CALFED WATER QUALITY

DRAFT WATER QUALITY IMPACTS TECHNICAL REPORT

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Prepared for

CALFED BAY-DELTA PROGRAM

CALFED Water Quality Action Team
Sacramento, CA

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the impacts of the No Action Alternative and Alternatives 1, 2, and 3 are described and compared.

3.0 ANALYTICAL METHODS AND THRESHOLDS OF SIGNIFICANCE

3.1 Analytical Methods

Two methods are used to evaluate the water quality impacts of the Common Programs and the Storage and Conveyance Components. For the Common Programs a description of the affected environment is used in conjunction with the program action descriptions to semi-quantitatively infer water quality changes. Numerical modeling is used to evaluate the operational consequences of the Storage and Conveyance Components. The construction impacts of the Storage and Conveyance Components are evaluated in a semi-quantitative manner similar to the Common Programs analysis method.

Numerical Modeling

Two types of analytical models are being used to predict the effects of the proposed storage and conveyance components 1) statewide water supply studies using the DWRSIM model and 2) Delta hydronamic and water quality studies using the DWRSDM model. These models represent the best available method to quantitatively simulate the effects of the proposed storage and conveyance components.

DWRSIM: DWRSIM is a generalized computer simulation model designed to simulate the operation of the Central Valley Project and the State Water Project (SWP) system of reservoirs and conveyance facilities. The model accounts for system operational objectives, physical constraints, legal requirements, and institutional agreements. These parameters include requirements for flood control storage, instream flows for fish and navigation, allocation of storage among system reservoirs, hydropower production, pumping plant capacities and limitations, the Coordinated Operating Agreement (COA), and required minimum Delta operations to meet water quality and Delta outflow objectives. 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.

DWRSIM utilizes a variety of relationships to define water quality in the Delta and in the San Joaquin River. The Kimmerer-Monosmith equation is used to calculate outflow requirements for "X2" objectives (1). Contra Costa Water District's "G" model is used to calculate outflow requirements for water supply objectives at Chipps Island, Collinsville, Antioch, Emmaton, Jersey Point and Rock Slough. A flow-salinity relationship upstream of the Stanislaus River is used in combination with a simple salt balance to calculate required water quality releases for the Vernalis salinity objective.

DWRSIM simulation results estimate how the entire system would perform when trying to meet project demands, assuming recurrence of the historical 73-year sequence of hydrology (1922-1994) at the 1995 level of development DWRSM has a number of limitations. Many of these limitations are due to a lack of information or objective criteria, and would be limitations of any similar model.

There is considerable variability in the criteria that might be selected for operating the system to achieve environmental, water quality and water supply goals. For the most part the DWRSIM analyses assumed that the system would be operated according to existing rules, including the SWRCB's May 1995 Water Quality Control Plan. Benchmark assumptions defined for the DWRSIM studies are provided in Appendix II. Additional assumptions were required to operate the proposed storage and conveyance systems. These assumptions are described in Appendix III.

DWRDSM: 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. The mean of the measured tidal variation over 19 years is used as boundary condition to simulate the effects of ocean tides on Delta water quality and hydrodynamics. 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.

3.2 Thresholds of Significance

The regualtory controls estbalished by the May 1995 Water Quality Control Plan for the San Francisco Bay/Sacramento-San Joaquin Delta Estuary, the State and Federal drinking water criteria, and the Clean Water Act Section 404(b)(1) Guidelines are used as signifcance criteria.

3.2.1 May 1995 Water Quality Control Plan for the San Francisco Bay/Sacramento-San Joaquin Delta Estuary (WQ Control Plan)

The WQ Control Plan sets forth water quality objectives for beneficial uses to be protected. The objectives for municipal and domestic water supplies (MUN), industrial service supply (IND), and industrial process supply (PROC), are designed to protect theses beneficial uses from the effects of salinity intrusion. Agricultural water supply (AGR) objectives address the effects of salinity intrusion and agricultural drainage in the western, interior, and southern Delta. The objectives for protection of fish and wildlfie beneficial uses include the following parameters: dissolved oxygen, salinity, Delta otuflow, river flows, export limits, and Delta Cross Channel gate operation.

The SWP is operated to comply with the salinity standards in the WQ Control Plan. The following stations or areas can be used as indicators of salinity changes that have the potential to create either positive or negative changes in salinity: 1) Sacramento River stations; 2) San Joaquin River stations; 3) Suisin Bay and Marsh station; and 4) Municipal and industrial uses. 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.

Sacramento River: 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.

San Joaquin River: 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.

Suisun Bay and Marsh: The standards at Montezuma Slough at National Steel; Montezuma Slough near Beldon Landing; Montezuma Slough near mouth; and Suisun Slough near mouth were developed to protect fish and wildlife beneficial uses.

Municipal and Industrial Water Supply: Water quality parameters at the Contra Costa Canal Intake, Los Vaqueros Reservoir Intake, Clifton Court Forebay, and the Tracy Wastewater Treatment Plant can be used as indicators of compliance with municipal and industrial supply standards.

3.2.2 State and Federal Drinking Water Criteria

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 formd during disinfection by chlorination. THM's are affeced 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 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 drinking water suppliers.

Clean Water Act Section 404(b)(1) Guidelines: The discharge or disposal of dredged or fill materials may result in impacts to water quality. Accoriding to Clean Water Act Section 404(b)(1) Guidelines potential impacts to water quality resulting from the discharge or dispsoal of dredged material are:

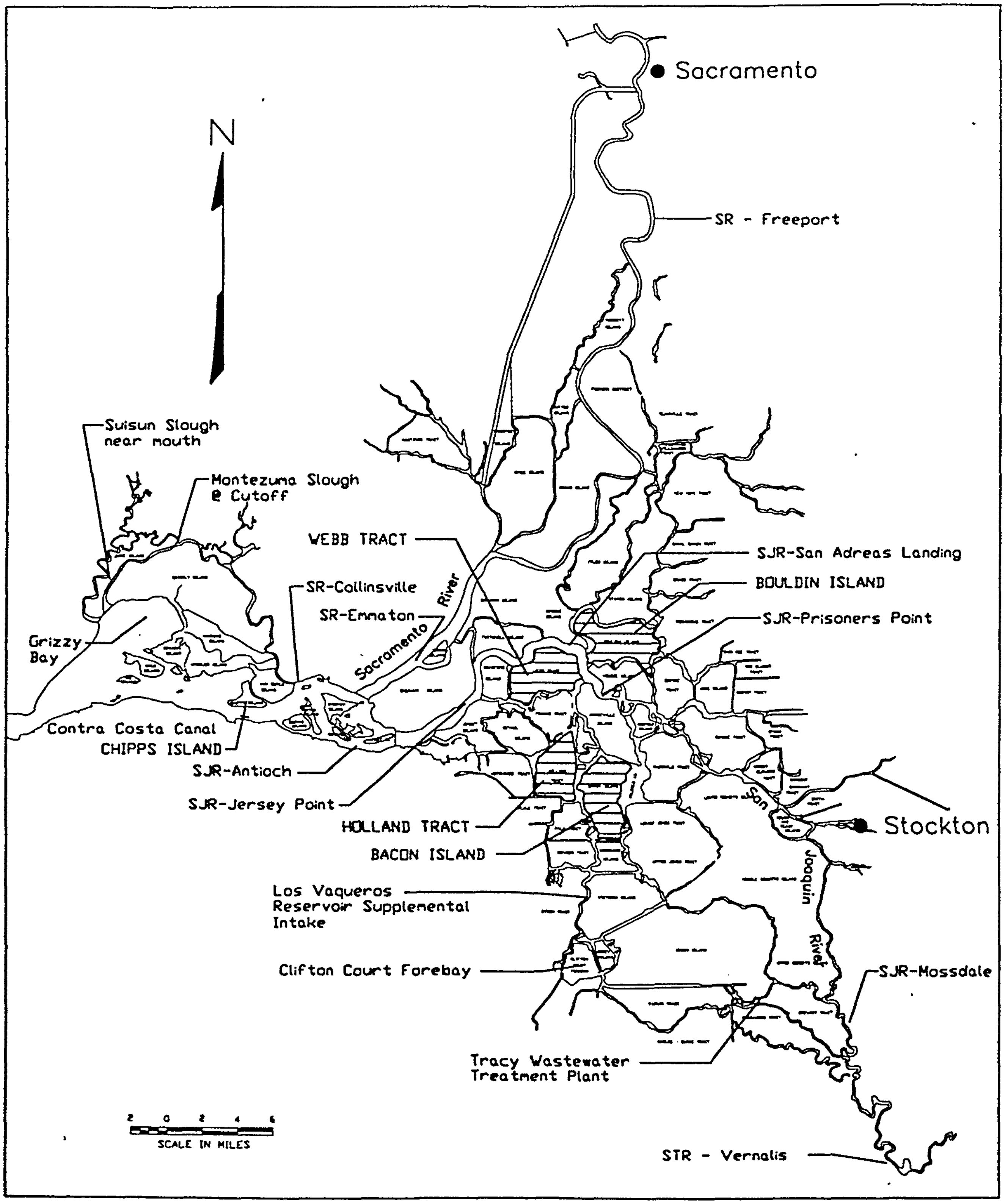

Figure 4-1. Water Quality Monitoring/Modeling Locations.

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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/l Chlorides
Clifton Court Forebay Intake at West Canal	All	All	250 mg/l Chlorides†
Delta Mendota Canal at Tracy Pumping Plant	All	All	250 mg/l Chlorides
Barker Slough at North Bay Aqueduct	All	All	250 mg/l Chlorides
Cache Slough at City of Vallejo Intake	All	All	250 mg/l 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/l 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/l Chlorides.
‡EC - Electrical Conductivity is reported as maximum 14-day average in mmhos/cm.

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

2) Alteration of normal water-level fluctuations which may result in chnages in slainity patterns, alteration of ersion and sedimentation rates, aggravation of water temperature extremes, and upsets in nutrient and dissolved oxygen balance ; and

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

Notes:

1. DWR, March 7, 1997, CALFED'S Storage and Conveyance Refinement Process: A Status Report on System Modleing with DWRSIM.

4.0 IMPACTS AND MITIGATION MEASURES

4.1 Common Programs

Four programs will be common to the three major alternatives. Each program consists of a number of programmatic actions. The programs include:

- Ecosystem Restoration Program - Includes actions to designed improve habitat and to promote a diverse and stable ecosystem in the Bay-Delta system.
- Water Quality Program - Includes actions to reduce pollutant load entering the Bay-Delta system.
- Water Use Efficiency Program - Includes policies and actions designed to increase water use efficiency.
- Levee System Integrity Program - Includes actions to improve the stability of levees throughout the Delta.

The impacts of each of the four programs are analyzed in the following sections.

4.1.1 Ecosystem Restoration Program Plan

The ecosystem restoration program consists of a series of actions designed to improve the quality and increase the extent of habitat for aquatic and terrestrial species in the Bay-Delta region. The habitat improvements are intended to support sustainable populations of diverse and valuable plant and animal species. The actions are organized by geographic region

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Delta Region

A series of programatic actions are proposed for the Delta. The programatic actions are listed in Table ERP-1. An initial screening was conducted to divide actions into two categories; those with minimal impacts on water quality; and those with potentially significant impacts. Actions were judged to have minimal impacts on water quality if they do not change the emission rate of pollutants or their concentration of pollutants in water bodies or if the changes they produce are clearly negligible. The results of the screening is shown in Table ERP-1. Actions judged to have potentially significant impacts were analysed further as described below and a determination made of their significance. Where an impact is determined to be significant, mitigation measures are suggested. No mitigation measures are required when the impacts are judged to be less-than-significant.

Table ERP-1
Ecosystem Restoration Program Plan
Programmatic Actions for Delta Region

Programmatic Action	Magnitude	Potentially Significant Impacts on Water Quality?
1. Restore tidal perennial aquatic habitat, and tidal emergent wetlands.	33,000 - 45,000 acres	Yes
2. Restore tidally influenced freshwater marsh.	20,000 - 25,000 acres	Yes
3. Restore tidally influenced channels and distributary sloughs.	150 - 250 miles, 900 - 2,300 acres	Yes
4. Restore shallow water habitat.	7,000 acres	Yes
5. Restore shoals.	500 acres	No
6. Create deep open water areas within restored freshwater emergent wetland areas.	500 acres	No
7. Create shallow open water areas within restored freshwater emergent wetland areas.	1,500 - 2,000 acres	No
8. Restore seasonal wetlands.	34,000 acres	Yes
9. Restore riparian habitat.	75 - 220 miles, 700 - 8,000 acres	Yes
10. Protect additional existing riparian woodlands.	500 acres	No
11. Restore non-tidal emergent wetlands.	15,000 acres	Yes
12. Restore channel islands.	200 - 800 acres	No

Action 1: Restore Tidal Perennial Aquatic Habitat And Tidal Wetlands

General Description Of Action: The acreage of open water aquatic habitat and tidal emergent wetlands will be increased by constructing setback levees, by flooding islands and by connecting dead end sloughs to Delta channels. Between 33,000 and 45,000 acres of agricultural land will be converted to aquatic habitat. Most of the aquatic habitat will consist of shallow open water with emergent vegetation around its margins.

Direct Short-Term Impacts: Creation of aquatic habitat will involve construction activities, principally the removal of sections of existing levee and the construction of new levees. Flooding of islands and the reconnection of dead-end sloughs will be accomplished by removal of levees. It is expected that only short sections of levee will be removed to initiate flow. The remaining portions of the no longer-useful levees will be abandoned and allowed to deteriorate and eventually disappear. Local increases in turbidity and suspended solids content will occur during levee removal.

Some of the aquatic habitat will be created by constructing new levees behind the existing levees. Once new levees are in place the existing levees will be breached and then allowed to gradually erode. The impacts of levee construction will depend on the method of construction and the nature of the materials used. In most cases, material will have to be imported for levee construction. Possible sources of material include dredging spoils from the Delta and the Bay Area. Because the source of material is uncertain the impacts associated with its excavation at the source are not discussed here. It is assumed that materials will arrive at the consstruction site by barge.

Because levee construction will occur in dry conditions, adverse impacts on water quality will be less than if construction had to be undertaken within the Delta channels. The new levees will be compacted, armored if necessary, and seeded. Minor and localized increases in turbidity can be expected when the new levees are first exposed to water. Any adverse impact on turbidity could be reduced by allowing vegetation to become established on the new levees before breaching the existing levees.

Construction will have negligible effects on other constituents of concern other than turbidity and suspended solids content. Dredged spoils may contain low concentrations of various toxic substances. Because the new levees will be built in the dry these substances will not be released to the aquatic environment during construction.

Direct Long-Term Impacts Compared To Existing Condition: The action involves the conversion of agricultural lands on Delta islands and bordering Delta channels to aquatic habitat. Currently, the agricultural lands emit various substances which are discharged to Delta channels. After implementation of this action, the created aquatic habitat will continue to emit various substances, but their types and quantity will be different. Emissions of metals, trace elements and microbes are expected to be negligible and are not discussed further. All other changes are discussed below.

Organics - Much of the agricultural land on Delta islands and bordering Delta channels is at an elevation below that of the adjacent waterways and is separated from the waterways by levees. Excess runoff and irrigation water drains from fields to perimeter ditches which flow to sumps adjacent to the levees. Runoff and agricultural drainage water is pumped over the levees and into the Delta channels. The water discharged to the Delta channels is fairly rich in organic matter as indicated in Table ERP-3. The organic matter is in both dissolved and particulate form and is probably attributable to wash off of organic matter from soils, particularly peat soils, and crop residues, and from aquatic plants growing in the drainage ditches. It is estimated that the annual emission rate of DOC from lowland agricultural acreage in the Delta is 12 grams/square meter. The corresponding value for upland agricultural acreage is 6 grams/square meter (1).

Table ERP-3
Delta Island Drainage Water Quality

Constituent	Units	Webb Tract	Jones Tract	Rindge Tract
Electroconductivity	µS/cm	1,036	730	954
Chloride	mg/l	160	115	161
Bromide	mg/l	0.58	0.31	0.70
DOC	mg/l	25.1	11.3	214
THMFP	µg/l	2,150	1,287	1,963
Nitrate	mg/l	13.7	8.1	5.8

Source: DWR MWQI data, 1986-1991

During the summer months, DOC content of water extracted from the Delta at Clifton Court Forebay is 1 to 3 mg/l higher than the content of Sacramento River water (2). Agricultural drainage discharges are thought to be the primary source of the increase in DOC content of waters within the Delta.

Conversion of land from agriculture to aquatic habitat will change the rate of DOC emission. It has been estimated that the annual emission rate of flooded Delta islands formerly used as cropland is 6 gm/square meter (3). If this estimate is accurate, then conversion of land from agriculture to aquatic habitat will half the rate of emission of DOC from sites in the Delta lowlands. There will be no change in emission from sites in the Delta uplands. However, experts disagree over the accuracy of the DOC emission estimates refered to above. Some have suggested that there is a considerable range of uncertainty and that conversion of agricultural land to wetlands could increase DOC emission by 10% or decrease it by up to 50% (4).

The total annual emission of DOC in agricultural drainage in the Delta is estimated to be 21,250 tons (5). If it is assumed that conversion of land from agricultural use to aquatic habitat reduces DOC emission by 50% and that all the land converted to aquatic habitat is in the Delta lowlands, then the annual reduction in DOC emission will be between 700 and 1,000 tons or 3.3% to 4.6% of the total. If it is assumed that conversion of land produces a 10% increase in DOC emission, then there will be an annual increase in DOC emission between 1,500 and 2,200 tons or 7.5% to 10% of the total.

The change in emission of organic carbon will affect beneficial use of Delta water for drinking water supply. Because dissolved organic matter is the primary precursor of trihalomethanes, a change in DOC content of Delta waters will alter its suitability as a source of drinking water supply. As noted above, the DOC concentration of water at the export pumps is 1 to 3 mg/l higher than the DOC concentration in Sacramento River water. Action 1 will very slightly increase or slightly decrease the concentration of DOC at the export pumps. However, because in either case, the change in concentration will be small, the affect on the suitability of Delta water as a water supply source, or on water supply practices will be minor. The other principal beneficial uses, agricultural and industrial water supply and fish and wildlife useof water would not be adversely affected.

Pesticides - Currently, various pesticides are used on the agricultural lands in the Delta. The most commonly used pesticides are carbonfuran, chlorpyrifos and idazinon. Conversion of agricultural lands to aquatic habitat will eliminate the use of pesticides on the lands subject to this action. and thus the discharge of pesticide-contained agricultural drainage water.

Salts - Approximately, 70% of the surface area of the Delta is devoted to irrigated agriculture (6). Irrigation water is drawn from the Delta channels and applied to cropland. The total dissolved solids content of the applied water is usually in the range 100 mg/l to 150 mg/l. When water is applied to agricultural land, some evaporates, some is used by crops, some runs off the surface of the land and some percolates into the ground. Farmers must apply sufficient water to the land to flush the salts contained in the applied water out of the upper soil layers. To do otherwise, would allow salt to build up in the soil with a consequent adverse effect on crop yields or the type of crops that can be cultivated.

In the Delta, little runoff of applied water occurs; most of the water not evaporated or used by plants, percolates into the ground and drains to ditches at the perimeter of the fields, from then is pumped back into the Delta channels. The volume of drainage water is estimated to be 25 to 50% of the volume of the applied water. It is further estimated that the average salt content of drainage water is 2 to 4 times greater than that of the applied water (7).

To summarize, large volumes of water with a relatively low salt content are abstracted from Delta channels to irrigate cropland. After agricultural use, considerably smaller volumes of water are returned to the channels with a much higher salt content. However, because salts cannot be allowed to accumulate in soils, the salt load in the applied water and the discharged drainage water are approximately the same and thus irrigated agriculture is not a net emitter of salts to Delta waters.

