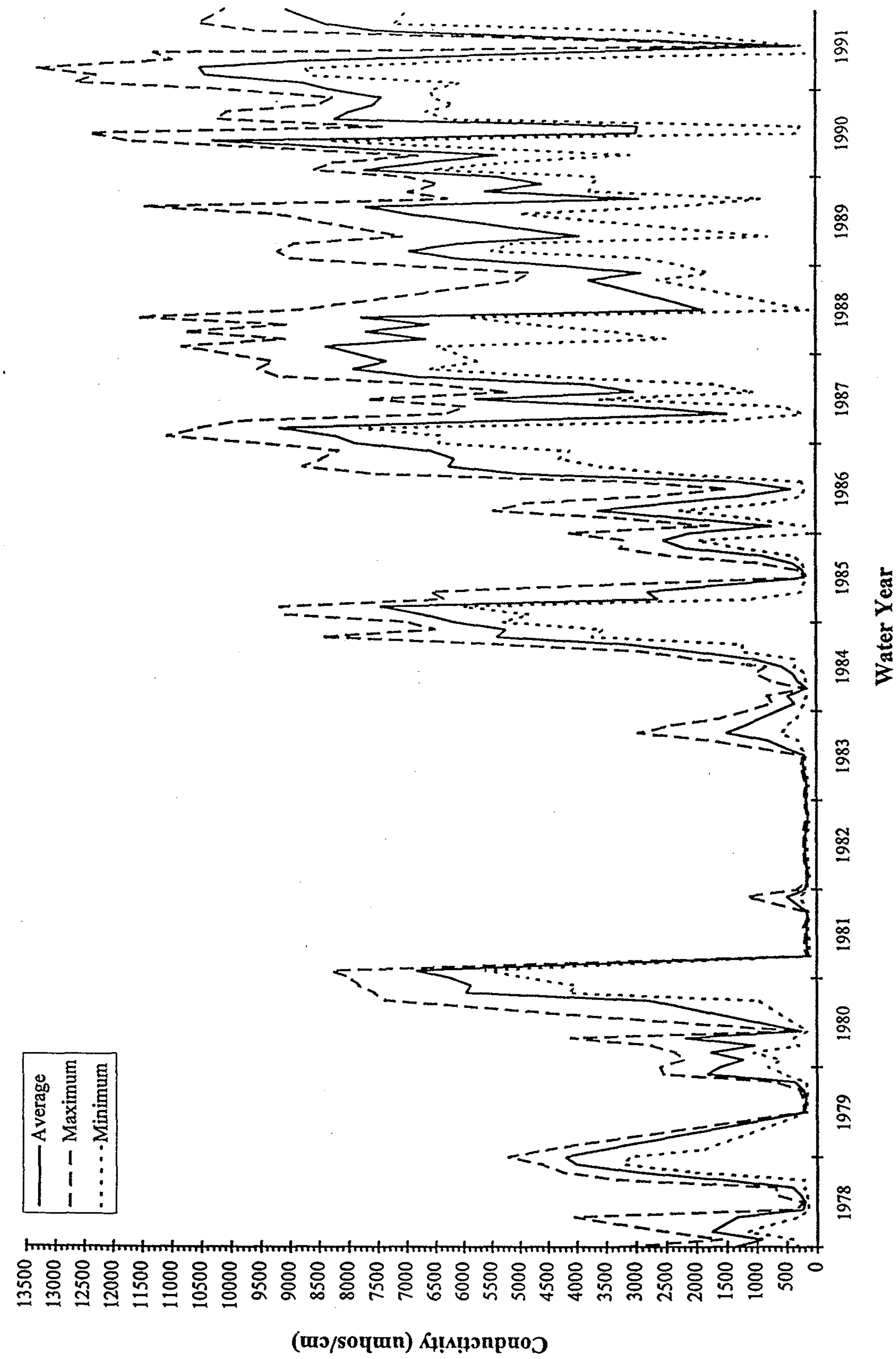

Figure 4-7. **Monthly Electrical Conductivity, Sacramento River at Collinsville 1978-1991.**

Table 4-2 Municipal and Industrial Outfalls in the Delta (after Gunther, *et al.*, 1987).

Discharger	Industry	Segment of the Estuary Receiving Waste	Avg. Flow 1984-1986 (mgd)
Sacramento RWTP	Delta POTW	North Delta	134.2
Stockton STP	Delta POTW	Central Delta	28.8
Lodi White Slough WPCP	Delta POTW	North Delta	5.0
West Sacramento STP	Delta POTW	North Delta	3.7
Tracy	Delta POTW	South Delta	3.7
Davis STP	Delta POTW	North Delta	3.2
Rio Vista WTP	Delta POTW	Central Delta	0.5
Central CCSD # 19	Delta POTW	Central Delta	0.3
Walnut Grove WTP	Delta POTW	North Delta	0.1a
PGE: Contra Costa	Power Plant	Central Delta	
Shell Oil (West Sacramento)	Oil Terminal	North Delta	
Tosco Corp.	Oil Terminal	North Delta	
Allied Energy	Oil Production	Central Delta	
Int'l Oil and Gas	Oil Production	Central Delta	
John Pestana Family	Oil Production	Central Delta	
Termo	Oil Production	Central Delta	
Crown Zellerbach	Paper	Central Delta	
Fibreboard	Paper	Central Delta	
Pacific Paperboard	Paper	Central Delta	
Discovery Bay	Lagoon	Central Delta	
Mohawk Rubber	Rubber	Central Delta	
Sacramento River Water TP	Water Treatment	North Delta	
Sharpe Army Depot	Depot	South Delta	
Union Carbide: Linde Div.	Gases	Central Delta	

a Reclaims wastewater in the summer. Wet season flows averaged over the entire year.

The south Delta in 1994. The discharge point is located on Old River just upstream from Paradise Cut (Figure 4-1). This plant has secondary treatment, and no heavy industrial sources within its service area. Two oil terminals, three paper processors, four oil production and several manufacturing facilities discharge to the Delta, and one power plant uses Delta water for cooling.

Downstream Waste Discharges. The area downstream from the Delta is heavily industrialized. Three refineries, four chemical plants, a steel processing plant, and two power plants discharge to Suisun Bay and the Carquinez Strait. The refineries are a significant source of selenium, while the U.S. Steel plant is a significant source of chromium (Gunther *et al.* 1987). There is also substantial oil tanker and other ship traffic through this area which creates the potential for oil or hazardous waste spills that could adversely affect Delta resources.

Non-Point Source Discharges - Delta Agricultural Drainage. More than 1,800 diversions provide water for crop and livestock production in the Delta (Figure 4-8), and water seeps onto the islands from surrounding channels. Water drained from the islands is pumped back into Delta channels at agricultural returns (Figure 4-9). Return water is typically saline and has high concentrations of organic compounds derived from the decay of vegetation and oxidation of the Delta's peat soils, and nutrients (nitrates and sulfates) derived from fertilizers. Water quality is particularly degraded in dead end channels of the south Delta such as Tom Paine Slough and Paradise Cut, as well as the reaches of Old River and San Joaquin River which have limited circulation. During the irrigation season, return water is recycled several times when flows are insufficient to flush the channel.

Pesticides are generally not typically detected in agricultural return water, except for small amounts of atrazine, simazine and 2, 4-D. Concentrations above the minimum reporting limit of chlorinated organic pesticides were detected at two of the eleven sites monitored within the Delta between 1987 and 1991 as part of DWR's D-1485 monitoring. Minimum reporting limits for marine toxicity levels for organisms proposed by the EPA, as well as primary or secondary drinking water standards. Several occurrences of chlorinated hydrocarbons were reported throughout the sampling network in May and July of 1982. No pesticides were found at the boundary stations of the Delta, suggesting that the chlorinated hydrocarbons were derived from agricultural activities within the Delta.

1 Personal Communication with City of Tracy.

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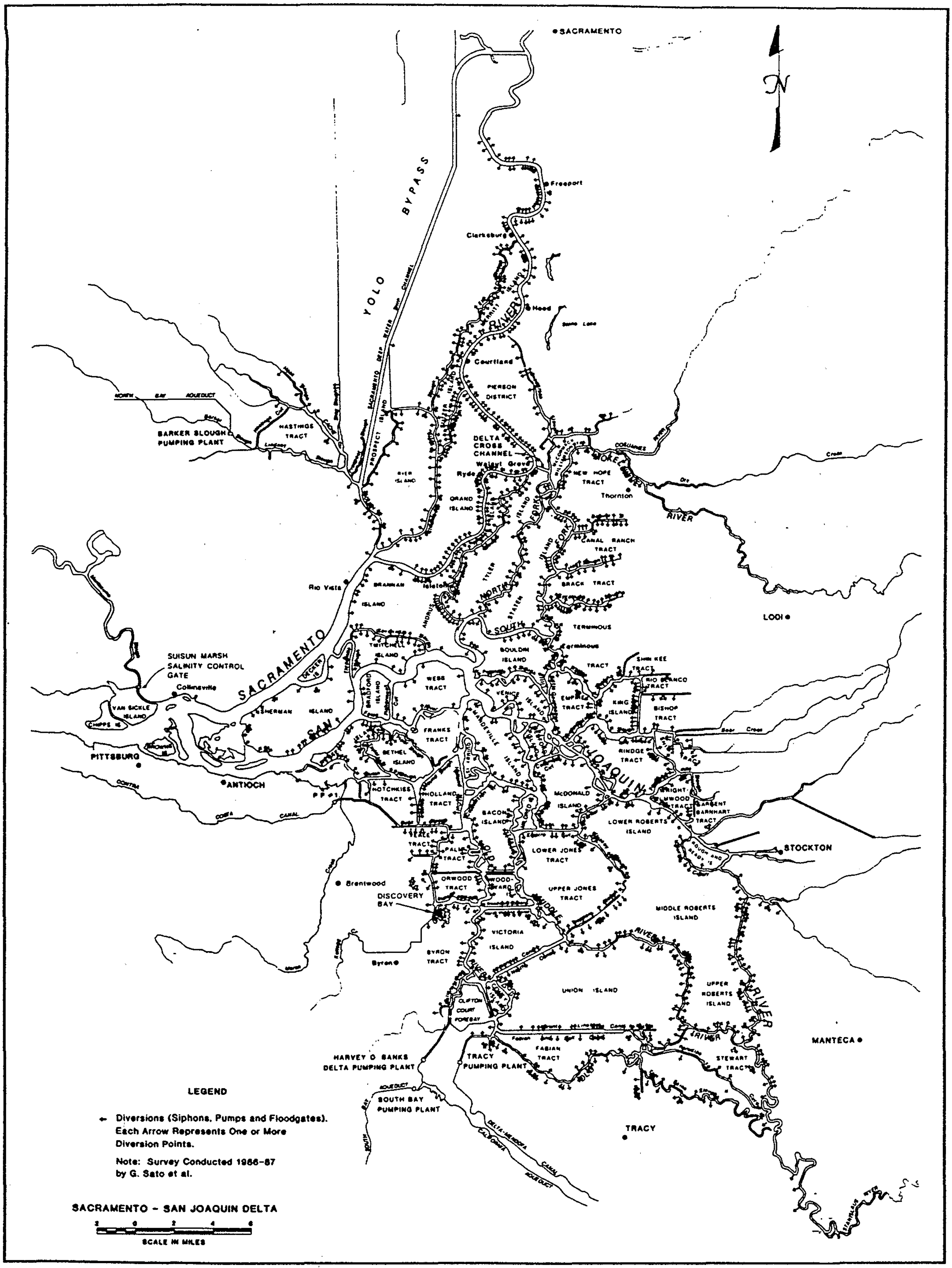

Figure 4-8. Irrigation Diversions.

