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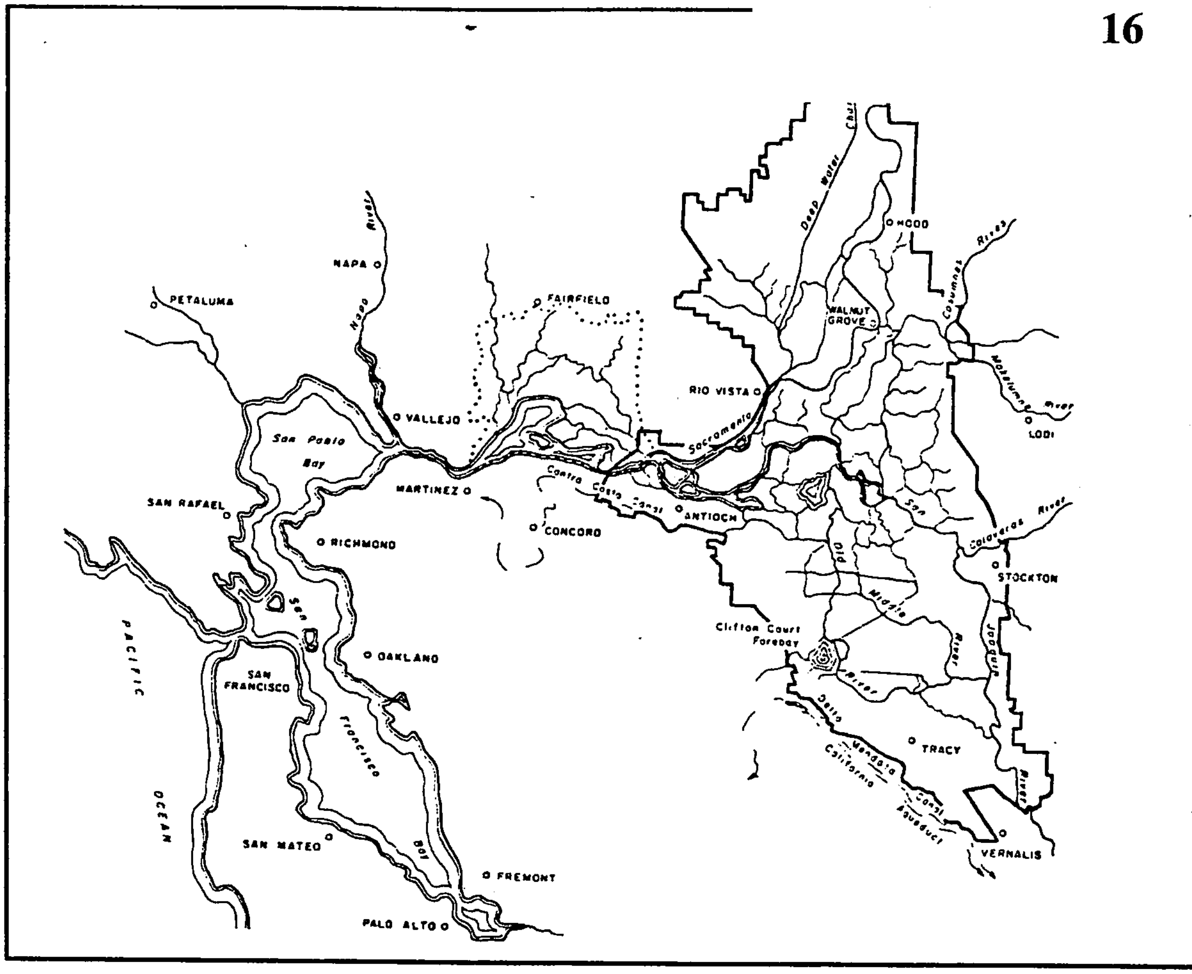

WATER QUALITY CONTROL PLAN FOR SALINITY

San Francisco Bay/ Sacramento - San Joaquin Delta Estuary

91-15WR

May 1991

STATE WATER RESOURCES CONTROL BOARD
BAY-DELTA PROGRAM WRINT
SWRCB EXH. 3
FOR IDENTIFICATION 07/22/92
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WATER RESOURCES CONTROL BOARD
STATE OF CALIFORNIA

WATER QUALITY
CONTROL PLAN FOR SALINITY

San Francisco Bay/
Sacramento - San Joaquin
Delta Estuary

Report Number, 91-15 WR

May 1991

Prepared by the Bay-Delta Section
Division of Water Rights
WATER RESOURCES CONTROL BOARD
STATE OF CALIFORNIA

STATE WATER RESOURCES CONTROL BOARD
RESOLUTION NO. 91-34

ADOPTION OF THE WATER QUALITY CONTROL PLAN FOR SALINITY --
SAN FRANCISCO BAY/SACRAMENTO-SAN JOAQUIN DELTA ESTUARY

WHEREAS:

1. The State Water Resources Control Board is responsible for the regulation of activities and factors which affect or may affect the quality of the waters of the State (Water Code Section 13001).

2. The State Board has undertaken a process, under its water quality authority, to develop a set of water quality objectives for salinity, temperature, and dissolved oxygen to protect beneficial uses of the Estuary.

3. The State Board has conducted 60 days of evidentiary hearing initiated on July 7, 1987, and concluded on August 23, 1990, in accordance with the Federal Clean Water Act (33 U.S.C.A. Sections 1251 to 1387) and the California Water Code, and has considered the evidence introduced at the hearing.

4. A draft Water Quality Control Plan for Salinity -- San Francisco/Sacramento-San Joaquin Delta Estuary was formulated and submitted for public review on January 18, 1991.

5. The State Board conducted a public hearing on the draft water quality control plan on March 11, 1991, after notice to all interested parties, in accordance with Federal and State requirements and has considered the oral and written comments submitted.

6. The Water Quality Control Plan, consisting of the Water Quality Control Plan for Salinity -- San Francisco/Sacramento-San Joaquin Delta Estuary, accompanying Technical Appendix, and the comments and responses thereto, has been revised to incorporate appropriate comments received from the interested parties.

7. The water quality objectives in the Water Quality Control Plan--San Francisco Bay/Sacramento-San Joaquin Delta Estuary will be reviewed at least once every three years.

8. The Water Quality Control Plan is an adjunct to the Basin Plans; together with the Basin Plans, it includes all necessary elements of water quality control plans in accordance with Sections 13241 and 13242 of the California Water Code and Federal requirements.

9. The State Board has prepared the Water Quality Control Plan under a certified program as a substitute document for an environmental impact report under Section 21080.5 of the California Public Resources Code (California Environmental Quality Act).

THEREFORE BE IT RESOLVED:

1. That the State Board adopts the Water Quality Control Plan--San Francisco Bay/Sacramento-San Joaquin Delta Estuary (Plan) in accordance with Section 13170 of the Water Code.

2. That the Executive Director is directed to forward copies of the Beneficial Use Designation and Water Quality Objectives portions of the Plan to the United States Environmental Protection Agency for review and approval in accordance with requirements of the Federal Clean Water Act [33 U.S.C.A. Section 1313(c)].

CERTIFICATION

The undersigned, Administrative Assistant to the Board, does hereby certify that the foregoing is a full, true, and correct copy of a resolution duly and regularly adopted at a meeting of the State Water Resources Control Board held on May 1, 1991.

Maureen Marché

Maureen Marché
Administrative Assistant to the Board

FOREWORD

Introduction

Consider water in California and you face a complex brew of physical, technical, political and cultural elements. Most of the State's water supply falls as rain and snow in the north, in the wintertime. Most of the consumptive use occurs south of the Sacramento-San Joaquin Delta, in the summer.

During the past century, the challenge was how best to capture, redistribute and safeguard this resource. As a consequence, pioneering projects dot the landscape with reservoirs and water transport canals which lace together the northern and southern parts of the State.

The current challenge is how to balance the redistribution of water to ensure maximum benefit to all of California, its people, its agriculture, its industry and its environment, including how best to protect its quality so that it serves our needs.

Balancing this redistribution is a major function of the State Water Resources Control Board.

Comprehensive Protection for the State's Waters

In California, the use of water must be planned within the framework of source availability, current as well as future needs and principles embodied in State law. California needs a water supply of sufficient quality to meet all reasonable uses. Although there exist sufficient water sources to meet all reasonable needs, these sources are insufficiently managed and/or developed to provide a reliable supply for all needs.

The Bay-Delta water system is a major source of supply to the State, providing more than half of all water used in California. Therefore, comprehensive planning for the ongoing protection, development and management of this unparalleled resource is needed.

The State Board has major planning and regulatory responsibilities for the State's water resources, and specifically the Bay-Delta system. The State Board is uniquely designed for this task: it has the dual responsibility of protecting the State's water resources as well as allocating the State's existing water supply.

The Basin Plans prepared by the Central Valley and San Francisco Regional Boards establish water quality objectives to protect beneficial uses of Bay-Delta waters. To supplement those efforts, in 1987, the State Board embarked on a major comprehensive program to protect the waters of the Bay-Delta system. That program is composed of five interrelated components. Each of the components is important and builds on the others.

The five components are: the California Water Quality Assessment, adopted in April, 1990; the Pollutant Policy Document, adopted in June 1990; the Inland Waters Plan and the Enclosed Bays and Estuaries Plan, adopted in April, 1991; the Water Quality Control Plan for Salinity for the Bay-Delta, adopted May 1991; and the Scoping and Water Right phases of the Bay-Delta proceedings (the Scoping Phase of which began in March, 1991).

Viewed in the context of these other Plans and actions, the Water Quality Control Plan for Temperature and Salinity represents but one step in a coordinated five-point program.

Genesis of the Bay-Delta Plan

In 1978, the Board issued several comprehensive reports on the uses and protections of the Delta. The proceedings were limited to current and near-term conditions in the Delta. When the original Delta Plan and accompanying Water Right Decision (D-1485) were issued, the Board realized that the Delta's importance would require another examination. The State Board committed itself to review the Delta Plan in about ten years.

This commitment as well as applicable court decisions have resulted in the current proceedings and have expanded the scope of the proceeding.

In 1986, the State Court of Appeal issued a decision, also known as the Racanelli or Delta Water Cases decision, addressing legal challenges to the Delta Plan and D-1485. The Court directed the State Board to take a global view toward its dual responsibilities to the State's water resources. According to the Court, the State Board's duty in its water quality role is to provide reasonable protection for beneficial uses, considering all demands made on the water. Moreover, the State Board's water allocation role is not confined to the consideration of existing water rights. The Court also recognized that a program to implement protections for the system would be lengthy and complex; the program would involve entities over which the State Board has little or no control, whose actions, however, affect the waterscape.

Content of the Current Bay-Delta Plan: Use of Water Quality Objectives for the Bay-Delta Waters

The current Plan is primarily concerned with salinity and temperature factors.

Numerous water quality objectives, protecting water quality and the beneficial uses of Bay-Delta waters (see Table 1-1), have been established for:

- Salinity at municipal and industrial intakes,
- Salinity levels to protect Delta agriculture,
- Salinity levels to protect export agriculture,
- Salinity for fish and wildlife resources in the Estuary.

Water quality objectives have also been established to provide:

- Expansion of the period of protection for striped bass spawning, and
- Temperature and dissolved oxygen levels for fisheries in the Delta.

Most importantly, this Plan sets the stage for the real heart of the Bay-Delta proceedings -- determining reasonable protection for all uses, and determining who will share responsibility for meeting the established water quality objectives.

The Scoping and Water Right Phases of the Proceedings

Immediately after adoption of this Plan, the State Board will conduct scoping hearings on other actions necessary to protect beneficial uses, including flow requirements.

The flow issue is critical to the State Board's final decision. Flow requirements yet to be established will ultimately determine how much water can be exported for consumptive use, as well as how much water is needed to protect fish and wildlife.

Central to all these issues is the question of what amount of water is available and who is required to manage it.

Currently, two major water systems, one State and one Federal, export Delta water to other areas in California. These systems -- the State Water Project (SWP), operated by the California Department of Water Resources (DWR), and the Central Valley Project (CVP), operated by the U.S. Bureau of Reclamation (Bureau) -- are responsible for meeting salinity objectives in the Bay-Delta. There are, however, approximately 7,000 parties which divert Delta water for usage throughout the State.

In order to establish an equitable means of water supply and distribution as embodied in Racanelli, the State Board has determined that other parties diverting Delta water, not only the CVP and SWP, should be required to meet water quality objectives in the Delta.

A primary task, among many others, of the Scoping and Water Right phases of the proceedings therefore will be the identification of appropriate requirements and of the parties responsible for providing for these needs. Initially, the State Board will review the operations of Sacramento and San Joaquin Valley reservoirs of 100,000 acre-feet and larger, as well as those of major direct water diverters, to determine how responsibility will be allocated for meeting the Bay-Delta Estuary's water quality and quantity needs. The extent to which smaller projects will be included will be considered during the Scoping Phase.

To complete the Scoping and Water Right phases, consideration will also be given to these issues:

- The record to date, plus the continuation of low runoff and depleted storage, clearly show that there are insufficiently managed fresh water flows to protect fully all beneficial uses during dry and critical years, and perhaps in subnormal years. Consequently, decisions are needed regarding new facilities, agreements on how to mitigate adverse impacts, modifications on water use and possibly new directives from the Legislature.

- At the end of the current proceedings (that is, after adopting a water right decision), the State Board will incorporate in a revised Plan of Implementation that will:

  - establish a time table to carry out best practicable management of the resources and uses thereof;
  - identify potential new facilities and time schedules for planning and construction to achieve best practicable management;
  - outline suitable mitigation measures based on negotiated agreements to offset losses if some specified beneficial uses are not reasonably protected by direct requirements;
  - establish requirements to modify uses to reasonably balance the allocation of fresh water resources and the beneficial uses; and
  - propose potential new legislative directives.

In addition, the State Board must evaluate new major facilities, and consider other actions that are already in the planning stages or under public discussion. These include but are not limited to:

Upstream from Delta	Auburn Dam and reservoir (could modify water right terms); additional fish hatcheries for salmon and steelhead.
In Delta	Delta island storage (permit terms and conditions) enlarge channels; isolated conveyance.
In Export Areas	Los Banos Grandes and Los Vaqueros reservoirs (permit terms and conditions); conjunctive use of ground water basins; southern California surface reservoirs.
Mitigation	Wetlands additions; improve fish hatchery outputs; improve planting of fish; improve aquatic habitat; reduce infestations of injurious phytoplankton, clams, etc.
Water Use Modification	Improve irrigation efficiencies; increase artificial ground water recharge; increase waste water reclamation.

Potential Legislation	Set priorities for types of beneficial uses; explore and propose agricultural land retirement where corrective drainage costs are excessive (similar to buy out of environmentally sensitive lands at Lake Tahoe).

Completion of the water right process will be a complex task. The most difficult decisions lie ahead. Scoping has already begun in March. As we move into the Water Right Phase, the State Board needs the guidance of all parties on the appropriate range of alternatives that should be evaluated -- toward the goal of having a balanced water right decision adopted in late 1992.

WATER QUALITY CONTROL PLAN
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APPENDICES

TECHNICAL APPENDICES
(Available Upon Request)

FIGURES

Number	Title	Page

TABLES

Number	Title	Page

CITING INFORMATION

When citing evidence in the hearing record, the following conventions have been adopted:

Information derived from the <u>TRANSCRIPT</u>:

T,XIX,123:09-125:20

- Ending page and line number (can be same as the starting page) - may be omitted if a single line reference is used
- Beginning page and line number
- Transcript Sequence Number (see Appendix G, Transcript Index)
- Transcript

Information derived from an <u>EXHIBIT SUBMITTED DURING PHASE I</u>:

SWRCB,25,45

- Page number, table number, graph number
- Exhibit number
- Identifying abbreviation of the information source (see Appendices A & B, Abbreviations/Symbols)

Information derived from an <u>EXHIBIT SUBMITTED AFTER PHASE I</u>:

P-CCWD-3,45

- Page number, table number, graph number
- Exhibit number
- Identifying abbreviation of the information source (see Appendix A & B, Abbreviations/Symbols)
- Phase of the proceedings
  (WQCP = Water Quality Control Plan, 2/90-Present
  EIRSP = Environmental Impact Report Scoping Phase)

When citing <u>REFERENCES</u> from outside of the hearing record, the following conventions have been adopted:

Information derived from published documents,
(a) in the text of the Plan:

Denton, 1985

- Year of publication
- Name of author or agency abbreviation

CITING INFORMATION (Continued)

(b) at the end of the appropriate Plan Chapter:

Denton, R.A. 1985. Currents in Suisun Bay. SWRCB, Publication No. 85-3wr. January 1985.

- Complete publication source
- Complete title of document cited
- Publication date
- Name of author or agency abbreviation

Information derived from Phase I closing <u>BRIEFS</u>:
(a) in the text of the Plan:

RIC,Brief,8

- Page number
- "Brief"
- Identifying abbreviation of the information source

(b) at the end of the appropriate Plan Chapter:

Brief of the Rice Industry Committee on Pollutants in the Bay-Delta Estuary, pg. 8.

For a complete list of the abbreviations for information sources, citations and symbols used in this document, see Appendix A and B.

Appendix C is a Glossary of Terms; Appendix G is a Index of Transcripts listing Transcript Sequence Numbers.

1.0 EXECUTIVE SUMMARY

1.1 Background

The San Francisco Bay and Sacramento-San Joaquin Delta Estuary (Bay-Delta Estuary) includes the Sacramento-San Joaquin Delta (Delta), Suisun Marsh and the embayments upstream of the Golden Gate. The Delta and Suisun Marsh are located where California's two major river systems, the Sacramento and San Joaquin rivers, converge to flow westward to where they meet incoming seawater tides flowing through the San Francisco Bay. The beneficial uses of the waters in this system are set forth within the water quality control plans adopted by the San Francisco and the Central Valley Regional Water Quality Control Boards. The beneficial uses of Delta waters encompass almost all uses of water imaginable. The watershed of the Bay-Delta Estuary provides drinking water to two-thirds of the State's population and water for a multitude of other urban uses; it supplies some of the State's most productive agricultural areas both inside and outside the Delta; it is one of the largest systems for fish and waterfowl habitat and production in the United States. The Sacramento-San Joaquin Delta serves as a critical link for projects which transfer water from surplus to deficient areas.

Two major water distribution systems divert water from the Delta: the State Water Project (SWP) operated by the California Department of Water Resources (DWR) and the Central Valley Project (CVP) operated by the United States Bureau of Reclamation (USBR). Numerous other water diversion and management efforts influence the inflows into, flows through, and outflows from the Bay-Delta estuary.

1.2 Procedural Setting

In July 1987, the State Water Resources Control Board (State Board) opened a public proceeding consistent with direction from the California Court of Appeal in U.S. v. State Water Resources Control Board, 182 Cal.App.3d 82, 227 Cal.Rptr.161 (1986). To provide a comprehensive approach to water quality management, the Board has reviewed and approved amendments to the two relevant regional basin plans, and has adopted a separate Pollutant Policy Document (PPD), the Enclosed Bays and Estuaries and Inland Surface Water Plans, and a Water Quality Assessment.

This Water Quality Control Plan for Salinity, San Francisco Bay/Sacramento-San Joaquin Delta Estuary (Plan), supersedes the regional water quality control plans for the Bay and Delta to the extent of any conflict. This document supersedes the 1978 Delta Plan to the extent that the 1978 Plan addresses the water quality parameters which are the subject of this Plan. In addition to setting water quality objectives for salinity, the 1978 Delta Plan established Delta outflow standards and operational constraints implemented through Water Right Decision 1485 (D-1485). These flow requirements are established for the purpose of assuring flows consistent with the reasonable protection of beneficial uses. The Board has determined that modification of these flow requirements is premature until the Water Right Phase of these proceedings is completed. Because changes to these flow requirements are not being proposed as part of the Water Quality Phase of these proceedings, the flow requirements and operational constraints in the 1978 Delta Plan will remain in effect until the conclusion of the Water Right Phase.[1]

Further, this document is a substitute for an environmental document, consistent with the process certified under Public Resources Code Section 21080.5.

After adoption of this Plan, the Board will commence comprehensive scoping hearings consistent with the California Environmental Quality Act. The purpose of the scoping hearings is to receive evidence from participants to: (1) develop specific alternatives for reasonable levels of protection for beneficial uses; (2) identify the current and potential role that proposed physical facilities, negotiated settlements, legislative action, and the actions of other agencies should play in the protection of beneficial uses of Bay-Delta waters; (3) draft a matrix of alternatives (to include flow amounts as appropriate); (4) assess implementation of the alternatives; and (5) compile a draft EIR.

Following the public review of the draft EIR prepared by the State Board, a hearing will be held on the draft EIR and on water right matters to which it applies. This Water Right Phase will be conducted as a quasi-adjudicative proceeding at several locations throughout the state. It will conclude with the adoption of a final EIR and a water right decision.

The product of the current Water Quality Phase of the planning process will be updated to reflect findings and conclusions at the end of the Water Right Phase and periodically, thereafter, whenever sufficient new information is received.

As set forth above, it is important to note that water quality objectives and water right permit terms for the Delta exist today. They were recognized by the court in U.S. v. State Water Resources Control Board. Current permit conditions which seek to protect the Delta are in effect and enforceable pending completion of these full proceedings.

In regard to the Suisun Marsh, the water quality objectives for Suisun Marsh are unchanged from the 1978 Delta Plan. The implementation vehicle, Water Right Decision 1485 (D-1485), was amended in 1985 to change (or delete) some monitoring stations and to revise the schedule for implementation. The DWR, USBR, DFG, and Suisun Resource Conservation District (SRCD) have signed and adopted a set of three agreements concerning the Suisun Marsh. These are the Suisun Marsh Preservation Agreement (SMPA), the Monitoring Agreement, and the Mitigation Agreement.

1/ The flow requirements established in the 1978 Delta Plan are implemented in the Board's Decision 1485 and will be enforced by the Board pursuant to its water rights authority until new terms and conditions are adopted in the Water Rights Phase of these proceedings. At the end of the Water Right Phase, this document will also be updated. At that point the Board will have evaluated all of the requirements of the 1978 Delta Plan, and will have retained or modified those requirements, as appropriate. It will no longer be necessary for any provision of the 1978 Delta Plan to remain in effect, except where the Board has decided to adopt that provision, with appropriate modifications, in the Water Quality or Water Right Phase of these proceedings.

The SMPA contains water quality standards for the managed marshes of Suisun Marsh which the four signatories would like the State Board to adopt as water quality objectives. The SMPA also describes the physical facilities that the four signatories have agreed would serve the managed marshes in order to maintain production of preferred waterfowl food plants. The facilities built so far, including the Suisun Marsh Salinity Control Gates (previously called the Montezuma Slough Control Structure), have changed the physical regime in the Marsh.

Revised water quality objectives incorporating the SMPA (with any modifications necessitated by the biological assessment) will be adopted by the State Board after the biological assessment (discussed in Section 7.4.2.6) is completed. Until that time, the water quality standards in the amended D-1485 will continue to be implemented; see Table 1-2 for a summary of these standards.

1.3 Scope of the Plan

This Plan is the product of extensive hearings. In this Plan, we make a distinction between thermal loadings and salinity effects caused by man's traditional land use and waste water additions to the waters of the state and those influences directly related to and resulting from the allocation of water for use through water control and diversion. This distinction is premised upon the different way federal and state laws treat waste discharges and the allocation of water for beneficial use. Waste dischargers are governed by both state and federal law. The appropriate regional boards adopt basin plans designed to regulate thermal loadings and salinity effects, as well as other pollutant components, of waste discharges. These plans are submitted to the Environmental Protection Agency in accordance with the provisions of the Clean Water Act. The allocation of water recognizes both the intended and unintended results of water control and diversion such as those resulting in salinity variations within the Estuary.

This Plan primarily addresses temperature and salinity objectives (for a complete listing, see Table 1-1). Water rights proceedings and other actions will follow in order to implement these objectives and others which can best be addressed in the allocation process. Initially, the State Board will be reviewing operations of Sacramento and San Joaquin Valley reservoirs of 100,000 acre-feet and larger, and major direct diverters, to determine how responsibility will be allocated for meeting the Bay-Delta Estuary's water quality and quantity needs. The extent to which small projects will be included will be considered during the Scoping Phase. The need for determining the specific responsibilities of other water right holders will be analyzed as we proceed. When the process is completed, the combination of water quality planning and the amended water right permits will provide the statutorily mandated reasonable protection of the beneficial uses.

1.4 General Comments

* State Water Planning Programs and the Federal Act

This Plan fully complies with the State's water quality statutes and with applicable federal law. The State's water quality planning is consistent with the federal Water Pollution Control Act as amended by the Clean Water Act Amendments of 1987. California's water planning program is more broad-based than the federal act, and encompasses planning and implementation powers affecting: determinations of waste and unreasonable use, allocations of water use through water rights decisions, review and approval of changes in the manner, timing and location of water use, and sources of pollution.

* Fish Migration

In the course of these proceedings, evidence was introduced that significant impacts to the fishery are due to the location, method and timing of diversions of water from and upstream of the Delta and are not related to the quality of the water. The impacts to the fishery are due in part to such factors as:

- direct entrainment losses at the points of diversion from the Delta;
- diversion of fish through the Delta Cross Channel into the interior Delta;
- reverse flows in various reaches of the San Joaquin River, Old River, Middle River and other Delta channels, caused by the CVP, SWP, CCC and local agricultural diversion pumps; and
- the lack of flows in some water years to either hold the entrapment zone in the proper location to provide a nursery area for young striped bass or to move (flush) the young striped bass into Suisun Bay where habitat conditions should be better than in the Delta.

These flow-related issues will be addressed by the State Board in the Scoping and Water Right phases of these proceedings. The State Board retains the option of setting flow objectives, if appropriate. However, in an effort to expand the Board's, and others', understanding of the potential benefits to the fishery and the cost in terms of reductions of available offstream water supply, operational information will be needed addressing the above issues. The study needs are discussed in more detail in Chapter 7. Such studies will permit the Board to evaluate a full range of social and economic benefits and costs, and to identify management options that could be implemented to reasonably protect the fishery resources.

* Fish versus People

During the proceedings an issue was raised and described as "fish v. people". Some parties wanted the Board to assign value or weight to people's needs for the water versus fish needs if the circumstances so required. The State Board must ensure reasonable protection of beneficial uses. In this case, municipal and industrial uses and aquatic life are the two beneficial uses to be protected. The court in U.S. v SWRCB directed that the Board was to equitably distribute the dry year shortages as well as the wet year benefits. Such balancing and distribution is the essence of allocation and will be undertaken during the Water Rights Phase of these proceedings. In establishing the reasonable objectives and goals of this Plan, there is no need to choose one beneficial use over the other. All beneficial uses are being reviewed for the reasonable protection of each use, and then for the reasonable protection of all uses as they relate to each other.

* Location and Operation of the Pumps and Cross Channel Facilities

The location and operation of the diversion pumps and cross channel facilities within the Delta have direct impacts upon uses in and out of the Delta. Evidence was submitted which dealt with the hydraulic effects of the state and federal diversions and their impacts on fishery resources. The record contains evidence that one of the chief impacts upon fishery beneficial uses is the operation of the diversion pumps, cross channel facilities and other physical facilities within the Delta, during critical times of migration and spawning. The record also reflects the serious potential impacts inherent in the location of the pumps to the beneficial uses of drinking water. The existence of disinfection by-products, caused by the treatment of water containing organic materials that result from decomposition of peat soils, may present a risk to drinking water supplies both in and out of the Delta.

In addressing both the fishery and drinking water impacts, it is necessary to understand their profound implications to uses throughout the state. These are examples of where it is necessary to protect the same resource for two equally important beneficial uses. Any attempt to set numeric objectives or to single out any one permanent implementation condition without a full balancing of the impacts to all uses in and out of the Delta would result in numerous and widespread inequities within California's water supply system.

The Board has broad powers to address these impacts and will also do so in the Scoping and Water Right phases. In light of the impacts to the fishery and to drinking water supplies, a solution may be to relocate the existing points of diversion for the projects. Therefore, the parties should provide necessary information within the Scoping Phase to enable the State Board to weigh alternatives to the existing places of diversion.

* Role of Fish Hatcheries as a Mitigation Measure

There is evidence of economic, social and resource benefits and impacts from the use of fish hatcheries and growout facilities as resource management tools. Potential negative impacts include disease transmissions and genetic effects on fish. Further evaluation of the influences and impacts of those management tools is required within the scoping and subsequent implementation stages of this process.

* Flow Requirements for the Bay

Requests have been made for the Plan to contain requirements for more flows to protect the Bay (downstream of Carquinez Straits). To have meaning the concept of "more flows" must include such factors as water year types, time of year, tidal influences, the relationship of demand to water availability, etc. There must be a demonstrated connection between flow and the reasonable protection of beneficial uses. Although data were presented on this topic, the Board finds the information inconclusive. The Board will consider Bay flow requirements during the Scoping and Water Right phases of these proceedings and may decide to set flow objectives.

The State Board is supporting a program to produce information about the Bay-Delta system that would be relevant to management decisions (e.g., what appropriate water quality objectives should the State Board set to reasonably protect beneficial uses being made of waters within the Bay-Delta Estuary complex). The program should:

1. Identify the activities that have an effect on the Bay and Delta and that can be managed (i.e., differentiate between natural phenomena and man-induced activities having an impact on the Bay-Delta);

2. Identify responsibilities for developing studies to allow resources agencies to better manage the Bay-Delta system.

3. Develop a stable funding mechanism for the needed studies through fees on point dischargers, nonpoint dischargers and upstream water users.

4. Develop time schedules and oversight committees to ensure timely implementation and coordination.

Since planning and executing studies of the Estuary require DFG to work closely with the other member agencies of the IESP, more stable and consistent funding of all IESP programs is required to achieve maximum benefits from these studies and to achieve effective Estuary management.

* Pulsing/Seasonal Flows

There was testimony given that the Board should establish pulsing/seasonal flows in order to improve stratification within the south Bay. Because the physical and biological importance of stratification is largely unknown, further information is needed and should be developed to determine if and how stratification influences or impacts beneficial uses. Further, there appears to be a need to examine stratification, or the ability to influence stratification, through operation of control and diversion facilities. Therefore, the Board believes that pulsing/seasonal flows should be further analyzed by the Operations Workgroup, with a progress report to be provided during the Scoping and Water Right phases of these proceedings.

* Exclusion of Unimpaired Flows

In an examination of the record and review of existing objectives, the Board determined that unimpaired flows are not a feasible alternative to the existing operations. Therefore they are not an appropriate basis for examining, evaluating and balancing the protection of beneficial uses. The Board has considered the existing facilities, reviewed operational data, analyzed relevant management tools and deliberated upon all submitted economic information. There are sufficient data available to support a partial evaluation of existing conditions. Such an evaluation is necessary to establish objectives and to ultimately refine these objectives after completion of the next portions of these proceedings. Unimpaired flows continue to be used as a basis for estimating available water supply and for determining year types.

* Limitations Upon Existing Supplies

Water supplies to southern California have been restricted by court decree and physical circumstance. California's supply from the Colorado River is limited and except for unusual circumstances fixed. Water available to Los Angeles from the Owens Valley and the Mono Lake Basin has been reduced by judicial decree. Various ground water basins within areas using Delta water supplies are facing serious limitations due to pollution or salt water intrusion. The record reflects that substantial increases in population are expected within all areas making use of water from the Delta.

* Water Resources Management

While the general public perception of reasonable conservation efforts includes such measures as odd-even watering days, low flush toilets, flow restrictors, and reasonable use of water by agriculture, much more needs to be done to expand conservation among all water users. Any determination of the reasonable use of water must be prefaced upon a demonstration that reasonable conservation efforts are being undertaken. The showing is the obligation of all users and advocates for the uses. This obligation extends to public trust uses. Temporary changes in fishery harvest regulations should be considered as part of an overall short-term approach to improve the situation until longer-term measures may be instituted. The Board does not believe that such measures should substitute for its own responsibilities to provide suitable habitat. Other public trust management activities may conserve water while maintaining the value of the resource.

Another measure that may be required is the use of water meters throughout the state. Meters draw attention to the fact that conservation is so fundamental that it requires recognition of the individual's impacts upon water use and demand. Coupled with the need to heighten each individual's understanding of his or her impact upon water use and demand is the need to heighten understanding of the impacts of individual loadings of waste and pollution into our water systems. Source controls, waste minimization and pollution prevention are necessary conservation measures to be planned for and implemented by all those using the resource.

Along with heightened awareness of conservation must come an understanding and full acceptance of the potential for reclaimed water. While many understand the need to protect the environment through recycling of aluminum, glass and paper, too few appreciate the waste that occurs whenever water is used once and then treated and dumped into the ocean. A good illustration of reclamation occurs in the Santa Ana River Basin. The need to maximize the beneficial use of all water, particularly that which can be reasonably treated and reused, must become part of the demonstration that reasonable conservation efforts are being undertaken.

A process being called Urban Water Conservation Best Management Practices (BMP) is being developed by urban water suppliers, environmental organizations, and other public interest groups statewide. The BMP process represents a consensus among the above groups on the issue of urban water conservation for the Bay-Delta hearing. The State Water Resources Control Board encourages such consensus recommendations.

During the course of the proceedings a number of effective urban and agricultural conservation and reclamation measures were demonstrated. Yet, concerns, attitudes and apprehensions were expressed about the following aspects of conservation, including:

* Apprehension that water users who were already exercising effective conservation measures would be penalized if sufficient credit wasn't given for voluntary or existing effort. While the obligation to prove such pre-existing conservation measures remains the burden of those seeking credit for conservation measures, any entity capable of showing historic or existing practices would receive credit in the balancing equation. Additional measures will be required only if they are feasible and reasonable.

* Concern that agricultural users are not conserving as much as they could. Some contend that if agriculture would retire marginal land from production and alter the kinds of crops grown to less water intensive crops, there would be enough water for all present and foreseeable future needs. All parties agreed that there is more that all sectors of California could do to conserve. But, conservation alone will not be the answer to the State's supply needs. Further, conservation imposed upon one sector of users based solely upon the amount used by that sector is not a demonstration of the balancing and integration of California's complex water needs. The parties should include more complete data during the Scoping Phase with respect to the potential for conservation by agriculture. During subsequent phases of the proceedings, the State Board will give significant consideration to the Interagency Report of the San Joaquin Valley Drainage Program.

1.5 General Conclusions
(With references to chapter and section, where appropriate)

o The State Board has a major but not all-inclusive role in the allocation and protection of water resources. Its decisions are a dynamic part of the total management and protection program affecting water resources.

o Reasonable protection of beneficial uses means that the Board considers available evidence and strikes a balance between the benefit of a water quality objective and the achievability of that objective. A partial, nonprioritized listing of factors considered in the balancing of benefit and achievability includes:

  - Agreements and accords offered by participating parties for the protection and management of the Bay-Delta Estuary, and reviewed by the Board as to their reasonableness;
  - Intrinsic values of the beneficial use in addition to quantitative data;

- Legal requirements to protect rare, threatened and endangered species;
- Present and future water supplies and demands;
- Social and economic values (including impacts to housing and agriculture);
- Alternatives to achieve comparable protection; and
- Existing water quality and water allocation laws.

WATER YEAR TYPES (Chapter 3)

- The Bay-Delta Estuary is a dynamic system characterized by wide annual, seasonal, and daily fluctuations in fresh water inflows and ocean derived salinities.

- Defining water year types is an essential tool in evaluating the amount of water available.

- Water availability is an essential factor in establishing reasonable objectives for ocean derived salts.

- The Board adopts the "40-30-30 Water Year Index" for the Sacramento River Basin as proposed by the Operational Studies Workgroup. In subsequent phases of the proceedings, the Board wishes to examine critically the use of the "subnormal snowmelt" and "year following dry or critical year" provisions which allow alterations of objectives.

- Changes to water year types will include development and refinement of an appropriate index before it can be implemented for the San Joaquin River Basin.

CURRENT AND FUTURE WATER SUPPLY CONDITIONS

- On the average, precipitation supplies about 193 MAF per year in California with another 6 MAF coming from out-of-state sources. About 58 percent of this water is used by native vegetation and unirrigated lands; about 25 percent flows to the sea, to salt sinks, or to Nevada; about 14 percent is diverted for offstream uses; and about 3 percent goes to the natural recharge of ground water basins.

- The watershed of the Bay-Delta is a major source of supply critical in satisfying the water needs of the entire State.

- The Bay-Delta watershed is influenced by water diversion and control. On the average about 40 percent of the flow entering the Delta is unmanaged. However, in dry years less than five percent is unmanaged.

- As California's population grows to over thirty-six million people by 2010, the currently developed water supplies will be inadequate to meet the needs of a growing population, expanding economy, and the aquatic environment.

- There are about 9.2 million acres of irrigated agricultural land in California, of which approximately 7.3 million are in the Central Valley.

- Agricultural acreage is currently not expected to increase.

- Agricultural demands are partially being met by groundwater overdraft in the San Joaquin Valley.

- The Final Report of the Interagency San Joaquin Valley Drainage Program addresses various aspects of agricultural conservation. The State Board will consider this and any additional submitted information concerning these matters.

- Planning for municipal and industrial water needs must focus on the primary requirements of a reliable supply of high quality drinking water at an affordable cost.

- Reductions in reliable water supplies could have adverse impacts on the economy and the environment of the state.

- Conservation, reclamation and conjunctive use of local ground water basins are important components of reliable water supplies.

- California water supplies have been affected by recent court decisions. The state's dependable share of water from the Colorado River has been reduced to 4.4 MAF per year. Interim court decisions have reduced the City of Los Angeles' water supply from tributaries in the Mono Lake Basin by 50 to 65 TAF. Also, court decisions have limited export of ground water from the Owens Valley Basin to levels lower than originally anticipated by the City of Los Angeles.

- Water conservation by the Imperial Irrigation District consistent with State Board Order 88-20 could make water available for use in other parts of the state by 100 TAF in the early 1990s, with a goal of about 368 TAF.

- Ground water is a diminishing resource upon which the state relies. Factors limiting the availability of that resource include toxics, overdraft, salt water intrusion, land use practices and lack of recharge and coordinated administrative practices.

<u>WATER QUALITY OBJECTIVES</u>

- There are numerous influences on the Estuary's beneficial uses. Some are not fully defined, including the impacts of commercial and sport fishing (legal and illegal), the adverse effects of accidentally introduced species (e.g., the clam <u>Potamocorbula</u> <u>amurensis</u>), and the potential problems with genetic alteration in fish resulting from reliance on hatcheries. There are also known harmful effects from toxic materials, dredging, structures, and others, on the health of the aquatic habitats in the Bay-Delta Estuary. (See 5.0)

Salinity Requirements for Municipal and Industrial Water Use

- There is a need for water from the best available sources to meet the drinking water need of all Californians. There is a need to design and implement a comprehensive trihalomethane formation potential (THMFP) monitoring program, and to develop best management practices, or other appropriate means, to control discharges of THMFP.

- For all municipal and industrial intakes within the Bay-Delta Estuary, the Board adopts the 250 mg/l chloride (salinity) objective which is the secondary standard for aesthetics (taste) and corrosion established by the Department of Health Services. However, additional salinity protection may be needed in some areas to protect drinking water supplies from disinfection by-products (DBPs).(5.1)

- The D-1485 objective of 150 mg/l chloride at the Contra Costa Water District's Rock Slough intake protects the municipal and industrial beneficial uses in Contra Costa County and provides benefits to the municipal supplies exported from the Delta. If and when additional storage capacity is built or other information is developed, this objective and its monitoring location will be reviewed. Meanwhile, deleting the 150 mg/l chloride objective in D-1485 at the Rock Slough Intake could result in increased bromide concentrations and increased salinity and consumer complaints due to the salty taste in the water.(5.1)

- Delta water at times contains bromides (often measured via correlations with chlorides) and organic substances which, upon disinfection, increase the risk of forming by-products (including trihalomethanes (THMs)) that are human health concerns.(5.2)

- In the Delta THM precursors come from organic carbon in Delta peat soils and from the watershed upstream. Bromides which naturally occur in ocean water and connate water exacerbate the formation of THMs upon disinfection.(5.2)

- Existing drinking water standards are being met through a combination of source water controls and current drinking water treatment processes.(5.2)

- If drinking water standards on DBPs are revised, the State Board will consider modifying existing salinity objectives.(5.2)

- In the future the Board will review and weigh all factors that might result in more stringent salinity objectives for drinking water after disinfection. This includes alternative water disinfection methods.(5.2)

- Due to the concerns with DBPs in treated water from the Delta and in keeping with the goal (not objective) of obtaining the best available drinking water, the Board finds that, whenever feasible, municipal water supply agencies should strive to obtain bromide levels of 0.15 mg/l or less (about 50 mg/l chloride in the Delta). Appropriate actions by these supply agencies include encouraging DWR and USBR to work with the SWRCB to ensure development of facilities to make maximum use of uncontrolled flows through off-stream storage, encouraging those agencies to move water supply intakes to better locations, working with the State and Regional Boards to eliminate problem discharges within the Delta, and continuing the development of alternative water treatment technologies.(5.2)

Western and Interior Delta Agriculture (5.3)

- To reasonably protect crops grown in the western and interior Delta, water quality objectives were developed using corn as the representative salt-sensitive crop.

- Assuming improved leaching practices are used, salinities up to 1.5 mmhos/cm EC could be allowed during the irrigation season without affecting crop yield. However, the economic costs of these practices are not in the record.

- Until adequate economic data are available on leaching costs, the Board will maintain the existing salinity objectives.

Southern Delta Agriculture (5.3)

- To reasonably protect crops grown in the southern Delta, water quality objectives were developed using beans and alfalfa as representative salt-sensitive crops.

- The objective of 0.7 mmhos/cm EC in the southern Delta protects beans during the summer irrigation season and the objective of 1.0 mmhos/cm EC protects alfalfa during the winter irrigation season. These or other adequately protective objectives at specified locations will be implemented over time.

Exported Water for Agriculture (5.17)

- Water is exported from the Delta for agricultural use in the San Joaquin Valley and southern California.

- To reasonably protect crops grown in the export areas, water quality objectives were developed using almond orchards as the representative salt-sensitive crop.

- The Board finds that the objective of 1.0 mmhos/cm EC reasonably protects salt-sensitive crops grown in the San Joaquin Valley and southern California.

Estuarine Habitat (5.4)

Fisheries: (Beneficial uses - Warm, Cold, Migration, Spawning, Rare)

- The State Board supports the natural perpetuation of species affected by water and water quality. It is the policy of the State to significantly increase the natural production of salmon by the end of this century.

- Because of the amounts of data, past practices and public interest, striped bass and Central Valley Chinook salmon will be given separate consideration in the development of water quality objectives.

- Fish hatcheries for some species are a management tool that will be evaluated for their benefit and operation within the watershed during subsequent phases of the Bay-Delta proceedings.

- With respect to temperature and salinity, the objectives set in this Plan protect selected estuarine habitat beneficial uses. There is insufficient information in the record to set specific salinity and temperature objectives for the protection of Delta smelt, American shad, benthos, resident fish or marine habitat outside the Estuary.

Chinook Salmon in the Central Valley (5.5)

- The Estuary is a migratory corridor and rearing area for Chinook salmon.

- Hatchery production has kept the total number of fall-run salmon relatively stable.

- The diversity of the gene pool from naturally produced salmon is desirable.

- The Sacramento River winter-run of the Chinook salmon has been listed as an endangered species and will receive additional consideration in the final phases of these proceedings.

- The Board finds that salinity is not a factor affecting salmon as they migrate through the Estuary.

- Elevated temperature is one of the factors which can affect Chinook salmon during their migration through the Delta.

- Temperatures no greater than 68°F during the periods of April through June and September through November at Freeport on the Sacramento River and Vernalis on the San Joaquin River should be achieved by controllable factors, such as waste discharge controls, increases in riparian canopy, and bypass of warming areas (e.g., Thermalito Afterbay).

- Controllable water quality factors are those actions, conditions, or circumstances resulting from human activities that may influence the quality of the water of the State, that are subject to the authority of the State Board, or the Regional Board, and that may be reasonably controlled. Based on the record in these proceedings, controlling temperature in the Delta utilizing reservoir releases does not appear to be reasonable, due to the distance of the Delta downstream of reservoirs, and uncontrollable factors such as ambient air temperature, water temperatures in the reservoir releases, etc. For these reasons, the State Board considers reservoir releases to control water temperatures in the Delta a waste of water; therefore, the State Board will require a test of reasonableness before consideration of reservoir releases for such a purpose.

- No temperature requirements were submitted for winter-run Chinook salmon. To provide some protection for this endangered species, the more conservative temperature objective of 66°F (developed for the fall-run) is provided for the winter-run. This objective should be achieved by controllable factors, as noted above, during the period January through March at Freeport on the Sacramento River.

Striped Bass (5.6)

- Studies over many years indicate that there are numerous factors affecting striped bass abundance, including diversions from the Delta, reduced Delta outflow, flow patterns in the interior Delta, fewer adults, toxic effects, changes in the food chain due to introduced species, recreational angler harvest, and illegal poaching.

- Studies should be continued and additional water operation tests should be conducted to determine the effects on striped bass and the best means for their protection.

- In light of various impacts on the fishery, particularly of the export pumps, it is necessary to examine existing points of water diversion. Within the Scoping Phase, the Board will consider alternatives to the existing points of diversion.

Striped Bass - Spawning Habitat from Prisoners Point to Vernalis

- Review of the evidence indicates that it may be desirable to expand existing spawning habitat for striped bass in the Delta. However, the State Board concludes that the most significant factor in the decline of striped bass is entrainment[1] due to pumping. The State Board will consider actions to be taken concerning entrainment losses during the Scoping and Water Right phases of the proceedings. Upon examination of the results of these actions, the State Board will consider the issue of expansion of spawning habitat.

Striped Bass - Spawning Habitat from Antioch to Prisoners Point

- The major spawning areas for striped bass are the Sacramento River above the Delta and the San Joaquin River area between Antioch and Prisoners Point.

- The Board finds benefits for the resource in maintaining spawning habitat in this reach by establishing boundary salinities at Antioch of 1.5 and at Prisoners Point of 0.44 mmhos/cm EC from April 15 through May 31. The end date of May 31 may be shortened if data indicate that spawning has ceased.

- Deficiencies in firm supplies and the level of protection afforded by the striped bass spawning objective should be correlated.

- The Board needs better information than is currently available to consider the complete economic relationship between improvements in striped bass spawning habitat and water availability.

Marshes

- The Board believes that the managed portions of Suisun Marsh are currently being protected by D-1485 as amended in 1985. The protections, including the operation of the Suisun Marsh Salinity Control Gate, are being used and evaluated.(5.10)

- A biological assessment is needed to assess the water quality requirements of the rare, threatened and endangered plants and animals (and their habitats) in the wetlands surrounding Suisun Bay to determine reasonably necessary amendments and additions to the Suisun Marsh objectives. The results will likely not be available in time for inclusion in the final Bay-Delta Environmental Impact Report or water right decision in 1992. When the bioassessment is completed the water quality objectives will be evaluated and incorporated as warranted.(5.10)

- Water quality objectives for San Pablo Bay exist in the Statewide Water Quality Plan for Enclosed Bays and Estuaries of California and in the Water Quality Control Plan for Region 2.(5.11)

1/ Entrainment means primarily the effects of project operations, such as operation of the Delta Cross Channel gates, export pumping, and reverse and low river flows, plus local non-project diversions.

1.6 Summary of Implementation Requirements

Water Year Classification (see 7.5.3.1)

- The current Sacramento River Water Year Classification approximates annual conditions of water availability with five distinct categories. DWR has proposed the addition of a sliding scale to the classification to smooth the transitions between categories. There is a need for the parties to study this proposal, and submit the results for review during the Scoping Phase of the proceedings.

- Due to a previous lack of analytical tools, the San Joaquin River Basin classification needs refinement. The State Board requests the parties to develop a San Joaquin River Basin classification with similar methodology as used for the Sacramento River Basin and submit the results for review during the Scoping Phase of the proceedings. This system, together with the Sacramento River classification, will be used during the Scoping and Water Right Phases to determine how the responsibilities of meeting water quality objectives should be distributed.

Municipal and Industrial

- There is a need for water from the best available sources to meet the drinking water needs of all Californians. The parties should advise the State Board during the Scoping Phase on their plans and programs to obtain high quality drinking water through the year 2010.(7.2.2.1)

- An Interagency Program led by DWR has been formed to continue the work conducted by the Delta Health Effects Study and the Delta M&I Workgroup. The primary task of the new workgroup is to investigate conditions that adversely affect drinking water. The State Board requests this workgroup to design and implement a comprehensive THMFP monitoring program for the Delta by June 1991, and to present annual progress reports to the State Board commencing in January 1992.(7.4.2.1)

- Additional information is required to assess adequately the impact of Delta agricultural drains on THM formation. There is a need to conduct appropriate, comprehensive monitoring of agricultural discharges. The Central Valley Regional Board shall require the development and implementation of best management practices or other means to appropriately control these discharges. This task should begin in the Rock Slough area.(7.4.2.1)

Western and Interior Delta Agriculture (7.4.2.2)

- The Corn Study provides important information on the sensitivity of corn. A leaching study was recently begun to evaluate its effectiveness, practicality, and costs. This information is needed before a new objective can be set to protect the western and interior Delta agriculture. This study should be completed and the results submitted during the Water Right Phase of the proceedings.

Salt-Load Reduction (7.2.2.2)

- o Upon adoption of this Plan, the State Board will request the Central Valley Regional Board to develop an initial salt-load reduction program. The goal of this initial program will be to reduce annual salt-loads discharged to the San Joaquin River by at least 10 percent and to adjust the timing of salt discharges from low flow to high flow periods. During the Water Right Phase of these proceedings, the Regional Board should discuss how it intends to implement this program (for example, drainage operation plans and best management practices).

Modeling Needs (7.4.3.2)

- o The Board recognizes the need to develop its own water right modeling capability which will assist in the consideration of water transfers, new water rights, review of existing water rights and future alterations of Delta water quality and flow requirements.

- o The three-dimensional model currently being developed by USGS for evaluating hydraulic and biological processes in the various embayments of the San Francisco Bay should be finalized.

- o An Interagency Modeling Development and Use Committee should be formed to:

  - Facilitate exchange of modeling information and to reduce duplication,
  - Improve access of information by all interested parties
  - Simulate operation of major reservoirs in addition to the CVP and SWP,
  - Consider effects of antecedent conditions,
  - Improve temperature modeling for the Sacramento and San Joaquin River basins,
  - Improve Delta channel depletion estimates in DAYFLOW,
  - Improve both water quality and flow modeling for the San Joaquin River basin,
  - Update hydrology to reflect current land use and groundwater/surface water interactions.

Monitoring

- o There is a need to develop, with the State Board's assistance, a coordinated monitoring program plan to ensure compliance with the water quality objectives contained in this Plan, and to identify meaningful changes in any significant water quality parameters potentially related to implementation of this Plan. The programs specified in Chapter 7 of the Plan should be carried out.

Special Temperature Considerations

- o Analysis is needed of the effectiveness of various means to control factors which will help maintain cooler waters in the Sacramento and San Joaquin rivers and their tributaries for the protection of all runs of Chinook salmon.

- The parties maintaining the continuous temperature gauges at Freeport on the Sacramento River and at Vernalis on the San Joaquin River should develop data related to the 68°F temperature objective for protection of salmon. The State Board directs DWR to continue the dissolved oxygen monitoring in the lower San Joaquin River between Turner Cut and Stockton to protect salmon migration.

Special Salinity Monitoring (7.4.2.4)

- Continuous EC and temperature monitoring equipment should be installed at various locations in the San Joaquin River between Antioch and Vernalis to obtain data on salinity conditions for striped bass spawning.

- The temperature data collected are to be submitted to the State Board which will then make a determination whether controllable factors should be controlled.

Estuarine Habitat (7.4)

- Past studies of the estuarine habitat have been extensive. Relatively few investigators have been able to specifically quantify the lower level of conditions that protect the beneficial uses. The studies discussed below should lead to interim actions that can be implemented to protect these uses more effectively.

Salmon (7.4.2.3)

- Identify the critical factors influencing smolt survival, including evaluation and implementation of the studies indicated in Chapter 7 of this Plan.

Marshes around Suisun Bay (7.4.2.6)

- A comprehensive biological assessment is being prepared for the rare, threatened and endangered species (and their habitat) of the managed and unmanaged wetlands around Suisun Bay. Studies are needed to determine the relationship between channel water salinity and soil water salinity in the unmanaged tidal wetlands around Suisun Bay.

Scoping and Water Right Issues (7.5)

- Only a few parties are currently responsible for meeting water quality and flow requirements and for compliance monitoring activities within the Delta. The Board requests that information be developed on how these burdens should be distributed over more water right holders and waste dischargers. This information will be considered and used by the Board during the Scoping and Water Right phases of the proceedings.

- For the development of alternatives to existing points of diversion and for the coordination of preparedness planning by other agencies, information should be presented during the Scoping Phase on the impact of flood control measures, levee conditions, dredging, channel deepening, barriers and seismic activities.

Striped bass (7.5.2.4)

- The direct entrainment losses of striped bass and other fish at the major diversions in the Delta are well documented. The Bureau of Reclamation and the Contra Costa Water District should each negotiate a fishery agreement with the Department of Fish and Game that would provide for mitigation of the direct entrainment losses at the Tracy Pumping Plant and Contra Costa Pumping Plant No. 1. These agreements should be completed prior to the conclusion of the Water Right Phase. Direct entrainment losses at Delta agricultural diversions are not well documented. The parties should evaluate such losses and identify corrective measures.

- A real-time monitoring program should be developed and used to assess the daily densities of striped bass eggs and larvae in the Sacramento River during the spring and initiate periodic closure of the Delta Cross Channel to reduce diversion of striped bass into interior Delta channels. Closure of the Delta Cross Channel should be coordinated with short duration pulsed flows in the Sacramento River, in combination with short term reductions in export pumping and reduced reverse flows, to transport striped bass eggs and larvae into the Suisun Bay.

- There is the need to initiate a detailed investigation and evaluation of alternative sites for establishing facilities for rearing juvenile striped bass salvaged from the SWP and CVP facilities for subsequent release to the Bay-Delta system.

- A detailed review and evaluation of alternative recreational angler harvest management options including, but not limited to, specific area and seasonal closures, alternative size limits including initiation of a slot limit, and restrictions on fishing gear such as use of single barbless hooks should be conducted. In addition, the impacts of poaching on the striped bass population should be evaluated, funding sources for expanded enforcement should be sought, and the unrestricted sale of striped bass in California should be eliminated. Temporary changes in fishery harvest regulations should be considered as part of an overall short-term approach to improve the situation until longer-term measures may be instituted. The Board does not believe such measures should substitute for its own responsibilities to provide suitable habitat.

- Additional water project operation tests should be conducted in the Delta to better determine the effects of diverting water from and upstream of the Delta on striped bass.

Other Aquatic Species (7.5.3)

- Additional means should be developed to assess the general health of the Estuary and serve as a basis for determining the impacts of new projects, physical and operational changes, introduced species, etc. DFG should develop a priority list of tasks to be performed. Consideration should be given to specific components, such as American shad, Delta smelt, and the benthos. Also, use of biocriteria should be considered.

San Francisco Bay (7.5.3)

- There is a need to examine further the impacts of San Francisco Bay inflows on fish, invertebrates, and other public trust resources, particularly as these inflows, including pulse flows, affect the distribution, abundance, and reproductive success of species inside the Estuary. Studies are also needed to provide the linkage, if any, between phytoplankton and higher trophic levels.

Entrapment Zone (7.5.3.3)

- Studies are needed to provide the degree of linkage between the location and productivity of the entrapment zone and the effects on the population levels of important fish species.

The State Board retains the option of setting flow objectives if appropriate.

1.7 Water Quality Objectives

To protect beneficial uses of the Bay-Delta Estuary, the State Board adopts the salinity, temperature and dissolved oxygen objectives listed in Table 1-1.

TABLE 1-1 WATER QUALITY OBJECTIVES

A) MUNICIPAL AND INDUSTRIAL

LOCATION	SAMPLING SITE NOs. (I-A/RKI)	PARAMETER	DESCRIPTION	INDEX TYPE	YEAR TYPE	DATES	VALUES
Contra Costa Canal at Pumping Plant #1	*C-5* *CHCCC06*	*Chloride (Cl-)*	*Maximum mean daily, in mg/l*	*Not Applicable*	*All*	*Oct-Sep*	*250*
Contra Costa Canal at Pumping Plant #1 *- or -* *San Joaquin River at Antioch Water Works Intake*	*C-5* *CHCCC06* *D-12(near)* *RSAN007*	*Chloride (Cl-)* *Chloride (Cl-)*	*Maximum mean daily 150 mg/l chloride for at least the number of days shown during the Calendar Year. Must be provided in intervals of not less than two weeks duration. (% of Calendar Year shown in parenthesis)*	*Sac R* *40-30-30* *Sac R* *40-30-30*	 *W* *AN* *BN* *D* *C*		*No. of days each Cal. Year < 150 mg/l Cl-* *240 (66%)* *190 (52%)* *175 (48%)* *165 (45%)* *155 (42%)*
West Canal at mouth of Clifton Court Forebay	*C-9* *CHWST0*	*Chloride (Cl-)*	*Maximum mean daily, in mg/l*	*Not Applicable*	*All*	*Oct-Sep*	*250*
Delta Mendota Canal at Tracy Pumping Plant	*DMC-1* *CHDMC004*	*Chloride (Cl-)*	*Maximum mean daily, in mg/l*	*Not Applicable*	*All*	*Oct-Sep*	*250*
Cache Slough at City of Vallejo Intake [1] *and/or*	*C-19* *SLCCH16*	*Chloride (Cl-)*	*Maximum mean daily, in mg/l*	*Not Applicable*	*All*	*Oct-Sep*	*250*
Barker Slough at North Bay Aqueduct Intake	*-* *SLBAR3*	*Chloride (Cl-)*	*Maximum mean daily, in mg/l*	*Not Applicable*	*All*	*Oct-Sep*	*250*

TABLE 1 – 1 (cont.) WATER QUALITY OBJECTIVES

B) AGRICULTURAL

AREA

LOCATION	SAMPLING SITE NOs. (I-A/RKI)	PARAMETER	DESCRIPTION	INDEX TYPE	YEAR TYPE	DATES	VALUES
			1) WESTERN DELTA				
Sacramento River at Emmaton	*D-22 RSAC092*	*Electrical Conductivity (EC)*	*Maximum 14-day running average of mean daily, in mmhos/cm (mmhos)*	*Sac R 40-30-30*		*0.45 EC April 1 to Date Shown*	*EC from Date Shown to Aug. 15 [2]*
					W	*Aug. 15*	--
					AN	*July 1*	*0.63*
					BN	*June 20*	*1.14*
					D	*June 15*	*1.67*
					C	--	*2.78*
San Joaquin River at Jersey Point	*D-15 RSAN018*	*Electrical Conductivity (EC)*	*Maximum 14-day running average of mean daily, in mmhos*	*Sac R 40-30-30*		*0.45 EC April 1 to Date Shown*	*EC from Date Shown to Aug. 15 [2]*
					W	*Aug. 15*	--
					AN	*Aug. 15*	--
					BN	*June 20*	*0.74*
					D	*June 15*	*1.35*
					C	--	*2.20*

TABLE 1-1 (cont.) WATER QUALITY OBJECTIVES

B) AGRICULTURAL

AREA

LOCATION	SAMPLING SITE NOs. (I-A/RKI)	PARAMETER	DESCRIPTION	INDEX TYPE	YEAR TYPE	DATES	VALUES
2) INTERIOR DELTA							
South Fork Mokelumne River at Terminous	*C-13 RSMKL08*	*Electrical Conductivity (EC)*	*Maximum 14-day running average of mean daily, in mmhos*	*Sac R 40-30-30*		*0.45 EC April 1 to Date Shown*	*EC from Date Shown to Aug. 15 [2]*
					W	*Aug. 15*	--
					AN	*Aug. 15*	--
					BN	*Aug. 15*	--
					D	*Aug. 15*	--
					C	--	*0.54*
San Joaquin River at San Andreas Landing	*C-4 RSAN032*	*Electrical Conductivity (EC)*	*Maximum 14-day running average of mean daily, in mmhos*	*Sac R 40-30-30*		*0.45 EC April 1 to Date Shown*	*EC from Date Shown to Aug. 15 [2]*
					W	*Aug. 15*	--
					AN	*Aug. 15*	--
					BN	*Aug. 15*	--
					D	*Jun. 25*	*0.58*
					C	--	*0.87*

TABLE 1 - 1 (cont.) WATER QUALITY OBJECTIVES

B) AGRICULTURAL

AREA

LOCATION	SAMPLING SITE NOs. (I-A/RKI)	PARAMETER	DESCRIPTION	INDEX TYPE	YEAR TYPE	DATES	VALUES
(To be implemented by 1996) [3]		**3) SOUTH DELTA**					
San Joaquin River at Airport Way Bridge, Vernalis	*C-10 RSAN112*	*Electrical Conductivity (EC)*	*Maximum 30-day running average of mean daily EC, in mmhos*	*Not Applicable*	*All*	*Apr 1-Aug 31* *Sep 1-Mar 31*	*0.7* *1.0*
Old River near Middle River	*C-8 ROLD69*					*or*	
Old River at Tracy Road Bridge	*P-12 ROLD59*			*If a three-party contract has been implemented among DWR, USBR and the SDWA, that contract will be reviewed prior to implementation of the above and, after also considering the needs of other beneficial uses, revisions will be made to the objectives and compliance/monitoring locations noted above, as appropriate.*			
San Joaquin River at Brandt Bridge [site]	*C-6 RSAN073*						
		4) EXPORT					
West Canal at mouth of Clifton Court Forebay -and-	*C-9 CHWSTO*	*Electrical Conductivity (EC)*	*Maximum monthly average of mean daily EC, in mmhos*	*Not Applicable*	*All*	*Oct-Sep*	*1.0*
Delta Mendota Canal at Tracy Pumping Plant	*DMC-1 CHDMC004*						

TABLE 1-1 (cont.) WATER QUALITY OBJECTIVES

C) FISH AND WILDLIFE

HABITAT/SPECIES

LOCATION	SAMPLING SITE NOs. (I-A/RKI)	PARAMETER	DESCRIPTION	INDEX TYPE	YEAR TYPE	DATES	VALUES
			CHINOOK SALMON				
DISSOLVED OXYGEN							
San Joaquin River between Turner Cut & Stockton	*RSAN050-RSAN061*	*Dissolved Oxygen (DO)*	*Minimum dissolved oxygen, in mg/l*	*Not Applicable*	*All*	*Sep 1-Nov 30*	*6.0*
TEMPERATURE							
Sacramento River at Freeport and	*RSAC155*	*Temperature*	*Narrative Objective*	*Not Applicable*	*All*	*"The daily average water temperature shall not be elevated by controllable factors above 68 deg. F from the I Street Bridge to Freeport on the Sacramento River, and at Vernalis on the San Joaquin River between April 1 through June 30 and September 1 through November 30 in all water year types." [4]*	
San Joaquin River at Airport Way Bridge, Vernalis	*C-10 RSAN112*	*Temperature*	*Narrative Objective*	*Not Applicable*	*All*		
Sacramento River at Freeport	*RSAC155*	*Temperature*	*Narrative Objective*	*Not Applicable*	*All*	*"The daily average water temperature shall not be elevated by controllable factors above 66 deg. F from the I Street Bridge to Freeport on the Sacramento River between January 1 through March 31." [4]*	

TABLE 1-1 (cont.) WATER QUALITY OBJECTIVES

C) FISH AND WILDLIFE

HABITAT/SPECIES

LOCATION	SAMPLING SITE NOs. (I-A/RKI)	PARAMETER	DESCRIPTION	INDEX TYPE	YEAR TYPE	DATES	VALUES
			STRIPED BASS-SALINITY: 1. ANTIOCH-SPAWNING				
Sacramento River at Chipps Island	*D-10 RSAC075*	*Delta outflow Index (DOI)*	*Average for the period not less than the value shown, in cfs*	*Not Applicable*	*All*	*Apr 1-Apr 14*	*6,700*
San Joaquin River at Antioch Water Works Intake	*D-12 (near) RSAN007*	*Electrical Conductivity (EC)*	*14-day running average of mean daily for the period not more than value shown, in mmhos*	*Not Applicable*	*All*	*Apr 15-May 31 (or until spawning has ended)*	*1.5*
			STRIPED BASS-SALINITY: 2. ANTIOCH-SPAWNING-RELAXATION PROVISION				
San Joaquin River at Antioch Water Works Intake	*D-12 (near) RSAN007*	*Electrical Conductivity (EC)*	*14-day running average of mean daily not more than value shown corresponding to deficiencies in firm supplies declared by a set of water projects representative of the Sacramento River and San Joaquin River watersheds, for the period shown, or until spawning has ended. The specific representative projects and amounts of deficiencies will be defined in subsequent phases of the proceedings.*	*Total Annual Imposed Deficiency (MAF)*		*Apr 1-May 31 EC in mmhos*	
						Dry	*Critical*
				0.0		*1.5*	*1.5*
This relaxation provision replaces the above Antioch & Chipps Island standard whenever the projects impose deficiencies in firm supplies.				*0.5*		*1.8*	*1.9*
				1.0		*1.8*	*2.5*
				1.5		*1.8*	*3.4*
				2.0 or more		*1.8*	*3.7*
				Linear interpolation is to be used to determine values between those shown.			
			STRIPED BASS-SALINITY: 3. PRISONERS POINT-SPAWNING				
San Joaquin River at: Prisoners Point	*D-29 RSAN038*	*Electrical Conductivity (EC)*	*14-day running average of mean daily for the period not more than value shown, in mmhos*	*Not Applicable*	*All*	*Apr 1-May 31 (or until spawning has ended)*	*0.44*

TABLE 1-1 (cont.) WATER QUALITY OBJECTIVES

C) FISH AND WILDLIFE

HABITAT/SPECIES

LOCATION	SAMPLING SITE NOs. (I-A/RKI)	PARAMETER	DESCRIPTION	INDEX TYPE	YEAR TYPE	DATES	VALUES
STRIPED BASS - SALINITY: 4. PRISONERS POINT - SPAWNING - RELAXATION PROVISION							
		When the relaxation provision for Antioch spawning protection is in effect:					
San Joaquin River at: Prisoners Point	*D-29 RSAN038*	*Electrical Conductivity (EC)*	*14-day running average of mean daily for the period not more than the value shown, in mmhos*	*Not Applicable*	*D&C*	*Apr 1-May 31 (or until spawning has ended)*	*0.55*

SUISUN MARSH

In regard to the Suisun Marsh, the water quality objectives for Suisun Marsh are unchanged from the 1978 Delta Plan. The implementation vehicle, Water Right Decision 1485 (D-1485), was amended in 1985 to change (or delete) some monitoring stations and to revise the schedule for implementation. The DWR, USBR, DFG, and Suisun Resource Conservation District (SRCD) have signed and adopted a set of three agreements concerning the Suisun Marsh. These are the Suisun Marsh Preservation Agreement (SMPA), the Monitoring Agreement, and the Mitigation Agreement. The SMPA contains water quality standards for the managed marshes of Suisun Marsh which the four signatories would like the State Board to adopt as water quality objectives. The SMPA also describes the physical facilities that the four signatories have agreed would serve the managed marshes in order to maintain production of preferred waterfowl food plants. The facilities built so far, including the Suisun Marsh Salinity Control Gates (previously called the Montezuma Slough Control Structure), have changed the physical regime in the Marsh.