If, as proposed in Action 1, agricultural land is converted to shallow water aquatic habitat, then cropland would be replaced by open water with a fringe of emergent wetlands. The created aquatic habitat would neither take up nor emit salts. Thus, the change in land use would have no effect on the emission of salts. It would, however, have an effect on salt concentration for the reasons noted below.

The evapotranspiration rate from open water will be greater than that from the corresponding acreage of agricultural land. The estimated evapotranspiration rate for open water in the Delta is 55.4 inches. The corresponding values for irrigated lands in the Delta uplands and lowlands are 35.9 and 31.2 inches, respectively (8). The effect can best be illustrated with an example; a 200-foot wide, 2,000-foot long channel, confined by levees in the Delta lowlands, is bordered by irrigated cropland. Under Action 1, a setback levee is built on one side of the channel, expanding its width to 600 feet. Approximately, 18 acres of irrigated agriculture is taken out of production and converted to aquatic habitat. The loss of water to evapotranspiration from the cropland was 48 acre-feet per year; the corresponding loss from the aquatic habitat is 85 acre-feet per year. The volume of water exiting the channel after the conversion of agricultural land to aquatic habitat will be less than before. As noted above, the salt load will remain the same and so the concentration of salt must increase.

Thus, the overall effect of conversion of land from irrigated agriculture to aquatic habitat is to reduce channel flow and increase salt concentration.

Nutrients - The principal nutrient in agricultural drainage water is nitrate. Phosphorus tends to become bound up in the soil and ammonia is converted to nitrate by nitrifying bacteria in the soil. Nitrate levels in agricultural drainage water are high, 25 to 50 times higher than in typical uncontaminated surface waters. Almost all the nitrate is attributable to nitrogen fertilizers applied to cropland.

Conversion of agricultural land to aquatic habitat will reduce nitrate emission. Plants in the newly created aquatic habitat will use nutrients during the growth season and release them in the form of organic nitrogen as plants die and decay. Unlike agricultural land the aquatic habitat will not be a large net exporter of nitrogen.

The acreage of land converted from agriculture to aquatic habitat under this action represents 8 % of the irrigated agricultural land in the Delta. If it is assumed that the change in land use reduces the emission of nitrate from each acre of land by 98% then the total nitrate emission reduction attributable to this action is also 8%.

Direct Long-Term Impacts Compared To No Action Condition: The direct long-term impacts compared to the no action condition will be similar to those compared to the existing condition. The changes in emission of various substances attributable to the conversion of agricultural lands to aquatic habitat will be the same. Concentrations of the substances in the Delta will be slightly altered because of the different flow regime prevailing under the No Action Condition.

Indirect Impacts: Action 1 will produce no indirect adverse impacts on water qaulity

Determination Of Significance:

Notes

1.0 SUMMARY

The following draft technical report includes a preliminary analysis of impacts of the CALFED Bay-Delta Program alternative solutions. The primary approach to impact analysis in this report is to analyze the individual programmatic and site-specific actions independently. The impacts of the independent actions are then aggregated to determine the overall impact of an alternative solution. This approach was used because it is anticipated that the components of the actions and the alternative solutions will change.

Two approaches to impact analysis were used. The first approach was to semi-quantitatively infer water quality changes. The second approach was to utilize existing numerical models (DWRSIM, DWRSDM) to evaluate the operational consequences of proposed storage and conveyance components. Thresholds of significance were derived from the May 1995 Water Quality Control Plan for the San Francisco Bay/Sacramento-San Joaquin Delta Estuary, State and Federal drinking water criteria, and the Clean Water Act.

The Common Programs analysis addresses the impacts of selected Ecosystem Restoration Program Plan (ERPP). All of the Bay and Delta actions are addressed in this report. ERPP actions in the Sacramento Valley Region and the San Joaquin Valley Region will be analyzed in the next submittal. Action 1 of the Levee System Integrity Programmatic Actions is also analyzed. Actions 2 and 3 will be analyzed in the next submittal.

The potential impacts of the proposed Storage and Conveyance Components are divided into two impact categories: 1) short-term construction impacts, and 2) long-term operational impacts. The approach for analyzing the construction impacts is similar to that of the ERPP analysis. The analysis of operational impacts is only in the conceptual stage in this report. Numerical modeling strategies using DWRSIM and DWRDSM need to be further defined in order to support the analysis of water quality impacts in the Delta.

The impacts of the alternative solutions are not addressed in this draft report because all of the alternative components have not been analyzed. The conceptual strategy for the alternative analysis is to analyze both the no action alternative and the alternative solutions by comparing both the positive and negative changes in the standards identified in the thresholds of significance.

2.0 INTRODUCTION

This report describes the potential water quality impacts of the Common Programs actions, the construction and operation of the Storage and Conveyance components, and a comparison of the impacts of Alternatives 1, 2, and 3. The discussion is organized as follows. First, the analytical methods and the standards of significance are described. Next, the impacts of the Common Programs actions are described. Following this discussion is an analysis of the operational and construction impacts of the Storage and Conveyance Components. Finally, The evapotranspiration rate from open water will be greater than that from the corresponding acreage of agricultural land. The estimated evapotranspiration rate for open water in the Delta is 55.4 inches. The corresponding values for irrigated lands in the Delta uplands and lowlands are 35.9 and 31.2 inches, respectively (8). The effect can best be illustrated with an example; a 200-foot wide, 2,000-foot long channel, confined by levees in the Delta lowlands, is bordered by irrigated cropland. Under Action 1, a setback levee is built on one side of the channel, expanding its width to 600 feet. Approximately, 18 acres of irrigated agriculture is taken out of production and converted to aquatic habitat. The loss of water to evapotranspiration from the cropland was 48 acre-feet per year; the corresponding loss from the aquatic habitat is 85 acre-feet per year. The volume of water exiting the channel after the conversion of agricultural land to aquatic habitat will be less than before. As noted above, the salt load will remain the same and so the concentration of salt must increase.

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Determination Of Significance:

Notes

1. Draft Delta Wetlands EIR/EIS, September, 1995. Appendix C4, p. C4-8.

2. Draft Delta Wetlands EIR/EIS, September, 1995. Appendix C1, p. C1-7.

3. Draft Delta Wetlands EIR/EIS, September, 1995. Appendix C4, p. C4-8. Notes that the DOC mass emission rates are somewhat uncertain.

4. Calculation uses data on acreages of irrigated lands in the Delta uplands (142,500 acres) and Delta lowlands (342,400 acres) obtained from Tables C4-2 and C4-3 contained in the Delta Wetlands EIR/EIS. Values in tons.

5. Data on acreages of land in the Delta from Tables C4-1, C4-2 and C4-3 in Delta Wetlands EIR/EIS. Lands are classified as urban, 26,200 acres; riparian, 9,000 acres; irrigated agricultural lands, 485,000 acres; idle agricultural land and natural, 104,000 acres; and open water 54,000 acres.

6. Draft Delta Wetlands EIR/EIS, September, 1995. Appendix C2, p. C2-5.

7. Evapotranspiration data from Tables C4-1, C4-2 and C4-3 in Delta Wetlands EIR/EIS.

Action 2: Restore Tidally-Influenced Freshwater Marsh

General Description Of Action: The acreage of tidally-influenced freshwater marsh will be increased by constructing setback levees and by flooding islands and island peninsulas. Between 20,000 and 25,000 acres of agricultural land will be converted to marsh. Most of the habitat will consist of emergent freshwater marsh which is subject to water surface elevation changes produced by the tide but which rarely if ever becomes brackish.

Direct Short-Term Impacts: Creation of freshwater marsh will involve construction activities, principally the removal of sections of existing levee and the construction of new levees. Flooding of islands will be accomplished by removal of levees. It is expected that only short sections of levee will be removed to initiate flow. The remaining portions of the no longer-useful levees will be abandoned and allowed to deteriorate and eventually disappear. Local increases in turbidity and suspended solids content will occur during levee removal.

Some of the freshwater marsh will be created by constructing new levees behind the existing levees. Once new levees are in place the existing levees will be breached and then allowed to gradually erode. The impacts of levee construction will depend on the method of construction and the nature of the materials used. In most cases, material will have to be imported for levee construction. Possible sources of material include dredging spoils from the Delta and the Bay Area. Because the source of material is uncertain the impacts associated with its excavation at the source are not discussed here. It is assumed that materials will arrive at the construction site by barge.

Because levee construction will occur in dry conditions, adverse effects on water quality will be less than if construction had to be undertaken within the Delta channels. The new levees will be compacted, armored if necessary, and seeded. Minor and localized increases in water turbidity can be expected when the new levees are first exposed to water. Any adverse effect on turbidity could be reduced by allowing vegetation to become established on the new levees before breaching the existing levees.

In parts of the Delta, agricultural lands are many feet below the water surface in the adjacent channels. If these areas are flooded they will, at least initially, be transformed into open water rather than freshwater marsh. In order to provide a substrate for marsh vegetation at a suitable elevation, the surface of the land will have to be built up. Imported fill., probably dredge spoils, will be used for this purpose. Several construction scenarios are possible. The setback levee would likely be constructed first. Dredge spoils could be delivered by barge to the site, lifted over the original levee, placed between it and the setback levee, and graded to the required level using earthmoving equipment. If the dredge spoils have a high moisture content they could be pumped into place between the levees. In either case, placement of the material would occur in isolation from water in the Delta channels. There would be no effect on turbidity during construction. Some local increases in turbidity would occur when the outer levee was breached.

An alternate construction method would involve breaching the original levee once the setback levee is complete, and dropping dredge spoils directly into place from barges. Substantial increases in local water turbidity would be expected if this construction method is used.

Construction will have negligible impacts on other constituents of concern other than turbidity and suspended solids content. Dredged spoils may contain low concentrations of various toxic substances. Levee construction in the dry will not release these substances to the aquatic environment. Placement of dredge spoils directly into open water would do so.

<u>Direct Long-Term Impacts Compared To Existing Condition</u>: The action involves the conversion of agricultural lands on Delta islands and bordering Delta channels to freshwater marsh. Currently, the agricultural lands emit various substances which are discharged to Delta channels. After implementation of this action, the created marsh habitat will continue to emit various substances, but their types and quantity will be different. Emissions of metals, trace elements and microbes are expected to be negligeable and are not discussed further. All other changes are discussed below.

Organics - The conversion of land from agriculture to freshwater marsh will change the rate of DOC emission in a similar way to the conversion to tidal perennial aquatic habitat described above (Action 1). As discussed above, there is considerable uncertainty about the nature and magnitude of the change. It has been suggested that the conversion of agricultural land to wetlands could increase DOC emission by 10% or decrease it by up to 50% (1).

The total annual emission of DOC in agricultural drainage in the Delta is estimated to be 21,250 tons (2). If it is assumed that conversion of land from agricultural use to aquatic habitat reduces DOC emission by 50% and that all the land converted to aquatic habitat is in the Delta lowlands, then the annual reduction in DOC emission will be between 440 and 550 tons or 2.0% to 2.6%. If it is assumed that conversion of land produces a 10% increase in DOC emission, then there will be an annual increase in DOC emission between 960 and 1,200 tons or between 4.5% to 5.6%.

The change in emission of organic carbon will affect beneficial use of Delta water for drinking water supply. Because dissolved organic matter is the primary precursor of trihalomethanes, a change in DOC content of Delta waters will alter its suitability as a source of drinking water supply. The DOC concentration of water at the export pumps is 1 to 3 mg/l higher than the DOC concentration in Sacramento River water. Action 2 will slightly increase or slightly decrease the concentration of DOC at the export pumps. However, because in either case, the change in concentration will be small, the affect on the suitability of Delta water as a water supply source, or on water supply practices will be low. The other principal beneficial uses, agricultural and industrial water supply and fish and wildlife use of water would be unaffected.

Pesticides - Currently, various pesticides are used on the agricultural lands in the Delta. The most commonly used pesticides are carbofuran, chlorpyrifos, and diezinon. Conversion of agricultural lands to freshwater marsh will eliminate the use of pesticides on the lands subject to this action and thus, the discharge of pesticide-contained agricultural drainage water.

Salts - The overall effect of conversion of land from irrigated agriculture to freshwater marsh would be similar to that described above in Action 1. Evapotranspiration rates would be increased and the salt content of waters corespondingly increased.

Nutrients - The principal nutrient in agricultural drainage water is nitrate. Almost all the nitrate is attributable to nitrogen fertilizers applied to cropland. Conversion of agricultural land to freshwater marsh will reduce nitrate emission. Plants in the newly created aquatic habitat will use nutrients during the growth season and release them in the form of organic nitrogen as plants die and decay. Unlike agricultural land, the aquatic habitat will not be a large net exporter of nitrogen.

The acreage of land converted from agriculture to aquatic habitat under this action represents - % of the irrigated agricultural land in the Delta. If it is assumed that the change in land use reduces the emission of nitrate from each acre of land by 98% then the total nitrate emission reduction attributable to this action is also -%.

<u>Direct Long-Term Impacts Compared To No Action Condition</u>: The direct long-term impacts compared to the no action condition will be similar to those compared to the existing condition. The changes in emission of various substances attributable to the conversion of agricultural lands to freshwater marsh will be the same. Concentrations of the substances in

the Delta will be slightly altered because of the different flow regime prevailing under the No Action Condition.

Indirect Impacts: Action 2 will produce no indirect adverse impacts on water qaulity

Determination Of Significance:

Notes:

Action 3: Restore Tidally-Influenced Channels And Distributary Sloughs

General Description Of Action: A system of channels and sloughs will be constructed in the Yolo Bypass and in the Cache and Putah creek sinks and connected to the larger Delta channels. In some cases, existing channels will be dredged and widened. The new and expanded waterways will recreate a network of tidally-influenced natural channels which existed before the land was drained for agriculture use. A total land area of 90 to 2,300 acres will be affected. For analytical purposes it is assumed that 70% of the land needed is currently used for agriculture.

Direct Short-Term Impacts: The channels and sloughs will be created by dredging existing channels and excavating new channels in agricultural lands. The effects of construction activities on water quality will depend on the construction methods used. New channels will likely be constructed in dry conditions using earthmoving equipment. No discharge of contaminants would occur during construction but some increases in water turbidity will occur when the new channels are connected to existing channels and tidal flow initiated. Enlargement of existing channels will also often be undertaken in the dry as the channels are currently isolated from tidal flow and are dry in the summer. Excavation in channels containing water will result in localized turbidity increases but the extent of the adverse effects can be limited by excavating behind coffer dams and diverting flow around excavations. Barge mounted dredgers will be used in the larger channels and will be a source of increased turbidity.

Direct Long-Term Impacts Compared To Existing Condition: The action involves the conversion of small amounts of agricultural lands to open water and emergent vegetation. The effects of conversion of agricultural land to open water and emergent vegetation on pollutant emissions was discussed under Action 1. The effects of Action 3 would be very similar to those of Action 1 but on a much smaller scale.

Direct Long-Term Impacts Compared To No Action Condition: The direct long-term impacts compared to the no action condition will be similar to those compared to the existing condition. The changes in emission of various substances attributable to the conversion of agricultural lands to aquatic habitat will be the same. Concentrations of the substances in the Delta will be slightly altered because of the different flow regime prevailing under the No Action Condition.

Indirect Impacts: Action 3 will produce no indirect adverse impacts on water qaulity

Determination Of Significance:

Action 4: Restore Shallow Water Habitat

General Description Of Action: The acreage of shallow water aquatic habitat will be increased by constructing setback levees and by flooding islands. Approximately 7,000 acres of agricultural land will be converted to aquatic habitat. Aquatic habitat will consist of shallow open water with emergent vegetation around its margins.

Direct Short-Term Impacts: Creation of aquatic habitat will involve construction activities, principally the removal of sections of existing levee and the construction of new levees. Flooding of islands will be accomplished by removal of levees. It is expected that only short sections of levee will be removed to initiate flow. The remaining portions of the no longer-useful levees will be abandoned and allowed to deteriorate and eventually disappear. Local increases in turbidity and suspended solids content will occur during levee removal.

Some of the aquatic habitat will be created by constructing new levees behind the existing levees. Once new levees are in place the existing levees will be breached and then allowed to gradually erode. The impacts of levee construction will depend on the method of construction and the nature of the materials used. In most cases, material will have to be imported for levee construction. Possible sources of material include dredging spoils from the Delta and the Bay Area. Because the source of material is uncertain the impacts associated with its excavation at the source are not discussed here. It is assumed that materials will arrive at the consstruction site by barge.

Because levee construction will occur in dry conditions, adverse effects on water quality will be less than if construction had to be undertaken within the Delta channels. The new levees will be compacted, armored if necessary, and seeded. Minor and localized increases in water turbidity can be expected when the new levees are first exposed to water. Any adverse effect on turbidity could be reduced by allowing vegetation to become established on the new levees before breaching the existing levees.

Construction will have negligible effects on other constituents of concern other than turbidity and suspended solids content. Dredged spoils may contain low concentrations of various toxic substances. Because the new levees will be built in the dry these substances will not be released to the aquatic environment during construction.

Direct Long-Term Impacts Compared To Existing Condition: The action involves the conversion of agricultural lands on Delta islands and bordering Delta channels to open water. Currently, the agricultural lands emit various substances which are discharged to Delta channels. After implementation of this action, the created shallow water habitat will continue to emit various substances, but their types and quantity will be different. Emissions of metals, trace elements and microbes are expected to be negligeable and are not discussed further. All other changes are discussed below.

Organics - The conversion of land from agriculture to shallow water habitat will change the rate of DOC emission in a similar way to the conversion to tidal perrennial aquatic habitat described above (Action 1). As discussed above, there is considerable uncertainty about the nature and magnitude of the change. It has been suggested that the conversion of agricultural land to wetlands could increase DOC emission by 10% or decrease it by up to 50% (1).

The total annual emission of DOC in agricultural drainage in the Delta is estimated to be 21,250 tons (2). If it is assumed that conversion of land from agricultural use to aquatic habitat reduces DOC emission by 50% and that all the land converted to aquatic habitat is in the Delta lowlands, then the annual reduction in DOC emission will be about 150 tons or 0.7% of the total. If it is assumed that conversion of land produces a 10% increase in DOC emission, then there will be an annual increase in DOC emission of about 340 tons or 1.6% of the total.

The change in emission of organic carbon will affect beneficial use of Delta water for drinking water supply. Because dissolved organic matter is the primary precursor of trihalomethanes, a change in DOC content of Delta waters will alter its suitability as a source of drinking water supply. The DOC concentration of water at the export pumps is 1 to 3 mg/l higher than the DOC concentration in Sacramento River water. Action 4 will very slightly increase or slightly decrease the concentration of DOC at the export pumps. However, because in either case, the change in concentration will be small, the affect on the suitability of Delta water as a water supply source, or on water supply practices will be minor. The other principal beneficial uses, agricultural and industrial water supply and recreational use of water would be unaffected.

Pesticides - Currently, various pesticides are used on the agricultural lands in the Delta. The most commonly used pesticides are carbofuran, chlorpyrifos, and diazinon. Conversion of agricultural lands to shallow open water habitat will eliminate the use of pesticides on the lands subject to this action and thus, the discharge of pesticide-contained agricultural drainage water.

Salts - The overall effect of conversion of land from irrigated agriculture toopen water would be similar to that described above in Action 1. Evapotranspiration rates would be increased and the salt content of waters corespondingly increased.