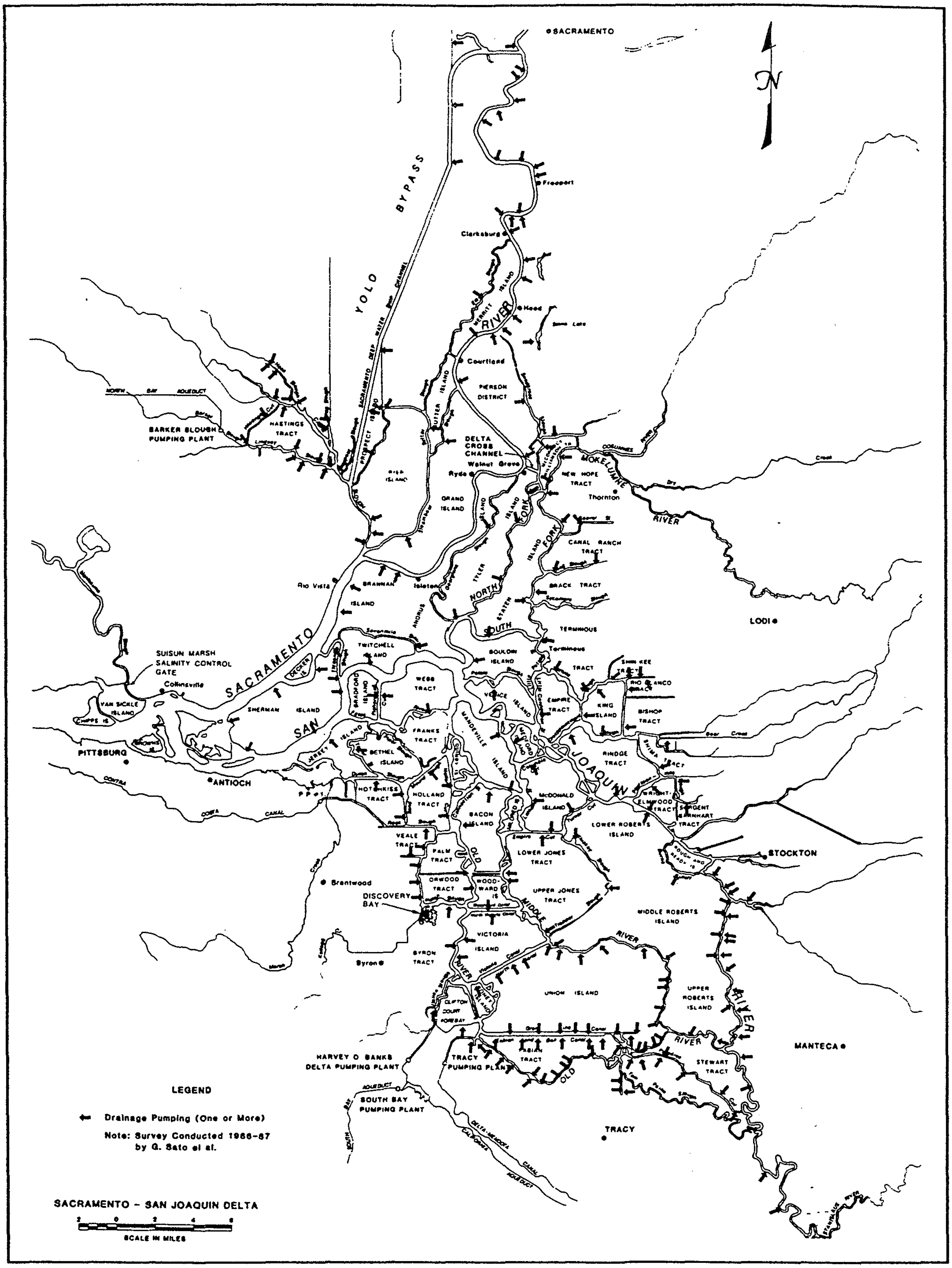

Figure 4-9. Agricultural Drainage Returns. 4-17

Non-Point Source Discharges - Urban Runoff. Urban runoff, particularly from Sacramento and Stockton, contributes pollutants to the Sacramento and San Joaquin Rivers, but little is known about the temporal and spatial effect of urban runoff in the area. One study in Sacramento (Montoya 1987) detected polynuclear aromatic hydrocarbons (PAHs) at high levels. Copper, lead, zinc, cadmium and chromium in runoff water and sediments often exceeded the U.S. EPA water quality criteria for protection of freshwater aquatic organisms.

Trace Metals. Trace metals concentrations generally depend on volume of flow. During DWR's D-1485 monitoring in the wet year 1982, all metals concentrations were below State and federal drinking water criteria. The pattern of the 1987-1991 drought years was as follows: arsenic was consistently detected in both the dissolved and total metal samples; total iron, manganese, and zinc were above minimum detection limits; dissolved and total cadmium, dissolved lead, and total mercury were not detected; total lead was rarely detected.

Tributyltin (TBT), an organic tin compound used in antifouling paints on boat hulls, is present in Delta water and sediments. Water in several marinas exceeded the U.S. EPA criterion (26 ng/1) for protection of freshwater aquatic organisms, sometimes by more than a factor of 10. Sediment samples were collected by DWR from the south Delta in 1992 and 1994. In both cases, TBT was below the detection limit of 2 μg/kg (1992) and 1 μg/kg (1994).

Trihalomethane Formation Potential. The organic content of export water is important because it is related to the formation of suspected human carcinogenic compounds, such as chloroform and bromoform, during chlorination of drinking water. These compounds are collectively known as trihalomethanes (THM's). Trihalomethane formation potential (THMFP) is a measure of the maximum amount of trihalomethanes that would be formed during disinfection by chlorination. THM's are affected by two drinking water standards. First, proposed EPA standards for bacteria and viruses in water require greater disinfection. If chlorination is the treatment method, then the disinfection increases the amount of THM's in drinking water whose source has a significant THMFP. The second EPA standard proposes to reduce the allowable concentration of THM's in drinking water. The THMFP of exported Delta water is therefore of concern to suppliers of water disinfection.

During the treatment of drinking water, the chlorine used as a disinfectant contacts the naturally occurring dissolved organic chemicals resulting from plant decay. The reaction forms chloroform, a type of THM containing chlorine and carbon. Bromine salts that enter the Delta from the ocean can also combine to form THM's that contain bromine in addition to chlorine and carbon. The bromine-containing THM's present a number of problems in drinking water. Their presence complicates treatment processes because they react differently to treatment methods than does chlorine. Since bromine has twice the molecular weight of chlorine, the presence of bromine-containing THM's increases the difficulty of meeting the weight-based drinking-water standard for THM's. There is also evidence that bromine-containing THM's may have a greater carcinogenic potential than chloroform.

The potential of Delta water to form bromine-containing THM's is related to the concentration of bromines in the water. One source of bromides in the Delta is ocean-derived salinity from the Bay estuary. The concentration ratio of bromine to chlorine in sea water is about 1:300. Measurements of Delta water indicate a similar ratio, suggesting that salinity intrusion from the

Bay is a major source of bromides in the Delta. A second source is agricultural return water; THMFP in agricultural return water is five to ten times higher than in water from Delta channels, and brominated pesticides can be found in the return water.

Dredging. The Delta is dredged to maintain ship channels, maintain access to ports and marinas, and to repair and maintain levees. With the exception of maintenance dredging of the Sacramento River and Stockton Deep Water Ship Channels, however, records are not kept on dredging activity in the Delta. Dredging may degrade Delta water quality by creating turbidity and resuspending contaminated sediments.

DWR sampled south Delta sediments in 1992, and the results are summarized in Table 4-3 (DWR, 1993a). Metals concentrations are below applicable criteria. Sampling conducted elsewhere in the south Delta found high concentrations of some compounds; samples from Mormon Slough and from the Stockton Ship Channel showed some of the highest levels of PAHs and PCBs measured on the Pacific coast (SFEP 1990).

In 1994, six additional sites were sampled for sediment and four additional sites for water. The sampling sites are located in the channel between North Victoria Canal and Clifton Court nickel, zinc, lead, cadmium, mercury, and selenium were all found in concentrations below their respective criteria. Silver was the only metal to exceed the SFRWQCB criteria. Concentrations of synthetic organic compounds in all samples analyzed were below the level of detection. The acid generation potential results indicated that in all cases the neutralizing potential is at least twice that of the acid forming potential.

- *Ground Water Quality*

There is little hydrologic distinction between surface water and ground water within the Delta. As the surface of water in the channel fluctuates with the tides, so does the ground water. Ground water levels vary approximately two feet each day with the tidal cycle depending on location. The quality of ground water is also closely related to the surface water quality. Ground water is high in organics due to the organic composition of the soils in the area.

Groundwater tends to seep through the levees and saturate soils in the island interiors. Since the islands are typically below sea level, water is regularly pumped from a depth of 2-3 feet below ground level to keep the land from flooding. Seepage rates and dewatering costs increase as the elevation difference between the channel surface and island interior increases. Seepage processes are relatively slow, however, and do not respond measurably to short-term fluctuations in channel flow (CCWD 1993).

The Sacramento and American rivers serve as sources and drains for groundwater in the Sacramento Valley. The rate and direction of seepage between the rivers and groundwater basins vary with the river stage, and the magnitude of change diminishes from the riverbed through the aquifer. As a result, small changes in river stage do not cause significant changes in groundwater levels or rates of recharge or discharge.

Table 4-3 Results from Soil and Sediment Chemical Analysis in South Delta (after DWR, 1993).
All units in mg/kg - dry weight.

Metals	Channel Sediments		Levee Soils		SF-RWQCB Criteria
	Concentration	Comments	Concentration	Comments	
Arsenic	7.5	site 4 only	---	---	33
Cadmium	ND	RL=2	---	---	5.0
Chromium	3.6 - 42.2	all sites	~5.5 - 32.5	all sites	220
Copper	1 - 38	all sites	~5 - 30	all sites	90
Lead	11 - 13	sites 2 & 7 only	~10 - 40	sites 1, 2, 5, 7, & 9	50
Mercury	0.03 - 0.24	excluding sites 2 & 5	~0.03 - 0.08	all sites	0.35
Nickel	5 - 52	all sites	~11 - 42	all sites	140
Selenium	ND	RL=?	---	---	0.7
Silver	2 - 3	sites 2 & 11 only	---	---	1.0
Zinc	8 - 85	all sites	~22 - 105	excluding site 10	160

4.3 *Environmental Impacts/Consequences*

This section describes the potential water quality consequences of construction and operation of the Interim South Delta Project. The discussion is organized as follows. First, the analytical methodology and the standards of significance are described. Next, operational consequences are described, including changes to salinity, water quality parameters other than salinity, groundwater quality, and an evaluation of the consequences of barrier operation. Finally, construction-related consequences are described.