Revised water quality objectives incorporating the SMPA (with any modifications necessitated by the biological assessment) will be adopted by the State Board after the biological assessment (discussed in Section 7.4.2.6 of the plan) is completed. Until that time, the water quality standards in the amended D-1485 will continue to be implemented; see Table 1-2 for a summary of these standards.

FOOTNOTES:

[1] The Cache Slough objective to be effective only when water is being diverted from this location.

[2] When no date is shown, EC limit continues from April 1.

[3] South Delta Agriculture objectives will be implemented in stages: two interim stages and one final stage. The first interim stage will be implemented with the adoption of the WQCP, the second interim stage by 1994, and the final stage by 1996. Interim Stage 1 — 500 mg/l mean monthly TDS all year at Vernalis. Interim Stage 2 — (to be implemented no later than 1994) 0.7 mmhos/cm EC April 1 to August 31, 1.0 mmhos/cm EC September 1 to March 31, 30-day running average, at Vernalis and Brandt Bridge; with water quality monitored at three current interior stations — Mossdale, Old River, near Middle River and Tracy Road Bridge, and an additional interior monitoring station on Middle River at Howard Road Bridge. Final Stage — (to be implemented no later than 1996) 0.7 mmhos/cm EC April 1 to August 31, 1.0 mmhos/cm EC September 1 to March 31, 30-day running average, at Vernalis and Brandt Bridge on the San Joaquin River; with two interior stations at Old River Near Middle River and Old River at Tracy Road Bridge. Monitoring stations will be at Mossdale at head of Old river and Middle River at Howard Road Bridge.

OR

If a three-party contract has been implemented among DWR, USBR and the SDWA, that contract will be reviewed prior to implementation of the above and, after also considering the needs of other beneficial uses, revisions will be made to the objectives and compliance/montioring locations noted above, as appropriate.

[4] Controllable water quality factors are those actions, conditions, or circumstances resulting from human activities that may influence the quality of the waters of the State, that are subject to the authority of the State Board, or the Regional Board, and that may be reasonably controlled. Based on the record in these proceedings, controlling temperature in the Delta utilizing reservoir releases does not appear to be reasonable, due to the distance of the Delta downstream of reservoirs and uncontrollable factors such as ambient air temperature, water temperatures in the reservoir releases, etc. For these reasons, the State Board considers reservoir releases to control water temperatures in the Delta a waste of water; therefore, the State Board will require a test of reasonableness before consideration of reservoir releases for such a purpose.

TABLE 1-2 IMPLEMENTATION REQUIREMENTS FOR SUISUN MARSH

LOCATION	SAMPLING SITE NOs. (I-A/RKI)	PARAMETER	DESCRIPTION	EFFECTIVE DATES	MONTHS	VALUES
Sacramento River at	C-2	Eletrical	Monthly average of both daily	Oct 1,1988	Oct	19.0
Collinsville	RSAC081	Conductivity (EC)	high tide values not to exceed		Nov	15.5
			the values shown, in mmhos/cm		Dec	15.5
Montezuma Slough at	S-64(new)		(or demonstrate that equivalent		Jan	12.5
National Steel	SLMZU25		or better protection will be		Feb	8.0
			provided at the location)		Mar	8.0
Montezuma Slough near	S-49				Apr	11.0
Beldon Landing	SLMZU11				May	11.0
Chadbourne Slough at	S-21(prop.)					
Chadbourne Road (proposed)	SLCBN1					
and				Oct 1,1991		
Cordelia Slough 500 ft west	S-33					
of S.P.R.R. crossing at Cygnus	SLCRD04					
-or-				or		
Chadbourne Slough at	S-21(prop.)					
Chadbourne Road (proposed)	SLCBN1					
and				Oct 1,1993		
Cordelia Slough at Cordelia	S-97(prop.)					
Goodyear Ditch (proposed)	SLCRD06					
Goodyear Slough at	S-35(new)			Oct 1,1991		
Morrow Island Clubhouse	SLGYR03					
-or-				or		
Goodyear Slough, 1.3 mi	S-75					
south of Morrow Island	SLGYR04			Oct 1,1994		
[Drainage] Ditch at Pierce						
Suisun Slough, 300 ft	S-42			Oct 1,1997		
south of Volanti Slough	SLSUS12					
Water Supply Intakes	No Locations					
for Waterfowl Manage-	specified					
ement Areas on Van						
Sickle and Chipps islands						

2.0 SCOPE OF THE PLAN

2.1 Introduction

The initial evidentiary hearing of the Bay-Delta proceedings, Phase I, has been completed. Succeeding phases have been renamed to clarify the purposes each is to serve. They are:

- o The Water Quality Phase
- o The Scoping Phase
- o The Water Right Phase

The Water Quality Phase will continue the review, revision and adoption of the Plan. A separate Pollutant Policy Document (PPD) for the Bay-Delta Estuary adopted by the State Board (June, 1990) addresses the effects of certain pollutants on beneficial uses in the Bay-Delta Estuary; it contains policy guidance to be used by the San Francisco Bay Region (2) and the Central Valley Region (5) when they update their Basin Plans. Other pollutants of concern are addressed in the Statewide Water Quality Control Plans for Inland Surface Waters and for Enclosed Bays and Estuaries. The Scoping Phase has already begun on issues related to water quality in the Estuary; it will include scoping hearings on such matters as the public trust, physical facilities, negotiated agreements and potential, administrative and legislative actions. A draft Environmental Impact Report (EIR) will be developed and circulated as a result of the Scoping Phase. Various alternatives developed in the Scoping Phase will be explored in the draft EIR. The Water Right Phase will include a water right hearing with adoption of a final EIR and water right decision(s). In these water right decisions the Board will decide which water users will help meet water quality objectives and flow requirements in the Estuary.

During the course of the water quality proceedings the Board received evidence on:

- o The beneficial uses being made of water flowing into, within, and from the Bay-Delta Estuary;
- o The levels of protection which should be afforded these beneficial uses;
- o Reasonable consumptive uses made of Bay-Delta waters;
- o The effects of pollutants on beneficial uses of Bay-Delta Estuary waters; and
- o Implementation measures available to achieve the levels of protection necessary to protect the beneficial uses.

2.2 Scope and Purpose of the Plan

o Scope

This Plan is a narrowly focused Basin Plan for the waters of the Bay-Delta Estuary. It is to be considered together with other water quality control plans applicable to the waters of the Bay-Delta Estuary, such as the 1978 Delta Plan, the Pollutant Policy Document for the Bay-Delta Estuary, and the Statewide Water Quality Control Plans for Inland Surface Waters and for Enclosed Bays and Estuaries in California, as well as all applicable San Francisco Bay (Region 2) and Central Valley (Region 5) Regional Basin Plans. This Plan supersedes any existing salinity and temperature objectives to the extent of any conflict.

o Review and Revision

The water quality objectives established in the Plan, together with other currently effective controls, will protect established beneficial uses in compliance with all applicable state laws.

This Plan is a substitute for a separate environmental document (Public Resources Code Section 21080.5). It therefore includes a discussion of alternatives in order to comply with CEQA's mandate to consider all reasonable alternatives to the preferred project.

This Plan is not meant to supersede any designation of beneficial uses, objectives (except where conflict exists), or other matter set forth in either the Basin 2 Plan or the Basin 5B Plan. Any questions of whether this Plan supersedes any provisions in either Regions' Plans, or in any other water quality control plan adopted by the State Board for the waters of the Bay-Delta Estuary, should be addressed to the State Board for an interpretation.

The Plan will undergo public review either on a triennial basis or sooner if needed.

o Flow Considerations

Although flow requirements are not set as objectives in this Plan, the State Board recognizes that flow requirements and salinity objectives are largely met by the regulation of water flow. The reasonableness of a salinity objective can be evaluated by using operation studies to estimate the impacts of these objectives on water supplies. Effects on these supplies may be used to evaluate the economic and social costs.

o Established Objectives

The State Board has established the following categories of objectives:

- Salinity for municipal and industrial uses,
- Salinity for Delta agriculture,
- Salinity for export agriculture,
- Salinity for fisheries in the Delta,
- Temperature and dissolved oxygen for fisheries in the Delta, and
- Salinity for Suisun Marsh habitat.

2.3 Authority for Regulation of Water in the Bay-Delta Estuary

The State Board is responsible for formulating and adopting state policy for water quality control (WC Section 13140). The authorities for regulation of water in the Bay-Delta Estuary are found in Appendix 2.0, State Board Authority.

3.0 BASIN AND HYDROLOGY DESCRIPTION

Conclusions: WATER YEAR TYPES

- **The Bay-Delta Estuary is a dynamic system characterized by wide annual, seasonal, and daily fluctuations in fresh water inflows and ocean derived salinities.**

- **Defining water year types is an essential tool in evaluating the amount of water available.**

- **Water availability is an essential factor in establishing reasonable objectives for ocean derived salts.**

- **The Board adopts the "40-30-30 Water Year Index" for the Sacramento River Basin as proposed by the Operational Studies Workgroup. In subsequent phases of the proceedings, the Board wishes to examine critically the use of the "subnormal snowmelt" and "year following dry or critical year" provisions which allow alterations of objectives.**

- **Changes to water year types will include development and refinement of an appropriate index before it can be implemented for the San Joaquin River Basin.**

3.1 Introduction

The Bay-Delta Estuary and tributary areas described in this Plan include:

- The Delta (Figure 3-1);
- The Delta's tributary areas, that is, the Sacramento River, the Central Sierra, the San Joaquin River basins[1/] (Figure 3-2); and
- The San Francisco Bay and its tributary hydrologic basin (Figure 3-3).

The Estuary and tributary areas provide about two-thirds of all the water used in California, including 40 percent of the state's drinking water.

This chapter and Appendix 3.0, Basin Description, outline the hydrologic conditions of the Estuary and its tributary areas by providing a description of each area's:

Physical Characteristics -- the geographical and legal dimensions; and

Hydrology -- the characteristics and nature of water movement, which can include:

- Unimpaired Flow Conditions -- the flow that would be available assuming no upstream impoundments, use, or diversions of runoff under current upstream and Delta channel configurations (SWRCB,3,8).

1/ The Tulare Lake Basin (Central Valley Regional Water Quality Control Board Basin 5D), although part of the Central Valley, is not considered to be tributary to the Delta for the purposes of this Plan.

FIGURE 3-1 Boundary of the Bay-Delta Estuary and locations of Estuary exports
(From: SWRCB, 3, 5)

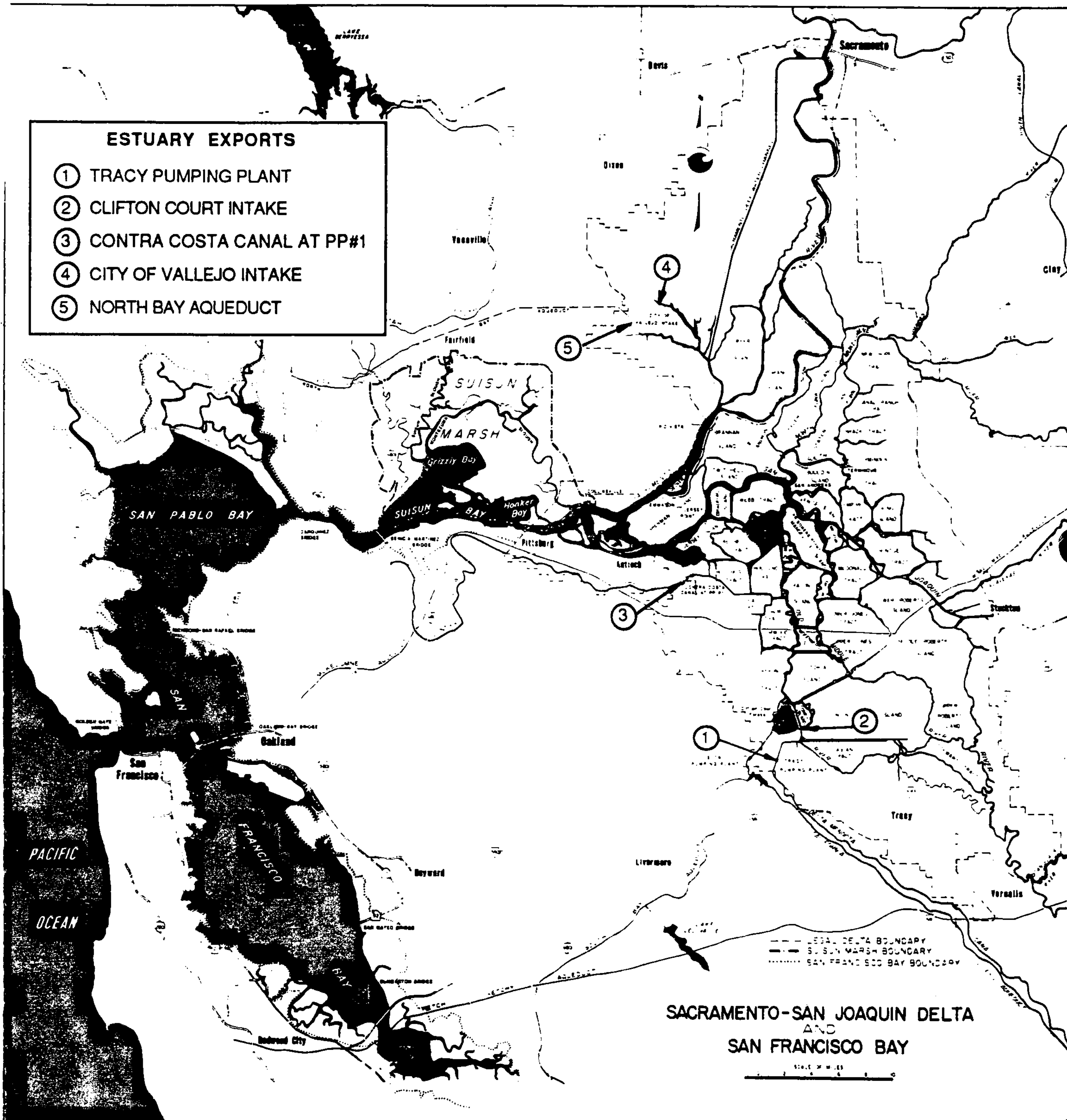


FIGURE 3-2 Boundaries of the Sacramento River (5A), Central Sierra and Delta (5B), and San Joaquin (5C) Basins (From: RWQCB 5, 1975)

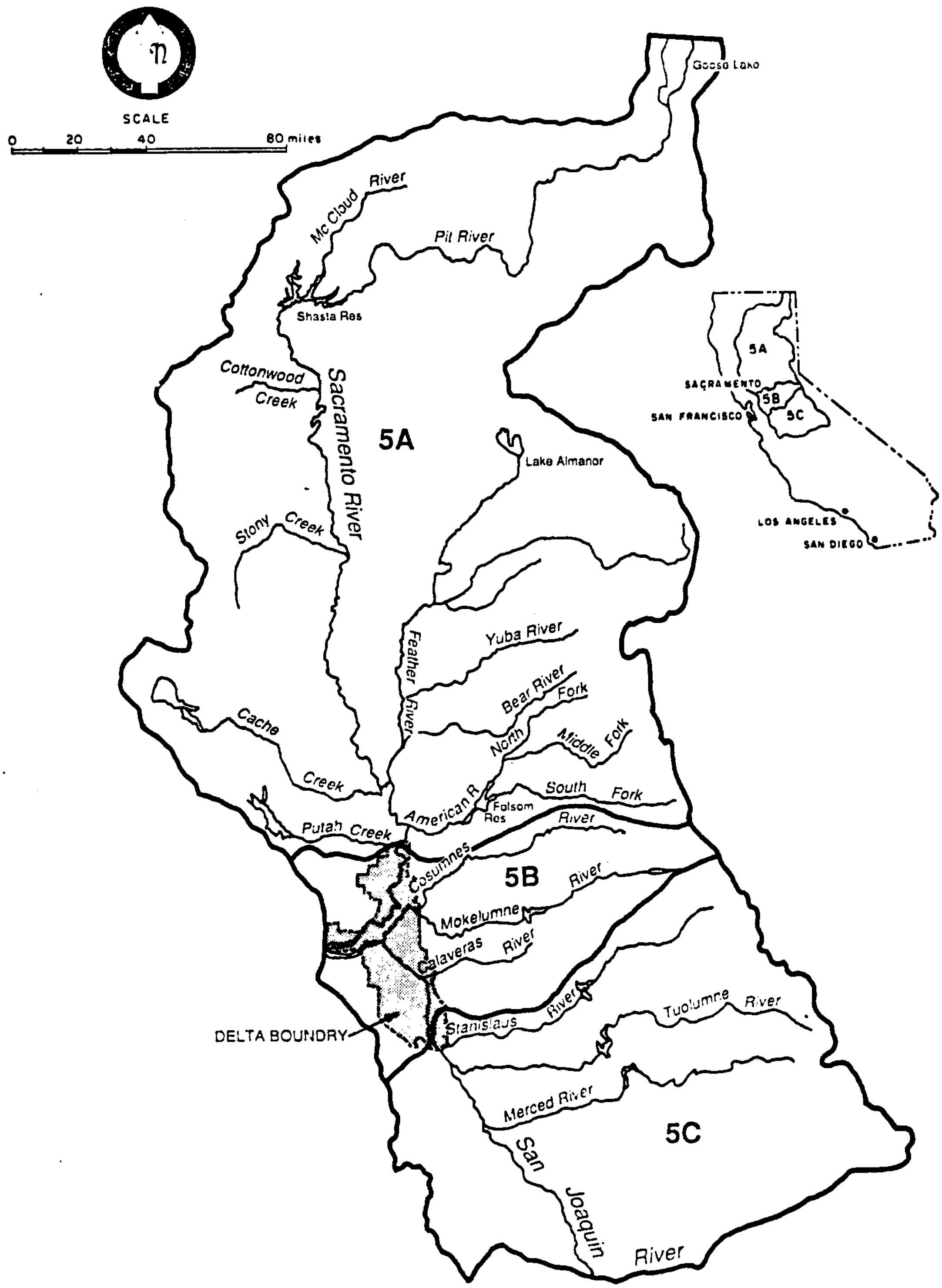
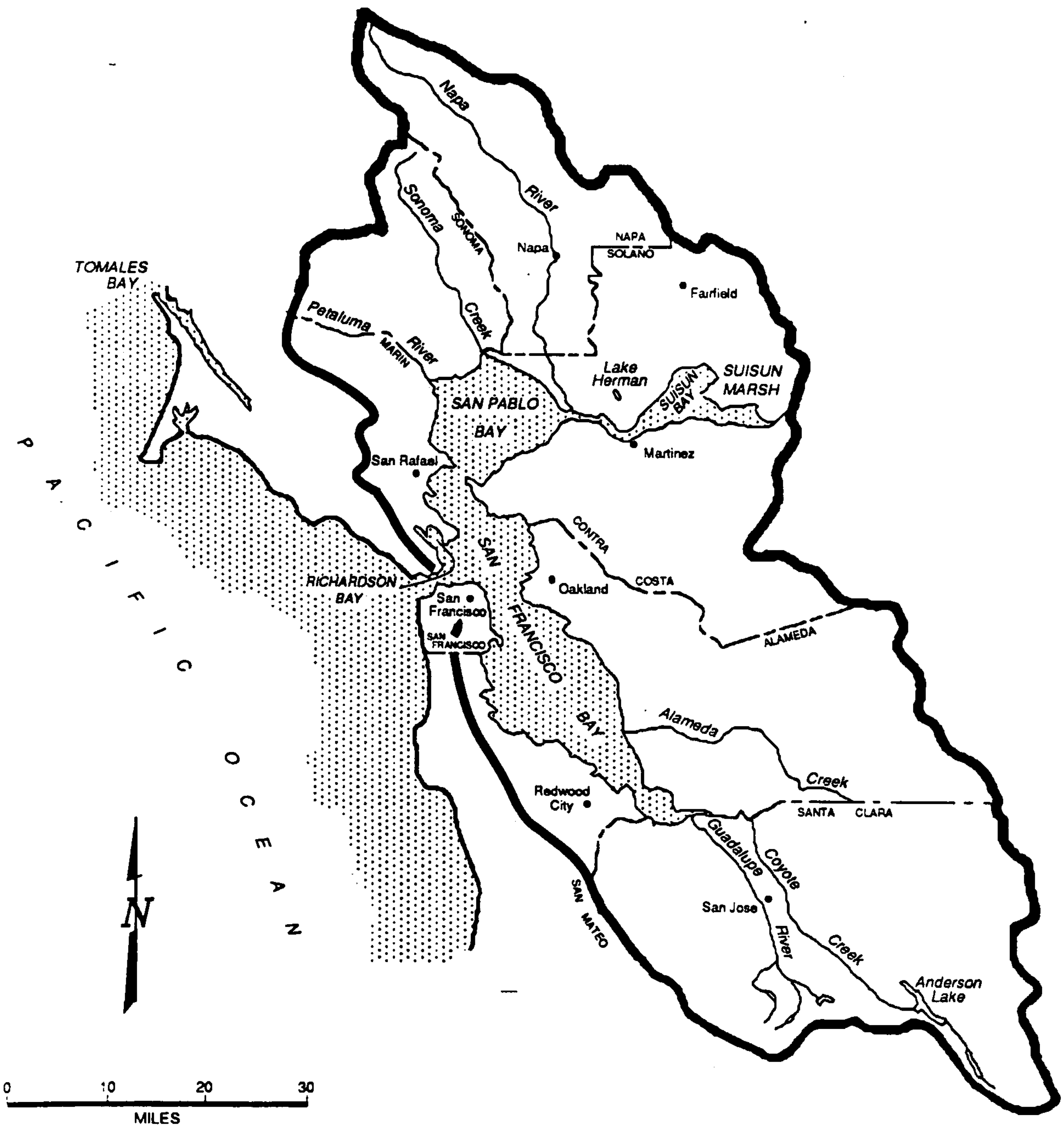


FIGURE 3-3 Boundary of the San Francisco Bay Basin
(From: SWRCB, 3, 12)



MAP0022

Unimpaired flow could also be defined as the present-day conditions if all storage and diversion were to cease. It is not a measure of natural or historic conditions (T,II,114:2-15).

- o Historic Flow Conditions -- the flow conditions that actually occurred over the historic hydrological period and were measured at various locations in the Central Valley Basin using flow measuring devices. These flows reflect upstream impoundments, use or diversions of runoff under the existing upstream storage, and channel configuration at the time of measurement.

- o Present Level Flow Conditions--the historic flow conditions that have been adjusted to reflect the present level-of-development reservoir operations, consumptive demands and Delta Plan standards or, where appropriate, the recent historic flow conditions from 1972 to the present. Present level-of-development flows are those estimated by DWR's 1990 level-of-development operations study. The Operations Study, which is conducted using DWR's Planning Simulation Model (DWRSIM), uses the hydrologic sequence of flows for the years 1922 through 1978. The 1972 to present historical flows represent the conditions under recent levels of water resource development. Compared with the pre-1972 development, the water resources development within the Bay-Delta watershed has been relatively minor since 1972. New Melones Reservoir, which became operational in 1978, and increasing Delta exports over these years are notable exceptions (SWRCB,3,8).

3.2 Water Year Types

3.2.1 Classifying Water Years for a Basin

Water Year (WY) classification systems provide relative estimates of the amount of water originating in a basin from rainfall and snowmelt runoff, and ground water accretion which is available to meet all demands.

This Plan improves the WY classification system used in the 1978 Delta Plan. The new classification system includes consideration of water availability from storage facilities as well as seasonal runoff.

Modified Water Year Classification System

This new WY classification uses the forecasted unimpaired runoff in millions of acre-feet (MAF) from two separate periods of the current water year (April through July and October through March) and a third parameter which accounts for the effects of reservoir storage, in order to determine the runoff classification for any particular year. This new method was used to develop the modified Sacramento Four River Index (Figure 3-4). Refer to Appendix 3.1 for an expanded description of the components of the new classification.

FIGURE 3-4
Sacramento Valley
Water Year Hydrologic Classification

Year classification shall be determined by computation of the following equation:

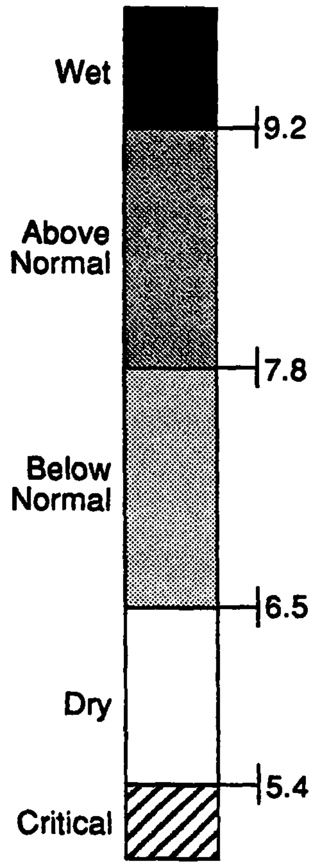
$$\text{INDEX} = 0.4 * X + 0.3 * Y + 0.3 * Z$$

Where:
- X = Current years April – July Sacramento Valley unimpaired runoff
- Y = Current October – March Sacramento Valley unimpaired runoff
- Z = Previous years index [1]

The Sacramento Valley unimpaired runoff for the current water year (October 1 of the preceding calendar year through September 30 of the current calendar year) as published in California Department of Water Resources Bulletin 120 is a forecast of the sum of the following locations: Sacramento River above Bend Bridge, near Red Bluff; Feather River, total inflow to Oroville Reservoir; Yuba River at Smartville; American River, total inflow to Folsom Reservoir. Preliminary determinations of year classification shall be made in February, March, and April with final determination in May. These preliminary determinations shall be based on hydrologic conditions to date plus forecasts of future runoff assuming normal precipitation for the remainder of the water year.

Classification	Index Millions of Acre-Feet
Wet	Equal to or greater than 9.2
Above Normal	Greater than 7.8 and less than 9.2
Below Normal	Equal to or less than 7.8 and greater than 6.5
Dry	Equal to or less than 6.5 and greater than 5.4
Critical	Equal to or less than 5.4

YEAR TYPE [2]
All Years for All Objectives



Index
Millions of Acre-Feet

[1] A cap of 10.0 MAF is put on the previous years index (Z) to account for required flood control reservoir releases during wet years.

[2] The year type for the preceding water year will remain in effect until the initial forecast of unimpaired runoff for the current water year is available.

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3.2.1.1 Sacramento Basin Index Description

The modified classification splits the index into three terms. The form of the index equation is as follows:

$$\text{Index} = C1*X + C2*Y + C3*Z$$

Where:

C1, C2, and C3 are weighting coefficients of 0.4, 0.3 and 0.3, respectively.

And:

X = April through July Four River Unimpaired Flow (MAF)
Y = October through March Four River Unimpaired Flow (MAF)
Z = Previous year's WY index (MAF) having a maximum cap value of 10 MAF.

Division of the index into three terms recognizes that there are distinct differences in seasonal contribution to water availability and accounts for reservoir carryover storage. The April-through-July period's runoff (factor X) is the most important contribution to water availability. The runoff contribution during October through March (factor Y) is less important due to flood control limitations on available reservoir storage space. The previous year's index (factor Z) is important because it accounts for carryover reservoir storage. A maximum value or cap of 10 MAF expressed in the third term sets a maximum level of the previous year's hydrology that can be maintained as carryover storage due to the limitations of total reservoir capacity and the requirement to maintain a flood control reservation space.

Water Year Classification Breakpoints

The method used to determine the index breakpoints that define the boundaries of the five water year types in the Delta Plan was also used to determine the breakpoints for this modified approach. This method is discussed in Appendix 3.1.

Regression Results

Table 3-1 lists some of the regression results of these statistical analyses. These results indicate that breaking the index into two separate hydrologic periods and adding the effect of the previous year's hydrology enhances the index's predictability.

TABLE 3-1
SELECTED RESULTS OF THE STATISTICAL ANALYSIS TO DETERMINE OPTIMAL WEIGHTING COEFFICIENTS

Classification[1/]	Weighting Coefficients(%)	R Squared Value
Proposed Modified	40 -- 30 -- 30 w/cap.	.85[2/]
Selected Alternatives	40 -- 20 -- 40	.88
	40 -- 30 -- 30	.87
Delta Plan w/new BP[3/]	33 -- 67 -- 00	.74
April through July	100 -- 00 -- 00	.66

3.2.1.2 San Joaquin Basin Index

Because of the differences in hydrology between the Sacramento and San Joaquin basins, a separate San Joaquin River Basin classification is needed.

The tools that were used in developing the Sacramento Basin Index were not available to develop an index for the San Joaquin Basin. These tools, a San Joaquin River Basin Operations Model and data base, recently became available. Development of the San Joaquin Basin Classification will soon begin. An example of a possible San Joaquin River Basin Classification using Sacramento River Basin coefficients is shown in Figure 3-5.

3.2.1.3 Eastside Basin

A separate classification for the Eastside Basin was not developed. The contribution to the Delta from the eastside rivers, the Cosumnes, Mokelumne and the Calaveras, is small compared to the Sacramento and San Joaquin Basins. Based on information that indicates the hydrologies of the Eastside Basin and the Sacramento Basin are similar (DWR,1,1-2;1978 D-1485 Hearing exhibit), the Sacramento Basin WY classification was also applied to the Eastside Basin.

3.2.1.4 Adjustments to Water Year Classification

In the 1978 Plan classification, two adjustments were created to account for unusual hydrologic conditions: a second classification for a year which follows a critical year, and a sub-normal snowmelt adjustment.

The "year following critical year" classification was developed to account for the effects that depleted reservoir and ground water storage have on the ability of project operations to meet their demands. Because the effects of previous year's conditions are included in the third term of the 40-30-30 Index, the "year following critical year" adjustment is not necessary. The "year following critical year" adjustment applies only to fish and wildlife standards.

1/ All classifications except proposed modified have no cap on third term.

2/ The R squared value for the Proposed Modified and Selected Alternatives classifications are very similar, with the values for the latter being slightly higher. It was the consensus of the subworkgroup that the 40-30-30 W/CAP Index was the preferable index.

3/ Breakpoint (BP), or threshold values are revised to reflect 1906 -- 1987 hydrology.

FIGURE 3-5
San Joaquin Valley
Water Year Hydrologic Classification [1]

Year classification shall be determined by computation of the following equation:

$$\text{INDEX} = 0.4 * X + 0.3 * Y + 0.3 * Z$$

Where: X = Current years April – July San Joaquin Valley unimpaired runoff

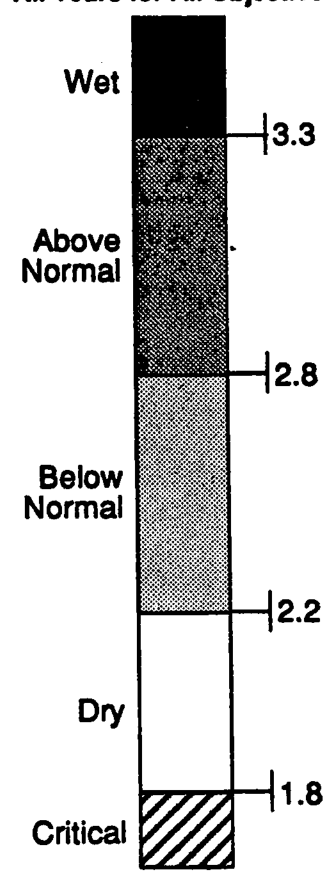
Y = Current October – March San Joaquin Valley unimpaired runoff

Z = Previous years index [2]

The San Joaquin Valley unimpaired runoff for the current water year (October 1 of the preceding calendar year through September 30 of the current calendar year) as published in California Department of Water Resources Bulletin 120 is a forecast of the sum of the following locations: Stanislaus River, total flow to New Melones Reservoir; Tuolumne River, total inflow to Don Pedro Reservoir; Merced River, total flow to Exchequer Reservoir; San Joaquin River, total inflow to Millerton Lake. Preliminary determinations of year classification shall be made in February, March, and April with final determination in May. These preliminary determinations shall be based on hydrologic conditions to date plus forecasts of future runoff assuming normal precipitation for the remainder of the water year.

Classification	Index Millions of Acre-Feet
Wet	Equal to or greater than 3.3
Above Normal	Greater than 2.8 and less than 3.3
Below Normal	Equal to or less than 2.8 and greater than 2.2
Dry	Equal to or less than 2.2 and greater than 1.8
Critical	Equal to or less than 1.8

YEAR TYPE [3]
All Years for All Objectives



Index
Millions of Acre-Feet

[1] This is example of the San Joaquin River Basin classification using Sacramento River Basin coefficients. When the San Joaquin Basin operations model is finished the San Joaquin River Basin classification will be developed using the same analytical techniques used for the Sacramento River Basin.

[2] A cap of 4.0 MAF is put on the previous years index (Z) to account for required flood control reservoir releases during wet years.

[3] The year type for the preceding water year will remain in effect until the initial forecast of unimpaired runoff for the current water year is available.

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The subnormal snowmelt adjustment was developed to account for years having spring runoff from snowmelt much less than expected. In the current objectives, the adjustment only applies to fish and wildlife flow standards. The 40-30-30 Index accounts for subnormal snowmelt from a water supply aspect but not from a level of protection aspect (when linked to the current flow standards in D-1485). The application of the 40-30-30 Index to determine the effects of various alternatives is discussed in Chapter 6, Section 6.2.1B.

3.2.1.5 Differences in Classification

The differences between the current and modified WY classifications for the Sacramento Basin are shown in Table 3-2. Two differences make these classifications not strictly comparable. First, the periods of the databases that were used to develop these classifications are not the same --1922-71 was used for the current classification used in the 1978 Delta Plan, and 1906-88 was used for the modified classification. This difference causes a shift in the threshold values. Second, where the current classification modifies the year type for subnormal snowmelt years and years following critical years, the modified classification does not. Together, these differences between the two classifications seem to show that the modified classification shifts the average classification to a drier condition. If, however, the conditions discussed above are accounted for in this comparison, the averages of these two classification systems are very similar. For the Sacramento River Basin (Table 3-2), as an example, about 35 percent of the years are classified by both systems as wet; about 33 percent as above normal, below normal (or below normal with subnormal snowmelt); and about 31 percent as dry or critical.

TABLE 3-2
SACRAMENTO RIVER BASIN:

COMPARISON OF PROPOSED MODIFIED 40-30-30 AND DELTA WATER YEAR CLASSIFICATION

WATER YEAR	DELTA PLAN CLASSIFICATION	INDEX 40-30-30	WATER YEAR	DELTA PLAN CLASSIFICATION	INDEX 40-30-30
1906	W	W	1948	AN	BN *
1907	W	W	1949	D	D
1908	BN/SS	BN *	1950	BN	BN
1909	W	W	1951	W/SS	AN *
1910	W	W	1952	W	W
1911	W	W	1953	W	W
1912	D	BN *	1954	AN	AN
1913	BN	D *	1955	D	D
1914	W	W	1956	W	W
1915	W	W	1957	BN	AN *
1916	W	W	1958	W	W
1917	AN	AN	1959	D	BN *
1918	D	D	1960	BN/SS	D *
1919	BN	BN	1961	D	D
1920	C	C	1962	BN	BN
1921	W	AN *	1963	W	W
1922	AN	AN	1964	D	D
1923	BN	BN	1965	W	W
1924	C	C	1966	BN/SS	BN *
1925	AN	D *	1967	W	W
1926	D	D	1968	BN/SS	BN *
1927	W	W	1969	W	W
1928	AN/SS	AN *	1970	W/SS	W *
1929	C	C	1971	W	W
1930	BN/D	D *	1972	BN/SS	BN *
1931	C	C	1973	W	AN *
1932	BN/D	D *	1974	W	W
1933	C	C	1975	AN	W *
1934	C	C	1976	C	C
1935	AN	BN *	1977	C	C
1936	AN	BN *	1978	W	AN *
1937	BN	BN	1979	D	BN *
1938	W	W	1980	W	AN *
1939	C	D *	1981	D	D
1940	W/AN	AN *	1982	W	W
1941	W	W	1983	W	W
1942	W	W	1984	W/SS	W *
1943	W	W	1985	D	D
1944	D	D	1986	W/SS	W *
1945	BN	BN	1987	C	D *
1946	AN	BN *	1988	C	C
1947	D	D	1989		

* Indicates year type has changed from Delta Plan year type

4.0 BENEFICIAL USES OF BAY-DELTA ESTUARY WATER

4.1 Introduction

The beneficial uses of Bay-Delta water are presented here in summary form. For a detailed account, see Appendix 4.0, Beneficial Uses of Bay-Delta Estuary Water.

4.2 Beneficial Uses

Agricultural Supply (AGR)	Includes crop, orchard and pasture irrigation, stock watering, support of vegetation for range grazing and all uses in support of farming and ranching operations. [SWRCB, Standard Beneficial Uses, Management Memorandum No. 20, March 1973]
Cold Fresh-Water Habitat (COLD)	Provides a coldwater habitat to sustain aquatic resources associated with a coldwater environment. [SWRCB, Standard Beneficial Uses, Management Memorandum No. 20, March 1973]
Estuarine Habitat (EST)	Provides an essential and unique habitat that serves to acclimate anadromous fishes (salmon, striped bass) migrating into fresh or marine conditions. This habitat also provides for the propagation and sustenance of a variety of fish and shellfish, numerous waterfowl and shore birds, and marine mammals. [RWQCB2, Water Quality Control Plan, San Francisco Bay Basin (2), December 1986]
Fish Migration (MIGR)	Provides a migration route and temporary aquatic environment for anadromous or other fish species. [SWRCB, Standard Beneficial Uses, Management Memorandum No. 20, March 1973]
Fish Spawning (SPWN)	Provides a high quality aquatic habitat especially suitable for fish spawning. [SWRCB, Standard Beneficial Uses, Management Memorandum No. 20, March 1973]
Groundwater Recharge (GWR)	Natural or artificial recharge for future extraction for beneficial uses and to maintain salt balance or halt saltwater intrusion into freshwater aquifers. [SWRCB, Standard Beneficial Uses, Management Memorandum No. 20, March 1973]

Industrial Process Supply (PROC)	Includes process water supply and all uses related to the manufacturing of products. [SWRCB, Standard Beneficial Uses, Management Memorandum No. 20, March 1973]
Industrial Service Supply (IND)	Includes uses which do not depend primarily on water quality such as mining, cooling water supply, hydraulic conveyance, gravel washing, fire protection and oil well repressurization. [SWRCB, Standard Beneficial Uses, Management Memorandum No. 20, March 1973]
Municipal and Domestic Supply (MUN)	Includes usual uses in community or military water systems and domestic uses from individual water supply systems. [SWRCB, Standard Beneficial Uses, Management Memorandum No. 20, March 1973]
Navigation (NAV)	Includes commercial and naval shipping. [SWRCB, Standard Beneficial Uses, Management Memorandum No. 20, March 1973]
Non-Contact Water Recreation (REC-2)[1]	Recreational uses which involve the presence of water but do not require contact with water, such as picnicking, sunbathing, hiking, beachcombing, camping, pleasure boating, tidepool and marine life study, hunting and esthetic enjoyment in conjunction with the above activities as well as sightseeing. [SWRCB, Standard Beneficial Uses, Management Memorandum No. 20, March 1973]
Ocean Commercial and Sport Fishing (COMM)	The commercial collection of various types of fish and shellfish, including those taken for bait purposes, and sport fishing in ocean, bays, estuaries and similar non-freshwater areas. [SWRCB, Standard Beneficial Uses, Management Memorandum No. 20, March 1973]

1/ DHS has recently (10/24/90) suggested different language and three separate parts, Rec. 1, 2 and 3.

Preservation of Rare and Endangered Species (RARE)	Provides an aquatic habitat necessary, at least in part, for the survival of certain species established as being rare and endangered species. [SWRCB, Standard Beneficial Uses, Management Memorandum No. 20, March 1973]
Shellfish Harvesting (SHELL)	The collection of shellfish such as clams, oysters, abalone, shrimp, crab and lobster for either commercial or sport purposes. [SWRCB, Standard Beneficial Uses, Management Memorandum No. 20, March 1973]
Warm Fresh-Water Habitat (WARM)	Provides a warm-water habitat to sustain aquatic resources associated with a warmwater environment. [SWRCB, Standard Beneficial Uses, Management Memorandum No. 20, March 1973]
Water Contact Recreation (REC-1)	Includes all recreational uses involving actual body contact with water, such as swimming, wading, waterskiing, skin diving, surfing, sport fishing, uses in therapeutic spas, and other uses where ingestion of water is reasonably possible. [SWRCB, Standard Beneficial Uses, Management Memorandum No. 20, March 1973]
Wildlife Habitat (WILD)	Provides a water supply and vegetative habitat for the maintenance of wildlife. [SWRCB, Standard Beneficial Uses, Management Memorandum No. 20, March 1973]

5.0 ALTERNATIVE LEVELS OF PROTECTION FOR BENEFICIAL USES OF BAY-DELTA ESTUARY WATER

Conclusions: WATER QUALITY OBJECTIVES

- **There are numerous influences on the Estuary's beneficial uses. Some are not fully defined, including the impacts of commercial and sport fishing (legal and illegal), the adverse effects of accidentally introduced species (e.g., the clam <u>Potamocorbula amurensis</u>), and the possible problems with genetic alteration in fish resulting from reliance on hatcheries. There are also known harmful effects from toxic materials, dredging, structures, and others, on the health of the aquatic habitats in the Bay-Delta Estuary.**

5.0.1 Overview

Chapter 4 and Appendix 4.0 identified the beneficial uses of Bay-Delta waters. In this chapter, the evidence supporting these uses is analyzed. Where the data are determined to be both appropriate and adequate to develop water quality objectives and the issue is within the scope of this Plan, potential objectives are established.

The water quality objectives in the Delta Plan were adopted in 1978. Water Rights Decision 1485 (D-1485) was adopted at the same time as the primary way to implement the Delta Plan. While water quality objectives for the southern Delta were included in the Delta Plan, they were not part of D-1485 and therefore have not been implemented. Water quality objectives in Suisun Marsh were set but consideration of alternative objectives proposed in the Suisun Marsh Preservation Agreement (SMPA) is pending (see 5.10). All of these matters are time consuming since they require substantial funds from the state and federal government, construction of physical facilities, and subsequent testing of these facilities to ensure that the desired objectives can be achieved.

Water quality objectives for parts of San Francisco Bay other than the Suisun Marsh were not adopted in the Delta Plan. Development of objectives for the south Delta will commence upon receipt of a negotiated agreement between the South Delta Water Agency (SDWA), USBR, and DWR.

The "estuarine habitat" beneficial use designation, for the purposes of this Plan, is broken down into various components, such as specific fisheries and fish protective habitat, to develop protection for those components addressed during the Phase I hearing. Further, there are several designated beneficial uses addressed in the Basin Plans of Regions 2 and 5 for which the State Board received evidence. However, that evidence did not indicate that salinity, temperature or dissolved oxygen would affect the beneficial uses of either contact or non-contact recreation or navigation. Therefore, even though discussed in this Plan, salinity, temperature and dissolved oxygen objectives are not proposed for these beneficial uses.

Specific water quality objectives have been developed for designated beneficial uses. In the case of estuarine habitat, the State Board has identified certain areas and life stages for the protection of specific fish species. These objectives, the State Board believes, will provide protection for other species until more appropriate measures are developed. The following uses are designated as beneficial uses to be specially protected by objectives in this Plan: (See Chapter 4 for more details)

USE	AREA
Municipal and Industrial (ind, proc, mun, gwr)	San Francisco Bay-Delta, Export Area
Agriculture (agr)	Delta, Export Area
Estuarine Habitat (est, migr, spwn, cold, warm, comm)	
Chinook Salmon (fall and winter run)	Delta
Striped Bass	Delta
Marsh Resource	Suisun Marsh

5.0.2 Hydrologic Considerations

Salinity at any particular location in the Delta is dependent upon Delta inflows, agricultural drainage return flows, consumptive uses, exports, tidal stage and the operation of the Delta Cross-Channel gates. The southern Delta is almost exclusively influenced by the San Joaquin River. The internal Delta, on the other hand, is influenced to some degree by both river systems, especially when Delta exports are high. For the purpose of considering river effects on the beneficial uses discussed in this chapter, all of the Estuary locations were considered to be part of the hydrologic classification of the Sacramento River system, except for the following which were considered to receive water from the San Joaquin River system: San Joaquin River at Vernalis, at Mossdale, at Rough and Ready Island, at Buckley Cove, and at the former location of Brandt Bridge; the bifurcation of Old and Middle River; Middle River at Howard Road Bridge; and Old River at Tracy Road Bridge.

5.0.3 Alternative Levels of Protection for Beneficial Uses

The following sections describe alternative levels of each protection for beneficial use in categories:

1. Present Conditions -- The current water quality conditions. These are usually reflected in the requirements set forth in D-1485 as amended or in a few cases more protective requirements contained in agreements between Delta interests and certain water projects. In many cases quality is better than objectives because of uncontrolled flow.

2. State Board Considerations -- State Board analysis of existing objectives, advocated levels of protection, any additional data obtained from agencies with appropriate expertise (e.g., DFG), peer reviewed literature, etc.

3. Potential Objectives -- Appropriate Alternatives proposed for each beneficial use. These potential objectives are further analyzed for economic and environmental effects in Chapter 6.

Levels of Protection advocated by the various parties are contained in Appendix 5.0, under the heading Advocated Levels of Protection. A matrix of the present, advocated and proposed potential objectives concludes the chapter (Table 5-5, Alternative Water Quality Objectives).

5.1 Municipal and Industrial

Conclusions: Salinity Requirements

- **For all municipal and industrial intakes within the Bay-Delta Estuary, the Board adopts the 250 mg/l chloride (salinity) objective which is the secondary standard for aesthetics (taste) and corrosion established by the Department of Health Services. However, additional salinity protection may be needed in some areas to protect drinking water supplies from disinfection by-products (DBPs).**

- **The D-1485 objective of 150 mg/l chloride at the Contra Costa Water District's Rock Slough intake protects the municipal and industrial beneficial uses in Contra Costa County and provides benefits to the municipal supplies exported from the Delta. If and when substantial additional storage capacity is built or other information is developed, this objective and its monitoring location will be reviewed. Meanwhile, deleting the 150 mg/l chloride objective in D-1485 could result in increased bromide concentrations and increased salinity and consumer complaints due to the salty taste in water.**

5.1.1 Present Conditions - (Salinity and Sodium)

Municipal and Industrial (M&I) use is currently protected by standards specified in the 1978 Delta Plan or D-1485 (in this Plan referred to as D-1485 or current objectives) (see Table 5-5). The 250 mg/l (maximum) chlorides level of protection considered adequate to protect municipal uses is based on the secondary standard for aesthetics (taste) and corrosion set by the Department of Health Services (DHS) and adopted by the Board in 1978 as being in the public interest.

The present objective of 150 mg/l chlorides was established at the Contra Costa Canal Intake during a portion of the year, depending on water year type, in order to protect industrial uses. This standard was intended to protect the historical water supply of two paper manufacturers in the Antioch area by providing a salinity necessary to maintain the quality of industry products. In adopting this standard the State Board recognized that it also provided better water quality to municipal customers.

5.1.2 State Board Considerations

Chlorides

The D-1485 objectives, with the inclusion of a MUN objective at Barker Slough and a conditional MUN objective at Cache Slough, sufficiently protect M&I uses (see Table 5-5).

MUN use is protected with respect to salinity, and taste and odor by the 250 mg/l chloride drinking water standard.

Industrial use is protected by the D-1485 150 mg/l periodic chloride objective at Rock Slough and Antioch. Industries requiring water quality of 150 mg/l chloride or less are negotiating with DWR to obtain alternative sources of high quality water; negotiations have been successful, although one industry is still negotiating with DWR. The negotiations to eliminate this objective have not been concluded; this is one reason that this objective will be maintained.

The 50 mg/l objective recommended for blending purposes for MUN use is addressed in the following section on trihalomethanes.

Because the North Bay Aqueduct diversion point is at Barker Slough and the old diversion point at Cache Slough will be used on occasion as an alternative point of diversion, objectives will be needed at both of these diversion points.

Sodium

Another issue related to salinity involves the consumption of sodium. Diets high in sodium, especially for people with a history of cardiovascular problems, can contribute to such problems. Some participants in the hearing suggested a sodium objective be adopted to protect against such concerns. Others were concerned that water containing high levels of sodium may reduce the efficiency of dialysis machines. The information presented to the State Board shows that sodium contained in drinking water represents a very small portion of normal daily sodium intake. People on restricted sodium diets should consult their physician and dietitian to revise their diet based on their local water supply or in rare cases consider bottled water low in sodium.

These sodium issues were all debated before adoption of D-1485. No new information was presented compelling a specific sodium objective. Concerns involving sodium levels can be resolved by achieving the 250 mg/l chloride objective in Delta waters or special action by health professionals.

5.1.3 Potential Objectives

No change (see Table 5-5).

5.2 Trihalomethanes (THMs) and other Disinfection By-Products (DBPs)

Conclusions:

- **Delta water at times contains bromides (often measured via correlations with chlorides) and organic substances which, upon disinfection, increase the risk of forming by-products (including trihalomethanes (THMs)) that are human health concerns.**

- **In the Delta THM precursors come from organic carbon in Delta peat soils and from the watershed upstream. Bromides which naturally occur in ocean water and connate water exacerbate the formation of THMs upon disinfection.**

- **Existing drinking water standards are being met through a combination of source water controls and current drinking water treatment processes.**

- **If drinking water standards on DBPs are revised, the State Board will consider modifying existing salinity objectives.**

- **In the future the Board will review and weigh all factors that might result in more stringent salinity objectives for drinking water after disinfection. This includes alternative water disinfection methods.**

- **Due to the concerns with DBPs in treated water from the Delta and in keeping with the goal (not objective) of obtaining the best available drinking water, the Board finds that, whenever feasible, municipal water supply agencies should strive to obtain bromide levels of 0.15 mg/l or less (about 50 mg/l chloride in the Delta). Appropriate actions by these supply agencies include encouraging DWR and USBR to work with the SWRCB to ensure development of facilities to make maximum use of uncontrolled flows through off-stream storage, encouraging those agencies to move water supply intakes to better locations, working with the State and Regional Boards to eliminate problem discharges within the Delta, and continuing the development of alternative water treatment technologies.**

5.2.1 Present Conditions

Trihalomethanes (THMs) are a subset of chemicals known as disinfection by-products (DBPs) which are formed when waters are disinfected. THMs are produced when dissolved organic substances, such as fulvic and humic acids produced by decaying crop residues or peat soil in fresh or saline waters, come in contact with the oxidizing agents used to disinfect drinking water (T,VI,38:3-5; T,XLVI,99:11-19). The levels of dissolved organic materials in water are most often assumed to be represented by the total organic carbon (TOC) concentration of the water. However, since TOC is a measure of all organic carbon, not just precursor molecules, it has not been found to be a consistent predictor of THM formation potential (THMFP) in Delta waters. Bromides contribute to the production of THMs and other DBPs. Bromides enter the Delta predominantly from ocean water. Minor sources of bromides are the Sacramento, and San Joaquin rivers, and connate water.

Drinking water supplies with THMs may pose a significant problem because health effects studies have indicated that chloroform and bromoform are animal carcinogens and are suspected human carcinogens (T,VI,38:12-16;DWR,226,2). For regulatory purposes, EPA assumes that all THMs are equally toxic to humans (T,VI,46:5-7) and in 1979 adopted a water quality standard for total THMs of 100 ug/l (EPA National Primary Drinking Water Regulations, 40 CFR 141). This standard is monitored in distribution systems of domestic water supplies. Sampling is performed at three month intervals and compliance is based upon a running average of four samples (T,XLVI,118:1-5). The EPA THM maximum contaminant level (MCL) applies to treated drinking water, rather than to sources of water, such as the Delta. D-1485 did not include any water quality objective for THMs. It was concluded that for public health reasons protection from THMs in water from the Delta is more properly addressed through the use of alternative water treatment techniques or relocation of problem intakes rather than through the setting of more stringent salinity or TOC objectives (Second Triennial Review of the Delta Plan, October 1984).

Data presented by the Metropolitan Water District of Southern California (MWD) show that chlorinated Delta water with postammoniation occasionally has produced finished drinking water with THM concentrations close to the present EPA water quality MCL (Krasner, 1989). In addition, it has been shown that when a water supply, such as the Delta, contains a significant concentration of bromide, THMs and DBPs can also be formed using disinfectants other than chlorine (e.g., ozone) (Delta Municipal and Industrial Water Quality Workgroup, 1989, p.4.; T,VI,44:8-45:1).

Data presented to the Delta Municipal and Industrial Water Quality Workgroup (Delta M&I Workgroup) by several researchers demonstrate that the presence of bromide exacerbates the problem of DBP formation in general, as well as the problem of THM formation. As bromide concentrations in Delta water increase, brominated forms of DBPs and THMs increase and at times dominate the total THM concentration (Krasner, 1989).

By analyzing THMFP data which were generated using a consistent set of collection and analytical techniques, it is possible to draw general conclusions regarding the sources of THMs in drinking water supplies taken from the Delta. Sources of THMFPs in Delta water appear to be ocean tidal waters, Delta organic soils and decaying crop residues, and Sacramento and San Joaquin river inflows to the Delta. One set of calculations concludes that "within-Delta" sources appear to contribute approximately 25 percent of the THMFPs in Delta water (SWC, Brief on Phase 1, February 1, 1988; p. V-7). DWR is currently conducting a study to determine the THMFP contribution to Delta water quality coming from local agricultural drainage returns (T,XLVI,83:14-84:12). To date, studies show that the mineral soils in the Delta contribute less THM precursors than the organic soils (T,XLVI,84:13-22).

If EPA's MCL for THM is lowered, it is likely that conventionally treated (chlorinated) Delta water with current inputs of total organic carbon and bromide will not be usable as a direct source of drinking water. At present, because of the correlation between chloride and bromide, when chloride concentrations exceed 100 mg/l and standard chlorination treatment is used, THM concentrations approach, but do not exceed, the current EPA THM MCL of 100 ug/l (Delta M&I Workgroup, Appendix A.10, 1989).

5.2.2 State Board Considerations

Information compiled by members of the Delta M&I Workgroup suggest that alternative water treatment techniques may not resolve all the concerns related to THMs. Reasons for this include:

1. The presence of bromide ions in the Delta (the majority of which come from seawater) and the inability of conventional and non-conventional treatment processes to remove either the bromide ion or the brominated forms of THMs;

2. The formation of other disinfection by-products (DBPs) which are suspected human health hazards by conventional and non-conventional water treatment processes;

3. The statement by EPA that it will be proposing maximum contaminant levels (MCLs) for disinfectants currently used to treat drinking water (e.g., chlorine and chloramines). New MCLs are also expected for DBPs. These MCLs are likely to include the DBPs formed by chlorination (e.g., trihalomethanes) as well as other oxidant DBPs.

A discussion of the three reasons mentioned above is found in Appendix 5.1, Trihalomethanes. The discussion is limited to information provided by the Delta M&I Workgroup, from the hearing record of Phase I, and to other information cited concerning formation of DBPs resulting from ozonation/chlorination treatment of drinking water.

Based on a detailed review of the information presented the State Board has concluded the following:

1. THMs, DBPs and some disinfectants (e.g., chlorine, chloramine and chlorine dioxide) currently in use present possible hazards to human health. Brominated THMs and chloroform are suspected human carcinogens.

2. EPA may be revising the total THM MCL in the near future. The revised standard may be more stringent. Under the current timetable, compliance is expected in 1994.

3. EPA is expected to set MCLs for other disinfection by-products and for disinfectants. Ranges of MCLs are unknown at this time. Under the current timetable, compliance is expected in 1994.

4. Every disinfectant currently being used produces some kind of disinfectant by-products. New treatment technologies contain technical and economic uncertainties which compound those associated with the health effects and potential regulation of disinfectant by-products.

5. The presence of bromide ions in the source water exacerbates the THM and DBP concerns. Bromide ions in the source water significantly increase levels of brominated DBPs produced by chlorination, chloramination and ozone.

6. A major source of bromide ions in Delta waters is sea water and a relationship has been documented to exist between chloride levels and bromide levels in seawater. However, the relationship between chloride and bromide levels in the Delta needs further study.

7. In addition to bromide, TOC is an important factor in the production of THMs and DBPs. Sources of TOC include seawater and estuarine water, the Sacramento River, the San Joaquin River and the Delta.

8. While the existing MCL for THMs is usually met with the current chloride objective in the Delta, concern exists that a new MCL for THMs is expected from EPA which may not be achieved without great cost to municipal users who divert from the Delta.

Solutions for the THM concern and newly recognized DBP concern do not lie solely with alternative water treatment techniques or relocation of existing intakes. Before costly and unproven steps are taken, there is urgent need for monitoring and research. Also, basic decisions by EPA are needed before objectives can be set to help address the DBP concerns which include THMs. Finally, the State Board realizes that while THMs are the DBP of current concern, further studies may indicate that other DBPs are of greater concern.

5.2.3 Potential Objectives

1. The current 150 mg/l chloride industrial objective which provides ancillary protection to municipal uses.

2. None. A water quality objective for THMFP is not appropriate at this time. The non-standardized nature of the analytical technique and the lack of a THMFP to THM correlation work together to render such a water quality objective scientifically unsound. A THM workgroup should be formed to address this, and other THM related issues (see Chapter 7.

3. A 0.15 mg/l bromide (about 50 mg/l chloride) level as advocated by the Delta M&I Workgroup. The State Board wants to examine the effects of setting such an objective. Therefore this concentration level will be identified as a "goal" for further analysis.

5.3 Agriculture

Conclusions:

Western and Interior Delta Agriculture

- **To reasonably protect crops grown in the western and interior Delta, water quality objectives were developed using corn as the representative salt-sensitive crop.**

- **Assuming improved leaching practices are used, salinities up to 1.5 mmhos/cm EC could be allowed during the irrigation season without affecting crop yield. However, the economic costs of these practices are not in the record.**

- **Until adequate economic data are available on leaching costs, the Board will maintain the existing salinity objectives.**

Southern Delta Agriculture

- **To reasonably protect crops grown in the southern Delta, water quality objectives were developed using beans and alfalfa as representative salt-sensitive crops.**

- **The objective of 0.7 mmhos/cm EC in the southern Delta protects beans during the summer irrigation season and the objective of 1.0 mmhos/cm EC protects alfalfa during the winter irrigation season. These objectives or other adequately protective objectives at specified locations will be implemented over time.**

- Southern Delta

The implementation plan is comprised of two interim stages and a final stage.

Interim Stage 1 -- 500 mg/l mean monthly TDS all year at Vernalis.

Interim Stage 2 -- (to be implemented no later than 1994) 0.7 mmhos/cm EC April 1 to August 31, 1.0 mmhos/cm EC September 1 to March 31; 30-day running average at Vernalis and Brandt Bridge, with water quality monitored at three current interior stations -- Mossdale, Old River, near Middle River and Tracy Road Bridge; and an additional interior monitoring station on Middle River at Howard Road Bridge.

Final Stage -- (to be implemented no later than 1996)
0.7 mmhos/cm EC April 1 to August 31, 1.0 mmhos/cm EC September 1 to March 31; 30-day running average at Vernalis and Brandt Bridge on the San Joaquin River, with two interior stations at Old River near Middle River and Old River at Tracy Road Bridge. Monitoring stations will be at Mossdale at head of Old River and Middle River at Howard Road Bridge.

or

If a three-party contract has been implemented among DWR, USBR and the SDWA, that contract will be reviewed prior to implementation of the above and, after also considering the needs of other beneficial uses, revisions will be made to the objectives and compliance/monitoring locations noted above, as appropriate.

5.3.1 Present Conditions

5.3.1.1 Western Delta

In D-1485, an agricultural water quality objective with a base level of 0.45 mmhos/cm EC was set for applied water in the western Delta. This objective is based upon estimates presented in the University of California exhibits. The information provided estimates of the quality needed to provide 100 percent corn yield in this region's subirrigated organic soil (1978 Delta Plan, UC ex. 1,2, and 8). On varying dates during the irrigation season, depending on year type, this objective is adjusted to a lower quality. This adjustment is made for all water year types except wet years at Emmaton and Jersey Point, and above normal years at Jersey Point. The amount of the adjustment is based on the time-weighted average of water quality over the period April 1 to August 15 for conditions that would exist without the CVP and the SWP (without project conditions).

5.3.1.2 Interior Delta

The D-1485 agricultural water quality objectives for the interior Delta uses the same estimates as the western Delta. However, under "without project" conditions, water quality in the interior Delta during the irrigation season was better than in the western Delta. Therefore, water year type adjustments for the interior Delta were smaller.

Table 5-5 lists western and interior Delta water quality objectives used as the present condition objectives.

5.3.1.3 Southern Delta

Three requirements primarily control current agricultural conditions in the southern Delta. These are:

- Regional Water Quality Control Board 5 Basin Plan (Basin 5 Plan)
- State Water Resources Control Board Decision 1422
- The terms of the draft contract for settling litigation brought by the SDWA against the USBR and DWR.

Current controlling conditions are set by the Basin 5 Plan objective for southern Delta agriculture (Table 5-5). This objective provides that "[i]n the San Joaquin River near Vernalis, the mean average TDS concentration shall not exceed 500 mg/l over any consecutive 30-day period" (Basin 5 Plan). This objective is set forth in Water Right Decision 1422 (New Melones Decision) (Table 5-5). Upon completion of the New Melones Reservoir the Bureau was required to meet the Basin 5 Plan objective with the necessary reservoir releases (SWRCB Decision 1422, April 1973).

This objective has not always been met, particularly in the recent years of drought. South Delta Water Agency and USBR have agreed on a number of occasions to release the limited supply from New Melones in a pattern which causes the objective to be violated at certain times of year, in order to preserve the dilution capability for more critical periods.

The USBR, SDWA and DWR entered into the Framework Agreement in October 1986 in an attempt to settle litigation brought by SDWA against the USBR and DWR. Since that time the parties have negotiated a proposed contract to settle the SDWA litigation. The proposed contract was agreed to by DWR's Director, USBR's Director of the Mid-Pacific Regional Office and SDWA's Board of Directors in August 1990. Each party also has its own approval process that must take place before the contract is fully executed.

5.3.2 <u>State Board Considerations</u>

Table 5-1 presents selected information concerning salt threshold and yield levels for sensitive and moderately sensitive surface irrigated crops grown on mineral soils (DWR,328). The salt threshold for a particular crop is the level below which no loss in yield is experienced due to soil salinity conditions.

TABLE 5-1

DELTA SERVICE AREA CROP SALT SENSITIVITY
(DWR,328)

Crop	Crop Salt Sensitivity	
	Threshold ECe[1]	Incremental Loss[2]
Sensitive Crops		
Beans	1.0	19%
Onion	1.2	16%
Moderately Sensitive Crops		
Fruits & Nuts		
Almonds	1.5	19%
Apricots	1.6	24%
Peaches	1.7	21%
Grapes	1.5	9.6%
Corn	1.7[3]	12%
Corn (subirrigated, organic soil)	2.1	20.2%
Potatoes	1.7	12%
Miscellaneous Truck Crops		
Carrots	1.0	14%
Lettuce	1.3	13%
Cabbage	1.8	9.7%
Broccoli	2.8	9.2%
Alfalfa	2.0	7.3%
Tomatoes	2.5	9.9%
Sudan	2.8	4.3%
Rice	3.0	12%

[1]ECe means Electrical Conductance of the soil saturation extract, reported as deciSiemens per meter (dS/m). With the exception of corn, which has both organic and mineral values, all crop values are based on mineral soil sensitivity.

[2]Loss in Yield per Unit Increase in dS/m Beyond Threshold.

[3]This tolerance of corn shown is for corn grown on a mineral soil using conventional methods of surface irrigation (furrow or sprinklers). The Delta corn trials (a.k.a. Corn Study) (reported by Hoffman et al., 1983) indicated that subirrigated corn has a slightly higher salt tolerance when grown on Delta peat soils. It is reported to be ECe=2.1 dS/m, or 23 percent higher. This is probably due to the higher water content of the peat. The usual tolerance (for mineral soils) can be multiplied by a factor of 1.23 to obtain tolerance of similar crops grown on subirrigated organic soils.

5.3.2.1&2 Western and Interior Delta

Protection for western and interior Delta agriculture is primarily based on the protection of corn grown on organic subirrigated soil.

In this region corn is a major salt-sensitive crop. Corn is grown on more than 21 percent of the total Delta land area, including more than 26 percent of the Delta lowlands (DWR,304). To help ensure a reasonable level of protection for agriculture in the western and interior Delta, the following information on leaching practices is needed:

(1) The effects of irrigation and leaching water quality on crop yield,
(2) The economics of implementing leaching practices, and
(3) The practicality of implementing leaching practices and their effectiveness.

Based on results from the Corn Study and the subworkgroup on western and interior Delta agriculture, it appears that corn can be grown and maintained with saltier water than proposed in D-1485; however, controlled leaching would be required periodically. The controlled leaching would be in addition to any leaching effect from rainfall and winter ponding. (See Appendix 5.2, Analysis of Corn Study to Variations in Applied Water and Leach Water Salinity). Information on the effectiveness, practicality, and the economics of such leaching needs field demonstration. Until this information is obtained, the D-1485 objectives will be continued for the protection of western and interior Delta agriculture.