Nutrients - The principal nutrient in agricultural drainage water is nitrate. Almost all the nitrate is attributable to nitrogen fertilizers applied to cropland. Conversion of agricultural land to open water will reduce nitrate emission. Plants in the newly created aquatic habitat will use nutrients during the growth season and release them in the form of organic nitrogen as plants die and decay. Unlike agricultural land, the aquatic habitat will not be a large net exporter of nitrogen.

The acreage of land converted from agriculture to aquatic habitat under this action represents - % of the irrigated agricultural land in the Delta. If it is assumed that the change in land use reduces the emission of nitrate from each acre of land by 98% then the total nitrate emission reduction attributable to this action is also -%.

Direct Long-Term Impacts Compared To No Action Condition: The direct long-term impacts compared to the no action condition will be similar to those compared to the existing condition. The changes in emission of various substances attributable to the conversion of agricultural lands to freshwater marsh will be the same. Concentrations of the substances in the Delta will be slightly altered because of the different flow regime prevailing under the No Action Condition.

Indirect Impacts: Action 4 will produce no indirect adverse impacts on water qaulity

Determination Of Significance:

Notes:

Action 5: Restore And Enhance Midchannel Islands And Schoals

General Description Of Action: The purpose of this action is to protect and expand midchannel islands and shoals that serve as refuges for terrestrial and aquatic species. This will be accomplished by restrictions on dredging to prevent diminution of existing schoals and islands and placement of fill to expand them. Between 200 and 800 acres of islands and shoals will be restored or created. Most of the land consumed for this purpose is currently used for agriculture.

Direct Short-Term Impacts: This action will be implemented in conjunction with Action 2. In most cases, Delta channels are currently too narrow to accommodate new shoals and islands. With the implementation of Action 2, many channels will be broadened by construction of setback levees and abandonment of existing levees. New schoals or islands could be created by adding material at the toe of existing levees.

Construction of the shoals and islands would be accomplished by placement of dredged materials or possibly by excess fill material produced as a result of Action 3. Placement of materials in moving water would increase local turbidity concentration. If dredged materials are used for construction, some toxic materails could be released.

Direct Long-Term Impacts Compared To Existing Condition: Action 5 involves the conversion of small amounts of agricultural land to shallow open water and emergent and riparian habitat. The effects of conversion of agricultural land to open water and marshland on pollutant emissions was discussed under Action 1. The effects of Action 5 would be very similar to those of Action 1 but on a much smaller scale.

Direct Long-Term Impacts Compared To No Action Condition: The direct long-term impacts compared to the no action condition will be similar to those compared to the existing condition. The changes in emission of various substances attributable to the conversion of agricultural lands to aquatic habitat will be the same. Concentrations of the substances in the Delta will be slightly altered because of the different flow regime prevailing under the No Action Condition.

Indirect Impacts: Action 5 will produce no indirect adverse impacts on water quality.

Determination Of Significance:

Action 8: Restore Seasonal Wetlands

General Description Of Action: The acreage of seasonal wetlands will be increased by flooding agricultural lands for during the winter and early spring. Small berms and other water control structure will be built so that water is temporarily retained in shallow basins. The berms may be temporary or permanent. Water will be primarily supplied by rainfall but may be obtained from Delta channels. Approximately, 34,000 acres of agricultural lands will be used as seasonal wetland. Crops will be grown after the land is drained in early spring.

Direct Short-Term Impacts: Creation of seasonal wetlands will involve the construction of small berms and dikes. Because the terrain is so flat the berms will rarely need to be higher than 2 or 3 feet. They may be permanent or may be rebuilt each year at the end of the growing season. Berms will usually be constructed with native soils available at the site but may be built with imported materials. Because the berms will be small and will not need to withstand high water pressures they will be constructed with relatively light-weight construction equipment or agricultural machines.

Construction of the berms could increase the availability of sediment for discharge to water bodies. However, because the berms will be constructed within agricultural fields, already subject to extensive ground disturbance during cultivation, any increase in erosion rates would be expected to be small. The flatness of the terrain also discourages water-caused erosion.

Direct Long-Term Impacts Compared To Existing Conditions: Action 8 does not involve a permanent change in land use. Instead, agricultural lands would be managed for several months each year to increase habitat value for waterfowl and other birds. Agricultural land which would otherwise be wet but not inundated in the winter and early spring would be flooded. The change in land management could produce a change in the emission rate of various substances and their concentration in water bodies.

Organics -

C-032719

Pesticides - Pesticide emissions are a result of agricultural use of pesticides. The winter and spring time use of agricultural land as seasonal wetlands will not alter agricultural activities on the land the reaminder of the year. There will be no change in pesticide emissions.

Salts - As noted earlier, neither irrigated agricultural lands nor wetlands are net emitters of salts. However, the concentration of salts in various water bodies may change as a result of evapotranspiration.

Nutrients - The principal nutrient emitted by agricultural land is nitrate. Almost all the nitrate is attributable to nitrogen fertilizers applied to cropland. Because crops will continue to be grown on the land managed for seasonal habitat there will be no change in nitrate emissions.

Direct Long-Term Impacts Compared To No Action Condition: The direct long-term impacts compared to the no action condition will be similar to those compared to the existing condition. The changes in emission of various substances attributable to the seasonal use of agricultural lands as wetlands. Concentrations of the substances in the Delta will be slightly altered because of the different flow regime prevailing under the No Action Condition.

Indirect Impacts: Action 8 will produce no indirect adverse impacts on water quality.

Action 9: Restore Riparian Habitat

General Description Of Action: Corridors of riparian vegetation will be restored along the San Joaquin River and its tributaries and along the shores of islands.

Direct Short-Term Impacts:

(Need more infomation on construction method-assume cannot plant directly on levees. Would a setback levee be built behind the existing levee and the existing levee demolished and the materials used to create a streamside bench on which riparian vegetation can be planted?)

Long-Term Impacts Compared To The Existing Condition: The restoration of corridors of riparian vegetation will increase shading of stream waters. The only water quality parameter directly affected will be temperature. Water temperature in small streams where a dense canopy shades much of the water surface for thousands of feet could be reduced by several degrees (1). Water temperature in broader streams and where the riparian corridor is fragmented will be reduced by lesser amounts.

Direct Long-Term Impacts Compared To No Action Condition: The direct long-term impacts compared to the no action condition will be the same as those compared to the existing condition.

Indirect Impacts: Action 9 will produce no indirect adverse impacts on water quality.

Notes:

Bay Region

A series of programatic actions are proposed for the bay. The programatic actions are listed in Table ERP-2. An initial screening was conducted to divide actions into two categories; those with minimal impacts on water quality; and those with potentially significant impacts. Actions were judged to have minimal impacts on water quality if they do not change the emission rate of pollutants or their concentration of pollutants in water bodies or if the changes they produce are clearly negligeable. The results of the screening is shown in Table ERP-2. Actions judged to have potentially significant impacts were analysed further as described below and a determination made of their significance. Where an impact is determined to be significant, mitigation measures are suggested. No mitigation measures are required when the impacts are judged to be less-than-significant.

Table ERP-2
Ecosystem Restoration Program Plan
Programmatic Actions for the San Francisco Bay Region

Programmatic Action	Magnitude	Potentially Significant Environmental Impacts on Water Quality?
1. Restore tidal perennial aquatic habitat and tidal emergent wetlands.	10,000 - 14,000 acres	Yes
2. Restore tidally influenced channels and distributary sloughs.	10 miles, 60 - 90 acres	No
3. Create deep open water within restored freshwater emergent wetlands.	500 acres	No
4. Restore seasonal wetlands.	7,000 acres	Yes
5. Restore riparian habitat.	10 - 15 miles, 20 - 80 acres	Yes
6. Protect vernal pool habitat.	500 - 1,000 acres	No
7. Restore perennial grasslands.	1,000 acres	No

Action 1: Restore Tidal Perennial Aquatic Habitat And Tidal Wetlands

General Description Of Action: The acreage of shallow water aquatic habitat and saline emergent wetlands will be increased by constructing setback levees and restoring tidal flow to 10,000 to 14,500 acres of land adjacent to Suisun Bay and Marsh, San Pablo Bay, the Napa and Petaluma Rivers and Sonoma Creek. The land to be converted is currently used for agriculture. Most of the aquatic habitat will consist of shallow open water with emergent vegetation around its margins.

Direct Short-Term Impacts: Creation of aquatic habitat will involve construction activities, principally the removal of sections of existing levee and the construction of new levees. Most of the aquatic habitat will be created by constructing new levees behind the existing levees. Once new levees are in place the existing levees will be breached and then allowed to gradually erode.

The impacts of levee construction will depend on the method of construction and the nature of the materials used. Possible sources of material include dredging spoils from the Delta and the Bay Area. Because the source of material is uncertain the impacts associated with its excavation at the source are not discussed here.

Because levee construction will occur in dry conditions, adverse effects on water quality will be less than if construction had to be undertaken in water. The new levees will be compacted, armored if necessary, and seeded. Minor and localized increases in turbidity can be expected when the new levees are first exposed to water. Any adverse effect on turbidity could be reduced by allowing vegetation to become established on the new levees before breaching the existing levees.

Construction will have negligible effects on other constituents of concern other than turbidity and suspended solids content. Even if dredged spoils, containing small amounts of toxic materials, are are used for levee construction the risk of release into water bodies is low because the new levees will be built in the dry.

Direct Long-Term Impacts Compared To Existing Condition: The action involves the conversion of agricultural lands on the fringes of Suisun and San Pablo Bays to aquatic habitat. Currently, the agricultural lands emit various substances which are discharged to the Bay. After implementation of this action, the created aquatic habitat will continue to emit various substances, but their types and quantity will be different. Table 1 indicates whether the action will change the emission of constituents of concern. Changes in emission of metals, trace elements and microbes are expected to be negligeable and are not discussed further. All other changes are discussed below.

Organics - Much of the agricultural land bordering Suisun and San Pablo Bays and the tidal reaches of tributary streams is at an elevation below that of the bay at high tide and is separated from it by levees. The agricultural land is of low quality and is used primarily for dry farming hay or as pasture. Little of the land is irrigated. Small acreages of irrigated pasture exist where there is a suitable water supply (*Need to check this*). Excess runoff and irrigation water drains from fields to perimeter ditches which flow to sumps adjacent to the levees. Runoff and agricultural drainage water is pumped over the levees and into the bay. The water discharged to the bay is probably similar to Delta drainage water shown in Table 2.

Conversion of land from agriculture to aquatic habitat in the Bay will change the rate of DOC emission as it will in the Delta (See earlier discussion). However, changes in DOC emission are of little significance because, even in Suisun Bay, Bay waters are too saline for use as drinking water supplies.

Pesticides- Currently, pesticides are used sparingly on the agricultural lands adjacent to the Bay. The most commonly used pesticides are chlorpyrifos and diazinon. Conversion of agricultural lands to aquatic habitat will eliminate the use of pesticides on the lands subject to this action, and thus the discharge of pesticides in agricultural drainage water.

Salts - Conversion of agricultural land to shallow water aquatic habitat and saline emergent wetlands. will have little effect on the emission of salts. It could, however, have some effect on salt concentrations in the Bay for the reasons noted below.

The evapotranspiration rate from open water will be greater than that from the corresponding acreage of agricultural land. The estimated evapotranspiration rate for open water in the north bay is -- inches. The corresponding value for dry farmed hay fields is -- inches. The increase in evapotranspiration on the fringes of the North Bay is unlikely to have much effect on the salinity of bay waters because the area involved in the land conversion is small relative to the Bay's surface area.

Nutrients -

Direct Long-Term Impacts Compared To No Action Condition: The direct long-term impacts compared to the no action condition will be similar to those compared to the existing condition. The changes in emission of various substances attributable to the conversion of agricultural lands to aquatic habitat will be the same.

Indirect Impacts: Action 1 will produce no indirect adverse impacts on water qaulity

Determination Of Significance:

Notes:

Action 4: Restore Seasonal Wetlands

General Description Of Action: The acreage of seasonal wetlands will be increased by flooding agricultural lands for several months in winter and early spring. Small berms and other water control structure will be built so that water is temporarily retained in shallow basins. The berms may be temporary or permanent. Water will be primarily supplied by rainfall and surface runoff. Approximately, 7,000 acres of agricultural lands will be used as seasonal wetland. Crops, primarily pasture, will be grown after the land is drained in early spring.

Direct Short-Term Impacts: Seasonal wetlands may be created by simply delaying the pumping out of diked off areas or by the construction of small berms and dikes. Because the terrain is flat the berms will rarely need to be higher than 2 or 3 feet. They may be permanent or may be rebuilt each year at the end of the growing season. Berms will usually be constructed with native soils available at the site but may be built with imported materials. Because the berms will be small and will not need to withstand high water pressures they will be constructed with relatively light-weight construction equipment or agricultural machines.

Construction of the berms could increase the availability of sediment for discharge to water bodies. However, because the berms will be constructed within agricultural fields, already subject to extensive ground disturbance during cultivation, any increase in erosion rates would be expected to be small. The flatness of the terrain also discourages water-caused erosion.

Direct Long-Term Impacts Compared To Existing Conditions: Action 4 does not involve a permanent change in land use. Instead, agricultural lands would be managed for several months each year to increase habitat value for waterfowl and other birds. Agricultural land which would otherwise be wet but not inundated in the winter and early spring would be flooded. The change in land management could produce a change in the emission rate of various substances and their concentration in water bodies.

Organics -

(Need more info if available)

Pesticides - Pesticide emissions are a result of agricultural use of pesticides. The winter and spring time use of agricultural land as seasonal wetlands will not alter agricultural activities on the land the reaminder of the year. There will be no change in pesticide emissions.

Salts - As noted earlier, neither irrigated agricultural lands nor wetlands are net emitters of salts. However, the concentration of salts in various water bodies may change as a result of evapotranspiration.

Nutrients - The principal nutrient emitted by agricultural land is nitrate. Almost all the nitrate is attributable to nitrogen fertilizers applied to cropland. Because crops will continue to be grown on the land managed for seasonal habitat there will be no change in nitrate emissions.

Direct Long-Term Impacts Compared To No Action Condition: The direct long-term impacts compared to the no action condition will be similar to those compared to the existing condition. The changes in emission of various substances attributable to the seasonal use of agricultural lands as wetlands. Concentrations of the substances in the Delta will be slightly altered because of the different flow regime prevailing under the No Action Condition.

Indirect Impacts: Action 4 will produce no indirect adverse impacts on water quality.

Action 5: Restore Riparian Habitat

General Description Of Action: Riparian vegetation and riverine aquatic habitat will be restored along the Napa and Petaluma Rivers, Sonoma Creek and along waterways in Suisun Marsh. Ten to fifteen miles (*should this be 40 to 60 miles- disagreement between sources*) will be restored. Restoration procedures will depend on circumstances at a particular site. Restoration in stream reaches without levees or riprap would involve clearing of non-native vegetation, minor regrading and replanting with appropriate native species. Depending on the characteristics of the adjacent land use, fencing of the riparian area to exclude livestock may be necessary.

Direct Short-Term Impacts:

(Need more infomation on construction method-assume cannot plant directly on levees. Would a setback levee be built behind the existing levee and the existing levee demolished and the materials used to create a streamside bench on which riparian vegetation can be planted?)

Long-Term Impacts Compared To The Existing Condition: The restoration of corridors of riparian vegetation will increase shading of stream waters. The only water quality parameter directly affected will be temperature. Water temperature in small streams where a dense canopy shades much of the water surface for thousands of feet could be reduced by several degrees (1). Water temperature in broader streams and where the riparian corridor is fragmented will be reduced by lesser amounts.

Direct Long-Term Impacts Compared To No Action Condition: The direct long-term impacts compared to the no action condition will be the same as those compared to the existing condition.

Indirect Impacts: Action 5 will produce no indirect impacts on water quality.

Notes:

4.1.2 Water Quality

4.1.3 Water Use Efficiency

4.1.4 Levee Sytem Integrity

Delta Region

Action 1: Rehabilitate Existing Levees To Pl-99 Standards

General Description Of Action: The waterside of levees will be armored with riprap to ensure stability; some levees also will have waterside and/or landside berms that will add stability and provide wildlife habitats and opportunities. The action will be conducted on

1100 total miles of levees which and will result in about 10,000 to 15,000 acres of PL-99 levees. It is currently assumed that the existing levees to be rehabilitated cover approximately 7500 to 11,250 acres, so this action will increase the total area of levees by about 2500- 3750 acres.

<u>Direct Short-Term Effects</u>: Construction of berms and installation of rip-rap on the waterside of the levees will resuspend some borrow material and possibly some levee sediments, creating a small turbidity plume in and downstream of the berm construction area. Existing suspended sediment concentrations in the Delta range from 20 mg/l during low flow conditions to over 1000 mg/l during high flows (Draft ISDP EIR/EIS, 1995), and the effects of a short-term localized increase in turbidity and suspended solids is not considered significant in the context of the large natural variability in the system.

Constituents that tend to be associated with the sediments (e.g., metals) will also be resuspended; however data on the levels of concentrations of metals of concern in levee sediments (Table 4-3, Draft ISDP EIR/EIS, 1995) indicate that concentrations are generally below sediment guidelines developed by the San Francisco Regional Water Quality Control Board for wetland creation and upland reuse (reference). Data on pesticides of concern in sediments from stations in the Delta similarly indicate levels that are generally below detection levels (page 56, Fox and Archibald, for CUWA, 1996). Some compounds were found in high concentrations at other sampling locations in the South Delta. Sampling conducted at Morman Slough and Stockton Ship Channel indicated high levels of PAHs and PCBs. Based on these data, resuspension of sediments from levee construction operations should not pose significant water quality problems.

<u>Direct Long-Term Impacts Compared To Existing Conditions</u>:

Organics - The creation of berms on the waterside of the levees and widening of the levees to meet PL-99 standards will result in a conversion of about 2500-3750 acres of agricultural lands to wider levees that, depending on specific design features, may provide for additional shallow water habitat and/or riparian habitat. Given the relatively high concentrations of DOC from agricultural lands, the conversion would result in a net decrease in DOC loading to the Delta. Given the limited acreage of land conversion involved, the reduction is not considered significant in affecting the DOC levels in the Delta and at the export facilities.

Salts - When water is diverted from the Delta and applied to agricultural land, some of it is released to the atmosphere through evaporatranspiration, some percolates into the ground, flushing salts from the surficial sediments, and some excess flows enter the tailwater sections of fields. Percolated water and tailwater are collected in subsurface agricultural drains and returned to the Delta via pumps. The volume of the drainage water is estimated to be 25% to 50% of the applied water and the average salt content of drainage water is 2 to 4 times greater that that of applied water (Appendix C2, page C2-5, Draft Delta Wetlands EIR/EIS, 1995). The net effect of this is that, although the salt load in the diverted and return flows are comparable, irrigated agriculture, by diverting and reducing flows, causes salt concentrations in the Delta to increase.

The effect of conversion of agricultural lands to shallow water habitat and riparian habitat depends on amount of evapotranspiration resulting under the Action compared to existing conditions. Evapotranspiration from open water (which would reflect shallow water habitat) is estimated to be about 55 inches per year whereas evapotranspiration from cropland is approximately 30-35 inches per year (Tables C4-1, 4-2,4-3Delta Wetlands EIR). However, it is assumed that the Action primarily will result in riparian vegetation whose net water demands will be less than that of current agricultural crops. Given this, the Action is likely to result in a decrease in salinity loads to the Delta. The amount of this decrease will be small given the relatively small acreage involved.

Pesticides - Concentrations of 30 pesticides from 6 agricultural drains in the Delta taken in 1983-1987 were all below detection limits, which ranged between about 0.01-10ug/l depending on the constituent (Table 29, Fox and Archibald, 1996). These data suggest that agricultural drains in the Delta are not a significant source of pesticides and therefore conversion of agricultural lands in the Delta will not affect pesticide loading to the Delta.