Two methods are utilized to evaluate the water quality consequences of ISDP. First, numerical modeling is used to evaluate the project impacts to salinity. Second, for water quality parameters other than salinity, the description of the affected environment is used in conjunction with the project description and hydrodynamic modeling to semi-quantitatively infer water quality changes. In some cases the changes can also be predicted by reference to the results of pilot studies, such as the Temporary Barriers Project.

- *Numerical Modeling Procedure*

Two types of computer analytical studies were used to predict the water quality effects of ISDP: 1) statewide water supply studies using the DWRSIM model, based on a 71 year record of historic hydrology from 1922 through 1992; and 2) Delta hydrodynamic and water quality studies using the DWRDSM model. These models constitute the best available method to quantitatively simulate the effects of ISDP and its alternatives on the SWP and the Delta.

DWRSIM, the statewide model, is a computer simulation model designed to simulate the operations of the CVP and SWP under different hydrologic sequences. Figure 4-10 summarizes some of the principal elements of this model. The Sacramento River and San Joaquin River inflows are shared between the CVP and SWP according to the Coordinated Operations Agreement. The model accounts for the availability, storage, release, use and export of water in the Sacramento, San Joaquin, Eastside river systems, the Delta, and the aqueduct and reservoir systems south of the Delta. Land use within the Delta watershed is estimated to reflect varying levels of demand. The model output provides monthly averages of reservoir storage, releases, Delta inflows, exports, and outflows. The model optimizes this water supply network to provide the maximum water withdrawal from the Delta system allowed by regulatory constraints, up to the total water demand. Additional system operational objectives, physical constraints, and institutional agreements also affect the model output. The two principal advantages of DWRSIM are that it models operation of the entire SWP, and that it considers the measured variation in water years by using the historical hydrologic record of unimpaired runoff (1922 through 1992) as input conditions. The principal limitation of DWRSIM, with respect to impact analysis, is that it treats only monthly averaged values.

DWRDSM, the Delta model, is a numerical simulation of flow and water quality within the Delta. It is a one-dimensional model that simulates changes in water levels, velocity, flow rate, and salinity. DWRDSM only simulates conditions in the Delta and, for the purposes of analysis of impacts within this study, uses the monthly average results of the Statewide model (DWRSIM) as the input and boundary conditions. The mean of the measured tidal variation over

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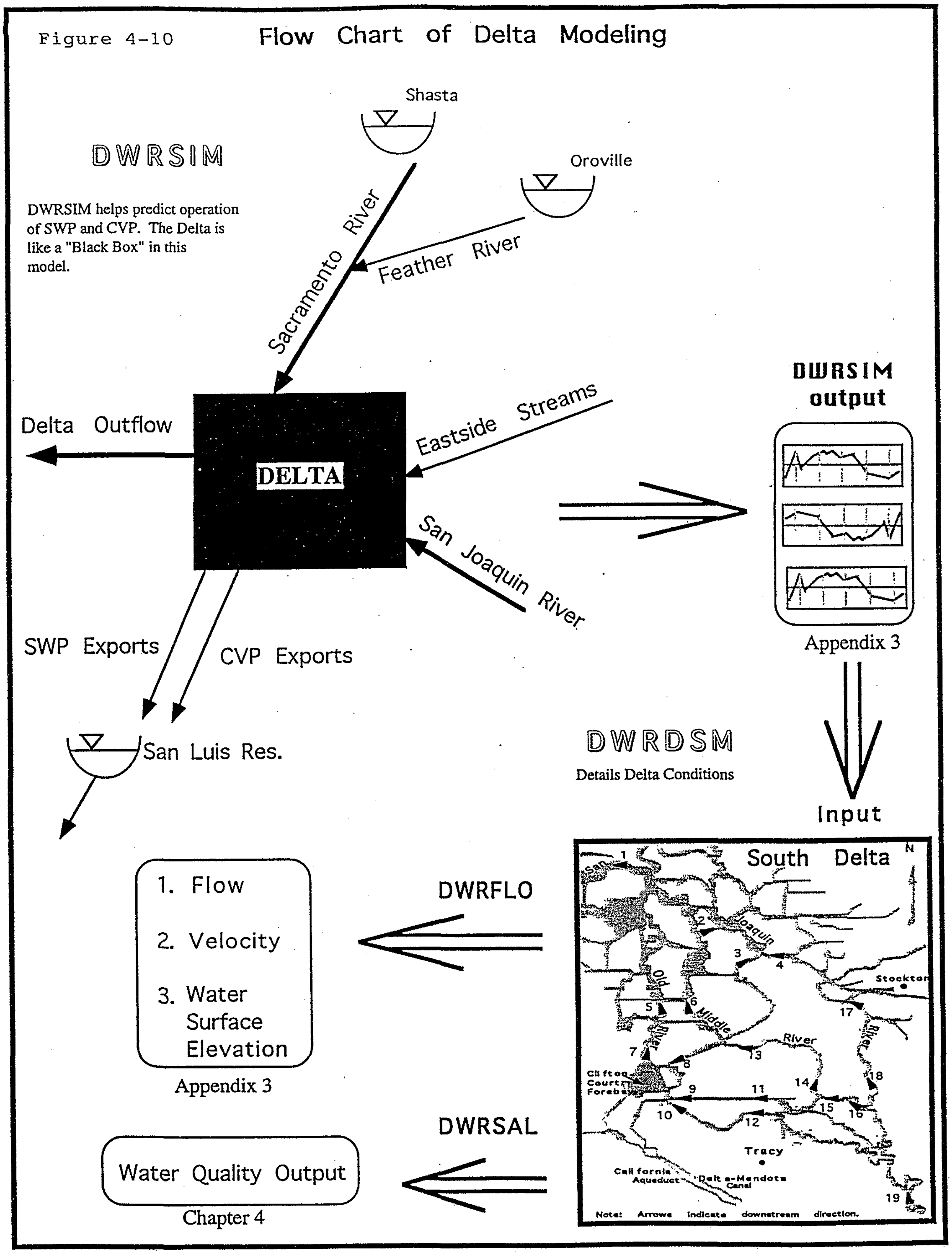

Figure 4-10. Flow Chart of Delta Modeling.

19 years is used as a boundary condition to simulate the effects of ocean tides on Delta water quality and hydrodynamics. The Delta model calculates changes on a 60-second time step for flow, and a 5-minute time step for salinity. Although these time steps are relatively short, the use of monthly averaged flow as boundary conditions (derived from the statewide model and the 19-year mean tide) prevents the model from simulating the extreme values that may result from, for example, a short-duration, high-intensity storm event or a week-long period of high pumping rates. Two of the principal advantages of DWRDSM are that it provides high resolution for flow and salinity changes within the Delta, and that it simulates the effects of ocean tides on Delta hydrodynamics and water quality. Figure 4-1 shows the Delta model locations that are analyzed in this section.

In considering the results of the two models, it is important to note that conditions in a specific model year do not match those observed in the actual year. The Statewide model takes unimpaired runoff as initial conditions, and then applies existing or future land development and consumptive use conditions on the unimpaired runoff. Exports and reservoir operations are then calculated for a specific level of demand given the entire 71-year period of record. The modeled conditions in any particular year will therefore not resemble the real conditions that occurred in that year, with the exception of unimpaired runoff. Even the modeled conditions for recent years usually do not resemble the real conditions that occurred in that year, because the model is optimizing operations over the 71-year period of record, and model reservoir levels at the start of the model year may be considerably different from what the actual levels had been. It is therefore most instructive to consider the Statewide model as optimizing SWP operation over "a 71-year sequence of unimpaired runoffs" rather than "water years 1922 through 1992." This consideration also extends to the Delta model, since it takes the results of the Statewide model as input and boundary conditions. In addition to the computational reasons why model years do not resemble actual years, the CVP became operational until 1951, and the SWP became operational until 1968.

Modeled Case Studies. The following case studies were modeled with the statewide model (DWRSIM). Monthly water supply studies of the existing SWP and CVP system for the 71-year period 1922 through 1992, with SWP variable demands of 2.6 to 3.6 MAF, were used to establish the No-Action State water supply conditions and Delta hydrologic conditions. This study is referred to as the Existing Demand Case Study throughout the text. A second run of the Existing Demand Case Study was made at the same level of SWP demands, which assumed ISDP allowing an increase in the pumping at the Banks Pumping Plant to 10,300 cfs. Future conditions were modeled with increased pumping capacity of ISDP and without ISDP and is referred to as the Future Demand Case Study.

Delta model (DWRDSM) studies were performed to provide a picture of the effects of the project on Delta water quality. These studies also assumed existing demands (2.6 to 3.6 MAF) and future demands (4.1 MAF) of the SWP under the 1994 Bay-Delta Accord. The Delta model provided data on water flows, velocities, salinity, and water elevations. Five water years were chosen as to represent the different water year types: 1991 as a critical year; 1981 as a dry year; 1966 as a below-normal year; 1957 as an above-normal year; and 1982 as a wet year. Each water year was chosen in an effort to maximize potential changes in Delta conditions for each water year type; to the extent possible, years preceded by dry or critical years and with a large increase in pumping due to ISDP were chosen. Case studies were modeled with and without

ISDP for each of the demand levels. The boundary conditions, including inflows of water to the Delta, Delta exports, and outflows, are provided from DWRSIM.

<u>Use of Modeling Results</u>. The model is a mathematical simulation used to evaluate potential changes to the Delta resulting from ISDP. It is not intended to provide absolute predictions of future Delta hydrodynamic and water quality conditions; rather the modeling is meant to be used as a tool to compare Delta conditions under various alternative actions. The results of the mathematical modeling are interpreted in terms of the direction and relative magnitude of changes in variables. The analysis in this discussion of how ISDP may affect the Delta water quality is based primarily on how the values of these parameters change with respect to the No-Action alternative. This evaluation of environmental consequences also assumes that regulatory controls will continue to determine operation of the SWP.

A screening-level criterion was used in the evaluation of the modeling results for salinity. If the operation of ISDP changes salinity by less than 10 percent at a given location, then the change is considered to be within the uncertainty of the field measurements and the modeling technique. This criterion focuses the discussion of salinity change to the times and locations where the change might be measurable.

Since worst-case impacts would occur under the Future Demand Case Study, these results will be presented to depict the potential magnitude of impacts. According to the Statewide model results, the SWP would be able to deliver at least 4.1 MAF nine years out of the 71-year period of record. The impacts of withdrawing greater than 4.1 MAF are not considered in this evaluation.

4.3.1 Significance Criteria

The standards of significance described in the NEPA, CEQA, and the Clean Water Act were used in this analysis, as described in the following.

The NEPA, Council on Environmental Quality (CEQ) regulations require a discussion of direct, and indirect effects of the proposed alternatives (40 CFR 1508.8). Any possible conflicts between the proposed action and the objectives of any land use plans, policies and controls in the area affected must also be discussed. In determining significance, NEPA requires that context and intensity of the effects be considered. Cumulative impacts must also be analyzed according to NEPA.