5.3.2.3 Southern Delta

Beans and alfalfa, the two most widely grown salt-sensitive crops in the southern Delta, were chosen as target crops for the purpose of setting objectives. Meeting the objectives for these crops will protect the less salt-sensitive crops. In developing objectives for beans and alfalfa, the evidence and exhibits from the Phase I hearings, information from the DWR-sponsored South Delta Agriculture Subworkgroup, and the southern Delta negotiations were taken into consideration.

Within the subworkgroup, three key issues were discussed that influence the level of salinity required for the protection of beans and alfalfa: crop response during the early stages of growth, the determination of leaching fractions[1] and the effectiveness of rainfall in reducing soil salinity during the irrigation season. The members of the subworkgroups have been unable to reach consensus. The State Board will base its analysis on the University of California's "Guidelines for The Interpretation of Water Quality for Agriculture" and the Delta Plan (1978, Delta Plan, UC ex.D).

The subject of agricultural objectives for the southern Delta should consider ongoing negotiations between DWR, USBR, and SDWA. Care should be exercised in setting objectives so as not to undermine negotiations but to bring the negotiations to a timely and fruitful conclusion. Any agreement resulting from the negotiations will be reviewed by the State Board before the objectives are revised to reflect those contained in the agreement.

1/ Leaching fraction is that fraction of the total amount of applied water that passes through a crop root zone (SWRCB,29,2).

5.3.2.4 San Francisco Bay

No data have been presented nor a need demonstrated to protect agriculture in the San Francisco Bay area. Therefore, no alternatives are being considered for Bay agriculture in this Water Quality Control Plan.

5.3.3 Potential Objectives

5.3.3.1 Western and Interior Delta

No change (see Table 5-5).

5.3.3.2 Southern Delta

A staged implementation of objectives is one alternative. For the reasons stated under "State Board Considerations" it is the only alternative to the existing objective which will be carried forward. The staged implementation plan, which contains two interim stages and a final stage, is discussed in Chapter 7, Program of Implementation. The objectives for the final stage are presented in Table 5-5.

The final stage (to be implemented by 1996) will be 0.7 mmhos/cm EC April 1 to August 31 and 1.0 mmhos/cm EC September 1 to March 31; 30-day running average at Vernalis, Brandt Bridge, Old River near Middle River, and Tracy Road Bridge.

In the final stage of the phased Plan, the State Board will consider requiring full implementation of water quality objectives as set forth in the 1978 Delta Plan for the southern Delta area. Also, any agreement affecting south Delta water quality will be fully reviewed by the State Board prior to implementation of the final stage. The objectives and locations at that time may be revised as the State Board deems appropriate.

5.4 Fish and Wildlife Beneficial Uses

Conclusions:

- **The State Board supports the natural perpetuation of species affected by water and water quality. It is the policy of the state to significantly increase the natural production of salmon by the end of this century.**

- **Because of the amounts of data, past practices and public perception, striped bass and Central Valley Chinook salmon will be given separate consideration in the development of water quality objectives.**

- **Fish hatcheries for some species are a management tool that will be evaluated for their benefit and operation within the watershed during subsequent phases of the Bay-Delta proceedings.**

- **With respect to temperature and salinity, the objectives set in this Plan protect selected estuarine habitat beneficial uses. There is insufficient information in the record to set specific salinity and temperature objectives for the protection of Delta smelt, American shad, benthos, resident fish or marine habitat outside the Estuary.**

5.4.1 Present Conditions -- Fishery Habitat Protection (Entrapment Zone) in the Bay-Delta Estuary

In recent years there have been extensive changes in the Bay-Delta Estuary area, the effects of which are not well understood. These changes include:

1. The introduction of the Asian copepod, Sinocalanus doerrii, and its apparent displacement of the native copepod, Eurytemora affinis, from the entrapment zone area (DFG,28,25-28);

2. Changes in phytoplankton bloom patterns in the Delta and Suisun Bay, with the appearance of dense blooms of the chain diatom, Melosira, in the central Delta (DFG,28,14-19);

3. Changes in Delta outflow, salinity, and rate of water exports from the Delta (DFG,20,22-25);

4. Increases in releases of water from New Melones Reservoir for interim improvement of southern Delta water quality (T,XV,21:1-9); and

5. The introduction and rapid increase in numbers and range of the Asian clam Potamocorbula and its possible adverse effects on phytoplankton and zooplankton abundance.

The largest concentrations of phytoplankton, zooplankton, and detritus are generally found in the entrapment zone, an area where suspended materials concentrate as a result of two-layered flow circulation (USBR,112). Depending upon season, the type of water year, the tidal stage, and the preceding freshwater flow patterns, the entrapment zone could occur anywhere from upstream of the mouth of the Sacramento River to San Pablo Bay. The timing of phytoplankton blooms and the size of the resulting standing crop have been directly associated with the tidally-averaged location of the entrapment zone adjacent to or just upstream of extensive shallow shoal waters (T,XLVI,44:9-11,48:6-10; CCCWA/EDF,9). The location of the entrapment zone can be approximated from specific conductance values of 2 to 10 millimhos/cm (approximately 1 to 6 parts per thousand (ppt) salinity) (CCCWA/EDF,9).

The various species of zooplankton are found at different salinities. Neomysis mercedis are most abundant in areas with surface salinities ranging from 1.2 to 4.6 ppt (CCCWA/EDF,8). As salinity intrusion decreases, Neomysis abundance increases (T,XLI,54:23-24).

Neomysis feed on a variety of phytoplankton; diatoms are the most important class eaten and are also the most abundant class in the estuary (T,XLI,54:25-55:3). Other zooplankton also constitute a significant portion of their diet (T,XLI,55:4-5). Both phytoplankton and zooplankton concentrations have declined, thus reducing the food supply for *Neomysis* (T,XLI,55:6-8). Statistical analyses indicate that the abundance of *Neomysis* increases as its food supply increases (T,XLI,54:21-23).

Phytoplankton and zooplankton are important parts of the food chain supporting fish and larger invertebrates in the Estuary. There are no current water quality objectives specifically to protect phytoplankton and zooplankton. There are some benefits provided by water quality objectives set for other beneficial uses, e.g., Delta agriculture or Delta outflow for striped bass spawning and survival.

5.4.2 State Board Considerations

The location of the entrapment zone plays a role in the abundance of phytoplankton and zooplankton in the Suisun Bay area. Salinity is an indication of its location. Because the location of the entrapment zone in Suisun Bay is related primarily to the freshwater outflow, however, the State Board will defer consideration of this issue to the Scoping and Water Right phases of the proceedings.

5.4.3 Potential Objectives

To be discussed in the Scoping and Water Right phases.

5.5 Chinook Salmon

Conclusions:

- **The Estuary is a migratory corridor and rearing area for Chinook salmon.**
- **Hatchery production has kept the total numbers of fall-run salmon relatively stable.**
- **The diversity of the gene pool from naturally produced salmon is desirable.**
- **The Sacramento River winter-run of the Chinook salmon has been listed as an endangered species and will receive additional consideration in the final phases of these proceedings.**
- **The Board finds that salinity is not a factor affecting salmon as they migrate through the Estuary.**
- **Elevated temperature is one of the factors which can affect Chinook salmon during their migration through the Delta.**
- **Temperatures no greater than 68°F during the periods of April through June and September through November should be achieved by controllable factors, such as waste discharge controls, increases in riparian canopy, and bypass of warming areas (e.g., Thermalito Afterbay).**

- **Controllable water quality factors are those actions, conditions, or circumstances resulting from human activities that may influence the quality of the water of the State, that are subject to the authority of the State Board, or the Regional Board, and that may be reasonably controlled. Based on the record in these proceedings, controlling temperature in the Delta utilizing reservoir releases does not appear to be reasonable, due to the distance of the Delta downstream of reservoirs, and uncontrollable factors such as ambient air temperature, water temperatures in the reservoir releases, etc. For these reasons, the State Board considers reservoir releases to control water temperatures in the Delta a waste of water; therefore, the State Board will require a test of reasonableness before consideration of reservoir releases for such a purpose.**

- **No temperature requirements were submitted for winter-run Chinook salmon. To provide some protection for this endangered species, the more conservative temperature objective of 66°F (developed for the fall-run) is provided for the winter-run. This objective should be achieved by controllable factors, as noted above, during the period January through March at Freeport on the Sacramento River.**

5.5.1 Present Conditions

Flow requirements in D-1485 were established at Rio Vista on the Sacramento River for the protection of Chinook salmon, *Oncorhynchus tshawytscha*. There are no fishery flow requirements for the San Joaquin portion of the Delta. In addition to flow requirements, D-1485 contains a provision to close the Delta Cross Channel to minimize cross-Delta movement of salmon. D-1485 does not include any water quality objectives for the protection of salmon.

5.5.1.1 Salinity, Temperature and Dissolved Oxygen

Various water quality conditions can affect Chinook salmon survival in the Delta. The water quality variables under consideration were temperature, dissolved oxygen (DO) and salinity. During and after Phase I of the proceedings, data were presented on some water quality requirements of the different runs of Chinook salmon during the freshwater life stages. Most of the information concerning water quality is related to temperature requirements.

No salinity objectives exist for salmon in the Sacramento and San Joaquin basins and Delta, and no salinity objectives have been proposed. Chinook salmon (adults and juveniles) tolerate and even benefit from a gradual salinity gradient from the upstream headwaters to the ocean. The Chinook salmon as they migrate through the Delta are genetically adapted to migrate well beyond the fresh and salt water boundary.

Natural populations of San Joaquin and Sacramento salmon are declining and San Joaquin populations are undergoing extreme fluctuations (USFWS,31,58). Natural populations of the fall-, late fall-, winter- and spring- Chinook salmon runs are smaller than they were when first recorded by DFG in 1959. The catch of fall-run Chinook salmon has been relatively stable over time because the increasing number of hatchery-produced fish has offset the decline in naturally-produced fish.

The winter-run Chinook salmon has been listed as an Endangered Species under State law by the Fish and Game Commission and as a Threatened Species under federal law by the National Marine Fisheries Service (NMFS). Additional information about this run has been submitted to the State Board (see below).

San Joaquin River flow at Vernalis during smolt emigration has been identified as a major factor affecting subsequent adult escapement of hatchery and naturally-produced Chinook two and one-half years later (T,XXXVI,139:17-22) (Figures 5-1 and 5-2). The temperatures in the south Delta are often too high for smolts (WQCP-USFWS-5). Survival of the hatchery fish transported by truck and released below the Delta is six to eight times better than naturally or hatchery-produced fish emigrating from upstream through the Delta (T,XXXVII,153:2-154:1,161:22-162:1).

Very little water quality information is available about the effects of present conditions on salmon smolts migrating through San Francisco Bay. The USFWS did however determine that Chinook survival through San Francisco Bay in 1985 was estimated to be 93 percent based on the ratio of tag recoveries of two and three-year-olds released at both Port Chicago and the Golden Gate Bridge, respectively (Table 15, see USFWS Exhibit 31 for methods). The survival rate in 1984 was 81 percent. Both years had a delta outflow of about 10,000 cfs during the smolt out-migration (WQCP-USFWS-3,54).

5.5.1.2 Legislation for Upper Sacramento River Fishery Resources and Riparian Vegetation Restoration

A number of efforts are being made in both the state legislature and congress to improve the anadromous fishery and the riparian vegetation in the upper Sacramento River. In 1986, Senate Bill 1086 (Nielsen) created an advisory council and action team of federal, state and local agencies and interested parties to develop the Upper Sacramento River Fisheries and Riparian Habitat Management Plan. The plan, submitted in 1989, addressed the issues concerning the declining population of anadromous fish in the Sacramento River and listed 22 specific actions to restore and protect the fisheries and riparian vegetation. The plan includes priority issues such as flows, modification of diversion facilities, and temperatures and turbidity control in the Sacramento River. Senate Concurrent Resolution 62 (Nielsen), filed as a follow-up to SB 1086, passed in October, 1989. The Resolution declares that it is state policy to proceed with appropriating sufficient funds to implement the various recommendations in the management plan.

5.5.2 <u>State Board Considerations</u>

5.5.2.1 Temperature

There are a number of factors that influence water temperatures in the Delta; they include water temperatures of tributary inflow, amount of inflow, solar radiation, ambient temperatures, temperature of irrigation return flow and the extent of the riparian vegetation or shade. There is

Figure 5-1 Mean spring flows at Vernalis and San Joaquin Basin escapement 2 1/2 years later

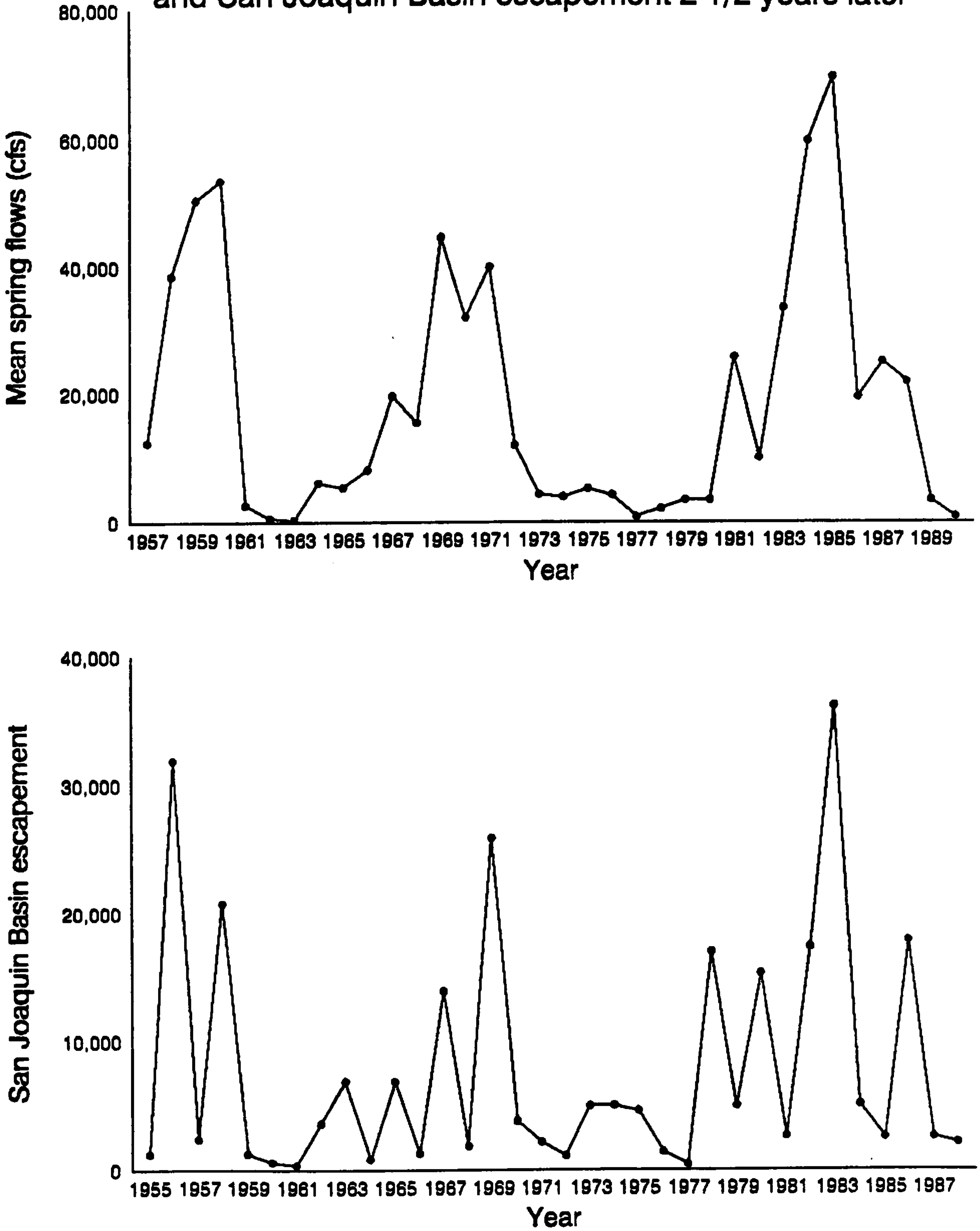
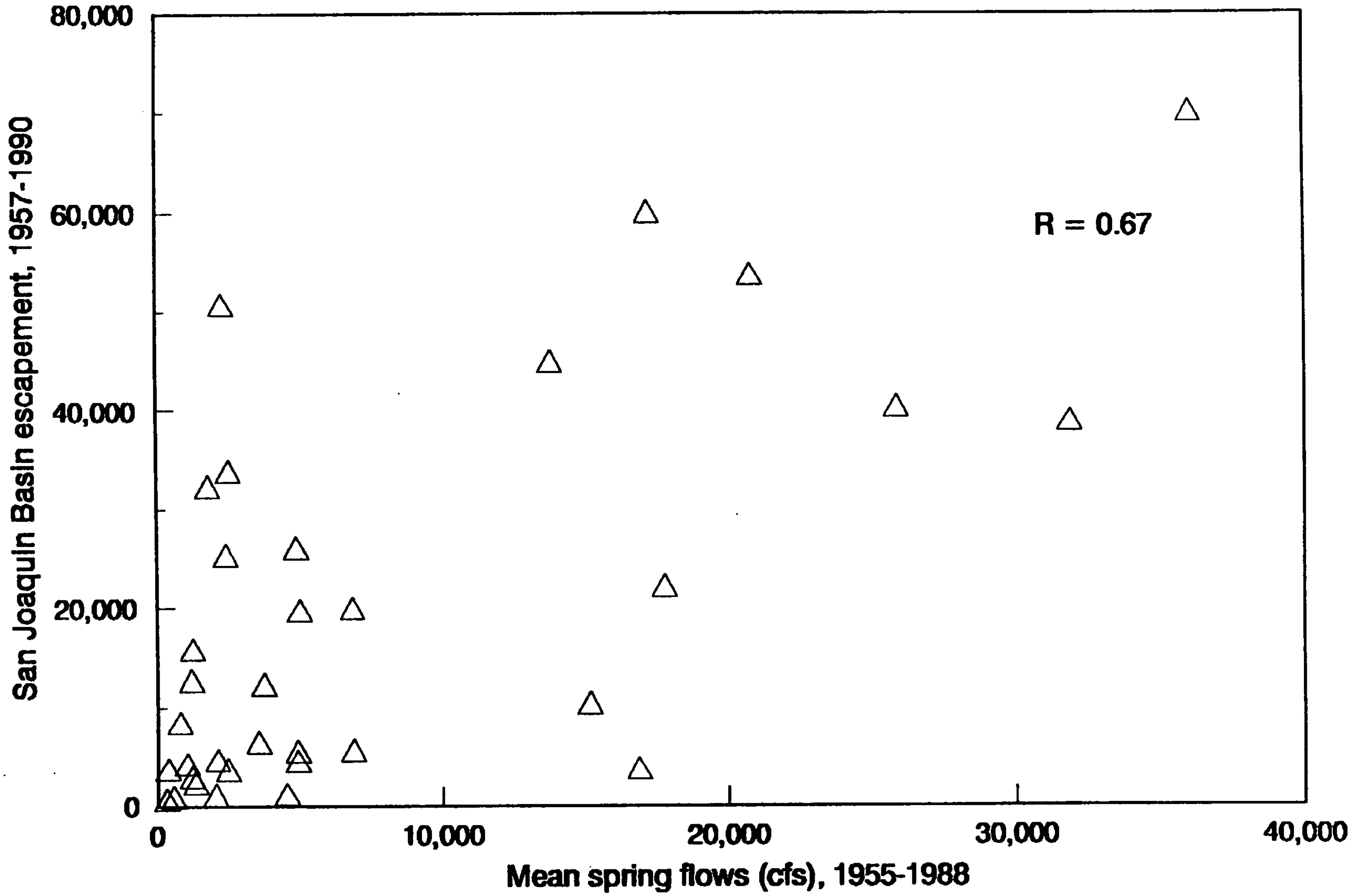


Figure 5-2 Relationship between mean spring flows at Vernalis and San Joaquin Basin escapement 2 1/2 years later



a general relationship between temperature and flow, with a considerable amount of variation in temperature at any given flow (DFG,15,145) (DWR,562). Water temperatures in the Delta/Estuary range from optimal to lethal to Chinook salmon depending on at least the above factors. Several methods are being pursued to improve the water temperatures in the Sacramento River and increase the survival rate of the various runs of Chinook salmon. Increased flows to move the juvenile salmon more quickly downstream, thus reducing exposure time to potential hazards, could have an effect on temperature.

The critical periods for fall- and winter-run Chinook salmon in the lower Sacramento and San Joaquin rivers are between December 1 and June 30 and September 1 and November 30 of each year, because these encompass the spawner migration and the juvenile outmigration phases through this area (See Appendix 5.3, Chinook Salmon). The ability and options available to attain a desired temperature objective at Freeport on the Sacramento River or Vernalis on the San Joaquin River during the various water year types have not been fully investigated.

Cooler water temperatures in the Sacramento River during the spring, early summer and fall months benefit different life stages of the winter-run as well as the fall-run Chinook salmon. In the spring and early summer, cooling the river for the outmigrating fall-run smolts would also benefit the winter-run adults spawning upstream. In the fall, cooling the water for the fall-run spawners would concurrently benefit the rearing of juvenile winter-run salmon in the river and the beginning of their emigration.

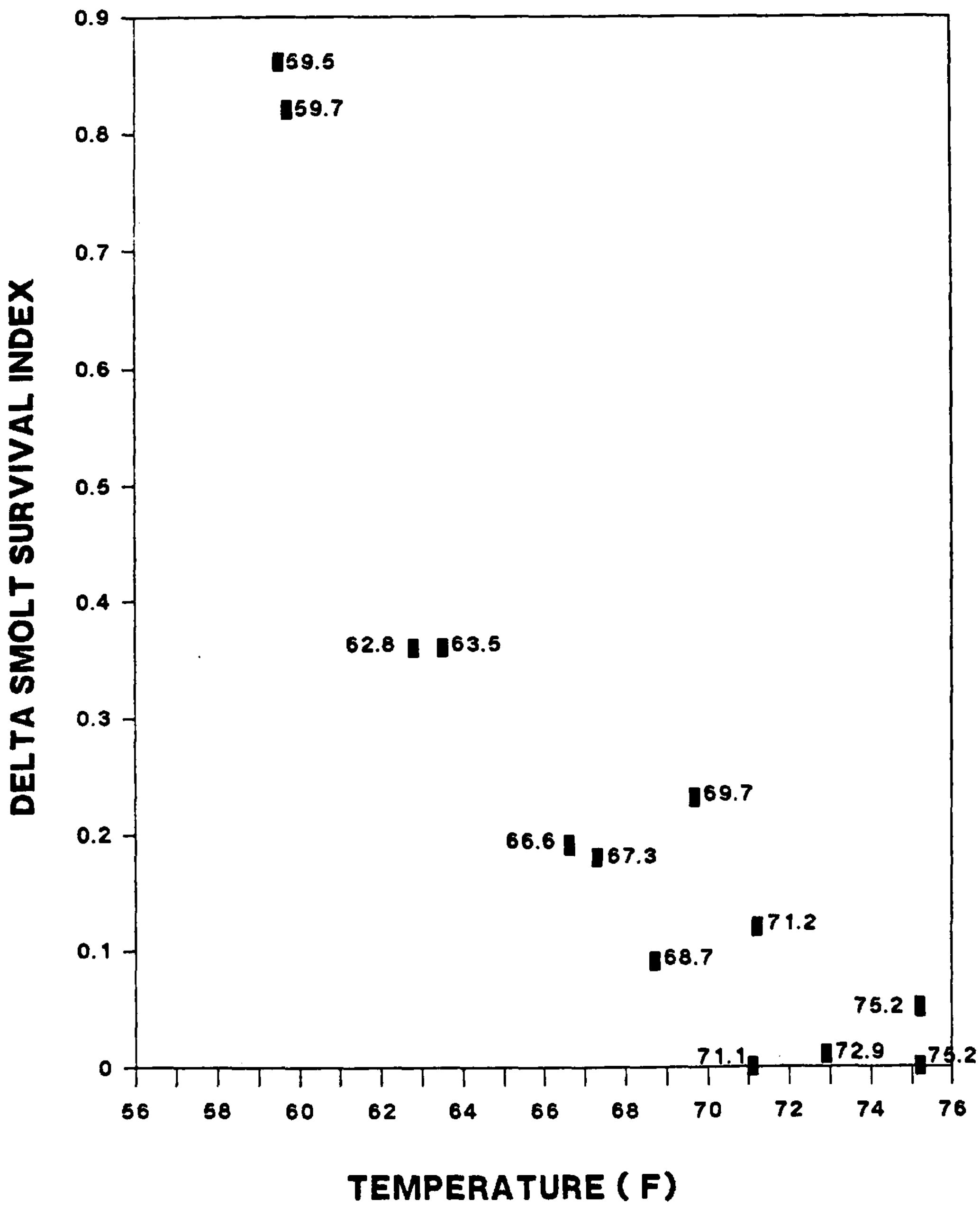
DWR's consultant testified that, since 1978, temperatures in the Sacramento River at Sacramento have been two to three degrees centigrade (about four to six degrees Fahrenheit) higher than before 1978 (T,XXXVII,157:11-15) (DWR,562,2). An evaluation of this theory might be possible by using the USBR Sacramento River temperature model (WQCP-USBR-127). Smolts emigrating in the months of warmer water temperatures are likely to suffer higher mortalities (T,XXXVII,226:15-20). Both wild and hatchery fish from both river systems are vulnerable to loss due to high temperature (WQCP-USFWS-5). The San Joaquin River portion of the Delta warms sooner than the Sacramento River system and is often about 70°F in early May. In the last few years, fishery investigators have determined that high water temperatures as well as low flows are a major problem for smolts emigrating through the San Joaquin River and Delta. Based on ocean tag recoveries, smolt survival through the Delta decreased as mean water temperatures in the Delta increased (USFWS,31,43). The same relationship is illustrated in Figure 5-3 which indicates the effect of temperature on the survival of emigrating juvenile salmon (See also Appendix 5.3, Chinook Salmon).

In contrast, the survival index generally exceeded 0.50 when the Sacramento River temperature at Freeport was 66°F or less (USFWS,31,43).

5.5.2.2 Fall-run Chinook Salmon

The upstream migration of fall-run Chinook salmon extends from approximately September through November in both the lower San Joaquin and Sacramento rivers. High water temperatures have blocked or delayed

FIGURE 5-3 Adjusted survival index of Chinook salmon smolts based on trawl recovery versus maximum daily water temperature on release day at Freeport, Reach 1 (WQCP-USFWS-1)



the upstream migration of fall-run Chinook in the years when there were high water temperatures in the fall. Temperatures above 70°F in the San Joaquin River have prevented salmon from migrating upstream from the Delta. This has often coincided with low dissolved oxygen levels especially between Stockton and Turner Cut. (Dissolved oxygen levels can be affected by temperature both directly and indirectly and the solubility of oxygen in the water varies inversely with temperature.) In the fall months in which DFG studied the situation, Chinook salmon were blocked by high water temperature in the lower San Joaquin River and upstream migration resumed when temperatures declined to 65°F. Temperatures between 65°F and 70°F created a partial block to salmon migration (Hallock et al., 1970). Although comparable findings have not been made for conditions in the Sacramento River, temperatures in the lower river, and in the tributaries as well, have sometimes been higher than optimum for adult migrants during the fall months.

Given the timing of the up- and downstream migration of the fall-run Chinook salmon, and the testimony and evidence of the parties at the hearing, the potential temperature objective for fall-run Chinook salmon is 68°F from April 1 through June 30 and from September 1 through November 30.

The fall-run Chinook salmon population has been supported by artificial propagation in hatcheries in both the Sacramento and San Joaquin rivers.

5.5.2.3 Winter-run Chinook Salmon

The winter-run has not been successfully produced in the hatcheries, in spite of numerous attempts. The population of the winter-run has declined in recent years, with the 1990 adult population estimated to be less than 500 fish. Given the current endangered status of the fish and its recent decline, a more conservative approach should be taken when determining a temperature objective for the winter-run Chinook salmon.

Both adult and young winter-run Chinook salmon would benefit from having a gradual salinity gradient from the Delta to the ocean and temperatures that do not exceed the mid-60 degrees Fahrenheit (memorandum to SWRCB from DFG, August 9, 1989). Temperature tolerances of winter-run Chinook salmon are unknown, although the Department of Fish and Game believes that they are similar to other Chinook runs. The timing of the outmigration of juveniles and the duration of rearing of the winter-run in the Delta are generally unknown. However, the time of the winter-run outmigration has been estimated from counts made in the upstream areas and subsequent catches of appropriately sized fish in the Delta area. These Chinook are determined to be winter-run by comparison with growth curves of winter-run hatchery fish. From these data, the DFG has determined that the period of peak outmigration through the Delta for juvenile winter-run Chinook salmon is between the months of January and April, with occasional downstream movements of fry during the fall months.

The adult winter-run Chinook salmon begin entering San Francisco Bay in November and continue to be found in the Sacramento-San Joaquin Delta into June. Peak adult migration through the Delta probably occurs from January to March.

Although there was no testimony presented on temperature requirements specifically for the winter-run, based on the hearing record and the testimony presented at the hearing, consideration of the more conservative temperature objective (66°F) for the fall-run Chinook salmon would be appropriate for the winter-run (Appendix 5.3, Chinook Salmon) during the period they are in the Sacramento River.

The winter-run Chinook salmon temperature objective is a cap to prevent water temperature from going higher than the present temperatures in the Delta. It is not a goal. This objective is just one of several ways of providing protection from elevated water temperatures. Other such protection measures include the Thermal Plan (see in Section 5.5.2.5) and the State Board "anti-degradation policy", "Statement of Policy With Respect to Maintaining High Quality of Water in California," Resolution 68-16.

5.5.2.4 Dissolved Oxygen

No objectives for dissolved oxygen were developed in D-1485.

The Central Valley Basin Plan (1975, Vol. I-4-12) states that: "The following objectives apply to Delta waters: The dissolved oxygen concentrations shall not be reduced below the following levels:

- 7.0 mg/l in the Sacramento River (below the I Street Bridge) and in all Delta waters west of the Antioch Bridge; and,

- 5.0 mg/l in all other Delta waters except for those bodies of water which are constructed for special purposes and from which fish have been excluded or where the fishery is not important as a beneficial use."

"Temperatures over 65°F have partially blocked migrations in the San Joaquin River past Stockton and ... dissolved oxygen concentrations of less than 5 mg/l constitute a virtual barrier to adult migrants" (USFWS,31,94). According to Hallock et al. (1970), after four years of investigation, "... no salmon moved past Stockton until the dissolved oxygen had risen to about 4.5 ppm, and the run did not become steady until oxygen levels were above 5 ppm." To address the problem of low dissolved oxygen levels in the San Joaquin River, an agreement was reached in 1969 between the USFWS, USBR, DWR, and DFG, in part, to take specific actions "...to maintain the dissolved oxygen content in the Stockton Ship Channel generally above 6 ppm when necessary...." DWR monitors DO levels in the San Joaquin River between Stockton and Turner Cut (Stockton Ship Channel) during the fall Chinook salmon migration. (Monitoring data are summarized and a report is submitted by DWR to the SWRCB annually in accordance with Water Right Decision 1485, Order 4(f)). If DO levels drop to 6 mg/l, a temporary rock barrier is installed across the head of Old River to increase San Joaquin River flows past Stockton, thus improving DO levels (T,XXXVII,85:4-22). Better treatment of cannery wastes since 1978 (reducing the biochemical oxygen demand) and improved flows and water quality from New Melones Reservoir operations were reported to have helped alleviate this problem (USFWS,31,94). Since then, the Old River barrier has been installed in the fall of 1979, 1981, 1984, 1987, 1988 and 1989 (H. Proctor, DWR, pers. comm.).

In the lower Sacramento River, no problems with dissolved oxygen levels were identified.

5.5.2.5 Miscellaneous Considerations for Salmon

o Pulse Flows as an Operational Option

Various operational options are available which may be beneficial to the salmon smolts but have not been not fully tested. "Pulse flows" are released from Shasta Dam on the Sacramento River to increase flows at the same time salmon smolts are released from the USFWS Coleman Hatchery on Battle Creek (tributary to the Sacramento River). The purpose of the "fish flush" is to move hatchery fish rapidly down the Sacramento River, past a number and variety of potential hazards. Pulse flows (fish flush flows) provide a window of time in which to coordinate the operation of various water diversion facilities, such as the Delta Cross Channel Gates, to maximize survival of the smolts. The fish are released as early in the season as possible to reduce the exposure to adverse water temperatures in the river.

The "pulse flow" experiment has been conducted for the last four years; however, the effects of the experimental operation on the hatchery fish as well as naturally produced fish are not yet fully known. Questions remain on the effects of the pulse flows on the rearing, timing of emigration and survival of the natural fish. The pulse flow experiment was conducted because it would have a beneficial effect, with spring flows higher than in recent years, but substantially less than would have occurred under natural conditions (WQCP-USFWS-2,-3 and-5). Pulse flow experiments are being considered in the San Joaquin River system as well.

o Temperature Model

The USBR temperature model (WQCP-USBR-127) may be helpful in evaluating the Sacramento River flows required to achieve various temperature alternatives at points in the Sacramento River or Delta during different months. The report on the temperature model describes a monthly time-step reservoir and river model developed as a tool to try to evaluate the effects of CVP and SWP project operations on water temperatures as they affect Chinook salmon in the Sacramento River Basin. Because it is a monthly rather than a daily model, it provides only a qualitative comparison of various operating scenarios. Average monthly temperatures can mask short-term fluctuations in temperature that could be lethal to certain salmonid life stages. The model, however, given operational flexibility and sufficient water, indicates relative benefits of various options to the instream life stages of the salmonids. A review of the model should be made to help clarify further the factors influencing temperatures in the Delta.

Because the runs of Chinook salmon can be impacted by temperatures in the spring, early summer and fall, it will be imperative to evaluate the flexibility of the operations and achieve the coldest temperatures possible in the different water year types. The Five-Agency Salmon Management Group is evaluating the costs and benefits of decreasing water temperature and the use of other measures in the Delta to improve salmon smolt survival. A temperature model at present is not available but would be useful for the San Joaquin River.

o Regional Water Quality Control Board Temperature Objectives

The temperature objective in the Central Valley Regional Board's Basin Plan for the Sacramento River is as follows: "The temperature shall not be elevated...above 68°F in the reach from Hamilton City to the I Street Bridge during periods when temperature increases will be detrimental to the fishery." This objective is based upon "controllable factors" discussed below. There is no temperature objective on the San Joaquin River system.

The fishery's temperature objective for the Delta specifies: "The natural receiving water temperature of intrastate waters shall not be altered unless it can be demonstrated to the satisfaction of the Regional Board that such alteration in temperature does not adversely affect beneficial uses." (Water Quality Control Plan Report, Central Valley Region 5, Vol. I, p.I-4-9)

o Thermal Plan

The State Water Resources Control Board adopted on May 18, 1972, A "Water Quality Control Plan for Control of Temperature in the Coastal and Interstate Waters and Enclosed bays and Estuaries in California," referred to as the "Thermal Plan." The Plan specifies limiting conditions of temperature in wastewaters discharged into interstate and coastal waters, estuaries and enclosed bays. For example, elevated temperature waste discharges into interstate waters designated as "cold" waters are prohibited while this type of discharge into "warm" interstate waters cannot be more than 5°F warmer than the receiving water and shall not cause the temperature in the receiving water to rise more than 5°F. Existing thermal discharges into coastal waters, estuaries and enclosed bays must comply with limitations necessary to assure protection of the beneficial uses and, for coastal waters, areas of special biological significance. (Water Quality Control Plan Report, Central Valley Region 5, Vol. II, p.II-9-14).

o Controllable Factors

Water temperature objectives in the Central Valley Basin Plan apply to controllable water quality factors which are defined as: "...those actions, conditions, or circumstances resulting from human activities that may influence the quality of the waters of the State, that are subject to the authority of the State Board or the Regional Board, and that may be reasonably controlled." (Revised Region 5 Basin Plan for Basins 5A, 5B, and 5C as approved by the State Board on March 22, 1990; also please see Tables 1-1 and 6-3, page 8 of 8).

In order to implement a water quality objective for temperature in the Delta, the Board will examine the controllable factors, and, where reasonable, require maintenance of the water temperatures such that they will not impact, and perhaps will improve, survival of anadromous salmonids.

5.5.3 Potential Objectives for Chinook Salmon

5.5.3.1 Temperature for Fall-Run Salmon

The following objective will be considered for the protection of the fall-run Chinook salmon:

The daily average water temperature shall not be elevated by controllable factors above 68°F from the I Street Bridge to Freeport on the Sacramento River, and at Vernalis on the San Joaquin River between April 1 through June 30 and September 1 through November 30 in all water year types.

When other factors result in the degradation of water quality beyond the levels of limits established as water quality objectives, then controllable factors shall not cause further degradation of water quality.

5.5.3.2 Temperature for Winter-Run Salmon

The following objective will be considered for the protection of the adult and juvenile life stages of the endangered winter-run Chinook salmon:

The daily average water temperature shall not be elevated by controllable factors above 66°F from the I Street Bridge to Freeport on the Sacramento River between January 1 through March 31 in all water years.

5.5.3.3 Dissolved Oxygen

Factors that may contribute to the low levels of dissolved oxygen, in addition to low flows in the San Joaquin River during the fall months, include: 1) the recently deepened ship channel; 2) the enlarged turning basin at the Port of Stockton; 3) the Stockton Sewage Treatment Plant; 4) upstream BOD sources; and 5) commercial use of the dead-end portion of the ship channel.

The following objective is proposed for consideration for the protection of the Chinook salmon in the San Joaquin River:

Minimum dissolved oxygen levels shall not fall below 6 mg/l from September 1 through November 30 in all water year types between Stockton and Turner Cut in the San Joaquin River.

Measures to implement this objective include the following:
1) regulation of the effluent from the Stockton Sewage Treatment Plant and other upstream discharges contributing to the BOD load; 2) installation of the temporary barrier or additional barriers as may be needed, 3) investigation of mechanical or chemical methods to oxygenate the water at critical points along the river channel, and 4) increase of flows in the San Joaquin River. A decision on the precise implementation measures will be made during the forthcoming proceedings.

5.6 Striped Bass

Conclusions:

- o Studies over many years indicate that there are numerous factors affecting striped bass abundance, including diversions from the Delta, reduced Delta outflow, flow patterns in the interior Delta, fewer adults, toxic effects, changes in the food chain due to introduced species, recreational angler harvest, and illegal poaching.

- o Studies should be continued and additional water operation tests should be conducted to determine the effects on striped bass and the best means for their protection.

- o In light of various impacts on the fishery, particularly of the exports pumps, it is necessary to examine existing points of water diversion. Within the Scoping Phase, the Board will consider the alternatives to the existing points of diversion.

Striped Bass - Spawning Habitat from Prisoners Point to Vernalis

- o Review of the evidence indicates that it may be desirable to expand existing spawning habitat for striped bass in the Delta. However, the State Board concludes that the most significant factor in the decline of striped bass is entrainment[1] due to pumping. The State Board will consider actions to be taken concerning entrainment losses during the Scoping and Water Right phases of the proceedings. Upon examination of the results of these actions, the State Board will consider the issue of expansion of spawning habitat.

Striped Bass - Spawning Habitat from Antioch to Prisoners Point

- o The major spawning areas for striped bass are the Sacramento River above the Delta and the San Joaquin River area between Antioch and Prisoners Point.

- o The Board finds benefits for the resource in maintaining spawning habitat in this reach by establishing boundary salinities at Antioch of 1.5 and at Prisoners Point of 0.44 mmhos/cm EC from April 15 through May 31. The end date of May 31 may be shortened if data indicate that spawning has ceased.

- o Deficiencies in firm supplies and the level of protection afforded by the striped bass spawning objective should be correlated.

- o The Board needs better information than is currently available to consider the complete economic relationship between improvements in striped bass spawning habitat and water availability.

1/ Entrainment means primarily the effects of project operations, such as operation of the Delta Cross Channel gates, export pumping, and reverse and low river flows, plus local non-project diversions.

5.6.1 Present Conditions

5.6.1.1 Background: D-1485 Objectives

Striped bass are specifically protected in D-1485 (Table II,38,39,40). These requirements evolved out of negotiations conducted among DFG, DWR, USFWS, and USBR prior to the 1978 hearing as part of a draft Four-Agency agreement; this agreement was never signed (DFG,25,133). Salinity (EC) objectives at Antioch and at Prisoners Point on the San Joaquin River establish a striped bass spawning area estimated to be about 17 miles in length from April 1 to May 5 in all water years. These objectives were first established (in an earlier form) by Water Right Decision 1379, adopted in July 1971. They were established after a review of an earlier State Board Resolution (68-17; Supplemental Water Quality Control Policy) indicated that striped bass spawning was not being protected. The recommended protection measures were similar to those proposed by a Department of Interior task force on Delta salinity objectives (Decision 1379, 32).

The objective at Antioch is 1.5 mmhos/cm EC (the first two weeks of protection are provided by a Delta Outflow Index requirement of 6,700 cfs rather than an EC objective to provide some ramping capability for the CVP and SWP water projects). This objective also includes a relaxation provision when the SWP or CVP declares deficiencies in delivery of firm project supplies. Upstream, the objectives provide for a maximum of 0.55 mmhos/cm EC at Prisoners Point; no relaxation provision is included.

In May, June and July, minimum Delta Outflow Index flows and limitations on export levels come into effect for protection of young bass. These requirements were designed to help move eggs and young into suitable nursery areas and to reduce entrainment into the SWP and CVP export systems. The Delta outflows were also expected to provide equivalent protection for later spawning in the San Joaquin River, at least in wet, above normal, and below normal water years; outflows during these periods were expected to be higher than the 6,700 cfs estimated to be required to maintain the 1.5 mmhos/cm EC at Antioch under steady-state conditions (1978 Delta Plan, VI-4). Provisions for periodic closure of the Delta Cross Channel gates (to reduce translocation of Sacramento River striped bass eggs and young into the central Delta) and recommendations (not mandatory requirements) for the operation of the projects' fish recovery facilities are included in D-1485. Other than the Delta Cross Channel gate closure, there are no specific objectives for protection of spawning or young bass in the Sacramento River.

5.6.1.2 Current Status

The adult population of striped bass in the Estuary has declined in recent years to about one-third or one-fourth of the population levels seen in the 1960s. A variety of sampling programs are employed to monitor various components of the striped bass population (see Appendix 5.4.1). While the decline rates and patterns may vary somewhat, all programs measuring striped bass abundance show large declines (DFG,25,6,9). The primary means of evaluating the overall condition of striped bass between years has been the Striped Bass Index (SBI). The objectives in D-1485 were designed to maintain the SBI at a long-term average of 79 (the so-called "without project" conditions). This goal has not been achieved; in 1990, the actual SBI reached an all-time low of 4.3; 1988 was the second-lowest on record with 4.6, and in 1989 the SBI was 5.1. The average SBI for the period 1979-1990 is 19.1 (see Appendix 5.4.2).

In the late 1970s declining striped bass populations indicated that the requirements in D-1485 for protection of striped bass were not achieving their intended and expected results. In response, the State Board organized a Striped Bass Work Group composed of staff from several state and federal agencies and outside consultants to investigate the cause(s) of this decline and to make recommendations on actions to correct it. Subsequent discussion and data analysis have resulted in an expanded and refined list of possible causative factors. These are discussed in Appendix 5.4.3. The relationship of the export area striped bass fishery to the Estuary fishery is discussed in Appendix 5.4.4. In large part, while the reasons for the striped bass decline are known, the relative importance of each factor is not completely understood (WQCP-DFG-3).

5.6.2 State Board Considerations

General: Salinity Objectives

Salinity objectives for striped bass apply to the spawning conditions and limitations for adult striped bass in the San Joaquin River. Striped bass in the Sacramento River spawn well above the influence of ocean-derived salinity, and, unlike the San Joaquin River, water quality and river flow are sufficient to prevent the formation of upstream salinity barriers to fish passage due to land-derived salts. No D-1485 objectives or advocated positions consider this area, and no alternatives are offered for consideration.

The D-1485 salinity objectives were expected to provide minimal, yet adequate, spawning habitat from approximately Antioch to Prisoners Point to sustain a healthy striped bass population. However, the continuing decline indicates that some new actions must be considered. Therefore, as one part of an overall program to increase protection for estuarine habitat, it is appropriate to consider modifying the three D-1485 San Joaquin River spawning objectives.

This section considers temperature in addition to salinity objectives at Antioch and Prisoners Point:

5.6.2.1 Antioch: Period of Protection for Spawning
5.6.2.2 Antioch: Relaxation Provision
5.6.2.3 Prisoners Point: EC Modification
5.6.2.4 Prisoners Point: Relaxation Provision
5.6.2.5 Temperature Objectives

5.6.2.1 Antioch: Period of Protection for Spawning

The current D-1485 objectives provide for striped bass spawning protection in the lower San Joaquin River for a period of 35 days, from April 1 to May 5. Protection during the first two weeks of this period is permitted to be met by a Delta Outflow Index (DOI) value of 6,700 cfs, rather than the EC objective of 1.5 mmhos/cm, to provide some operational flexibility for the SWP and CVP without significantly degrading protection of spawning habitat. Since spawning activity is minimal in early April in most years, the small variations in salinity which may occur under this provision are not significant.

After May 5, striped bass spawning habitat is not specifically protected, although spawning in the Delta continues through most of May and occasionally even into June, depending upon water temperatures and perhaps other factors. Some collateral protection is provided by DOI flows designated for protection of young bass. The flow requirements in wet, above normal, and below normal water years are generally sufficient to maintain the 1.5 mmhos/cm EC salinity in the vicinity of Antioch (the lower end of the spawning area) or even farther downstream. However, in subnormal snowmelt, dry and critical water years, DOI requirements are reduced, resulting in loss of spawning habitat. DFG testified that the spawning habitat protection provided under present D-1485 objectives is minimal rather than optimal, and that striped bass would be put under additional stress if the relaxation provision were in effect (see below) (1978 Delta Plan testimony, May 30, 1978, 67:14-19). DFG also testified that the flow requirements (DOI) set for striped bass do not provide adequate protection during dry or critical water years, or those of subnormal snowmelt (T,LXVIII,76:2-4). Therefore, several alternative spawning habitat objectives which provide various levels of protection are considered.

The current objectives provide protection through May 5. Table 5-2 shows the results of DFG egg sampling in the San Joaquin River. For each year, the date on which a specified percentage of total eggs collected is noted. For example, in 1985, 30 percent of the total number of eggs collected by DFG that year were collected by May 1. These data are analogous to, and derived in part from, the cumulative total curves in Turner (1976). This table indicates that a May 5 cutoff date for protection of spawning means that only 30 to 40 percent of the total spawning activity (as measured by eggs collected) in any given year has occurred by that date. The data in Table 5-2 indicate that extending the cutoff date to May 31 protects about 95 percent of the spawning activity in most years.

Alternative levels of protection may be summarized as follows:

TABLE 5-2

STRIPED BASS SPAWNING PATTERNS, SAN JOAQUIN RIVER

PERCENT OF LIVE EGGS COLLECTED, BY DATE

WATER YEAR IS 40/30/30

YEAR	WATER YEAR	PERCENT OF TOTAL EGGS COLLECTED >0	5	10	20	30	40	50	60	70	80	90	95	100
1963*	AN	4/26	5/01	5/05	5/14	5/15	5/16	5/16	5/17	5/19	5/21	5/23	5/27	6/13
1964*	D	4/15	4/15	4/27	5/06	5/15	5/16	5/16	5/17	5/18	5/19	5/23	5/25	6/05
1965*	W	Very few eggs collected; sampling program missed most of spawning; eggs present through 6/19												6/19
1966*	BN	4/14	4/15	4/16	4/20	4/25	4/27	5/01	5/02	5/05	5/07	5/08	5/14	6/18
1967*	W	5/03	5/04	5/04	5/06	5/09	5/17	5/18	5/19	5/20	5/23	6/13	6/18	6/22
1968+	BN	4/03	4/12	4/26	5/02	5/08	5/08	5/08	5/08	5/10	5/10	5/17	5/24	6/14
1969*	W	4/08	4/11	4/15	4/21	5/02	5/08	5/14	5/17	5/20	5/24	5/27	6/01	6/12
1970+	AN	4/21	5/02	5/04	5/05	5/14	5/14	5/15	5/15	5/17	5/18	5/19	5/21	6/30
1971+	W	Sampling begun in late May, eggs present from 5/23 to 7/12; bulk of spawning probably somewhat earlier												7/12
1972+	D	4/29	5/07	5/08	5/10	5/10	5/10	5/11	5/12	5/13	5/19	5/23	5/31	7/06
1973+	AN	Sampling begun in late May; eggs present from 5/29 to 7/04; bulk of spawning probably somewhat earlier												7/04
1975+	W	5/01	5/08	5/11	5/13	5/18	5/21	5/24	5/26	5/27	5/28	6/05	6/06	7/14
1977	C	4/19	4/20	4/21	4/30	5/01	5/01	5/09	5/14	5/15	5/15	5/15	5/28	6/10
1984+	W	4/16	4/23	4/25	5/02	5/07	5/08	5/09	5/13	5/13	5/14	5/15	5/17	7/01
1985+	BN	4/16	4/19	4/24	4/29	5/01	5/03	5/06	5/12	5/13	5/15	5/19	5/22	6/27
1986+	W	4/16	4/21	4/21	4/23	4/30	5/09	5/10	5/11	5/12	5/17	5/22	5/25	7/01
1988+	C	4/12	4/14	4/21	4/23	4/25	4/26	4/27	5/07	5/08	5/09	5/18	5/24	6/15
1989+	D	4/12	4/17	4/18	4/20	4/24	5/03	5/04	5/05	5/06	5/10	5/26	6/01	6/23
AVERAGE DATE OF COLLECTION FOR PERCENT INDICATED		--	4/23	4\26	4/30	5/05	5/08	5/11	8/13	5/14	5/17	5/22	5/27	6/21

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* = Values derived from curves in Figure 2 of Turner (1976);
remaining years from cumulative totals of live eggs from DFG data (Lee Miller)

+ = Eggs present on first day of sampling (date in >0 column); some spawning probably occured prior to date shown

Alternatives	Approximate percent of spawning activity protected
1. April 1 through May 5, with ramping* (present condition)	30-40%
2. April 15 through May 15, without ramping	55-65%
3. April 1 through May 15, with ramping	60-70%
4. April 15 through May 31, without ramping	90%
5. April 1 through May 31, with ramping	95%
6. April 1 through May 31, without ramping	>95%

* ramping = 6,700 cfs Delta Outflow Index value for period April 1 through April 14

The percent of spawning activity assumed protected under each alternative in the table above is determined directly from Table 5-2. The range of percent spawning activity protected is simply the amount of spawning activity measured (i.e., percent of total eggs collected) by the end date of each alternative. There is assumed to be relatively little spawning which occurs before about April 15 each year, so the absence of ramping (i.e., appropriate salinity from April 1 rather than ramping flows to April 14) was assumed to add only about 5 percent additional spawning activity protection over that provided by ramping. The relative lack of data before April 15 makes this somewhat speculative, but in any case it is probably not significant.

The State Water Contractors proposed extending protection of spawning activity only to May 21 in dry and critical years (WQCP-SWC-627,3-4).

The present Antioch standard of 1.5 mmhos/cm EC was primarily designed, as is described in Section 5.6.1.1, to provide a suitable spawning habitat upstream of Antioch, not at the Antioch location itself. According to the recollection of Don Stevens of DFG (pers. comm., 3/91), Antioch was chosen as a monitoring point because a salinity monitoring station was already established at the Antioch Water Works. The use of 1.5 mmhos/cm EC at Antioch for spawning protection appears not to be generally appropriate, since DFG's own testimony indicates that striped bass prefer to spawn in freshwater, and that a spawning objective of 0.44 mmhos/cm EC represents the "best scientific evidence" of the water quality needed to restore spawning in the historical spawning area of the San Joaquin River (DFG-WQCP-9,4) (see Section 5.6.2.3). However, the Antioch water quality objective may continue to serve the purpose of being an ultimate delimiter of spawning habitat; the Antioch objective can also be considered an "implementing measure" since maintaining that objective should produce less saline, and thus more suitable habitat, upstream of Antioch in the San Joaquin River. DFG has observed some spawning in the Antioch to Jersey Point reach, sometimes in ECs of 1.5 mmhos/cm or higher, in some very dry years (1972 and 1977). Laboratory studies also indicate that egg survival is not affected adversely in water with ECs up to 1.5 mmhos/cm (DFG,25,46). These conditions have typically produced some of the lowest abundance indices, however. We also agree that the striped bass spawning objectives, as proposed, do not in fact designate a spawning reach, but only a single location (Prisoners Point) where appropriate salinities for the majority of spawning, as determined by DFG, are required to be present.

5.6.2.2 Antioch: Relaxation Provision

Decision 1485 provides for a relaxation of the protection for striped bass spawning when the SWP or CVP impose deficiencies in their firm supplies. The EC objective is relaxed proportional to the amount of deficiency imposed. Under extreme conditions, when the projects impose deficiencies of 4.0 MAF or more, D-1485 in theory allows the EC at Antioch to degrade to 25.2 mmhos/cm, which would result in substantial reduction of spawning habitat to an estimated reach of about 9.5 miles or less (Delta Plan and D-1485 Final EIR,V-24 to V-26). However, it was believed that the Suisun Marsh protection objectives (critical years) or Delta agricultural objectives (dry years) would in fact control salinity in the lower San Joaquin River throughout the month of May. Therefore, the actual EC at Antioch, regardless of the size of the deficiency imposed, was not expected to exceed 3.7 mmhos/cm in critical years, and 1.8 mmhos/cm in dry years (letter from SWRCB to EPA April 3, 1979 -- information based on DWR 1978 Hearing Ex. 7B).

As several participants have pointed out, there is considerable confusion about the appropriateness of the proposed relaxation criteria, in terms of what salinity is appropriate at Antioch for various deficiency levels. As has been discussed, the 1978 Delta Plan and EIR based the relaxations on a salinity/flow relationship for the Sacramento River, which was assumed to be applicable to the San Joaquin River as well. In addition, the theoretical extent of salinity degradation was supposedly limited to a maximum of 3.7 mmhos/cm EC because of the Chipps Island Suisun Marsh standard. The entire process is built on a series of artificial relationships which are unrelated to the main issue at hand, which is the establishment and maintenance of suitable spawning habitat for striped bass in the San Joaquin River and the relaxation of that habitat requirement when water project firm deliveries are reduced.

The State Board continues to believe that, as stated in its conclusions on striped bass (Section 5.6), the "[d]eficiencies in firm supplies and the level of protection afforded by the striped bass spawning objective should be correlated." The present deficiency schedule does not do that, since no specific relationship between extent of habitat and change in salinity intrusion has been made. The present relationship is based on a Sacramento River salinity/flow relationship. Several participants have appropriately questioned the basis for this relationship.

In 1990, the projects declared a deficiency and invoked the relaxation provision. Despite compliance with other D-1485 standards, the theoretical expected Antioch maximum EC of 3.7 mmhos/cm was exceeded. In addition, monitoring data from 1990 suggest that ECs greater than 0.44 mmhos/cm occurred throughout nearly all of the striped bass spawning area, not simply at the downstream end.

The State Board would like to relate deficiencies to spawning area in a direct, measurable way: by simply making increases in deficiencies directly related to the shortening of the length of river reach in which suitable spawning habitat will be required to be maintained. The Board believes this approach would have a negligible effect on water supplies during most years because D-1485 provides some umbrella spawning protection upstream of Antioch by means of the central and western Delta agricultural standards. These standards are presently under review, and the required water quality at some locations may be reduced (salinity increased). By establishing a separate spawning habitat objective, no re-evaluation of the effects of water quality degradation on striped bass habitat will be required. The present agricultural water quality objective includes a level of 0.45 mmhos/cm EC at Jersey Point from April 1 to August 15 (in all but critical years). This objective essentially duplicates the current EC and starting date requirements for striped bass spawning protection. In Section 7.5.2.4, Program of Implementation, the State Board outlines a proposal for evaluation of the concept of establishment of a specific spawning protection zone and a directly related relaxation provision.

5.6.2.3 Prisoners Point: EC Modification

The D-1485 objective for EC at Prisoners Point on Venice Island is 0.55 mmhos/cm for the period April 1 to May 5, in all water years, to delimit the upstream end of the San Joaquin River spawning area. No relaxation provision for deficiencies is included. Transfer of water across the Delta to the export pumps results in relatively low salinity in the Prisoners Point area of the San Joaquin River. Salinity in the San Joaquin River increases upstream of Prisoners Point due to reduced freshwater inflow and saline agricultural return flows from the eastern and southern Delta and from the River above the Delta. Thus, the absence of salinity objectives above Prisoners Point effectively establishes a barrier to adult migration and spawning farther upstream on the San Joaquin River.

Three issues are involved with this standard: period of protection, extension of spawning habitat farther upstream, and appropriate EC levels.

Period of Protection

As noted above, there is substantial spawning in the Delta throughout May. Flows through the Mokelumne River system, especially the movement of Sacramento River water through the Delta Cross Channel, most likely provide considerable protection of water quality in the area around Prisoners Point throughout much of the spring months.

For consistency with the objectives proposed for Antioch, the State Board will examine the effect of setting the same period of protection as at Antioch: April 1 to May 31 in all water years.

Extension of Available Spawning Habitat Upstream

The major issue involving the current striped bass spawning objectives is whether the spawning area should be expanded beyond its present size. The present objective results in substantial spawning in the channels which move water to the export pumps in the south Delta; for part of the spawning period (April), there are no restrictions on export rates. This undoubtedly results in substantial losses of eggs and young. In its comments on the proposed objectives in D-1485, DFG noted that the designated spawning area provided "minimal suitable conditions" (Testimony, 1978 Delta Plan, 4/27/77, XXII, 160:17-19).

In Phase I, DFG testified that striped bass used to spawn farther up the San Joaquin River than at present, but do not do so now because of increased salinity (T,XLI,68:3-20). Despite testimony to the contrary (see for example, U.S. Department of Interior comments, 4/23/90, p.6), numerous records from the early decades of this century indicate that striped bass regularly migrated up the San Joaquin River and its tributaries. As late as 1963, substantial spawning in the San Joaquin River occurred in the reach between Stockton and Mossdale (Farley, 1966). Spawning occurred above Vernalis in 1968, with many of the eggs appearing near Patterson, 104 miles above the mouth of the river (Turner, 1976). In wetter years large striped bass are still seen in the San Joaquin River tributaries (W. Loudermilk, DFG, pers. comm., 1988). It appears that the upper Delta and the tributary rivers may still support striped bass spawning when appropriate habitat conditions are provided.

On the other hand, several arguments have been offered to support retention of the present objective (limit spawning to west of Prisoners Point). These arguments are based primarily on two factors: (1) assumptions that eggs and young that were produced farther upstream would be carried to the export pumps and lost to the Delta; and (2) lack of a strong experimentally-derived correlation between salinity and spawning success. These arguments are discussed in Appendix 5.4.5.

Appropriate Electrical Conductivity Levels

The Phase I testimony and exhibits indicate that striped bass prefer to spawn in water with an EC of less than 0.3 mmhos/cm (TDS=170 mg/l) (DFG,25,46 and 47). Farley (1966) concluded that striped bass require a TDS of less than 250 mg/l (= 0.44 mmhos/cm EC). It is DFG's belief that this represents the "best scientific evidence" to restore spawning in the historical spawning area of the San Joaquin River (WQCP-DFG-4,9). Higher salinities may affect egg survival as well as spawning activity. Turner (1976) found that, in water of 600-800 mg/l TDS (= 1.03-1.36 mmhos/cm EC) on the San Joaquin River above the Delta in 1968, 94 percent of the eggs he collected were dead. However, it is not clear whether this high percent of dead eggs was caused by salinity or some other factor.

Establishing an objective of 0.55 mmhos/cm EC in the reach from Prisoners Point to Vernalis would not expand the spawning area since, based on prior testimony, that EC level would still act as a barrier to migration upstream of Prisoners Point. Likewise, establishing any objective at a single location well up in the Delta (such as at Vernalis) will not assure that the intervening stretch of river will be of quality adequate for spawning. The appropriate objective must be applied at several points along the San Joaquin River to assure continuity.

5.6.2.4 Prisoners Point: Relaxation Provision

The D-1485 objective for Prisoners Point did not include a relaxation provision. However, consideration of a relaxation provision is appropriate, should one of the alternatives which improve water quality above the present objective of 0.55 mmhos/cm EC be selected.

5.6.2.5 Temperature Objectives

Evidence presented in Phase I, and analysis of other data, indicate that high water temperatures may result in some possible losses of bass eggs and young. However, these losses are not considered significant. Temperature issues are discussed in Appendix 5.4.6. Based on the information available, no special measures are warranted at this time.

5.6.3 <u>Potential Objectives</u>

In view of the above considerations, the State Board has developed the following potential objectives at these locations, in addition to the possible retention of the current objectives.

5.6.3.1 Antioch: Period of Protection for Spawning
5.6.3.2 Antioch: Relaxation Provision
5.6.3.3 Prisoners Point: EC Modification
5.6.3.4 Prisoners Point: Relaxation Provision
5.6.3.5 Temperature Objectives

5.6.3.1 Antioch: Period of Protection for Spawning

Objective 1-A The 14-day running average of the mean daily EC at the Antioch Waterworks Intake on the San Joaquin River shall be not more than 1.5 mmhos/cm for the period April 1 to May 31, or until spawning has ended, in all water years.

Objective 1-B The 14-day running average of the mean daily EC at the Antioch Waterworks Intake on the San Joaquin River shall be not more than 1.5 mmhos/cm for the period April 1 to May 31, or until spawning has ended, in all water years, except that protection during the period April 1 to April 14 may be provided by maintenance of an average Delta Outflow Index for that period of not less than 6,700 cfs.

Objective 1-C The 14-day running average of the mean daily EC at the Antioch Waterworks Intake on the San Joaquin River shall be not more than 1.5 mmhos/cm for the period April 1 to May 31, or until spawning has ended, in wet, above normal, and below normal water years; or for the period April 1 to May 21, or until spawning has ended, in dry and critical water years; except that protection during the period April 1 to April 14 in all water years may be provided by maintenance of an average Delta Outflow Index for that period of not less than 6,700 cfs.

5.6.3.2 Antioch: Relaxation Provision

Objective 2-A No relaxation provision.

Objective 2-B The 14-day running average of the mean daily EC at the Antioch Waterworks Intake on the San Joaquin River shall be not more than the values (shown in the table below) corresponding to the deficiencies in firm supplies declared by the SWP and CVP, in dry and critical water years, for the period April 1 to May 31, or until spawning has ended.

Total Annual Declared Deficiencies (MAF)	April 1 to May 31 EC in mmhos/cm	
	Dry	Critical
0.0	1.5	1.5
0.5	1.8	1.9
1.0	1.8	2.5
1.5	1.8	3.4
2.0 or more	1.8	3.7

Linear interpolation is to be used to determine values between those shown.

Objective 2-C Same as 2-B, except that deficiencies are defined as deficiencies in firm supplies declared by a set of water projects representative of the Sacramento River and San Joaquin River watersheds. The specific representative projects and amounts of deficiencies would be defined in subsequent phases of the proceedings under this alternative.

Objective 2-D Same as Objective 2-B or 2-C except the period of protection is April 1 to May 21.

Objective 2-E The 14-day running average of the mean daily EC at the Antioch Waterworks Intake on the San Joaquin River shall be not more than 3.7 mmhos/cm for the period April 1 to May 31, or until spawning has ended, when the April 1, 40-30-30 Sacramento Basin Index is equal to or less than 4.8 MAF.

5.6.3.3 Prisoners Point: EC Modification

Objective 3-A The 14-day running average of the mean daily EC shall be not more than 0.30 mmhos/cm (TDS=170 mg/l) for the period April 1 to May 31, or until spawning has ended, in all water years, at the following stations: Prisoners Point, Buckley Cove, Rough and Ready Island, Brandt Bridge (site), Mossdale Bridge, and Vernalis.

Objective 3-B The 14-day running average of the mean daily EC shall be not more than 0.44 mmhos/cm (TDS=250 mg/l) for the period April 1 to May 31, or until spawning has ended, in all water years, at the following stations: Prisoners Point, Buckley Cove, Rough and Ready Island, Brandt Bridge (site), Mossdale Bridge, and Vernalis.

Objective 3-C The 14-day running average of the mean daily EC shall be not more than 0.44 mmhos/cm (TDS=250 mg/l) for the period April 1 to May 31, or until spawning has ended, in wet, above normal, and below normal water years; or for the period April 1 to May 21, or until spawning has ended, in dry and critical water years, at the following stations: Prisoners Point, Buckley Cove, Rough and Ready Island, Brandt Bridge (site), Mossdale Bridge, and Vernalis.

Objective 3-D The 14-day running average of the mean daily EC shall be not more than 0.44 mmhos/cm (TDS=250 mg/l) for the period April 1 to May 31, or until spawning has ended, in wet, above normal, and below normal water years, at the following stations: Prisoners Point, Buckley Cove, Rough and Ready Island, Brandt Bridge (site), Mossdale Bridge, and Vernalis. In dry and critical water years, the EC objective would be met only at Prisoners Point.

Objective 3-E The 14-day running average of the mean daily EC shall be not more than 0.44 mmhos/cm (TDS=250 mg/l) for the period April 1 to May 31, or until spawning has ended, at the following river reaches in the respective water years:

Wet	Prisoners Point to Vernalis
Above Normal	Prisoners Point to Mossdale Bridge
Below Normal	Prisoners Point to Rough and Ready Island
Dry	Prisoners Point to Buckley Cove
Critical	Prisoners Point only

Objective 3-F The 14-day running average of the mean daily EC at Prisoners Point shall be not more than 0.44 mmhos/cm (TDS=250 mg/l) for the period April 1 to May 31, or until spawning has ended, in all water years.

5.6.3.4 Prisoners Point: Relaxation Provision

Objective 4-A No relaxation provision.

Objective 4-B The 14-day running average of the mean daily EC shall be not more than 0.55 mmhos/cm for the period April 1 to May 31, or until spawning has ended, at Prisoners Point only, when the Antioch relaxation provision for spawning protection is in effect.

(It can be argued that the use of the Sacramento Basin 40-30-30 Water Year Index, or SWP and CVP deficiency declaration, to trigger a relaxation on an upper San Joaquin River objective is inappropriate. However, since consensus has not yet been reached on an appropriate San Joaquin Basin Index, it cannot be applied here. On the other hand, the hydrologic record shows that a critical year in the Sacramento Basin is almost always accompanied by similar conditions in the San Joaquin Basin. The State Board urges participants to complete development of a San Joaquin Basin Index for application to upper San Joaquin River objectives as soon as possible.)