Nutrients -

4.2 Storage And Conveyance Components

The storage and conveyance components include varying configurations of in-Delta and out of Delta conveyance and storage sytems, inlcuding groundwater banking, in-lieu conjunctive use, and more surface storage capacity. The conveyance components address more efficent use of the existing system of conveyance, modifications to through-Delta conveyance, and dual conveyance using both through-Delta and isolated conveyance facilities. The storage components include storage upstream of the Delta on the tributaries of the Sacramento and San Joaquin River sytems, storage within the Delta, or storage connected to SWP or CVP export aqueducts.

4.2.1 Delta Region

Action: South Delta Channel Improvements

General Description Of Action: A new intake would be construced at Clifton Court Forebay and operated to complement the operation of the existing intake structure. Approxiamtely 2,6000 linerar feet of new levee sections would be constructed from West Canal to Clifton Court Forebay. Approximately 1.24 million cubic yards of material would be dredged from a 4.9 mile reach of Old River to increase channel capacity north of the new intake. A fish control structure would be constructed at the confluence of the head of Old River and the San Joaquin River. Three flow control structures at Middle River, Grant Line Canal, and Old River would be constructed to improve existing water levels and circulation patterns in the South Delta.

Direct Short-Term Impacts: Short-term water quality impacts will result from the construction of the new intake at Clifton Court Forebay, the new levee section from West Canal to Clifton Court Forebay, the dredging of Old River, the fish control structure on Old River, and the flow control structures on Middle River, Grant Line Canal, and Old River.

New Intake at Clifton Court Forebay - Dry construction methods and installation of a cofferdam on the interior side of the intake is not expected to generate significant amounts of suspended sediment or turbidity. No increase in suspended load is expected in water taken from the forebay for export, since approximately 70 percent of the wash load currently entering the forebay is trapped in the reservoir (1).

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 strcuture should not produce significant turbidity (1).

New Levee Section from West Canal to Clifton Court Forebay - Because levee construction will occur in dry conditions, adverse effects on water quality will be less than if construction had to be undertaken within the Delta channels. The levee will be compacted, armored if necessary, and seeded. Minor and localized increases in turbidity can be expected when the new levees are first exposed to water.

Flow Control Strcutures on Middle River, Grant Line Canal, and Old River - Increases in turbidity and suspended sediment may occur during construction of the flow control strcutures. There would be a brief introduction of sediment into the channels during breaching of the levees at the Old River control structure. Increases in turbidity form all of these activities are expected to be simailr to those observed during temporary barrier construction, with turbidity increasing by values of 20 to 40 NTU (2).

Dredging Old River - Disturbance of bottom sediment and its partial suspension into the water column is not expected to mobilize cotaminants into the water column at substantial levels because concentrations in sediment are relativley low and small amounts of suspended sediments will be generated. Levels of total oil and grease (TOG) at approximately 100 mg/kg might be locally mobilized as part of the dredging based on one preveious sample from the Old River sediments (3).

Increased oxygen demand may briefly occur during dredging in association with the 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 (3). 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 (3). This reduction is not significant.

Dredged Material Disposal - Dredged material will be disposed of on islands adjacent to the Old River. The disposal could have elements of both upland sites and a direct discharge to waters of the State, and compilance with regulations of both types of disposal is recommended. These activities could result in significant adverse impacts on water quality.

Direct Long-Term Impacts Compared To Existing Condition: Delta conditions under the existing configuration and the proposed South Delta Channel Improvements (SDCI) were modeled (1). Boundaries for the existing conditions, as well as the, consisted of Sacramento River at I Street, San Joaquin River at Vernalis, and Carquinez Strait at Martinez. The period of April through May was simulated. The Delta inflows and exports were derived from the historic period of April and May of 1989. These flows were adjusted to reflect how SWP and CVP might have been operated over this period to meet State Water Resources Control Board's 1995 Water Quality Control Plan. As shown in Figure 6, the Sacramento River inflow varied from over 40,000 cfs at the start of April to near 10,000 cfs in May. Combined CVP and SWP pumping ranged from over 10,000 cfs to 2,000 cfs. The boundary tide at Martinez was the historically observed tide during April and May of 1989. DWRDSM1 daily results of maximum, minimum, and average flows, velocities, and stages were averaged over the periods of April 1 - 15, April 16 - 30, and May 1 - 31. April was broken up into two periods because of the operation or installation of a fish control structure on April 16th for each alternative, substantially changing flow patterns in the south Delta.

For the existing concdition temporary flow and fish control structures in the south Delta were assumed to be installed from mid April through May (Figure 1). This period was chosen to provide results in April for two conditions - for with and without installation of the structures. The flow control structures consisted of a weir and culverts. The culverts allowed landward flow on the flood tide, but closed on the ebb tide preventing seaward flow. Seaward flow over the weir waspossible for sufficiently high water levels. The fish control structure at the head of Old River was assumed to be a complete closure, sending all San Joaquin River flow down past the bifurcation with Old River. Clifton Court Forebay intake gates were assumed to take flow into the forebay any time water levels allowed. This was assumed for both the existing condition and the SDCI. Maximum allowable flow into the forebay was set at 15,000 cfs. The Delta Cross Channel was assumed open during the April through May period.

Delta conditions for the SDCI were simulated (Figure 2) (1). The simualtion replaced the temporary flow and fish control structures with permanent structures holding radial gates, placed additional forebay intake gates on the north of the forebay and enlarged a portion of Old River. The flow control structures on Middle and Old rivers were operated to allow landward flow on the flood tide, then closed to prevent any seaward flow on the ebb tide. South Delta Channel Improvements proposed flow control structure on Grant Line Canal was not operated in the April through May period since current planning assumes that the fish control structure and the flow control structure on Grant Line Canal would not be operated simultaneously. The fish control structure was operated to create a complete closure at the head of Old River. The intake to Clifton Court Forebay was moved to the northern end of the forebay. Intake gates with a total flow opening of 2500 sq feet and a capacity of 25,000 cfs

Figure 6
Boundry Tide at Martinez
Sacramento River Flow, San Joaquin River Flow, Combined CVP & SWP Exports
April and May of 1989 Reoperated for SWRCB WQCP

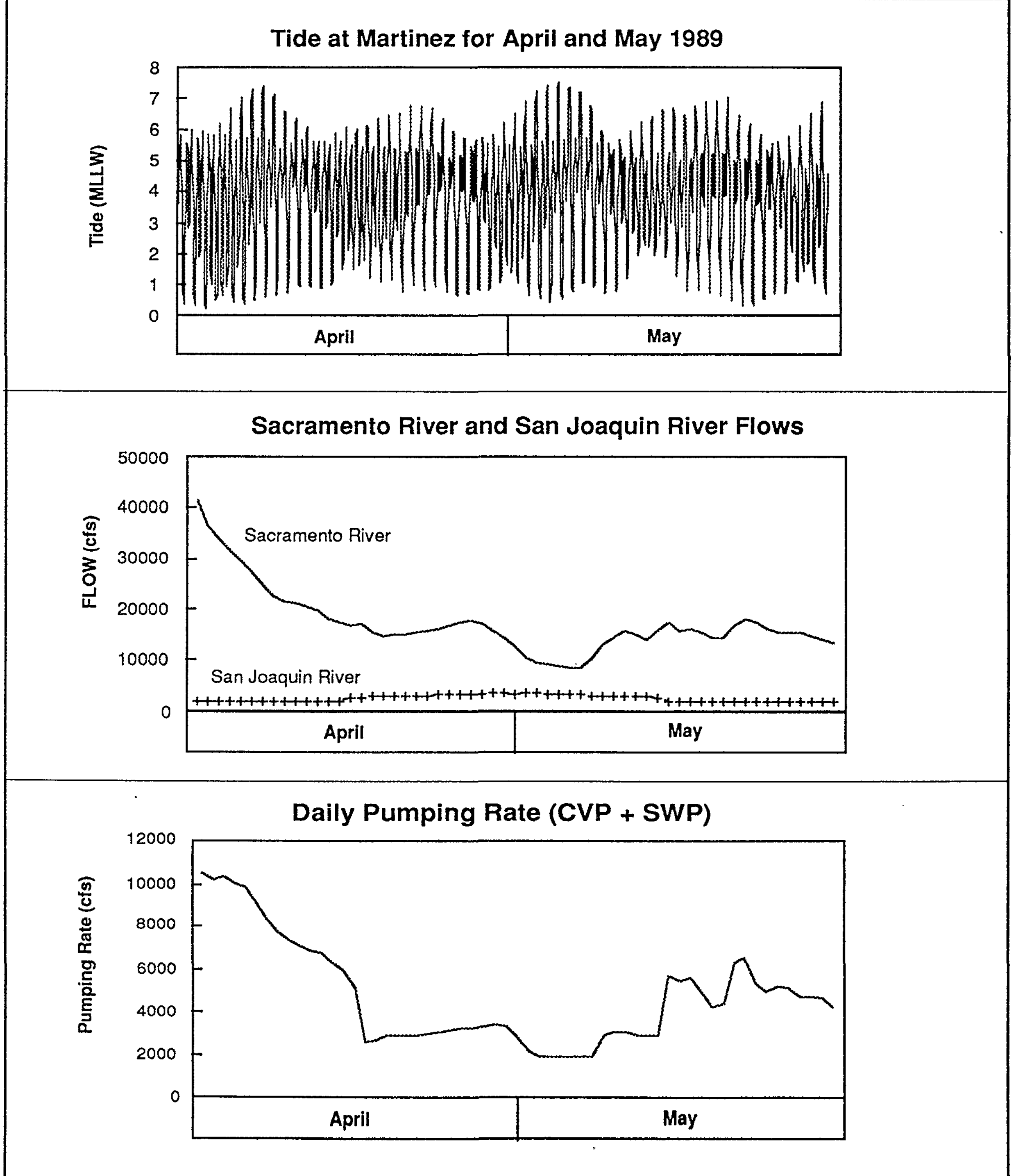


Figure 1

Existing Delta Geometry

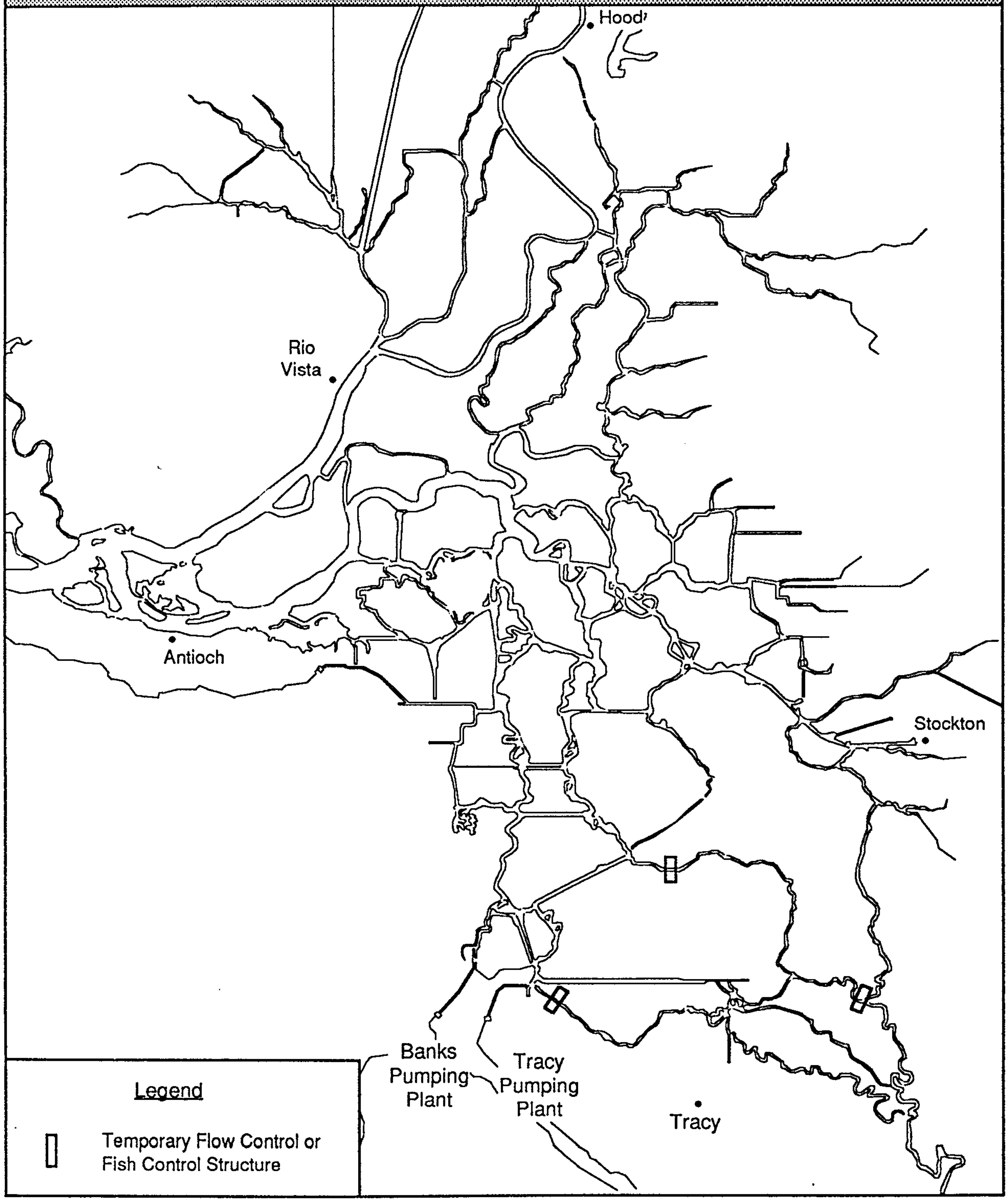
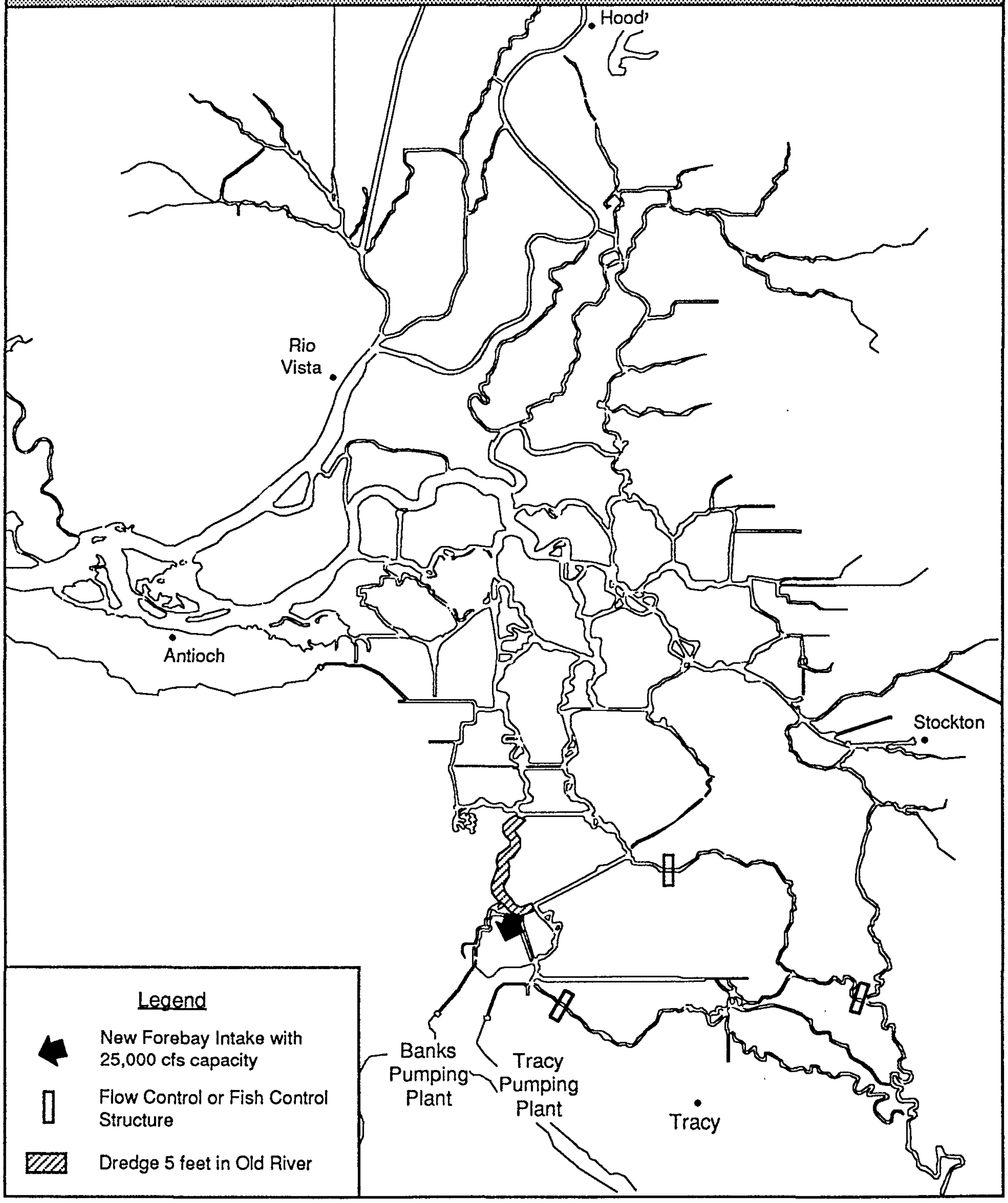


Figure 2

Interim South Delta Program Geometry



were assumed. Old River from Victoria Canal to Woodward Canal was dredged 5 feet. The Delta Cross Channel was open.

Analysis of the Existing Delta Geometry and the SDCI Geometry show that the SDCI alternative had verylittle impact on flows and velocities in the Sacramento River and the north Delta. In the south Delta, however, the SDCI alternative couldchange flows and levels. In the first half of April, the Existing Delta Geometry alternative assumed that no flow control structureswere installed while the SDCI alternative operated structures in Middle and Old rivers. The operation of the Middle River and the OldRiver flow control structures in the SDCI alternative caused more SanJoaquin River water to flow downstream of the head of Old River. Minimum water levels were raised and changes in the flow circulation in the south Delta also resulted. The periods of the second half of April and May operated similar structures for these two alternatives. The permanent flow control structures in the SDCI alternative boosted minimum water levels more and induced greater circulation than did thetemporary structures in the Existing Delta Geometry alternative. Also, the SDCI alternative tended to draw more flow up Old Rivertowards the pumps and less up Middle River (Figures 7 - 12). As shown in Figures 22 - 27, the SDCI alternative tended to increase the range of maximum downstream and upstream flow in lower Old River, lower Middle River, Columbia Cut, and Turner Cut.

(Note: Model simulations of all storage and conveyance components should be conducted and the proposed additional storage components should be integrated into the model simulations. Also, the DWRSIM simulation outputs should include salinity, because salinity is a key component of the water quality objectives for the Delta.)

Direct Long-Term Impacts Compared To No Action Condition: The direct long-term impacts compared to the no action condition will be similar to those compared to the existing condition.

Indirect Impacts:

Determination Of Significance:

Notes:

1. DWR and USBR, July, 1996, Interim South Delta Program Draft EIS/EIR, p. 4-36.

2. DWR and USBR, July, 1996, Interim South Delta Program Draft EIS/EIR, p. 4-37.

3. DWR and USBR, July, 1996, Interim South Delta Program Draft EIS/EIR, p. 4-38.

4. DWR, March 7, 1997, Progress Report -Preliminary Delta Simulation Model Studies of CALFED Delta Conveyance Components.