According to the guidance provided in Appendix G of the California Environmental Quality Act (CEQA), an impact to water resources is considered to have significant effects if it would: 1) conflict with adopted community goals and environmental plans; 2) interfere substantially with ground water recharge; 3) induce substantial growth or concentration of population; or 4) cause substantial flooding, erosion or siltation. In this analysis, the regulatory controls discussed earlier, particularly the May 1995 Water Quality Control Plan for the San Francisco Bay/Sacramento-San Joaquin Delta Estuary (SWRCB 1995a) and State and Federal drinking water criteria, are used as significance criteria.

According to Clean Water Act Section 404(b)(1) Guidelines, the discharge of dredged or fill materials may result in significant adverse impacts to water resources. Potential impacts to aquatic ecosystems resulting from disposal of dredged materials, as related to water flows are:

1) Modification of current patterns and water circulation resulting in changes in location and dynamics of aquatic communities, shoreline and substrate erosion and deposition rates, and rate and extent of mixing of dissolved and suspended components of the water body;

2) Alteration of normal water-level fluctuations which may result in changes in salinity patterns, alteration of erosion and sedimentation rates, aggravation of water temperature extremes, upsets in nutrient and dissolved oxygen balance, and alteration or destruction of communities and populations of aquatic animals and vegetation; and

3) Obstruction or diversion of flows resulting in changes to salinity gradients.

4.3.2 Operational Consequences

Operation of ISDP may influence salinity and other water quality parameters, groundwater quality, or have consequences that are specific to barrier operation. Potentially significant consequences were analyzed and are described in the following.

- *Salinity Within The Delta*

Delta-wide Changes in Salinity. There are three principal sources of saline water to the Delta: the Pacific Ocean, the San Joaquin River and agricultural discharges. ISDP can influence the resultant distribution of these source waters in the Delta. The impact of ISDP and its alternatives to the salinity distribution in the Delta depends on how those alternatives change Delta outflow (hence the influence of the Pacific Ocean) and San Joaquin River flow and direction. Operation of ISDP does not lead to violations of water quality objectives, hence these changes are not considered to be less-than-significant adverse impacts.

The timing of SWP exports and their influence on Delta water quality would be changed with ISDP. Export increases would generally occur in September through December; flows are relatively high during this period, and the San Joaquin River contributes a relatively small portion of Delta inflow. Delta outflow is reduced during these periods, with a corresponding upstream movement of saline water. Export decreases would generally occur in January through August, with slight increases in June or July. During these times of year, Delta outflow is increased and the interface with saline water from the Pacific Ocean is further downstream.

Operation of the barriers would route the San Joaquin River downstream to the central Delta rather than through the south Delta towards the export pumps. Since the San Joaquin River is more saline than the Delta as a whole, the barriers cause a general decrease in south Delta salinity with a corresponding slight increase in central Delta salinity. The evaluation of ISDP-

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related changes in salinity did not indicate violations of central Delta beneficial uses. Therefore, the adverse impacts are considered to be less-than-significant.

Salinity Changes at Specific Delta Locations. The SWP is operated to comply with all regulatory standards, including the salinity standards in the May 1995 Bay/Delta Water Quality Control Plan (SWRCB 1995a). Therefore, the operation of ISDP is not expected to result in significant adverse impacts due to non-compliance with salinity standards. The following stations or areas are discussed, however, to illustrate the times of year when the greatest project changes in salinity occur, either positive or negative: 1) Sacramento River stations; 2) San Joaquin River stations; 3) Suisun Bay and Marsh station; 4) Municipal and industrial uses; and 5) Delta Islands project locations. The stations were chosen because they can be controlling stations for SWP operation in order to protect municipal and industrial water supply, agricultural uses, and fish and wildlife.

Figure 4-1 shows the locations of the stations discussed in this section, and Table 4-1 summarizes the salinity standards that must be met. The discussion of each area will focus on the results for the Future Demand case study, as it represents the worst case analysis. A change of greater than 10 percent is used as a screening-level value, because changes of less than this amount are within the uncertainty of the field measurements and the modeling-related uncertainty.

Sacramento River. The Sacramento River stations at Collinsville and at Emmaton were analyzed. The standard at Emmaton was developed to protect agricultural beneficial uses, and the standard at Collinsville was developed to protect fish and wildlife beneficial uses. When these stations become controlling stations in SWP operations, most frequently Emmaton, reservoir releases have a greater impact on their salinity than do changes in exports.

In the Future Demand Case Study (Figure 4-11), project-related increases in salinity generally occur in October through December of the representative worst-case dry, below normal, and above normal years. Project-related decreases in salinity occur in summer of the representative worst-case dry, below normal and above-normal years. These are considered less-than-significant adverse impacts.

San Joaquin River. The San Joaquin River stations at Prisoners Point, San Andreas Landing, Jersey Point, and Antioch were analyzed. The standards at Prisoners Point and Antioch were developed to protect fish and wildlife beneficial uses, and the standards at San Andreas Landing and Jersey Point were developed to protect agricultural beneficial uses. When these stations become controlling stations in SWP operations, most frequently Jersey Point, changes in exports have a greater impact on their salinity than do changes in reservoir releases.

Sacramento River at Emmaton

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
Critical	+	-	-	-	-	-	0	0	-	+	0	-
Dry	+	+	+	+	+	0	-	-	-	-	+	-
Below Normal	+	+	+	+	0	0	0	+	-	-	-	-
Above Normal	+	+	-	-	-	-	0	-	-	-	+	-
Wet	-	-	0	0	0	0	0	0	0	+	-	+

Sacramento River at Collinsville

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
Critical	0	-	-	-	-	-	0	+	0	+	+	-
Dry	+	+	+	+	+	-	-	-	0	-	+	-
Below Normal	+	+	+	+	-	-	+	0	-	-	-	-
Above Normal	+	+	-	-	-	-	-	[illegible]	[illegible]	-	+	-
Wet	-	-	0	0	0	0	0	0	-	0	-	+

+	project increases salinity
-	project decreases salinity
+ (light shading)	>+10% change
- (dark shading)	< -10% change

Figure 4-11. Changes in Average Chloride Concentrations, Future Demand, Sacramento River.

In the Future Demand Case Study (Figure 4-12), increases in salinity generally occur from October through January of dry, below normal, and above normal years. At Prisoner's Point, increases also occur in April and May. Project related decreases occur sporadically either in summer or in January and February. These are considered less-than-significant adverse impacts.

Suisun Bay and Marsh. The following four Suisun Bay and Marsh stations were analyzed: Montezuma Slough at National Steel; Montezuma Slough near Beldon Landing; Montezuma Slough near Mouth; and Suisun Slough near Mouth. These standards were developed to protect fish and wildlife beneficial uses. When these stations become controlling stations in SWP operations, changes in both exports and reservoir releases can impact salinity.

In the Future Demand Case Study (Figure 4-13), project-related increases in salinity generally would occur in October through January of dry, below normal, and above normal years and September and November of wet years. Project-related decreases in salinity generally occur in January through August of above-normal years. These are considered less-than-significant adverse impacts.

Municipal and Industrial Water Supply. The following four Municipal and Industrial use locations were analyzed: Contra Costa Canal Intake, Los Vaqueros Reservoir Intake, Clifton Court Forebay, and the Tracy Wastewater Treatment Plant discharge. The Future Demand Case Study is evaluated for each location.

Salinity generally would increase at the Contra Costa Canal intake from October through January of dry, below normal, and above normal years (Figure 4-14). It also would increase in April and May of most year types except wet years. Salinity decreases would be experienced during January, February, and August of above normal years. The increase in salinity would be considered less-than-significant impacts.

The intake for Contra Costa Water District's Los Vaqueros Reservoir is located on Old River at the Highway 4 crossing (Figure 4-1); it is a supplemental intake to improve the quality of delivered water, provide consistent and reliable water, and provide enough water for emergency storage. Diversion to the reservoir will only occur during November through June when chloride concentration at the intake is 50 mg/l or lower (CCWD, 1991). Salinity would increase from October through January of dry, below normal, and above normal years. It would also increase in April and May of all year types except wet years. Project-related decreases in salinity would occur during January and February of above normal years (Figure 4-14). Based on model predictions, project-related increases in salinity above 50 mg/l chlorides could occur in May of critical years, November through January and May of dry years, November of below normal years, and November and December of above normal years. During these months, ISDP-related increases in salinity would be in the range of 14 to 49 percent. The increases are likely due to either the operation of the Fish Control Structure at the head of Old River, or increased export pumping during December and January. These increases may limit the usefulness of the supplemental intake, especially during critical, dry, and below normal years. The SWP's water rights are senior to those for Los Vaqueros Reservoir, and Contra Costa County's permit for diversion and use of water explicitly recognizes that the permit is subject to prior rights, as follows:

San Joaquin River at Prisoner's Point

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
Critical	+	+	+	-	-	-	+	+	0	+	+	+
Dry	+	+	+	+	+	+	+	+	0	+	-	+
Below Normal	-	+	+	+	+	0	+	+	+	+	+	-
Above Normal	+	+	+	-	-	0	+	+	0	+	-	+
Wet	-	+	-	-	+	0	0	0	+	+	0	+

San Joaquin River at Antioch Water Works

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
Critical	0	-	-	-	-	-	0	+	+	+	+	+
Dry	+	+	+	+	+	0	-	-	0	-	+	-
Below Normal	+	+	+	+	+	-	0	+	+	-	-	-
Above Normal	+	+	-	-	-	-	-	-	-	-	+	+
Wet	-	-	+	0	+	+	0	0	-	-	0	+

San Joaquin River at Jersey Point

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
Critical	-	+	-	-	-	-	-	0	+	+	+	+
Dry	+	+	+	+	+	-	+	+	0	+	+	+
Below Normal	+	+	+	+	+	-	+	+	+	-	-	0
Above Normal	+	+	-	-	-	-	0	+	-	+	-	+
Wet	-	-	+	-	+	+	0	0	0	-	0	+

San Joaquin River at San Andreas Landing

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
Critical	-	0	+	-	-	-	-	+	0	+	+	+
Dry	+	+	+	+	-	-	+	+	0	+	0	+
Below Normal	0	+	+	+	0	0	+	+	0	+	+	0
Above Normal	+	+	+	-	-	-	+	+	-	+	-	+
Wet	-	-	0	0	+	+	0	0	0	0	-	+

+	project increases salinity
-	project decreases salinity
+ (shaded)	>+10% change
- (shaded)	< -10% change

Figure 4-12. Changes in Average Chloride Concentrations, Future Demand, San Joaquin River.