5.6.3.5 Temperature Objectives

No temperature objectives are proposed at the present time for protection of adult striped bass migration and spawning, or for survival of young striped bass.

5.7 American Shad

5.7.1 Present Conditions

There are no D-1485 objectives specifically for the protection of American shad, although the striped bass standards were expected to provide collateral protection for American shad as well. DFG estimates of population size based on sampling in the mid-1970s suggest that the population is one-third to two-thirds as large as it was in the early decades of this century (DFG,23). About this same time, DFG lowered the daily catch limit from 50 to 25 fish (Michael Meinz, SWRCB, pers. comm., 6/90). Abundance of adult shad has been relatively stable over the past two decades. However, abundance of juvenile shad may vary by more than an order of magnitude between years, with the strongest year classes occurring with the highest river flows during the spawning and nursery periods (DFG,23).

5.7.2 State Board Considerations

The decline of American shad in the Estuary from levels found early in the century appears to parallel, although perhaps not so severely, the great decline seen in East Coast shad populations (USFWS & NMFS, 1977, viii). Declines in East Coast stocks have been attributed to a variety of causes, including pollution, lack of floodplain management, construction of barrier dams without fish passage facilities, and expanded and indiscriminate inshore and offshore fishing (USFWS & NMFS, 1977, vii-viii). Most of these elements may also be playing a part in the decline in Estuary stocks (DFG,23,23), although DFG cites flows and diversions as the primary areas of concern (T,XXXIX,16:4-18:18;47:7-16). DFG also testified that temperature and salinity, as well as flow, were important to production of American shad (T,XXXIX,24:22-25:1), but did not specify what temperature and salinity requirements were critical to shad production.

Because no information on salinity requirements for shad was presented or obtained from other sources, no salinity objective is offered. However, shad feed on Neomysis and other zooplankton during their spawning migration through the Delta (see Table A4-8), which suggests that the entrapment zone may serve an important function for adults as well as young of the year of this species. The nature of this function warrants study.

The Delta and its tributary streams, especially in the Sacramento Valley, are major spawning and nursery areas for American shad. If young shad react to high temperatures as many other fish species do, they are most sensitive during their first few days to weeks of growth. Young are found in the Delta and at the SWP facilities in midsummer, indicating substantial summer spawning activity within or near to the Delta (DFG,23,8-10). DFG observations indicate that these eggs and young are susceptible to considerable risk from elevated water temperatures: eggs appeared deformed and failed to develop normally when water temperatures were 70°F and above (Michael Meinz, SWRCB, pers. comm., October 1989). As indicated in Table A4-8, the optimum spawning temperature for American shad is between 60° and 70°F. The temperature objective for salmon may serve to protect American shad to some degree. The actual status and population trend of American shad remains unclear. Substantial additional work is recommended in the areas of population, reproduction and ecological requirements for this species, to provide a firm basis for possible future actions.

5.7.3 Potential Objectives

On the basis of the foregoing discussion, no objectives for protection of American shad are proposed at this time.

5.8 Delta Smelt

5.8.1 Present Conditions

Currently there is no D-1485 objective specifically for the protection of the Delta smelt, *Hypomesus transpacificus*, in the Delta. The Delta smelt is endemic to the Sacramento-San Joaquin Delta-Estuary (Moyle, 1989) and, at present, is not known to exist anywhere else in the world (Federal Register, Volume 154, No. 4). Their range extends from below Mossdale on the San Joaquin River and Isleton on the Sacramento River to Suisun Bay, Carquinez Strait and San Pablo Bay during portions of the year (Moyle, 1976).

The population of Delta smelt, once very common in the upper Estuary, has been declining over time and appears to be critically low. Several sources of information regarding long-term trends in Delta smelt numbers are available, the primary ones being: (1) DFG, mid-water trawl surveys (Stevens et al., 1990); (2) research and monitoring data from the University of California at Davis (UC Davis) (Moyle and Herbold, 1989; Moyle and Herbold, 1990); and (3) and screen salvage data from the Byron and Tracy Pumping Plants (SWC,1990;DFG,17,1-20). The data from the pumping plants are not very reliable due to the lack of an effective quality control program which may have resulted in misidentification (e.g., other species of smelt or other fish altogether) and other recording errors (SWC, 1990). Each data set however indicates a decline in the numbers of Delta smelt.

DFG (Stevens et al., 1990) stated that like the summer townet survey, the fall midwater trawl survey indicates that abundance of Delta smelt has been highly variable and has suffered a major decline. Bay survey catches show a striking decline in Delta smelt abundance after 1981, and since 1981 there has been an irregular but persistent decline. Part of this is due to the fact that the four of the last five years were low flow years and the population has been concentrated in the Delta. In the seine survey, the lowest average catches of adult Delta smelt occurred in 1980 and 1984-1989. The persistent low catches from 1984-1989 are consistent with the population decline exhibited by the midwater trawl and summer townet surveys. The DFG concluded that "the relatively stable, albeit low, population is not in imminent danger of extinction," however the Delta smelt may well "become an endangered species in the foreseeable future."

The Delta Smelt Index (Stevens and Miller, 1983) has been calculated annually from 1967-1990, except for 1974 and 1979 when no surveys were conducted; it shows an overall decrease in population size, especially from 1980-1988 (see Table 5-3; Figure 5-4). The population has fluctuated a great deal over the years; however, since 1983, the population has been consistently low. The UC Davis data show a similar trend. Several factors have possibly contributed to the decline, including invasions of exotic phytoplankton and invertebrates, entrainment into diversions and modification of the Delta smelt habitat.

5.8.2 State Board Considerations

Delta smelt are affected by the location of the entrapment zone, which appears to be important to their survival. When the entrapment zone is located in the deep, narrow channels of the Delta and Sacramento River, or in Carquinez Strait and the deeper parts of San Pablo Bay, primary productivity is lower (Moyle and Herbold, 1989). When the entrapment zone is located in Suisun Bay, the nutrients and algae can circulate in sunlit water, allowing algae to grow and reproduce rapidly, in turn, providing an abundance of food for plankton-feeding fish, such as the Delta smelt (Moyle, 1989). Years of major decline in the Delta Smelt Index occurred not only in dry years (1987,1988) but also wet years (1982,1986); in both cases, the entrapment zone moved out of Suisun Bay. Thus, Stevens and Miller (1983) did not develop a regression model for Delta smelt because all of the correlations between their abundance and flow measurements were not statistically significant. One of the strongest determinants of Delta smelt abundance is high primary productivity (as reflected by phytoplankton abundance) in late spring, April to June (Moyle and Herbold, 1989).

Table 5-3

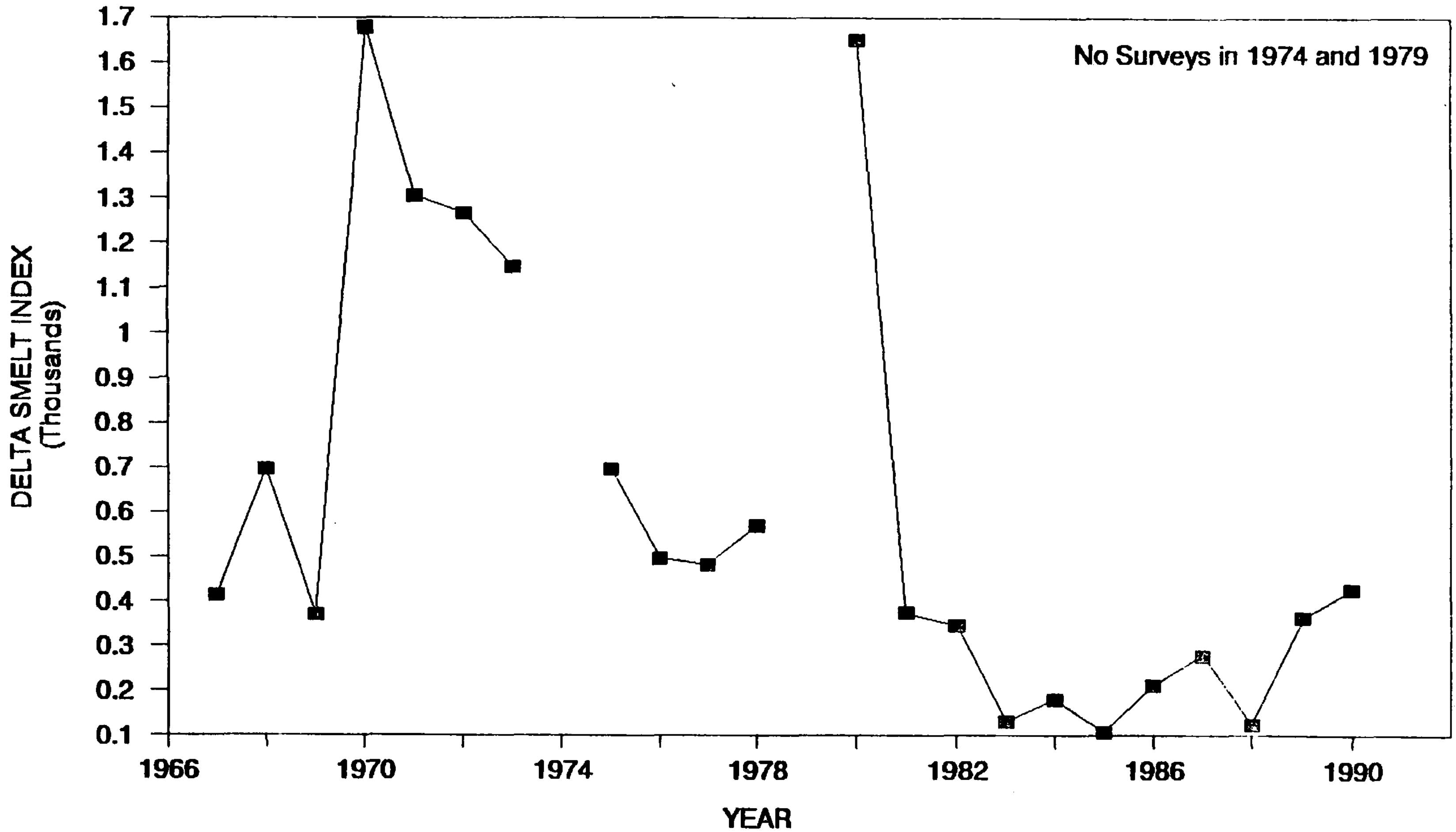
DELTA SMELT ABUNDANCE INDEX
MIDWATER TRAWL SURVEY
1967-1990

YEAR	INDEX
1967	415
1968	697
1969	371
1970	1678
1971	1305
1972	1267
1973	1146
1974	
1975	698
1976	497
1977	483
1978	570
1979	
1980	1651
1981	375
1982	346
1983	132
1984	181
1985	109
1986	212
1987	280
1988	126
1989	364
1990	427

Note: Trawl surveys were not conducted in 1974 & 1979.

From Stevens, D.E., L.W. Miller and B.C. Bolster. 1990. Report to the Fish and Game Commission: A status review of the Delta smelt (Hypomesus transpacificus) in California.

Figure 5-4 Delta Smelt Index Values



Stevens, D.E., L.W. Miller and B.C. Bolster. 1990. Report to the Fish and Game Commission: A status review of the Delta smelt (Hypomesus transpacificus) in California. Department of Fish and Game.

Further study will be required to define more specifically the habitat requirements of the Delta smelt and identify the variables contributing to their decline. The Fish and Game Commission has made a decision not to place the Delta smelt on the endangered species list; however, further analyses are being conducted in part for the requirements of the state and federal Endangered Species Acts.

Delta smelt habitat indicates a salinity preference of less than 2 ppt and seldom greater than 10 ppt (Ganssle, 1966 in SWC 1990) (less than 15 mmhos/cm EC). Another critical life history characteristic is that they spawn in sloughs and channels in the upper Delta, although spawning has also been recorded in Montezuma Slough in Suisun Bay (Moyle, 1989; SWC, 1990). They spawn from January through May and where they spawn may be influenced by the location of the fresh-saltwater interface during this time period (Moyle and Herbold, 1990). Peak numbers of smelt are salvaged at the SWP and CVP pumping plants each year during April and May (SWC, 1990, Figure 7). These smelt are either the spawning adults or the larval smelt (the information presented does not indicate which stage of development). One effective means of reducing impacts to the Delta smelt would be to reduce entrainment into the SWP and CVP pumping plants.

The location of the entrapment zone appears to be important to the survival of the Delta smelt. Although the precise level of salinity that separates acceptable and unacceptable spawning conditions is not known, existing knowledge suggests that salinities of 2 ppt or less are desired in Suisun Bay from March through June. The same needs exist for protection of the Delta smelt nursery area in Montezuma Slough (WQCP-USFWS-5). As the entrapment zone is a flow issue, this will be discussed in the Scoping and Water Right Phases of the proceedings.

There is insufficient information to set an EC or salinity objective for spawning for Delta smelt at present. Further study may provide an objective to help reverse their decline. Further studies are proposed for determining, with greater accuracy, the abundance and the factors affecting Delta smelt abundance in the Delta. The details of these studies will be discussed in the Program of Implementation, Chapter 7. Subsequent review of data may lead to appropriate water quality objectives.

5.8.3 Potential Objectives

No potential salinity or temperature objectives can be specified at this time.

5.9 Other Resident Fish in the Bay-Delta Estuary

5.9.1 Present Conditions

The Department of Fish and Game presented information on several species of resident fish found in the Bay-Delta Estuary (Appendix 4). The information on water quality habitat criteria was of a very general nature. Some species, for example, were said to have a relatively greater preference, or tolerance, for higher levels of dissolved solids or turbidity than other species. DFG recently submitted a report on white sturgeon that states the fish move up or downstream in response to salinity changes and that management of the volume of freshwater flow may be important in maintaining the sturgeon population (WQCP-DFG-1).

5.9.2 State Board Considerations

For the majority of the resident fish of the Estuary, the material presented is insufficient to be used to develop water quality objectives.

5.9.3 Potential Objectives -- None

5.10 Suisun Marsh

Conclusions:

- **The Board believes that the managed portions of Suisun Marsh are currently being protected by D-1485 as amended in 1985. The protections, including the operation of the Suisun Marsh Salinity Control Gate, are being used and evaluated.**

- **A biological assessment is needed to assess the water quality requirements of the rare, threatened and endangered plants and animals (and their habitats) in the wetlands surrounding Suisun Bay to determine reasonably necessary amendments and additions to the Suisun Marsh objectives. The results will likely not be available in time for inclusion in the final Bay-Delta Environmental Impact Report or water right decision in 1992. Shortly thereafter, the objectives will be evaluated and incorporated as warranted.**

5.10.1 Present Conditions

Since adoption of the Delta Plan and D-1485 in 1978, the SWP and CVP have been operated to meet the "interim standards." The water quality has thus been equal to or better than the interim standards.

Since the adoption of the 1978 Delta Plan and D-1485, the Four Parties have worked to implement the Plan of Protection (see Appendix 5.6). The interim Suisun Marsh standards in the 1978 Delta Plan, as implemented by D-1485, were met consistently by the DWR and the USBR. The internal marsh control stations on Montezuma Slough at National Steel and near Beldon's Landing became effective on October 1, 1988, in accordance with the amended schedule of compliance approved by the State Board on December 5, 1985 ("amended D-1485").

The improved duck club management schemes discussed in the Plan of Protection have been, for the most part, implemented. Some other intake or drainage improvements may still be needed. Construction of the Suisun Marsh Salinity Control Gate (referred to in the 1978 Delta Plan and described in more detail in the Plan of Protection) was completed in 1988; testing was begun in the winter of 1988-89 and continued through 1990. Full operation of the control gates causes a fairly rapid drop in salinity at Beldon's Landing, with a slower and more limited change in salinity in the western Marsh (farther downstream). Further testing to refine the optimal scheme for operation of the structure was done during the winter of 1990-91. The extent of the control gate's effects on western Suisun Marsh water quality will help determine whether or not additional structures mentioned in the Plan of Protection are needed, and, if any are needed, which one(s) would be best.

5.10.2 State Board Considerations

A technical analysis of the water quality standards in the SMPA is found in Appendix 5.6, Technical Analysis of the SMPA.

The 1978 Delta Plan listed eight salinity control stations for the original Suisun Marsh objectives. Seven of these stations were interior marsh stations; the eighth was on the Sacramento River at Collinsville Road, upstream of Montezuma Slough. In 1985 the State Board amended D-1485 to change both some control station locations and the compliance schedule.

The control stations on the Sacramento River at Collinsville (C-2) and Suisun Slough near Volanti Slough (S-42) were not changed. The station on Cordelia Slough above S.P.R.R. (mis-labeled S-32 in the Delta Plan) is actually the same as the station on Cordelia Slough, 500 feet west of the Southern Pacific crossing at Cygnus (S-33).

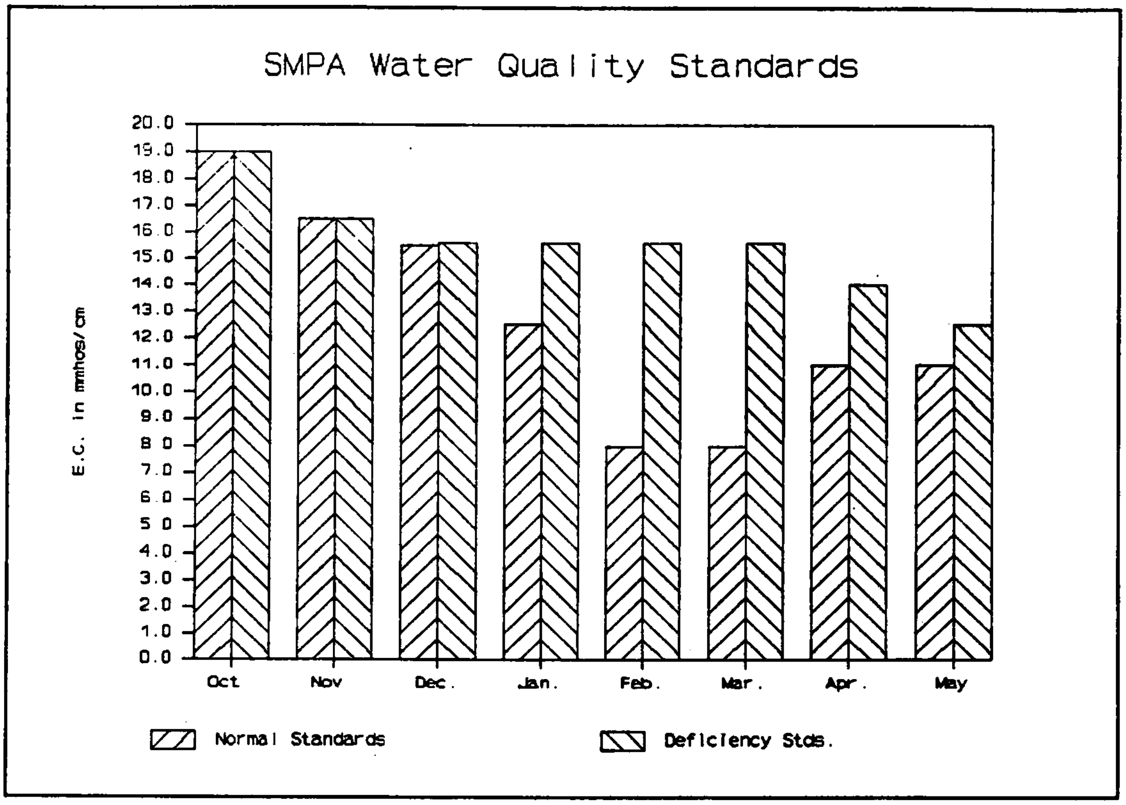
The station at Miens Landing on Montezuma Slough (S-64) was replaced with National Steel on Montezuma Slough (also S-64), three miles to the south (upstream) of Miens Landing. The station on Montezuma Slough at Cutoff Slough (S-48) was replaced with Montezuma Slough near Beldon's Landing (S-49), 0.35 miles east of Grizzly Island Bridge, approximately one-half mile upstream from the old station. The station on Goodyear Slough south of Pierce Harbor (S-35) was moved about one-half mile upstream to the Morrow Island Clubhouse, but is still designated S-35. These changes would not seem to change the level of protection afforded by the original Delta Plan stations.

The major change that the amended D-1485 made in the salinity control stations was the elimination of the two westernmost stations in Suisun Slough near its mouth (mis-labeled S-31 in the Delta Plan, actually designated S-36) and Montezuma Slough near its mouth (no exact designation in the Delta Plan, but often called D-7 in other documents). No substitutes for S-36 and D-7 are proposed. The managed marshes in this area now receive water from inland sources rather than Grizzly or Suisun bays.

Based upon the work done to date, the "Normal Standards" (see Figure 5-5) in the SMPA may adequately protect the managed wetland habitat of the Suisun Marsh. However, the SMPA also contains relaxations of these conditions during dry periods. The State Board needs additional information on the water quality requirements of the rare, threatened, and endangered species identified since DWR prepared the 1984 Plan of Protection before it can consider modifying the current water quality objectives.

A biological assessment under CESA and ESA is needed to determine the water quality requirements of the rare, threatened, and endangered plants and animals (and their habitats) in the wetlands surrounding Suisun Bay (see Chapter 7 for a description of the information needed). Based upon the results of the biological assessment, the State Board will review the proposed water quality objectives and determine if any changes are needed. The State Board will then, in a later action, assign responsibilities for meeting any changed objectives.

Figure 5-5



Month	SMPA-Normal Standards (Mean Monthly High Tide, E.C. in mmhos/cm)	SMPA-Deficiency[1] Standards (Mean Monthly High Tide, E.C. in mmhos/cm)
Oct.	19.0	19.0
Nov.	16.5	16.5
Dec.	15.6	15.6
Jan.	12.5	15.6
Feb.	8.0	15.6
Mar.	8.0	15.6
Apr.	11.0	14.0
May	11.0	12.5

1 SMPA Article 1(f): "Deficiency Period" shall mean (1) a Critical Year following a Dry or Critical Year; or (2) a Dry Year following a year in which the Four Basin Index was less than 11.35; or (3) the second consecutive Dry Year following a Critical Year.

SMPA Article 1(r): "Wet Year", "Above Normal Year", "Below Normal Year" and "Subnormal Snowmelt Year" are as defined in Footnote 2 of Table II of D-1485 as adopted by the SWRCB in August 1978. "Critical Year" and "Dry Year" are also as defined in Footnote 2 of Table II of D-1485 except that runoff for the remainder of the water year shall be assumed to be equal to the lower value of the 80 percent probability range, as shown in the most recent issue of Bulletin 120, "Water Conditions in California".

5.10.3 Potential Objectives

In order to allow sufficient time for the biological assessment to be completed, the State Board will continue implementation of the interim standards for Suisun Marsh as identified in the 1978 Delta Plan. An implementation plan is proposed, with the first stage based on D-1485 as amended in 1985. A discussion of this implementation plan is found in Chapter 7 (see also Table 1-2).

5.11 Wildlife Habitat in Other Tidal Marshes

- **Water quality objectives for San Pablo Bay exist in the Statewide Water Quality Plan for Enclosed Bays and Estuaries of California and in the Water Quality Control Plan for Region 2.**

5.11.1 Present Conditions

The tidal marshes outside the legally-defined Suisun Marsh include the southern shore of Suisun Bay (essentially from Pittsburg to Martinez) as well as the marshes around San Pablo Bay, Central Bay, and South Bay.

The current objectives provide protection for the managed marshes within the legally-defined Suisun Marsh. No water quality objectives were set specifically for tidal marshes either inside or outside the legally-defined Suisun Marsh.

5.11.2 State Board Considerations

The marshes of Central San Francisco Bay and South Bay support mostly pickleweed or cordgrass. DFG testified that they have concluded that these salt marshes would not be adversely affected by changes in the salinity regime in the northernmost portion of the Bay-Delta area (T,XXIX,146:22-147:2). The State Board concurs with the conclusions of DFG and therefore does not plan to set water quality objectives specifically for the protection of the Central and South Bay salt marshes.

San Pablo Bay is a transition zone between the saline waters of Central Bay and the brackish to fresh waters of Suisun Bay (T,XXIX,147:3-6). DFG testified that reductions in Delta outflow could result in a vegetative shift from cattails and tules to more salt-tolerant plant species such as cordgrass and pickleweed (T,XXIX,186:18-25; DFG,7,11-12). Such a vegetative shift would be detrimental to some wildlife species and beneficial to others (T,XXIX,187:1-8,223:15-224:7; DFG,7,11-13). DFG considers some impacts on rare plants to be possible.

There is no evidence that might allow the Board to set water quality objectives at this time specifically for the protection of the San Pablo Bay marshes.

The south shore of Suisun Bay is outside the legally-defined Suisun Marsh. Many of the plants and animals found in the unmanaged wetlands of the Suisun Marsh are also found in the tidal marshes of the south shore (also called the Contra Costa County shoreline). The federal and state-listed threatened, endangered, and candidate species found within the legally-defined Suisun Marsh may also be found in the south shore marshes. In addition, the federal and state-listed endangered California least tern (Sterna antillarum browni) has two nesting colonies on the south shore (USFWS,20). Additional information regarding listed species is found in Appendix 4.6.2 and Appendix 5.5.

In addition to the possible direct effects on the habitat (for animals) or on the survival (for plants, especially) of the listed species, changes in the salinity regime could indirectly affect a species by effects on its prey base. The most sensitive species in this regard is the endangered California least tern. The least terns require a nearby supply of small fish in shallow water areas (DFG, At the Crossroads 1980, p.101). USFWS testified that changes in water quality standards that could result in changes in the location of the entrapment zone could significantly affect the prey base for the tern (T,XXX,6:1-6).

Staff compared the water quality objectives proposed by BCDC for protection of the unmanaged tidal marshes outside of the legally-defined Suisun Marsh (BCDC,5,T4) and those for Suisun Marsh in the 1978 Delta Plan (SWRCB,1978,Table VI-1,p.VI-33). The BCDC proposal is based on historical records for the period 1950 to 1977 when brackish tidal marshes persisted in the area (BCDC,5,31-32). Direct comparison of the two sets of values is difficult since BCDC presented only the high-high tide salinities (mean tide salinities adjusted to high tide salinities [BCDC,5,31]) while the 1978 Delta Plan used the daily mean of both high tide salinities.

It is not possible to determine at this time whether or not the stations proposed by BCDC would provide better locations than the 1978 Delta Plan stations at Chipps Island and in Grizzly Bay at which protective levels for south shore tidal marshes can be accurately measured.

5.11.3 Potential Objectives

As stated in Section 5.10.2 a new biological assessment will be prepared. Based on the results of the biological assessment, the State Board will decide if additional objectives should be adopted.

5.12 Benthos

5.12.1 Present Conditions

Densities of benthic organisms are highly variable in the Estuary. At any location their survival, growth and reproduction can be affected by factors such as predation, disease, parasites, currents which carry them away, salinity regime, and broodstock population size (DFG,60,57). Density estimates[1] as high as 910 to 1153 grams of biomass per square meter (g/m^2) are reported in South Bay channels, and as low as 4 to 17 g/m^2 in the channels of San Pablo Bay. Suisun Bay has benthic

1/ Abundance or density of benthic organisms measured by biomass per square meter.

invertebrate biomass ranging from 25 to 34 g/m^2 in channel substrates and from 6 to 30 g/m^2 in shoal areas (CCCWA/EDF,10,T2). The number of organisms varies much more than the biomass, with a few large animals sometimes equalling the biomass of many smaller ones. At the Carquinez Strait, this biomass was made up of about 160,000 and 40,000 organisms/m^2 in June and October of 1976; 25,000 organisms/m^2 in March of 1977; and less than 1,000 organisms/m^2 in October 1977 and in 1978 (Markmann,1986,F8-F11). Numbers of organisms per square meter at all stations were low in 1978; numbers appeared to recover to about 40,000 organisms/m^2 in the western Delta (Station D4) in 1979 and 1981, although Carquinez Strait stations were no longer sampled (Markmann,1986,F8-F11). The brief peak in organism numbers in 1976 and 1977 during a major drought was due in part to an invasion of Suisun Bay by the filter-feeding clam, Mya arenaria, which replaced the usual deposit-feeding fauna (CCCWA/EDF,7,383).

Only limited evidence on the uses of benthic organisms was presented by participants in Phase I. Sport shellfishing is one use of benthic organisms, but their acceptability may be limited by pollutants (T,LIV,56:10-58:4). Both CBE and CCCWA/EDF noted that benthic organisms, especially shellfish, were food for several species of fish in the Estuary, including striped bass, starry flounder, sturgeon, English sole and staghorn sculpin (T,LIV,59:14-16;192:5-8).

5.12.2 State Board Considerations

Understanding of the benthos and its relationship to the overall estuarine ecosystem is still limited, and the introduction and rapid proliferation of Potamocorbula amurensis have further complicated benthic data analysis. Substantial additional information is required to provide a basis for possible future actions.

5.12.3 Potential Objectives

No objectives are proposed for the protection of benthic organisms at this time.

5.13 Marine Habitat

5.13.1 Present Conditions

The marine habitat outside the Golden Gate is not formally included in the definition of the San Francisco Bay-Delta Estuary (Workplan). However, the nearshore ocean habitat in the Gulf of the Farallones is closely interrelated with the Estuary by means of freshwater outflow, gravitational circulation, and tidal exchange.

Testimony presented in Phase I concerning outflows from San Francisco Bay described two main effects on marine habitat. The first is that the plume of freshwater in the Gulf of the Farallones provides for an abundant amount of marine life and thus serves as a concentrated feeding habitat for fish, marine mammals and birds (T,LIV,142:13-153:3). Two bird species which particularly use this plume area are the Brandt's cormorant and the common murre (T,LIV,154:3-13). The second effect of

San Francisco Bay outflow is related to the movement of organisms, especially the larvae and juveniles of finfish and shellfish, into the Bay (T,LI,267:23-268:4). In certain cases, such as for bay shrimp, movement of larvae out of the Bay into the Gulf of the Farallones and their return later in the year is facilitated by higher Bay outflows (T,LI,272:6-19). In some circumstances, pulse flows, and their timing, were shown to be important in the determination of abundance of larvae (T,LI,289:5-25). The larvae or adults of English sole, Dungeness crab, Pacific herring and northern anchovy are transported back into the Bay on the bottom current inflows (T,LI,292:15-25).

5.13.2 State Board Considerations

All evidence presented relates to flow rather than salinity factors. The relationship between outflow and effect on beneficial uses has not been quantified. Therefore, protection for marine habitat will be considered if further information becomes available.

5.13.3 Potential Objectives -- None

5.14 Navigation

5.14.1 Present Conditions

At present, U.S. Army Corps of Engineers (COE) criteria provide primary protection for the navigation beneficial use in the Estuary and its tributaries. For example, the CVP is required to maintain a flow of 5,000 cfs at Wilkins Slough, just below the Tisdale Wier on the Sacramento River, for protection of shallow water commercial navigation (T,I,43:15-21). In critical years the flow required is 4,000 cfs (Mike Jackson, USBR, pers. comm., 10/17/89). Likewise, the SWP and CVP export pumps currently operate to COE criteria: maximum flow rates for Clifton Court Forebay are stipulated for various times of the year to maintain minimum depths in South Delta channels (DWR,708,10). There are no Delta Plan objectives in effect specifically for the protection of this beneficial use.

5.14.2 State Board Considerations

The issues of water quality objectives for navigation are concentrated in a few specific areas: present effects of navigation channels and dredging, effects of planned projects to enhance navigation, and consideration of the effects of other projects on the navigation beneficial use. The present COE requirements are not directly related to salinity or temperature objectives for protection of the navigation beneficial use.

Navigation in the Estuary is enhanced by a network of deepwater channels to the major ports, including Sacramento and Stockton. These channels have two major effects. The deeper channels allow increased salt water intrusion into the Estuary (T,LVI,176:9-178:8;DWR,709,1-2). The proposed deepening of the Sacramento River Deep Water Ship Channel from its current 30-foot depth to 35 feet (COE, pers. comm., 10/89) could result in additional salt water penetration into the Delta in the future.

This increased salinity may have impacts on other beneficial uses such as recreational boating, which could see greater maintenance costs from hull fouling, corrosion of propellors and structures, and related problems (T,LV,158:1-7). Increased salinity intrusion could increase the amount of carriage water required to maintain Estuary salinity objectives, and may have impacts on other beneficial uses, such as recreation and sport fishing.

The second effect of the deepwater channels is the impact of dredging and dredge spoils disposal on water quality (see, for example, T,XLVIII,71:20-102:9). In 1985, nearly 8.6 million cubic yards of material were dredged in the Estuary, at a cost of more than $17 million (NOAA, 1986,97). Current and proposed actions, such as the disposal of dredge spoils from Oakland Harbor on Delta island levees, have water quality implications, but these are primarily related to pollutants and turbidity. The water quality impacts of dredging are discussed in the Pollutant Policy Document.

Other proposed projects, such as North Delta and South Delta facilities, could affect the navigation beneficial use, but the effects would primarily be the disruption or blockage of navigation channels. Effects of new projects on the navigation beneficial use will be considered when these projects are formally proposed.

5.14.3 Potential Objectives

At present there is no information which indicates that salinity or temperature objectives are needed to protect the navigation beneficial use.

5.15 Estuary Recreation Beneficial Use

5.15.1 Present Conditions

There are no Delta Plan objectives for the protection of the estuary recreation beneficial use. The waters of the Estuary are used for a variety of contact and non-contact forms of recreation, including swimming, boating, fishing, hunting, water skiing, and houseboating. The waters are also used for competitive events, marine parades and emerging activities, such as boardsailing and jetskiing. There are a variety of water-oriented, non-contact activities, such as sightseeing and bird watching, which depend on the esthetics or visual quality of the Estuary's waters to some degree (EBRPD,1,33).

Delta

SWC presented figures for projected user-days and economic values for freshwater recreation in the Delta as compared to similar types of recreation at storage and export reservoirs and facilities (SWC,65,24). Freshwater-oriented recreation in the Delta was estimated to be 8.3 million user-days in 1977-78, although this number includes some activities which do not depend entirely on the Delta's waters. However, brackish and ocean water activities were not included in the total (SWC,66,5). Testimony and evidence indicated that recreation visits to

Estuary shoreline park facilities have been growing rapidly compared to the projections used by SWC, i.e., 122 percent in two years vs. 0.8 percent/year (EBRPD,24,T1). Millions of user-days per year and daily values of $20 or more per user day for water use are calculated for recreational use of Estuary water (BISF,38,T4). An extrapolation of old studies of Delta recreation has generated estimates in the range of 13 million recreation-days annually (PICYA,2,51). No recent information based on recreation use studies is available (T,LV,137:13-16).

Suisun Marsh and Carquinez Straits Area

Some evidence was submitted on the recreational use of the Suisun Marsh or Carquinez Straits area of the Bay-Delta Estuary. BAAC submitted evidence inferring that bird-watching goes on in the Suisun Marsh (BAAC,20,26,27). From evidence submitted by EBRPD, estimated recreation at its Contra Costa shoreline facilities (Antioch and Martinez shoreline) has increased rapidly from 1981 to 1987, growing from 84,000 visitors to 287,000 visitors, or about 240 percent in six years (EBRPD,34,T1). There is little evidence linking the quantity of recreation in this reach to water quality. Both BAAC and EBRPD expressed concern that visitors to these recreational areas would experience losses of the value they place on wildlife and fish resources if those resources were harmed by flow decreases and resulting salinity increases (T,XXX,45:12-23; T,LV,184:15-25,185:1-2).

Recreational use in EBRPD units with water quality problems, Point Isabel and San Leandro Bay, increased from 71,000 to 487,000 users between 1981 and 1987, an increase of over 680 percent (EBRPD,34,T1). In comparison, the rate of growth at the nearby, unpolluted Hayward and Miller-Knox shorelines has moved from 21,000 users to 196,000, an increase of 830 percent in the same time. There was no specific information on the features which prompt users to attend the various park units, nor on the method by which use estimates were made. It does not seem reasonable to suppose that a moderate change (of one or two parts per thousand) in salinity would substantially change future recreational use. This might not be true if the change were such as to convert a freshwater beach to saltwater; however, no data are in the record on this subject.

San Francisco Bay and Adjacent Ocean

The Basin Plan for Region 2, the San Francisco Bay Basin, identifies most of the same forms of recreation as in the Delta. Recreational uses are identified for the Pacific Ocean, the San Francisco Bay system and all other surface waters (RWQCB,2,1975). Water-oriented recreation in the San Francisco Bay area was estimated to total over 127 million user-days (BISF,38,T3).

5.15.2 State Board Considerations

Water quality objectives to protect specific fish species and marsh habitat areas are intended to protect recreational uses also.

5.15.3 Potential Objectives

No other objectives for recreational use are proposed for consideration.

5.16 Export Recreation and Export Fishery Habitat

5.16.1 Present Conditions

There are no specific Delta Plan objectives for the protection of the export recreation and export fishery habitat. The SWP and CVP reservoirs and conveyance channels provide a warm water fishery habitat, and export area recreation occurs primarily at the reservoirs. Salinity throughout the system is largely controlled by the quality of the Delta water being exported. Water temperature in the export system is a function of ambient Delta water temperatures, export area weather, and project operations (flow rates, reservoir storage levels, etc.). Water temperatures in reservoirs tend to become critical primarily under conditions of extreme drawdown.

5.16.2 State Board Considerations

No participant proposed any salinity or temperature objectives specifically for protection of export recreation and fisheries. As stated before, the SWP and CVP operate to not exceed a minimum export water quality of 250 mg/l chlorides.

5.16.3 Potential Objectives

Because the factors which determine water temperature and salinity in the facilities in the export areas are influenced primarily by operation of these facilities, local water conditions, and Delta water quality, establishment of a separate specific objective for protection of export recreation and export fishery habitat is not warranted.

5.17 Export Agriculture

Conclusions:

- **Water is exported from the Delta for agricultural use in the San Joaquin Valley and southern California.**

- **To reasonably protect crops grown in the export areas, water quality objectives were developed using almonds orchards as the representative salt-sensitive crop.**

- **The Board finds that the objective of 1.0 mmhos/cm EC reasonably protects salt-sensitive crops grown in the San Joaquin Valley and southern California.**

5.17.1 Present Conditions

The Delta Plan does not contain any water quality objectives for export agriculture.

5.17.2 State Board Considerations

The drinking water objective, which is about 1.0 mmhos/cm EC, would protect most agricultural uses (see Potential Objectives in this section) of the exported water for irrigation of crops grown in the San Joaquin Valley and southern California. However, whenever a beneficial use of water exists and an appropriate objective can be specified, the use should be provided with specific protection.

5.17.3 Potential Objectives

A water quality objective of 1.0 mmhos/cm EC will be considered for the CVP and SWP export pumps for the protection of export agriculture. This objective fully protects the most sensitive crop in the CVP and SWP service area which constitutes at least 5 percent of each service area, respectively, and provides reasonable protection for minor crops. Based on information on CVP crop acreages (CVPWA,12; EDF,11,G-148), and SWP crop acreages (DWR,489h), the crops which constitute at least 5 percent of either service area are shown in Table 5-4. Salinity tolerances, in terms of EC, of several crops shown in export areas were presented by DWR (DWR,327).

TABLE 5-4

CROPS COMPRISING AT LEAST FIVE PERCENT OF EITHER THE CVP OR SWP SERVICE AREAS AND THEIR SALINITY TOLERANCES

Crop	Salinity Tolerances, EC (mmhos/cm)	Crop as % of CVP Service Area	Crop as % of SWP Service Area	Crop as % of CVP & SWP Service Area
Cotton	5.1	36.5	47.2	39.4
Alfalfa	1.3	8.5	9.0	8.6
Wheat	4.0	7.1	6.7	7.0
Tomatoes	1.7	6.9	0.4	5.0
Orchards	1.0	6.3	15.5	8.8

5.18 Matrix of Alternative Water Quality Objectives

Table 5-5, Alternative Water Quality Objectives, summarizes beneficial uses according to three categories described in this chapter and Appendix 5.0:

- Present Objectives
- Advocated Levels (of Protection)
- Potential Objectives

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TABLE 5-5 ALTERNATIVE WATER QUALITY OBJECTIVES

A) MUNICIPAL AND INDUSTRIAL

ALTERNATIVES/ *SOURCE*	LOCATION	SAMPLING SITE NOs. (I-A/RKI)	PARAMETER	DESCRIPTION	INDEX TYPE	YEAR TYPE	DATES	VALUES
PRESENT OBJECTIVES								
D-1485	*Cache Slough at City of Vallejo Intake*	*C-19 SLCCH16*	*Chloride (Cl-)*	*Maximum mean daily, in mg/l*	*Not Applicable*	*All*	*Oct-Sep*	*250*
D-1485	*Contra Costa Canal at Pumping Plant #1*	*C-5 CHCCC06*	*Chloride (Cl-)*	*Maximum mean daily, in mg/l*	*Not Applicable*	*All*	*Oct-Sep*	*250*
D-1485	*Contra Costa Canal at Pumping Plant #1 - or - San Joaquin River at Antioch Water Works Intake*	*C-5 CHCCC06* / *D-12(near) RSAN007*	*Chloride (Cl-)* / *Chloride (Cl-)*	*Maximum mean daily 150 mg/l chloride for at least the number of days shown during the Calendar Year. Must be provided in intervals of not less than two weeks duration. (% of Calendar Year shown in parenthesis)*	*D-1485 (Water Year)* / *D-1485 (Water Year)*	*W* *AN* *BN* *D* *C*		*No. of days each Cal. Year < 150 mg/l Cl-* *240 (66%)* *190 (52%)* *175 (48%)* *165 (45%)* *155 (42%)*
D-1485	*West Canal at mouth of Clifton Court Forebay*	*C-9 CHWST0*	*Chloride (Cl-)*	*Maximum mean daily, in mg/l*	*Not Applicable*	*All*	*Oct-Sep*	*250*
	Delta Mendota Canal at Tracy Pumping Plant	*DMC-1 CHDMC004*	*Chloride (Cl-)*	*Maximum mean daily, in mg/l*	*Not Applicable*	*All*	*Oct-Sep*	*250*
ADVOCATED LEVELS								
DWR	*Barker Slough at North Bay Aqueduct Intake*	*- SLBAR3*	*Chloride (Cl-)*	*Maximum mean daily, in mg/l*	*None Specified*	*All*	*Oct-Sep*	*250*
USBR	*Barker Slough at North Bay Aqueduct Intake*	*- SLBAR3*	*Chloride (Cl-)*	*Maximum mean daily, in mg/l*	*None Specified*	*All*	*Oct-Sep*	*250*
SWC	*Barker Slough at North Bay Aqueduct Intake*	*- SLBAR3*	*Chloride (Cl-)*	*Maximum mean daily, in mg/l*	*None Specified*	*All*	*Oct-Sep*	*250*
DWR	*Contra Costa Canal at Pumping Plant #1*	*C-5 CHCCC06*	*Chloride (Cl-)*	*Maximum mean daily, in mg/l*	*None Specified*	*All*	*Oct-Sep*	*250*
DWR	*Old River near Rancho Del Rio*	*D-28A ROLD21*	*Chloride (Cl-)*	*Maximum mean daily, in mg/l*	*None Specified*	*All*	*Oct-Sep*	*250*

TABLE 5-5 (cont.) ALTERNATIVE WATER QUALITY OBJECTIVES

A) MUNICIPAL AND INDUSTRIAL

ALTERNATIVES/ *SOURCE*	LOCATION	SAMPLING SITE NOs. (I-A/RKI)	PARAMETER	DESCRIPTION	INDEX TYPE	YEAR TYPE	DATES	VALUES
ADVOCATED LEVELS (cont.)								
USBR	*Contra Costa Canal at Pumping Plant #1*	*C-5 CHCCC06*	*Chloride (Cl-)*	*Maximum mean daily, in mg/l*	*None Specified*	*All*	*Oct-Sep*	*250*
SWC	*Contra Costa Canal at Pumping Plant #1*	*C-5 CHCCC06*	*Chloride (Cl-)*	*Maximum mean daily, in mg/l*	*None Specified*	*All*	*Oct-Sep*	*250*
SWC	*Old River near Rancho Del Rio*	*D-28A ROLD21*	*Chloride (Cl-)*	*Maximum mean daily, in mg/l*	*None Specified*	*All*	*Oct-Sep*	*250*
CCWD	*Contra Costa Canal at Pumping Plant #1 [1]*	*C-5 CHCCC06*	*Chloride (Cl-)*	*Maximum mean daily, in mg/l*	*None Specified*	*All*	*Apr-Jun*	*50*
CCWD	*Contra Costa Canal at Pumping Plant #1*	*C-5 CHCCC06*	*Sodium (Na+)*	*Maximum mean daily, in mg/l*	*None Specified*	*All*	*Oct-Sep*	*20*
DWR	*West Canal at mouth of Clifton Court Forebay*	*C-9 CHWST0*	*Chloride (Cl-)*	*Maximum mean daily, in mg/l*	*None Specified*	*All*	*Oct-Sep*	*250*
DWR	*Delta Mendota Canal at Tracy Pumping Plant*	*DMC-1 CHDMC004*	*Chloride (Cl-)*	*Maximum mean daily, in mg/l*	*None Specified*	*All*	*Oct-Sep*	*250*
USBR	*West Canal at mouth of Clifton Court Forebay*	*C-9 CHWST0*	*Chloride (Cl-)*	*Maximum mean daily, in mg/l*	*None Specified*	*All*	*Oct-Sep*	*250*
USBR	*Delta Mendota Canal at Tracy Pumping Plant*	*DMC-1 CHDMC004*	*Chloride (Cl-)*	*Maximum mean daily, in mg/l*	*None Specified*	*All*	*Oct-Sep*	*250*
SWC	*West Canal at mouth of Clifton Court Forebay*	*C-9 CHWST0*	*Chloride (Cl-)*	*Maximum mean daily, in mg/l*	*None Specified*	*All*	*Oct-Sep*	*250*
SWC	*Delta Mendota Canal at Tracy Pumping Plant*	*DMC-1 CHDMC004*	*Chloride (Cl-)*	*Maximum mean daily, in mg/l*	*None Specified*	*All*	*Oct-Sep*	*250*
DWR/SWC CONTRACT	*West Canal at mouth of Clifton Court Forebay*	*C-9 CHWST0*	*Chloride (Cl-)*	*Max monthly average, in mg/l*	*None Specified*	*All*	*Oct-Sep*	*100*

TABLE 5-5 (cont.) ALTERNATIVE WATER QUALITY OBJECTIVES

A) MUNICIPAL AND INDUSTRIAL

ALTERNATIVES/ *SOURCE*	LOCATION	SAMPLING SITE NOs. (I-A/RKI)	PARAMETER	DESCRIPTION	INDEX TYPE	YEAR TYPE	DATES	VALUES
ADVOCATED LEVELS (cont.)								
DWR/SWC CONTRACT	*West Canal at mouth of Clifton Court Forebay*	*C-9 CHWST0*	*Chloride (Cl-)*	*Max 10-year average, in mg/l*	*None Specified*	*All*	*Oct-Sep*	*55*
	West Canal at mouth of Clifton Court Forebay	*C-9 CHWST0*	*Total Dissolved Solids (TDS)*	*Max monthly average, in mg/l*	*None Specified*	*All*	*Oct-Sep*	*440*
	West Canal at mouth of Clifton Court Forebay	*C-9 CHWST0*	*Total Dissolved Solids (TDS)*	*Max 10-year average, in mg/l*	*None Specified*	*All*	*Oct-Sep*	*220*
POTENTAL OBJECTIVES								
	Contra Costa Canal at Pumping Plant #1	*C-5 CHCCC06*	*Chloride (Cl-)*	*Maximum mean daily, in mg/l*	*Not Applicable*	*All*	*Oct-Sep*	*250*
	Contra Costa Canal at Pumping Plant #1 - or - San Joaquin River at Antioch Water Works Intake	*C-5 CHCCC06* / *D-12(near) RSAN007*	*Chloride (Cl-)* / *Chloride (Cl-)*	*Maximum mean daily 150 mg/l chloride for at least the number of days shown during the Calendar Year. Must be provided in intervals of not less than two weeks duration. (% of Calendar Year shown in parenthesis)*	*Sac R 40-30-30* / *Sac R 40-30-30*	*W* *AN* *BN* *D* *C*		*No. of days each Cal. Year < 150 mg/l Cl-* *240 (66%)* *190 (52%)* *175 (48%)* *165 (45%)* *155 (42%)*
	West Canal at mouth of Clifton Court Forebay	*C-9 CHWST0*	*Chloride (Cl-)*	*Maximum mean daily, in mg/l*	*Not Applicable*	*All*	*Oct-Sep*	*250*
	Delta Mendota Canal at Tracy Pumping Plant	*DMC-1 CHDMC004*	*Chloride (Cl-)*	*Maximum mean daily, in mg/l*	*Not Applicable*	*All*	*Oct-Sep*	*250*
	Cache Slough at City of Vallejo Intake [2] and/or	*C-19 SLCCH16*	*Chloride (Cl-)*	*Maximum mean daily, in mg/l*	*Not Applicable*	*All*	*Oct-Sep*	*250*
	Barker Slough at North Bay Aqueduct Intake	*- SLBAR3*	*Chloride (Cl-)*	*Maximum mean daily, in mg/l*	*Not Applicable*	*All*	*Oct-Sep*	*250*

TABLE 5-5 (cont.) ALTERNATIVE WATER QUALITY OBJECTIVES

A) MUNICIPAL AND INDUSTRIAL

TRIHALOMETHANES

ALTERNATIVES/ *SOURCE*	LOCATION	SAMPLING SITE NOs. (I-A/RKI)	PARAMETER	DESCRIPTION	INDEX TYPE	YEAR TYPE	DATES	VALUES
PRESENT OBJECTIVES								
EPA Standards [3]	*All points of delivery*		*Trihalomethanes (THMs)*	*Running average of quarterly sampling, in ug/l*	*Not Applicable*	*All*	*Oct-Sep*	*100 [3]*
ADVOCATED LEVELS								
MWD	*All M&I supply intakes in Delta*		*Trihalomethane Precursors (THM Precursors)*		*None Specified*	*None Specified*	*None Specified*	*To be developed by SWRCB*
Delta M&I Workgroup	*All M&I supply intakes in Delta*		*Chloride (Cl-)*	*To limit bromide to <= 0.15 mg/l*	*None Specified*	*None Specified*	*When Feasible*	*50 mg/l*
POTENTIAL OBJECTIVES								
	Contra Costa Canal at Pumping Plant #1	*C-5 CHCCC06*	*Chloride (Cl-)*	*Maximum mean daily 150 mg/l chloride for at least the number of days shown during the Calender Year. Must be provided in intervals of not less than two weeks duration. (% of calendar years shown in parenthesis)*	*Sac R 40-30-30*		*No. of days each Cal. [4] Year < 150 mg/l Cl-*	
						W		*240 (66%)*
						AN		*190 (52%)*
						BN		*175 (48%)*
						D		*165 (45%)*
						C		*155 (42%)*
	All M&I supply intakes in Delta		*Chloride (Cl-)*	*To limit bromide to <= 0.15 mg/l*	*None Specified*	*None Specified*	*When Feasible*	*50 mg/l*

TABLE 5 - 5 (cont.) ALTERNATIVE WATER QUALITY OBJECTIVES

B) AGRICULTURAL

AREA

ALTERNATIVES/ *SOURCE*	LOCATION	SAMPLING SITE NOs. (I-A/RKI)	PARAMETER	DESCRIPTION	INDEX TYPE	YEAR TYPE	DATES	VALUES
				1) WESTERN DELTA				
PRESENT OBJECTIVES								
D-1485	*Sacramento River at Emmaton*	*D-22 RSAC092*	*Electrical Conductivity (EC)*	*Maximum 14-day running average of mean daily, in mmhos/cm (mmhos)*	*D-1485 (Water Year)*		*0.45 EC April 1 to Date Shown*	*EC from Date Shown to Aug. 15 [5]*
						W	*Aug. 15*	--
						AN	*July 1*	*0.63*
						BN	*June 20*	*1.14*
						D	*June 15*	*1.67*
						C	--	*2.78*
	San Joaquin River at Jersey Point	*D-15 RSAN018*	*Electrical Conductivity (EC)*	*Maximum 14-day running average of mean daily, in mmhos*	*D-1485 (Water Year)*		*0.45 EC April 1 to Date Shown*	*EC from Date Shown to Aug. 15 [5]*
						W	*Aug. 15*	--
						AN	*Aug. 15*	--
						BN	*June 20*	*0.74*
						D	*June 15*	*1.35*
						C	--	*2.20*
ADVOCATED LEVELS								
CVPWA, SWC	*Sacramento River at Emmaton - and -*	*D-22 RSAC092*	*Electrical Conductivity (EC)*	*Maximum 14-day running average of mean daily, in mmhos*	*None Specified*		*1.5 EC April 1 to Date Shown*	*3.0 EC Date Shown to Aug. 15 [5]*
	San Joaquin River at Jersey Point	*D-15 RSAN018*	*Electrical Conductivity (EC)*	*Maximum 14-day running average of mean daily, in mmhos*	*None Specified*	*W*	*Aug. 15*	--
						AN	*Aug. 15*	--
						BN	*Aug. 15*	--
						D	*Aug. 15*	--
						C	*Jul. 31*	*Aug. 1*
DWR	*Sacramento River at Emmaton -and- San Joaquin River at Jersey Point*	*D-22 RSAC092 D-15 RSAN018*	*Electrical Conductivity (EC)*	*Average monthly, in mmhos*	*None Specified*	*----------- Based on Corn Study ----------*		

TABLE 5 - 5 (cont.) ALTERNATIVE WATER QUALITY OBJECTIVES

B) AGRICULTURAL

AREA

ALTERNATIVES/ *SOURCE*	LOCATION	SAMPLING SITE NOs. (I-A/RKI)	PARAMETER	DESCRIPTION	INDEX TYPE	YEAR TYPE	DATES	VALUES
			1) WESTERN DELTA (cont.)					
ADVOCATED LEVELS (cont.)								
CCCWA	*Sacramento River at Emmaton -and- San Joaquin River at Jersey Point*	*D-22 RSAC092 D-15 RSAN018*	*Electrical Conductivity (EC)*	*Maximum 14-day running average of mean daily, in mmhos*	*None Specified*	*All*	*Apr 1-Aug 15*	*0.45*
CDWA	*Sacramento River at Emmaton -and-*	*D-22 RSAC092*	*Electrical Conductivity (EC)*	*Maximum monthly average of mean daily, in mmhos*	*None Specified*	*All*	*Apr 1-Mar 31*	*0.45*
						------ adjustments not quantified ------		
	San Joaquin River at Jersey Point	*D-15 RSAC018*	*Electrical Conductivity (EC)*	*Maximum monthly average of mean daily, in mmhos*		*All*	*Apr 1-Mar 31*	*0.45*
						------ adjustments not quantified ------		
POTENTIAL OBJECTIVES								
	Sacramento River at Emmaton	*D-22 RSAC092*	*Electrical Conductivity (EC)*	*Maximum 14-day running average of mean daily, in mmhos/cm*	*Sac R 40-30-30*		*0.45 EC April 1 to Date Shown*	*EC from Date Shown to Aug. 15 [5]*
						W	*Aug. 15*	*--*
						AN	*July 1*	*0.63*
						BN	*June 20*	*1.14*
						D	*June 15*	*1.67*
						C	*--*	*2.78*
	San Joaquin River at Jersey Point	*D-15 RSAN018*	*Electrical Conductivity (EC)*	*Maximum 14-day running average of mean daily, in mmhos*	*Sac R 40-30-30*		*0.45 EC April 1 to Date Shown*	*EC from Date Shown to Aug. 15 [5]*
						W	*Aug. 15*	*--*
						AN	*Aug. 15*	*--*
						BN	*June 20*	*0.74*
						D	*June 15*	*1.35*
						C	*--*	*2.20*

TABLE 5-5 (cont.) ALTERNATIVE WATER QUALITY OBJECTIVES

B) AGRICULTURAL

AREA

ALTERNATIVES/ *SOURCE*	LOCATION	SAMPLING SITE NOs. (I-A/RKI)	PARAMETER	DESCRIPTION	INDEX TYPE	YEAR TYPE	DATES	VALUES
			2) INTERIOR DELTA					
PRESENT OBJECTIVES								
D-1485	*South Fork Mokelumne River at Terminous*	*C-13 RSMKL08*	*Electrical Conductivity (EC)*	*Maximum 14-day running average of mean daily, in mmhos*	*D-1485 (Water Year)*		*0.45 EC April 1 to Date Shown*	*EC from Date Shown to Aug. 15 [5]*
						W	*Aug. 15*	--
						AN	*Aug. 15*	--
						BN	*Aug. 15*	--
						D	*Aug. 15*	--
						C	--	*0.54*
	San Joaquin River at San Andreas Landing	*C-4 RSAN032*	*Electrical Conductivity (EC)*	*Maximum 14-day running average of mean daily, in mmhos*	*D-1485 (Water Year)*		*0.45 EC April 1 to Date Shown*	*EC from Date Shown to Aug. 15 [5]*
						W	*Aug. 15*	--
						AN	*Aug. 15*	--
						BN	*Aug. 15*	--
						D	*Jun. 25*	*0.58*
						C	--	*0.87*
ADVOCATED LEVELS		[6]						
NDWA/ DWR CONTRACT	*Sacramento River at Emmaton*	*D-22 RSAC092*	*Electrical Conductivity (EC)*	*Maximum 14-day running average of mean daily, in mmhos*	*D-1485 (Water Year)*	*per contract*	*per contract*	*0.45-3.6 [7]*
	South Fork Mokelumne River at Terminous	*C-13 RSMLK08*	"	"	"	"	"	*0.45-1.1 [7]*
	San Joaquin River at San Andreas Landing	*C-4 RSAN032*	"	"	"	"	"	*0.45-1.2 [7]*
	Sacramento River at Rio Vista Bridge	*D-24 RSAC101*	"	"	"	"	"	"
	North Fork Mokelumne River near Walnut Grove (exact location not specified)	- *RMKL020 (?)*	"	"	"	"	"	*0.45-0.6 [7]*

TABLE 5 – 5 (cont.) ALTERNATIVE WATER QUALITY OBJECTIVES

B) AGRICULTURAL

AREA

ALTERNATIVES/ *SOURCE*	LOCATION	SAMPLING SITE NOs. (I-A/RKI)	PARAMETER	DESCRIPTION	INDEX TYPE	YEAR TYPE	DATES	VALUES
			2) INTERIOR DELTA					
ADVOCATED LEVELS (cont.)		*[6]*						
NDWA/ DWR CONTRACT	*Sacramento River at Walnut Grove -and- Steamboat Slough at Sutter Slough*	*- RSAC124 - SLSBT11*	*Electrical Conductivity (EC)*	*Maximum 14-day running average of mean daily, in mmhos*	*D-1485 (Water Year)*	*not shown*	*not shown*	*0.45-0.6 [7]*
ECCID/DWR CONTRACT	*Old River at Indian Slough*	*- ROLD32*	*Electrical Conductivity (EC)*	*Maximum 14-day running average of mean daily, in mmhos*	*D-1485 (Water Year)*	*not shown*	*not shown*	*0.45-1.2 [7]*
DWR	*South Fork Mokelumne River at Terminous San Joaquin River at San Andreas Landing -and- Cache Slough near Junction Point (proposed)*	*C-13 RSMLK08 C-4 RSAN032 CS-1(prop.) SLCCH00*	*Electrical Conductivity (EC)*	*Maximum 14-day running average of mean daily, in mmhos*	*None Specified*	*----- Based on Corn Study -----*		
DTAC	*Central Delta*	*-*	*Electrical Conductivity (EC)*	*Maximum 14-day running average of mean daily, in mmhos*	*None Specified*	*All except C*	*Apr 1-Aug 15*	*1.5-2.5*
						C	*"*	*None*
CCCWA	*Delta lowlands with organic soils*	*-*	*Electrical Conductivity (EC)*	*Maximum 14-day running average of mean daily, in mmhos*	*None Specified*	*All*	*Apr 1-Aug 15*	*0.45*
CDWA	*San Joaquin River at San Andreas Landing*	*C-4 RSAN032*	*Electrical Conductivity (EC)*	*Maximum monthly average of mean daily, in mmhos*	*None Specified*	*All*	*Apr 1-Mar 31*	*0.45*
							------ except for ------	
							Aug / Sep / Oct	
						D	*--- / 0.65 / 0.60*	
						C	*0.54 / 0.80 / 0.90*	

TABLE 5 - 5 (cont.) ALTERNATIVE WATER QUALITY OBJECTIVES

B) AGRICULTURAL

AREA

ALTERNATIVES/ *SOURCE*	LOCATION	SAMPLING SITE NOs. (I-A/RKI)	PARAMETER	DESCRIPTION	INDEX TYPE	YEAR TYPE	DATES	VALUES
				2) INTERIOR DELTA (cont.)				
ADVOCATED LEVELS (cont.)		[6]						
CDWA	*South Fork Mokelumne River at Terminous*	*C-13 RSMLK08*	*Electrical Conductivity (EC)*	*Maximum monthly average of mean daily, in mmhos*	*None Specified*	*All*	*Apr 1-Mar 31*	*0.45*
						------ *adjustments not quantified* ------		
	Old River near Holland Tract (exact loc. not spec.) -or-	*- ROLD19(?)*	*Electrical Conductivity (EC)*	*Maximum monthly average of mean daily, in mmhos*	*None Specified*	*All*	*Apr 1-Mar 31*	*0.45*
						------ *adjustments not quantified* ------		
	Old River near Rancho Del Rio	*D-28A ROLD21*	*Electrical Conductivity (EC)*	*Maximum monthly average of mean daily, in mmhos*	*None Specified*	*All*	*Apr 1-Mar 31*	*0.45*
						------ *adjustments not quantified* ------		
	Turner Cut near McDonald Island Bridge	*MD-4 CFTRN1*	*Electrical Conductivity (EC)*	*Maximum monthly average of mean daily, in mmhos*	*None Specified*	*All*	*Apr 1-Mar 31*	*0.45*
						------ *adjustments not quantified* ------		
POTENTIAL OBJECTIVES								
	South Fork Mokelumne River at Terminous	*C-13 RSMKL08*	*Electrical Conductivity (EC)*	*Maximum 14-day running average of mean daily, in mmhos*	*Sac R 40-30-30*		*0.45 EC April 1 to Date Shown*	*EC from Date Shown to Aug. 15 [5]*
						W	*Aug. 15*	--
						AN	*Aug. 15*	--
						BN	*Aug. 15*	--
						D	*Aug. 15*	--
						C	--	*0.54*
	San Joaquin River at San Andreas Landing	*C-4 RSAN032*	*Electrical Conductivity (EC)*	*Maximum 14-day running average of mean daily, in mmhos*	*Sac R 40-30-30*		*0.45 EC April 1 to Date Shown*	*EC from Date Shown to Aug. 15 [5]*
						W	*Aug. 15*	--
						AN	*Aug. 15*	--
						BN	*Aug. 15*	--
						D	*Jun. 25*	*0.58*
						C	--	*0.87*

TABLE 5 – 5 (cont.) ALTERNATIVE WATER QUALITY OBJECTIVES

B) AGRICULTURAL

AREA

ALTERNATIVES/ *SOURCE*	LOCATION	SAMPLING SITE NOs. (I-A/RKI)	PARAMETER	DESCRIPTION	INDEX TYPE	YEAR TYPE	DATES	VALUES
			3) SOUTH DELTA					
PRESENT OBJECTIVES								
D-1422 [8]	*San Joaquin River at Airport Way Bridge, Vernalis*	*C-10 RSAN112*	*Total Dissolved Solids (TDS)*	*Mean monthly, in mg/l*	*Not Applicable*	*All*	*Oct-Sep*	*500*
Region 5 Water Quality Control Plan	*San Joaquin River at Airport Way Bridge, Vernalis*	*C-10 RSAN112*	*Total Dissolved Solids (TDS)*	*Maximum 30-day running average of mean daily, in mg/l*	*Not Applicable*	*All*	*Oct-Sep*	*500*
USBR/SDWA AGREEMENT	*San Joaquin River at Airport Way Bridge, Vernalis*	*C-10 RSAN112*	*Total Dissolved Solids (TDS)*	*Maximum 14-day running average of mean daily EC, in mmhos*	*Not Applicable*	*All*	*Apr 1-Oct 31* *Nov 1-Mar 31*	*450 ** *500 **
				** May be modified by agreement of parties or because of emergency conditions. Releases from New Melones Reservoir will be limited to a maximum of 150,000 AF/water year in addition to releases to maintain Fish & Water Quality in accordance with D-1422*				
ADVOCATED LEVELS		[6]						
SDWA	*San Joaquin River at Airport Way Bridge, Vernalis*	*C-10 RSAN112*	*Total Dissolved Solids (TDS)*	*Maximum monthly average of mean daily, in mg/l*	*None Specified*	*All*	*Mar 1-Sep 30*	*400 [9]*
	Old River at Tracy Road Bridge	*P-12 ROLD59*		*Maximum 7-day running average of mean daily, in mg/l*	*None Specified*	*All*	*Mar 1-Jun 30*	*400 [9]*
	Old River near Middle River	*C-8 ROLD69*		*Maximum 7-day running average of mean daily, in mg/l*	*None Specified*	*All*	*Jul 1-Oct 31*	*500 [9]*
	San Joaquin River at Brandt Bridge [site]	*C-6 RSAN073*		*Maximum 7-day running average of mean daily, in mg/l*	*None Specified*	*All*	*Nov 1-Feb 28*	*500 [9]*
	San Joaquin River at Mossdale Bridge	*C-7 RSAN087*						
	Middle River at Howard Road Bridge	*P-11 RMID34*						
	Old River at Westside ID Intake	*-- ROLD51*						