Figure 7
Flows and Velocities
Averaged over April 1 - 15, 1989 (Reoperated)
Existing Delta Geometry

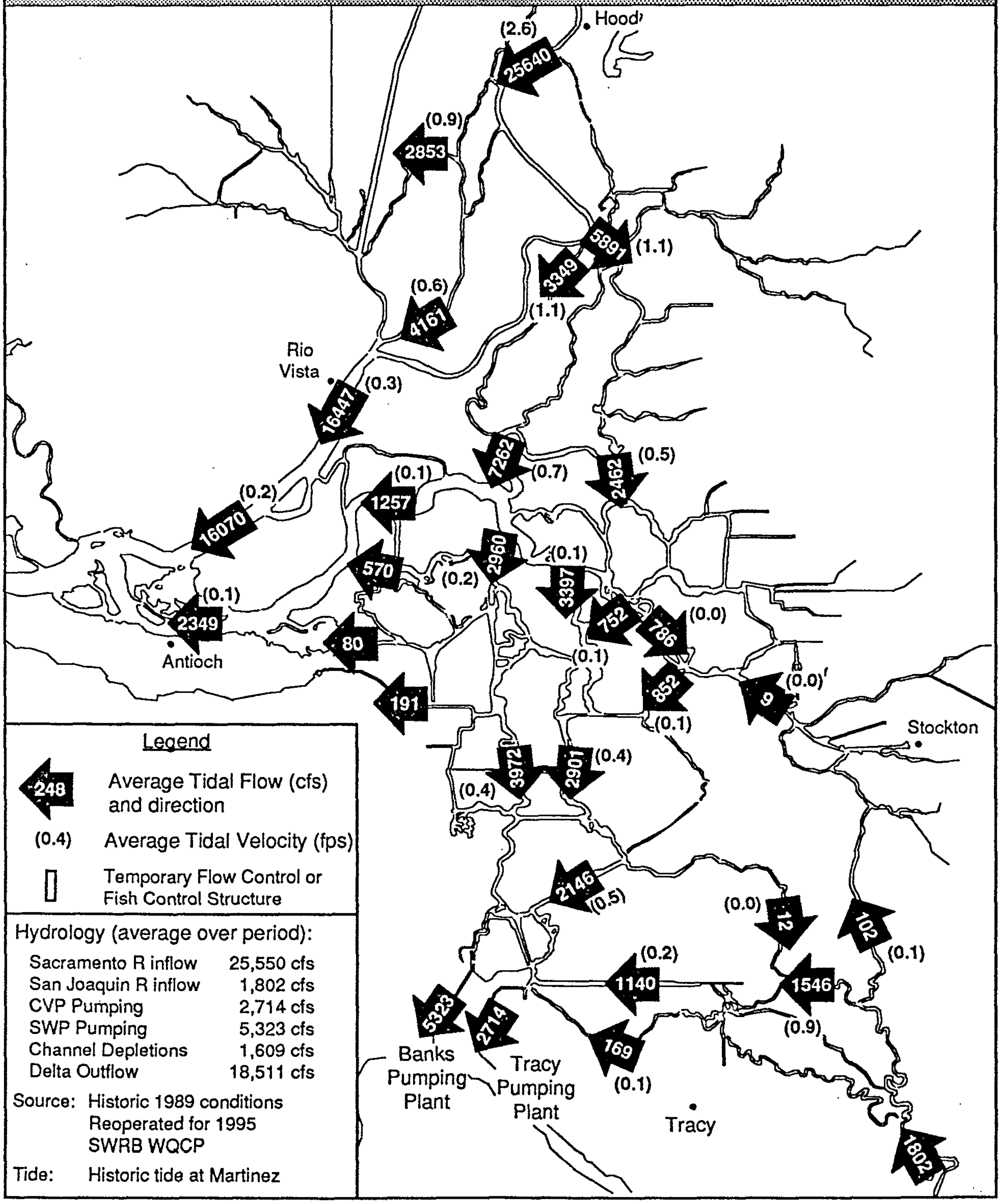


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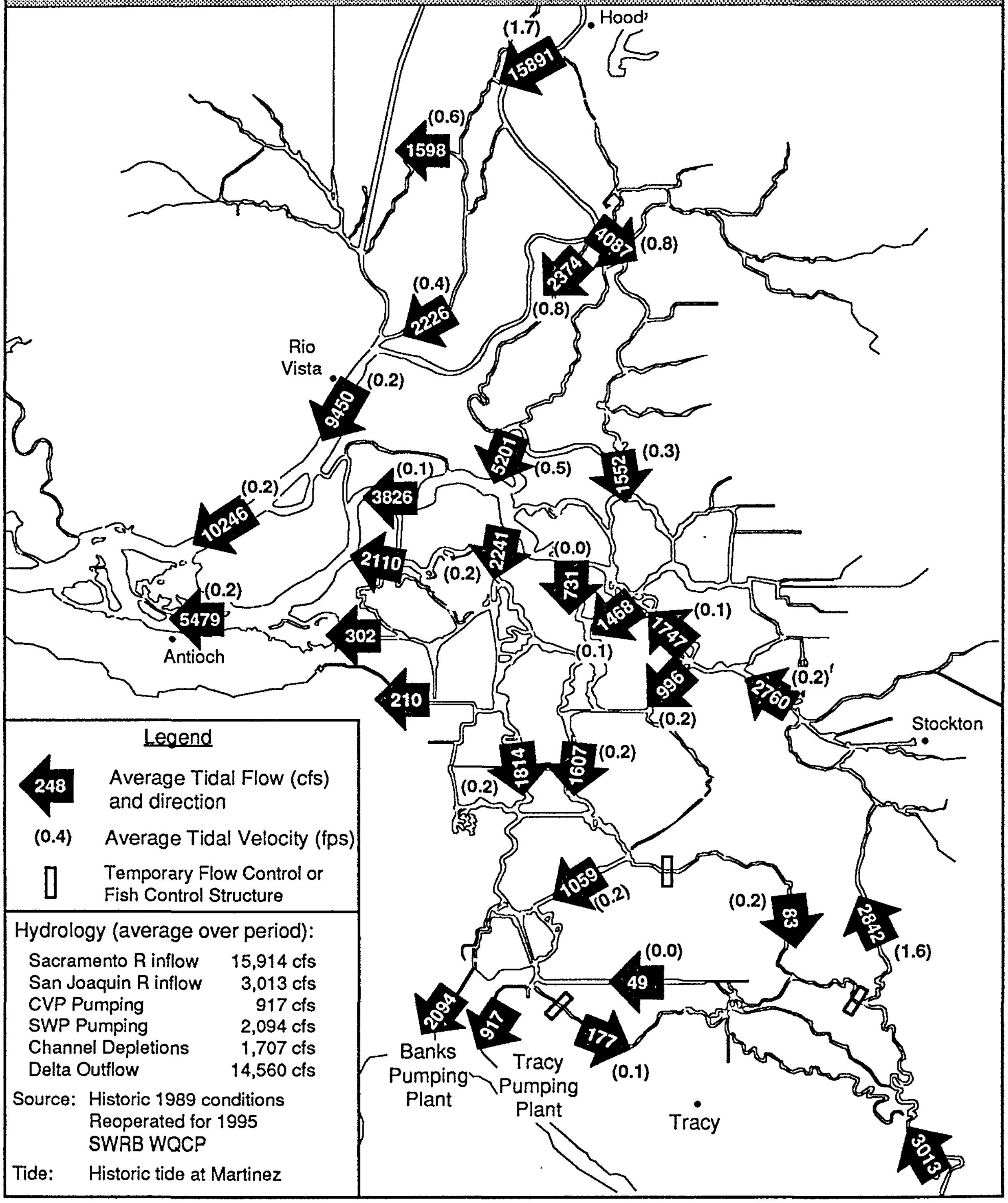
Figure 8
Flows and Velocities
Averaged over April 16 - 30, 1989 (Reoperated)
Existing Delta Geometry



Hydrology (average over period):

Sacramento R inflow	15,914 cfs
San Joaquin R inflow	3,013 cfs
CVP Pumping	917 cfs
SWP Pumping	2,094 cfs
Channel Depletions	1,707 cfs
Delta Outflow	14,560 cfs

Source: Historic 1989 conditions Reoperated for 1995 SWRB WQCP

Tide: Historic tide at Martinez

Figure 9
Flows and Velocities
Averaged over May 1 - 31, 1989 (Reoperated)
Existing Delta Geometry

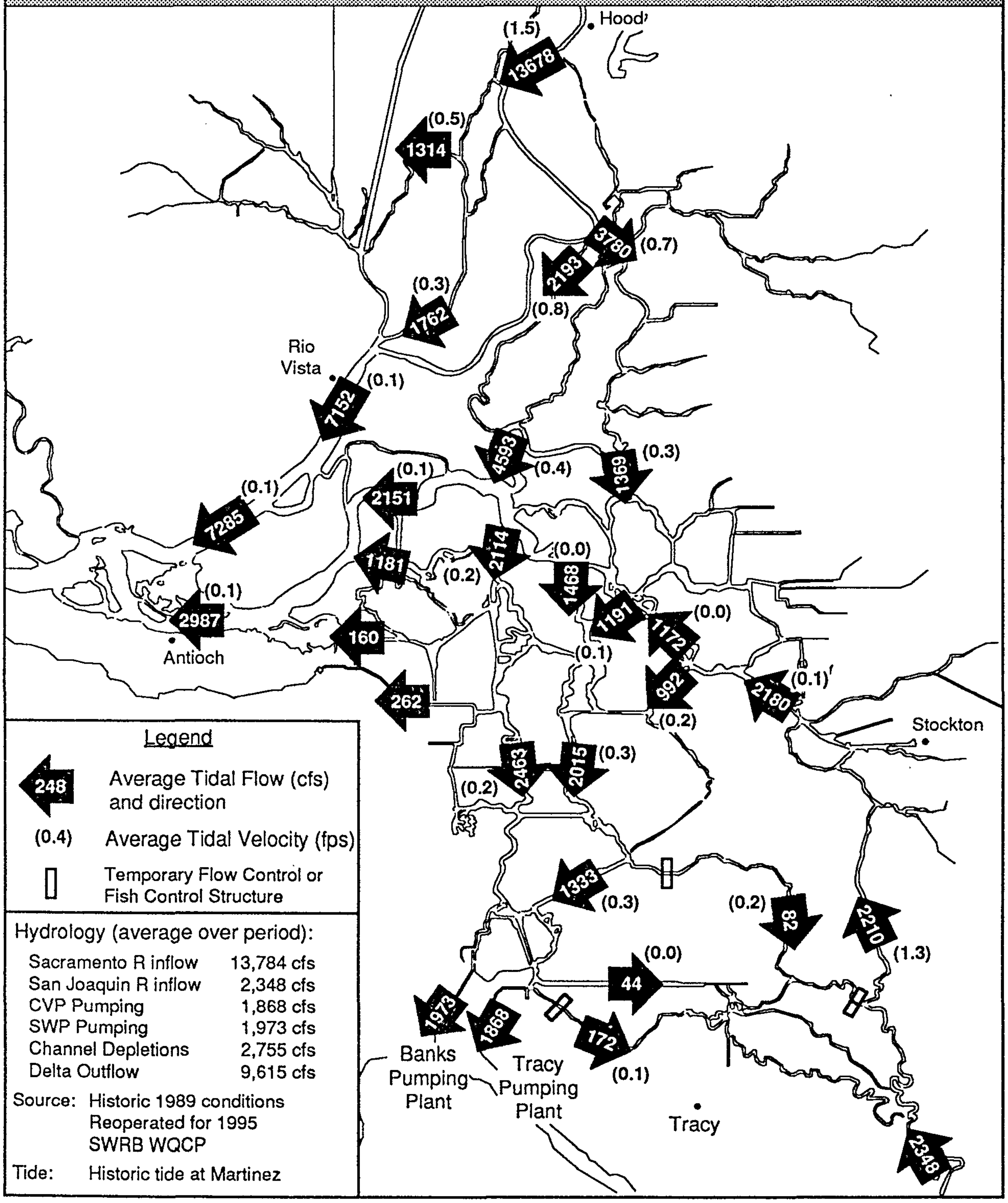


Figure 10
Flows and Velocities
Averaged over April 1 - 15, 1989 (Reoperated)
Interim South Delta Program Geometry

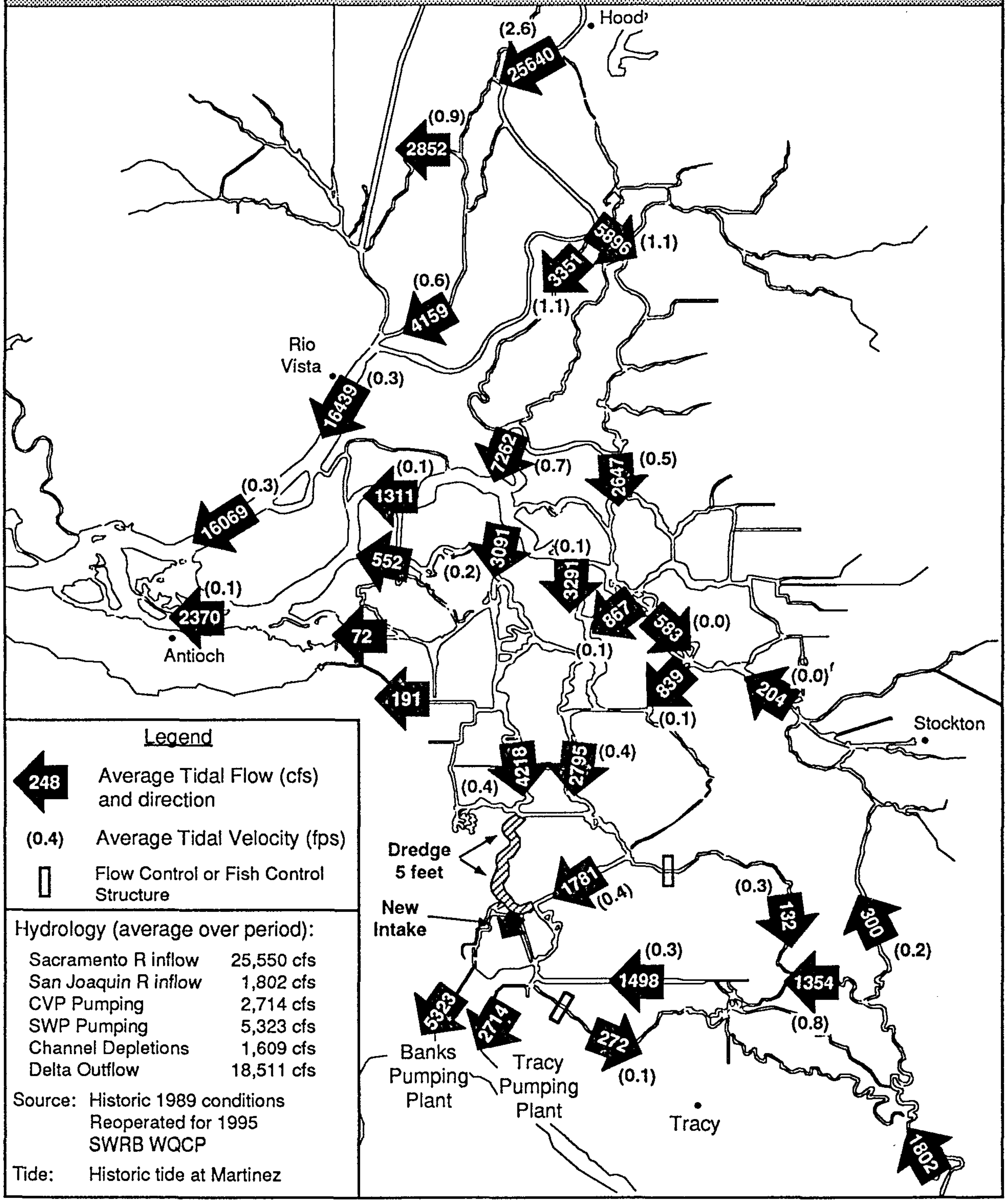


Figure 11
Flows and Velocities
Averaged over April 16 - 30, 1989 (Reoperated)
Interim South Delta Program Geometry