Montezuma Slough at National Steel

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
Critical	+	-	-	-	-	-	0	+	+	+	+	+
Dry	+	+	+	+	-	-	-	-	-	-	0	-
Below Normal	+	-	+	+	-	-	-	-	+	-	-	-
Above Normal	+	+	-	-	-	-	-	-	-	-	+	-
Wet	-	+	+	0	0	+	0	0	-	+	+	+

Montezuma Slough near Beldon Landing

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
Critical	0	-	-	-	-	-	0	+	0	+	+	+
Dry	+	+	+	+	+	-	-	-	-	-	-	-
Below Normal	+	-	+	+	-	-	+	+	0	-	-	-
Above Normal	+	+	+	-	-	-	-	-	-	-	-	-
Wet	-	+	+	+	0	+	0	0	-	-	-	+

Montezuma Slough near Mouth

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
Critical	0	-	-	-	-	-	0	0	0	+	+	0
Dry	+	+	+	+	-	-	-	0	0	-	+	-
Below Normal	+	+	+	-	-	-	0	0	0	-	-	-
Above Normal	+	+	-	-	-	-	-	-	-	-	+	+
Wet	-	+	+	-	0	0	0	-	0	0	0	+

Suisun Slough near Mouth

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
Critical	-	-	-	-	-	-	0	+	0	+	+	0
Dry	+	+	+	+	-	-	0	-	0	-	+	-
Below Normal	+	+	+	-	-	-	+	0	0	-	-	-
Above Normal	+	+	-	-	-	-	-	-	-	-	+	+
Wet	-	+	+	0	+	0	+	0	0	0	0	+

+	project increases salinity
-	project decreases salinity
+	>+10% change
-	< -10% change

Figure 4-13. Changes in Average Chloride Concentrations, Future Demand, Suisun Marsh.

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Contra Costa Canal Intake

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
Critical	-	-	0	-	-	-	+	+	+	+	+	+
Dry	+	+	+	+	+	+	+	+	+	+	-	-
Below Normal	0	+	+	+	+	+	+	+	+	+	-	-
Above Normal	+	+	+	-	-	-	+	+	0	+	-	+
Wet	-	-	-	-	+	+	0	0	+	+	-	+

Los Vaqueros Reservoir Supplemental Intake

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
Critical	+	+	-	-	-	-	+	+	+	+	+	+
Dry	+	+	+	+	+	+	+	+	+	+	-	0
Below Normal	+	+	+	+	+	+	+	+	+	+	0	-
Above Normal	+	+	+	-	-	+	+	+	+	+	-	+
Wet	-	0	-	-	+	-	0	-	-	+	+	+

Clifton Court Forebay

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
Critical	+	+	+	+	+	0	+	+	+	+	+	+
Dry	+	+	+	+	+	-	-	+	+	+	+	+
Below Normal	+	+	+	+	+	+	-	+	+	+	+	+
Above Normal	+	+	+	-	-	+	+	+	+	+	+	+
Wet	+	+	-	-	+	-	+	+	-	+	+	+

Downstream from Tracy Wastewater Treatment Plant

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
Critical	-	-	0	+	0	+	-	-	-	-	-	-
Dry	+	+	0	0	0	0	-	+	0	-	+	-
Below Normal	-	+	0	0	0	0	0	+	-	-	+	-
Above Normal	-	-	0	0	0	0	-	+	-	0	+	-
Wet	-	-	+	0	0	0	0	0	0	0	0	0

+	project increases salinity
-	project decreases salinity
+	>+10% change
-	< -10% change

Figure 4-14. Changes in Average Chloride Concentrations, Future Demand, Municipal and Industrial Water Use.

Permittee is put on notice that, during some years, water will not be available for diversion during or all of the season authorized herein. The annual variation in demands and hydrologic conditions in the San Joaquin River are such that, in any year of water scarcity, the season of diversion authorized herein may be reduced or completely eliminated on order of this Board (e.g. State Water Resources Control Board).

Consequently, the increases in salinity at this supplemental intake would be considered less-than-significant adverse impacts.

The change in salinity for Clifton Court Forebay was evaluated by considering the quality of water in the Forebay itself, rather than the new versus old intake locations. The results indicate an increase in salinity levels from May through December for most year types (Figure 4-14). Project-related salinity decreases would occur during February of above normal years. The increases are considered less-than-significant adverse impacts.

The City of Tracy discharges effluent from its wastewater treatment plant into Old River, just upstream of Paradise Cut, in the south Delta (Figure 4-1). The quality of the receiving water partially determines whether the discharge will remain in compliance with its NPDES permit. Project-related increases in salinity would occur in October and November of dry years. Project-related decreases in salinity would occur in November, April, May, and August of critical years, November and April of above normal years, and October and November of wet years (Figure 4-14). During times when salinity would decrease, the receiving water quality would be improved. During October and November of dry years, when salinity would increase, the receiving water quality would be lowered slightly. Results of the Temporary Barriers Project, however, show that water quality in the channels downstream of the barrier were not substantially affected. The project is expected to have a less-than-significant impact upon the receiving water quality for the City of Tracy's wastewater treatment plant.

Delta Islands Project. As proposed, the Delta Islands Project will divert surplus inflows, transferred water, or banked water to four Delta islands (Figure 4-1). Two of the islands, Bacon Island and Webb Tract, will be used as reservoirs to store water for later release to meet Delta outflow and water quality requirements. The other two islands, Bouldin Island and Holland Tract, will be habitat islands, managed and operated to support wetlands and wildlife habitat (SWRCB and Corps, 1995). At the Webb Tract diversion, ISDP-related increases in salinity would generally occur in October through December of dry, below normal years, and above normal years. ISDP-related decreases in salinity would occur in January, February, and August of above normal years (Figure 4-15). The water that is diverted to the reservoir islands would be released and directed through the Delta channels to export pumps before being used as municipal and industrial water supply. For the habitat island (Holland Tract), ISDP-related increases in and above normal years and, for the southern siphon, also April and May. Project-related decreases in salinity would occur in January, February, and August of above normal years and, for the northern intake, also in November of wet years (Figure 4-15). The increases in salinity are considered to be less-than-significant adverse impacts.

Webb Tract North

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
Critical	-	+	+	-	-	-	-	+	0	+	+	+
Dry	+	+	+	+	-	-	+	+	0	+	-	+
Below Normal	-	+	+	+	-	0	+	+	0	+	+	+
Above Normal	+	+	+	-	-	-	+	+	0	+	-	+
Wet	-	-	0	0	+	+	0	0	+	0	-	+

Webb Tract South

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
Critical	-	-	-	-	-	-	-	+	-	+	+	+
Dry	+	+	+	+	+	-	+	+	0	+	-	+
Below Normal	+	+	+	+	+	-	+	+	+	+	-	-
Above Normal	+	+	+	-	-	-	+	+	-	+	-	+
Wet	-	-	-	-	+	+	0	-	+	-	-	+

Holland Tract North

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
Critical	-	+	-	-	-	-	-	+	+	+	+	+
Dry	+	+	+	+	+	0	+	+	0	+	0	+
Below Normal	+	+	+	+	+	0	+	+	+	+	0	0
Above Normal	+	+	+	-	-	-	+	+	-	+	-	+
Wet	-	-	-	0	+	+	0	-	0	-	-	+

Holland Tract South

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
Critical	-	-	+	-	-	-	+	+	+	+	+	+
Dry	+	+	+	+	+	+	+	+	+	+	-	-
Below Normal	+	+	+	+	+	0	+	+	+	+	-	-
Above Normal	+	+	+	-	-	-	+	+	-	+	-	+
Wet	-	-	-	-	+	+	+	-	+	+	-	+

+	project increases salinity
-	project decreases salinity
+ (shaded)	>+10% change
- (shaded)	< -10% change

Figure 4-15. Changes in Average Chloride Concentrations, Delta Islands Project.

- *Other Water Quality Parameters*

This section describes changes to the water quality parameters other than salinity. It relies on water quality measurements made during the Temporary Barriers Program, and by extrapolation from modeling results for hydrodynamics and salinity.

Operational Water Quality Consequences. Water quality consequences of the project within the Delta depend strongly on the water year type and on the hydraulic conditions during the increase in exports. During winter months, the Sacramento River is a proportionally greater contributor to the Delta and subsequent exports than the San Joaquin River. The San Joaquin River system tends to have peak flow during spring runoff rather than during winter storms. While the project would not affect the water quality in these contributing river systems, the relative mix of those sources would be influenced by the changes in pumping schedules, reservoir releases, and barrier operations. The increases in pumping with ISDP are highest in October, November, and December; salinity also tends to increase in these months due to increased sea water intrusion. Since relatively good quality river water is the major contributor to inflow during these months, ISDP is expected to have a less-than-significant adverse impact upon general water quality. Pumping does not increase appreciably when San Joaquin inflows alone are high, during spring runoff, therefore water quality would not be degraded by project-related rerouting of flow.

Trihalomethane Formation Potential. Trihalomethane formation potential (THMFP) may increase slightly in export water, based on the salinity results. The general increases in salinity of export water appears to occur because sea water intrusion is increased, which would increase the bromine content of export water (Hutton and Chung 1994b). If the loading of organic material to the Delta is assumed to be constant, then the increase in bromine levels would increase the total amount of THM's formed by disinfection on a weight percent basis. Since the salinity is always within regulatory limits, the operation-related increase in THMFP would be considered a less-than-significant adverse impact.

THMFP would temporarily increase in the dredge disposal area due to mobilization of undissolved organic matter in soils underlying and adjacent to the dewatering ponds. THMFP increases should be short term as exposed/available organic matter is exhausted and as silt and THMFP is expected to decrease to normal levels shortly following introduction of dredge spoils for dewatering. Although the organic material is only exposed for a short time, this is considered an unavoidable significant adverse impact.

- *Consequences Of Barrier Operation*

The consequences of barrier operation to south Delta chemical water quality are first evaluated utilizing the results of Delta flow modeling presented in Appendix 3, Project-Related Hydrodynamics. They are then evaluated by reference to the results of the Temporary Barriers Program.

Agricultural drainage impairs water quality in dead-end channels such as Tom Paine Slough, Paradise Cut, Old River, and portions of the San Joaquin River. The Delta modeling results indicate that operation of the barriers increases circulation in these channels and increases the minimum water levels. Water levels and circulation are improved upstream of the barriers by tidal pumping. Tidal pumping allows unidirectional flow into the channels upstream of the barriers during the flood tide, and blocks water movement during the ebb tide. These operations retain flood tide flows in south Delta channels for a longer period of time to raise minimum water levels. In addition, the Grant Line Canal barrier is open for a portion of the ebb tide. This operation helps to increase circulation in the south Delta by providing a downstream outlet. These modeled improvements to water levels and circulation alleviate the water quality concerns of south Delta water users.

The operation of the barriers would also affect water quality by routing San Joaquin River flows north towards the central Delta, and away from the south Delta pumping plants. The San Joaquin River is generally most saline during the irrigation season of May through August owing to lower flows and agricultural return water. During these months, barrier operation would tend to direct the San Joaquin River north; the modeled average velocities are never upstream (that is, towards the pumping plants) with ISDP, as they sometimes are under existing conditions. This effect should improve south Delta water quality, while potentially degrading water quality in the central Delta. The evaluation of ISDP-related changes in salinity did not indicate violations of central Delta beneficial uses, and by inference other conservative species should not be significantly degraded. In addition, beneficial uses are similar in the central Delta to those in the south Delta. Since the existing water quality distribution does not degrade south Delta beneficial uses, then the routing of the relatively poor quality San Joaquin River water to the central Delta by barrier operation would not substantially degrade central Delta beneficial uses. Therefore, any central Delta adverse impacts would be considered less-than-significant.