TABLE 5 – 5 (cont.) ALTERNATIVE WATER QUALITY OBJECTIVES

B) AGRICULTURAL

AREA

ALTERNATIVES/ SOURCE	LOCATION	SAMPLING SITE NOs. (I-A/RKI)	PARAMETER	DESCRIPTION	INDEX TYPE	YEAR TYPE	DATES	VALUES
			3) SOUTH DELTA (cont.)					
ADVOCATED LEVELS (cont.)								
USBR	*Delta Uplands*	--	*Total Dissolved Solids (TDS)*	*Maximum monthly average of mean daily, in mg/l*	*None Specified*	*Normal* *C*	*Apr 1-Mar 31* "	*800* *600*
CVWPA	*San Joaquin River at Airport Way Bridge, Vernalis*	*C-10* *RSAN112*	*Total Dissolved Solids (TDS)*	*Maximum 30-day running average of mean daily, in mg/l*	*None Specified*	*All*	*Oct-Sep*	*500*
POTENTIAL OBJECTIVES		*(To be implemented by 1996) [10]*						
	San Joaquin River at Airport Way Bridge, Vernalis	*C-10* *RSAN112*	*Electrical Conductivity (EC)*	*Maximum 30-day running average of mean daily EC,in mmhos*	*Not Applicable*	*All*	*Apr 1-Aug 31* *Sep 1-Mar 31* *or*	*0.7* *1.0*
	Old River near Middle River	*C-8* *ROLD69*			*If a three-party contract has been implemented among DWR, USBR and the SDWA, that constract wil be reviewed prior to implementation of the above and, after also considering the needs of other beneficial uses, revisions will be made to the objectives and compliance/monitoring locations noted above, as appropriate.*			
	Old River at Tracy Road Bridge	*P-12* *ROLD59*						
	San Joaquin River at Brandt Bridge [site]	*C-6* *RSAN073*						
			4) EXPORT					
PRESENT OBJECTIVES								
	None specified for export agriculture.							
ADVOCATED LEVELS								
	None advocated for export agriculture.							
POTENTIAL OBJECTIVES								
	West Canal at mouth of Clifton Court Forebay -and-	*C-9* *CHWST0*	*Electrical Conductivity (EC)*	*Maximum monthly average of mean daily EC,in mmhos*	*Not Applicable*	*All*	*Oct-Sep*	*1.0*
	Delta Mendota Canal at Tracy Pumping Plant	*DMC-1* *CHDMC004*						

TABLE 5 - 5 (cont.) ALTERNATIVE WATER QUALITY OBJECTIVES

C) FISH AND WILDLIFE

HABITAT/SPECIES

ALTERNATIVES/ *SOURCE*	LOCATION	SAMPLING SITE NOs. (I-A/RKI)	PARAMETER	DESCRIPTION	INDEX TYPE	YEAR TYPE	DATES	VALUES
			FISHERY HABITAT PROTECTION (ENTRAPMENT ZONE)					
PRESENT OBJECTIVES								
	None specified							
ADVOCATED LEVELS								
CCCWA/ EDF	*Sacramento River at Chipps Island*	*D-10 RSAC075*	*Electrical Conductivity (EC)*	*28-day tidally averaged mean bottom salinity less than value shown in mmhos*	*D-1485 (Water Year)*	*All except C*	*Apr 1-Sep 30*	*2.0*
CCCWA/ EDF	*Suisun Bay at Martinez*	*D-6 RSAC056*	*Salinity (TDS)*	*Tidally averaged bottom salinity less than value shown in parts per thousand (ppt) over at least a 28-day period between dates shown*	*D-1485 (Water Year)*	*All except C*	*Oct 1-Apr 30*	*5.0*
POTENTIAL OBJECTIVES								
	None Specified							

ALTERNATIVES/ *SOURCE*	LOCATION	SAMPLING SITE NOs. (I-A/RKI)	PARAMETER	DESCRIPTION	INDEX TYPE	YEAR TYPE	DATES	VALUES
			CHINOOK SALMON					
PRESENT OBJECTIVES - DISSOLVED OXYGEN								
Region 5 Water Quality Control Plan	*Sacramento River and all Delta waters west of the Antioch Bridge*	*All*	*Dissolved Oxygen (DO)*	*Minimum dissolved oxygen, in mg/l*	*None Specified*	*All*	*All year*	*7.0*
	All other Delta waters except: - Man-made bodies of water - Sites where fishery is not a beneficial use	*All*	*Dissolved Oxygen (DO)*	*Minimum dissolved oxygen, in mg/l*	*None Specified*	*All*	*All year*	*5.0*
DFG,USFWS DWR & USBR Agreement	*San Joaquin River between Turner Cut & Stockton*	*RSAN050- RSAN061*	*Dissolved Oxygen (DO)*	*Minimum dissolved oxygen, in mg/l*	*None Specified*	*All*	*All year*	*6.0*
ADVOCATED LEVELS - DISSOLVED OXYGEN								
USFWS, DFG	*San Joaquin River between Turner Cut and Stockton*	*RSAN050- RSAN061*	*Dissolved Oxygen (DO)*	*Minimum dissolved oxygen, in mg/l*	*None Specified*	*All*	*Sep 1-Nov 30*	*6.0*

TABLE 5 - 5 (cont.) ALTERNATIVE WATER QUALITY OBJECTIVES

C) FISH AND WILDLIFE

HABITAT/SPECIES

ALTERNATIVES/ *SOURCE*	LOCATION	SAMPLING SITE NOs. (I-A/RKI)	PARAMETER	DESCRIPTION	INDEX TYPE	YEAR TYPE	DATES	VALUES
CHINOOK SALMON (cont.)								
POTENTIAL OBJECTIVES - DISSOLVED OXYGEN								
	San Joaquin River between Turner Cut & Stockton	*RSAN050- RSAN061*	*Dissolved Oxygen (DO)*	*Minimum dissolved oxygen, in mg/l*	*None Specified*	*All*	*Sep 1-Nov 30*	*6.0*
PRESENT OBJECTIVES - TEMPERATURE								
Regional Water Quality Control Board Basin Plan 5	*Sacramento River from Hamilton City to I Street Bridge*		*Temperature*	*Narrative Objective*		*All*		*
				* *The temperature shall not be elevated above 68 degrees F in the reach from Hamilton City to the I Street Bridge during periods when temperature increases will be detrimental to the fishery (also see page III-6 of Basin Plan 5).*				
Regional Water Quality Control Board Basin Plans 2 & 5	*All Delta waters*	-	*Temperature*	*Narrative Objective*		*All*		**
				** *The natural receiving water temperature of intrastate waters shall not be altered unless it can be demonstrated to the satisfaction of the Regional Board that such alteration in temperature does not adversely affect beneficial uses.*				
Thermal Plan	*Estuary Waters*	-	*Temperature*	*Narrative Objective*		*All*		***
				*** *The plan specifies limiting conditions of temperature in wastewaters discharged into interstate and coastal waters, estuaries and enclosed bays. For example, elevated temperature waste discharges into interstate waters designated as "cold" waters are prohibited while this type of discharge into "warm" interstate waters cannot be more than 5 degrees F warmer than the receiving water and shall not cause the temperature in the receiving water to rise more than 5 degrees F. Existing thermal discharges into coastal waters, estuaries and enclosed bays shall comply with limitations necessary to assure protection of the beneficial uses and, for coastal waters, areas of special biological significance.*				
ADVOCATED LEVELS - TEMPERATURE								
USFWS	*Sacramento River at Freeport*	*RSAC155*	*Temperature*	*When temperature increases are controllable, they shall be limited to a maximum 7 day surface temperature.*		*W*	*May 1-Jun 15*	*66 degrees F*
						AN	*May 1-Jun 15*	*66 degrees F*
						BN	*May 1-Jun 15*	*66 degrees F*
	San Joaquin River at Airport Way Bridge, Vernalis and (Other locations, e.g., Isleton and Jersey Point)	*C-10 RSAN112*	*Temperature*			*D*	*May 1-May 31*	*66 degrees F*
						C	*May 1-May 31*	*66 degrees F*

TABLE 5-5 (cont.) ALTERNATIVE WATER QUALITY OBJECTIVES

C) FISH AND WILDLIFE

HABITAT/SPECIES

ALTERNATIVES/ *SOURCE*	LOCATION	SAMPLING SITE NOs. (I-A/RKI)	PARAMETER	DESCRIPTION	INDEX TYPE	YEAR TYPE	DATES	VALUES
				CHINOOK SALMON (cont.)				
ADVOCATED LEVELS - TEMPERATURE (cont.)								
DFG	*Sacramento River at Freeport and*	*RSAC155*	*Temperature*	*Narrative Objective*		*All*		*The temperaure shall not be elevated above 68 degrees F during periods when temperature increases will be detrimental to the fishery.*
	San Joaquin River at Airport Way Bridge, Vernalis	*C-10 RSAN112*	*Temperature*	*Narrative Objective*		*All*		
SWC	*Sacramento River at Freeport and*	*RSAC155*	*Temperature*	*7-day average of maximum mean daily surface temperatures*		*All*	*Oct-Sep*	*An objective of 68 degrees F at Freeport and Vernalis would be acceptable as long as the plan states clearly that an objective cannot be met with flows.*
	San Joaquin River at Airport Way Bridge, Vernalis	*C-10 RSAN112*	*Temperature*	*7-day average of maximum mean daily surface temperatures*		*All*		
CVPWA	*Sacramento River at Freeport and*	*RSAC155*	*Temperature*	*Narrative Objective*				*"During the months of May and June, the water temperature to which juvenile chinook are exposed should not exceed temperatures which are reasonable, taking into account all demands on water supplies, the total values involved, and the limited ability to implement specific objectives."*
	San Joaquin River at Airport Way Bridge, Vernalis	*C-10 RSAN112*	*Temperature*	*Narrative Objective*				
POTENTIAL OBJECTIVES - TEMPERATURE								
	Sacramento River at Freeport and	*RSAC155*	*Temperature*	*Narrative Objective*	*Not Applicable*	All		*The daily average water temperature shall not be elevated by controllable factors above 68 degrees F from the I Street Bridge to Freeport on the Sacramento River, and at Vernalis on the San Joaquin River between April 1 through June 30 and September 1 through November 30 in all year types. [11]*
	San Joaquin River at Airport Way Bridge, Vernalis	*C-10 RSAN112*	*Temperature*	*Narrative Objective*	*Not Applicable*	All		

C) FISH AND WILDLIFE

HABITAT/SPECIES

ALTERNATIVES/ *SOURCE*	LOCATION	SAMPLING SITE NOs. (I-A/RKI)	PARAMETER	DESCRIPTION	INDEX TYPE	YEAR TYPE	DATES	VALUES
			CHINOOK SALMON (cont.)					
POTENTIAL OBJECTIVES - TEMPERATURE (cont.)								
	Sacramento River at Freeport	*RSAC155*	*Temperature*	*Narrative Objective*	*Not Applicable*	*All*	*The daily avearge water temperature shall not be elevated by controllable factors above 66 degrees F from the I Street Bridge to Freeport on the Sacramento River between January 1 through March 31. [11]*	
			STRIPED BASS-SALINITY: 1. ANTIOCH-SPAWNING					
PRESENT OBJECTIVES								
D-1485	*Sacramento River at Chipps Island*	*D-10 RSAC075*	*Delta outflow Index (DOI)*	*Average for the period not less than the value shown, in cfs*	*D-1485 (Water Year)*	*All*	*Apr 1-Apr 14*	*6,700*
D-1485	*San Joaquin River at Antioch Water Works Intake*	*D-12 (near) RSAN007*	*Electrical Conductivity (EC)*	*Average of mean daily for the period not more than the value shown, in mmhos*	*D-1485 (Water Year)*	*All*	*Apr 15-May 5*	*1.5*
ADVOCATED LEVELS								
	None other than above							
POTENTIAL OBJECTIVES								
1-A	*San Joaquin River at Antioch Water Works Intake*	*D-12 (near) RSAN007*	*Electrical Conductivity (EC)*	*14-day running average of mean daily for the period not more than value shown, in mmhos*	*Not Applicable*	*All*	*Apr 1-May 31 (or until spawning has ended)*	*1.5*
1-B	*Sacramento River at Chipps Island*	*D-10 RSAC075*	*Delta outflow Index (DOI)*	*Average for the period not less than the value shown, in cfs*	*Not Applicable*	*All*	*Apr 1-Apr 14*	*6,700*

TABLE 5-5 (cont.) ALTERNATIVE WATER QUALITY OBJECTIVES

C) FISH AND WILDLIFE

HABITAT/SPECIES

ALTERNATIVES/ *SOURCE*	LOCATION	SAMPLING SITE NOs. (I-A/RKI)	PARAMETER	DESCRIPTION	INDEX TYPE	YEAR TYPE	DATES	VALUES
				STRIPED BASS-SALINITY: 1. ANTIOCH-SPAWNING (cont.)				
POTENTIAL OBJECTIVES (cont.)								
	San Joaquin River at Antioch Water Works Intake	*D-12 (near) RSAN007*	*Electrical Conductivity (EC)*	*14-day running average of mean daily for the period not more than value shown, in mmhos.*	*Not Applicable*	*All*	*Apr 15-May 31 (or until spawning has ended)*	*1.5*
1-C	*Sacramento River at Chipps Island*	*D-10 RSAC075*	*Delta outflow Index (DOI)*	*Average for the period not less than the value shown, in cfs*	*Not Applicable*	*All*	*Apr 1-Apr 14*	*6,700*
	San Joaquin River at Antioch Water Works Intake	*D-12 (near) RSAN007*	*Electrical Conductivity (EC)*	*14-day running average of mean daily for the period not more than value shown, in mmhos*	*Not Applicable*	*W,AN&BN*	*Apr 15-May 31 (or until spawning has ended)*	*1.5*
						D&C	*Apr 15-May 21 (or until spawning has ended)*	*1.5*

STRIPED BASS-SALINITY: 2. ANTIOCH-SPAWNING-RELAXATION PROVISION

ALTERNATIVES/ *SOURCE*	LOCATION	SAMPLING SITE NOs. (I-A/RKI)	PARAMETER	DESCRIPTION	INDEX TYPE	YEAR TYPE	DATES	VALUES
PRESENT OBJECTIVES								
D-1485	*San Joaquin River at Antioch Water Works Intake*	*D-12 (near) RSAN007*	*Electrical Conductivity (EC)*	*Average of mean daily for the period, not more than the values shown corresponding to the deficiencies taken by the SWP and CVP, in mmhos*	*D-1485 (Water Year)*	*All*	*Apr 1-May 5*	--

This relaxation provision replaces the above Antioch & Chipps Island standard whenever the projects impose deficiencies in firm supplies.

Total Annual Imposed Deficiency in Firm Supplies (MAF)	*EC*
0.0	*1.5*
0.5	*1.9*
1.0	*2.5*
1.5	*3.4*
2.0	*4.4*
3.0	*10.3*
4.0 or more	*25.2*

TABLE 5 – 5 (cont.) ALTERNATIVE WATER QUALITY OBJECTIVES

C) FISH AND WILDLIFE

HABITAT/SPECIES

ALTERNATIVES/ *SOURCE*	LOCATION	SAMPLING SITE NOs. (I-A/RKI)	PARAMETER	DESCRIPTION	INDEX TYPE	YEAR TYPE	DATES	VALUES
		STRIPED BASS - SALINITY: 2. ANTIOCH - SPAWNING - RELAXATION PROVISION (cont.)						
ADVOCATED LEVELS								
	None other than above							
POTENTIAL OBJECTIVES								
2-A	*No relaxation provision*							
2-B	*San Joaquin River at Antioch Water Works Intake*	*D-12 (near) RSAN007*	*Electrical Conductivity (EC)*	*14-day running average of mean daily not more than values shown corresponding to deficiencies in firm supplies declared by the SWP & CVP for the period shown, or until spawning has ended.*	*Total Annual Declared Deficiencies (MAF)*		*Apr 1-May 31 EC, in mmhos*	
	This relaxation provision replaces the above Antioch & Chipps Island standard whenever the projects impose deficiencies in firm supplies.						*Dry*	*Critical*
					0.0		*1.5*	*1.5*
					0.5		*1.8*	*1.9*
					1.0		*1.8*	*2.5*
					1.5		*1.8*	*3.4*
					2.0 or more		*1.8*	*3.7*
					Linear interpolation is to be used to determine values between those shown.			
2-C	*Same as 2-B, except that deficiencies are defined as deficiencies in firm supplies declared by a set of water projects representative of the Sacramento River and San Joaquin River watersheds. The specific representative projects and amounts of deficiencies will be defined in subsequent phases of the proceedings.*							

TABLE 5 - 5 (cont.) ALTERNATIVE WATER QUALITY OBJECTIVES

C) FISH AND WILDLIFE

HABITAT/SPECIES

ALTERNATIVES/ *SOURCE*	LOCATION	SAMPLING SITE NOs. (I-A/RKI)	PARAMETER	DESCRIPTION	INDEX TYPE	YEAR TYPE	DATES	VALUES
			STRIPED BASS - SALINITY: 2 ANTIOCH - SPAWNING - RELAXATION PROVISION (cont.)					
POTENTIAL OBJECTIVES (cont.)								
2-D	*Same as Objective 2-B except the period of protection is April 1 to May 21.*							
2-E	*San Joaquin River at Antioch Water Works Intake*	*D-12 (near) RSAN007*	*Electrical Conductivity (EC)*	*14-day running average of mean daily for the period not more than value shown, in mmhos, when the April 1, 40-30-30 Sacramento Basin Index is equal to or less than 4.8 MAF. [12]*	*Sac R 40-30-30*		*Apr 1-May 31 (or until spawning has ended)*	*3.7*
			STRIPED BASS - SALINITY: 3 PRISONERS POINT - SPAWNING					
PRESENT OBJECTIVES								
D-1485	*San Joaquin River at Prisoners Point*	*D-29 RSAN038*	*Electrical Conductivity (EC)*	*Average of mean daily for the period not more than value shown, in mmhos*	*D-1485 (Water Year)*	*All*	*Apr 1-May 5*	*0.55*
ADVOCATED LEVELS								
	None other than above							
POTENTIAL OBJECTIVES								
3-A	*San Joaquin River at:*		*Electrical Conductivity (EC)*	*14-day running average of mean daily for the period not more than value shown, in mmhos*	*Not Applicable*	*All*	*Apr 1-May 31 (or until spawning has ended)*	*0.30*
	Prisoners Point	*D-29 RSAN038*						
	Buckley Cove	*P-8 RSAN056*						
	Rough and Ready Island	*- RSAN062*						
	Brandt Bridge [site]	*C-6 RSAN073*						
	Mossdale Bridge	*C-7 RSAN087*						
	Airport Way Bridge, Vernalis	*C-10 RSAN112*						

TABLE 5 – 5 (cont.) ALTERNATIVE WATER QUALITY OBJECTIVES

C) FISH AND WILDLIFE

HABITAT/SPECIES

ALTERNATIVES/ *SOURCE*	LOCATION	SAMPLING SITE NOs. (I-A/RKI)	PARAMETER	DESCRIPTION	INDEX TYPE	YEAR TYPE	DATES	VALUES
		STRIPED BASS-SALINITY: 3. PRISONERS POINT - SPAWNING (cont.)						
POTENTIAL OBJECTIVES (cont.)								
3-B	*San Joaquin River at:*		*Electrical Conductivity (EC)*	*14-day running average of mean daily for the period not more than value shown, in mmhos*	*Not Applicable*	*All*	*Apr 1-May 31 (or until spawning has ended)*	*0.44*
	Prisoners Point	*D-29 RSAN038*						
	Buckley Cove	*P-8 RSAN056*						
	Rough and Ready Island	*RSAN062*						
	Brandt Bridge [site]	*C-6 RSAN073*						
	Mossdale Bridge	*C-7 RSAN087*						
	Airport Way Bridge, Vernalis	*C-10 RSAN112*						
3-C	*San Joaquin River at:*		*Electrical Conductivity (EC)*	*14-day running average of mean daily for the period not more than value shown, in mmhos*	*SJ River (when developed)*	*W,AN, &BN*	*Apr 1-May 31 (or until spawning has ended)*	*0.44*
	Prisoners Point	*D-29 RSAN038*						
	Buckley Cove	*P-8 RSAN056*				*D&C*	*Apr 1-May 21 (or until spawning has ended)*	*0.44*
	Rough and Ready Island	*RSAN062*						
	Brandt Bridge [site]	*C-6 RSAN073*						
	Mossdale Bridge	*C-7 RSAN087*						
	Airport Way Bridge, Vernalis	*C-10 RSAN112*						

TABLE 5 - 5 (cont.) ALTERNATIVE WATER QUALITY OBJECTIVES

C) FISH AND WILDLIFE

HABITAT/SPECIES

ALTERNATIVES/ *SOURCE*	LOCATION	SAMPLING SITE NOs. (I-A/RKI)	PARAMETER	DESCRIPTION	INDEX TYPE	YEAR TYPE	DATES	VALUES
			STRIPED BASS - SALINITY: 3. PRISONERS POINT - SPAWNING (cont.)					
POTENTIAL OBJECTIVES (cont.)								
3-D	*San Joaquin River at:*		*Electrical Conductivity (EC)*	*14-day running average of mean daily for the period not more than value shown, in mmhos*	*SJ River (when developed)*	*W,AN, &BN*	*Apr 1-May 31 (or until spawning has ended)*	*0.44*
	Prisoners Point	*D-29 RSAN038*				*D&C (EC would only be met at Prisoners Point)*	*Apr 1-May 31 (or until spawning has ended)*	*0.44*
	Buckley Cove	*P-8 RSAN056*						
	Rough and Ready Island	*RSAN062*						
	Brandt Bridge [site]	*C-6 RSAN073*						
	Mossdale Bridge	*C-7 RSAN087*						
	Airport Way Bridge, Vernalis	*C-10 RSAN112*						
3-E	*San Joaquin River at:*		*Electrical Conductivity (EC)*	*14-day running average of mean daily for the period not more than value shown, in mmhos*	*SJ River (when developed)*		*Apr 1-May 31 (or until spawning has ended)*	*0.44*
	Prisoners Point	*D-29 RSAN038*						
	Buckley Cove	*P-8 RSAN056*						
	Rough and Ready Island	*RSAN062*						
	Brandt Bridge [site]	*C-6 RSAN073*						
	Mossdale Bridge	*C-7 RSAN087*						
	Airport Way Bridge, Vernalis	*C-10 RSAN112*						

W - Prisoners Point to Vernalis
AN - Prisoners Point to Mossdale
BN - Prisoners Point to Rough and Ready Island
D - Prisoners Point to Buckley Cove
C - Prisoners Point only

TABLE 5 – 5 (cont.) ALTERNATIVE WATER QUALITY OBJECTIVES

C) FISH AND WILDLIFE

HABITAT/SPECIES

ALTERNATIVES/ *SOURCE*	LOCATION	SAMPLING SITE NOs. (I-A/RKI)	PARAMETER	DESCRIPTION	INDEX TYPE	YEAR TYPE	DATES	VALUES
			STRIPED BASS-SALINITY: 3. PRISONERS POINT-SPAWNING (cont.)					
POTENTIAL OBJECTIVES (cont.)								
3-F	*San Joaquin River at Prisoners Point*	*D-29 RSAN038*	*Electrical Conductivity (EC)*	*14-day running average of mean daily for the period not more than value shown, in mmhos*	*Not Applicable*	*All*	*Apr 1-May 31 (or until spawning has ended)*	*0.44*
			STRIPED BASS-SALINITY: 4. PRISONERS POINT-SPAWNING RELAXATION PROVISION					
4-A	*No relaxation for Prisoners Point when the Antioch relaxation provision for spawning protection is in effect.*							
				When the Antioch relaxation provision for spawning protection is in effect:				
4-B	*San Joaquin River at Prisoners Point*	*D-29 RSAN038*	*Electrical Conductivity (EC)*	*14-day running average of mean daily for the period not more than value shown, in mmhos*	*Not Applicable*	*D,C*	*Apr 1-May 31 (or until spawning has ended)*	*0.55*

TABLE 5-5 (cont.) ALTERNATIVE WATER QUALITY OBJECTIVES

C) FISH AND WILDLIFE

HABITAT/SPECIES

ALTERNATIVES/ *SOURCE*	LOCATION	SAMPLING SITE NOs. (I-A/RKI)	PARAMETER	DESCRIPTION	INDEX TYPE	YEAR TYPE	DATES	VALUES
			SUISUN MARSH					
PRESENT OBJECTIVES								
D1485 (Interim)	*Sacramento River at Chipps Island*	*D-10 RSAC075*	*Electrical Conductivity (EC)*	*Max 28-day running average of mean daily, in mmhos*	*D-1485 (Water Year)*	*All*	*Oct 1-May 31*	*12.5*
						------- except for ---------		
						D/C	*Oct 1-Dec 31*	*15.6*
						only if projects are taking deficiencies in scheduled water supplies		
D-1485	*Sacramento River at Collinsville*	*C-2 RSAC081*	*Electrical Conductivity (EC)*	*Monthly average of both daily high tide values not to exceed the values shown, in mmhos (or demonstrate that equivalent or better protection will be provided at the location)*	*D-1485 (Water Year)*	*All (effective Oct 1,1984)*	*Oct*	*19.0*
	Montezuma Slough at Miens Landing	*S-64(old) SLMZU20*					*Nov*	*15.5*
	Montezuma Slough at Cutoff Slough	*S-48 SLMZU10*					*Dec*	*15.5*
	Montezuma Slough near mouth	*D-7(near) SLMZU01*					*Jan*	*12.5*
	Suisun Slough 300 ft south of Volanti Slough	*S-42 SLSUS12*					*Feb*	*8.0*
	Suisun Slough near mouth	*S-36 * SLSUS01*					*Mar*	*8.0*
	Goodyear Slough south of Pierce Harbor	*S-35(old) SLGYR02*					*Apr*	*11.0*
	Cordelia Slough above S.P.R.R. crossing at Cygnus	*S-33 * SLCRD05*					*May*	*11.0*

* *Station numbers were incorrect in D-1485, these are the corrected numbers.*

TABLE 5-5 (cont.) ALTERNATIVE WATER QUALITY OBJECTIVES

C) FISH AND WILDLIFE

HABITAT/SPECIES

ALTERNATIVES/ *SOURCE*	LOCATION	SAMPLING SITE NOs. (I-A/RKI)	PARAMETER	DESCRIPTION	INDEX TYPE	YEAR TYPE	DATES	VALUES
			SUISUN MARSH (cont.)					
PRESENT OBJECTIVES (cont.)								
Amended D-1485	*Sacramento River at Collinsville*	*C-2 RSAC081*	*Electrical Conductivity (EC)*	*Monthly average of both daily high tide values not to exceed the values shown, in mmhos (or demonstrate that equivalent or better protection will be provided at the location)*	*D-1485 (Water Year)*	*All (effective Oct 1,1988)*	*Oct*	*19.0*
	Montezuma Slough at National Steel	*S-64(new) SLMZU25*					*Nov*	*15.5*
	Montezuma Slough near Beldon Landing	*S-49 SLMZU11*					*Dec*	*15.5*
							Jan	*12.5*
							Feb	*8.0*
							Mar	*8.0*
							Apr	*11.0*
							May	*11.0*
	Chadbourne Slough at Chadbourne Road (proposed)	*S-21(prop.) SLCBN1*	*Electrical Conductivity (EC)*	*Monthly average of both daily high tide values not to exceed the values shown, in mmhos (or demonstrate that equivalent or better protection will be provided at the location)*	*D-1485 (Water Year)*	*All (effective Oct 1,1991)*	*Oct*	*19.0*
	and						*Nov*	*15.5*
	Cordelia Slough 500 ft west of S.P.R.R. crossing at Cygnus	*S-33 SLCRD04*					*Dec*	*15.5*
	or					*or*	*Jan*	*12.5*
	Chadbourne Slough at Chadbourne Road (proposed)	*S-21(prop.) SLCBN1*				*All (effective Oct 1,1993)*	*Feb*	*8.0*
	and						*Mar*	*8.0*
	Cordelia Slough at Cordelia Goodyear Ditch (proposed)	*S-97(prop.) SLCRD06*					*Apr*	*11.0*
							May	*11.0*
	Goodyear Slough at Morrow Island Clubhouse	*S-35(new) SLGYR03*	*Electrical Conductivity (EC)*	*Monthly average of both daily high tide values not to exceed the values shown, in mmhos (or demonstrate that equivalent or better protection will be provided at the location)*	*D-1485 (Water Year)*	*All (effective Oct 1,1991)*	*Oct*	*19.0*
	or					*or*	*Nov*	*15.5*
	Goodyear Slough, 1.3 mi south of Morrow Island [Drainage] Ditch at Pierce	*S-75(old) SLGYR04*				*All (effective Oct 1,1994)*	*Dec*	*15.5*
							Jan	*12.5*
							Feb	*8.0*
							Mar	*8.0*
							Apr	*11.0*
							May	*11.0*

TABLE 5-5 (cont.) ALTERNATIVE WATER QUALITY OBJECTIVES

C) FISH AND WILDLIFE

HABITAT/SPECIES

ALTERNATIVES/ *SOURCE*	LOCATION	SAMPLING SITE NOs. (I-A/RKI)	PARAMETER	DESCRIPTION	INDEX TYPE	YEAR TYPE	DATES	VALUES
			SUISUN MARSH (cont.)					
PRESENT OBJECTIVES (cont.)								
Amended D-1485	*Suisun Slough, 300 ft south of Volanti Slough*	*S-42 SLSUS12*	*Electrical Conductivity (EC)*	*Monthly average of both daily high tide values not to exceed the values shown, in mmhos (or demonstrate that equivalent or better protection will be provided at the location)*	*D-1485 (Water Year)*	*All (effective Oct 1, 1997)*	*Oct*	*19.0*
							Nov	*15.5*
							Dec	*15.5*
							Jan	*12.5*
	Water Supply Intake locations for Water-fowl Manangement Areas on Van Sickle Island and Chipps Island	*No Locations specified*					*Feb*	*8.0*
							Mar	*8.0*
							Apr	*11.0*
							May	*11.0*
ADVOCATED LEVELS								
BCDC	*Sacramento River at Chipps Island*	*D-10 RSAC075*	*Electrical Conductivity (EC)*	*Monthly average of daily higher high tide values not to exceed the values shown. in mmhos*	*D-1485 (Water Year)*	*All (effective Oct 1, 1984)*	*Oct*	*19.0*
							Nov	*16.5*
	Sacramento River at Collinsville	*C-2 RSAC081*					*Dec*	*15.5*
							Jan	*12.5*
	Montezuma Slough at Miens Landing	*S-64(old) SLMZU20*					*Feb*	*8.0*
							Mar	*8.0*
	Montezuma Slough at Cutoff Slough	*S-48 SLMZU10*					*Apr*	*11.0*
							May	*11.0*
	Montezuma Slough near mouth	*D-7(near) SLMZU01*						
	Suisun Slough 300 ft south of Volanti Slough	*S-42 SLSUS12*						
	Suisun Slough near mouth	*S-36 SLSUS01*						
	Goodyear Slough south of Pierce Harbor	*S-35(old) SLGYR02*						
	Cordelia Slough above S.P.R.R. crossing at Cygnus	*S-33 SLCRD05*						

TABLE 5-5 (cont.) ALTERNATIVE WATER QUALITY OBJECTIVES

C) FISH AND WILDLIFE

HABITAT/SPECIES

ALTERNATIVES/ *SOURCE*	LOCATION	SAMPLING SITE NOs. (I-A/RKI)	PARAMETER	DESCRIPTION	INDEX TYPE	YEAR TYPE	DATES	VALUES
			SUISUN MARSH (cont.)					
ADVOCATED LEVELS (cont.)								
SMPA[13] "Normal Standards" and "Deficiency Standards"	*Monitoring Stations same as for Amended D-1485*		*Electrical Conductivity (EC)*	*Monthly mean of both daily high tide values in mmhos*	*D-1485 (Water Year)*	*Normal Standards*	*Oct*	*19.0*
							Nov	*16.5*
							Dec	*15.5*
							Jan	*12.5*
							Feb	*8.0*
							Mar	*8.0*
							Apr	*11.0*
							May	*11.0*
						Deficiency Standards	*Oct*	*19.0*
							Nov	*16.5*
							Dec	*15.6*
							Jan	*15.6*
							Feb	*15.6*
							Mar	*15.6*
							Apr	*14.0*
							May	*12.5*
POTENTIAL OBJECTIVES								
Amended D-1485	*Sacramento River at Collinsville*	*C-2 RSAC081*	*Electrical Conductivity (EC)*	*Monthly average of both daily high tide values not to exceed the values shown, in mmhos (or demonstrate that equivalent or better protection will be provided at the location)*	*Not applicable*	*All (effective Oct 1,1988)*	*Oct*	*19.0*
	Montezuma Slough at National Steel	*S-64(new) SLMZU25*					*Nov*	*15.5*
	Montezuma Slough near Beldon Landing	*S-49 SLMZU11*					*Dec*	*15.5*
							Jan	*12.5*
							Feb	*8.0*
							Mar	*8.0*
							Apr	*11.0*
							May	*11.0*

TABLE 5 - 5 (cont.) ALTERNATIVE WATER QUALITY OBJECTIVES

C) FISH AND WILDLIFE

HABITAT/SPECIES

ALTERNATIVES/ *SOURCE*	LOCATION	SAMPLING SITE NOs. (I-A/RKI)	PARAMETER	DESCRIPTION	INDEX TYPE	YEAR TYPE	DATES	VALUES
			SUISUN MARSH (cont.)					
POTENTIAL OBJECTIVES (cont.)								
Amended D-1485	*Chadbourne Slough at Chadbourne Road (proposed)*	*S-21(prop.) SLCBN1*	*Electrical Conductivity (EC)*	*Monthly average of both daily high tide values not to exceed the values shown, in mmhos (or demonstrate that equivalent or better protection will be provided at the location)*	*Not applicable*	*All (effective Oct 1,1991)*	*Oct*	*19.0*
	and						*Nov*	*15.5*
	Cordelia Slough 500 ft west of S.P.R.R. crossing at Cygnus	*S-33 SLCRD04*					*Dec*	*15.5*
	or					*or*	*Jan*	*12.5*
	Chadbourne Slough at Chadbourne Road (proposed)	*S-21(prop.) SLCBN1*				*All (effective Oct 1,1993)*	*Feb*	*8.0*
	and						*Mar*	*8.0*
	Cordelia Slough at Cordelia Goodyear Ditch (proposed)	*S-97(prop.) SLCRD06*					*Apr*	*11.0*
							May	*11.0*
	Goodyear Slough at Morrow Island Clubhouse	*S-35(new) SLGYR03*	*Electrical Conductivity (EC)*	*Monthly average of both daily high tide values not to exceed the values shown, in mmhos (or demonstrate that equivalent or better protection will be provided at the location)*	*Not applicable*	*All (effective Oct 1,1991)*	*Oct*	*19.0*
							Nov	*15.5*
							Dec	*15.5*
	or					*or*	*Jan*	*12.5*
	Goodyear Slough, 1.3 mi south of Morrow Island [Drainage] Ditch at Pierce	*S-75(old) SLGYR04*				*All (effective Oct 1,1994)*	*Feb*	*8.0*
							Mar	*8.0*
							Apr	*11.0*
							May	*11.0*
	Suisun Slough, 300 ft south of Volanti Slough	*S-42 SLSUS12*	*Electrical Conductivity (EC)*	*Monthly average of both daily high tide values not to exceed the values shown, in mmhos (or demonstrate that equivalent or better protection will be provided at the location)*	*Not applicable*	*All (effective Oct 1,1997)*	*Oct*	*19.0*
							Nov	*15.5*
							Dec	*15.5*
							Jan	*12.5*
	Water Supply Intake locations for Water-fowl Management Areas on Van Sickle Island	*No Locations specified*					*Feb*	*8.0*
							Mar	*8.0*
							Apr	*11.0*
							May	*11.0*

TABLE 5 - 5 (cont.) ALTERNATIVE WATER QUALITY OBJECTIVES

C) FISH AND WILDLIFE

HABITAT/SPECIES

ALTERNATIVES/ *SOURCE*	LOCATION	SAMPLING SITE NOs. (I-A/RKI)	PARAMETER	DESCRIPTION	INDEX TYPE	YEAR TYPE	DATES	VALUES
			OTHER TIDAL MARSHES					
PRESENT OBJECTIVES								
	None specified							
ADVOCATED LEVELS								
BCDC	*Suisun Bay at Martinez*	*D-6* *RSAC056*	*Electrical Conductivity (EC)*	*Monthly average of daily higher high tide values not to exceed the values shown, in mmhos*	*D-1485 (Water Year)*	*All except C*	*Feb*	*15.0*
	Suisun Slough at mouth	*S-36* *SLSUS00*					*Mar*	*15.0*
	Suisun Bay at Seal Islands (Port Chicago)	*D-2* *RSAC063*					*Apr*	*18.0*
	Sacramento River at Chipps Island	*D-10* *RSAC075*					*May*	*20.0*
POTENTIAL OBJECTIVES								
	Suisun Bay at Martinez	*D-6* *RSAC056*	*Electrical Conductivity (EC)*	*Monthly average of daily higher high tide values not to exceed the values shown, in mmhos*	*D-1485 (Water Year)*	*All except C*	*Feb*	*15.0*
							Mar	*15.0*
							Apr	*18.0*
							May	*20.0*

FOOTNOTES:

[1] Exact location of diversion point is yet to be determined; West Canal at mouth of Clifton Court Forebay is a possible alternate diversion point.

[2] The Cache Slough objective to be effective only when water is being diverted from this location.

[3] EPA safe drinking water maximum contaminant level.

[4] To prevent exacerbating potential problems with THMs and other DBPs.

[5] When no date is shown, EC limit continues from April 1.

[6] Many participants made recommendations that are not quantifiable.

[7] Exact value chosen in the indicated range depends on a number of factors and conditions, e.g., Sac. Basin Four-River Index, deficiencies in entitlement deliveries, season, etc.

[8] A water right permit term is a standard not an objective.

[9] Objective applies to all seven South Delta stations identified by SDWA.

[10] South Delta Agriculture objectives will be implemented in stages; two interim stages and one final stage. The first interim stage will be implemented with the adoption of the WQCP, the second interim stage by 1994, and the final stage by 1996. Interim Stage 1 — 500 mg/l mean monthly TDS all year at Vernalis.
Interim Stage 2 — (to be implemented no later than 1994) 0.7 mmhos/cm EC April 1 to August 31, 1.0 mmhos/cm EC September 1 to March 31, 30-day running average, at Vernalis and Brandt Bridge; with water quality monitored at three current interior stations — Mossdale, Old River, near Middle River and Tracy Road Bridge, and an additional interior monitoring station on Middle River at Howard Road Bridge.
Final Stage -- (to be implemented no later than 1996) 0.7 mmhos/cm EC April 1 to August 31, 1.0 mmhos/cm EC September 1 to March 31, 30-day running average, at Vernalis and Brandt Bridge on the San Joaquin River; with two interior stations at Old River Near Middle River and Old River at Tracy Road Bridge. Monitoring stations will be at Mossdale at head of Old river and Middle River at Howard Road Bridge.

OR

If a three-party contract has been implemented among DWR, USBR and the SDWA, that contract will be reviewed prior to implementation of the above and, after also considering the needs of other beneficial uses, revisions will be made to the objectives and compliance/montioring locations noted above, as appropriate.

[11] Controllable water quality factors are those actions, conditions, or circumstances resulting from human activities that may influence the quality of the waters of the State, that are subject to the authority of the State Board, or the Regional Board, and that may be reasonably controlled. Based on the record in these proceedings, controlling temperature in the Delta utilizing reservoir releases does not appear to be reasonable, due to the distance of the Delta downstream of

reservoirs and uncontrollable factors such as ambient air temperature, water temperatures in the reservoir releases, etc. For these reasons, the State Board considers reservoir releases to control water temperatures in the Delta a waste of water; therefore, the State Board will require a test of reasonableness before consideration of reservoir releases for such a purpose.

[12] Only the April 1 Sacramento Valley 40-30-30 Index value shall be used to determine whether the relaxation provision will be in effect in any particular year. Determination of the April 1 Index value shall assume normal precipitation conditions for the calculation of the April to July Four River Unimpaired Flow.

[13] Suisun Marsh Preservation Agreement:

1(f)..."Deficiency Period" shall mean (1) a Critical year following a Dry or Critical Year; or (2) a Dry Year following a year in which the Four Basin Index was less than 11.35; or (3) the second consecutive Dry Year following a Critical Year.

1(r)... "Critical Year" and "Dry Year" are also defined as in Footnote 2 of Table II of D-1485 except that runoff for the remainder of the water year shall be assumed to be equal to the lower value of the 80 percent probability range, as shown in the most recent issue of Bulletin 120, "Water Conditions in California".

6.0 EVALUATION OF ALTERNATIVE WATER QUALITY OBJECTIVES

6.1 Introduction

In Chapter 5 potential objectives for salinity, temperature and dissolved oxygen were developed to protect the beneficial uses made of Bay-Delta water. In this chapter, the adequacy and reasonableness of the potential objectives are evaluated to determine if they or other objectives should be developed by the State Board.

CEQA requires that cumulative impacts be addressed and that alternatives to the project being analyzed be considered. In this case the project is the adoption of a water quality control plan to address the direct effects of salinity, temperature and dissolved oxygen. The State Board's total planning and regulatory processes include consideration of a much broader suite of alternatives than those which fall within the scope of this Plan. The record clearly shows that an important means of helping protect beneficial uses and mitigating for the effects of development is by setting instream flow requirements. Flow standards address problems other than the direct effects of salinity, etc. Therefore the Board has elected to set them in the subsequent broader phases of this process. In order to comply with the spirit of CEQA and to help set the stage for the Scoping and Water Right phases, the State Board has reviewed the effects of differing flow regimes to a limited extent. The results of the analysis are presented herein for information and guidance. A detailed analysis of flow regimes will be done during the Water Right Phase of these proceedings.

Water Code §13241 requires that the State Board consider, at a minimum, the following factors when establishing water quality objectives:

1) the past, present, and probable future beneficial uses of water;
2) the environmental characteristics of the hydrographic unit, including the quality of water available to it;
3) the water quality conditions that could reasonably be achieved through the coordinated control of all factors which affect water quality in the area;
4) economics considerations; and
5) the need for developing housing within the region.

- The State Board has reviewed the beneficial uses designated for Bay-Delta waters that are included in the Basin Plans for Regions 2 and 5 and finds that the designations are still appropriate.

- The environmental characteristics of the hydrographic unit can be found in Chapter 3 and Appendix 3.0 of this Plan. The State Board took those characteristics into account in developing possible water quality objectives.

- "The coordinated control of all factors" is discussed in the implementation program found in Chapter 7.

- The only direct economic consequences for which any evidence is forthcoming are the costs of changing leaching practices for Delta agriculture; this analysis is in progress. For reasons which are summarized in Section 6.7, all other economic effects were analyzed using water availability as an indicator of economic cost. These discussions are found in the evaluation of each alternative.

- Protecting the quality of waters designated as M&I supplies is an essential part of meeting housing needs within the Bay-Delta watershed and export areas.

6.2 Water Quality Alternatives

Several specific objectives have been chosen for consideration in this chapter, ones that cover a broad range of possible protective measures; they represent a 'framework' or 'set of limits' within which alternative mixes of objectives can be compared. Some indication of the protection offered by intermediate alternatives can in this way be provided.

Table 6-1 contains a list of seven potential sets of water quality objectives for the Delta. The alpha-numeric code under the number of the alternative refers to the operation model run (DWRSIM) which was used to evaluate the relative water supply effects of the alternative. The State Board selects Alternative 3 based on the following discussion in this chapter.

The alternatives were evaluated using DWR's Planning Simulation Model, DWRSIM, a generalized computer model designed to simulate the operation of the CVP and SWP project reservoirs and conveyance facilities. These operation studies are conducted on a monthly time basis and use the historical 57-year hydrologic sequence of flows from water years 1922 through 1978. In addition, these studies account for system operational objectives, physical constraints, statutes, and agreements. These parameters include requirements for flood control in system reservoirs, hydropower generation, pumping plant capacities and limitations, and Delta operations to meet water quality objectives. A more detailed description of the DWRSIM model as well as the operations criteria used in the studies is presented in Appendix 6.1, Analysis Assumptions for Water Supply Impacts.

Operation studies are run with adjustments to the combined CVP-SWP system only. The local non-project reservoirs upstream of the Delta and the CVP Friant Reservoir on the San Joaquin River are pre-operated or have a "predetermined" operation throughout the simulation period. They are not operated to meet Delta objectives. Therefore, the combined CVP-SWP system acts as a surrogate to reflect water supply consequences of the alternatives on all users in the watershed.

Currently the operations study is not designed to analyze the water needed to meet water quality objectives for interior stations of the south Delta, nor is it designed to analyze the water distribution effects of the interior Suisun Marsh objectives. Until the Suisun Marsh hydrodynamic and salinity models presently being developed by DWR are completed, any prediction of the effects of changing the interior marsh objectives on Delta outflow (as measured at Chipps Island) or on water exports must be used with caution.

TABLE 6-1

ALTERNATIVE SETS OF WATER QUALITY OBJECTIVES

BENEFICIAL USE OR PARAMETER	ALTERNATIVE [1,2]						
	1A (A7)	1B (B7)	2 (L7)	3 (H7)	4 (P7)	5 (K7)	6 (N7)
Alternative Name	BASE	BASE w/ 40-30-30	250 CL CCC/1.5 W DEL AG	S DEL AG/ANT SPAWN	50 CL BANKS PP	50 CL CCC/0.44 VERN SP	R,T, & E/0.3 VERN SP
Water Year Classification	Decision 1485 Water Year	40-30-30 (w/ Subn Snowmelt)	40-30-30 (w/ Subn Snowmelt)	40-30-30 (w/ Subn Snowmelt)	40-30-30 (w/ Subn Snowmelt)	40-30-30 (w/ Subn Snowmelt)	40-30-30 (w/ Subn Snowmelt)
Municipal and Industrial	250 Cl except 150 Cl 42-66% of the time at CCC Intake	Same as Base	250 Cl All Year at CCC Intake	Same as Base [3]	Same as Base Plus 0.15 Br (= 50 Cl) All Year at Banks PP [4]	0.15 Br (= 50 Cl) All Year at CCC Intake [4]	0.15 Br (= 50 Cl) All Year at CCC Intake [4]
Western / Interior Delta Agriculture	0.45-2.78 EC Apr 1-Aug 15	Same as Base	1.5-3.0 EC Apr 1-Aug 15 [5]	Same as Base	Same as Base	Same as Base	Same as Base
Southern Delta Agriculture	USBR Agreement: [6] 450 TDS Apr 1-Oct 31 500 TDS Nov 1-Mar 31	Same as Base	Same as Base	0.7 EC Apr 1-Aug 31 1.0 EC Sep 1-Mar 31 [7]	0.7 EC Apr 1-Aug 31 1.0 EC Sep 1-Mar 31 [7]	0.7 EC Apr 1-Aug 31 1.0 EC Sep 1-Mar 31 [7]	0.7 EC Apr 1-Aug 31 1.0 EC Sep 1-Mar 31 [7]
Export Agriculture	None	Same as Base	Same as Base	1.0 EC All Year	1.0 EC All Year	1.0 EC All Year	1.0 EC All Year
Antioch Striped Bass Spawning	1.5 EC Apr 15-May 5 1.6-25.2 EC in Deficiency Years	Same as Base	Same as Base	1.5 EC Apr 15-May 31 or When Spawning Ends 1.6-3.7 EC in Def. Yrs.	1.5 EC Apr 15-May 31 or When Spawning Ends 1.6-3.7 EC in Def. Yrs.	1.5 EC Apr 15-May 31 or When Spawning Ends 1.6-3.7 EC in Def. Yrs.	1.5 EC Apr 1-May 31 w/o Apr 1-Apr 15 Ramping Flow
Prisoners Point / Vernalis Striped Bass Spawning	0.55 EC Apr 1-May 5 at Prisoners Pt.	Same as Base	Same as Base	0.44 EC Apr 1-May 31 at Prisoners Pt. or When Spawning Ends 0.55 EC at Prisoners Pt. in Deficiency Years	0.44 EC Apr 1-May 31 at Prisoners Pt. or When Spawning Ends 0.55 EC at Prisoners Pt. in Deficiency Years	0.44 EC Apr 1-May 31 Vernalis to Prisoners Pt. or When Spawning Ends 0.55 EC at Prisoners Pt. in Deficiency Years	0.3 EC Apr 1-May 31 Vernalis to Prisoners Pt.
Suisun Marsh Wildlife [8]	Interim Objectives of 12.5-15.6 EC at Chipps 1978 Delta Plan Interior Marsh Obj's of 8.0-19.0 EC to be Phased In	Same as Base	Interim Objectives of 12.5-15.6 EC at Chipps Suisun Marsh Preservation Agreement	Same as Base [9]	Same as Base [9]	Same as Base [9]	Same as Base except 1978 Delta Plan Objectives [9]
Tidal Marshes R, T, & E Species	None	Same as Base	Same as Base	Same as Base [9]	Same as Base [9]	Same as Base [9]	15-20 EC Feb 1-May 31 at Martinez
Salmon [8] (Temperature)	Region 5 Basin Plan: 68 F when needed in Sacramento R., (If Controllable) [10]	Same as Base	Same as Base	68 F Apr 1-Jun 30 & Sep 1-Nov 30 in Sac R. and SJR 66 F Jan 1-Mar 31 in Sac R., (If Controllable)	68 F Apr 1-Jun 30 & Sep 1-Nov 30 in Sac R. and SJR 66 F Jan 1-Mar 31 in Sac R., (If Controllable)	68 F Apr 1-Jun 30 & Sep 1-Nov 30 in Sac R. and SJR 66 F Jan 1-Mar 31 in Sac R., (If Controllable)	66 F Apr 1-Jun 30 & Sep 1-Nov 30 in Sac R. and SJR 66 F Jan 1-Mar 31 in Sac R., (If Controllable)
Salmon [8] (Dissolved Oxygen)	Region 5 Basin Plan: [10] 5.0-7.0 DO All Year Depending on Delta Area	Same as Base	Same as Base	6.0 DO Sep 1-Nov 30 Stockton to Turner Cut	6.0 DO Sep 1-Nov 30 Stockton to Turner Cut	6.0 DO Sep 1-Nov 30 Stockton to Turner Cut	6.0 DO Sep 1-Nov 30 Stockton to Turner Cut
Flow	D-1485 Objectives	Same as Base	Same as Base	Same as Base	Same as Base	Same as Base	Same as Base

[1] The letter/number combination in parentheses below the alternative numbers identify the corresponding DWR operation study.
[2] Chlorides (Cl), Bromides (Br), Total Dissolved Solids (TDS), Dissolved Oxygen (DO) in mg/l :: Electrical Conductivity (EC) in mmhos/cm :: Temperature in degrees Fahrenheit (F).
[3] Alternative also includes a goal of 0.15 mg/l bromides, which is approximately equivalent to 50 mg/l chlorides. This goal, however, was not modeled as part of alternative 3.
[4] Operation studies P7, K7, and N7 use an M&I objective of 40 mmhos/cm chlorides to provide an operational buffer.
[5] Operation study L7 includes a 1.7 mmhos/cm EC leaching provision, which is not part of Alternative 2.
[6] At Vernalis: 450 mg/l TDS = 0.775 mmhos/cm EC; 500 mg/l TDS = 0.860 mmhos/cm EC.
[7] The ultimate Southern Delta agricultural objectives will be phased in through 1996. The objectives and locations may be revised as the Board deems appropriate.
[8] The temperature goals and interior Suisun Marsh and dissolved oxygen objectives were not included in the operation studies due to a lack of adequate analytic modeling tools.
[9] These alternatives also include a biological assessment.
[10] All Regional Board objectives remain in effect for all alternatives.

LEGEND: SELECTED ALTERNATIVE

05/02/91

At this time, only rough estimates of a projected salmon survival index can be made, based on general assumptions of flow and temperature. The ability to analyze the impacts on salmon from the model runs is limited. Therefore, the discussion of the alternatives is a comment on the relative benefit or impact of a particular alternative on the Chinook salmon.

Water Supply Impacts

The "water supply impacts" of the alternatives are defined as the change in base flows and exports caused by the implementation of the alternative sets of water quality objectives. The base condition, Alternative 1A in Table 6-1, incorporates a present (1990) level of development operations study that uses the water quality objectives of the 1978 Delta Plan, the flow requirements of D-1485, and Bureau Agreement on the New Melones Reservoir as the controlling Delta criteria.

Table 6-2 presents the water supply consequences of the seven alternative sets of water quality objectives shown in Table 6-1. The water supply impacts are analyzed in terms of the following factors:

o San Joaquin River Inflow
o Sacramento River Inflow
o Total Delta Exports
o Other Flows/Diversions
o Total Delta Outflow

Figure 6-1 shows the water supply parameters used in Table 6-1.

The Table 6-2 results are presented on average annual and April through July bases for the 57-year hydrologic period 1922 through 1978 and the critically-dry hydrologic period May 1928 through October 1934. Figures 6-2 and 6-3 graphically show the 57-year average annual water supply results from Table 6-2. The values shown in Table 6-2 and Figures 6-2 and 6-3 represent the combined effects of the water quality objectives <u>and</u> the new 40-30-30 water year classification. Positive values indicate an increase in flow or export; negative values indicate a decrease.

The following discussion includes, for each alternative, a short summary of the model results presented in Table 6-2 and brief comments on the reason(s) for any changes from the base condition. The statistical significance of these results cannot be determined.

It must be recognized that the impacts shown on Table 6-2 and Figures 6-2 and 6-3 and discussed in the following pages do not include the potential impacts on water supply of meeting any changes in current Suisun Marsh objective, the revised Antioch relaxation provisions for striped bass or the objectives for interior stations in the south Delta. Each of these objectives could cause a reduction in water available for other beneficial uses. When the impact of one or more of these objectives is known, the State Board will review such objectives for reasonableness and amend them, if necessary.

TABLE 6-2

WATER SUPPLY IMPACTS
OF THE
ALTERNATIVE SETS OF WATER QUALITY OBJECTIVES

WATER SUPPLY PARAMETER	BASE CONDITIONS (TAF)		CHANGE IN BASE CONDITIONS NEEDED TO MEET OBJECTIVES (TAF) [1] — ALTERNATIVE [2]													
			1A (A7)		1B (B7) [3]		2 (L7)		3 (H7) [4]		4 (P7) [4,5]		5 (K7) [4,5]		6 (N7) [4,5]	
ALTERNATIVE NAME	D-1485 BASE		BASE		BASE w/ 40-30-30		250 CCC/1.5 W AG		S DEL AG/ANT SP		50 BANKS PP		50 CCC/.44 VER SP		R,T, & E/.3 VER SP	
	Annual	Apr-Jul	Annual	Apr-Jul	Annual	Apr-Jul	Annual	Apr-Jul	Annual	Apr-Jul	Annual	Apr-Jul	Annual	Apr-Jul	Annual	Apr-Jul
Average																
San Joaquin River Inflow	1996	624	0	0	0	0	0	0	1	21	1	21	9	86	150	290
Sacramento River Inflow	15624	5087	0	0	-6	-16	-9	-73	-6	-37	-8	-85	-8	-127	-6	-179
Total Delta Exports [6]	6295	1762	0	0	4	1	50	20	-1	3	-207	-57	-399	-123	-674	-224
Other Flows/Diversions [7]	1652	-211	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Delta Outflow [8]	12977	3738	0	0	-10	-17	-59	-93	-6	-19	200	-7	400	82	818	335
Critically-Dry Period																
San Joaquin River Inflow	1153	315	0	0	0	0	0	0	-6	29	-6	29	58	91	247	273
Sacramento River Inflow	8890	3141	0	0	-21	-23	-47	-36	-18	-51	-19	-190	-9	-223	-4	-183
Total Delta Exports [6]	5290	1448	0	0	6	1	63	12	-11	-6	-364	-147	-984	-393	-1078	-321
Other Flows/Diversions [7]	-726	-645	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Delta Outflow [8]	4027	1363	0	0	-27	-24	-110	-48	-13	-16	339	-14	1033	261	1321	411

Footnotes:

[1] Change in base conditions = Alternative minus Base; Positive values indicate an increase in flow or export.
[2] The letter/number combination in parentheses below the alternative numbers identify the corresponding DWR operation study.
The temperature goals and interior Suisun Marsh and dissolved oxygen objectives were not included in the operation studies due to a lack of adequate analytic modeling tools.
[3] Alternative 1B is the base case (1A) with the new 40-30-30 water year classification.
[4] The ultimate Southern Delta objectives will be phased in through 1996. The objectives and locations may be revised as the Board deems appropriate.
[5] Operation studies P7, K7, and N7 use an M&I objective of 40 mg/l chlorides to provide an operational buffer.
P7, K7, and N7 include base Delta outflows of 3500, 6000, and 6000 cfs, respectively.
[6] Total Delta Exports include Contra Costa Canal, North Bay Aqueduct, and Banks and Tracy Pumping Plants.
[7] Other Flows/Diversions include Net Delta Consumptive Use, City of Vallejo diversions, Yolo Bypass inflow, and East Side Streams inflow.
The Base Conditions values are negative when the Net Consumptive Use plus the City of Vallejo diversions are greater than the Yolo Bypass inflow plus the East Side Streams inflow.
[8] Total Delta Outflow equals the San Joaquin River inflow + Sacramento River inflow - Total Delta Exports + Other Flows/Diversions.

LEGEND:

SELECTED ALTERNATIVE (boxed column: Alternative 3)

03/07/91

FIGURE 6-1

DELTA HYDROLOGIC SCHEME USED IN THE WATER SUPPLY IMPACT ANALYSIS

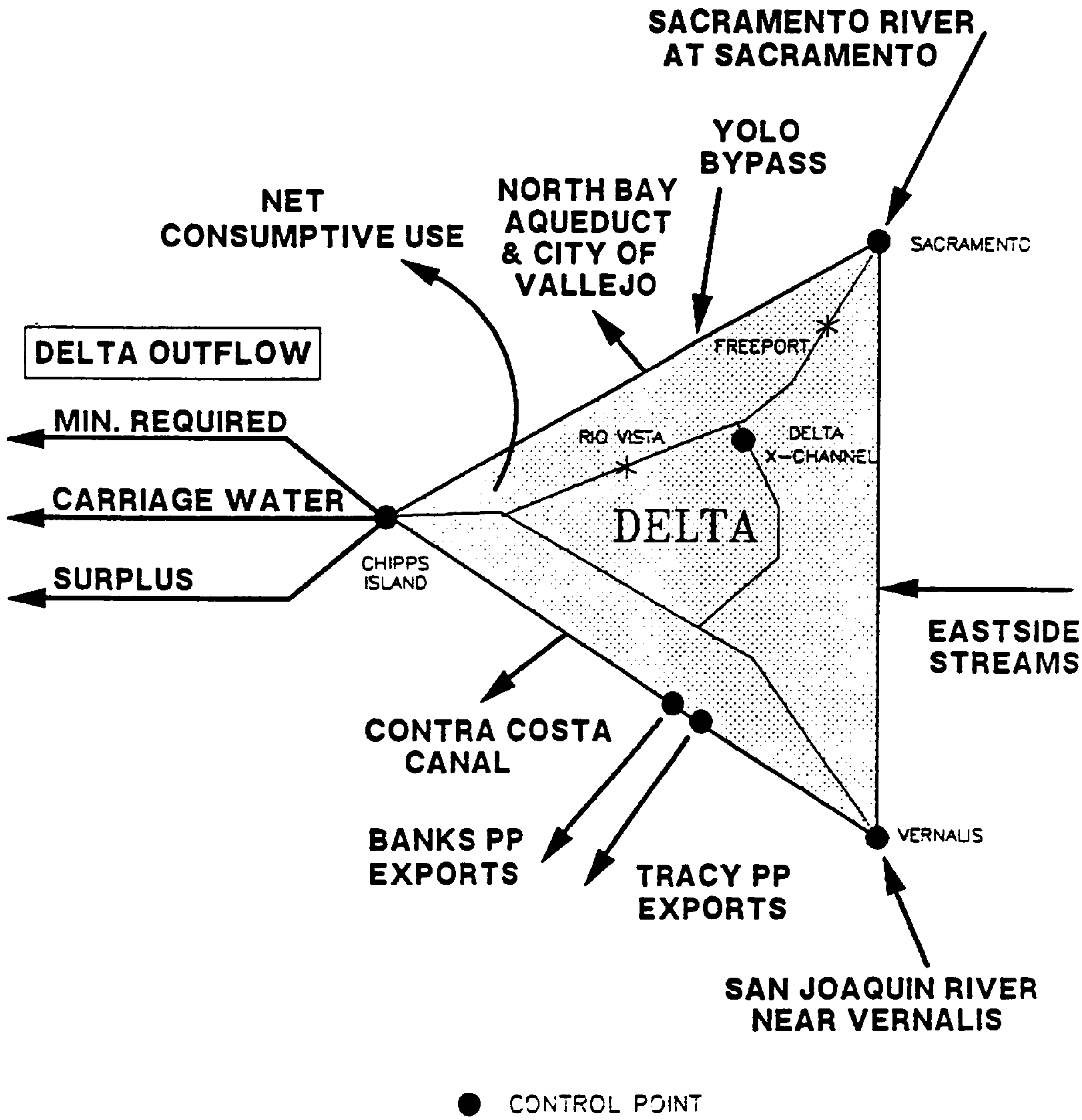
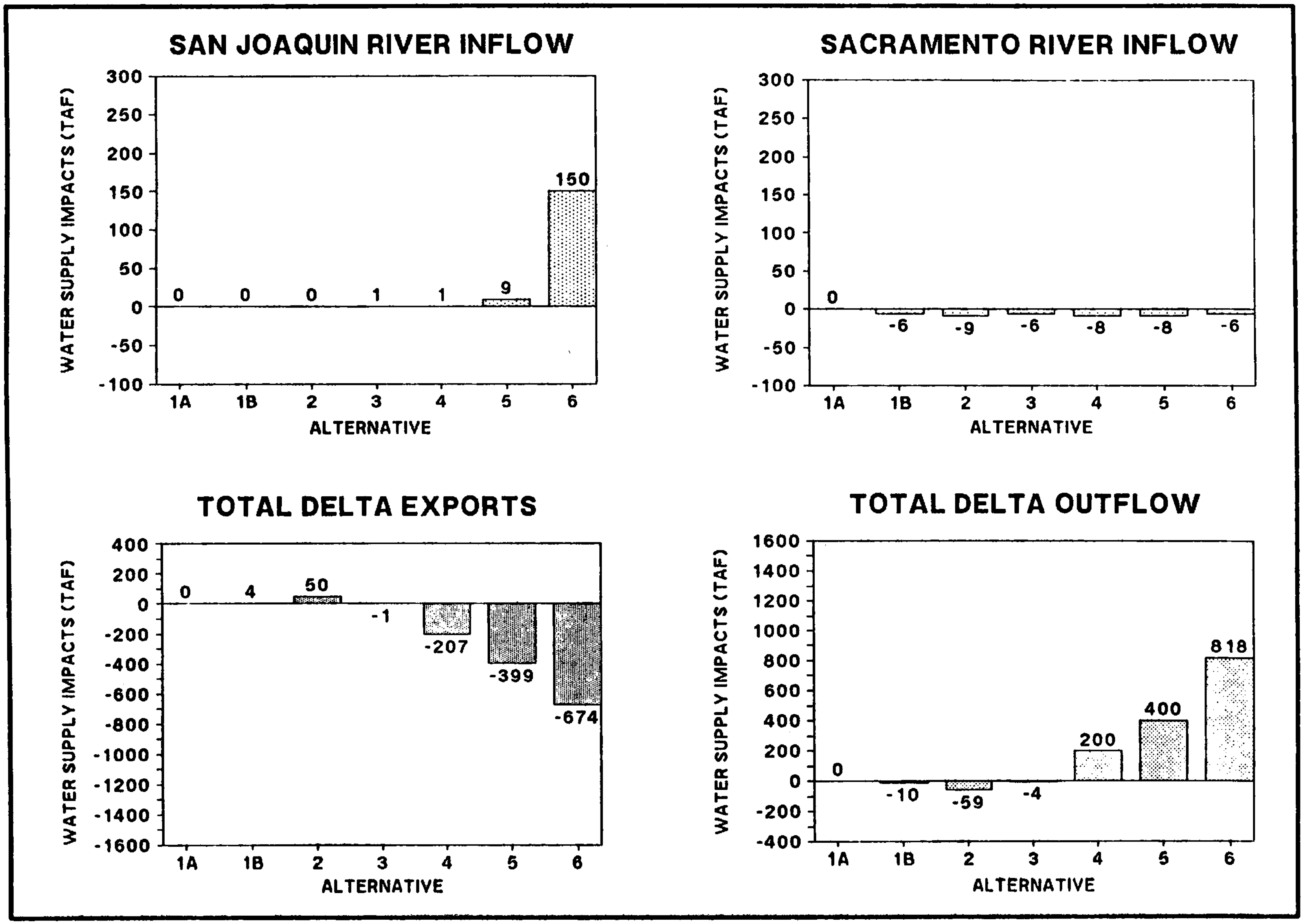
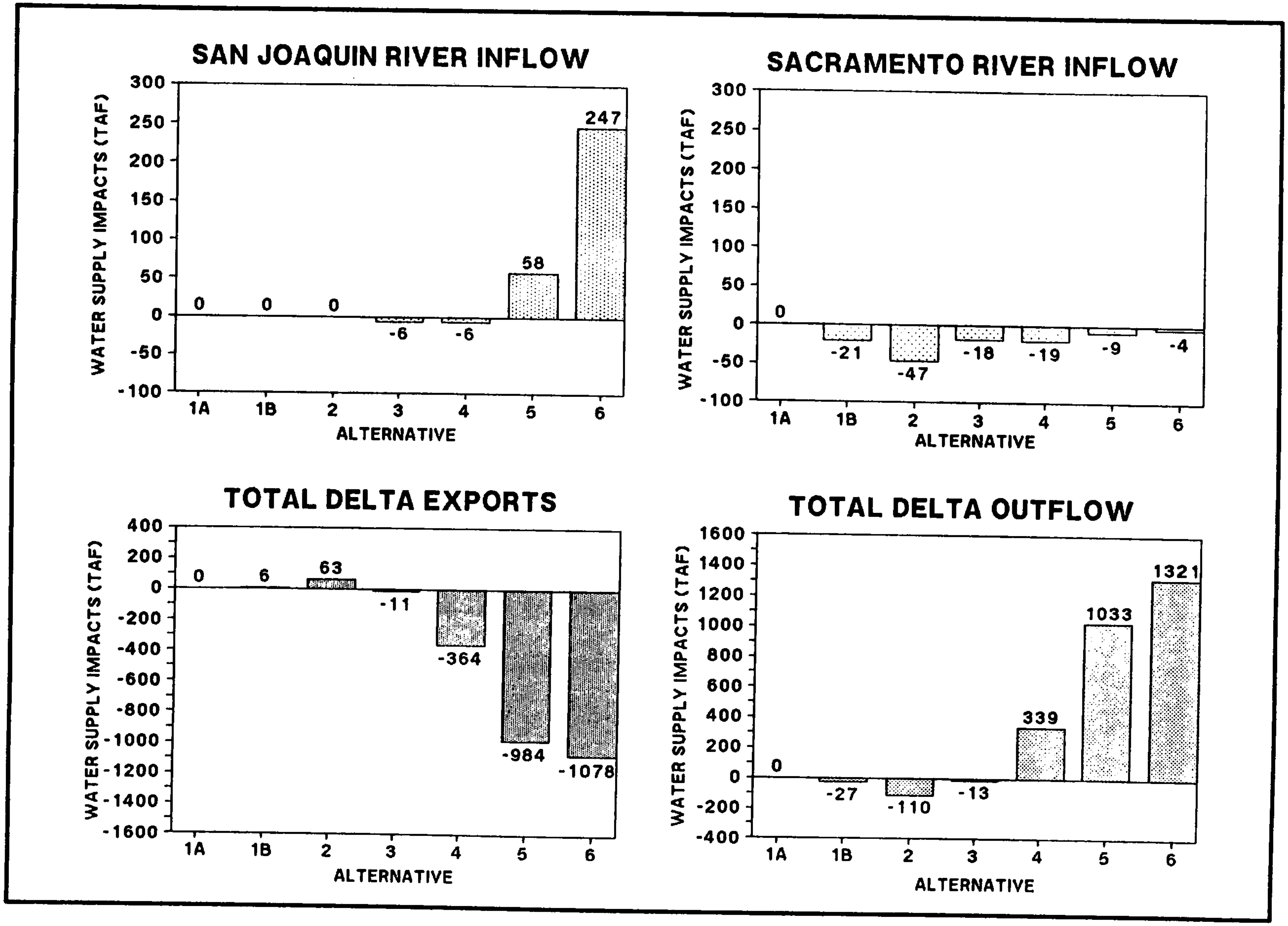


FIGURE 6-2
AVERAGE ANNUAL WATER SUPPLY IMPACTS



03/08/91

FIGURE 6-3
CRITICALLY DRY PERIOD WATER SUPPLY IMPACTS



03/08/91

6.2.1A

Alternative 1A. This is the base: it represents the 'present conditions' against which the other alternatives are compared. The base conditions include the set of water quality objectives contained in D-1485 (for more details, see Appendix 6.2, D-1485). Therefore, the model results show no changes from the base. Given the variety of locations and uses, our discussion of the alternatives has considered D-1485 objectives, special modifications used in the operations models, and actual conditions, as appropriate.