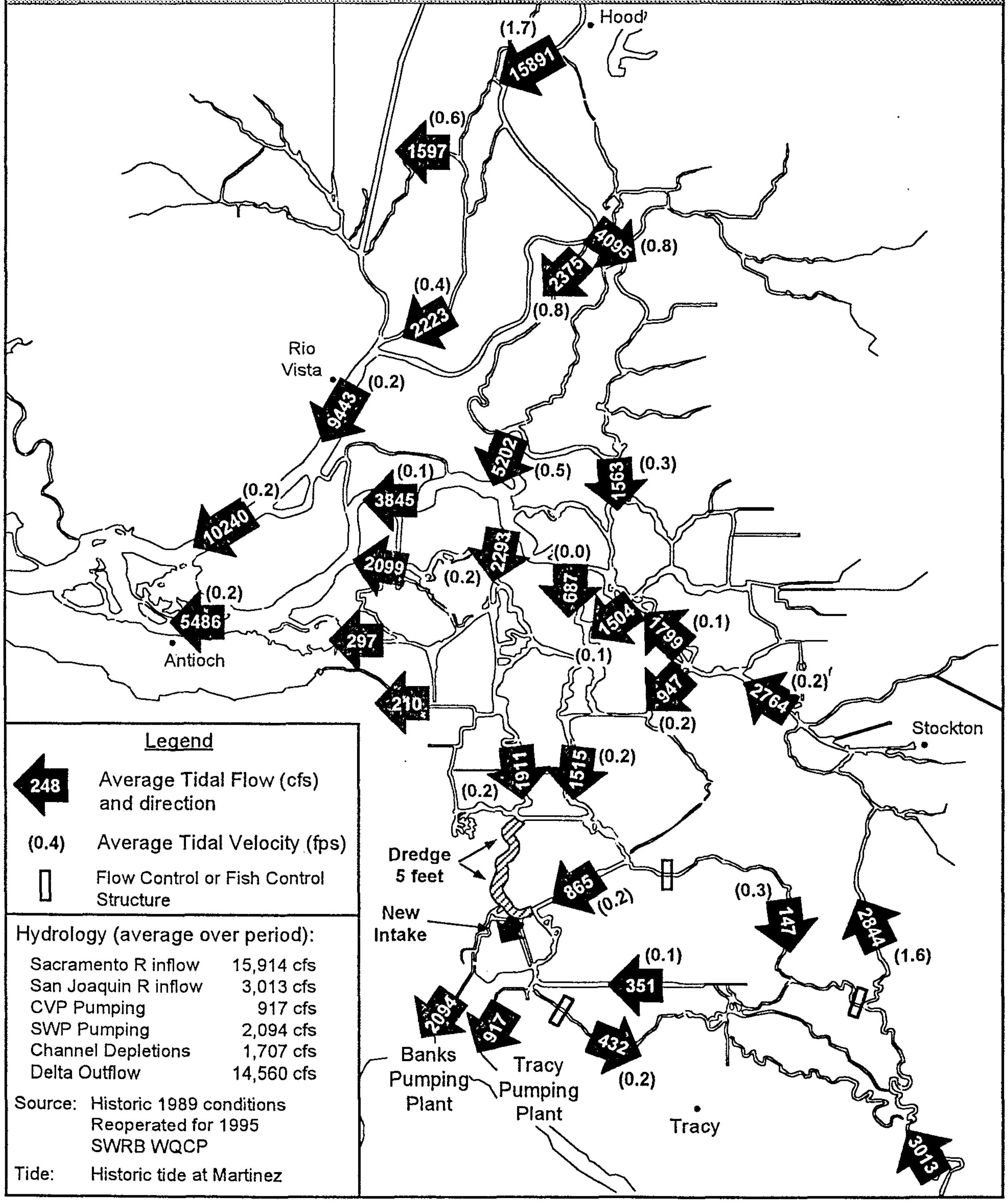
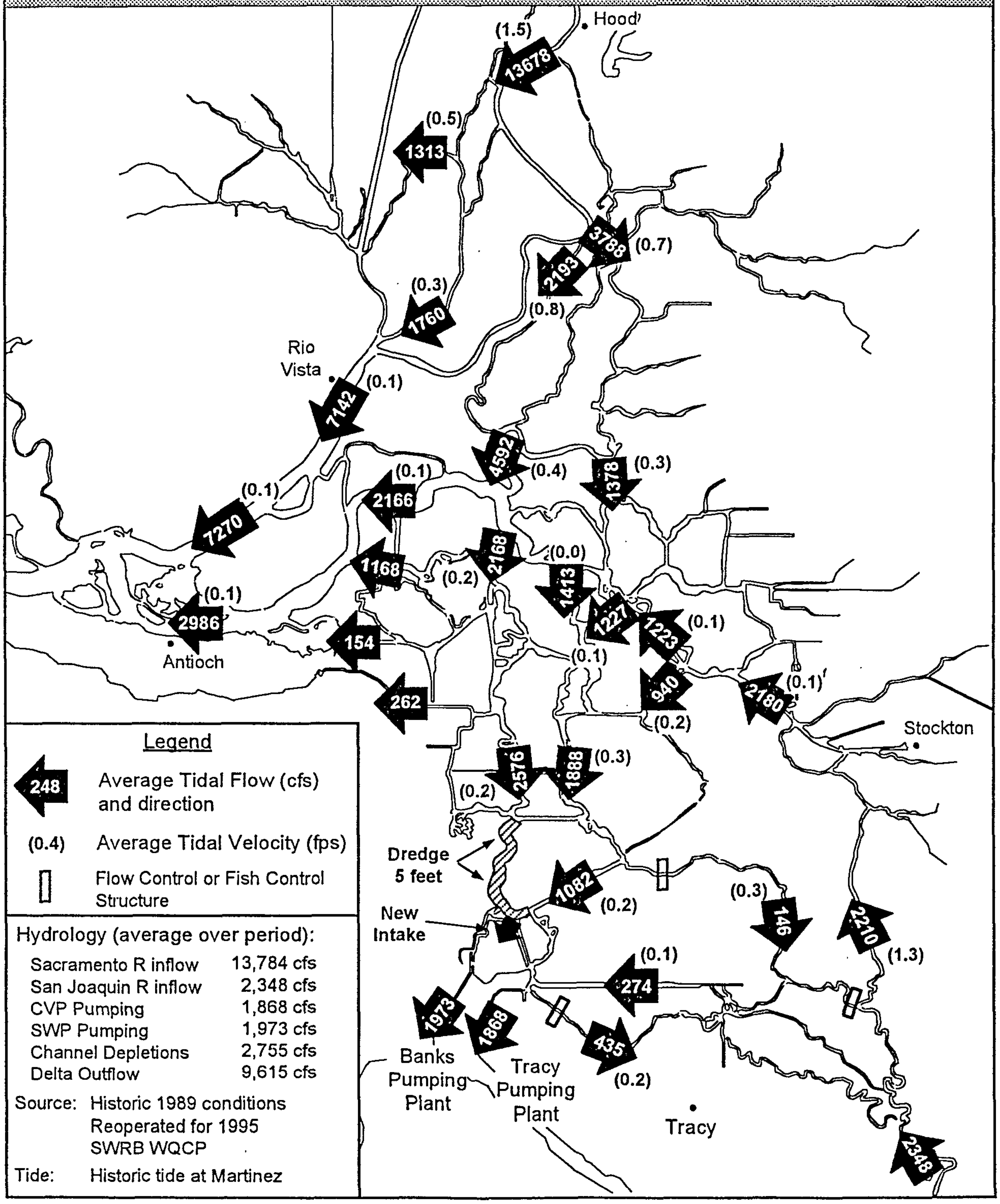
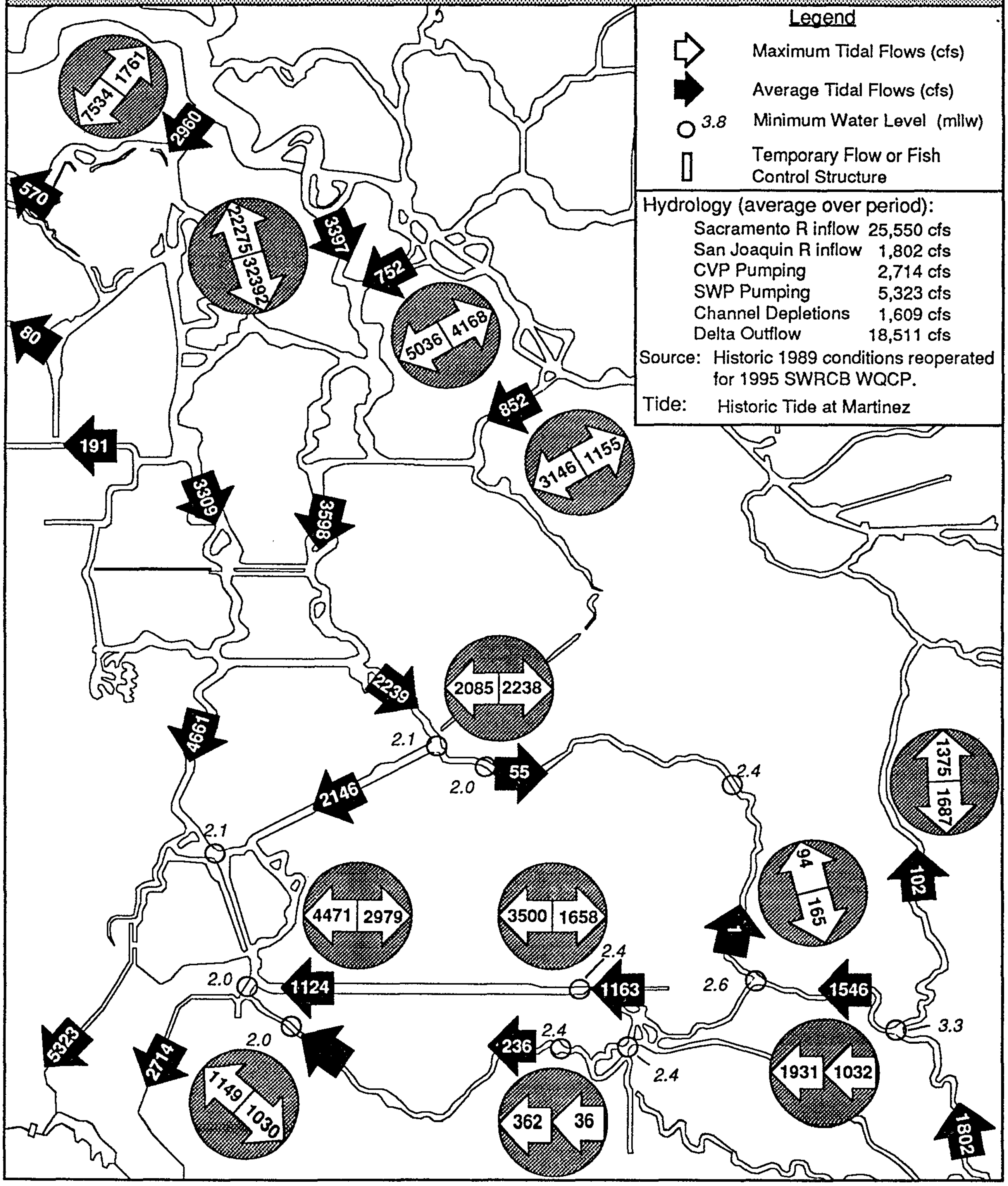


Figure 12
Flows and Velocities
Averaged over May 1 - 31, 1989 (Reoperated)
Interim South Delta Program Geometry



C-032739

Figure 22
Flows and Water Levels
Averaged over April 1 - April 15, 1989 (Reoperated)
Existing Delta Geometry



C —0 3 2 7 4 0

C-032740

Figure 23
Flows and Water Levels
Averaged over April 16 - April 30, 1989 (Reoperated)
Existing Delta Geometry

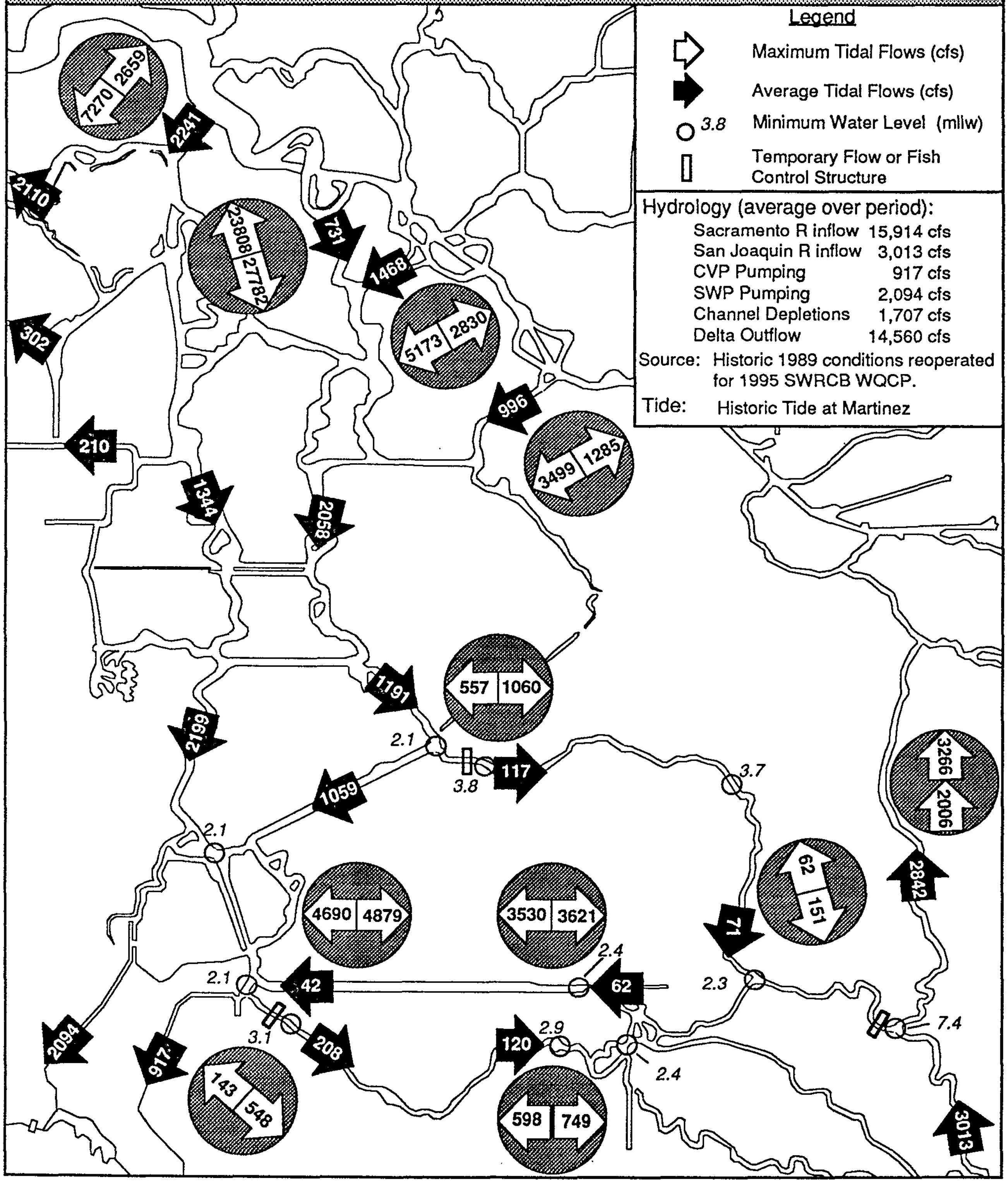


Figure 24
Flows and Water Levels
Averaged over May 1 - May 31, 1989 (Reoperated)
Existing Delta Geometry

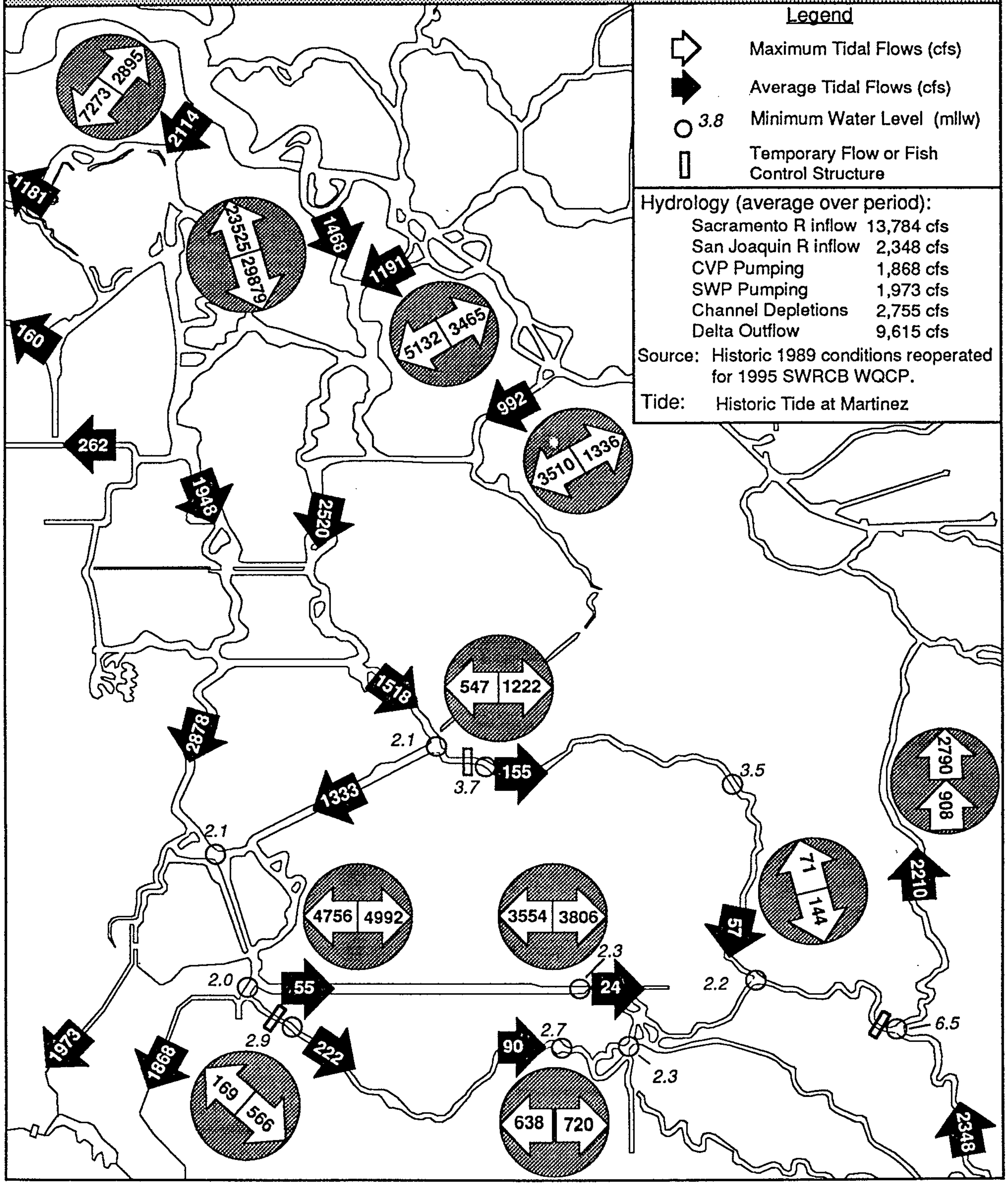


Figure 25
Flows and Water Levels
Averaged over April 1 - April 15, 1989 (Reoperated)
Interim South Delta Program Geometry