The potential impact to south Delta chemical water quality resulting from the installation of permanent barriers was also evaluated using the results of the Temporary Barriers Program. The temporary barriers program provides data for critical years, hence they should provide a depiction of water quality during low-flow conditions in the south Delta. The Temporary Barriers Project was initiated in 1991, and included the installation of rock barriers in Middle River, Old River near the Delta-Mendota Canal, and Old River near the San Joaquin River. The Middle River Barrier has been installed each year since 1987, and the Old River fish control structure has been installed most years since 1967. The locations are those proposed for the ISDP, with the exception of Grant Line Canal, which has not had a temporary barrier. The permanent barriers are designed to handle higher flows and have more operational flexibility than the temporary rock barriers. During the monitoring program for the Temporary Barriers Project, the following water quality parameters were measured: temperature, turbidity, organic nitrogen, chlorophyll, dissolved oxygen, specific conductance, coliform bacteria (total and fecal), and total dissolved solids. The results of the monitoring program are described in detail in several DWR monitoring reports (DWR 1992a; DWR 1994a), and are summarized here.

In general, the Old River Flow Control Structure near DMC and the barrier on Middle River had a minor effect on chemical water quality. The following observations refer to the Middle River barrier. Specific conductance decreased upstream of the barrier slightly, less than 200 μS/cm. Dissolved oxygen concentration decreased upstream of the barrier, coupled with an increase in water temperature. Both of these effects were seasonal. Turbidity, chlorophyll, coliform, and organic nitrogen were similar upstream and downstream of the barrier. The Old River Flow

Control Structure near DMC did not have a substantial effect on any of the water quality parameters measured. The Old River Fish Control Structure near Mossdale did not affect measured water quality parameters. Therefore, the operation the permanent south Delta barriers not expected to have less-than-significant adverse impacts on these water quality parameters.

- *Ground Water Quality*

There may be a slight increase in seepage of water from the channels into the lowlands of the adjacent islands, but seepage from channels to island interiors responds sluggishly to short-term fluctuations in channel flow. Therefore project-related changes in water levels are not likely to substantially increase seepage. The small changes in reservoir operation and downstream river stage resulting from ISDP would cause minor changes in groundwater levels and rates of recharge or discharge, and not substantially impact groundwater quality in the Sacramento Valley. These are considered to be less-than-significant adverse impacts.

4.3.3 Construction-Related Consequences

This section discusses the water quality consequences of the construction of the new intake at Clifton Court Forebay, installation of the barriers, and the dredging of a reach of Old River. Two regulatory controls are intended to limit the consequences of the construction activities. The first is the Corps of Engineers, which implements the Rivers and Harbors Act - Section 10 and the Clean Water Act - Section 404. The second is the State Board General Construction Activity Storm Water Permit, which is required for construction activities and associated storm water discharges which occur outside Corps jurisdiction on upland sites. Sites that are regulated by the Corps are excluded from the Storm Water Permit process but are, however, subject to certification requirements of the Clean Water Act - Section 401.

- *Clifton Court Forebay*

Changes in the sediment transport regime during construction were evaluated, but were not found to be significant. Scour and sedimentation is likely to be minimal during construction of the forebay intake due to the minor constriction of the channel and the proposed method of dry construction. The dry method of construction should also lead to insignificant increases in turbidity or suspended sediment load in the vicinity of the intake for the three year period of the construction. Installation of the cellular cofferdam on the interior side of the intake is not expected to generate substantial amounts of suspended sediment or turbidity. No increase in suspended load is expect in water taken from the forebay for export, since approximately 70 percent of the wash load currently entering Clifton Court Forebay is trapped in the reservoir (DWR 1977). These are considered to be less-than-significant adverse impacts.

- *Fish Control Structure On Old River*

Construction of the Fish Control Structure entails installation and removal of cofferdams which would temporarily effect both turbidity and flow velocities. Based on turbidity increases observed during the Temporary Barriers Program, construction of the permanent structure should not produce significant turbidity. The method of installing the present temporary barrier at this location has a relatively small increase of 20 to 40 Nephelometric Turbidity Units (NTU) (DWR 1992a). This current method generates more turbidity than the proposed method of construction for the permanent structure, hence the proposed method will not lead to significant increases in turbidity. The construction would block half the channel with sheet-pile coffer dams, and increase velocities in the vicinity of the construction area. Since the channel restriction will lead to some flow being routed down the San Joaquin River, water velocities may increase by approximately 50 percent. Velocities are not anticipated to reach values of concern for scouring. These are considered to be less-than-significant adverse impacts.

- *Barriers On Middle River, Grant Line Canal And Old River*

Increases in turbidity and suspended sediment may occur during construction of the barriers. Minor sediment may be suspended by barge activities. No substantial increase in suspended sediment is expected during removal of the cofferdams, particularly at the Middle River control structure where construction specifies that cofferdams be cut off at the selected invert depth. There would be a brief introduction of sediment into the channels during breaching of the levees at the Old River control structure during existing levee removal; this is expected to be a short-term event. Increases in turbidity from all of these activities are expected to be similar to those observed during the temporary barrier construction activities, with turbidity increasing by values of 20 to 40 NTU (DWR 1992a). These are considered to be less-than-significant adverse impacts.

- *Dredging On Old River*

Two dredging methods are being considered for the Old River, suction dredging and clamshell dredging.

Use of a suction dredge reduces many of the adverse impacts associated with other methods of dredging. Potential changes in velocity and in turbidity were evaluated. The proposed suction dredge method draws in large quantities of water in comparison to the proportion of sediment removed. The cutterhead intake velocity would be approximately 2.5 feet per second (fps) at the dredge pipe. The velocity distribution in the vicinity of the cutterhead would vary with distance and elevation of the cutterhead, above the bed. Maximum values of approximately 0.8 fps may occur at the periphery of the cutterhead falling to approximately 0.3 fps at 3 feet from the cutterhead. These velocities assume a 1 foot tabular intake pattern, which is a conservative extreme. The actual velocities are expected to be lower.

A small turbidity plume would emanate from the cutterhead into the channel. Existing suspended sediment loads within the Delta range from 20 to 1,000 mg/l depending on the season (Amorocho 1983; Ball 1989), with an average of approximately 100 mg/l. Analysis using expected project-related cutterhead dredging parameters indicates that the concentration of sediment at the cutterhead intake is expected to be approximately 400 gm/l; values would rapidly decrease outside the zone of cutterhead operation. Turbidity caused by cutterhead dredging is not expected to present a substantial water quality problem because such turbidity is only a transient condition lasting a few hours (Stern and Stickle 1978). Due to the relative effectiveness

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of the suction dredge, only the lower five percent of the water column is expected to be impacted to any extent by dredging activities. Elevated levels of suspended sediment are generally limited to approximately 1.5 m from the channel bottom and appear to decrease exponentially upward from the bottom (Barnard 1978). In the case of steady dredging of a thin sedimented mud layer, Barnard (1978) found the effect of dredging on turbidity to be almost imperceptible at locations several tens of meters from the cutter head. Generally low suspended sediment concentrations are confirmed by the data of Hayes et al. (1984) which indicates that suspended sediment concentrations within 20 feet of cutterhead dredges range from 1.5 mg/l to 460 mg/l above background with most values being around 30 mg/l above background. These turbidity levels are not considered significant.

Disturbance of the bottom sediment and its partial suspension into the water column is not excepted to mobilize contaminants into the water column at substantial levels because concentrations in sediment are relatively low, and because small amounts of suspended sediments are anticipated. Levels of total oil and grease (TOG) at approximately 100 mg/kg might be locally mobilized as part of the dredging based on one previous sample from the Old River sediments. These effects are considered less-than-significant adverse impacts.

Increased oxygen demand may briefly occur during dredging in association with release of organic material. A decrease in dissolved oxygen associated with this phenomenon should last only a short time. Oxygen demand has been reported to increase approximately ten times over quiescent sediment conditions during active dredging (Stern and Stickle 1978). However, field monitoring of releases of freshly dredged sediments in San Francisco Bay indicated that even in open water disposal of dredge material depressions of dissolved oxygen only reach 50 to 70 percent and lasted only 3 to 4 minutes. These depressions were found only near the point of release (U.S. Army Engineer District, San Francisco, 1973 in Stern and Stickle (1978). This reduction is not significant. Dissolved oxygen in the pumped dredge slurry would be essentially zero (Barnard 1972). These are considered less-than-significant adverse impacts.

The alternative form of dredging, clamshell dredging, allows for quicker drying and placement of dredged material, and avoids discharging substantial quantities of liquids. The clamshell bucket is a mechanical dredger, which ranges in size from 2.6 to 26 cubic yards. Typical bucket sizes in the Delta have a five to ten cubic yard capacity. The clamshell bucket is connected to cables and lifted by a crane which is mounted on a barge. Anchors and spuds are used to position and move the barge during dredging operations. Dredging occurs when the clamshell bucket is dropped into position and the jaws are closed by wire cables operated from the crane. The dredged material is then hoisted up and either released into a barge or deposited directly onto a levee. Twenty to thirty of such cycles may be completed in an hour. The resuspension of clamshell dredging occurs during the impact of the bucket on the floor, sediment sloughing during the closing of the jaw, and spillage and leakage during hoisting and swinging the bucket into the barge. Based on estimation made for past clamshell operation in other areas, about 20 to 30 percent of the excavated material was spilled during each cycle in open clamshell buckets. During dredging, each cycle creates a plume of sediments. The plum intensity decreases as the distance from the dredging area increases.

Expected turbidity levels at the site of dredging have not been estimated, but based on turbidities measured during use of the clamshell dredge in other areas, increase of 6.2 Nephelometric

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Turbidity Units (NTU) above background turbidity are expected which could exceed background levels by as much as 200 percent. Data available for clamshell operation in other areas indicate that resuspension during bucket operation is mainly a near field phenomena and is therefore a small temporal and spatial scale turbidity. This is considered to be a less-than-significant adverse impact.

- *Dredged Material Disposal*

Dredged material will be disposed on Victoria Island, Byron Tract, or Twitchell Island. The disposal has elements of both an upland site and a direct discharge to waters of the State, and compliance with the regulations of both types of disposal is recommended and discussed in this analysis.

Upland disposal of dredged sediment is regulated by California Code of Regulations Title 23, Chapter 15. Waste discharges to land are classified according to Article 2 of Chapter 15, which in its introduction states "*wastes which can be discharged directly or indirectly to waters of the state are regulated under waste discharge requirements which implement applicable water quality control plans.*" This refers to the waste discharge requirements issued for compliance with the state Porter Cologne Act and the federal Clean Water Act National Pollutant Discharge Elimination System (NPDES) permit. This project alternative includes the decanting of water to an existing agriculture drainage ditch and pumping into Old River, and is therefore subject to Section 401 of the Clean Water Act and the NPDES permit process. These activities could result in significant adverse impacts on water quality.

4.4 Mitigation

4.4.1 Operational Impacts

No significant water quality impacts from the operation of ISDP were identified. Therefore, no mitigation is required.