The current objectives protect striped bass spawning habitat only through May 5, and protection thereafter declines substantially in dry and critical water years because Delta Outflow Index requirements for protection of eggs and young are substantially lower. The experience of 1990 also shows that in extremely dry years when water deficiencies are imposed the expected maximum Antioch EC of 3.7 mmhos/cm was exceeded, and ECs exceeded 0.44 mmhos/cm at most locations in the central Delta spawning area and approached the present objective (0.55 mmhos/cm) at Prisoners Point.

6.2.1B

Alternative 1B is the same as the base condition with the exception of the water year classification. The year type classification used in the water supply impact analysis is the 40-30-30 year type classification described in Chapter 3.[1] Although the 40-30-30 classification does not have any adjustments, the special Decision 1485 subnormal snowmelt adjustment is retained for the reasons explained below. The subnormal snowmelt adjustment only applies to fish and wildlife flows when spring runoff from snowmelt is much less than normal. It is invoked in wet, above normal, and below normal years when the April through July unimpaired runoff is 5.9 million acre-feet or less.

The Decision 1485 subnormal snowmelt adjustment and its flow requirements are retained in the operation studies for two reasons. First, the consideration of flow requirements has been deferred to the Scoping and Water Right phases of the proceedings. Second, the use of the 40-30-30 classification with the subnormal snowmelt flow relaxation maintains approximately the same level of flow protection for fish and wildlife as under Decision 1485. Elimination of the subnormal snowmelt adjustment would prematurely alter the flow requirements before the next phase of the proceedings and would compromise the intent to isolate the effect of the technical adjustment to the classification system.

The Water Year Classification Workgroup has reviewed operation study results to determine the relative impact of the flow reduction for subnormal snowmelt on Delta flows and exports. These studies show that the removal of the subnormal snowmelt flow requirements would increase the Delta outflow and reduce the critically-dry period exports (WQCP-DWR-5,4). During the critically dry period, the operations studies results show an average loss in exports of approximately 29 TAF, or a total of about 189 TAF (29 TAF x 6.5 years). During the 57-year period, the average annual export loss is about 20 TAF.

1/ The interim Suisun Marsh objectives were analyzed using the Decision 1485 water year type classifications, including the subnormal snowmelt adjustment.

Another "classification adjustment" examined in Chapter 3 is the "year following dry or critical year" relaxation. This relaxation was not included in the water supply impact analysis since the use of the 40-30-30 classification without the "year following dry or critical year" relaxation maintains approximately the same level of flow protection for fish and wildlife as under Decision 1485.

The new year type classification has a relatively small effect; it allows decreases in the total Delta outflow during the 57-year dry and critically-dry periods by 10 and 27 TAF, respectively. The Delta outflow changes are also relatively small for the April through July periods.

These modest changes occur because the new classification shifts the average classification to a slightly drier condition.

The 40-30-30 water year type classification does not affect the flows past Vernalis on the San Joaquin River since, under the controlling USBR southern Delta Agreement, the south Delta agricultural objectives do not vary by year type. The new classification allows for some decreases in Delta inflow from the Sacramento River Basin as well as some additional export from the Delta.

The addition of the 40-30-30 Water Year Index to the base case provides little change in protection for instream uses. As discussed above, the model runs retained the "subnormal snowmelt" category. If a complete 40-30-30 Index (without this category) were implemented some additional outflow would result. The deletion of the "year following dry or critical year" category theoretically would result in additional outflow. However, the new Index offsets this effect by including the previous water year in the formula, resulting in a reclassification of the current water year into a drier category compared to the base case. Thus the Delta outflow remains essentially unchanged. This may result in a small decrease in protection for spawning and for eggs and young after May 5 compared to the base case. The frequency of occurrence or severity of deficiency for the relaxation provision is probably not changed significantly under this alternative.

Further, like the basic condition, Alternative 1B retains the 150 mg/l chloride industrial objective for a portion of the year at the Contra Costa Canal intake. This was retained for evaluation so as to avoid exacerbation of public health hazards that may be caused by the formation of disinfection by-products when the water is treated. Alternative 3 has the same proviso.

6.2.2

Alternative 2 has four differences from the base condition including the use of the 40-30-30 water year classification. The M&I objective is 250 mg/l all year at the Contra Costa Canal Intake. The western/interior Delta Agriculture objective is 1.5 mmhos/cm EC for April 1 through August 15 at Emmaton and Jersey Point and adjusted to 3.0 mmhos/cm EC from August 1 through August 15 in critical years. The SMPA Suisun Marsh objectives are the deficiency standards: 12.5 to 15.6 EC, depending on the month, at Chipps Island.

6.2.2.1 Municipal and Industrial Impacts

Salinity - A 250 mg/l chloride objective at the Contra Costa Canal Intake year-round would make paper industries unable, at times, to produce salt-sensitive products without some form of water treatment. The 1978 Delta Plan specified a chloride objective of 150 mg/l for a portion of the year solely to protect the paper industries. However, the continued need of that objective is questionable because no evidence was presented indicating that such a need still exists.

6.2.2.2 THM Formation Potential

As new and pending drinking water standards take effect, the water quality objectives in Alternative 2 may result in negative impacts for purveyors of Delta water. These negative impacts may take the form of violation of state and federal drinking water standards for disinfection by-products. It is not possible to accurately quantify those impacts at present.

6.2.2.3 Agricultural Impacts

Western and Interior Delta - The 1.5/3.0 mmhos/cm EC objectives are based on the results of the interagency Corn Study. These objectives would allow salinity to increase during wet, above normal, and below normal years, and a decrease in dry and critical years in the western Delta. In the interior Delta the objectives would allow an increase in all but critical years, and decrease in critical years. There should be little or no effect on corn yield due to these objectives if adequate leaching is performed. However, the effectiveness and economic effects of additional leaching practices are not yet known.

Southern Delta - Same as base, no impact.

6.2.2.4 Salmon - Same as base.

6.2.2.5 Striped Bass

This alternative does not make any direct changes in striped bass protection, but may have indirect effects because of changes in the Contra Costa Canal and western Delta objectives. Reduced Sacramento River inflow and increased exports may have some negative impact on survival of eggs and young in most years. However, the increased protection for western Delta agriculture may provide some incremental increased protection in critical years, as is shown by the slight increased Sacramento River inflow in these years.

6.2.2.6 Water Supply

This alternative would produce the largest reduction in total Delta outflow and, consequently, the largest increase in exports. This alternative would allow decreases in the total Delta outflow during the 57-year and critically-dry periods by 59 and 110 TAF, respectively. The corresponding increases in exports during the two hydrologic periods are 50 and 63 TAF, respectively.

These changes are caused by the modifications in the municipal and industrial objective and the western/interior Delta agricultural objectives.

The impact of the interior Suisun Marsh objectives specified in the Suisun Marsh Preservation Agreement has not been quantified because of a lack of adequate flow/salinity relationships.

6.2.3

Alternative 3 in Table 6-1 is the "Selected" alternative. Seven objectives in this alternative (in addition to the water year classification) differ from the base. The southern Delta agriculture objective is based on the UC guidelines for the water quality requirement of two important salt-sensitive crops, beans and alfalfa. The recommended water quality for beans is an EC of 0.7 mmhos/cm from April 1 to September 30; for alfalfa it is an EC of 1.0 mmhos/cm from October 1 through March 31. Export agriculture is set at an EC of 1.0 mmhos/cm in all year types. For fish and wildlife, the recommended objective for striped bass spawning at Antioch is an EC of 1.5 mmhos/cm from April 15 (with ramping) to May 31, or until spawning has ended (to be determined by monitoring), and 1.6 to 3.7 mmhos/cm in deficiency years. The other objectives for striped bass spawning are 0.44 mmhos/cm at Prisoners Point from April 1 through May 31, or until spawning has ended, and 0.55 mmhos/cm in deficiency years.

The recommended temperature objective for Chinook salmon is 68°F from April 1 to June 30 for the protection of fall-run Chinook smolts and from September 1 to November 30 for the protection of fall-run Chinook salmon adults both at Freeport on the Sacramento River and Vernalis on the San Joaquin River. A temperature of 66°F is specified from January 1 to March 31 at Freeport for the protection of winter-run Chinook salmon smolts and adults. The objective is subject to available "controllable factors" as defined in Chapter 5, Section 5.5. The dissolved oxygen objective is 6.0 mg/l from September 1 through November 30 at Vernalis for the upstream migration of fall-run Chinook salmon in the San Joaquin River.

Also, while the Suisun Marsh objective is the same as the base condition, a biological assessment is to be conducted. This assessment would include the tidal marshes and inventory of rare, threatened and endangered species habitat as well.

6.2.3.1 Municipal and Industrial

Salinity - Same as base, no impact. Note that the 150 mg/l chloride objective for industry for a portion of the year was evaluated for the same reasons stated in Alternative 1B.

6.2.3.2 THM Formation Potential

Alternative 3 will not result in any measurable negative or positive impact on THM formation over base conditions, assuming standard chlorination treatment is used.

6.2.3.3 Agriculture

Western and Interior Delta - With the hydrologic conditions that have occurred and the leaching practices that have been used since D-1485 was adopted, agriculture in the western and interior Delta has been maintained or enhanced under the base level of protection. This alternative retains this same level of protection and does not impose additional management or other economic costs on western or interior Delta farmers.

Southern Delta - The objectives were set to protect beans and alfalfa, based on University of California guidelines. However, allowable salinity levels were lowered to account for leaching limitations in the southern Delta. The impact of these objectives could be an improvement in overall growing conditions.

6.2.3.4 Salmon

Under Alternative 3 during the April through July period, San Joaquin River inflow would increase in average years; the Sacramento River inflow would decrease. The degree to which the increased flow would affect water temperatures in the San Joaquin River cannot be determined at present. A salmon smolt survival model based on spring water temperatures in the San Joaquin River has not yet been developed. The correlation that has been demonstrated between spring outflow in the San Joaquin River and adult returns two and a half years later indicates that the increased flow in the spring months may improve conditions for the outmigrating salmon smolts in the San Joaquin River.

Using the smolt survival index for the Sacramento River (USFWS), based on average April to June flow at Rio Vista, and the flow computed under this alternative, the only year type in which average salmon smolt survival index would be greater than 0.50 would be in wet years. Above normal water years would provide an average survival index of 0.42 and the remainder of the year types less than 0.30.

The implementation of the dissolved oxygen objective has not been fully explored. Apparently there is at least one source of effluent in the vicinity which contains high BOD; the lack of natural circulation in the Stockton turning basin may also negatively affect the DO levels. A partial analysis estimating the flow required (September and November only) to change the dissolved oxygen level 1 mg/l using a multiple regression analysis was submitted. Further analysis of the impacts of the water quality objectives will be made in the forthcoming proceedings. Several methods to improve DO levels besides increasing inflow are available including the traditional installation of the seasonal barrier in Old River.

6.2.3.5 Striped Bass

This alternative provides direct increased protection for striped bass spawning compared to the base case. The period of protection is extended through May 31, which covers nearly all of the period of spawning on the San Joaquin River. In addition, the 3.7 mmhos/cm EC limit on the Antioch relaxation provision should provide some small additional protection. The definition of deficiency will be re-examined in later phases of these proceedings; the frequency of the deficiency declaration, as well as the numerical salinity limits, will further define the level of impact on striped bass spawning.

Likewise, the change in the maximum EC at Prisoners Point from 0.55 to 0.44 mmhos/cm should theoretically improve spawning conditions in this area. However, due to umbrella protections, water quality is almost always better than 0.44 mmhos/cm EC at this location. The State Board prefers specific protection rather than relying on umbrella protection. Also, the protection period has been extended from May 5 to May 31. The relaxation to 0.55 mmhos/cm EC during deficiency periods retains the base condition, and appears not to be exceeded (based on 1990 data), so there is no change in protection here.

The model run used to simulate Alternative 3 assumes some increase in San Joaquin River flow, little change in exports, reduced Sacramento River flow and reduced Delta outflow. The impacts on indirect protection for eggs and young under this alternative, as modeled, are unclear.

Potential Objective 2E in Section 5.6.3.2 for the Antioch relaxation provision called for a relaxation to 3.7 mmhos/cm EC whenever the Sacramento Valley 40-30-30 Index was equal to or less than 4.8 MAF. This alternative was not modeled, and it is not included in Table 6-1. However, it is discussed here for informational purposes. Since it was designed to reflect actual or anticipated years of deficiency (1977, 1990, 1928-1934, etc.), the impacts of using this alternative should be essentially the same as Alternative 1B with a 3.7 mmhos/cm EC limit on the Antioch relaxation provision. Its substitution in Alternatives 3 through 5 should result in somewhat reduced protection because the Antioch value goes immediately to 3.7 mmhos/cm EC regardless of the amount of deficiency, rather than according to a sliding scale as in these alternatives and D-1485. However, direct comparisons with these other alternatives are not possible because the definition and frequency of deficiency conditions have not yet been defined.

6.2.3.6 Water Supply

Without considering the potential impact of meeting the revised Antioch relaxation provision for striped bass and the interior objectives in the south Delta, and assuming that the existing Suisun Marsh standards are not revised, Alternative 3 would allow decreases in the total Delta outflow as shown in Table 6-2. This water is obtained by decreasing the total Delta exports and decreasing the Delta inflows from both the Sacramento and San Joaquin River basins.

The principal reason for the decrease in Delta outflow is the new 40-30-30 year type, which allowed for more water to be stored in the Sacramento River Basin.

The level of impact on water supplies of this alternative, not including the impact of the striped bass relaxation provision and the interior south Delta objectives, is less than 0.5 percent of the dry period exports of the CVP and SWP.

6.2.4

Alternative 4 is the same as Alternative 3 except for the M&I objective. Alternative 4 adds a bromide (Br^-) objective of 0.15 mg/l (50 mg/l) Cl in all years at Banks Pumping Plant.

6.2.4.1 Municipal and Industrial

Drinking Water Quality - Salinity - The impact of setting a 50 mg/l chloride objective at Banks Pumping Plant will be to lower chloride levels at the Contra Costa Canal intake to less than 140 mg/l if seawater intrusion were the primary source of the chlorides. The chloride levels at the Banks Pumping Plant will be improved significantly; the lower salinity levels in SWP water delivered via the Banks Pumping Plant will enhance reclamation efforts and will improve the taste of the water and reduce corrosion.

6.2.4.2 THM Formation Potential

Alternative 4 will result in improved water quality, that is, less THM formation potential, over Alternative 3, particularly at the Banks Pumping Plant. This positive effect at Banks Pumping Plant may result in lower THM formation potential in the water at Rock Slough. It is not possible to quantify these impacts.

6.2.4.3 Agriculture

Western and Interior Delta - Same as Alternative 3

Southern Delta - Same as Alternative 3

6.2.4.4 Salmon - Same as Alternative 3

6.2.4.5 Striped Bass

This provides the same level of direct protection for striped bass spawning as Alternative 3. The indicated increase in San Joaquin River inflow and Delta outflow, combined with reductions in exports, may provide additional indirect protection for eggs and young even though Sacramento River inflow is reduced.

6.2.4.6 Water Supply

Alternative 4 is the same as Alternative 3 except for the additional 0.15 mg/l bromide objective at the Banks Pumping Plant to meet the trihalomethane objective. The changes in exports and total outflow are shown in Table 6-2.

6.2.5

Alternative 5 is also the same as Alternative 3 except for a change in the M&I and striped bass objectives. This alternative changes the location of M&I bromide objective of 0.15 mg/l to the Contra Costa Canal intake all year. It extends the location of the striped bass spawning objective from Prisoners Point to the area between Vernalis and Prisoners Point.

6.2.5.1 Municipal and Industrial

The 50 mg/l chloride objective at Contra Costa Canal will significantly reduce salinity levels at this intake. This will result in more improvement in water quality than Alternative 4.

6.2.5.2 THM Formation Potential

Alternative 5 would result in more positive impacts for Delta water purveyors (less THM formation potential) than Alternative 4. It is believed that the chloride/bromide levels provided by this alternative would result in THM levels well below the current maximum contaminant level (MCL) of 100 parts per billion (ppb).

6.2.5.3 Agriculture

Western and Interior Delta - Same as base

Southern Delta - Same as Alternative 3

6.2.5.4 Salmon - Same as Alternative 3

6.2.5.5 Striped Bass

This alternative provides for expansion of spawning habitat beyond Prisoners Point to Vernalis, potentially restoring access to spawning habitat formerly available in the upper San Joaquin River and its tributaries. The effects of deficiencies are the same as for Alternative 3. This alternative also provides additional protection for eggs and young because of reduced exports and additional San Joaquin River inflow. It has been hypothesized that allowing spawning farther upstream will simply expose these eggs and young to entrainment, and other effects of the projects, through Old River. Even if some are lost by this method, there may still be a net increase in survival because of reductions in exports and reverse flows, since substantial spawning would still occur in the central Delta area where reverse flows and entrainment have substantial impacts. Given the recommendations of DFG, consideration of this alternative will be deferred until the entrainment question of project operations is dealt with.

6.2.5.6 Water Supply

Alternative 5 is the same as Alternative 4 except for the additional 0.15 mg/l bromide objective at the Contra Costa Canal Pumping Plant #1 and the extension of the Prisoners Point striped bass spawning objective upstream on the San Joaquin River to Vernalis. The principal reason for the increase in total Delta outflow is the increased carriage water needed to meet the 0.15 mg/l bromide (50 mg/l chloride) objective at the Contra Costa Canal. Like Alternative 4, the primary source of this additional water is from a corresponding reduction in exports and/or reduction in upstream diversion and use.

The combined effect of the southern Delta agricultural objective and the Prisoners Point to Vernalis (0.44 mmhos/cm EC) striped bass spawning objective requires an additional 9 and 58 TAF, respectively, in the 57-year and critically-dry period flows. Since Alternative 4, which includes the agriculture objective and the Vernalis inflow, is independent of the change in exports, the differences in the Alternative 4 and 5 Vernalis flows represent the additional water needed for the Prisoners Point striped bass spawning objective. Consequently, about 8 and 64 TAF of additional Vernalis flows are needed to meet the striped bass objective during the average and dry conditions, respectively.

The overall water supply effects of this alternative are considered more adverse than Alternative 4.

6.2.6

Alternative 6 includes the bromide objective of 0.15 mg/l at the Contra Costa Canal Intake and changes five other objectives from the "Recommended" alternative. In the striped bass spawning objective at Antioch, the provision for the higher EC values during deficiency years (1.6 to 3.7 mmhos/cm) is deleted. It also eliminates both the provision for raising the EC during this period if spawning ends earlier and the ramping flow between April 1 and April 15. The striped bass spawning objective between Vernalis and Prisoners Point is changed to an EC of 0.3 mmhos/cm from April 1 to May 31. The Suisun Marsh wildlife objective is modified from the Alternative 3 to include the original D-1485 objectives. For the protection of the Tidal Marshes and Rare, Threatened and Endangered Species, an objective of 15 to 20 mmhos/cm EC is set from February 1 through May 31 at Martinez in all years. The final change is the Chinook salmon temperature objective. The water temperature in the Sacramento and San Joaquin rivers in the fall and spring is reduced to 66°F for the protection of fall-run Chinook salmon.

6.2.6.1 Municipal and Industrial

While it is likely that this alternative would provide water quality equal to or slightly better than Alternative 5, the degree of improvement would be dependent upon the source of water to the San Joaquin River. Currently there is no model adequately sensitive to quantify the water quality changes.

6.2.6.2 THM Formation Potential - See 6.2.6.1

6.2.6.3 Agriculture

Western and Interior Delta - While the objectives are the same as in Alternative 3, the "umbrella" protection provided by the other objectives is likely to provide water of lower salinity to the Delta agricultural areas. This should, in turn, reduce the need for leaching.

Southern Delta - See 6.2.6.3

6.2.6.4 Salmon

This alternative provides an increase in San Joaquin River inflow on the average during the months April through July. However, the Sacramento River inflow is decreased during this period. Therefore this alternative would probably not improve the temperature conditions in the Sacramento River in the spring but temperatures may be improved in the San Joaquin River. In addition, because total Delta outflow is increased over the base condition and exports are decreased, it is possible that salmon rearing habitat in the Suisun Bay would be improved and reverse flows and entrainment into the pumps may be reduced. These conditions should result in minor improvements for salmon.

6.2.6.5 Striped Bass

This alternative provides full protection for striped bass spawning from April 1 to May 31 from Antioch to Vernalis, with no relaxation provision. Substantial increases in San Joaquin River inflow and Delta outflow, combined with substantial decreases in exports, also would provide extensive additional protection for eggs and young, especially in dry and critical years.

6.2.6.6 Water Supply

Alternative 6 provides the largest change from the base conditions. The additional increase in required Delta outflow, compared to Alternative 5, is due to the tidal marshes objective at Martinez and the more stringent striped bass objective. The 57-year exports decrease by 674 TAF or about 11 percent. The critically-dry period exports decrease by 1078 TAF or about 20 percent.

The water supply impacts of the "original" Decision 1485 Suisun Marsh objectives, if met solely with Delta outflow, were estimated to be 2 million acre-feet per year in the 1978 Plan (SWRCB,3, VI-11). However, this estimate should be used with caution since no documentation was provided to support it. Furthermore, this estimate has not been re-evaluated to reflect the effect of the Suisun Marsh Salinity Control Gate or future Marsh facilities.

The 0.3 mmhos/cm Vernalis to Prisoners Point striped bass spawning objective significantly increases the required Vernalis flow.

A comparison of the historical temperature data in the Sacramento River with the temperature objectives shows that, from 1978 through 1985, the five-day average temperatures are greater than the temperature objective of 66°F approximately 2 percent of the time in April, 23 percent of the time in May, and 79 percent of the time in June. A similar comparison for the San Joaquin River shows that the five-day average temperatures are greater than 66°F approximately 27 percent of the time in May and 43 percent of the time in June (WQCP-CVPWA-202).

6.3 Issues to be Considered in Establishing Water Quality Objectives

The implications of these alternatives are substantial. Any changes in salinity and temperature objectives can have pronounced effects on the economic health of California and on the protection of such resources as fish and wildlife. The total amounts of, and the parties responsible for fresh water flows in the watershed have yet to be determined. Attempts to model the effects of these factors is limited but improving rapidly. Any figures used to estimate the effects of these alternatives must be viewed with caution -- and with the commitment that these objectives can and must be altered when appropriate.

6.3.1 Cumulative Impacts of Flow Alternatives

The overall approach to the flow objectives is to provide increased protection for the salmon outmigration period and most of the striped bass spawning season, protecting both the adults and the young. The establishment and maintenance of the entrapment zone would be for the benefit of the Chinook salmon and the striped bass, as well as numerous other vertebrate and invertebrate species. It is recognized that a number of the parties are actively negotiating in an attempt to reach agreement on fishery protection measures. The State Board encourages these efforts. Any product of these negotiations will be evaluated along with flow alternatives and other options which may be proposed.

During the course of the proceedings, evidence was introduced stating that the addition of physical solutions, such as facilities, could greatly benefit the various beneficial uses of Bay-Delta waters. Evidence was also introduced that the most significant impacts to the fishery are due to the location, method, and timing of diversions, all of which affect instream flows.

As stated in Chapter 6.1 and to the extent discussed, two different flow alternatives were developed to analyze their water supply effects. One flow alternative used the objectives developed for the selected Alternative 3; the other used the objectives developed for Alternative 6. The same flows were added to both. They range, depending upon water year type, from 2,900 to 30,000 cfs at Chipps Island for the protection of striped bass eggs and larvae; from 2,500 to 22,500 cfs at Rio Vista for salmon outmigration in the Sacramento River and from 500 to 14,000 cfs at Vernalis in the San Joaquin River; and about 15,000 cfs for placement of the entrapment zone around Chipps Island.

These additional flows would result in Delta exports decreasing by 800 and 983 TAF, respectively, while the San Joaquin River inflow to the Delta would increase by 575 and 300 TAF, respectively. These comparative estimates are based upon operation study outputs.

6.3.2 Operation Studies

In this evaluation, the effects of the potential objectives were compared insofar as possible with the existing condition, or base case. The alternative objectives were reviewed for environmental impact, economic consequences and water cost.

One of the tools used in this analysis is the modelling results produced by DWR under the guidance of the operations studies workgroup. The modelling results provide valuable insight into the effects of various objectives. There are important limitations that must be recognized. The operations model generally uses the conditions of Water Right Decision 1485 (under which the CVP and SWP have operated for the past 12 years) as the base case. However, some changes have been made in recent months to improve the models, and all of the variations have not been rerun with the new assumptions. Further, the "1990 level of development" used in the model does not reflect actual diversions at this time. The modelling for the San Joaquin Basin is not as refined as is the case for the Sacramento/Delta. In recent years salinity objectives in the south Delta have been specified in Water Right Decision 1422, but the modelling uses slightly different objectives, based on a USBR/South Delta agreement. Given the variety of locations and beneficial uses, our discussion of the alternatives has considered D-1485 objectives, special modifications used in the operations models, and actual conditions, as appropriate.

The DWR representatives most familiar with the models agree that their work products should not be used to attempt to quantify effects of changes in objectives precisely. However, it has been agreed that they are very useful in establishing the relative effects of various assumptions.

In summary, better information will become available as the efforts to refine the models continue. This will be true in the foreseeable future. Despite the limitations described above, there is no valid basis for delaying our evaluation or for deferring use of the currently available model runs as a primary tool in our analysis of alternatives (See Appendix 6.3, Operation Studies.)

6.3.3 Fish and Wildlife

We recognize the importance of the protection of aquatic resources which may be primarily dependent upon aquatic habitat in the Delta. However, the State Board has received inconsistent recommendations regarding one of the most obvious problems, i.e., striped bass. With respect to spawning objectives, DFG has recommended deferring actions to restore this habitat to later phases of the hearing process, in part because it has concerns about the benefits which will accrue in view of possible large diversions of eggs and larvae to the SWP and CVP pumps via Old River. DFG does agree that expansion of appropriate habitat would be beneficial in the long run.

USFWS also recognizes that the benefits to striped bass which would be obtained by improving habitat at this time may be limited. However, it identified the issue as a water quality issue, and recommended establishing the additional salinity objectives at this time as a first step, to be combined with flows, diversion restrictions and/or physical facilities developed in later phases to provide overall increased protection.

Various participants have argued that there is no evidence that striped bass spawning habitat is limiting, and that striped bass have been observed to spawn in water with salinity higher than 0.44 mmhos/cm EC. Laboratory tests also suggest that eggs can survive and hatch in higher salinity water (see Section 5.6.2.1). On the other hand, observations on other striped bass populations indicate that, given a choice, all prefer to spawn above the limits of seawater intrusion. In the San Joaquin River, upstream salinity barriers appear to inhibit their ability to move entirely out of the effects of ocean salinity. We agree that the evidence for whether spawning habitat is limiting for striped bass, and what the maximum allowable salinity might be, is not definitive, particularly when comparing laboratory and field observations. However, we also recognize that spawning success, as measured by survival of eggs and young bass, is inextricably linked to the effects of flows, toxics, and other factors, so that distinguishing the effects of spawning habitat salinity alone may be impossible. Additional studies and data analysis on actual spawning conditions, spawning locations in different year types, and spawning success are sorely needed. We invite all participants to evaluate this question further, and we propose that a thorough review of this objective be undertaken at the next Triennial Review of this Plan (see Program of Implementation, Section 7.5.2.4).

Data supporting the 0.44 mmhos/cm EC are not without question and the data on the potential effects of extending the striped bass spawning protection from Prisoners Point to Vernalis are too inconclusive to warrant setting the potential objective as the water quality objective.

6.4 The Water Quality Objectives

The State Board believes that, on balance, the objectives contained in Table 6-3 (Alternative 3 in Table 6-1) best protect the beneficial uses of the waters of the Bay-Delta Estuary.

- Minor improvements are provided from the 1978 Delta Plan.
- The State Board did not hear any compelling testimony nor did it receive any exhibits indicating that major changes were needed in salinity, temperature or dissolved oxygen water quality objectives for the Bay-Delta Estuary.
- The 150 mg/l chloride objective is being retained in order to protect municipal water quality at present levels until more is known about the public health hazards of disinfection by-products.
- The objectives for agriculture continue the existing water quality objectives or the recognized agreements containing them.
- The change in the striped bass objective for Prisoners Point recognizes the existing condition in the area, sets a lower salinity objective to prevent degradation and extends the spawning period protection.
- This alternative will have some minimal effect on water distribution. Therefore, the economic impacts of this plan will also be minimal.

TABLE 6-3 WATER QUALITY OBJECTIVES

A) MUNICIPAL AND INDUSTRIAL

LOCATION	SAMPLING SITE NOs. (I-A/RKI)	PARAMETER	DESCRIPTION	INDEX TYPE	YEAR TYPE	DATES	VALUES
Contra Costa Canal at Pumping Plant #1	*C-5 CHCCC06*	*Chloride (Cl-)*	*Maximum mean daily, in mg/l*	*Not Applicable*	*All*	*Oct-Sep*	*250*
Contra Costa Canal at Pumping Plant #1	*C-5 CHCCC06*	*Chloride (Cl-)*	*Maximum mean daily 150 mg/l chloride for at least the number of days shown during the Calendar Year. Must be provided in intervals of not less than two weeks duration. (% of Calendar Year shown in parenthesis)*	*Sac R 40-30-30*			*No. of days each Cal. Year < 150 mg/l Cl-*
- or -					*W*		*240 (66%)*
San Joaquin River at Antioch Water Works Intake	*D-12(near) RSAN007*	*Chloride (Cl-)*		*Sac R 40-30-30*	*AN*		*190 (52%)*
					BN		*175 (48%)*
					D		*165 (45%)*
					C		*155 (42%)*
West Canal at mouth of Clifton Court Forebay	*C-9 CHWST0*	*Chloride (Cl-)*	*Maximum mean daily, in mg/l*	*Not Applicable*	*All*	*Oct-Sep*	*250*
Delta Mendota Canal at Tracy Pumping Plant	*DMC-1 CHDMC004*	*Chloride (Cl-)*	*Maximum mean daily, in mg/l*	*Not Applicable*	*All*	*Oct-Sep*	*250*
Cache Slough at City of Vallejo Intake [1]	*C-19 SLCCH16*	*Chloride (Cl-)*	*Maximum mean daily, in mg/l*	*Not Applicable*	*All*	*Oct-Sep*	*250*
and/or							
Barker Slough at North Bay Aqueduct Intake	*- SLBAR3*	*Chloride (Cl-)*	*Maximum mean daily, in mg/l*	*Not Applicable*	*All*	*Oct-Sep*	*250*

TABLE 6-3 (cont.) WATER QUALITY OBJECTIVES

B) AGRICULTURAL

AREA

LOCATION	SAMPLING SITE NOs. (I-A/RKI)	PARAMETER	DESCRIPTION	INDEX TYPE	YEAR TYPE	DATES	VALUES
			1) WESTERN DELTA				
Sacramento River at Emmaton	*D-22 RSAC092*	*Electrical Conductivity (EC)*	*Maximum 14-day running average of mean daily, in mmhos/cm (mmhos)*	*Sac R 40-30-30*		*0.45 EC April 1 to Date Shown*	*EC from Date Shown to Aug. 15 [2]*
					W	*Aug. 15*	--
					AN	*July 1*	*0.63*
					BN	*June 20*	*1.14*
					D	*June 15*	*1.67*
					C	--	*2.78*
San Joaquin River at Jersey Point	*D-15 RSAN018*	*Electrical Conductivity (EC)*	*Maximum 14-day running average of mean daily, in mmhos*	*Sac R 40-30-30*		*0.45 EC April 1 to Date Shown*	*EC from Date Shown to Aug. 15 [2]*
					W	*Aug. 15*	--
					AN	*Aug. 15*	--
					BN	*June 20*	*0.74*
					D	*June 15*	*1.35*
					C	--	*2.20*

TABLE 6-3 (cont.) WATER QUALITY OBJECTIVES

B) AGRICULTURAL

AREA

LOCATION	SAMPLING SITE NOs. (I-A/RKI)	PARAMETER	DESCRIPTION	INDEX TYPE	YEAR TYPE	DATES	VALUES
			2) INTERIOR DELTA				
South Fork Mokelumne River at Terminous	*C-13 RSMKL08*	*Electrical Conductivity (EC)*	*Maximum 14-day running average of mean daily, in mmhos*	*Sac R 40-30-30*		*0.45 EC April 1 to Date Shown*	*EC from Date Shown to Aug. 15 [2]*
					W	*Aug. 15*	--
					AN	*Aug. 15*	--
					BN	*Aug. 15*	--
					D	*Aug. 15*	--
					C	--	*0.54*
San Joaquin River at San Andreas Landing	*C-4 RSAN032*	*Electrical Conductivity (EC)*	*Maximum 14-day running average of mean daily, in mmhos*	*Sac R 40-30-30*		*0.45 EC April 1 to Date Shown*	*EC from Date Shown to Aug. 15 [2]*
					W	*Aug. 15*	--
					AN	*Aug. 15*	--
					BN	*Aug. 15*	--
					D	*Jun. 25*	*0.58*
					C	--	*0.87*

TABLE 6-3 (cont.) WATER QUALITY OBJECTIVES

B) AGRICULTURAL

AREA

LOCATION	SAMPLING SITE NOs. (I-A/RKI)	PARAMETER	DESCRIPTION	INDEX TYPE	YEAR TYPE	DATES	VALUES
(To be implemented by 1996) [3]		**3) SOUTH DELTA**					
San Joaquin River at Airport Way Bridge, Vernalis	*C-10 RSAN112*	*Electrical Conductivity (EC)*	*Maximum 30-day running average of mean daily EC, in mmhos*	*Not Applicable*	*All*	*Apr 1-Aug 31*	*0.7*
						Sep 1-Mar 31	*1.0*
Old River near Middle River	*C-8 ROLD69*					*or*	
Old River at Tracy Road Bridge	*P-12 ROLD59*			*If a three-party contract has been implemented among DWR, USBR and the SDWA, that contract will be reviewed prior to implementation of the above and, after also considering the needs of other beneficial uses, revisions will be made to the objectives and compliance/monitoring locations noted above, as appropriate.*			
San Joaquin River at Brandt Bridge [site]	*C-6 RSAN073*						
		4) EXPORT					
West Canal at mouth of Clifton Court Forebay -and-	*C-9 CHWST0*	*Electrical Conductivity (EC)*	*Maximum monthly average of mean daily EC, in mmhos*	*Not Applicable*	*All*	*Oct-Sep*	*1.0*
Delta Mendota Canal at Tracy Pumping Plant	*DMC-1 CHDMC004*						

TABLE 6-3 (cont.) WATER QUALITY OBJECTIVES

C) FISH AND WILDLIFE

HABITAT/SPECIES

LOCATION	SAMPLING SITE NOs. (I-A/RKI)	PARAMETER	DESCRIPTION	INDEX TYPE	YEAR TYPE	DATES	VALUES
		CHINOOK SALMON					
DISSOLVED OXYGEN							
San Joaquin River between Turner Cut & Stockton	*RSAN050- RSAN061*	*Dissolved Oxygen (DO)*	*Minimum dissolved oxygen, in mg/l*	*Not Applicable*	*All*	*Sep 1-Nov 30*	*6.0*
TEMPERATURE							
Sacramento River at Freeport and	*RSAC155*	*Temperature*	*Narrative Objective*	*Not Applicable*	*All*	*"The daily average water temperature shall not be elevated by controllable factors above 68 deg. F from the I Street Bridge to Freeport on the Sacramento River, and at Vernalis on the San Joaquin River between April 1 through June 30 and September 1 through November 30 in all water year types." [4]*	
San Joaquin River at Airport Way Bridge, Vernalis	*C-10 RSAN112*	*Temperature*	*Narrative Objective*	*Not Applicable*	*All*		
Sacramento River at Freeport	*RSAC155*	*Temperature*	*Narrative Objective*	*Not Applicable*	*All*	*"The daily average water temperature shall not be elevated by controllable factors above 66 deg. F from the I Street Bridge to Freeport on the Sacramento River between January 1 through March 31." [4]*	

TABLE 6-3 (cont.) WATER QUALITY OBJECTIVES

C) FISH AND WILDLIFE

HABITAT/SPECIES

LOCATION	SAMPLING SITE NOs. (I-A/RKI)	PARAMETER	DESCRIPTION	INDEX TYPE	YEAR TYPE	DATES	VALUES
STRIPED BASS-SALINITY:1.ANTIOCH-SPAWNING							
Sacramento River at Chipps Island	*D-10 RSAC075*	*Delta outflow Index (DOI)*	*Average for the period not less than the value shown, in cfs*	*Not Applicable*	*All*	*Apr 1-Apr 14*	*6,700*
San Joaquin River at Antioch Water Works Intake	*D-12 (near) RSAN007*	*Electrical Conductivity (EC)*	*14-day running average of mean daily for the period not more than value shown, in mmhos*	*Not Applicable*	*All*	*Apr 15-May 31 (or until spawning has ended)*	*1.5*
STRIPED BASS-SALINITY:2 ANTIOCH-SPAWNING-RELAXATION PROVISION							
San Joaquin River at Antioch Water Works Intake	*D-12 (near) RSAN007*	*Electrical Conductivity (EC)*	*14-day running average of mean daily not more than value shown corresponding to deficiencies in firm supplies declared by a set of water projects representative of the Sacramento River and San Joaquin River watersheds, for the period shown, or until spawning has ended. The specific representative projects and amounts of deficiencies will be defined in subsequent phases of the proceedings.*	*Total Annual Imposed Deficiency (MAF)*		*Apr 1-May 31 EC in mmhos*	
This relaxation provision replaces the above Antioch & Chipps Island standard whenever the projects impose deficiencies in firm supplies.						*Dry*	*Critical*
				0.0		*1.5*	*1.5*
				0.5		*1.8*	*1.9*
				1.0		*1.8*	*2.5*
				1.5		*1.8*	*3.4*
				2.0 or more		*1.8*	*3.7*
				Linear interpolation is to be used to determine values between those shown.			
STRIPED BASS-SALINITY:3 PRISONERS POINT-SPAWNING							
San Joaquin River at: Prisoners Point	*D-29 RSAN038*	*Electrical Conductivity (EC)*	*14-day running average of mean daily for the period not more than value shown, in mmhos*	*Not Applicable*	*All*	*Apr 1-May 31 (or until spawning has ended)*	*0.44*

C) FISH AND WILDLIFE

HABITAT/SPECIES

LOCATION	SAMPLING SITE NOs. (I-A/RKI)	PARAMETER	DESCRIPTION	INDEX TYPE	YEAR TYPE	DATES	VALUES
STRIPED BASS - SALINITY: 4. PRISONERS POINT - SPAWNING - RELAXATION PROVISION							
		When the relaxation provision for Antioch spawning protection is in effect:					
San Joaquin River at: Prisoners Point	*D-29 RSAN038*	*Electrical Conductivity (EC)*	*14-day running average of mean daily for the period not more than the value shown, in mmhos*	*Not Applicable*	*D&C*	*Apr 1-May 31 (or until spawning has ended)*	*0.55*

SUISUN MARSH

In regard to the Suisun Marsh, the water quality objectives for Suisun Marsh are unchanged from the 1978 Delta Plan. The implementation vehicle, Water Right Decision 1485 (D-1485), was amended in 1985 to change (or delete) some monitoring stations and to revise the schedule for implementation. The DWR, USBR, DFG, and Suisun Resource Conservation District (SRCD) have signed and adopted a set of three agreements concerning the Suisun Marsh. These are the Suisun Marsh Preservation Agreement (SMPA), the Monitoring Agreement, and the Mitigation Agreement. The SMPA contains water quality standards for the managed marshes of Suisun Marsh which the four signatories would like the State Board to adopt as water quality objectives. The SMPA also describes the physical facilities that the four signatories have agreed would serve the managed marshes in order to maintain production of preferred waterfowl food plants. The facilities built so far, including the Suisun Marsh Salinity Control Gates (previously called the Montezuma Slough Control Structure), have changed the physical regime in the Marsh.

Revised water quality objectives incorporating the SMPA (with any modifications necessitated by the biological assessment) will be adopted by the State Board after the biological assessment (discussed in Section 7.4.2.6 of the plan) is completed. Until that time, the water quality standards in the amended D-1485 will continue to be implemented; see Table 1-2 for a summary of these standards.

FOOTNOTES:

[1] The Cache Slough objective to be effective only when water is being diverted from this location.

[2] When no date is shown, EC limit continues from April 1.

[3] South Delta Agriculture objectives will be implemented in stages: two interim stages and one final stage. The first interim stage will be implemented with the adoption of the WQCP, the second interim stage by 1994, and the final stage by 1996. Interim Stage 1 — 500 mg/l mean monthly TDS all year at Vernalis. Interim Stage 2 — (to be implemented no later than 1994) 0.7 mmhos/cm EC April 1 to August 31, 1.0 mmhos/cm EC September 1 to March 31, 30-day running average, at Vernalis and Brandt Bridge; with water quality monitored at three current interior stations -- Mossdale, Old River, near Middle River and Tracy Road Bridge, and an additional interior monitoring station on Middle River at Howard Road Bridge. Final Stage — (to be implemented no later than 1996) 0.7 mmhos/cm EC April 1 to August 31, 1.0 mmhos/cm EC September 1 to March 31, 30-day running average, at Vernalis and Brandt Bridge on the San Joaquin River; with two interior stations at Old River Near Middle River and Old River at Tracy Road Bridge. Monitoring stations will be at Mossdale at head of Old river and Middle River at Howard Road Bridge.

OR

If a three-party contract has been implemented among DWR, USBR and the SDWA, that contract will be reviewed prior to implementation of the above and, after also considering the needs of other beneficial uses, revisions will be made to the objectives and compliance/montioring locations noted above, as appropriate.

[4] Controllable water quality factors are those actions, conditions, or circumstances resulting from human activities that may influence the quality of the waters of the State, that are subject to the authority of the State Board, or the Regional Board, and that may be reasonably controlled. Based on the record in these proceedings, controlling temperature in the Delta utilizing reservoir releases does not appear to be reasonable, due to the distance of the Delta downstream of reservoirs and uncontrollable factors such as ambient air temperature, water temperatures in the reservoir releases, etc. For these reasons, the State Board considers reservoir releases to control water temperatures in the Delta a waste of water; therefore, the State Board will require a test of reasonableness before consideration of reservoir releases for such a purpose.

Table 6-4 provides a qualitative assessment of the impacts of the various alternatives and illustrates the basis for the selection of Alternative No. 3. Alternatives 1A, 1B, and 2 would fail to implement several water quality improvements which are within the scope of this plan and which are now reasonably achievable. Alternative 4 would provide positive, but unquantified benefits with respect to M&I use. There would be a definite cost in water supply to provide the benefit. As explained in Chapter 5, the uncertainty surrounding the issue of disinfection by-products makes it premature to attempt a final analysis of the benefits and detriments of this alternative. Alternatives 5 and 6 suffer the same defects. Additionally, expansion of the bass spawning area is premature, as is amendment of marsh objectives in advance of the biological assessment. Work on those issues must be completed before the benefits of more stringent objectives can be fairly compared to the high water supply cost. None of those alternatives (except No. 2) have any potential for growth inducing impacts. In conclusion, Alternative No. 3 is the most reasonable of those evaluated.

6.5 Environmental Effects

The State Board will prepare a separate EIR for the upcoming water right decision(s). The Scoping Phase of this Proceeding will help the State Board identify the issues to be addressed in that EIR; the EIR may refer to and build upon this environmental analysis, if appropriate.

The analysis of impacts in this discussion is confined to the effects of adopting or revising certain selected water quality objectives in the 1978 Delta Plan and D-1485, as amended. This discussion does not, and indeed cannot, thoroughly analyze the effects of decisions which may be made in the future by the State Board or other public or private entities. In particular, this analysis assumes that the flow standards contained in the 1978 Delta Plan (and implemented in D-1485) will remain in effect. The impacts of any future changes in flow standards will be fully analyzed in conjunction with any decision or decisions to change those standards in the upcoming EIR on the water rights decision.

An environmental checklist of possible impacts from the proposed State Board objectives is presented in Table 6-5. The State Board has concluded that the Plan will not have any significant or potentially significant effects. Impacts of specific objectives are analyzed in Chapter 5 and in the preceeding sections of this chapter.

6.6 Implementation

The means of implementing these objectives are discussed in Chapter 7 of this Plan.

6.7 Economic Considerations

During these proceedings, the State Board has often been told that California's water resources are vital to its economy, both in areas where water originates and where it is imported.

TABLE 6-4
QUALITATIVE ASSESSMENT OF IMPACTS

BENEFICIAL USE / IMPACT CRITERIA	ALTERNATIVE 1A BASE	1B BASE w/ 40-30-30 YT	2 250 CL CCC/ 1.5 W DEL AG	3 S DEL AG/ ANT SPAWN	4 50 CL BANKS PP	5 50 CL CCC/ 0.44 VERN SP	6 R,T, & E/ 0.3 VERN SP
MUNICIPAL AND INDUSTRIAL							
SALINITY	O	O	—	O	+	+ +	+ +
TRIHALOMETHANE FORMATION POTENTIAL	O	O	—	O	+	+ +	+ +
AGRICULTURE							
WESTERN / INTERIOR DELTA WATER QUALITY	O	O	—	O	O	O	+
SOUTHERN DELTA WATER QUALITY	O	O	O	+	+	+	+ +
EXPORT WATER QUALITY	O	O	O	O	O	O	O
FISH AND WILDLIFE							
STRIPED BASS HABITAT	O	O	—	+	+	+	+ +
SUISUN MARSH WILDLIFE HABITAT	O	O	O	O	O	O	+
TIDAL MARSHES R, T, & E SPECIES HABITAT	O	O	—	O	O	O	+
SALMON HABITAT	O	O	O	+	+	+	+
WATER SUPPLY							
WATER SUPPLY	O	O	O	O	—	— —	— —

LEGEND:

\+ BENEFICIAL IMPACT
O INSIGNIFICANT IMPACT
— ADVERSE IMPACT

SELECTED ALTERNATIVE

NOTE:

This summary provides a gross, subjective indication of the direction and magnitude of changes in conditions

01/10/91

Revised 11 January 1991

TABLE 6-5

ENVIRONMENTAL CHECKLIST

I. BACKGROUND

Name of Proponent: State Water Resources Control Board
Address: Executive Director
P.O. Box 100
Sacramento, CA 95810
Telephone: (916) 445-3085, James W. Baetge
Date of Checklist: December 13, 1990
Agency Requiring Checklist: State Water Resources Control Board
Proposal: Adoption of Water Quality Control Plan for Salinity and Temperature for the San Francisco Bay/Sacramento-San Joaquin Delta Estuary

II. ENVIRONMENTAL IMPACTS

Legend: Y=yes
?=maybe
N=no

1 Earth. Will the proposal result in:	
a. Unstable earth conditions or in changes in geologic substructures?	N
b. Disruptions, displacements, compaction or overcovering of the soil?	N
c. Change in topography or ground surface relief features?	N
d. The destruction, covering or modification of any unique geologic or physical features?	N
e. Any increase in wind or water erosion of soils, either on or off the site?	N
f. Changes in deposition or erosion of beach sands, or changes in siltation, deposition or erosion which may modify the channel of a river or stream or the bed of the ocean or any bay, inlet, or lake?	N
g. Exposure of people or property to geologic hazards such as earthquakes, landslides, mudslides, ground failure, or similar hazards?	N
2 Air. Will the proposal result in:	
a. Substantial air emissions or deterioration of ambient air quality?	N
b. The creation of objectionable odors?	N
c. Alteration of air movement, moisture, or temperature, or any change in climate, either locally or regionally?	N

TABLE 6-5 (CONT.)

II. ENVIRONMENTAL IMPACTS (CONT.)

Legend: Y=yes
?=maybe
N=no

3 Water. Will the proposal result in:	
a. Changes in currents, or the course or direction of water movements, in either marine or fresh waters?	N
b. Changes in absorption rates, drainage patterns, or the rate and amount of surface runoff?	N
c. Alterations in the course or flow of flood waters?	N
d. Change in the amount of surface water in any water body?	N
e. Discharge into surface waters, or in any alteration of surface water quality including but not limited to temperature, dissolved oxygen, or turbidity?	N
f. Alteration of the direction or rate of flow of ground waters?	N
g. Change in quantity of ground waters, either through direct additions or withdrawals, or through interception of an aquifer by cuts or excavations?	N
h. Substantial reduction in the amount of water otherwise available for public water supplies?	N
i. Exposure of people or property to water related hazards such as flooding or tidal waves?	N
4 Plant Life. Will the proposal result in:	
a. Change in the diversity of species, or number of any species of plants (including trees, shrubs, grass, crops, and aquatic plants)?	N
b. Reduction of the numbers of any unique, rare, or endangered species of plants?	N
c. Introduction of a new species of plants into an area, or in a barrier to the normal replenishment of existing species?	N
d. Reduction of acreage of any agricultural crop?	N
5 Animal Life. Will the proposal result in:	
a. Change in the diversity of species, or numbers of any species of animals (birds, land animals including reptiles, fish and shellfish, benthic organisms or insects?	N
b. Reduction of the numbers of any unique, threatened or endangered species?	N

TABLE 6-5 (CONT.)

II. ENVIRONMENTAL IMPACTS (CONT.)

Legend: Y=yes
?=maybe
N=no

c. Introduction of new species of animals into an area, or result in a barrier to the migration or movement of animals?	N
d. Deterioration to existing fish or wildlife habitat?	N
6 Noise. Will the proposal result in:	
a. Increases in existing noise levels?	N
b. Exposure of people to severe noise levels?	N
7 Light and Glare. Will the proposal produce new light or glare?	N
8 Land Use. Will the proposal result in a substantial alteration of the present or planned use of an area?	N
9 Natural Resources. Will the proposal result in:	
a. Increase in the rate of use of any natural resources?	N
10 Risk of Upset. Will the proposal involve:	
a. A risk of an explosion or the release of hazardous substances (including, but not limited to, oil, pesticides, chemicals or radiation) in the event of an accident or upset conditions?	N
b. Possible interference with an emergency response plan or an emergency evacuation plan?	N
11 Population. Will the proposal alter the location, distribution, density, or growth rate of the human population of an area?	N
12 Housing. Will the proposal affect existing housing, or create a demand for additional housing?	N
13 Transportation and Circulation. Will the proposal result in:	
a. Generation of substantial additional vehicular movement?	N
b. Effects on existing parking facilities, or demand for new parking?	N

TABLE 6-5 (CONT.)

II. ENVIRONMENTAL IMPACTS (CONT.)

Legend: Y=yes
?=maybe
N=no

c. Substantial effect on existing transportation systems?	N
d. Alterations to present patterns of circulation or movement of people and/or goods?	N
e. Alterations to waterborne, air, or rail traffic?	N
f. Increase in traffic hazards to motor vehicles, bicyclists, or pedestrians?	N

14 Public Services. Will the proposal have an effect upon, or result in a need for new or altered governmental services in any of the following areas:

a. Fire protection?	N
b. Police protection?	N
c. Schools?	N
d. Parks or other recreational facilities?	N
f. Maintenance of public facilities, including roads?	N
g. Other governmental services?	N

15 Energy. Will the proposal result in:

a. Use of substantial amounts of fuel or energy?	N
b. Substantial increase in demand upon existing sources of energy, or require the development of new sources of energy?	N

16 Utilities. Will the proposal result in a need for new systems, or substantial alterations to the following utilities:

a. Sewerage?	N
b. Water?	N
c. Electricity?	N
d. Natural gas?	N
e. Telephone?	N

17 Human Health. Will the proposal result in:

a. Creation of any health hazard or potential health hazard (excluding mental health)?	N
b. Exposure of people to potential health hazards?	N

18 Aesthetics. Will the proposal result in the obstruction of any scenic vista or view open to the public, or will the proposal result in the creation of an aesthetically offensive site open to public view? N

TABLE 6-5 (CONT.)

II. ENVIRONMENTAL IMPACTS (CONT.)

Legend: Y=yes
?=maybe
N=no

19	Recreation. Will the proposal result in an impact upon the quality or quantity of existing recreational opportunities?	N
20	Cultural Resources.	
	a. Will the proposal result in the alteration or the destruction of a prehistoric or historic archaeological site?	N
	b. Will the proposal result in adverse physical or aesthetic effects to a prehistoric or historic building, structure, or object?	N
	c. Does the proposal have the potential to cause a physical change which would affect unique ethnic cultural values?	N
	d. Will the proposal restrict existing religious or sacred uses within the potential impact area?	N
21	Mandatory Findings of Significance.	
	a. Does the proposal have the potential to degrade the quality of the environment, substantially reduce the habitat of a fish or wildlife species, cause a fish or wildlife population to drop below self-sustaining levels, threaten to eliminate a or animal community, reduce the number or restrict the range of a rare, threatened, or endangered plant or animal, or eliminate important examples of the major periods of California history or prehistory?	N
	b. Does the project have the potential to achieve short-term, to the disadvantage of long-term, environmental goals?	N
	c. Does the project have impacts which are individually limited, but cumulatively considerable?	N
	d. Does the project have environmental effects which will cause substantial adverse effects on human beings, either directly or indirectly?	N

TABLE 6 - 5 (CONT.)

III. DISCUSSION OF ENVIRONMENTAL IMPACTS

Responses to any Y or ? answers are found in the text.

IV. DETERMINATION

On the basis of this evaluation, I find that the proposed project will not have any significant adverse effects on the environment because the State Board has set the water quality objectives at levels designed to adequately protect the designated beneficial uses of the Sacramento-San Joaquin Delta and San Francisco Bay waters.

Gerald E. Johns 5/1/91

Signature Date

Environmental Program Manager II

Title

for the State Water Resources Control Board

The following data were offered as policy statements. The degree of dependency on imported water varies, but is high in the San Francisco Bay area and in the San Joaquin Valley; dependency is also high in southern California. The San Diego region is 96 percent dependent on imported water (T,LXXIPOL,48).

For municipal and industrial use, the prime requirements are reliability of supply and high quality drinking water. Planning for the future must focus on improved reliability of supply and improvement in water quality.

Population and economic projections indicate growing M&I water demands. California's population today is just under 30 million. The state's population grew by 750,000 in 1989 (SWC,612,p.1). The Department of Finance has estimated that the state's population will increase to 36,280,000 by 2010 (DOF,1987). The DOF expects the population of the six most populated counties in southern California--Ventura, Los Angeles, Orange, Riverside, San Bernardino, and San Diego counties to increase from the 1986 level of 15,290,000 people to 20,200,000 by 2010 (SWC,6,7). With average daily water use of 188 gallons per capita, this implies a rise in California water use of approximately 1,322,000 AF, and a rise in southern California water use of a little over 1,033,000 AF by 2010 (DWR,14,91-113). The expected additional M&I demand for Bay Delta water supply is a result both of the loss of alternative water supplies and of the increase in population (SWC,4,6).

A reliable supply of imported water is one of the most important elements of southern California's economic strength. Southern California has an estimated 6.5 million jobs, about 50 percent of the people employed in the state, income of around $260 billion, which accounts for about 55 percent of the state's tax revenue (T,LXXIPOL,114). A reduction in water supply will cause a loss of productivity, income, and jobs. The analysis of this must rest on examination of marginal costs of water to marginal industries. SWC estimates suggest that a 45 percent reduction in the M&I projected water supply (approximately 2,592,000 AF) in the year 2000, would cause a loss of 1.5 million jobs and cause a potential income loss estimated at $98 billion (SWC,51,16;SWC,3,3). These estimates and others will be studied to determine the marginal costs of developing replacement water supplies, and the effects of shifting part of the burden from the industrial to the municipal sector.

The loss of jobs and income in southern California would have economic impacts beyond the region. Related jobs and income would be lost in other areas of the state as a result of jobs and income loss in southern California. This would also mean a significant loss of sales tax and income tax revenue to the state of California. Local governments would also lose tax revenues such as the occupancy tax for motels and hotels. Some examples from policy statements indicate the importance of imported water to the economic well being of the state and southern California. The building industry is said to generate about $55 billion in business activity representing about 22 percent of the economy of the region (T,LXXIIIPOL,54). Flower and ornamental plant sales in San Diego county total about $400 million per year and about 5,000 jobs are dependent on this industry in San Diego county (T,LXXIPOL,71). It is estimated that the flower and ornamental plant industry uses about 600,000 AF of water per year (T,LXXIPOL,73). A related industry, landscape contractors, is said to have 1,700 members statewide with sales of $10.2 billion (T,LXXIPOL,109).

The value of agriculture, using water exported from the Bay-Delta, is discussed in the Technical Appendix (see Sections 4.0.4.1 and 4.0.9.2).

In the future the SWP and the CVP plan to expand deliveries to new areas and to areas experiencing increased need. SWP is studying a Coastal Branch which will supply water to Santa Barbara and San Luis Obispo counties, and an East Branch enlargement which will increase deliveries to the eastern part of the MWD's service area, and to San Bernardino County and the Antelope Valley. CVP is studying an extended San Felipe Branch which will supply water to Monterey and Santa Cruz counties, as well as an American River Aqueduct which will increase deliveries to EBMUD's service area in the Bay Area. SWP is also planning additional transfer and storage facilities at the following locations to increase its water distribution capabilities: the Kern Water Bank, Los Banos Grandes Reservoir, the south Delta, the north Delta, and additional pumps at the Delta Pumping Plant (DWR,707,42-53).

The issues discussed in this section address water quantity rather than quality. The availability of water for export uses is not significantly affected by this Plan. As stated in Section 6.1 and elsewhere, flow (water quantity) issues will be dealt with in detail during the Water Rights Phase of the proceedings. Interested parties that have provided testimony during the water quality phase should be prepared to discuss marginal costs and marginal value of water in their areas of interest.

7.0 PROGRAM OF IMPLEMENTATION

7.1 Introduction

A program of implementation is required in all water quality control plans (Water Code Section 13242). This chapter provides the program of implementation; it includes a discussion of how and when the water quality objectives set forth in this Plan are to be implemented, along with issues that need further study and that will be considered in the Scoping and Water Right phases of the proceedings and beyond.

To outline actions that will, or need to be taken, the discussion in this chapter has been divided into:

7.2 Implementation Measures
7.3 Compliance Monitoring
7.4 Special Studies and Reviews
7.5 Scoping and Water Right Issues.

7.1.1 Outstanding Scoping and Water Right Issues to be Discussed

The State Board will use its water quality and water right authorities and actions by others to implement the objectives in this Plan. Implementation alternatives will be further examined during the Scoping Phase. Those measures requiring water allocation adjustments will be determined by the State Board during the Water Right Phase of the proceedings.

At the end of the current proceedings (that is, after adopting a water right decision), the State Board will incorporate a revised Plan of Implementation that:

- establishes a timetable to carry out best practicable management of the resources and uses thereof;

- identifies potential new facilities and time schedules for planning and construction to achieve best practicable management;

- outlines suitable mitigation measures based on negotiated agreements to offset losses if some specified beneficial uses are not reasonably protected;

- requires modified uses to reasonably balance the allocation of fresh water resources to the beneficial uses; and

- proposes either new legislative directives or suggestions for that kind of legislation.

In addition, the State Board will evaluate new major facilities:

Upstream from Delta	Auburn Dam and Reservoir (could modify water right terms); additional fish hatcheries for salmon and steelhead.

In Delta	Delta island storage (permit terms and conditions) enlarge channels; isolated conveyance.
In Export Areas	Los Banos Grandes and Los Vaqueros (permit terms and conditions); conjunctive use of ground water basins; southern California surface reservoirs.
Mitigation	Wetlands additions; improve fish hatchery outputs; improve planting of fish; improve aquatic habitat; reduce infestations of injurious phytoplankton, clams, etc.
Water Use Modification	Improve irrigation efficiencies; retire agricultural land that causes drainage and other problems; increase artificial ground water recharge; increase waste water reclamation.
Potential Legislation	Set priorities for types of beneficial uses; fund agricultural land retirement where corrective drainage costs are high (similar to buy out of environmentally sensitive lands at Lake Tahoe).

7.1.2 Statewide Water Management

Achievement of reasonable protection for beneficial uses will require better management of California's water resources and equitable sharing of responsibilities to meet water quality objectives in the Bay-Delta Estuary.

All users of Estuary waters must share in the responsibility of meeting objectives to protect Bay-Delta beneficial uses. All users should pursue reclamation and conservation of water to their full feasible potential.

Currently, only certain permits of the CVP and SWP facilities are required to meet Bay-Delta Estuary water quality and flow objectives. (Other users are required to cease diversion when those projects are releasing stored water for Delta Water Quality). These projects represent only about one-half of the almost 30 million acre-feet of storage capacity within the watershed. The State Board will consider an equitable sharing of this responsibility among all users of Bay-Delta Estuary waters during the Scoping and Water Right phases of these proceedings. A first step that the State Board will consider during the Scoping Phase is expansion of the responsibility for maintaining Estuary water quality to all in-basin reservoirs larger than 100,000 acre-feet. This action would add 31 reservoirs to the list of those assigned this responsibility. Almost 90 percent of the water stored in the watershed would then be operated to help maintain Estuary objectives. The extent to which smaller projects will be included will be considered during the Scoping Phase.

7.2 Implementation Measures

7.2.1 General

New measures are limited to a Salt Load Reduction Program and a staged implementation of water quality objectives in the southern Delta.

In regard to the Suisun Marsh, the water quality objectives for Suisun Marsh are unchanged from the 1978 Delta Plan. The implementation vehicle, Water Right Decision 1485 (D-1485), was amended in 1985 to change (or delete) some monitoring stations and to revise the schedule for implementation. The DWR, USBR, DFG, and Suisun Resource Conservation District (SRCD) have signed and adopted a set of three agreements concerning the Suisun Marsh. These are the Suisun Marsh Preservation Agreement (SMPA), the Monitoring Agreement, and the Mitigation Agreement. The SMPA contains water quality standards for the managed marshes of Suisun Marsh which the four signatories would like the State Board to adopt as water quality objectives. The SMPA also describes the physical facilities that the four signatories have agreed would serve the managed marshes in order to maintain production of preferred waterfowl food plants. The facilities built so far, including the Suisun Marsh Salinity Control Gates (previously called the Montezuma Slough Control Structure), have changed the physical regime in the Marsh.

Revised water quality objectives incorporating the SMPA (with any modifications necessitated by the biological assessment) will be adopted by the State Board after the biological assessment (discussed in Section 7.4.2.6) is completed. Until that time, the water quality standards in the amended D-1485 will continue to be implemented; see Table 1-2 for a summary of these standards.

7.2.2 Achieving Objectives for Beneficial Uses

7.2.2.1 Municipal and Industrial Uses

General Requirements

- **There is a need for water from the best available sources to meet the drinking water needs of all Californians. The water supply agencies should advise the State Board during the Scoping Phase on their plans and programs to obtain high quality drinking water through the year 2010.**

o Within the Delta and in Export Areas

There are no differences between the M&I water quality objectives developed in this Plan and those developed in D-1485. With minor exceptions, these objectives are currently being met. The existing requirements and operations include mechanisms for dealing with violations which occur. Therefore, no new implementation measures are needed. Currently DWR and USBR are responsible for meeting these objectives.

o Weste… Interior Delta

There are no differences between the objectives for agriculture on the Western and interior Delta developed in this Plan and those developed in D-1485. With minor exceptions these objectives are currently being met.

o Southern Delta

The implementation plan is comprised of two interim stages and a final stage.

Interim Stage 1 -- 500 mg/l mean monthly TDS all year at Vernalis.

Interim Stage 2 -- (to be implemented no later than 1994) 0.7 mmhos/cm EC April 1 to August 31, 1.0 mmhos/cm EC September 1 to March 31, 30-day running average, at Vernalis and Brandt Bridge; with water quality monitored at three current interior stations -- Mossdale, Old River, near Middle River and Tracy Road Bridge, and an additional interior monitoring station on Middle River at Howard Road Bridge.