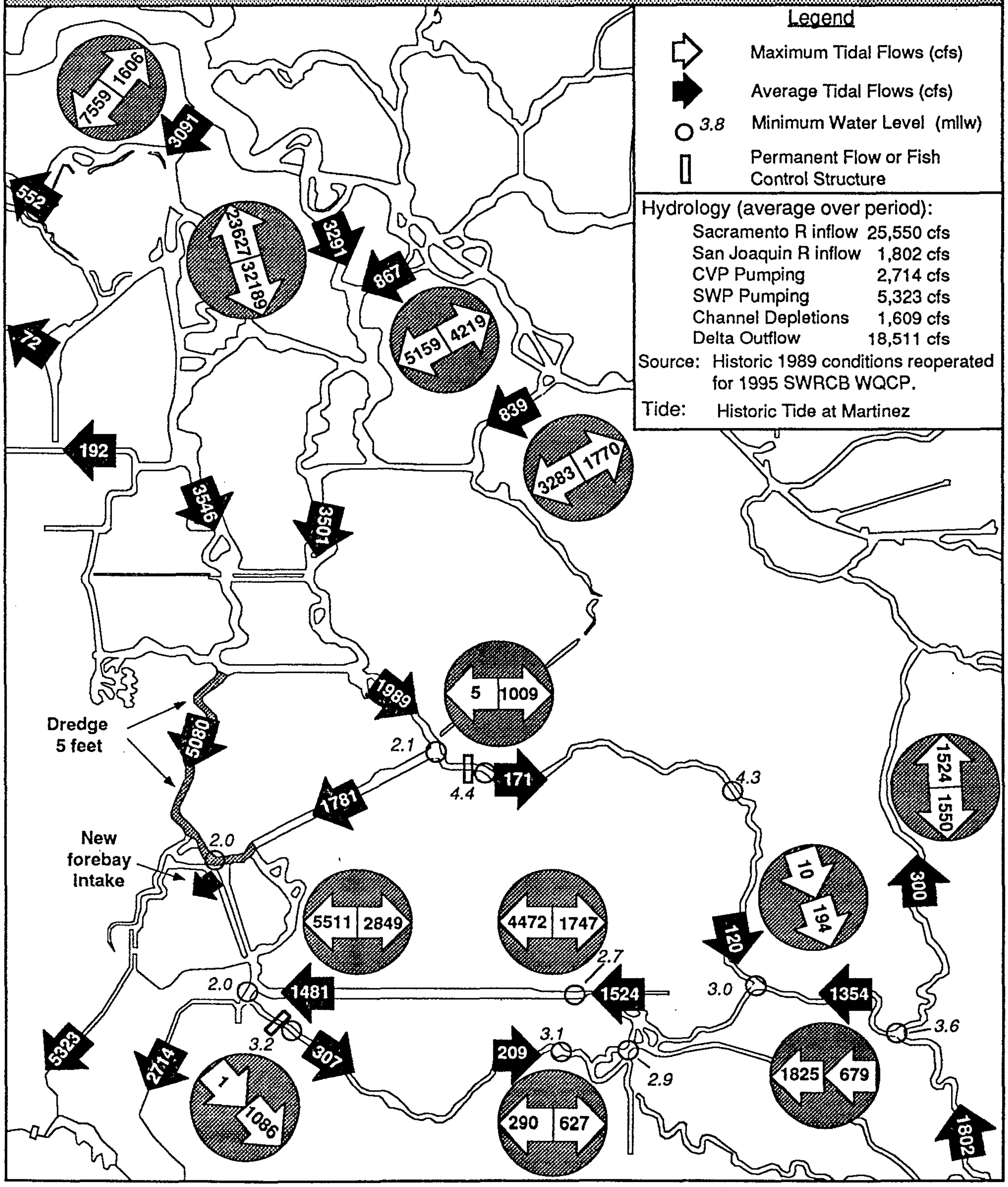
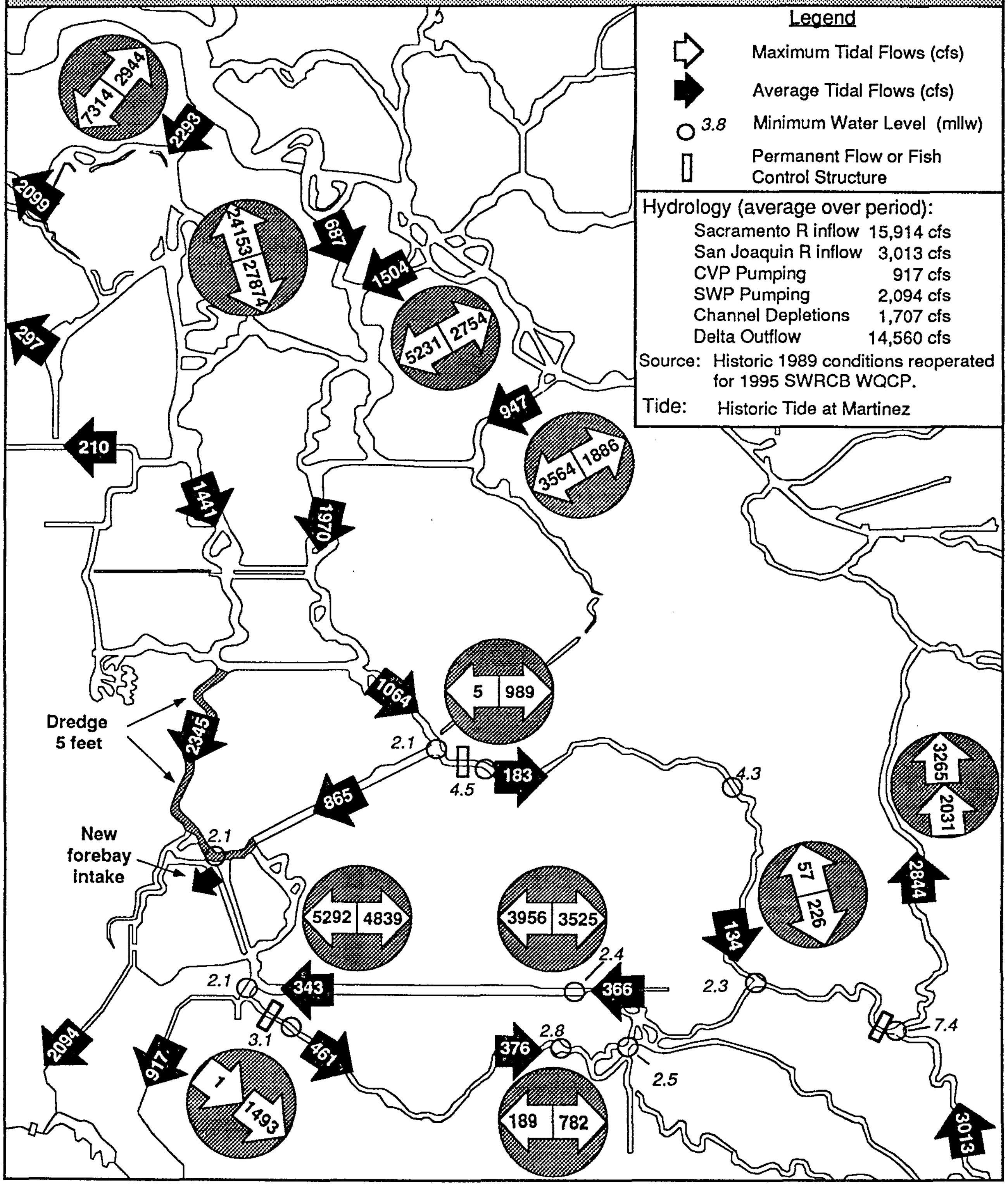


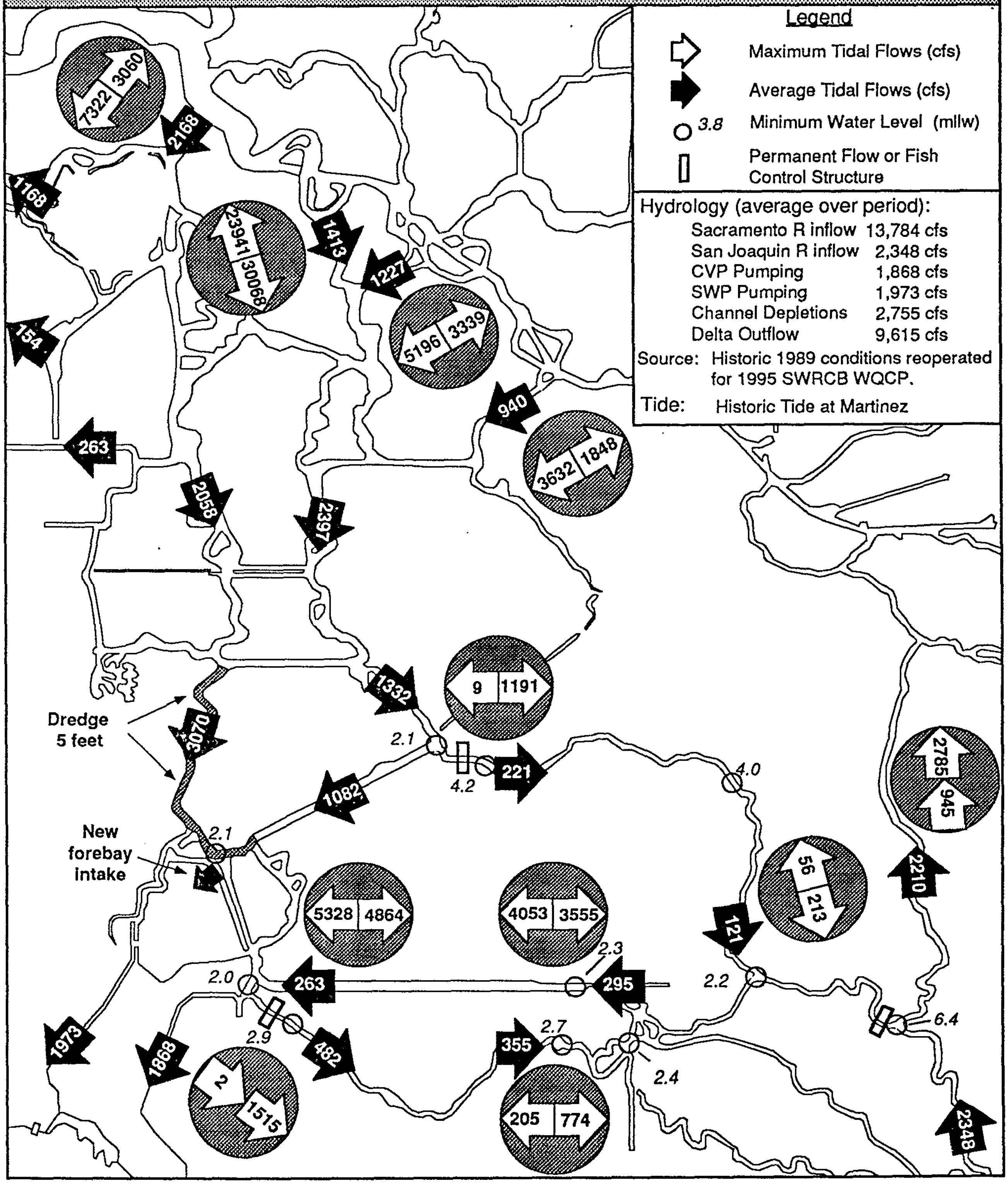
Figure 26
Flows and Water Levels
Averaged over April 16 - April 30, 1989 (Reoperated)
Interim South Delta Program Geometry



C —0 3 2 7 4 4

C-032744

Figure 27
Flows and Water Levels
Averaged over May 1 - May 31, 1989 (Reoperated)
Interim South Delta Program Geometry



4.2.2 Sacramento River Basin

Thomes-Newville Reservoir Project

General description of action: The Thomes-Newville Reservoir Project would be built about 100 miles north of Sacramento in the foothills of the Coast Range about 30 miles west of the Sacramento River. It would store water from the North Fork and mainstem of Stony Creek, Thomes Creek and the Sacramento River. The storage component of the project, Newville Reservoir would be located on the North Fork about 10 miles upstream of existing Black Butte Reservoir. Two reservoir capacities are under consideration, 1.84 maf and 3.08 maf. Newville Dam would rise 320 to 400 feet above the streambed and would be constructed with earthfill. A single saddle dam would be needed for a 1.84 maf reservoir. Ten saddle dams would be needed for the 3.08 maf reservoir. The area of inundation would be 13,990 to 16,700 acres. A diversion would be built on Thomes Creek and a canal constructed to convey water to Newville Reservoir.

Excess Sacramento River water would be routed to the reservoir via the existing Tehama-Colusa Canal and a series of new pumping plants and canals. Water would be conveyed from the Tehama-Colusa Canal to the Sour Grass Pump/Generator Plant by a four and one-half mile long canal. The pump plant would lift water into the 4.5 mile long Black Butte Canal which would convey it to the Black Butte Pump/Generator Plant. The plant would lift water into the existing Black Butte Reservoir. Water from Black Butte Reservoir would be conveyed to the Tehenn Pump/Generator Plant by the 5-mile long Tehenn Canal. The pump plant would lift water into the Tehenn Reservoir immediately downstream of Newville Reservoir. Tehenn Reservoir would be formed by the 112-foot high earthfill Tehenn Dam. The Newville Pump/Generator Plant would lift water from Tehenn Reservoir into Newville Reservoir. Water would be released from Newville Reservoir and conveyed to the Tehama-Colusa Canal through the series of canals and generators.

Direct short-term impacts: Direct short-term impacts on water quality will result from construction activities. Most the impacts will be associated with ground disturbance and will consist of increases in erosion rates. Construction of the canals and pump/generator plants will take place away from water bodies. Conventional construction site erosion controls should be sufficient to prevent adverse water quality impacts.

North Fork Stony Creek flows will be diverted under the Newville and Teheen Dams and so the effects of dam construction on water quality will be minimal.

Red Bank Project

The Red Bank Project consists of several dams and reservoirs located about 20 miles west of the city of Red Bluff. The reservoirs would store water from the South Fork Cottonwood Creek and Red Bank Creek. Dippingvat Reservoir would be located on South Fork Cottonwood Creek. It would be formed by a 251 foot high roller-compacted concrete (RCC) dam. The reservoir would have a capacity of 104,000 acre-feet and a water surface area of 1,270 acres. Schoenfield Reservoir would be located on Red Bank Creek and would be formed by a 300 foot high dam. It would have a capacity of 250,000 acre-feet and a surface area of 2,770 acres.

A portion of the flows captured at Dippingvat Reservoir would be conveyed to Schoenfield Reservoir for storage. Schoenfield Reservoir is sized to accommodate both local inflow from Red Bank creek and diversions from Dippingvat Reservoir. The conveyance facilities from Dippingvat Reservoir to Schoenfield Reservoir include an 1,800 foot long tunnel, two small reservoirs and three short canals.

Storage in Dippingvat and Schoenfield Reservoirs could be used for several purposes. Stored water could be released down Cottonwood and Red Bank Creeks to supplement Sacramento River flows. Alternatively, water could be released to the Corning or Tehama Colusa Canals in order to reduce the diversion of Sacramento River water at the Red Bluff Diversion Dam.

Direct short-term impacts: Direct short-term impacts on water quality will result from construction activities. Most the impacts will be associated with ground disturbance and will consist of increases in erosion rates. Construction of the canals and pump/generator plants will take place away from water bodies. Conventional construction site erosion controls should be sufficient to prevent serious water quality impacts.

North Fork Stony Creek flows will be diverted under the Newville and Teheen Dams and so the effects of dam construction on water quality will be minimal.

4.2.3 San Joaquin River Basin

Notes:

4.3 Comparison of Alternatives

4.3.1 No Action

4.3.2 Alternative 1

4.3.3 Alternative 2

4.3.4 Alternative 3

APPENDIX II
DWR PLANNING SIMULATION MODEL (DWRSIM) ASSUMPTIONS FOR
CALFED BENCHMARK STUDY
1995C6F-CALFED-472

Study 472 meets SWRCB'S May 1995 Water Quality Control Plan (Plan) and includes selected upstream ESA requirements and CVPIA flow prescriptions (see Item III). Assumptions are identical to Study 471 (B160-98 Public Draft) except than 2020 level South-of-Delta demands are assumed.

I. New Model Features

A new DWRSIM version with the following enhancements is employed:

A. A new SWP and CVP south-of-Delta delivery logic uses (i) runoff forecast information and uncertainty (not perfect foresight), (ii) a delivery versus carryover risk curve and (iii) a standardized rule (Water Supply Index versus Demand Index Curve) to estimate the total water available for delivery and carryover storage. The new logic updates delivery levels monthly from January 1 through May 1 as water supply parameters become more certain. Refer to Leaf and Arora (1996) for additional information on the new delivery logic.

B. An expanded network schematic includes more details in the Delta and along the DMC and SWP-CVP Joint Reach facility.

C. A network representation of the San Joaquin River basin was adapted from USBR's SANJASM model. The San Joaquin River basin schematic was expanded to include (i) the Tuolumne River upstream to Hetch Hetchy and Cherry/Eleanor Reservoirs, (ii) the Merced River upstream to Lake McClure, (iii) the Chowchilla and Fresno Rivers upstream to Eastman and Hensley Lakes, respectively, and (iv) the San Joaquin River upstream to Millerton Lake.

D. Contra Costa Water District's "G" model is used to relate Delta flows and salinities. Refer to Denton (1993) for additional information on the procedure.

E. References:

Leaf, R.T. and Arora, S.K. (1996). "Annual Delivery Decisions in the Simulation of the California State Water Project and Federal Central Valley Project using DWRSIM." *Proceedings 1996 North American Water and Environment Congress*, ASCE, C.T. Bathala, Ed.

Denton, R.A. (1993). "Accounting for Antecedent Conditions in Seawater Intrusion Modeling - Applications for the San Francisco Bay-Delta." *Proceedings 1993 National Conference on Hydraulic Engineering*, ASCE, H.W. Shen, Ed.

II. Instream Flow Requirements

A. Trinity River minimum fish flows below Lewiston Dam are maintained at 340 TAF/year for all years, based on a May 1991 letter agreement between the USBR and the U.S. Fish and Wildlife Service.

B. Sacramento River navigation control point (NCP) flows are maintained at 5,000 cfs in wet and above normal water years and 4,000 cfs in all other years. This criterion is relaxed to 3,500 cfs when Shasta carryover storage drops below 1.9 MAF and is further relaxed to 3,250 cfs when Shasta carryover storage drops below 1.2 MAF.

C. Feather River fishery flows are maintained per an agreement between DWR and the Calif. Dept. of Fish & Game (August 26, 1983). In normal years these minimum flows are 1,700 cfs from October through March and 1,000 cfs from April through September. Lower minimum flows are allowed in low runoff years and when Oroville storage drops below 1.5 MAF. A maximum flow restriction of 2,500 cfs for October and November is maintained per the agreement criteria.

D. Stanislaus River minimum fish flows below New Melones Reservoir range from 98 TAF/year up to 302 TAF/year, according to the interim agreement (dated June 1987) between the USBR and the Calif. Dept. of Fish & Game. The actual minimum fish flow for each year is based on the water supply available for that year. Additional minimum flow requirements are imposed in June through September (15.2 - 17.4 TAF per month) to maintain dissolved oxygen levels in the Stanislaus River. Channel capacity below Goodwin Dam is assumed to be 8,000 cfs. CVP contract demands above Goodwin Dam are met as a function of New Melones Reservoir storage and inflow per an April 26, 1996 letter from USBR to SWRCB.

E. Tuolumne River minimum fishery flows below New Don Pedro Dam are maintained per an agreement between Turlock and Modesto Irrigation Districts, City of San Francisco, Dept. of Fish & Game and others (FERC Agreement 2299). Base flows range from 50 cfs to 300 cfs. Base and pulse flow volumes depend on time of the year and water year type.

F. Instream flow requirements are maintained in accordance with CVPIA criteria (see Item III) at the following locations: below Keswick Dam on the Sacramento River, below Whiskeytown Dam on Clear Creek and below Nimbus Dam on the American River.

III. CVPIA Flow Criteria

The following CVPIA flow criteria are in accordance with an April 26, 1996 letter from USBR to SWRCB. (This information is preliminary. It is envisioned that when significant changes occur within the CVP/SWP system, the criteria will be reviewed and possibly revised):

A. Flow objectives between 3,250 cfs and 5,500 cfs are maintained below Keswick Dam on the Sacramento River. Flow requirements during October through April are triggered by Shasta carryover storage.

C-032749

B. Flow objectives between 52 cfs and 200 cfs are maintained below Whiskeytown Dam on Clear Creek, depending on month and year type.

C. Flow objectives between 250 cfs and 4,500 cfs are maintained below Nimbus Dam on the American River. Flow requirements during October through February are triggered by Folsom carryover storage. Flow requirements in other months are triggered by previous month storage plus remaining water year inflows.

IV. Trinity River Imports

Imports from Clair Engle Reservoir to Whiskeytown Reservoir (up to a 3,300 cfs maximum) are specified according to USBR criteria. Imports vary according to month and previous month Clair Engle storage.

V. Hydrology (HYD-C06F)

A new 1995 level hydrology, HYD-C06F, was developed similar to HYD-C06B described in a June 1994 memorandum report entitled "Summary of Hydrologies at the 1990, 1995, 2000, 2010 and 2020 Levels of Development for Use in DWRSIM Planning Studies" published by DWR's Division of Planning. HYD-CO6B was based on DWR Bulletin 160-93 land use projections and simulates the 71 year period 1922-92. HYD-C06F, developed through consultation with USBR to address differences in San Joaquin basin hydrology, simulates two additional years (through 1994) and includes the following major modifications compared to HYD-C06B:

A. Stand-alone HEC-3 models of the American, Yuba and Bear River subsystems were updated and extended through 1994. Yuba River minimum fishery flows below Bullards Bar Dam were not modified to reflect new FERC requirements. According to consultants for the Yuba County Water Agency, water supply impacts of the new requirements are not substantially different from those modeled in HYD-C06B.

B. Mokelumne River minimum fishery flows below Camanche Dam are modeled in HYD-C06F per an agreement between EBMUD, U.S. Fish and Wildlife Service, and Calif. Dept. of Fish & Game (FERC Agreement 2916). Base flows range from 100 cfs to 325 cfs from October through June, depending on time of the year and water year type. Base flows are maintained at 100 cfs from July through September for all water year types. Water year types are determined by reservoir storage and unimpaired runoff. For the months of April through June, additional pulse flows are maintained up to 200 cfs depending on water year type and reservoir storage.

C. Historical 1993-94 land use was estimated by linear interpolation between 1990 and 2000 normalized projected levels.

VI. Pumping Plant Capacities, Coordinated Operation & Wheeling

A. SWP Banks Pumping Plant average monthly capacity with 4 new pumps is 6,680 cfs (or 8,500 cfs in some winter months) in accordance with USACE October 31, 1981 Public Notice criteria.

C-032750

B. CVP Tracy Pumping Plant capacity is 4,600 cfs, but physical constraints along the Delta Mendota Canal and at the relift pumps (to O'Neil Forebay) can restrict export capacity as low as 4,200 cfs.