4.4.2 Construction Impacts

Dredged Material Disposal. The disposal of dredged material may lead to significant adverse impacts on water quality. Implementation of the following mitigation measure will comply with State and federal Water Quality Regulations and reduce associated adverse impacts to a level that is less-than-significant. The upland disposal of material and subsequent diffuse discharge of water that may affect groundwater quality requires compliance with Subchapter 15. According to this Subchapter, the RWQCB shall implement the regulations by issuing waste discharge requirements for waste management units (WMU). These requirements specify the waste classification and methods for discharge of the waste to land. For similar projects, the RWQCB has issued a consolidated permit containing Waste Discharge Requirements for surface impoundment and a NPDES permit for discharge of the dredged sediment decant water.

To obtain a waste discharge requirement, the discharger must submit a "Report of Waste Discharge" to the RWQCB and include details of the location and type of discharge and proposed method of disposal. This report should also include specific construction standards, programs for water quality monitoring, a maintenance plan, contingency plan, and a monitoring plan.

The dredged material may be classified as a "designated waste." According to Subchapter 15, a "designated waste" is a non-hazardous waste which consists of or contains pollutants which, under ambient environmental conditions at the waste management unit, could be released at concentrations in excess of applicable water quality objectives, or which could cause degradation of waters of the state." The discharger may establish, to the satisfaction of the RWQCB, that the dredged material is not a "designated waste" by showing that a particular waste constituent or combination of constituents presents a lower risk of water quality degradation. A designated waste must be discharged to a "Waste Management Unit" (WMU) which is designed and constructed according Subchapter 15 specifications.

For direct discharge to waters of the state, an NPDES permit is required under the CWA; a waste discharge requirement is issued under the Porter-Cologne act and serves as the NPDES. This permit is obtained through the RWQCB by also submitting a report of waste discharge. This application is evaluated relative to the water quality objectives adopted by the RWQCB, the Areawide Waste Treatment Management (Section 208) Plan, and the water quality control plan (Basin Plan). The RWQCB would then set effluent limits for the discharge which protect the beneficial uses of the receiving water.

4.5 Comparative Evaluation Of The Alternatives

4.5.1 Enlargement Of Clifton Court Forebay, Construction Of Two Intake Structures, Increased Export Capability, And Construction Of Permanent Barriers

- *Delta Water Quality*

This alternative differs from the preferred alternative by increasing the size of Clifton Court Forebay, providing two new intake structures at the northern edge of the new forebay, and by dredging a portion of Middle River to increase hydraulic capacity, rather than a portion of Old River. The alternative does not change the amount of increased export capability, and it assumes that demand is the same as for the preferred alternative.

This alternative would not result in any additional impacts to salinity and pollutants of concern relative to those already noted for ISDP.

Trihalomethane formation potential may increase as a result of flooding agricultural land on Victoria Island to enlarge the forebay. The potentially large amount of undissolved organic material in the soil would dissolve in the water of the forebay, increasing the THMFP. It is anticipated that the organic material would be exhausted, causing to THMFP reducing to existing levels. Silt deposition from forebay waters could cover the organic materials, effectively isolating them from contact with forebay water. This is a potentially significant adverse impact. It is not known how long the forebay water would be exposed to the organic material, or to what levels the THMFP would be increased.

- *Construction-Related Impacts*

This alternative anticipates significantly more construction than ISDP. The construction activities (dredging, filling, providing temporary flow diversion) are the same as those analyzed for ISDP. They would occur over a greater area, and in some different channels.

4.5.2 Reduction Of CVP/SWP Exports And Management Or Reduction Of Demand For SWP Water

- *Methodology*

A screening-level computer simulation was performed to assess the hydrodynamic impacts of a reduction in both the CVP and the SWP exports during the irrigation season. The irrigation season in the south Delta typically extends from April through September, with peak demands in July. Exports from Banks Pumping Plant average 3,800 cfs in April; 5,000 cfs in August; and 3,600 cfs in September. Exports from Tracy Pumping Plant average 3,200 cfs in April; and 4,000 cfs in July through September. This existing average export schedule is compared to the reduced export schedule for this alternative totaling 1,500 cfs during the period from April through September. The reduced exports are shared between the CVP and SWP as follows: 1,000 cfs is pumped at Tracy, and 500 cfs is pumped from Banks. For the screening-level analysis, a critically dry condition was used for the model boundary conditions. By inference from the modeling performed for the preferred alternative, the consequences observed during the critical year would be similar in timing during the other year types, but may differ in magnitude. The critical year sometimes produces the "worst-case" conditions, but not always.

The 4.1 MAF demand case modeled for the preferred alternative with DWRSIM was used as a baseline for evaluating the environmental consequences of this alternative. The Delta model (DWRDSM) was used to simulate changes in water levels and salinities, evaluated at several south Delta locations as shown in Figure 4-1. The Delta model run for the critical year without ISDP was used to simulate the existing environment. The consequences of the alternative were simulated by reducing CVP and SWP exports during April through September. No other changes were made to the simulations performed for the preferred alternative.

- *Delta Water Quality*

The water quality consequences of this alternative are evaluated by considering the model results for salinity. Salinity is a reasonable indicator for the behavior of conservative chemical compounds, and it is a good indicator of the contributions of the ocean and the San Joaquin River to Delta water quality. As a result of the reduced pumping during April through September with this alternative, the San Joaquin River flows preferentially down the Middle River and the San

Joaquin River north of the confluence with Old River, rather than being drawn into the Old River channel by export pumping. As a result, salinity in the Old River decreases under this alternative compared to the future no action case, and salinity in Middle River and the San Joaquin River increase. Other water quality parameters could be degraded in the channel reaches receiving a greater contribution from the San Joaquin River, owing to the relatively high concentration of agriculture-related compounds during the irrigation season.

It is assumed that there would be sufficient management or reduction in demand for SWP water to compensate for the reduction in exports during the irrigation season, as described for component two of this alternative. Under this assumption, exports would not increase during the period from October through March to compensate for the reduction in export during the irrigation season. If the demand reduction is successfully implemented, then the water quality consequences of the preferred alternative in the non-irrigation season (October through March) would not change for this alternative.

4.5.3 Modification Of CVP/SWP Exports, Consolidation Of Agricultural Diversions, Extension Of Existing Agricultural Diversions, And Increased Pumping At Harvey O. Banks Up To 10,300 cfs

Operation of this alternative may influence salinity and other water quality parameters, groundwater quality, or have consequences that are specific to regulating reservoir construction. Potentially significant consequences were analyzed in the same manner as for ISDP and are described in the following.

- *Salinity*

Delta-wide Changes in Salinity. With the exception of the period from mid-April to mid-May, the timing and magnitude of export pumping is similar between this alternative and ISDP. The changes in Delta outflow and salinity are therefore similar between the two alternatives. During the period from mid-April to mid-May, Delta outflow is higher and the interface with saline Pacific Ocean water is further downstream.

No barriers are installed with this alternative, with the exception of the fall installation of a rock barrier at the head of Old River. As a result, relatively saline water from the San Joaquin River flows through the south Delta and the export pumps. Water levels and circulation will not be improved, as they are with the barriers.

Salinity Changes at Specific Delta Locations. The SWP is operated to comply with all regulatory standards, including the salinity standards in the May 1995 Bay/Delta Water Quality Control Plan (SWRCB 1995). Therefore, the operation of this alternative is not expected to result in significant adverse impacts due to non-compliance with salinity criteria. The same stations that were analyzed for ISDP are also considered for this alternative in order to illustrate the times of year when the greatest changes in salinity occur, either positive or negative. The discussion of each area will focus on the results for the Future Demand case study, as it represents the worst case analysis. A change of greater than ten percent is used as a screening-

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level value, because changes of less than this amount are within the uncertainty of the field measurements and the modeling-related uncertainty.

Sacramento River. The Sacramento River stations at Collinsville and at Emmaton were analyzed. In the Future Demand Case Study (Figure 4-16), the greatest increases in salinity occur in October of above normal years at both Emmaton and Collinsville. Generally, increases would occur during April through August of dry and below normal years and October through December of below and above normal years at Colinsville. The greatest reduction in salinity values would occur during December of dry years at both Emmaton and Collinsville. Salinity decreases at both Emmaton and Collinsville during September through June of critical years.

San Joaquin River. The San Joaquin River stations at Prisoners Point, San Andreas Landing, Jersey Point, and Antioch were analyzed. These stations show the largest changes, as they are directly influenced by the increased flow requirements from mid-April to mid-May of this alternative. In the Future Demand Case Study (Figure 4-17), salinity increases generally from October through January of above normal years. At Prisoner's Point, increases also occur in April and May of critical, dry, below and above normal years, whereas other locations experience either nominal increases or decreases. In general, salinity decreases during December through February of dry years.

Suisun Bay and Marsh. The following four Suisun Bay and Marsh stations were analyzed: Miens Landing at National Steel; Montezuma Slough near Beldon Landing; Montezuma Slough near Mouth; and Suisun Slough near Mouth. In the Future Demand Case Study (Figure 4-18), salinity generally increases in October through December of above normal years and September of critical, dry, and wet years. Salinity decreases in December through June of dry years and April and May of all year types.

Municipal and Industrial Water Supply. The following three Municipal and Industrial use locations were analyzed: Contra Costa Canal Intake, Los Vaqueros Reservoir Intake, and Clifton Court Forebay. The Future Demand Case Study is evaluated for each location (Figure 4-19).

Salinity generally increases at the Contra Costa Canal intake occur during the following periods: October through February as well as April, May, and July of above normal years; November through May of below normal years; March through May of dry years: February, March, and September of wet years. In critical years, salinity is reduced in all months with the exception of August and September. The largest decreases in salinity would occur during October through February of dry years (Figure 4-19).

Salinity increases at Contra Costa Water District's Los Vaqueros Reservoir intake during the following time periods: October through May, July, and September of above normal years; November through August of below normal years; March through May and November of dry years; April, May, and September of critical years; and September of wet years. The greatest decreases in salinity would occur during December, January and August of dry years (Figure 4-19). It is noteworthy to point out that with the exception of wet years, for all other year types during the April-May Period (reduction in pumping), a considerable increase in the salinity occurs.

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Sacramento River at Emmaton

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
Critical	-	-	-	-	-	-	-	-	-	+	-	-
Dry	+	+	-	-	-	-	-	-	+	0	+	+
Below Normal	-	+	+	+	0	0	-	-	-	-	-	-
Above Normal	+	+	+	-	0	-	0	-	+	-	+	-
Wet	-	-	0	0	0	0	0	0	0	+	-	+

Sacramento River at Collinsville

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
Critical	-	-	-	-	-	-	-	-	-	+	+	-
Dry	+	+	-	-	-	-	+	+	+	+	+	+
Below Normal	+	+	+	+	+	+	+	+	+	+	+	-
Above Normal	+	+	+	-	-	-	-	-	+	-	+	-
Wet	-	-	0	-	0	0	0	0	0	-	-	+

+	project increases salinity
-	project decreases salinity
+ (light shading)	>+10% change
- (dark shading)	< -10% change

Figure 4-16. Changes in Average Chloride Concentrations, Consolidated Diversions Alternative, Sacramento River.