Final Stage -- (to be implemented no later than 1996)
0.7 mmhos/cm EC April 1 to August 31, 1.0 mmhos/cm EC September 1 to March 31, 30-day running average, at Vernalis and Brandt Bridge on the San Joaquin River; with two interior stations at Old River near Middle River and Old River at Tracy Road Bridge. Monitoring stations will be at Mossdale at head of Old River and Middle River at Howard Road Bridge.

or

If a three-party contract has been implemented among DWR, USBR and the SDWA, that contract will be reviewed prior to implementation of the above and, after also considering the needs of other beneficial uses, revisions will be made to the objectives and compliance/monitoring locations noted above, as appropriate.

o Export Agriculture

The export agriculture EC objective is presently met at virtually all times. The salt load reduction goal discussed here will help to continue achieving this objective.

o Salt Load Reduction Goal

o Upon adoption of this Plan, the State Board will request the Central Valley Regional Board to develop and adopt a salt-load reduction program. The goal of this initial program will be to reduce annual salt-loads discharged to the San Joaquin River by at least 10 percent and to adjust the timing of salt discharges from low flow to high flow periods. During the Water Right Phase of these proceedings, the Regional Board should discuss how it intends to implement this program (for example, drainage operation plans and best management practices).

The goal of this program shall be to reduce the salt load discharged to the San Joaquin River by at least 10 percent. This amount should be achieved by increasing the irrigation efficiency on the west side of the San Joaquin River Basin to a target level of 73 percent with a five percent leaching fraction as recommended by the Agricultural Water Conservation Workgroup. This should reduce the annual subsurface drainage from tile drained portions of the west side by about 40 percent as envisioned by the State Board's Technical Committee and the San Joaquin Valley Drainage Program (see EDF,11,V-13-20 and San Joaquin Valley Drainage Program, 1990). Since about 25 percent of the annual San Joaquin River salt load is from west side subsurface drainage, this drainage reduction amounts to a 10 percent reduction in annual San Joaquin River salt load (0.40 x 0.25 = 0.10) based on State Board staff modeling results (see EDF,11,Appendix C). Annual salt loads could be further decreased by reducing and recycling tailwater discharges to the San Joaquin River from the west side.

In addition to annual reduction in salt load, it would also be possible to adjust the timing of salt load discharge from the west side of the San Joaquin River Basin through storage of drainage flows (see Pickett and Kratzer, 1988). The need for dilution flows from the east side of the San Joaquin River Basin to meet seasonal water quality standards in the southern Delta would be reduced.

The salt load reduction policy, which would help to protect beneficial uses in the southern Delta, should be achieved through development of best management practices and waste discharge requirements for non-point source dischargers. The Central Valley Regional Board should present the policy to the State Board no later than the Water Right Phase of the proceedings. If adequate progress is not being made, the State Board will proceed under its authorities.

7.2.2.3 Chinook Salmon

The temperature objectives at Freeport on the Sacramento River and at Vernalis on the San Joaquin River are to be implemented through controllable factors (see Section 5.5.2.5). Methods of implementation will be discussed during the Scoping Phase.

7.2.2.4 Striped Bass

The striped bass spawning protection objectives set specific EC requirements at Antioch and Prisoners Point. These objectives will be implemented by flows, primarily by Sacramento River flows in most years. Responsibility for meeting these requirements by specific water rights holders will be determined in the Scoping and Water Rights phases.

7.2.2.5 Other Fish and Wildlife

No implementation measures are needed currently, since there are insufficient data to set water quality objectives for this beneficial use. Additional data are requested to help determine if objectives are needed.

7.2.2.6 Suisun Marsh

The implementation schedule for the Suisun Marsh objectives is the schedule in D-1485, as amended in 1985 (see Table 1-2). Once the biological assessment described in Section 7.4.2.6 is completed, the implementation schedule will be reviewed and, if necessary, revised.

7.3 Compliance Monitoring

7.3.1 General

The goals of the compliance monitoring program are to (1) ensure compliance with the water quality objectives contained in this Plan; and (2) identify meaningful changes in any significant water quality parameters potentially affecting the designated beneficial uses. In the main, the compliance monitoring stations in Table 7-1 are the same, or only slightly relocated, stations as in the original D-1485 adopted in 1978. The only differences are in Suisun Marsh and south Delta agriculture. The Suisun Marsh control stations have been changed to those in the 1985 amendment to D-1485. Some compliance monitoring stations have been added in the south Delta (see Table 7-1 for details). Any additional monitoring not required by D-1485 will have to be adopted in future actions by the Board.

- o Operate and maintain continuous electrical conductivity recorders at the stations indicated in Table 7-1 to report representative water quality conditions.

- o Conduct water quality profiles in the main navigation channels in South Bay and between the Golden Gate Bridge on the west and Stockton and Rio Vista on the east, using a boat-mounted continuous recorder for the following parameters: water temperature, electrical conductivity, pH, dissolved oxygen, turbidity, and <u>in vivo</u> chlorophyll.

- o Establish continuous recorders at representative stations in selected channel sections of the Bay-Delta Estuary to collect information on air and water temperature, wind velocity and direction, pH, dissolved oxygen, turbidity, and, where feasible, <u>in vivo</u> chlorophyll. These data should be evaluated and correlated with conditions as they exist in the adjacent main channels.

- o Conduct ongoing and future monitoring surveys recommended by DFG and concurred with by the State Board, concerning food chain relationships and fish and wildlife impacts as they are affected by implementation of this Plan. The responsibility for funding and performing these surveys and preparing a report will be addressed and assessed during the Scoping and Water Right Phases of the proceedings.

The results of the above monitoring should be provided to the State Board and other interested agencies upon request. Detailed annual reports summarizing the previous water year's findings and detailing future study plans shall be submitted to the State Board by April 1 of each year. This report will not be required until after the Water Right Phase.

TABLE 7-1
BAY-DELTA ESTUARY WATER QUALITY MONITORING PROGRAM [1]

	Station Location	E.C. *	Base* Param. [2]	Phyto.* [3]	Phos.,TDS* & Cl [4]	H.M/Pest [5] *	Benthos [6]
C2	Sacramento River @ Collinsville	C					
C3	Sacramento River @ Greens Landing	C	SM/M	SM/M	M	SA	SA
C4	San Joaquin River @ San Andreas Landing	C					
C5	Contra Costa Canal @ PP#1	C [7]					
C6	San Joaquin River @ Brandt Bridge (site)	C					
C7	San Joaquin River @ Mossdale	C	SM/M	SM/M	M	SA	SA
C8	Old River near Middle River	C					
C9	West Canal @ mouth/intake to Clifton Ct. Forebay	C [7]	SM/M	SM/M	M		
C10	San Joaquin River near Vernalis	C/TEMP	SM/M		M		
C13	Mokelumne River @ Terminous	C					
C19	Cache Slough @ City of Vallejo Intake	C [7]					
NBA	North Bay Aqueduct Intake @ Barker Slough	C [7]					
D4	Sacramento River above Point Sacramento		SM/M	SM/M	M	SA	SA
D6	Suisun Bay at Bulls Head Point nr. Martinez		SM/M		M	SA	SA
D7	Grizzly Bay @ Dolphin nr. Suisun Slough		SM/M	SM/M	M		SA
D8	Suisun Bay off Middle Point nr. Nichols		SM/M	SM/M	M		
D9	Honker Bay near Wheeler Point		SM/M	SM/M	M	SA	SA
D10	Sacramento River @ Chipps Island	C/FLOW	SM/M		M		
D11	Sherman Lake near Antioch		SM/M		M	SA	SA
D12	San Joaquin River @ Antioch Ship Canal		SM/M	SM/M	M	SA	
D12N	San Joaquin River @ Antioch Water Works	C [7]					
D14A	Big Break near Oakley		SM/M		M	SA	SA
D15	San Joaquin River @ Jersey Point	C	SM/M	SM/M	M		
D16	San Joaquin River @ Twitchell Isl.		SM/M		M		
D19	Franks Tract near Russo's Landing		SM/M		M	SA	SA
D22	Sacramento River @ Emmaton	C	SM/M		M		
D24	Sacramento River below Rio Vista Bridge	FLOW	SM/M	SM/M	M		
-	Sacramento River @ Freeport (RSAC155)	TEMP					
D26	San Joaquin River @ Potato Point		SM/M	SM/M	M		
D28A	Old River near Rancho Del Rio	C	SM/M		M	SA	SA
D29	San Joaquin River @ Prisoners Point	C					
D42	San Pablo Bay near Rodeo		SM/M	SM/M	M		
DMC1	Delta Mendota Canal	C [7]					
MD6	Sycamore Slough near Mouth		SM/M		M		SA
MD7	South Fork Mokelumne River below Sycamore Sl.		SM/M	SM/M	M		SA
MD10	Disappointment Slough @ Bishop Cut Turner Cut @		SM/M	SM/M	M		
-	Light 26 (RSAN050)	C					
-	San Joaquin River @ mouth of Fourteen-mile Slough (RSAN052)	C	SM/M				
P8	San Joaquin River 1.5 Km NW of Rough & Ready Island @ Light 40 (Buckley Cove) (RSAN056)	C	SM/M	SM/M	M	SA	SA
-	San Joaquin River @ Country Club Landing @ Light 43 (RSAN059)	C	SM/M				
-	San Joaquin River @ Rough & Ready Island (RSAN062)	C	SM/M				
-	San Joaquin River between Turner Cut & Stockton (RSAN050 - RSAN061)	D.O. cont.					

TABLE 7-1 (cont.)
BAY-DELTA ESTUARY WATER QUALITY MONITORING PROGRAM [1]

	Station Location	E.C. *	Base* Param. [2]	Phyto.* [3]	Phos.,TDS* & Cl [4]	H.M/Pest [5] *	Benthos [6]
P10	Middle River @ Borden Highway	C/G.H.	SM/M		M		
P11	Middle River @ Howard Road Bridge	C/G.H.					
P12	Old River @ Tracy Road Bridge	C	SM/M		M		
S21	Chadbourne Slough @ Chadbourne Road	C/G.H.					
S33	Cordelia Slough, 550 ft. west of Southern Pacific crossing at Cygnus	C/G.H.					
S35	Goodyear Slough at Morrow Island Clubhouse.	C/G.H.					
S36	Suisun Slough near Mouth	C/G.H.					
S42	Suisun Slough 300 ft. south of Volanti Slough	C/G.H.	SM/M	SM/M	M		
S49	Montezuma Slough near Beldon's Landing	C/G.H.					
S54	Montezuma Slough @ Hunter's Cut	C/G.H.					
S64	Montezuma Slough @ National Steel	C/G.H.					
S75	Goodyear Slough 1.3 mi. south of Morrow Island [Drainage] Ditch @ Pierce	C/G.H.					
S97	Cordelia Slough @ Cordelia-Goodyear Ditch (proposed)	C/G.H.					
-	Water supply intake locations on Van Sickle Island and Chipps Island	C/G.H.					

* Column Abbreviation Key

E.C. - Electrical Conductivity

B.P. - Base Parameters

Phyto.- Phytoplankton

Phos. TDS & Cl- - Phosphorous, Total Dissolved Solids, and Chlorides

H.M/Pest.- Heavy Metals, Pesticides

C - Continuous

SM - Semi-Monthly (twice a month)

M - Monthly

SA - Semi-annually (spring and fall)

G.H. - Gage Height

[1] The compliance monitoring needed for this plan or Decision 1485 are shaded.

[2] Air and water temperature, electrical conductivity, pH, dissolved oxygen, turbidity, water depth to 1% light intensity, secchi disc depth, volatile and non-volatile suspended solids, nitrate.nitrite, ammonia, total organic nitrogen, chlorophyll a, silica.

[3] Enumeration and identification to the species level where possible.

[4] Orthophosphate and total phosphorus.

[5] Heavy metals - arsenic, cadmium, chromiun (all valences), copper, iron, lead, manganese, mercury, zinc.

Pesticides - chlorinated hydrocarbones to include: Aldrin, Altrazine, BHC, Chlodane, Dacthal, DDD, DDE, DDT, Dieldrin, Endrin, Endosulfan, Heptachlor, Kelthane, Lindane, Methoxychlor, Simazine, Toxaphene, PCB.

Sampling to take place in water column and bottom sediments. Sediment samples are to be taken in transects across the channel.

[6] Benthic samples are to include identification and enumeration to the lowest taxonomic level possible. Samples to be taken in transects across the channel. Continuation of this aspect of the monitoring program will be reevaluated annually.

[7] Municipal and Industrial intake objectives are specified in chlorides. EC can be monitored and converted to chlorides.

7.3.2 Compliance Monitoring for Specific Beneficial Uses

7.3.2.1 Municipal and Industrial

Barker Slough, the diversion point for the recently completed North Bay Aqueduct, is monitored and additional monitoring requirements are needed. The Cache Slough Intake, the previous location of the diversion point for the Vallejo M & I water supply, will be used only on a limited and irregular basis. Therefore, monitoring need only be done at the Cache Slough Intake when diversions occur.

7.3.2.2 Agriculture

See Table 7-1 for appropriate monitoring requirements.

7.3.2.3 Salmon

Monitoring of temperature to verify achievement of the proposed objective would require recording and reporting daily temperatures at Freeport on the Sacramento River and Vernalis on the San Joaquin River. This requirement should be carried out by USGS until other responsible parties are identified.

The temperature data collected are to be submitted to the State Board, which will then make a determination whether controllable factors should be controlled.

DO levels in the lower San Joaquin River have been monitored by DWR between Turner Cut and Stockton since at least 1969. DWR should continue the monitoring for the protection of Chinook salmon in the lower San Joaquin River.

7.3.2.4 Striped Bass

Compliance with the Antioch objective is presently documented by continuous monitoring of EC at Antioch, as well as by grab samples taken as part of the DWR compliance monitoring program. Prisoners Point does not have a continuous monitor in place since D-1485 does not require one. Apparently, no monitoring was required at Prisoners Point because the objective was in effect for such a short time period each year. Some monitoring has been accomplished by the taking of occasional grab samples at Prisoners Point, and by extrapolation from observations taken at a monitoring location in Potato Slough. These data have indicated that ECs at Prisoners Point have apparently not exceeded the current objective of 0.55 mmhos/cm EC for the period April 1 to May 5. Given the proposed lowered EC objective in the present Plan and the extended period of protection, continuous monitoring should be instituted at Prisoners Point (see also discussion in Special Studies, 7.4).

7.3.2.5 Other Fish and Wildlife

o Benthos

For the present time, the 1978 Delta Plan benthic monitoring program will continue unchanged, pending any changes resulting from input received during the Scoping and Water Right phases.

7.3.2.6 Suisun Marsh

See Table 7-1 for appropriate monitoring requirements.

7.4 Special Studies and Reviews

o **Past studies of the estuarine habitat have been extensive. Relatively few have led to specifically quantify the lower levels of conditions that protect the beneficial uses. The studies discussed below should lead to actions that can be implemented to protect these uses more effectively.**

7.4.1 General

The purpose of special studies is to develop a better understanding of the hydrology, hydrodynamics, water quality, water use, and significant ecological interactions of the Bay-Delta Estuary and its watershed and export areas. The activities necessary to accomplish this goal include performing special studies and developing and enhancing physical, chemical, and biological predictive tools. This information will be necessary for future revisions of this Plan and for use in the Scoping and Water Right phases of the proceedings.

7.4.2 Special Studies for Beneficial Uses

7.4.2.1 Municipal and Industrial Uses

o **Additional information is required to assess adequately the impact of Delta agricultural drains on THM formation. There is a need to conduct appropriate, comprehensive monitoring of agricultural discharges. The Central Valley Regional Board shall require the development and implementation of best management practices or other means to appropriately control these discharges. This task should begin in the Rock Slough area.**

o An Interagency Program led by DWR has been formed to continue the work conducted by the Delta Health Effects Study and the Delta M&I Workgroup. The primary task of the new workgroup is to investigate conditions that adversely affect drinking water. The State Board requests this workgroup to design and implement a comprehensive THMFP monitoring program for the Delta by June 1991, and to present annual progress reports to the State Board commencing in January 1992.

The primary tasks of the new workgroup should be to:

1) Continue the studies conducted by DWR to assess completely the impact of agricultural drain discharges affecting the Delta with relation to THMFP. Agricultural drains located near municipal water supply intakes which are suspected of causing significant effects on drinking water quality should be given priority. The State and Regional Boards shall employ appropriate measures to ensure monitoring can be conducted. Design and implement a comprehensive THMFP monitoring program for the Delta by July 1991. This program should be designed around the Municipal Water Quality Investigation. Results and recommended actions should be completed no later than January 1, 1993.

2) Encourage continued research on various techniques of disinfection which may reduce or eliminate the production of hazardous DBPs. Research should focus on promising techniques such as PREOZONATION and ozonation/chlorination/ammoniation. Progress of research and recommended actions should be reported by January 1, 1992.

3) Develop a correlation between THMFP, as measured by the monitoring program, and THM concentrations in treated drinking water.

7.4.2.2 Agriculture

o Western and Interior Delta

o **The Corn Study provides important information on the sensitivity of corn. A leaching study was recently begun to evaluate its effectiveness, practicality, and costs. This information is needed before a new objective can be set to protect the western and interior Delta agriculture. This study should be completed and the results submitted during the Water Right Phase of the proceedings.**

o Southern Delta Agriculture

The information presented in Phase I and in the Southern Delta Agriculture Subworkgroup has shown that more information is needed to resolve differences. A study in the following areas is needed:

- crop requirements during germination and the early stage of growth,

- potential leaching fractions,

- effectiveness of rainfall in reducing leaching requirement,

- timing of the objective, and

- response of crops other than beans and alfalfa.

This proposed study should be jointly-funded by the beneficiaries, performed by the University of California Cooperative Extension and completed in time to be used in the next Triennial Review.

7.4.2.3 Salmon

The Five Agency Salmon Committee (composed of DFG, DWR, USBR, USFWS, and NMFS) will continue to pursue studies which identify the critical factors influencing smolt survival. In the short-term, studies will probably be designed to investigate the influence of temperature, especially in the San Joaquin River, on smolt survival. The effect of temperature will be analyzed in relation to various release sites, diversion curtailments, export levels, reverse flows, total outflow levels, migratory routes, Bay survival, etc. The State Board recommends that the Committee work with agricultural representatives to study whether agricultural methods can be modified to minimize increasing the temperature of the receiving water in the Sacramento and San Joaquin River waters during April through June.

SWC recommended that a salmon and striped bass punchcard management system be implemented by DFG to assist them in more accurately assessing the total annual catch of salmon and striped bass in the inland sport fishery. Such a program could be useful as well for the ocean sport fishery.

Water quality parameters, such as temperature and dissolved oxygen, have been discussed in terms of the fall-run Chinook salmon. Winter-run may also be adversely affected by these parameters. There is no evidence of a winter-run in the San Joaquin River system; however, the winter-run of Sacramento River (and possibly Calaveras River) origin may be drawn into the central and south Delta during the up-or downstream migrations. Therefore, two things need to be investigated: 1) when and where do the winter-run migrate through the Delta, and 2) what are the ranges of temperatures and dissolved oxygen in those areas during those times. The Five Agency Salmon Management Committee should investigate the particular methods possible to better define the critical pathways and times of occurrence of winter-run in the Delta. As stated in Chapter 5.5.2.3 in the Bay-Delta DFG differentiates winter-run salmon from fall-run salmon by size difference. We recommend that DFG continue its effort to find a better method of differentiation.

Salmon Smolt Survival in the Delta

There is a great variety of potential studies that would improve our understanding of salmon smolt survival in the Sacramento-San Joaquin Delta. Some of these have been implemented and will be continued. The studies listed below (Kjelson et al., 1990) are not necessarily listed by priority and should be considered by the Five Agency Committee for implementation.

All appropriate studies will be considered; the list of studies is not meant to be exclusive.

- Evaluate the survival of smolts under a wide range of inflow/export ratios with particular emphasis to ratios between 1.0 and 5.0 when inflow is greater than about 5000 cfs.

- Document the proportion of smolts that are diverted into upper Old River under varied flows, export rates and tidal conditions.

- Measure survival of fish released above the upper Old River diversion point (i.e., Vernalis or Mossdale) to compare with survival data from past releases in upper Old River and in the San Joaquin River at Dos Reis Park.

- Evaluate survival of smolts, tagged with coded wires and released in the lower Mokelumne River, at Jersey Point, Dos Reis Park, and lower Old River at varied export and inflow levels.

- Evaluate the effect of high cross Delta flow on smolt survival migrating out of the San Joaquin River as would characterize conditions with DWR's Delta alternative projects. A barrier in upper Old River with high exports would yield such conditions.

- Evaluate the relative proportion of smolts entering the intakes to Clifton Court Forebay and the CVP's Tracy Facility.

- Evaluate direct and indirect mortality in the Delta using multiple release locations in varied channels and control release sites at the intakes to Clifton Court Forebay and the Tracy Facility.

- Evaluate the louver efficiencies and general effectiveness of the Tracy Fish Facility.

- Evaluate smolt survival in the San Joaquin Delta at varied temperatures (60° to 70°F).

- Evaluate the difference in survival of smolts that are restricted to salvage at the Tracy Facilities to those that are vulnerable to both Clifton Court and the CVP intakes.

- Evaluate the effectiveness of pulse flows of different timing, magnitude and duration in the Sacramento and San Joaquin rivers.

The studies already implemented are evaluated on an annual basis and are compared among years. Study designs are evaluated and improved each year prior to the fall-run Chinook salmon smolt emigration period. Any modification of water quality objectives should be based on the results of the annual studies compiled to date.

7.4.2.4 Striped Bass

o **Continuous EC and temperature monitoring equipment should be installed at various locations in the San Joaquin River between Antioch and Vernalis to obtain data on salinity conditions for striped bass spawning.**

The Interagency Ecological Study Program and others need to study:

1. EC and the effects of different salinities on striped bass and their habitat between Antioch and Prisoners Point;

2. Water quality effects of salinity and temperature on eggs and larval development, particularly in the San Joaquin River;

3. The annual die-off of striped bass to determine if it is due to water quality factors;

4. The effects of agricultural return flows on striped bass;

5. The actual patterns of spawning periodicity, locations, water quality conditions, and fate of eggs and young; and

6. The impact of introduced exotic organisms, e.g., Potamocorbula amurensis, and other factors on striped bass food chains.

These studies could provide data which are critical to our understanding of the effects of water quality on striped bass migration and spawning success.

7.4.2.5 Other Fish and Wildlife Studies

o American Shad

The DFG data on American shad suggest a pattern of relationships between upstream migration into tributary streams for spawning and subsequent early rearing of young. The role of the Delta and Suisun Bay areas as spawning and nursery habitat is not clearly presented in terms which can be quantified to establish water quality objectives, flow requirements or operational constraints. Substantial additional information is required before the State Board can implement either water quality objectives or water right permit terms and conditions for the protection of this fishery in the Estuary. Participants should plan to present information and any demonstrations that specific objectives are needed at the next Trienniel Review.

o Delta Smelt

In 1991, DFG should analyze existing data on environmental conditions, including reverse flows, affecting Delta smelt growth, survival, reproductive success and spatial distribution; this information should be ready for submittal to the State Board during the Scoping Phase.

The feasibility of a mark and recapture study or other study to better document seasonal movements and habitat preferences of Delta smelt in its various life stages should be investigated by DFG. Such a study would require a few years of sampling to document trends, and should be completed and analyzed by the Trienniel Review of the Plan.

Historical SWP and CVP data on Delta smelt salvage has not been very reliable. DFG is confident that, currently, quality control is sufficient for the enumeration of trends in species composition. DFG will be assuming responsibility for enumerating fish at the SWP facility this next year. Improvements in procedures will be made in future. Salvage data on Delta smelt from both facilities, including sampling methods, should be submitted during the forthcoming proceedings.

o Benthos

Benthic communities in various parts of the Estuary must be viewed in terms of their role in the overall Estuary. Their relative value, particularly in terms of balancing the needs of various beneficial uses, is difficult to determine when compared to striped bass, agricultural crops or other beneficial uses which can be more readily measured and compared. Parties should be prepared to discuss ways to answer these questions in terms of the overall functioning of the Estuary, as well as the specific reactions of individual species or groups of species (such as bay shrimp) to changing salinity, flow, and other conditions. Parties should plan to present these discussions during the Scoping and Water Right Phases.

7.4.2.6 Marshes around Suisun Bay

A. Biological Assessment

o **A new comprehensive Biological Assessment is being conducted concerning the rare, threatened and endangered species (and their habitat) of the managed and unmanaged wetlands around Suisun Bay.**

The information needed for the Biological Assessment under CESA includes:

1. A full description of the Sacramento-San Joaquin Delta/San Francisco Bay region, with an explanation of the area affected by any proposed changes in the water quality objectives, plus maps.

2. The known and potential distribution of rare, threatened, and endangered species in the region and affected area based on recent field surveys. In addition, the State Board needs information about any federal candidate species and any species of special concern to DFG in order to discuss fully possible impacts on those species as required under CEQA.

3. Any additional information on species distribution and habitat requirements from the literature, scientific data review, and discussion with experts.

4. Analysis of the possible effects of the proposed water quality objectives on these listed species, including any cumulative effects.

5. An analysis of alternatives designed to reduce or eliminate adverse effects to listed species.

For Item 1, the State Board has sufficient information to describe the Bay-Delta region. The State Board is as yet unable to delineate in any clear way the actual area where the water quality objectives could result in detectable changes in water quality. Adoption of the SMPA water quality objectives for the Suisun Marsh and Bay would, according to DWR, result in higher salinities in Grizzly and Honker bays, but the full extent of the affected area is not clear (DWR,511,11-18,27,60). Salinity modeling studies are needed to allow the State Board to predict the effects of these objectives better.

For items 2 and 3, the State Board has information for some of the listed species, but in some cases it is neither recent nor geographically comprehensive. Most of the information has been collected or noted during work done for other purposes, and is thus spotty both in time and geography. Where information is missing, additional studies will be needed. Compilation of information from the literature as well as from unpublished data sources can be done in parallel with field work. Additional laboratory studies determining the salinity requirements of some of the rare plants may be needed.

For item 4, once a sufficiently accurate salinity model is operable and the environmental requirements of the various species are known, this analysis can proceed. The relative effects of alternatives on other beneficial uses can then be estimated and a final set of objectives chosen.

DWR has volunteered to conduct the biological assessment to evaluate the impacts of adopting the SMPA standards as water quality objectives. The State Board will need an acceptable biological assessment on or before April 1, 1996, allowing review of the results of the assessment as part of its regular triennial review.

B. Studies

- **Studies are needed to determine the relationship between channel water salinity and soil water salinity in the tidal wetlands around Suisun Bay.**

These studies should include at least:

1) A regular monitoring program for the managed areas of one or more of the channel islands (Roe, Ryer, Snag, and Freeman islands) including a) the EC of the applied water, the EC of water in the root zone, and the seed production per acre at two or more sites; and b) continuous EC measurements of the applied water and monthly measurements of the soil water from October through June (the results should be reported as mean monthly EC of applied water, monthly EC of soil water, and annual seed production per acre).

2) A regular monitoring program for the unmanaged tidal wetlands within the legally-defined Suisun Marsh including: at least one site on either Joice or Grizzly Island near the mouth of Montezuma Slough, a site north of Cutoff Slough, a site on one or more of the channel islands or on the shore of Simmons Island facing the channel islands, and a site on Van Sickle or Wheeler Island facing Honker Bay. This

distribution of sites should give the State Board sufficient information to determine the effects of the water quality objectives and to estimate the effects of any changes that may be proposed or needed in the future.

3) The interagency programs, including the Suisun Marsh Fish Monitoring Program, and the Neomysis/Zooplankton Survey, are on-going; coordination of these activities should provide the State Board with the information necessary to monitor the effects of the water quality objectives.

7.4.3 Other Special Studies and Reviews

7.4.3.1 Aquatic Habitat Status Report

Although many individual studies on various aspects or species have been conducted over the years, an integrated picture of the overall condition or "health" of the Estuary has not been produced. Such an overall condition or status report is needed to provide a context for past, present and future conditions in the Delta. The data are sufficient in many areas to provide at least an overall view of recent (last 20 to 25 years) changes and current status. Such a status report would provide an overall context in which to view proposals for new projects, physical structures and operational changes, and for the impacts of newly introduced species, etc. Future sampling and monitoring programs should be designed and executed with a view to integrating the results obtained into a comprehensive overview.

Parties should discuss during the Scoping Phase the feasibility of preparing such a report, the responsibilities and plans for developing it and means to update and revise this status report on a regular basis. Parties should consider the idea of an annual oral summary review and presentation to the State Board as one way to communicate and update this status report, combined with appropriate documentation and timely data analysis.

7.4.3.2 Modeling Needs

A. Current Modeling

o **The three-dimensional model currently being developed by USGS for evaluating hydraulic and biological processes in the various embayments of the San Francisco Bay should be finalized.**

o **An Interagency Modeling Development and Use Committee should be formed to:**

- facilitate exchange of modeling information and to reduce duplication,

- improve access of information to all interested parties

- simulate operations of major reservoirs in addition to the CVP and SWP,

- consider effects of antecedent conditions,

- **improve temperature modeling for the Sacramento and San Joaquin River basins,**

- **improve Delta channel depletion estimates in DAYFLOW,**

- **improve both water quality and flow modeling for the San Joaquin River Basin,**

- **update hydrology to reflect current land use and groundwater/surface water interactions.**

To facilitate the exchange of modeling information and to reduce the duplication of modeling work, some members of the modeling community have suggested that an Interagency Modeling Development and Use Committee should be formed. As envisioned, this committee would meet periodically to perform the following tasks:

o Work cooperatively to develop and improve computer models and data bases;

o Train new model users on the proper use of existing and new computer models;

o Inform others on the advances in computer technology, including geographic information systems (GIS); and

o Review various study modeling assumptions, and assure that when assumptions are varied they are clearly documented when reporting model outputs.

DWR, USBR, CCWD, the State Board and other participants of the Operation Studies Workgroup are already working together to improve the operation studies model, DWRSIM. DWRSIM, which simulates the operation of the CVP and SWP reservoirs and conveyance facilities, is being revised by incorporating the following:

o Flow/salinity relationships that consider antecedent (preceding) conditions.

o A new up-to-date hydrology, which is the result of more recent land use information.

o The new Central Valley Ground Water Simulation Model, which significantly improves the estimates of ground and surface water interaction.

The Board encourages DWR to link DWRSIM with major M&I operations models such as those in the Los Angeles, San Diego, Sacramento and San Francisco Bay areas.

The Board believes that models would be improved by incorporating field data from the following types of studies:

- o Water quality profiles in the main navigation channels in South Bay and between the Golden Gate Bridge on the west and Stockton and Rio Vista on the east, by the use of a boat-mounted continuous recorder for the following parameters: water temperature, electrical conductivity, pH, dissolved oxygen, turbidity, and *in vivo* chlorophyll;

- o Better description of Delta hydrology, including inflow and outflow measurements, amount of in-Delta diversions, and channel velocities; and

- o Water quality, tidal height, water temperature, turbidity, meteorological and other data throughout the Estuary.

B. State Board Modeling Capability

o **The Board recognizes the need to develop its own modeling capability which will assist in the consideration of appropriate water transfers, new water rights, review of existing water rights and future alterations of Delta water quality and flow requirements.**

To further improve the modeling capability of the water community, the State Board is conducting a management study to determine the feasibility of enhancing the State Board's modeling capability. The purpose of this enhancement would be to ensure that the State Board (and others) have adequate resources to evaluate the water supply, environmental, and economic impacts of future water quality objectives, flow standards, or facility proposals. The possible modeling enhancement study approaches include, but are not limited to: (1) no-action, (2) more reliance on other state and federal water agencies, (3) more reliance on private consulting firms, and (4) enhancement of the State Board's "in-house" modeling capability. In addition, the management study will address the need for enhancement of water right and water resources databases that will be needed for modeling purposes.

C. Fishery Models

The following fishery models, in addition to any others that may be proposed, may be considered, as appropriate, in the impact analysis:

- o Abundance and Survival of Delta Smolts in the Sacramento-San Joaquin Estuary by the USFWS.

The USFWS (since 1978) has annually conducted research on the survival and abundance of Chinook smolts and fry as they migrate down the Sacramento through the Estuary. The research has led to the development of several different models, including: annual index of abundance of fall-run smolts; smolt survival based on adults returns 2-1/2 years later; and smolt survival index using flow, temperature, percent diverted at Walnut Grove, export rates and migration route variables. A San Joaquin River smolt survival index is being developed based on different release sites, various levels of inflow from the San Joaquin River, SWP and CVP export rates and ocean recoveries of adults.

- o Chinook Salmon Population Model for the Sacramento River Basin by BioSystems Analysis, Inc.

This model estimates the abundance of fall-run Chinook salmon under a given set of flow and temperature conditions, mortality parameters, and assumptions about harvest in the ocean and river fisheries for the Sacramento River Basin. At present it serves as an indicator of the population trends as it has not yet been calibrated. Another version is presently being developed for winter-run Chinook salmon.

- o Draft San Joaquin River System Chinook Salmon Population Model by EA Engineering, Science and Technology.

This is mechanistic simulation model representing the principle factors influencing the abundance and production of fall-run Chinook salmon in the San Joaquin River Basin.

7.5 Scoping and Water Right Issues

- o **Only a few parties are currently responsible for meeting water quality and flow requirements and for compliance monitoring activities within the Delta. The Board requests that information be developed on how these burdens of meeting the objectives should be distributed over more water right holders and waste dischargers. This information will be considered and used by the State Board during the Scoping and Water Right phases of the proceedings.**

- o **For the development of alternatives to existing points of diversion and for the coordination of preparedness planning by other agencies, information should be presented during the Scoping Phase on the impact of flood control measures, levee conditions, dredging, channel deepening, barriers and seismic activities.**

7.5.1 General

In addition to implementation issues related to water quality objectives in this Plan, other issues, as illustrated in Chapter 7.1.1, will be considered in the Scoping and Water Rights phases. To facilitate preparation for those phases, expected issues are summarized below. The list includes matters which have been discussed specifically in earlier sections.

7.5.2 Summary of Beneficial Use Issues

7.5.2.1 Municipal and Industrial Uses

- Retention of the 150 mg/l chloride objective for industry,

- Within the Delta Export water quality to enhance reclamation,

- Relative advantages and disadvantages of maintaining high water levels in SWP terminal reservoirs.

7.5.2.2 Agriculture

o Western and Interior Delta

- Consideration of objectives for crops other than corn

- Cost and feasibility of leaching

o Southern Delta Agriculture

A request by SDWA that "[w]ater quality required at the inflow points would be specified as a function of net daily inflow rate and of channel depletion by months for the channel reaches receiving water from each inflow point."; and that "[t]he required net daily inflow rates at each inflow point would be in accordance with a monthly schedule sufficient to maintain the required unidirectional net flow in each channel reach" (SDWA,116,2).

7.5.2.3 Salmon

- Flow needs of migrating salmon

- Use, timing and quantity of water for pulse flows

- Appropriate use of hatcheries to supplement natural production

7.5.2.4 Striped Bass

Agreements and information on the following issues will be helpful for developing an appropriate environmental impact report.

o **The direct entrainment losses of striped bass and other fish at the major diversions in the Delta are well documented. The Bureau of Reclamation and the Contra Costa Water District should each negotiate a fishery agreement with the Department of Fish and Game that would provide for mitigation of the direct entrainment losses at the Tracy Pumping Plant and Contra Costa Pumping Plant No. 1. These agreements should be completed prior to the conclusion of the Water Right Phase. Direct entrainment losses at Delta agricultural diversions are not well documented. The parties should evaluate such losses and identify corrective measures.**

o **A real-time monitoring program should be developed and used to assess the daily densities of striped bass eggs and larvae in the Sacramento River during the spring and initiate periodic closure of the Delta Cross Channel to reduce diversion of striped bass into interior Delta channels. Closure of the Delta Cross Channel should be coordinated with short duration pulsed flows in the Sacramento River, in combination with short-term reductions in export pumping and reduced reverse flows, to transport striped bass eggs and larvae into the Suisun Bay.**

- **There is the need to initiate a detailed investigation and evaluation of alternative sites for establishing facilities for rearing juvenile striped bass salvaged from the SWP and CVP facilities for subsequent release to the Bay-Delta system.**

- **A detailed review and evaluation of alternative recreational angler harvest management options including, but not limited to, specific area and seasonal closures, alternative size limits including initiation of a slot limit, and restrictions on fishing gear such as use of single barbless hooks should be conducted. In addition, the impacts of poaching on the striped bass population should be evaluated, funding sources for expanded enforcement should be sought, and the unrestricted sale of striped bass in California should be eliminated. Temporary changes in fishery harvest regulations should be considered as part of an overall short-term approach to improve the situation until longer-term measures may be instituted. The Board does not believe such measures should substitute for its own responsibilities to provide suitable habitat.**

- **Additional water project operation tests should be conducted in the Delta to better determine the effects of diverting water from and upstream of the Delta on striped bass.**

To make certain that the State Board develops water quality objectives that are based on sound scientific data, and which are appropriately protective of striped bass spawning habitat, we request DFG to analyze the protective values of setting up a specific spawning habitat zone of 0.44 mmhos/cm EC, or some other more appropriate EC value, in the river reach between Jersey Point and Prisoners Point. Analysis of historical springtime EC data indicates that 0.44 mmhos/cm EC at Jersey Point would apparently maintain an EC at Antioch of just about 1.5 mmhos/cm, which DFG would like to retain. DFG should also analyze the possibility and the effects of relating a relaxation provision to declared deficiencies. Specifically, DFG should be prepared to discuss the effects of reducing the spawning habitat by moving the downstream end of the spawning habitat reach upstream from Jersey Point a distance proportional to the percent reduction in delivery of firm supplies, along the lines proposed in the table below. In the remaining reach, the 14-day running average of the mean daily EC would be no more than 0.44 mmhos/cm EC for the period April 1 to May 31, or until spawning has ended.

Percent Delivery Reduction	Percent River Reach Reduced
0	0
1-10	10
11-20	20
21-30	30
31-40	40
>40	40

Deficiencies are defined as deficiencies in firm supplies declared by a set of water projects representative of the Sacramento River and San Joaquin River watersheds. The specific projects and amounts of deficiencies would be defined in subsequent phases of these proceedings.

DWR should be prepared to discuss the potential effects, i.e., water costs, that would result if the State Board were to adopt water quality objectives as outlined above. The Board would like to hear from USBR, USFWS and any other interested parties on this subject at the next Triennial Review.

7.5.2.5 Other Fish and Wildlife Issues

- Marine Habitat

Issues concerning marine habitat center on the effects of Bay outflow rather than salinity, and so will be considered in the Scoping and Water Right phases.

- Navigation

Effects on beneficial uses of deepening the Sacramento Deep Water Ship Channel

- Export Recreation and Export Fishery Habitat

In the Scoping Phase, participants should be prepared to discuss the effects of more variable levels and flows on fishery habitat, especially as related to temperature stress, turbidity, algal growth, dissolved oxygen depressions and other water quality considerations.

Documentation is required of the types and extent of water-associated recreational activities, particularly in terms of present usage of both reservoir activities and flowing-stream activities (fly-fishing, rafting, kayaking, etc.). In addition, estimates are needed of the potential impacts of changes in operations on recreational activities, or on storage levels of reservoirs both upstream and in the export areas. Participants should be prepared to discuss these topics in at least qualitative terms during the Scoping Phase, and have quantitative data available by the Water Right Phase. With the type of information addressed above, the State Board will be better able to develop a balanced water management program.

- Estuary Recreation

The information presented during Phase I was based upon data gathered over ten years ago. Current surveys of recreational uses of facilities within the Estuary are needed. Appropriate agencies should provide current data.

7.5.2.6 Marshes around Suisun Bay

A biological assessment will be continuing during these phases.

7.5.3 Other Scoping and Water Right Issues

- **Additional means including the use of biocriteria should be developed to assess the general health of the Estuary and serve as a basis for determining the impacts of new projects, physical and operational changes, introduced species, etc. DFG should develop a priority list of tasks to be performed. Consideration should be given to specific components such as American shad, Delta smelt, and the benthos. Also, use of biocriteria should be considered.**

- **There is a need to examine further the impacts of San Francisco Bay inflows on fish, invertebrates, and other public trust resources, particularly as these inflows, including pulse flows, affect distribution, abundance, and reproduction success of species inside the Estuary. Studies are also needed to provide the linkage, if any, between phytoplankton, and higher trophic levels.**

7.5.3.1 Water Year Classification

- **The current Sacramento River Water Year Classification approximates annual conditions of water availability with five distinct categories. The Water Year Classification subworkgroup has adopted, in concept, the addition of a sliding scale to the classification to smooth the transitions between categories. There is a need for the parties to study this proposal and submit the results for review during the Scoping Phase of the proceedings.**

- **Due to a previous lack of analytical tools, the San Joaquin River Basin classification needs refinement.**

  There is a need for the parties to develop a San Joaquin River Basin classification with similar methodology as used for the Sacramento River Basin and submit the results for review during the Scoping Phase of the proceedings. Other issues, such as the variation in hydrologies among tributary basins, and the absence of coordination between the major San Joaquin River basin reservoirs, can then also be addressed. This system, together with the Sacramento River classification, will be used during the Scoping and Water Right phases to determine how the responsibilities of meeting water quality objectives should be distributed.

  Development of Annual Four Basin Unimpaired Flow

  Part of the process to determine each water year's classification is the estimation of the Sacramento and San Joaquin basins' Four River Unimpaired Flow Indexes, a measure of seasonal wetness. For the months of February through May, estimates of these unimpaired flow indices are made on the first of each month. Unimpaired flow is estimated from both measured and forecasted flows and snowpack amounts. The hydrologic portion of the water year index that relies on forecasts is subject to assumptions made by the forecaster. This forecasting process is performed by DWR. There is no documentation explaining this process. The assumptions and process should be documented and readily available. DWR should convene a technical forum for interested parties for the purpose of providing the parties with the details of the methodology and assumptions used in the forecasting process. After this initial forum, additional meetings should be convened only when the methodology or the assumptions are changed.

7.5.3.2 Economic Analysis

The Scoping Phase will help identify alternative methods to provide the protections needed for the beneficial uses made of Bay-Delta waters. To determine if an alternative is reasonable the State Board considers economic effects. For example, studies will be needed to determine the costs of south Delta facilities, the cost of dilution releases to the farmers required to forego use of water, and the secondary costs associated with reservoir reoperation and other actions. Determination of the overall costs of alternatives will require input from technical studies on the appropriate mixes of required actions.

7.5.3.3 Entrapment Zone

- **Studies are needed to better define the degree of linkage between the location and productivity of the entrapment zone and the effects on the population levels of important fish species.**

The Phase I hearing record includes many pages of exhibits and testimony concerning the importance of the entrapment zone. The definition and placement of the entrapment zone is more closely tied to freshwater outflow than to salinity. Further consideration of this issue will occur in the Scoping and Water Right Phases of these proceedings. During the Scoping Phase, the State Board seeks further information on the following:

1. The location of the entrapment zone in relation to freshwater outflow;

2. The importance of the entrapment zone organisms in the fish food chains, especially with regard to striped bass, Delta smelt, and out-migrating salmon smolts;

3. The significance of introduced invertebrates, both benthic filter-feeders and zooplankton, on food supplies in the Bay-Delta waters,

4. The relative importance of phytoplankton, bacteria and detritus as food sources for higher trophic levels in the entrapment zone;

5. The relationship between entrapment zone location and level of primary productivity or phytoplankton concentrations; and

6. The relationship between phytoplankton abundance, zooplankton abundance and fish productivity.

These topics are not exclusive; if any parties believe that other subjects need to be addressed, they are welcome to introduce them.

7.5.3.4 Physical Facilities

Information Needed on Physical Facilities

During the first two phases of the Bay-Delta proceedings several parties indicated that proper facilities would help stretch the water supply to meet more of the needs of various beneficial uses. Included in these discussions were several isolated facilities to provide better water quality for export M&I, hatcheries to help supplement the populations of specific fisheries and reservoirs to help store water from times of surplus for distribution during times of need (see below). While the State Board supports these concepts in theory, it must have detailed information as to their effects on beneficial uses in the Estuary.

Isolated facilities can provide better water quality for M&I use. However, some questions need to be answered:

- Are there appropriate and cost-effective ways of isolating this water from that large volume of water exported for agriculture purposes which do not need the higher quality? What would be the effects of this facility on areas of origin, on the Bay-Delta Estuary's aquatic habitat, etc.

- Since this water would be expensive, should consideration of separate plumbing for internal domestic use be addressed? To help reduce project cost should the use of existing rights-of-way be considered?

New reservoirs are being planned south of the Delta. The State Board believes that additional information is needed particularly in regard to the timing and amount of diversions to these facilities. During the Scoping Phase, parties should be prepared to discuss the potential effects of diversions to South-of-the-Delta reservoirs on beneficial uses in the Estuary.

Specific Physical Facilities and Projects to be Discussed in the Scoping Phase

A. Delta Water Management Facilities - Three DWR Delta Water management programs comprise a plan to enhance the SWP capability to increase exports while attempting to solve problems affecting Delta beneficial uses. These programs are:

1) The North Delta Water Management Program - The primary objectives of this program are to help alleviate flooding in the north Delta area, reduce reverse flow in the lower San Joaquin River, improve water quality, reduce fishery impacts, and improve water supply reliability. Secondary objectives are to improve navigation and enhance recreational opportunities. Under this program the South Fork Mokelumne River will be dredged, the Delta Cross Channel gates may be modified, partial tide gate structures in the Sacramento River may be built to raise water levels in the Sacramento to divert additional water into the Delta Cross Channel, a partial tide gate structure in Three-Mile Slough may be built, and a new Sacramento River connecting channel near Hood or Isleton may be built to divert additional flow through the interior of the Delta.

2) The Western Delta Management Program - This program includes four major issues: flood control, water quality, wildlife concerns, and water supply reliability. Sherman Island, the major Delta island situated farthest west, is the focus of this program. Levee rehabilitation and land acquisition for the development of wildlife and wetland habitat will be a part of this program.

3) The South Delta Water Management Program - The objectives of this program are to help solve the following problems: water level and water circulation related to agricultural needs in the south Delta, water quality, project water supply reliability, and fishery impacts. Under this program four barriers will be installed in the south Delta, a portion of Middle River will be enlarged, Clifton Court Forebay will be enlarged, and an additional forebay will be constructed on the northern half of Victoria Island with a siphon connection to Clifton Court Forebay (DWR & USBR, 1990).

B. Isolated Facilities - The purpose of such a facility is to isolate water being conveyed from the Sacramento River to Clifton Court, from the Delta. This facility would improve the salinity, and drinking water quality of this water, while theoretically reducing the carriage water requirement and permitting better control of Delta circulation (Brown and Caldwell, Delta Drinking Water Quality Study, May 1989). The reduction of the carriage water requirement and the control of circulation patterns has the potential for enhancing the beneficial uses that continue to be made of water directly from the Estuary. There is a great concern among many, especially northern Californians, that the isolated facility would be operated in a manner that would harm the Estuary. Proponents of the isolated facility have stated that protection of all Delta beneficial uses is a primary concern, and that an isolated facility would not be built without guaranteeing this protection. A number of alternative isolated facilities have been suggested. The facilities most often discussed are the following:

1) Peripheral Canal - This is a 42-mile-long isolated channel rejected by California voters in 1982. This facility would convey water from the Sacramento River around the Delta, releasing a portion of it for Delta channel flow improvement, and delivering the remaining water to Clifton Court Forebay and then to the Delta export pumps.

2) Dual Transfer System - This facility would convey about half of the water being exported from the Delta through existing channels, and the remainder in a isolated channel extending from Hood on the Sacramento River to the Clifton Court Forebay.

3) Bifurcated System - This facility is the same as the Dual Transfer System, except that it would provide a bifurcated transmission system south of the Delta so that only high quality water would be delivered to southern California for M&I purposes.

4) Sierra Source-to-User System - This isolated facility would be comprised of a number of facilities used to convey water for M&I water use from the Feather River/Sacramento River confluence around the Delta and directly to the Tracy Pumping Plant.

C. Auburn Dam - The proposed Auburn Dam was originally designed to be a 2.3 MAF multipurpose reservoir for water supply, power, recreation, flood control, and fishery enhancement. Construction was begun in 1967 but stopped in 1976 to permit further study of seismic and design issues. Environmental issues have further affected the future of the Auburn Dam. Currently, there are three proposals for an Auburn Dam: a dry dam used only for flood control, a flood control dam with the flexibility to allow later expansion to a multi-purpose dam, and a full multi-purpose dam (DWR & USBR, 1990).

D. Kern Water Bank - The Kern Water Bank (KWB) is a conjunctive use ground water project being developed by DWR, in conjunction with the Kern County Water Agency and local water districts, to augment the dependable water supply of the SWP. The KWB would allow storage and extraction of ground water, in coordination with the operation of surface water storage and conveyance facilities. In general, water would be banked in the basin during years of above-average water supply and withdrawn during drier years, when surface water supplies are below average. The first stage, with a capacity of 300 TAF, is planned for development by 1991, with maximum capacity of 1 MAF planned for development by 1994 or 1995 (DWR & USBR, 1990).

E. Los Banos Grandes Reservoir - The Los Banos Grandes Reservoir (LBG) is proposed to be solely an SWP off-stream water supply facility filled with water from the California Aqueduct. LBG will provide operational flexibility for the SWP to allow improved operation for the fisheries and enable a greater shift in exports to months when fish are not as abundant and when very high Delta outflows occur. The current schedule estimates that the LBG facilities could be completed and in operation by the year 2002 (DWR & USBR, 1990).

F. Los Vaqueros Reservoir - The proposed Los Vaqueros Reservoir, to be operated by the Contra Costa Water District, will be a 100,000-AF reservoir in the hills southeast of Contra Costa County. The purpose of this reservoir is to improve the quality and reliability of delivered water and is scheduled for completion in 1995 (Jones & Stokes, 1991).

G. Delta Wetlands Project - The Delta Wetlands Project is proposed by Bedford Properties, a land development company, to store water seasonally on four Delta islands (Bacon and Bouldin islands, and Holland and Webb tracts) and to manage the islands for wetland wildlife habitat during July-December. Stored water would be diverted from unregulated Delta outflow when available during January-April of each year. Stored water (up to 270,000 AF) would be discharged from the islands during May-July for sale to various water users (Jones & Stokes, 1990).

H. Additional Banks Pumping Plant Capacity - DWR is installing four additional pumping units at the Banks Pumping Plant, increasing the pumping capacity from 6,400 cfs to 10,300 cfs. In order to operate the Banks Pumping Plant above 6,400 cfs a revised Corps of Engineers permit is required. These pumps begin operation in 1991 and will provide standby capacity for the present units and permit a larger share of the pumping with cheaper off-peak power. DWR plans to divert more water during the winter to facilitate offstream storage reservoirs and groundwater recharge operations south of the Delta (DWR & USBR, 1990).

I. Baldwin and Stockton Ship Channel Projects - These two ship channel projects, undertaken by the Corps of Engineers, will deepen existing or create new channels that will allow larger commerce shipping access to inland ports.

J. Desalination Projects - In California, desalting is used to reclaim brackish ground water, desalt sea water, and treat water for such industries as the electronics industry, which require processed water of high purity. The principal limitation of desalting is its high cost, which is directly linked to its high energy requirements. Of various desalting techniques, the membrane processes (reverse osmosis and electro-dialysis) offer the best potential to further reduce costs and thus increase use. Recent research has been able to reduce the energy requirements dramatically. With further reductions in the energy requirements and future increases in competition for water supplies, desalting is becoming a viable alternative for the development of marginal water supply (DWR & USBR, 1990). Currently, Santa Barbara, Marin, and MWD are considering construction of desalting facilities to develop marginal water supply during dry periods.

K. Reclamation Projects - Reclaimed water is used for various purposes, including crop and landscape watering, industrial cooling, and ground water recharge. Industries sometimes recycle water at a facility to recover heat or materials, to save water, and to eliminate the cost of discharge to a municipal system. Waste water can be treated to drinking water quality, but the higher cost of such treatment, institutional prohibitions, and public reluctance to use reclaimed water discourages its use when water of equal quality is available from other sources. Urban water managers continue to seek suitable locations to replace drinking quality water with treated municipal waste water for such applications as landscape and crop irrigation. The greatest potential for wider use exists in the coastal areas of southern California where hundreds of thousands of acre-feet of treated water are discharged to the ocean every year. Dual or separate delivery water systems are being studied. These dual delivery systems will separate water delivered for human consumption from reclaimed water delivered for irrigation or industrial uses. Use of wastewater for M&I purposes has not received complete acceptance by the public and the health authorities (DWR, Bulletin 160-87, pp. 53-54).

The parties should be prepared to discuss in detail these and other issues concerning physical facilities during the Scoping Phase of the proceedings. The Board will use this information to form a balanced decision in the Water Right Phase.

7.5.3.5 Agricultural Water Conservation

The overall goal of the Agricultural Water Conservation Workgroup and its Subworkgroups is to identify potential water savings (annual and seasonal) through increased irrigation efficiency within the following constraints:

1) Maintain present level of crop production (i.e., protection of "present" beneficial use),

2) Maintain present amount of annual net recharge to ground water in non-saline sink areas,

3) Reduce annual net recharge to ground water in saline sink areas (if possible) by increasing irrigation efficiencies to the minimum target efficiency for irrigation, and

4) Maintain salt balance in the crop root zone as necessary to maintain present crop productivity.

The Workgroup will attempt to identify annual savings in saline sink areas and seasonal savings in non-saline sink areas. The State Board anticipates receiving valuable information from the Agricultural Water Conservation Workgroup during the Scoping Phase.

7.5.3.6 Conjunctive Use

The State Water Project Conjunctive Use (SWPCU) Workgroup is evaluating both put-and-take or seasonal storage, and long-term storage forms of conjunctive use. The SWPCU Workgroup's study area is primarily the SWP service areas. The workgroup intends to provide the State Board with a report for the Scoping Phase. This report should detail the following information for the major ground water basins of California:

(1) existing ground water production capacity, (2) imported water delivery capacity, (3) ground water-surface water delivery overlap, (4) existing recharge capacity, (5) available capacity by month, (6) potential existing recharge facility expansion, (7) potential new recharge facility projects, and (8) ground water basin constraints.

7.5.3.7 Suggested Legislation

Water Rights Monitoring

Under the Porter-Cologne Act (Water Code Section 13267(b)), a Regional Board may require any discharger of waste to prepare technical or monitoring program reports. No similar provision allows the State Board to require technical or monitoring program reports from water right holders who divert and use water from a watercourse. The diversion and use of water may cause adverse effects to downstream beneficial uses of water. For example, the diversion and use of water may adversely affect aquatic life downstream, cause seawater intrusion into underground water supplies, cause pollution as a result of return flows into rivers, and impair the water supplies of other water users.

While the State Board is able to require new appropriators of surface water to monitor potential impacts, the State Board cannot conveniently require existing water right holders to initiate new monitoring programs. In order to require an existing water right holder to conduct a monitoring program under current law, the State Board must conduct an enforcement action, a change petition proceeding, a proceeding to prevent waste and unreasonable use under Article X, Section 2 of the Constitution or a proceeding to apply the public trust doctrine.

Legislation should authorize the State Board through administrative means to require monitoring by individual water right holders where such a requirement is related to the individual's diversion. The legislation should also authorize the State Board to impose annual fees on all permit and license holders to assure that an adequate compliance monitoring program can be implemented.

Screening of Agricultural Diversions

Screening of agricultural diversions in the Delta has been identified as a method of improving young striped bass and salmon survival in the Estuary. A recent survey by DWR determined there are over 1,900 pumps and siphons in the Delta with intake pipe diameter ranging from 3 to 36 inches (Sato et al., 1987 in Hopelain 1989). Salmon entrainment data collected in the Delta and Feather River ranged from averages of 1.38 to 4.66 salmon per acre foot, respectively and average numbers of juvenile striped bass lost through Delta agricultural diversions during April through July, 1978 and 1979 were 19 and 12 million, respectively (Hopelain, 1989).

Fish and Game Code, Sections 5980 through 6028 apply to screening and preventing fish losses through water diversion intakes. The sections essentially state that if a diversion was constructed after 1971 and adversely affects fish populations, the owner is required to construct, operate and maintain a screen on the diversion. If the diversion was constructed prior to 1971 and is larger than 250 cfs, the costs of screening is to be shared equally by the owner and DFG. If the diversion was constructed prior to 1971 and is less than 250 cfs, the entire cost of screening is to be borne by DFG. Most Delta agricul-tural diversion fall into the latter category with the financial responsibility resting with DFG; consequently, the agricultural diversions remain unscreened. DFG should prepare a report to SWRCB presenting a plan of action and possible sources of funding and proposed legislation by the beginning of the Water Right Phase of the proceedings.

Finally, a program is needed to produce information about the Bay-Delta system relevant to management decisions. Such a program should:

1) Identify the manageable (man-induced) effects on the Bay-Delta;

2) Identify responsibilities for developing studies to allow resource agencies to better manage the Bay-Delta system;

3) Develop a stable funding mechanism through fees on point source dischargers, non-point source dischargers and upstream water users; and

4) Develop time schedules and oversight committees to ensure timely implementation and coordination.