C. CVP/SWP sharing of responsibility for the coordinated operation of the two projects is maintained per the Coordinated Operation Agreement (COA). Storage withdrawals for in-basin use are split 75 percent CVP and 25 percent SWP. Unstored flows for storage and export are split 55 percent CVP and 45 percent SWP. In months when the export-inflow ratio limits Delta exports, the allowable export is shared equally between the CVP and SWP. (The COA sharing formula is based on D-1485 operations, not on May 1995 Water Quality Control Plan operations. The sharing formula will likely be modified to conform with Water Quality Control Plan operations. Such a change has unknown, but potentially significant, operational implications.)

D. CVP water is wheeled to meet Cross Valley Canal demands when unused capacity is available in Banks Pumping Plant.

E. Enlarged East Branch aqueduct capacities are assumed from Alamo Powerplant to Devil Canyon Powerplant.

VII. Target Reservoir Storage

A. Shasta Reservoir carryover storage is maintained at or above 1.9 MAF in all normal water years for winter-run salmon protection per the NMFS biological opinion. However, in critical years following critical years, storage is allowed to fall below 1.9 MAF.

B. Folsom Reservoir storage capacity was reduced from 1010 TAF down to 975 TAF due to sediment accumulation as calculated from a 1992 reservoir capacity survey.

C. Folsom flood control criteria are in accordance with the December 1993 USACE report "Folsom Dam And Lake Operation Evaluation". This criteria uses available storage in upstream reservoirs such that the maximum flood control reservation varies from 400 TAF to 670 TAF.

VIII. SWP Demands, Deliveries & Deficiencies

A. 2020 demand level is assumed to be fixed at full entitlement of 4.2 MAF. MWDSC's monthly demand patterns assume an Eastside Reservoir and an Inland Feeder pipeline in accordance with a July 26, 1995 memorandum from MWDSC.

B. Deficiencies are imposed as needed per the draft "Monterey Agreement" criteria and are calculated from the following Table A entitlements for year 2020:

Agricultural Entitlements	1,175 TAF/year
M & I Entitlements	2,958
Recreation & Losses	64
Total Entitlements	4,197 TAF/year

C. When available, "interruptible" water is delivered to SWP south-of-Delta contractors in accordance with the following assumptions based on the Monterey Amendment White Paper redraft dated September 28, 1995:

1. Interruptible water results from direct diversions from Banks Pumping Plant. It is not stored in San Luis Reservoir for later delivery to contractors.

2. A contractor may accept interruptible water in addition to its monthly scheduled entitlement water. Therefore, the contractor may receive water above its Table A amount for the year. Interruptible water deliveries do not impact entitlement water allocations.

3. If demand for interruptible water is greater than supply in any month, the supply is allocated in proportion to the Table A entitlements of those contractors requesting interruptible water.

IX. CVP Demands, Deliveries & Deficiencies

A. 2020 level CVP demands, including canal losses but excluding San Joaquin Valley wildlife refuges are assumed as follows (see Item IX.B below for refuge demands):

Contra Costa Canal	=	202 TAF/year
DMC and Exchange	=	1,561
CVP San Luis Unit	=	1,447
San Felipe Unit	=	196
Cross Valley Canal	=	128
Total CVP Delta Exports	=	3,534 TAF/year

Including wildlife refuges, total CVP demand is 3,822 TAF/year. The Contra Costa Canal monthly demand pattern assumes Los Vaqueros operations in accordance with a July 11, 1994 e-mail from CCWD.

B. Sacramento Valley refuge demands are modeled implicitly in the hydrology through rice field and duck club operations. Sacramento Valley refuges include Gray Lodge, Modoc, Sacramento, Delevan, Colusa and Sutter. Level II refuge demands in the San Joaquin Valley are explicitly modeled at an assigned level of 288 TAF/year. San Joaquin Valley refuges include Grasslands, Volta, Los Banos, Kesterson, San Luis, Mendota, Pixley, Kern and those included in the San Joaquin Basin Action Plan.

C. CVP south-of-Delta deficiencies are imposed when needed by contract priority. Contracts are classified into four groups: agricultural (Ag), municipal and industrial (M&I), Exchange and Refuge. Deficiencies are imposed in accordance with the Shasta Index and sequentially according to the following rules:

1. Ag requests are reduced up to a maximum of 50 percent.

2. Ag, M&I and Exchange requests are reduced by equal percentages up to a maximum of 25 percent. At this point, cumulative Ag deficiencies are 75 percent.

3. Ag, M&I and Refuge requests are reduced by equal percentages up to a maximum of 25 percent. At this point, cumulative Ag and M&I deficiencies are 100 percent and 50 percent, respectively.

4. M&I requests are reduced until cumulative deficiencies are 100 percent.

5. Further reductions are imposed equally upon Exchange and Refuge.

D. Deficiencies in the form of "dedicated" water and "acquired" water to meet 800 TAF/year CVPIA demands are not imposed.

X. Delta Standards

In the following assumptions related to Delta standards, reference is made to the SWRCB's May 1995 Water Quality Control Plan (Plan):

A. Water Year Classifications

1. The Sacramento Valley 40-30-30 Index (as defined on page 23 of the Plan) is used to determine year types for Delta outflow criteria and Sacramento River system requirements unless otherwise specified in the Plan.

2. The San Joaquin Valley 60-20-20 Index (page 24) is used to determine year types for flow requirements at Vernalis.

3. The Sacramento River Index, or SRI (Footnote 6, page 20), is used to trigger relaxation criteria related to May-June Net Delta Outflow Index (NDOI) and salinity in the San Joaquin River and western Suisun Marsh.

4. The Eight River Index (Footnote 13, page 20) is used to trigger criteria related to (i) January NDOI, (ii) February-June X2 standards and (iii) February export ratio.

B. M&I Water Quality Objectives (Table 1, page 16)

1. The water quality objective at Contra Costa Canal intake is maintained in accordance with the Plan. A "buffer" was added to insure that the standard is maintained on a daily basis. Thus, DWRSIM uses a value of 130 mg/L for the 150 mg/L standard and a value of 225 mg/L for the 250 mg/L standard.

2. The M&I water quality objectives at Clifton Court Forebay, Tracy Pumping Plant, Barker Slough and Cache Slough are not modeled.

C. Agricultural Water Quality Objectives (Table 2, page 17)

1. Water quality objectives on the Sacramento River at Emmaton and on the San Joaquin River at Jersey Point are maintained in accordance with the Plan.

2. Plan water quality objectives on the San Joaquin River at Vernalis are 0.7 EC in April through August and 1.0 EC in other months. These objectives are maintained primarily by releasing water from New Melones Reservoir. A cap on water quality releases is imposed per criteria outlined in an April 26, 1996 letter from USBR to SWRCB. The cap varies between 70 TAF/year and 200 TAF/year, depending on New Melones storage and projected inflow.

3. The interior Delta standards on the Mokelumne River (at Terminous) and on the San Joaquin River (at San Andreas Landing) are not modeled.

4. The export area 1.0 EC standards at Clifton Court Forebay and Tracy Pumping Plant are not modeled.

D. Fish & Wildlife Water Quality Objectives: Salinity (Table 3, page 18)

1. The 0.44 EC standard is maintained at Jersey Point in April and May of all but critical years. Per Footnote 6 (page 20), this criteria is dropped in May if the projected SRI is less than 8.1 MAF. The salinity requirement at Prisoners Point is not modeled.

2. The following EC standards are maintained at Collinsville for eastern Suisun Marsh salinity control:

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May
EC - Ave. High Tide	19.0	15.5	15.5	12.5	8.0	8.0	11.0	11.0

The corresponding EC standards for other locations in the eastern and western Suisun Marsh are not modeled.

E. Fish & Wildlife Water Quality Objectives: Delta Outflow (Table 3, page 19)

1. Minimum required NDOI (cfs) is maintained as follows:

Year Type	Oct	Nov	Dec	Jan	Feb-Jun	Jul	Aug	Sep
Wet	4,000	4,500	4,500	*	**	8,000	4,000	3,000
Above Normal	4,000	4,500	4,500	*	**	8,000	4,000	3,000
Below Normal	4,000	4,500	4,500	*	**	6,500	4,000	3,000
Dry	4,000	4,500	4,500	*	**	5,000	3,500	3,000
Critical	3,000	3,500	3,500	*	**	4,000	3,000	3,000

* January: Maintain either 4,500 cfs or 6,000 cfs if the December Eight River Index was greater than 800 TAF (per Footnote 13 page 20).

** February-June: Maintain 2.64 EC standards (X2) as described below.

2. For February through June, outflow requirements are maintained in accordance with the 2.64 EC criteria (also known as X2) using the required number of days at Chipps Island (74 km) and Roe Island (64 km). See Footnote 14 for Table 3 (Table A) page 26.

a. At the Confluence (81 km), the full 150 days (February 1 - June 30) of 2.64 EC is maintained in all years, up to a maximum required flow of 7,100 cfs. This requirement is dropped in May and June of any year for which the projected SRI is less than 8.1 MAF. In those years when the criteria is dropped, a minimum outflow of 4,000 cfs is maintained in May and June.

b. The criteria -- "If salinity/flow objectives are met for a greater number of days than the requirements for any month, the excess days shall be applied to meeting the requirements for the following month" -- is not modeled. See Footnote "a" of Footnote 14 for Table 3 (Table A).

c. The Kimmerer-Monismith monthly equation is used to calculate outflow required (in cfs) to maintain the EC standard (average monthly position in kilometers). In this equation the EC position is given and Delta outflow is solved for.

$$\text{EC position} = 122.2 + [0.3278 * (\text{previous month EC position in km})] - [17.65 * \log_{10}(\text{current month Delta outflow in cfs})]$$

In months when the EC standard is specified in more than one location (e.g. 19 days at the confluence and 12 days at Chipps Island), required outflow for the month is computed as a flow weighted average of the partial month standards.

3. Additional details on the 2.64 EC criteria are modeled as follows:

a. The trigger to activate the Roe Island standard is set at 66.3 km from the previous month, as an average monthly value.

b. The maximum required monthly outflows to meet the 2.64 EC standard are capped at the following limits: 29,200 cfs for Roe Island; 11,400 cfs for Chipps Island; and 7,100 cfs for the Confluence.

c. Relaxation criteria for the February Chipps Island standard is a function of the January Eight River Index as follows:

(i) X2 days = 0 if the Index is less than 0.8 MAF
(ii) X2 days = 28 if the Index is greater than 1.0 MAF

(iii) X2 days vary linearly between 0 and 28 if the Index is between 0.8 MAF and 1.0 MAF

F. Fish & Wildlife Water Quality Objectives: River Flows (Table 3, page 19)

1. Minimum Sacramento River flow requirements (cfs) at Rio Vista are maintained as follows:

Year Type	Sep	Oct	Nov	Dec
Wet	3,000	4,000	4,500	4,500
Above Normal	3,000	4,000	4,500	4,500
Below Normal	3,000	4,000	4,500	4,500
Dry	3,000	4,000	4,500	4,500
Critical	3,000	3,000	3,500	3,500

2. From February 1 through June 30, minimum flows on the San Joaquin River at Vernalis are maintained per the table below. For each period, the higher flow is required whenever the 2.64 EC Delta outflow position is located downstream of Chipps Island (<74 km). If the 2.64 EC Delta outflow position is upstream of Chipps Island (>74 km), then the lower flow requirement is used.

	Minimum Flows at Vernalis (cfs)	
Year Type	Feb1-Apr14 & May16-June30	April15-May15
Wet	2,130 or 3,420	7,330 or 8,620
Above Normal	2,130 or 3,420	5,730 or 7,020
Below Normal	1,420 or 2,280	4,620 or 5,480
Dry	1,420 or 2,280	4,020 or 4,880
Critical	710 or 1,140	3,110 or 3,540

3. For the month of October, the minimum flow requirement at Vernalis is 1,000 cfs in all years PLUS a 28 TAF pulse flow (per Footnote 19, page 21). The 28 TAF pulse (equivalent to 455 cfs monthly) is added to the actual Vernalis flow, up to a maximum of 2,000 cfs. The pulse flow requirement is not imposed in a critical year following a critical year. These two components are combined as an average monthly requirement as follows:

October Minimum Flows at Vernalis (cfs)

Base Flow	Required Flow
<1,000	1,455
1,000-1,545	Base Flow + 455
>1,545	2,000

4. The above flow requirements at Vernalis are maintained primarily by releasing additional water from New Melones Reservoir. In years when New Melones Reservoir

drops to a minimum storage of 80 TAF (per April 26, 1996 letter from USBR to SWRCB), additional water is provided equally from the Tuolumne and Merced River systems to meet the Vernalis flow requirements. If these sources are insufficient to meet objectives at Vernalis, nominal deficiencies will be applied to upstream demands.

G. Fish & Wildlife Water Quality Objectives: Export Limits (Table 3, page 19)

1. Ratios for maximum allowable Delta exports are specified as a percentage of total Delta inflow as follows:

Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
65	65	65	65	45-35	35	35	35	35	65	65	65

a. In February the export ratio is a function of the January Eight River Index per Footnote 25, page 22 as follows:

(i) 45% if the Jan. 8-River Index is less than 1.0 MAF
(ii) 35% if the Jan. 8-River Index is greater than 1.5 MAF
(iii) Varies linearly between 45% and 35% if the January Eight River Index is between 1.0 MAF and 1.5 MAF.

b. For this ratio criteria, total Delta exports are defined as the sum of pumping at the SWP Banks and CVP Tracy Pumping Plants. Total Delta inflow is calculated as the sum of river flows from the Sacramento River, Yolo Bypass, total from the Eastside stream group, and San Joaquin River inflow. Delta area precipitation and consumptive uses are not used in this ratio.

2. Based on Footnote 22 page 21, April and May total Delta export limitations are modeled as follows:

a. April 15 - May 15 exports are limited to 1,500 cfs OR 100 percent of the San Joaquin River flow at Vernalis, whichever is greater.

b. April 1-14 and May 16-31 export limits are controlled by either the export/inflow ratio (35%) or pumping plant capacity, whichever is smaller.

H. Fish & Wildlife Water Quality Objectives: Delta Cross Channel (Table 3, page 19)

1. The Delta Cross Channel (DCC) is closed 10 days in November, 15 days in December and 20 days in January for a total closure of 45 days per Footnote 26, page 22.

2. The DCC is fully closed from February 1 through May 20 of all years and is closed an additional 14 days between May 21 and June 15 per Footnote 27, page 22.

APPENDIX III
CALFED STORAGE & CONVEYANCE COMPONENTS: OPERATIONS CRITERIA

I. Isolated Component of Dual Transfer Facility

The Isolated Component of the Dual Transfer Facility (i.e. the Isolated Facility) is operated to maximize water quality benefits. In other words, the maximum amount of water is diverted into the Facility regardless of any additional upstream releases that may be required. Diversion into the Isolated Facility is governed by the following operations criteria:

A. Minimum Thru-Delta Conveyance: This is a user-specified minimum export that must be diverted from Delta channels before diversions through the Isolated Facility can be made.

B. Maximum Allowable Conveyance Through the Isolated Facility: This is a user-specified fraction of the net export that can be transferred through the Isolated Facility. The net export does not include export that is obtained by a release from the In-Delta Storage Facility.

C. Isolated Facility Capacity Constraint: This is the user-specified physical capacity of the Isolated Facility.

D. Service to SWP Only: This is a user-specified option to operate the facility only for SWP net export. If selected, conveyance through the Isolated Facility is further limited to the SWP net export, excluding wheeling for the CVP.

E. Export Ratio Restrictions: This is a user-specified option that allows Isolated Facility conveyance to be included or excluded from Delta "inflow" and "export" computations for the February-June export restriction and the April-May export restriction.

II. In-Delta & North of Delta Storage Components

The In-Delta Storage facility (IDS), the North of Delta Surface Storage facility (NDSS), and the North of Delta Groundwater Storage facility (NDGS) are operated based on the following criteria:

A. Releases from IDS, NDSS and NDGS are restricted as follows:

> 1. Additional releases from IDS, NDGS, NDSS and Oroville storage are made only to satisfy the SWP share of Delta In-Basin requirements and SWP export.
>
> 2. Release is made first from IDS. The IDS release is limited by available storage and by a user-specified maximum release capacity. Releases are made only to reduce SWP releases from upstream storage facilities and only up to the amount that is required for SWP export. Releases from IDS are not considered in export ratio calculations. Releases are not made as an alternative to cutting export under the export ratio constraint.

3. Extraction/Releases are then made from NDGS, NDSS and Oroville storage. Extraction/Release from NDGS and NDSS are balanced with the Oroville release in the HEC III manner (i.e. balancing based on user specified logical levels). This balancing technique is flexible enough to consider a very wide range of priorities.

4. Extraction/Release from NDGS and NDSS are limited by the user-specified aquifer/reservoir extraction/outlet capacities..

B. Natural recharge of the NDGS is calculated as a user-specified percentage of the available storage capacity at the beginning of the month. The resulting recharge is considered as a Sacramento River basin requirement.

C. Artificial recharge of NDGS and filling of NDSS and IDS facilities is restricted as follows:

1. In each water year, artificial recharge of NDGS and filling of NDSS will not be permitted until a flushing volume of at least 550 TAF in one month occurs at the diversion point for filling of NDSS. In determining the artificial recharge of NDGS and the filling of NDSS for the month in which the flushing volume occurs, only Sacramento River flow in excess of the 550 TAF/month flow at each respective diversion will be considered for use in recharging/filling the facilities.

2. If any releases are being made to satisfy Delta In-Basin requirements, artificial recharge of NDGS and filling of NDSS and IDS will not be permitted.

3. Only Sacramento River inflow into the Delta that is in excess of the export ratio requirement and is also surplus Delta outflow is considered for use in the artificial recharge of NDGS and filling of NDSS and IDS.

4. The artificial recharge of NDGS is considered first. Artificial recharge of NDGS is limited to the excess Sacramento River flow above any required river flow between its diversion point and the point of inflow into the Delta. It is also limited to its available unfilled capacity and a user- specified maximum recharge rate.

5. The filling of NDSS is considered second. Filling of NDSS is limited to the excess Sacramento River flow above any required river flow between its diversion point and the point of inflow into the Delta minus the diversion for the artificial recharge of the NDGS. It is also limited to its available unfilled capacity and a user-specified maximum fill rate.

6. The filling of IDS is considered third. Filling of IDS is limited to its available unfilled capacity and a user-specified maximum fill rate.

7. The filling of IDS is considered an export and is, therefore, subject to the export ratio requirement. Since filling IDS is using only surplus water (CVP has taken all it can) it is not subject to COA sharing.

III. South of Delta Storage Components

The South of Delta Surface Storage facility (SDSS) and the South of Delta Groundwater Storage facility (SDGS) are operated based on the following criteria:

A. Storage capacities of SDSS and SDGS are user-specified.

B. Storage releases from SDSS and SDGS to meet downstream demands are restricted as follows:

> 1. The order of priority for storage releases is as follows: (a) SDGS, (b) SDSS and (c) SWP San Luis Reservoir.
>
> 2. Storage release capacities for SDSS and SDGS are user-specified.

C. Diversions to SDSS and SDGS are restricted as follows:

> 1. The order of priority for storage diversions is as follows: (a) SDGS, (b) SDSS and (c) SWP San Luis Reservoir.
>
> 2. Storage diversion capacities for SDSS and SDGS are user-specified.

D. SDSS operations (releases and diversions) are balanced with SWP San Luis operations.

E. SDSS and SWP San Luis operations are triggered by combined south of Delta target storage. This combined storage is filled during some high outflow periods and with storage transfers from upstream reservoirs.

F. Diversions (recharge) to SDGS are based on surplus outflow and storage transfer.

G. SDGS recharge and extraction are functions of SWP delivery and Oroville storage.