San Joaquin River at Prisoner's Point

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
Critical	+	+	-	-	-	-	+	+	-	-	+	+
Dry	-	+	-	-	-	+	+	+	0	-	-	-
Below Normal	-	+	+	+	+	0	+	+	0	+	+	+
Above Normal	+	+	+	+	+	0	+	+	0	+	-	+
Wet	-	+	0	-	+	0	0	0	+	+	0	+

San Joaquin River at Antioch Water Works

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
Critical	-	-	-	-	-	-	-	-	-	+	+	+
Dry	+	+	-	-	-	-	-	-	-	+	+	+
Below Normal	-	+	+	+	+	-	-	-	-	-	-	-
Above Normal	+	+	+	-	-	-	-	-	+	-	+	-
Wet	-	-	+	0	+	+	0	0	0	-	-	+

San Joaquin River at Jersey Point

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
Critical	-	+	-	-	-	-	-	-	-	+	+	+
Dry	+	+	-	-	-	-	-	-	-	+	-	+
Below Normal	-	+	+	+	+	-	-	-	-	-	-	-
Above Normal	+	+	+	+	+	-	-	+	0	+	-	+
Wet	-	-	+	-	+	+	0	0	0	-	-	+

San Joaquin River at San Andreas Landing

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
Critical	-	-	-	-	-	-	-	-	-	-	+	+
Dry	0	+	-	-	-	-	+	+	-	-	-	+
Below Normal	-	+	+	+	0	0	+	0	0	+	+	+
Above Normal	+	+	+	+	+	-	+	+	0	+	-	+
Wet	-	-	0	0	+	+	0	0	0	0	-	+

+	project increases salinity
-	project decreases salinity
+ (shaded light)	>+10% change
- (shaded dark)	< -10% change

Figure 4-17. Changes in Average Chloride Concentrations, Consolidated Diversions Alternative, San Joaquin River.

Montezuma Slough at National Steel - Mien's Landing

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
Critical	-	-	-	-	-	-	-	-	-	+	+	+
Dry	+	+	-	-	-	-	-	-	-	-	+	+
Below Normal	-	+	+	+	-	-	-	-	-	-	-	-
Above Normal	+	+	+	+	-	0	-	-	-	-	-	-
Wet	-	+	+	0	0	+	0	0	-	-	-	+

Montezuma Slough near Beldon Landing - Cutoff

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
Critical	-	-	-	-	-	-	-	-	-	+	+	+
Dry	+	+	-	-	-	-	-	-	-	-	+	+
Below Normal	+	-	+	+	-	-	-	-	-	-	-	-
Above Normal	+	+	+	+	+	+	+	-	-	-	-	-
Wet	-	+	+	0	-	+	0	-	-	-	-	+

Montezuma Slough near Mouth

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
Critical	-	-	-	-	-	-	-	-	-	+	+	+
Dry	+	+	-	-	-	-	-	-	-	+	+	+
Below Normal	-	+	+	+	-	-	-	-	-	-	-	-
Above Normal	+	+	+	-	+	-	-	-	+	-	+	-
Wet	-	+	+	0	0	+	0	-	+	+	0	+

Suisun Slough near Mouth

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
Critical	-	-	-	-	-	-	-	-	-	+	+	+
Dry	+	+	-	-	-	-	-	-	-	+	+	+
Below Normal	-	+	+	+	-	-	-	-	+	-	-	-
Above Normal	+	+	+	-	+	-	-	-	+	-	+	-
Wet	-	+	+	+	0	0	0	-	+	+	-	+

+	project increases salinity
-	project decreases salinity
+ (light shading)	>+10% change
- (dark shading)	< -10% change

Figure 4-18. Changes in Average Chloride Concentrations, Consolidated Diversions Alternative, Suisun Marsh.

Contra Costa Intake

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
Critical	-	-	-	-	-	-	+	+	-	-	+	+
Dry	-	+	-	-	-	+	+	+	-	-	-	+
Below Normal	-	+	+	+	+	+	+	+	0	+	+	+
Above Normal	+	+	+	+	+	0	+	+	0	+	-	+
Wet	-	-	-	-	+	+	0	-	+	+	-	+

Clifton Court Forebay

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
Critical	+	+	+	+	+	-	+	-	+	+	+	+
Dry	-	+	-	-	-	+	+	+	+	+	-	+
Below Normal	+	+	+	+	+	0	+	+	0	+	+	+
Above Normal	+	+	+	+	+	+	+	+	0	+	+	+
Wet	+	+	-	-	+	-	0	+	-	-	+	+

Los Vaqueros Reservoir Supplemental Intake

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
Critical	+	+	-	-	-	-	+	+	-	-	+	+
Dry	-	+	-	-	-	+	+	+	0	0	-	+
Below Normal	-	+	+	+	+	+	+	+	+	+	+	0
Above Normal	+	+	+	+	+	+	+	+	0	+	-	+
Wet	-	-	-	-	+	-	0	-	-	+	+	+

+	project increases salinity
-	project decreases salinity
+ (shaded)	>+10% change
- (dark shaded)	< -10% change

Figure 4-19. Changes in Average Chloride Concentrations, Consolidated Diversions Alternative, Municipal and Industrial Water Use.

The change in salinity for Clifton Court Forebay was evaluated by considering the quality of water in the Forebay itself. The results indicate that the largest increases in salinity occur as follows: August through December of critical years; November of dry years; September through January, and July of above normal years; November and December of below normal years; and February and October of wet years. December and January of dry years would experience the most noticeable decreases in salinity.

Other Water Quality Parameters

This section describes changes to the water quality parameters other than salinity. It relies on extrapolation from modeling results for hydrodynamics and salinity.

<u>Trihalomethane Formation Potential</u>. As it was the case with the preferred alternative, but to a lesser extent, trihalomethane formation potential (THMFP) may increase slightly in export water, based on the salinity results. The general increases in salinity of export water appears to occur because sea water intrusion is increased, which would increase the bromine content of export water (Hutton and Chung 1994 a,b).

<u>Groundwater Quality</u>. The construction of reservoirs would lead to increased seepage in the vicinity of the impound. Although the chemical quality of groundwater should not be impaired, groundwater levels near the reservoirs could be significantly increased.

- *Construction-Related Consequences*

The construction-related impacts of barrier installation, as discussed under preferred alternative section, will be avoided. Implementation of this alternative would require significantly more dredging than the preferred alternative. The dredging activities would last for a longer time and be distributed over a much wider area of the south Delta. Dredging on this scale may result in extended periods and/or higher levels of turbidity and increased trihalomethane formation potential, compared to the preferred alternative. These are considered to be less-than-significant adverse impacts.

4.5.4 ISDP Project With An Additional Clifton Court Forebay Intake At Italian Slough

- *Delta Water Quality*

This alternative would not result in any additional impacts to salinity and pollutants of concern relative to those already noted for ISDP.

- *Construction-Related Impacts*

This alternative expects significantly more construction than ISDP. The construction activities (dredging, filling, providing temporary flow diversion) are the same as those analyzed for the preferred alternative. In addition to the impacted areas described for ISDP, there would be similar impacts in Italian Slough due to intake construction and due to isolation of Clifton Court Forebay from Italian Slough.

4.5.5 ISDP Without The Northern Intake, And With An Expanded Existing Intake

- *Delta Water Quality*

This alternative would not result in any additional impacts to salinity and pollutants of concern relative to those already noted for ISDP.

- *Construction-Related Impacts*

This alternative anticipates a similar level of new construction compared to ISDP. The construction activities (dredging, filling, providing temporary flow diversion) are the same as those analyzed for the preferred alternative. Channel dredging impacts would likely occur in West Canal and Old River due to expansion of the existing intake. Impacts due to intake construction would occur at the site of the existing intake rather than at the site of the northern intake of the preferred alternative. These are considered to be less-than-significant adverse impacts.

4.5.6 No Action (Maintain Existing Conditions)

This alternative differs from ISDP by maintaining conditions as they exist at present. The Delta environment and water project operations as they have existed from 1978 through 1991 are described as the existing conditions in Section 4.1. That section provides a representation of the variability in the existing environment, given changes in climate, changes in demand, and changes in regulatory constraints. In order to describe the existing conditions as they will be from now into the future, it is important to minimize the effects of this historic variability in demand and regulatory constraints. For example, in 1990, the regulatory operations, so there are in fact only two years of data available to describe the no action alternative under the existing demand and regulatory conditions. These years, 1991 and 1992, were critical year types and would not provide a complete picture of what the existing demand and regulatory conditions would produce during the other water year types. For this reason, a simulation of water project operations and the Delta environment was made to augment the description of the existing environment in evaluating the consequences of the no action alternative. The existing demand on the SWP was set between 2.6 and 3.6 MAF to provide a base case study.

- *Water Quality*

In terms of water quality, this alternative differs the most from ISDP by not providing the barriers within the south Delta. The benefits to water levels and circulation would not occur in the no-action alternative. Increased salinity in the central Delta resulting from the placement of barriers would not result from this alternative.

Concerns over the quality of municipal water supplies would remain under the no-action alternative. The quality of water supplies is affected by Delta outflows, reverse flows, and local agricultural return flows. Without the barriers in place, as proposed in ISDP, the water entering the water project pumps in the south Delta would be mostly composed of San Joaquin River water. This water is of lesser quality than that of rivers entering the central and northern Delta. Greater improvements in water quality would be required at treatment plants where the water supplies are processed.

Agricultural users of water in the Delta are concerned with low water levels and poor water quality. These concerns would persist under this alternative. During some year types the water levels would fall below the pumping levels for agricultural uses and the water would be high in salinity concentrations.

4.5.7 No Action (Maintain Conditions As They Would Exist In The Future)

This alternative differs from ISDP by maintaining conditions as they would exist in the future. Unlike the no action alternative above, which considers the existing environment to remain unchanged in the future, this alternative considers projects or actions likely to be implemented in the reasonably foreseeable future. This alternative includes the use of water demand management or water supply augmentation measures throughout the State, project operations and the Delta environment was made to characterize the no-action alternative in the reasonably foreseeable future environment. The future demand on the SWP was set at 4.1 MAF to provide a base case study; this same model run was used as a baseline in evaluating the impacts of ISDP (Future Demand Case Study). Changes in Delta hydrodynamics and water quality that are likely to occur are summarized and compared with impacts of ISDP in the following section.

- *Water Quality*

Placement of the permanent barriers would not occur in this alternative. The benefits to water levels and circulation would not occur in the no-action alternative. Increased salinity in the central Delta resulting from the placement of barriers would not result from this alternative.

Concerns over the quality of municipal water supplies would remain under the no-action alternative. The quality of water supplies is affected by Delta outflows, reverse flows, and local agricultural return flows. Without the operational flexibility provided by ISDP's increased pumping capacity, withdrawals will occur during times of year when water quality conditions are worst (April through September). Without the barriers in place, as proposed in ISDP, the water entering the water project pumps in the south Delta would be mostly composed of San Joaquin

River water. This water is of lesser quality than that of rivers entering the central and northern Delta. Greater improvements in water quality would likely be required at treatment plants where the water supplies are processed.

Agricultural users of water in the Delta are concerned with low water levels and poor water quality. These concerns would persist under this alternative since barriers are not installed. During some year types the water levels may fall below the pumping levels for agricultural uses and the water would be high in salinity concentrations.

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