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APPENDICES

A. Abbreviations for Information Sources and Citations
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APPENDIX A
ABBREVIATIONS FOR
INFORMATION SOURCES AND CITATIONS

ABBREVIATION	NAME
ACH	THE CITIES OF AVENAL, COALINGA & HURON
ACWD	ALAMEDA COUNTY WATER DISTRICT
AFC&WCD	ALAMEDA FLOOD CONTROL AND WATER CONSERVATION DISTRICT
AHI	AQUATIC HABITAT INSTITUTE
ANTIOCH	THE CITY OF ANTIOCH
ASA	CALIFORNIA ASSOCIATION OF SANITATION AGENCIES
BAAC	BAY AREA AUDUBON COUNCIL
BADA	BAY AREA DISCHARGERS ASSOCIATION
BALIA	BAY AREA LEAGUE OF INDUSTRIAL ASSOCIATIONS
BCDC	SAN FRANCISCO BAY CONSERVATION AND DEVELOPMENT COMMISSION
BISF	THE BAY INSTITUTE OF SAN FRANCISCO
BUSCH	ANHEUSER-BUSCH COMPANIES
Bureau	U.S. BUREAU OF RECLAMATION (also USBR)
CALCWD	CALAVERAS COUNTY WATER DISTRICT
CBE	CITIZENS FOR A BETTER ENVIRONMENT
CCCWA	CONTRA COSTA COUNTY WATER AGENCY
CCIQW	CONCERNED CITIZENS FOR IMPROVED QUALITY WATER
CCWD	CONTRA COSTA WATER DISTRICT
CDWA	CENTRAL DELTA WATER AGENCY
CFBF	CALIFORNIA FARM BUREAU FEDERATION
CMWD	CASITAS MUNICIPAL WATER DISTRICT
CNPS	CALIFORNIA NATIVE PLANT SOCIETY
COE	U. S. ARMY CORPS OF ENGINEERS (also U.S. Corps)
CSPA	CALIFORNIA SPORTFISHING PROTECTION ALLIANCE
CVAWU	CENTRAL VALLEY AGRICULTURAL WATER USERS
CVPWA	CENTRAL VALLEY PROJECT WATER ASSOCIATION
CVWD	COACHELLA VALLEY WATER DISTRICT
CWA	CALIFORNIA WATERFOWL ASSOCIATION

APPENDIX A
ABBREVIATIONS FOR
INFORMATION SOURCES AND CITATIONS

ABBREVIATION	NAME
CWPC	COMMITTEE FOR WATER POLICY CONSENSUS
CWPC	COMMITTEE FOR WATER POLICY CONSENSUS
CWPCA	CALIFORNIA WATER POLLUTION CONTROL ASSOCIATION
CWPCA	CALIFORNIA WATER POOLUTION CONTROL ASSOCIATION
DAWDY	DAVID R. DAWDY
DDWD	DEVILS DEN WATER DISTRICT
DELTAWET	DELTA WETLANDS (a.k.a. BEDFORD PROPERTIES, INC.)
DFG	CALIFORNIA DEPARTMENT OF FISH AND GAME
DOF	DEPARTMENT OF FINANCE
DRWD	DUDLEY RIDGE WATER DISTRICT
DTAC	DELTA TRIBUTARY AGENCIES COMMITTEE
DUNNING	HARRISON C. DUNNING, PROFESSOR OF LAW
DWA	DESERT WATER AGENCY
DWR	DEPARTMENT OF WATER RESOURCES
EA	EA ENGINEERING, SCIENCE AND TECHNOLOGY, INC.
EBMUD	EAST BAY MUNICIPAL UTILITY DISTRICT
EBRPD	EAST BAY REGIONAL PARK DISTRICT
ECCID	EAST CONTRA COSTA IRRIGATION DISTRICT
EDF	ENVIRONMENTAL DEFENSE FUND
EPA	U.S. ENVIRONMENTAL PROTECTION AGENCY (also Agency)
EWID	EMPIRE WESTSIDE IRRIGATION DISTRICT
FAO	FOOD AND AGRICULTURAL ORGANIZATION OF THE UNITED NATIONS
HOOPA	HOOPA VALLEY TRIBE
KCWA	KERN COUNTY WATER AGENCY
LADWP	LOS ANGELES DEPARTMENT OF WATER AND POWER
LCC	LEAGUE OF CALIFORNIA CITIES
LWVC	LEAGUE OF WOMEN VOTERS OF CALIFORNIA
MAS	MARIN AUDUBON SOCIETY
MET	SEE MWD
MID	MODESTO IRRIGATION DISTRICT
MWD	THE METROPOLITAN WATER DISTRICT OF SOUTHERN CALIFORNIA (formerly MET)

APPENDIX A
ABBREVIATIONS FOR INFORMATION SOURCES AND CITATIONS

ABBREVIATION	NAME
NASOC	NATIONAL AUDUBON SOCIETY
NDWA	NORTH DELTA WATER AGENCY
NHI	NATURAL HERITAGE INSTITUTE
NMFS	U.S. NATIONAL MARINE FISHERIES SERVICE
NOAA	U.S. NATIONAL OCEANOGRAPHIC AND ATMOSPHERIC ADMINISTRATION
NRDC	NATURAL RESOURCES DEFENSE COUNCIL
OFWD	OAK FLAT WATER DISTRICT
OWD	OAKLEY WATER DISTRICT
PALMDALE	PALMDALE WATER DISTRICT
PCFFA	PACIFIC COAST FEDERATION OF FISHERMEN'S ASSOCIATIONS
PCWD	PLACER COUNTY WATER DISTRICT
PG&E	PACIFIC GAS & ELECTRIC
PICYA	PACIFIC INTER-CLUB YACHT ASSOCIATION
PRBO	POINT REYES BIRD OBSERVATORY
RIC	RICE INDUSTRY COMMITTEE
RWQCB_2	SAN FRANCISCO BAY REGIONAL WATER QUALITY CONTROL BOARD (REGION 2)
RWQCB_4	LOS ANGELES REGIONAL WATER QUALITY CONTROL BOARD (REGION 4)
RWQCB_5	CENTRAL VALLEY REGIONAL WATER QUALITY CONTROL BOARD (REGION 5)
Region 2	See RWQCB_2
Region 5	See RWQCB_5
SACTO	THE CITY OF SACRAMENTO
SACTOCO	THE COUNTY OF SACRAMENTO
SAVESF	SAVE THE SAN FRANCISCO BAY ASSOCIATION, THE
SAWPA	SANTA ANA WATERSHED PROJECT AUTHORITY
SCLDF	THE SIERRA CLUB LEGAL DEFENSE FUND
SCVWD	SANTA CLARA VALLEY WATER DISTRICT
SCWC	SOUTHERN CALIFORNIA WATER COMMITTEE, INC.
SDIEGO	SAN DIEGO COUNTY WATER AGENCY AND THE CITY OF
SDWA	SOUTH DELTA WATER AGENCY
SFBAWUA	SAN FRANCISCO BAY AREA WATER USERS ASSOCIATION
SFEP	EPA's SAN FRANCISCO ESTUARINE PROJECT

APPENDIX A
ABBREVIATIONS FOR
INFORMATION SOURCES AND CITATIONS

ABBREVIATION	NAME
SFRISCO	THE CITY AND COUNTY OF SAN FRANCISCO
SHELL	SHELL OIL COMPANY
SIERRA	SIERRA CLUB, THE
SJVAWC	SAN JOAQUIN VALLEY AGRICULTURAL WATER COMMITTEE
SMUD	SACRAMENTO MUNICIPAL UTILITY DISTRICT
SRCD	SUISUN RESOURCE CONSERVATION DISTRICT
SRWCA	SACRAMENTO RIVER WATER CONTRACTORS ASSOCIATION
SWC	STATE WATER CONTRACTORS
SWRCB	CALIFORNIA STATE WATER RESOURCES CONTROL BOARD (also State Board)
TIBCEN	THE ROMBERG TIBURON CENTER FOR ENVIRONMENTAL STUDIES
TID	TURLOCK IRRIGATION DISTRICT
TLBWSD	TULARE LAKE BASIN WATER STORAGE DISTRICT
TRACY	THE CITY OF TRACY
TRI-TAC	TRI-AGENCY TECHNICAL ADVISORY COMMITTEE -- LCC, CASA AND CWPCA
TRICO	TRINITY COUNTY
UAC	UNITED ANGLERS OF CALIFORNIA
USBR	U.S. BUREAU OF RECLAMATION (also Bureau)
USDA-SCS	U.S. DEPARTMENT OF AGRICULTURE - SOIL CONSERVATION SERVICE (also SCS)
USDI	U.S. DEPARTMENT OF THE INTERIOR (also DOI)
USFDA	U.S. FOOD AND DRUG ADMINISTRATION (also FDA)
USFWS	U.S. FISH AND WILDLIFE SERVICE
USGS	U.S. GEOLOGICAL SURVEY
VCC	VALLEJO CHAMBER OF COMMERCE
WACOC	WATER ADVISORY COMMITTEE OF ORANGE COUNTY
YCWD	YUBA COUNTY WATER DISTRICT
YOLO	YOLO COUNTY FLOOD CONTROL AND WATER CONSERVATION DISTRICT

APPENDIX B
LIST OF ABBREVIATIONS/SYMBOLS

ABBREVIATION/ SYMBOL	DEFINITION
AF	Acre-Foot = 43,560 cubic feet = 325,900 gallons
AF/yr	Acre-Feet per year
AW	Total applied water (in acre-feet per acre)
As	Arsenic
BAT	Best available technology
BOD	Biochemical oxygen demand
BU	Beneficially used applied water (in acre-feet per acre)
Br	Bromine
Br-	Bromide ion
CAC	California Administrative Code (OBSOLETE--Now Cal. Code of Regulations, CCR)
CCC	Contra Costa Canal
CCR	California Code of Regulations (formerly Cal. Administrative Code, CAC)
CEQA	California Environmental Quality Act
CESA	California Endangered Species Act
CFR	U.S. Code of Federal Regulations
COD	Chemical oxygen demand
CP	Amount of water applied due to cultural practices (in ac-ft/ac)
CVP	Central Valley Project
CWC	California Water Code
Cl	Chlorine
Cl-	Chloride ion
D-1485	SWRCB Water Rights Decision 1485 (1978)
DBP(s)	Disinfection by-product(s)
DMC	Delta-Mendota Canal
DO	Dissolved oxygen
DOI	Delta outflow index
Delta	Sacramento-San Joaquin Delta
Delta Plan	1978 SWRCB WQCP - Sacramento-San Jouquin Delta and Suisun Marsh
EC	Electrical conductivity (also refered to as specific conductance)
ECe	Electrical conductivity of a soil saturation extract (generally in dS/m)

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LIST OF ABBREVIATIONS/SYMBOLS

ABBREVIATION/ SYMBOL	DEFINITION
ECi	Electrical conductivity of applied irrigation water
ECsw	Electrical conductivity of soil water in the root zone (ECsw approx. = ECe / 0.6
Estuary	San Francisco Bay and Sacramento-San Joaquin Delta Estuary
FSA(s)	Flow study area(s)
GAC	Granular activated carbon
I-A/RKI	Interagency/River Kilometer Index Station Code
IDHAMP	Interagency Delta Health Aspects Monitoring Program
IE	Irrigation efficiency (in acre-feet per acre)
M&I	Municipal and Industrial (generally associated with "water supply")
MAF	Million acre feet
MCL(s)	Maximum contaminant level(s) (associated with drinking water)
MCLG(s)	Maximum contaminant level goal(s)
MGD	Million(s of) gallons per day
MLLW	Mean lower low water
Mn	Manganese
Ni	Nickel
PIE	Preirrigation efficiency
PPD	Pollutant Policy Document
Plan	1988 or 1990 Draft Water Quality Control Plan (also WQCP)
Region 2	San Francisco Bay Basin (also Basin 2). See RWQCB_2
Region 5A	Sacramento River Basin (also Basin 5A)
Region 5B	Sacramento-San Joaquin Delta Basin (also Basin 5B)
Region 5C	San Joaquin River Basin (also Basin 5C)
SBI	Striped bass index
SMPA	Suisun Marsh Preservation Agreement
SMR	Applied water needed for soil moisture replacement (in ac-ft/ac)
SS	Suspended solids

APPENDIX B
LIST OF ABBREVIATIONS/SYMBOLS

ABBREVIATION/ SYMBOL	DEFINITION
SWP	State Water Project
Se	Selenium
TAF	Thousand acre feet
TDS	Total dissolved (filterable) solids
THM(s)	Trihalomethane(s)
THMBr(s)	Brominated trihalomethane(s)
THMFP	Trihalomethane formation potential
TOC	Total organic carbon
TTHMFP	Total trihalomethane formation potential
WQCP	1988 or 1990 Draft Water Quality Control Plan (also Plan)
WY	Water year (October 1 through September 30)
YOY	Young-of-year
ac	Acre = 43,560 square feet
cfs	Cubic feet per second = 448.8 gallons per minute = 1.983 acre-feet per day
dS/m	DeciSiemen/meter = 1.0 milliSiemen/cm (a measure of electrical conductivity)
ft	Foot or feet
g/l	Grams per liter
g/sq. m.	Gallons per square meter
gpcd	Gallons per capita per day
hr(s)	Hour(s)
lb	Pound (avdp.) = 16 oz (avdp.) = 453.6 grams
m	Meter or meters = 3.28 feet
mS/cm	milliSiemens per centimeter = millimhos per centimeter
mg/l	Milligrams per liter (approximately equal to ppm in aqueous solutions)
mmhos/cm	Millimhos per centimeter = 1,000 umhos/cm (a measure of EC)
ppb	Parts per billion (approximately equal to ug/l in aqueous solutions)
ppm	Parts per million (equal to mg/kg, approx. equal to mg/l in aqueous solutiions)
ppt	Parts per thousand (approximately equal to g/l in aqueous solutions)

APPENDIX B
LIST OF ABBREVIATIONS/SYMBOLS

ABBREVIATION/ SYMBOL	DEFINITION
sq. ft.	Square foot or feet
sq. mi.	Square mile = 640 acres = 259 hectares
uS/cm	MicroSiemens per centimeter = micromhos per centimeter (a measure of EC)
ug/l	Micrograms per liter (approximately equal to ppb in aqueous solutions)
umhos/cm	Micromhos per centimeter (a measure of EC)

APPENDIX C

GLOSSARY

WORD/PHRASE	DEFINITION
1-in-20 dry year	A statistical term refering to a water year with a total annual runoff exceeded by 95% of the water years which are likely to occur.
Acaricide (Miticide)	A material used primarily in the control of plant-feeding mites (acarids) especially spider mites. Typical acaricides with little insect-killing efficiency are chlorobenzilate, Kelthane, and Omite. Some insecticides, especially phosphorous compounds, are effective also against mites. [Farm Chemicals Handbook, 1987]
Acre-foot (AF)	The quantity of water which will cover an acre of land to a depth of one foot (i.e. 43,560 cubic feet or 325,900 gallons).
Alevin	See Fry.
Algae	Simple rootless plants that grow in bodies of water at rates in relative proportion to the amounts of nutrients available in the water or, in the case of nitrogen, in the atmosphere overlying the water body.
Ambient	The prevailing condition in the vicinity, usually relating to some physical measurement such as temperature. Sometimes used as a synonym for background. [SWRCB Order No. WQ 85-1]
Anadromous	Pertaining to fish that spend part of their life cycle in the ocean and return to freshwater streams to spawn. [SWRCB Order No. WQ 85-1]
Anaerobic	Life or processes that can occur without free oxygen.
Applied water	The quantity of water delivered to the intake to a city's water system, the farm head gate, the factory, and for wildlife, the amount of water supplied to a marsh or other wetland either directly or by incidental drainage flows. [DWR Bulletin 160]
Aquifer	State of California definition: A geologic formation, group of formations or part of a formation that is water bearing and which transmits water in sufficient quantity to supply springs and pumping wells. [DWR Bulletin 74-81] Federal definitions: (1) A formation, group of formations, or part of a formation that contains sufficient saturated permeable material to

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	yield significant quantities of water to wells and springs (10 CFR 960.2)
	(2) A geologic formation, group of formations, or part of a formation capable of yielding a significant amount of ground water to wells or springs. Any saturated zone created by uranium or thorium recovery operations would not be considered an aquifer unless the zone is or potentially is (a) hydraulically interconnected to a natural aquifer, (b) capable of discharge to surface water, or (c) reasonably accessible because of migration beyond the vertical projection of the boundary of the land transferred for long-term government ownership and care (10 CFR 40 Appendix A).
	(3) A zone, stratum, or group of strata that can store or transmit water in sufficient quantities for specific use (30 CFR 710.5).
	(4) A geological formation, groups of formations, or part of a formation, that is capable of yielding a significant amount of water to a well or spring (40 CFR 146.03; 260.10; 270.2).
	(5) A geologic formation, group of formations, or portion of a formation capable of yielding usable quantities of ground water to wells or springs (40 CFR 257.3-4). [USGS, Federal Glossary of Selected Terms: Subsurface-Water Flow and Solute Transport, August 1989]
Arsenic (As)	A highly poisonous metallic element. Arsenic and its compounds are used in insecticides, weed killers and industrial processes. [SWRCB Order No. WQ 85-1]
	Arsenic occurs in two environmentally significant valence states, As +3 or As III (trivalent) and As +5 or As V (pentavalent), with different toxic properties. The various organic forms of arsenic include: methylated forms, arseno-lipids, arseno-sugars, arseno-betaine, and arseno-choline.
Bacteria	Single-cell, microscopic organisms that possess rigid cell walls; may be aerobic (need oxygen), anaerobic (no oxygen present), or facultative (either with or without oxygen); can cause disease; and some are important in the stabilization of solid wastes. [Resources Conservation Glossary]
Banks Pumping Plant, Harvey O.	The Department of Water Resources' State Water Project main deltapumping plant located West of Tracy. The source of the

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	water in the California Aquaduct.
Basin Plan	A plan for the protection of water quality prepared by a Regional Water Quality Control Board in response to the Porter Cologne Water Quality Control Act also contains Water Quality Standards for the federal Clean Water Act.
Bathymetry	Measurements of the differences in depth between mean lower low water and the bottom of the bay.
Bay-Delta Estuary (the Estuary)	San Francisco Bay, the Sacramento-San Joaquin Delta and Suisun Marsh, as defined in Sec. 6610 and 6611 of the Cal. Government Code, Sec. 12220 of the Cal. Water Code, and Sec. 29101 and 29101.5 of the Cal. Public Resources Code, respectively.
Beneficial uses	"Beneficial uses" of the waters of the state that may be protected against quality degradation include but are not limited to, domestic, municipal, agricultural and industrial supply; power generation; recreation; esthetic enjoyment; navigation; and preservation and enhancement of fish, wildlife, and other aquatic resources or preserves. [CWC Sec. 13050(f)] Equivalent to "designated uses" under federal law.
Benthos	The whole assemblage of plants or animals living on the bottom of a water body: distinguished from plankton.
Best available technology (BAT)	The best technology, treatment technique, or other means which the Administrator [of the EPA] finds, after examination for efficacy under field conditions and not solely under laboratory conditions, are available (taking cost into consideration). For the purposes of setting MCLs for synthetic organic chemicals, any BAT must be at least as effective as granular activated carbon. [40 CFR 141.2]
Best management practices (BMPs)	State definition: A practice, or combination of practices, that is the most effective and feasible means of controlling pollution generated by nonpoint sources for the attainment of water quality objectives. [23 CCR 2601] Federal definition: A practice, or combination of practices, that is determined after ...problem assessment, examination of alternative practices, and appropriate public participation to be the most effective, practicable (including technological,

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	economic, and institutional considerations) means of preventing or reducing the amount of pollution generated by nonpoint sources to a level compatible with water quality goals. [40 CFR]
Bioaccumulative	A characteristic of a chemical species when the rate of intake into a living organism is greater than the rate of excretion or metabolism. This results in an increase in tissue concentration relative to the exposure concentration.
Bioassay	A method for determining the relative toxicity (or other biological activity) of a substance by observing its effects on a suitable organism under controlled conditions.
Biochemical oxygen demand (BOD)	The results of an empirical test in which standardized laboratory procedures are used to determine the relative oxygen requirements of wastewaters, effluents, and polluted waters. [Standard Methods ..., 14th ed., 1975] Usually considered, the amount of oxygen required by bacteria while stabilizing decomposable organic matter under aerobic conditions. The BOD test is widely used to determine the pollutional strength of domestic and industrial wastes in terms of the oxygen that they will require if discharged into natural watercourses in which aerobic conditions exist. The test is essentially a bioassay procedure involving the measurement of oxygen consumed by living organisms (mainly bacteria) while utilizing the organic matter present in a waste, under conditions as similar as possible to those that occur in nature. [Sawyer, C.N. and McCarty, P.L., Chemistry for Sanitary Engineers, 1967]
Bioconcentration	The positive difference in concentration of a chemical between water and that in an organism living in that body of water due to direct uptake of the chemical from the water. [SWRCB Order No. WQ 85-1]
Biocriterion (plural biocriteria)	Short for "biological criterion" The numerical or narrative expression of the biological characteristics of ambient aquatic communities (often structural measures, e.g., species composition, organism abundance or diversity). Biocriteria, as generally applied in State programs, are designed to reflect attainable characteristics under minimally impacted conditions. As such, biocriteria describe the ecological potential for aquatic community health in a given watershed, drainage basin or ecological region. [EPA, Report of the National Workshop on Instream Biological Monitoring and Criteria, Lincolnwood, IL, 12/2-4/87]

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Biodegradable	Any substance that decomposes through the action of microorganisms.
Biomagnification	The net accumulation and increase of a substance in an organism as a result of consuming organisms from lower trophic levels, e.g., the consumption of algae by fish or water plants by ducks. [SWRCB Order No. WQ 85-1]
Biomass	The total amount of living material, plants and/or animal, above or below ground in a particular habitat or area. [40 CFR]
Biota	All living organisms that exist in an area.
Bloom	A proliferation of algae and/or higher aquatic plants in a body of water.
Cancer	Any disorder of cell growth that results in invasion and destruction of surrounding healthy tissue by the abnormal cells.
Carcinogen	Any agent that produces cancer, e.g. tobacco smoke, silica and asbestos particles, certain industrial chemicals, and ionizing radiation (such as X-rays and ultraviolet rays).
Carquinez Strait	The narrow strait between Suisun and San Pablo bays. It has a mean surface area of 12 sq. mi., mean depth of 29 ft., and mean volume of 223,000 AF.
Carriage water	The amount of Delta outflow needed to meet all of the water quality requirements of D-1485 less (minus) that needed to meet the requirements excluding those for Contra Costa Canal at Pumping Plant No. 1 (D5) and Clifton Court Forebay Intake at West Canal (C9). The quantity of additional Delta outflow (carriage water) is a function of Delta export pumping and south Delta inflow rates. It is necessary to reduce the effects of sea water intrusion into the Delta around the south side of Sherman Island (reverse flows up the San Joaquin River). This definition differs from that used by others in that it does not include additional Delta outflow which may be needed to meet certain contractual obligations of the Department of Water Resources. [T,III,8:25-10:23]
Central Bay	Central San Francisco Bay. That portion of San Francisco Bay bounded by the Golden Gate, San Francisco-Oakland Bay and Richmond-San Rafael bridges. Surface area = 103 sq. mi. at MLLW, mean depth = 35 ft, and mean volume = 2.307 MAF.

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Chemical oxygen demand (COD)	The results of a laboratory chemical analytical technique which is used to measure the amount of oxygen required to oxidize all compounds in a sample of water, organic and inorganic. [Environmental Glossary 4th ed.]
Chloramination	The use of a combination of chlorine and ammonia to disinfect water supplies.
Chloride (Cl-)	The ionic form of the gaseous element chlorine, usually found as a metallic salt with potassium or sodium. [SWRCB Order No. WQ 85-1]
Chlorinated hydrocarbons	A class of pesticides which contain chlorine, carbon, and hydrogen. See Chlorinated organic insecticides and acaricides. [Farm Chemical Handbook, 1987] They include solvents (e.g., TCE, TCA), heat exchangers (e.g., PCBs), contaminants (e.g., TCDD, TCDF), herbicides (e.g., ZAP), and wood preservatives (e.g., Pentachlorphenol).
Chlorinated organic insecticides and acaricides	The organic-chlorine chemicals form one of three principal pesticide families. This class in the insecticides and acaricides has related pharmacological effects, and EPA has limited the total amount of these related chemicals for residue purposes. Included are the following chemicals and their metabolites: Aldrin, BHC (benzene hexachloride), Chlorbenside, Chlordane, Chlorobenzilate, DDT, Dicofol, Dieldrin, Endosulfan, Endrin, Heptachlor, Lindane, Methoxychlor, Mirex, Ovex, TDE, Tetradifon, Toxaphene [Farm Chemicals Handbook, 1987]
Chlorination	The application of chlorine to drinking water, sewage, or industrial waste to disinfect or oxidize undesirable compounds.
Chlorine (Cl)	A greenish yellow, poisonous, readily liquified gaseous element of the halogen group, with a suffocating odor, obtained principally from common salt, and widely used in industry, medicine, etc. [Funk & Wagnalls Standard College

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	Dictionary, 1973]
	Commonly used to disinfect drinking water and to bleach paper pulp.
Chromosomes	Thread-like bodies occurring in animal and plant cell nuclei; they contain genes, the material that makes possible the transfer of characteristics from parent to offspring.
Coagulation	A clumping of particles in water or wastewater which may result in the settling out of suspended materials. often induced by the addition of chemicals such as lime or alum, or a change in the dissolved ions in a water body such as that which occurs in an estuary when the fresh water inflow mixes with intruding seawater (i.e., in the entrapment zone).
Coliform organisms	All of the aerobic and faculative anaerobic, gram-negative, nonspore-forming, rodshaped bacteria that ferment lactose with gas formation within 48 hr at 35 degrees C. [Standard Methods ..., 14th ed., 1975]
	Large numbers of these organisms are found in the intestinal tracts of humans and warm-blooded animals, their presence in water is often used as an indicator of pollution or potentially pathogenic bacterial contamination.
Colloidal matter	Finely divided solids which will not settle by gravity but may be removed by coagulation or biological action or membrane filtration.
Conductance (Specific)	See Electrical conductivity.
Conjunctive use	The management of surface-and ground-water resources in a coordinated operation to the end that the total yield of such a system over a period of years exceeds the sum of the yields of the separate components of the system resulting from the uncoordinated operation.
	The objective of conjunctive use is to increase the yield, reliability of supply, and general efficiency of a water system by diverting water from streams or surface reservoirs for conveyance to and storage in ground-water basins for latter use when surface water is not available. [Coe, J.J., Conjunctive Use-Advantages, Constraints, and Examples, ASCE Journal of Irrigation and Drainage, v. 116, no. 3, May/June 1990]
Connate water	State definition:

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	Water entrapped in the interstices of a sedimentary rock at the time it was deposited. These waters may be fresh, brackish, or saline in character. Usually applies only to water found in geologically older formations. [DWR Bulletin 74-81] Federal definition: Water entrapped in the interstices of a sedimentary or extrusive igneous rock at the time of its deposition. [USGS, Federal Glossary of Selected Terms: Subsurface-Water Flow and Solute Transport, August 1989]
Conservative constituent (or property)	A constituent (or property) the concentration of which is not effected by chemical or biological processes. [T,XLV,5:16-5:25]
Contaminant	Federal definition: Any physical, chemical, biological, or radioactive substance or matter in water. [40 CFR 141.2]
Contamination	State definition: An impairment of the quality of the waters of the state by waste to a degree which creates a hazard to the public health through poisoning or through the spread of disease...includ[ing] any equivalent effect resulting from the disposal of waste, whether or not waters of the state are affected. [CWC Sec. 13050(k)] Federal definition: The addition to water of any substance or property preventing the use or reducing the usability of water. Sometimes considered synonymous with pollution. [USGS, Federal Glossary of Selected Terms: Subsurface-Water Flow and Solute Transport, August 1989]
Copepod	One of an order (Copepoda) of small, free-swimming, fresh-water and marine crustaceans. [Funk & Wagnalls Standard College Dicionary, 1973]
Crustacea	A class of anthropoids containing over 35,000 species distributed worldwide, mainly in freshwater and marine habitats, where they constitute a major component of plankton. Crustaceans include shrimps, crabs, and lobsters, copepods, and the terrestrial woodlice. The segmented body usually has a distinct head (bearing compound eyes, two

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	pairs of antennae, and various mouth parts), thorax, and abdomen, and is protected by a shell-like carapace. Each body segment may bear a pair of branched (biramous) appendages used for locomotion, as gills, and for filtering food particles from the water. Appendages in the head region are modified to form jaws and in the abdominal region are often reduced or absent. Typically, the eggs hatch to produce a free-swimming nauplius larva. This develops either by a series of moults or undergoes metamorphosis to the adult form. [Dictionary of Biology, Warner Books]
Current flow conditions	Flow conditions as they exist at present. The factors considered when defining flow conditions include: land and water use patterns, reservoir capacities and operating rules, channel configurations, diversion point locations aand capacities, etc. Hydrologic investigations typically impose various sets of flow conditions upon the available "hydrologic record" and analyze the resultant effects. Within this Plan current flow conditions are those used by the Department of Water Resources to produce the results from their 1990 level of development Operations Study (e.g., DWR Exhibit 30). The DWR Operations Study used the hydrologic record for WY 1922 through 1978.
DAYFLOW	A Department of Water Resources flow accounting model used to calculate daily Delta outflow at Chipps Island. It also estimates interior Delta flows at specified locations, and fish-related parameters and indices.
DDT	The first chlorinated hydrocarbon insecticide It has a half-life of 15 years and can collect in fatty tissues of certain animals. EPA banned registration and interstate sale of DDT for virtually all but emergency uses in the U.S. in 1972 because of its persistence in the environment and accumulation in the food chain. CHEMICAL NAME: Dichloro diphenyl trichloroethane. The principal isomer present (not less than 70%) is 1, 1,1-trichloro-2, 2-bis (p-chlorophenyl)-ethane. [Farm Chemicals Handbook, 1987]
Dabbling duck	A duck which feeds in shallow water, usually from the surface or by "tipping-up." Generally a species in the family Anatidae.
Deep percolation	The drainage of soil water downward by gravity below the maximum effective depth of the root zone toward storage in subsurface strata. [USGS, Federal Glossary of Selected Terms: Subsurface-Water Flow and Solute Transport, August 1989]

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Defoliant	Any substance or mixture of substances intended for causing the leaves or foliage to drop from a plant, with or without causing abscission. [Federal Insecticide, Fungicide, and Rodenticide Act]
Degradation	The act or process of degrading, specifically: A process of transition from a higher to a lower quality or level. [American Heritage Dictionary]
Delta	The Sacramento-San Joaquin rivers delta as defined in the CWC Sec. 12220.
Delta channel depletion	The diversions of Delta channel waters via pumps, siphons, and subsurface seepage onto the Delta uplands and lowlands for consumptive use by agriculture and native plants. [T,I,121: et. seq.] The consumptive use values used by the USBR and DWR to operate the CVP and SWP were fixed in the Federal-State Memorandum of Agreement dated April 9, 1969.
Demersal	Free-swimming on or near the bottom of a water body (as opposed to benthic, which is within or attached to the bottom, and pelagic, which is free-swimming in the water column).
Deterioration	An impairment of water quality. [DWR Bulletin 74-81]
Diatom	A marine or fresh-water plankton, unicellular or colonial, belonging to the family Chlorophyceae of microscopic green algae, characterized by bivalve walls containing silica. [Funk & Wagnalls Standard College Dictionary, 1973]
Disinfectant	Any oxidant, including but not limited to chlorine, chlorine dioxide, chloramines, and ozone added to water that in any part of the treatment or distribution process, that is intended to kill or inactivate pathogenic microorganisms. [40 CFR 141.2]
Disinfection	A process which inactivates pathogenic organisms in water by chemical oxidants or equivalent agents. [40 CFR 141.2]
Dissolved oxygen (DO)	A measure of the amount of oxygen available for biochemical activity in a given amount of water. Adequate levels of DO are needed to support aquatic life. Low dissolved oxygen concentrations can result from inadequate waste treatment. [Environmental Glossary 4th ed.]
Diving duck	A duck which feeds on bottom organisms while swimming,

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	usually fully submerged. Generally in the family Aythyidae.
Dredge sediment (spoil)	The material removed from the bottom of a water body by the process of dredging which must be disposed of.
Dredging	The removal of material from the bottom of water bodies using a scooping or suction machine.
Drinking water	(Excluding Surface Water) Ground waters suitable, or potentially suitable, for municipal or domestic water supply are defined to be: All ground water, with the exception of: (1) portions of aquifers with waters in excess of 10,000 mg/l TDS, (2) waters with existing or potential beneficial use designations which are unsuitable for domestic or municipal use, and (3) subsurface oil-bearing zones. (This definition is not intended for any purpose other than this document)
Ebb tide	The reflux of tide water; the outgoing or falling tide: opposed to flood tide. [Webster's New Universal Unabridged Dictionary, 2nd. ed., 1979]
Economic poisons	Chemicals used to control pests, disinfect, preserve wood, and other agricultural products; anti-foulant paints, and defoliants for cash crops such as cotton (see pesticide).
Edmonston, A.D. Pumping Plant	The Department of Water Resources State Water Project (SWP) pumping plant located at the south end of the San Joaquin Valley. The prime mover for all SWP water used south of the Tehachapi Mountains, in Southern California.
Effluent	(1) Solid, liquid, or gaseous wastes that enter the environment as a by-product of man-oriented processes. (2) The discharge or overflow of fluid from ground or subsurface storage.
El Nino	A weather phenomenon also know as the "Southern Oscillation" which refers to a periodic failure of upwelling off Peru and associated wind and current changes in the Pacific Ocean.
Electrical conductivity or conductance (EC)	The EC of a water sample is an indirect measure of the total dissolved solids (TDS) or salinity levels of a water sample (i.e., the higher the EC the greater the TDS). Electrical conductivity, or specific conductance, is generally measured

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	in milli- or micro- mhos, or milliSiemens per centimeter (mmhos/cm, umhos/cm or dS/cm, respectively.).
	State definitions:
	The relative ability of water to conduct electrical current. It depends on the ion concentration of and can be used to approximate the total filterable residue (total dissolved solids) in the water. [23 CCR 2601]
	A measure of the ability of water to conduct electricity current at 77 degrees F (25 degrees C). It is related to the total concentration of ionizable solids in the water. [DWR Bulletin 74-90]
	Federal definition:
	[A] measure of the ability of material to conduct an electrical current. For water samples, it depends on the concentration and type of ionic constituents in the water and temperature of the water; and it is expressed in siemens per meter. [USGS, Federal Glossary of Selected Terms: Subsurface-Water Flow and Solute Transport, August 1989]
Enrichment	Sewage effluent, or agricultural drainage or runoff adding nutrients (nitrogen, phosphorus, carbon compounds) to a water body, greatly increasing the growth potential for algae and aquatic plants.
Entrainment	For purposes of this report entrainment is meant to include primarily the effects of project operations, such as closure of the Delta Cross Channel gates, pumping, and reverse and low flows.
Entrapment zone	An area in an estuary where suspended materials (including certain biota) accumulate. Net upstream transport of the particulate materials that settle into the bottom density current is nullified by the net downstream transport of materials in the river inflow. As a result, certain suspended materials concentrate in the area where the bottom currents are nullified (see Null Zone). [Arthur, J.F. and Ball, M.D., The Significance of the Entrapment Zone Location to the Phytoplankton Standing Crop in the SF Bay-Delta Estuary, USBR, November 1980]
Escapement	The number of adult salmon escaping harvest and returning to the spawning grounds.
Estuary	The mouth of a stream which serves as a mixing zone for fresh and ocean water. Mouths of streams which are

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	temporarily separated from the ocean by sandbars are considered as estuaries by the SWRCB. Estuarine waters are generally considered to extend from a bay or the open ocean to a point upstream where there is no significant mixing of fresh water and seawater. Estuarine waters are considered to extend seaward if significant mixing of fresh and seawater occurs in the open coastal waters. [SWRCB, Water Quality Control Policy for the Enclosed Bays and Estuaries of California, May 1974] In this document Estuary is used when referring to the San Francisco Bay and Sacramento-San Joaquin Delta Estuary.
Euryhaline	Designating aquatic organisms that can tolerate a wide range of salinity. Euryhaline organisms may be found in an estuary (salt content approximately 14 parts per 1000) or in the open sea (salt content 35 parts per 1000). [Dictionary of Life Sciences, 2nd ed., revised, 1983]
Evaporation	The process by which a substance passes from liquid or solid state to the vapor state. [Glossary of Geology, 1972]
Evapotranspiration	The combined loss of water from a given area by evaporation from the land and transpiration from plants. [USGS, Federal Glossary of Selected Terms: Subsurface-Water Flow and Solute Transport, August 1989]
Exchange contractors	Those who formerly diverted water from the San Joaquin River, but exchanged their diversion rights for a contract that granted more consistent water supplies from the Delta Mendota Canal. The maximum contractual entitlement of these users is 0.84 million AF/yr. [USBR, Factsheet: "Exhibits and Testimony before SWRCB, Bay-Delta Hearing 1987", 1987]
Fertilizer	Any organic or inorganic material of natural or synthetic origin that is added to a soil to supply elements essential to plant growth. [Resources Conservation Glossary]
Filter feeding	A method of feeding, found in many aquatic invertebrates, in which minute food particles are ingested from the surrounding water. Filter feeders are common in plankton and benthos communities. [Martin, E.A., Dictionary of Life Sciences, 2nd ed., 1983]
Flocculation	A process to enhance agglomeration or collection of smaller floc particles into larger, more easily settleable particles through gentle stirring by hydraulic or mechanical means. [40 CFR 141.2]
Flood tide	The rising tide: opposed to ebb tide. [Webster's New

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	Universal Unabridged Dictionary, 1979]
Flow-weighted sampling	Samples taken in a manner that allows determination of mass emissions, i.e., samples taken in proportion to the rate of flow of a river or stream.
Flushing	The process by which contaminant concentrations in a body of water are diluted by river inflow and, where applicable, tidal exchange of "new" uncontaminated water combined with the net advection of the contaminants away from their source by residual currents.
Food chain	The pyramidal relationship of producers (plants) and consumers (animals) by which solar energy is converted through photosynthesis to plant tissue which is consumed by animals which are in turn consumed. At each step up the food chain consumers are usually larger but fewer in number.
Food web	The sum of the interacting food chains in an ecological community. [SWRCB Order No. W.Q. 85-1]
Fry	The stage in the life of a fish between the hatching of the egg and the absorption of the yolk sac (same as sac fry or alevin). From this stage until they attain a length of one inch the young fish are considered advanced fry. [Bell, M.C., Fisheries Handbook of Engineering Requirements and Biological Criteria, U.S. COE, 1986]
Geochemistry	The science dealing with the chemistry of the earth's crust.
Geometric mean	The antilogarithm of the mean of a group of logarithms of a measured variable. The geometric mean is used to transform logarithmically distributed numbers for statistical purposes. (See definitions for Logarithm and Logarithmic Distribution.)
Grab sample	A single sample taken at an instant in time to represent the conditions at that instant.
Gravitational circulation	Net internal motions caused by horizontal density gradients. The denser fluid flows along the bottom and lighter fluid along the surface in an attempt to restore a stable vertical stratification. In the case of a longitudinal salinity gradient, this produces a net landward bottom current and compensating seaward current of fresher water at the surface. Also refered to as Baroclinic Circulation. (Also see Null Zone.)
Gravitational overturn	The formation of a lens of fresh water on the surface of an estuary during a period of high runoff. Also refered to as

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	Gravitational Overflow. This surface layer can spread beyond the mouth of the estuary into the ocean.
Ground water	(1) That part of the subsurface water that is in the saturated zone. (2) Loosely, all subsurface water as distinct from surface water. (3) All water which occurs below the land surface. It includes both water within the unsaturated and saturated zones. (4) The water below the land surface in a zone of saturation, for purposes of this appendix, ground water is the water contained within an aquifer (10 CFR 40 Appendix A). (5) All water which occurs below the land surface (10 CFR 60.2). (6) All subsurface water as distinct from surface water (10 CFR 960). (7) Subsurface water that fills available openings in rock or soil materials to the extent that they are considered water- saturated (30 CFR 710.5). (8) water below the land surface in a zone of saturation (40 CFR 270.2; 40 CFR 146.3; 40 CFR 144.3). (9) water in a saturated zone or stratum beneath the surface of land or water (40 CFR 300.6; 40 CFR 257.3-4).
Ground water banking	The act, by a public agency, of recharging or replenishing a ground water basin. There is an account kept on the water recharged and it is extracted in dry years to meet dry-year needs. A ground water bank is operated very much the same as a surface reservoir. The extraction of the stored water is controlled by the public agency and is not restricted to overlying users such as is the case with normal ground water use. See Overdraft correction programs.
Ground water basin	A ground water basin consists of an area underlain by permeable materials which are capable of storing or furnishing a significant water supply; the basin includes both the surface area and the permeable materials beneath it. [DWR Bulletin 74-81]
Ground water	The condition of a ground water basin in which the amount of

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overdraft	ground water withdrawn under current development exceeds the amount of water that replenishes the basin over a hydrologically mean period. [DWR Bulletin 118]
Grow-out facilities	Ponds at a hatchery or pumping facility where fish are kept until they are large enough to survive on their own.
Gyre	A circular or spiral motion: whirl: revolution.
Habitat	The sum of environmental conditions in a specific place that is occupied by an organism, population, or community.
Hard water	Those waters that require considerable amounts of soap to produce a foam or lather and that also produce scale in hot-water pipes, heaters, boilers, and other units in which the temperature of water is increased materially. [Sawyer, C.N. and McCarty, P.L., Chemistry For Sanitary Engineers, 1967]
Hardness	A waters content of metallic (i.e., positive) polyvalent ions, principally calcium and magnesium, that react with sodium soaps to produce solid soaps and that react with negative ions, when the water is evaporated in boilers, to produce solid boiler scale. Hardness is usually expressed as mg/l of equivalent calcium carbonate ($CaCO_3$). [Camp, T.R. and Meserve, R.L., Water And Its Impurities, 1974]
Hazardous material	(a) "Hazardous material" means a substance or combination of substances which, because of its quantity, concentration, or physical, chemical, or infectious characteristics, may: (1) Cause, or significantly contribute to an increase in serious irreversible, or incapacitating reversible, illness; or (2) Pose a substantial present or potential hazard to human health or environment when improperly treated, stored, transported or disposed of or otherwise managed. (b) Unless expressly provided otherwise, the term "hazardous material" shall be understood to also include extremely hazardous material. [22 CCR 66100 et seq.]
Heavy metals	Metallic elements like mercury (Hg), chromium (Cr), cadmium (Cd), arsenic (As), and lead (Pb), with high molecular weights. They can damage living things at low concentrations and tend to accumulate in the food chain.
Herbicides	All substances or mixtures of substances used to control or destroy undesirable plants.

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Historic flows	Depending on the context used can mean either; (1) those flows before man began influencing river flows (i.e., the Natural Flow), [SWRCB,3] or (2) flow conditions that actually occured over the historic hydrological period and were measured at various locations in the Central Valley Basin using flow measuring devices. These flows reflect upstream impoundments, diversions or use of runoff under the existing upstream storage and channel configurations at the time of measurement. [SWC Comments on January 19, 1990 Draft Revised WQCP, p. 6, April 9, 1990]
Homologous	In Biology: Anatomical features of different organisms (species) which correspond in structure and evolutionary origin, as the flipper of a seal and the arms of a human being. [American Heritage Dictionary 2nd ed.] In Chemistry: The members of a series of organic compounds having the same structure, but in which each differs from the preceding one by a constant increment, as the methane series. [Funk & Wagnalls Standard College Dictionary, 1973]
Hybrid	An offspring of two animals or plants of different races, breeds, varieties, species, or genera.
Hybridization	The act or process of producing hybrids.
Hydraulics	The branch of physics having to do with the mechanical properties of water and other liquids and with the application of these properties in engineering.
Hydrocarbons	A large and important group of organic compounds that contain only hydrogen and carbon. There are two types, saturated and unsaturated. Saturated hydrocarbons are those in which adjacent carbon atoms are joined by a single valence bond and all other valences are satisfied by hydrogen. Unsaturated hydrocarbons have at least two carbon atoms that are joined by more than one valence bond and all remaining valences are satisfied by hydrogen. The saturated hydrocarbons form a whole series of compounds starting with one carbon atom and increasing one carbon atom, stepwise. These compounds are also known as the paraffin series, the methane series, and as the alkanes. The principal source is petroleum. Gasoline is a mixture containing several of them; diesel fuel is another such mixture.

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	The unsaturated hydrocarbons are usually seperated into four classes: (i) the ethylene series of compounds all contain one double valence bond between two adjacent carbon atoms; (ii) the diolefin series of compounds all contain two double bonds in their molecules; (iii) the polyenes contain more than two double bonds, these compounds occur in the vastevaters produced by the canning industry (the chlorine demand of wastewaters containing polyenes is extremely high); (iv) the acetylene series of unsaturated hydrocarbons have a triple bond between adjacent carbon atoms, these compounds are found in some industrial wastewater (particularly those from the manufacture of some types of synthetic rubber).
Hydrodynamics	The motion and action of water and other liquids, i.e., the dynamics of liquids, and the study thereof.
Hydrology	The science of water in nature: its properties, distribution, and behavior.
Impairment	A change in quality of water which makes it less suitable for beneficial use. [DWR Bulletin 74-81]
In vivo	Designating biological processes that are performed, outside living organisms, traditionally in a test tube. [Dictionary of Life Sciences, 2nd ed., 1976]
Injection well	Any bored, drilled, driven shaft, dug pit, or hole in the ground into which water or fluid is discharged, and any associated subsurface appurtenances, and the depth of which is greater than the circumference of the shaft, pit, or hole. [CWC Sec. 13051]
Insecticides	All substances or mixtures of substances intended for preventing or inhibiting the establishment, reproduction, development, or growth of, destroying or repelling any member of the Class Insecta or other allied Classes in the Phylum Arthropoda considered to be a pest.
Irrigation efficiency (IE)	The efficiency of a single on-farm irrigation; the ratio of the depth of water beneficially used (BU) to the depth of applied water (AW), expresses as a percent. $IE = (BU/AW) \times 100$ [Westlands Water District, Water Conservation and Drainage Reduction Programs, 1987-1988, Definition of Terms, November 1989]

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WORD/PHRASE	DEFINITION
Kesterson National Wildlife Refuge (Kesterson NWR)	A waterfowl management area adjacent to Kesterson Reservoir in Merced county California which was originally planned to utilize San Luis Drain water. When first established, Kesterson National Wildlife Refuge (NWR) used a mixture of fresh CVP water and local tailwater to develop wetland habitat. As the use of San Luis Drain water, including an increasing proportion of tile drain waters, was phased in, deformities and reproductive abnormalities began to affect the birds nesting there. [SWRCB Order No. WQ 85-1]
Kesterson Reservoir	A water storage facility adapted as an interim evaporation basin for the Central Valley Project San Luis Drain. [SWRCB Order No. WQ 85-1]
Larvae	The juvenile stage in the life cycle of most invertebrates, amphibians, and fish, which hatch from eggs, is unlike the adult in form, and is usually incapable of sexual reproduction. It develops into the adult by undergoing metamorphosis. Larvae can feed themselves and are otherwise self-supporting. Examples are the tadpoles of frogs, the caterpillars of butterflies, and the ciliated planktonic larvae of many marine animals. [Dictionary of Biology. Warner Books]
Leachate	Any fluid formed by the drainage of liquids from waste or by the percolation of liquid through waste. It includes any constituents extracted from the waste and dissolved or suspended in the fluid. [23 CCR 206]
Leaching	The flushing of salts from the soil by the downward percolation of water.
Leaching fraction	That fraction of the total amount of applied water that passes through a crop root zone. [SWRCB,29,2]
Lead (Pb)	A soft, malleable, ductile, bluish white dense metallic element, with a variety of toxic salts. [SWRCB Order No. WQ 85-1]
Levee	An embankment, especially along the shore of a river, built for portection against floods. [Funk & Wagnalls Standard College Dictionary, 1973]
Logarithm (Log)	The exponent expressing the power to which a fixed number (the base) must be raised in order to produce a given number (the antilogarithm). The most common logarithms are for the base 10. For example, 3 is the base 10 logarithm of 1,000 -- 100 is the base 10 antilogarithm of 2. See Natural logarithum

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Logarithmic distribution	The distribution of a set of observations of a variable which is limited at its lover end by zero (i.e., cannot have a value of less than zero) but is otherwise unrestrained. The logarithms of the observations of a logarithmically distributed variable are symmetrical about (i.e., 50% above and 50% below) the logarithm of the geometric mean of the variable.
Logarithmic mean (or log mean)	See definition of geometric mean.
Lunar day	The time of rotation of the moon about the earth, 24.84 hours.
Manganese (Mn)	A hard, brittle, grayish white metallic element, oxidizing readily and forming an important component of certain alloys, as manganese steel. [Funk & Wagnalls Standard College Dictionary, 1973]
Marsh or marshland	A tract of low, wet, soft land; swamp; bog; morass; fen.
Maximum contaminant level (MCL)	The maximum permissible level of a contaminant in water which is delivered to the free flowing outlet of the ultimate user of a public water system, except in the case of turbidity where the maximum permissible level is measured at the point of entry to the distribution system. Contaminants added to the water under circumstances controlled by the user, except those resulting from corrosion of piping and plumbing caused by water quality, are excluded from this definition. [40 CFR 141.2]
Maximum contaminant level goal (MCLG)	The maximum level of a contaminant in drinking water at which no known or anticipated adverse effect on the health or persons would occur, and which allows an adequate margin of safety. Maximum contaminant level goals are nonenforceable goals. [40 CFR 141.2]
Maximum total trihalomethane potential (MTTP or MTP)	The maximum concentration of total trihalomethanes produced in a given water containing a disinfectant residual after 7 days at a temperature of 25 degrees C or above. [40 CFR 141.2]
Measured flow	The flow of water determined with a measuring device.
Mho	A unit of measure for electrical conductivity equal to the reciprocal, or inverse, of the standard unit of electrical resistance, the ohm. One mho is equal to one Siemen, the standard unit of electrical conductivity.

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Mutagenic	An agent that causes an increase in the number of mutants (see mutation) in a population. Mutagens operate either by causing changes in the DNA of the genes, so interfering with the coding system, or by causing chromosome damage.
Mutation	A sudden random change in the genetic material of a cell that may cause it and all cells derived from it to differ in appearance or behavior from the normal type. A relatively abrupt and permanent change in DNA that can be transmitted during cell division.
National Pollutant Discharge Elimination System (NPDES)	The national program for issuing, modifying, revoking and reissuing, terminating, monitoring and enforcing permits, and imposing and enforcing pretreatment requirements, under sections 307, 318, 402, and 405 of the Clean Water Act. The term includes appoved state programs. [40 CFR]
Natural or true natural flow	The embayment and channel flows which existed at the time of the first Spanish exploration of California, i.e., before the Gold Rush.
Neap tide	The tide occurring just after the first and third quarters of the lunar month: at these times the difference between high and low tides is smallest. [Webester's New Universal Unabridged Dictionary, 2nd. ed., 1979]
Nekton	The aggregate of animal organisms capable of swimming freely, relatively independent of currents, waves, etc., ranging in size from microorganisms to whales. Compare to "Plankton"
New water	Water which has not entered the Bay for at least several tidal cycles. [Denton and Hunt, 1986]
Nickel (Ni)	A hard, ductile, mallable, silver-white metallic element of the iron-cobalt group.
Nitrate	An ion composed of one atom of nitrogen bound to three atoms of oxygen. An important plant nutrient. In high concentrations, it can bind to hemoglobin resulting in methemoglobinemia. also refers to salts of the nitrate ion with other ionic substances, usually metals. [SWRCB Order No. WQ 85-1]
Non-point source	Causes of water pollution that are not associated with point sources, such as agricultural fertilizer runoff, or sediment from construction. Examples include (i) Agriculturally related non-point sources of pollution including runoff from manure disposal areas, and from land used for livestock and

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	crop production; (ii) Siviculturally related non-point sources of pollution; (iii) Mine-related sources of pollution including new, current and abandoned surface and underground mine runoff; (iv) Construction activity related sources of pollution; (v) Sources of pollution from disposal on land, in wells or in subsurface excavations that affect ground and surface water quality; (vi) Salt water intrusion into rivers, lakes, estuaries and ground water resulting from reduction of fresh water flow from any cause, including irrigation, obstruction, ground water extraction, and diversion; and (vii) Sources of pollution related to hydrologic modifications, including those caused by changes in the movement, flow, or circulation of any navigable waters or ground waters due to construction and operation of dams, levees, channels, or flow diversion facilities.
Null zone	The region in a partially- or well-mixed estuary where the residual bottom currents are effectively zero. Landward of this point there is a net seaward residual velocity along the bottom caused by river inflow and seaward of the null zone, gravitational circulation produces a net landward transport of denser more saline water along the bottom. The null zone is the theoretical upstream boundary of the entrapment zone.
Organic	Referring to or derived from living organisms. In chemistry, any compound containing carbon. [Environmental Glossary 4th ed.]
Organism	Any living thing. [Environmental Glossary 4th ed.]
Organochlorines	A range of compounds used mainly as pesticides, and the polychlorinated biphenyls (PCBs), which are of industrial origin. These compounds share a range of properties which set them apart from other types of pollutants. They are generally of relatively low water solubility, also known as chlorinated hydrocarbons. [AHI, 304]
Overdraft correction programs	Programs wherein water is imported or local waters are used to recharge a basin for the benefit of all overlying users in the basin. There is no ownership of the recharged water. It becomes part of the safe yield of the basin. See Groundwater banking.
Oxidizing agent	A substance (such as oxygen, chlorine, or bromine) that oxidizes by taking up electrons.
Ozonation	The municipal water treatment process wherein ozone is used to disinfect a water supply.

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Ozone	An unstable allotropic form of oxygen, O3, with a pungent odor like that of chlorine, formed variously, as by the passage of electricity through the air. It is a powerful oxidizing agent, much more active than ordinary oxygen, and is used for bleaching oils, waxes, ivory, flour, [paper bulp] and starch, and for disinfecting drinking water. [Funk & Wagnalls Standard College Dictionary, 1973]
PEROXONE	A combination of ozone and hydrogen peroxide.
Partially-mixed estuary	An estuary in which vertical mixing due to tidal currents is large enough to prevent a distinct vertical density stratification between fresh and seawater but not strong enough to completely remove any vertical variation in density. The northern reach of San Francisco Bay is typical of a partially-mixed estuary.
Peat	A substance consisting of partially carbonized vegetable material, chiefly mosses, found usually in bogs. [Funk & Wagnalls Standard College Dictionary, 1973]
Pelagic	Describes open-water (or deep-water) habitat or those organisms which depend upon it.
Perozonation	The use of PEROXONE to disinfect water.
Pesticide	All chemical agents which are used for the control of some noxious insect, plant, or animal. Pesticide compounds, synthetic as well as substances which occur in nature, can be categorized into four groups as follows: (1) Chlorinated hydrocarbons containing carbon, hydrogen, and chlorine. Examples are DDT, toxaphene, lindane, chlordane, and endrin. (2) Organic phosphorus (thiophosphate) compounds of phosphorus, oxygen, carbon, and hydrogen. Examples are parathion and malathion. (3) Organic compounds including organic sulfur compounds, organic mercurials, dinitrophenols, carbamates, and natural products such as rotenone, nicotine, and strychnine. (4) Inorganic compounds of copper sulfate, arsenate of lead, zinc, chlorine, thallium, calcium arsenate, and sodium floroacetate. [ASCE, SA 5, p. 28, October, 1967]
Phytoplankton	Free-floating aquatic plants.
Piscivore	Fish eater.

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Plankton	The animal and plant organisms that drift or float with currents, waves, etc., unable to influence their own coures, ranging in size from microorganisms to jellyfish: distinguished from benthos. Compare to "Nekton". [Funk & Wagnalls Standard College Dictionary, 1973]
Point source	Any discernible, confined and discrete conveyance, including but not limited to any pipe, ditch, channel, tunnel, conduit, well, discrete fissure, container, rolling stock, concentrated animal feeding operation, or vessel or other floating craft, from which pollutants are or may be discharged. This term does not include agricultural stormwater discharges and return flows from irrigated agriculture. [CWA, Sec. 502 (14)]
Pollution	An alteration of the quality of the waters of the state by waste to a degree which unreasonably affects (1) such waters for beneficial uses, or (2) facilities which serve such beneficial uses. "Pollution" may include "contamination". [CWC Sec. 13050(1)]
	The introduction into the groundwater of the state of an active ingredient, other specific product, or degradation product of an active ingredient of an economic poison above a level, with an adequate margin of safety, that does not cause adverse health effects. [CFAC Sec. 13142]
Polychlorinated biphenyls (PCBs)	A mixture of compounds composed of the biphenyl molecule which has been chlorinated to varying degrees. [Environmental Glossary, 4th ed.]
	PCBs are considered an environmental problem because of their abundance, very great persistence, and considerable toxicity to aquatic biota. [AHI,304]
Postammoniation	The addition of ammonia to water as the last step in municipal water treatment.
Potable water	Suitable for drinking. [Funk & Wagnalls Standard College Dictionary, 1973]
Preammoniation	The addition of ammonia to water as it first enters a municipal water treatment, prior to the application of any other water treatment process.
Precipitation	The discharge of water (as rain, snow or hail) from the atmosphere upon the earth's surface. [DWR Bulletin 118]
Preirrigation	The efficiency of an on-farm preirrigation; the ratio of the

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WORD/PHRASE	DEFINITION
efficiency (PIE)	sum of the depth of water used for soil moisture replacement (SWR1) and cultural practices (CP1) to the depth of applied water (AW1), expressed as a percent. No leaching requirement is included. [Westlands Water District, Water Conservation and Drainage Reduction Programs, 1987-1988, Definition of Terms, November 1989]
Progressive wave	A tidally-driven wave which travels along an estuary. This type of wave occurs in long shallow estuaries where there is a significant frictional resistance to the tidal flow and only weak wave reflection at the head of the estuary. The tide in the northern reach of San Francisco Bay travels upstream as a progressive wave.
Pulse flow	A substantial increase in the flow of water followed by a decrease within a relatively short period of time.
Quality of water	The chemical, physical, biological, bacteriological, radiological, and other properties and characteristics of water which affect its use. [CWC Sec. 13050(h)]
Rare species	A species, subspecies, or variety is rare when, although not presently threatened with extinction, it is in such small numbers throughout its range that it may become endangered if its present environment worsens. [CFGC Sec. 1901]
Recharge	The flow to ground water storage from precipitation, infiltration from streams, and other sources of water. [DWR Bulletin 118]
Reclaimed water	Water which, as a result of treatment of waste, is suitable for a direct beneficial use or a controlled use that would not otherwise occur. [CWC Sec. 13050(n)]
Recruitment	Addition by reproduction of new individuals to a population.
Reservoir reoperation	A quantitative study in which the operating rules for a reservoir are changed from the rules actually used in the historical operation of the reservoir. The new operating rules result in different releases from the reservoir than actually occurred historically.
Residual current	The net transport of a particle averaged over a complete tidal cycle.
Residual disinfectant concentration	The concentration of disinfectant measured in mg/l in a representative sample of water. [40 CFR 141.2]
Residue	Generally refers to that portion of a sample remaining after

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	drying at 103-105 degrees C or 180 degrees C to a constant weight. [Standard Methods ... 14th ed.,1975]
	Under certain circumstances, the toxic material found when a sample has been analyzed; usually refers to a toxicant in a food or tissue sample, expressed as a proportion of the original weight. [SWRCB Order No. WQ 85-1]
Resource	That which is, or may be, readily available as a source of supply or support; anything that can be drawn upon when needed, whether material or non-material. [Resource Conservation Glossary]
Reverse flow	In the context of this report, the term reverse flow refers to net flow being in the upstream direction in the Southern and Western Delta. This condition occurs between approximately the western end of Sherman Island (in the Delta) and the export pumps when Delta inflow is relatively, low and Delta consumptive uses and exports are high.
Riparian	Pertaining to the banks and other terrestial environs adjacent to water bodies, watercourses, and surface-emergent aquifers (e.g. springs, seeps, oases), whose waters provide soil moisture significantly in excess of that otherwise available through local precipitation. Vegetation typical of this environment is dependent on the availability of excess water.
Riparian water right	The right to use water on land bordering a stream. See also Water rights. [SWRCB Order No. WQ 85-1]
Riparian wetland	A zone which may be periodically inundated by water, characterized by moist soil and associated vegetation; typically bounded on one border by a drier upland and on the other by a freshwater body. [SWRCB Order No. WQ 85-1]
Riverine	Pertaining to or like a river; riparian. [Funk & Wagnalls Standard College Dictionary, 1973]
Run	To migrate, especially to move in a shoal in order to spawn. [American Heritage Dictionary 4th ed.]
Runoff	That part of precipitation which is not absorbed by soil, evaporated, or transpired by plants, but finds its way into streams as surface flow. [Fundamentals of Ground Water Contamination Glossary, 1985]
	Any precipitation, leachate, or liquid that drains from any part of a waste management unit. [23 CCR 2601]

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Salinity	The total concentration of dissolved ions in water, a conservative property. [T,XLV,5:12-5:25] The salt content of a water. [SWRCB Order No. WQ 85-1] Usually expressed as ppt (g/l), or ppm (mg/l).
Salvage	Those fish diverted away from or removed from screens at intakes to diversion structures and subsequently returned to a water body.
San Pablo Bay	The portion of San Francisco Bay encompassing the area from the Richmond-San Rafael Bay Bridge on the south side to the Petaluma River on the north and the Carquinez Strait on the east. It has a surface area of 105 sq. mi. at MLLW, mean depth of 9 ft., and mean surface area of 605,000 AF.
Saturated zone	An underground zone in which all openings in and between natural geologic materials are filled with water. [23 CCR 2601]
Secondary treatment	Biochemical treatment of wastewater after a primary stage, using microorganisms to consume the organic material in the wastewater. Use of trickling filters, or the activated sludge process, removes floating and settleable solids and about 90 percent of oxygen demanding substances (BOD) and suspended solids (TSS).
Selenium (Se)	A non-metallic element chemically resembling sulfur. Essential for animals at trace concentrations, selenium is toxic to animals in deficient or excessive dietary exposure. [SWRCB Order No. WQ 85-1] Selenium occurs in three environmentally significant valence states Se -2 (selenide), Se +4 (selenite), and Se +6 (selenate), with different toxic properties.
Semidiurnal tide	A tidal variation consisting of two high and two low tides per lunar day (24.84 hrs). In San Francisco Bay, the cycle typically consists of a high high followed by a low low, a low high, a high low and back to a high high tide.
Shoal	A shallow place in any body of water, or an assemblage or multitude; throng (i.e., a school of fish). [Funk & Wagnalls Standard College Dictionary, 1973]
Shorebird	Any of various birds (suborder Charadrii) that frequent beaches and also the shores of inland waters, including the snipe, sandpiper, and plover. [Funk & Wagnalls Standard

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	College Dictionary, 1973]
Siemen	The standard unit of electrical conductivity, equal to 1 mho. The reciprocal, or inverse, of the standard unit of electrical resistance, the ohm.
Slot limit	Fishing regulation which permits taking of fish only with specified lengths, usually medium-sized fish to protect both very young or immature fish and very large, older and typically more fecund (high reproductive capacity) fish.
Slough	A stagnant swamp, backwater, bayou, inlet, or pond in which waterbacks up. [Funk & Wagnalls Standard College Dictionary,1973]
Sludge	Residual solids and semi-solids from the treatment of water, wastewater, and other liquids. It does not include liquid effluent discharged from treatment processes. [23 CCR 2601]
Smolt	An anadromous fish that is physiologically ready to undergo the transition from fresh to salt water; age varies depending on species and environmental conditions. [Bell, M.C., 1986]
Soluble, e.g., soluble selenium	Any substance capable of passing through a membrane filter with a rated pore diameter of 0.45 microns. [Standard Methods..., 14th ed., 1975] Capable of entering into solution or of being dissolved; as, a soluble substance. [Webster's New Universal Unabridged Dictionary, 1979]
South Bay	The portion of the San Francisco Bay stretching from the San Francisco-Oakland Bay Bridge on the north to Mountain View in the south. It has a surface area of 214 sq. mi. at MLLW, mean depth of 11 ft. and mean volume of 1,507,000 AF
Species	A unit used in the classification of plants and animals. Ideally a species is defined as a group of organisms that interbreed with each other to produce fertile offspring. Members of different animal species do not normally interbreed; if they do, the progeny are sterile. Hybrids of two plant species are usually sterile but may occasionally be made fertile by allopolyploidy [doubling the number of chromosomes present in the sterile hybrid]. Members of the same species usually resemble each other closely, but when species are subdivided into subspecies, clines, or cultivated varieties, the members of these subgroups often

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	differ from one another in appearance. [Dictionary of Life Sciences, 2nd ed., 1976]
Spring tide	(1) The tide that appears at or soon after the new moon and the full moon: it is normally the highest tide of the month. (2) Any great flow, rush or flood. [Webster's New Unabridged Dictionary, 1979]
Standard	See Water Quality Standard.
Standing wave	A wave which does not travel so the point of maximum amplitude (crest to trough) remains fixed in space. Standing waves occur in an estuary when the resistance to the flow is small. The tide in South Bay is an example of a standing wave.
Statewide plan	A water quality control plan adopted by the State Water Resources Control Board in accordance with the provisions of Cal.Water Code Sec. 13240 to 13244, for waters where water quality standards are required by the Federal Water Pollution Control Act. Such plans supersede regional water quality control plans for the same waters to the extent of a conflict. [CWC Sec. 13170]
Striped bass index (SBI)	An index of the number of young bass which have survived through their first summer. Young bass are sampled with nets which are most efficient for fish about 1.5 inches in length. Sampling methods are consistent (with respect to location, frequency, technique, etc.) so that the number of young striped bass caught may be compared with the catch at various locations year to year. The number of young bass caught by the standard sampling methods allows statistical treatment of data to estimate the abundance of young striped bass and to correlate changes in the number caught with changes in environmental factors. [SWRCB, Final EIR for the 1978 WQCP and D-1485]
Subsurface agricultural drainage system	A set of tile drains, collectors and, in most cases, one or more sump pumps which are installed in a field to remove water from the root zone of any crops which may be planted. Generally installed in areas with shallow perched water tables.
Suisun Bay	The portion of San Francisco Bay between the entrance to the Carquinez Strait and Chipps Island, including Grizzly and Honker bays. It has a surface area of 36 sq. mi. at MLLW, mean depth of 14 ft. and mean volume of 323,000 AF.

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Suisun Marsh	The marshlands generally located in southern Solano County, south of the cities of Fairfield and Suisun City. It is bordered on the south by Suisun Bay including Grizzly and Honker bays, and the confluence of the Sacramento and San Joaquin rivers; on the east from Denverton along Shiloh Road to Collinsville. Suisun Marsh occupies an area of 116,000 acres, including about 88,000 acres below the five-foot contour It is the largest contiguous brackish water marsh in the United States. Suisun Marsh's boundaries are legally defined in CPRC Sec. 29101 and 29101.5.
Suspended solids (SS)	Tiny particles of solids dispersed but undissolved in a solid, liquid, or gas. Suspended solids in sewage cloud the water and require special treatment to remove (Environmental Glossary 4th ed.). Generally considered those particles subject to Brownian diffusion.
Threatened or endangered	Fish and wildlife, and plants are in danger of or threatened with extinction because their habitats are threatened with destruction, adverse modification, or severe curtailment, or because of over exploitation, disease, perdition, or other factors. [CFGC Sec. 2051]
Tidal prism	The increase in water volume landward of a given cross-section from low tide to high tide. Related to the tidal volume on the ebb and flood tide and the cumulative upstream inflows.
Tile drains	A System of clay pipes installed beneath irrigated lands to artificially remove water saturating the soil of the crop root zone by gravity flow.
Total dissolved solids (TDS)	A measure of the salinity equal to the amount of material remaining after evaporating a water sample at 103 to 105 degrees Celsius (formerly centigrade) for one hour. [SWRCB Order No. WQ 85-1] Total dissolved solids levels are expressed in units of weight per unit of volume (e.g. mg/l).
Toxic pollutants (elements, metals or organics)	Those pollutants, or combinations of pollutants, [elements, metals,or organics] including disease-causing agents, which after discharge and upon exposure, ingestion, inhalation, or assimilation into any organism, either directly from the environment or indirectly by ingestion through food chains, will cause death, disease, behavioral abnormalities, cancer, genetic mutations, physiological malfunctions, or physical

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	deformations, in such organisms or their offspring. [Resource Conservation Glossary]
Toxicant	(1) A chemical that controls pests by killing rather than repelling them. (2) A harmful substance or agent that may injure an exposed organism. [Environmental Glossary 4th ed.]
Trace elements (metals or organics)	Those elements [metals or organics] generally present in natural water samples at concentrations of less than one milligram per liter. [SWRCB Order No. WQ 85-1]
Tracy Pumping Plant	The U.S. Bureau of Reclamation Central Valley Project pumping plant in the Delta west of Tracy. The source of the water in the Delta-Mendota Canal.
Transpiration	The photosynthetic and physiological process by which plants release water into the air in the form of water vapor. [Resource Conservation Glossary]
Tributary area	The whole area or region from which a waterbody receives its supply of water. An alternative phrase for watershed.
Triennal basis	Once every three years.
Trihalomenthane formation potential (THMFP)	The analytical results from a non-standard laboratory technique which is used on raw water supplies in an attempt to quantify the likelihood that trihalomethanes will be formed when the water is disinfected.
Trihalomethanes (THMs) or Total trihalomethanes (TTHMs)	Singular; One of the family of organic compounds, named as derivatives of methane (CH4), wherein three of the four hydrogen atoms are each substituted by a halogen atom [e.g., chlorine, bromine] in the molecular structure. [40 CFR 141.2] Plural; (1) A subset of chemicals known as disinfection by-products (DBPs) which are formed when waters are disinfected. THMs are produced when dissolved organic substances, such as fulvic and humic acids produced by decaying crop residues or peat soil in fresh or saline waters, come in contact with the oxidizing agents used to disinfect drinking water. [T,VI,38:3-5; T,XLVI,99:11-19] (2) The sum of the concentration in mg/l of the trihalomethane compounds (trichloromethane [chloroform], dibromochloromethane, bromodichloromethane, and tribromomethane [bromoform]), rounded to two significant figures. [40 CFR 141.2]

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Tule	A large bulrush (Scirpus acutus) growing on damp or flooded land in the southwestern United States. [Funk & Wagnalls Standard College Dictionary, 1973]
Turbidity	Hazy air due to the presence of particles and pollutants; a similar cloudy condition in water due to suspended silt or organic matter. [Environmental Glossary 4th ed.]
Unimpaired flow	The embayment and channel flows which would exist in the absence of upstream impoundments and diversions of rainfall or snowmelt runoff, but in the presence of existing channel configurations, both upstream and in the Delta.
Unsaturated zone	The underground zone in which not all openings in and between natural geologic material are filled with water. The zone may contain water or other liquid held by capillary forces, or percolating liquids. [23 CCR 2601]
Usable storage capacity	The quantity of ground water that can be economically withdrawn from storage. [DWR Bulletin 118]
Waste	Sewage and any and all other waste substances, liquid, solid, gaseous, or radioactive, associated with human habitation, or of human or animal origin, or from any producing, manufacturing, or processing operation of whatever nature, including such waste placed within containers of whatever nature prior to, and for purposes of, disposal. [CWC Sec. 13050(d)]
Water borne	(1) Floating on or supported by water; afloat. (2) Transported by water, as freight. (3) Transmitted in water, as a disease germ. [American Heritage Dictionary]
Water quality	See Quality of water.
Water quality control	The regulation of any activity or factor which may affect the quality of the water of the state and includes the prevention and correction of water pollution and nuisance. [CWC Sec. 13050(i)]
Water quality control plan	A designation or establishment for the waters within a specified area of (1) beneficial uses to be protected, (2) water quality objectives, and (3) a program of implementation needed for achieving water quality objectives. [CWC Sec. 13050(j)]

APPENDIX C

GLOSSARY

WORD/PHRASE	DEFINITION
Water quality objective	The limits or levels of water quality constituents or characteristics which are established for the reasonable protection of beneficial uses of water or the prevention of nuisance within a specific area and time frame. Water quality objectives may be either numerical or narrative. [CWC Sec. 13050] Factors to be considered in establishing water quality objectives shall include, but not be limited to all of the following: (a) past, present, and probable future beneficial uses of water, (b) environmental characteristics of the hydrographic unit under consideration, including the quality of water available thereto, (c) water quality conditions that could reasonably be achieved through the coordinated control of all factors which affect water quality in the area, (d) economic considerations, and (e) the need for developing housing within the region. [CWC Sec. 13241]
Water quality standard	A term used in connection with the federal Clean Water Act which is roughly equivalent to water quality objectives and designated beneficial uses.
Water rights	A form of property rights which give their holder the right to use public waters. During the history of California, a variety of procedures have been in effect by which a person could acquire a water right A summary follows: Appropriative rights initiated prior to December 19, 1914 - prior to the 1914 statutes which established the present system for appropriating water (taking water and putting it to a use removed from property adjoining the water source) two methods of appropriation existed. Prior to 1872, appropriative rights could be acquired simply by taking water and putting it to beneficial use. In 1872, Sections 1410 through 1422 of the California Civil Code enacted a permissive procedure by which priority of rights could be established as of the date of posting of notice of intention to appropriate water, subject to a show of diligence in carrying out construction of diversion works and actual use of water. Appropriators who did not follow the permissive procedure had priority from the date of actually putting the water to use. Because in an appropriative water rights system, first in priority means first served by available water, considerable advantage attaches to an earlier date of

APPENDIX C

GLOSSARY

WORD/PHRASE	DEFINITION
	appropriation. Appropriative rights initiated after December 19, 1914 - an appropriation of water must now comply with provisions of Part Two, Division Two of the California Water Code. The right to use water appropriated under earlier procedures as well as under the current procedure maybe lost by abandonment or non-use. Riparian rights - an owner of land adjoining a water source has, under common law, the right to use a share of the water available from the source. Only those parcels of land adjoining the source may be served by it under riparian right, unless a nonadjoining parcel was at one time part of a riparian parcel and the riparian right was transferred when the parcel was sold. No priority is established for riparian rights, and all riparian users must share the available supply. Riparian owners have priority of use over all appropriators. Prescriptive rights - rights obtained when water is taken and put to use for five years even though other right holders' interests are damaged, if the injured parties take no action in their own defense. California Water Code Section 1225 and State Water Resources Control Board policies have made obtaining secure prescriptive rights essentially impossible since 1914. [SWRCB Order No. WQ 85-1]
Waters of the state	Any water, surface or underground, including saline waters within the boundaries of the state. [CWC Sec. 13050(e)]
Watershed	The land area that drains into a body of water. [Environmental Glossary 4th ed.] Also see Tributary area
Winter ponding	The practice of flooding large agricultural field areas for the purpose of controlling weeds, and reducing salt concentrations in the upper region of the soil profile. Secondary benefits are recreation, possible salt leaching.
Yearling	An organism that is one year old but has not completed its second year.
Yolk	The store of food material, mostly protein and fat, that is present in the eggs of most animals. [Martin, E.A., Dictionary of Life Sciences, 2nd ed., 1983]
Yolk sac	The four extraembryonic membranes that surround vertebrates during early development. The yolk sac forms as a ventral

APPENDIX C

GLOSSARY

WORD/PHRASE	DEFINITION
	outgrowth of the embryonic gut of most fish, reptiles, and birds. As the yolk is absorbed the sac is withdrawninto the embryo. [Martin, E.A., Dictionary of Life Sciences, 2nd ed., 1983]
Young-of-year (YOY)	Fish of other organisms less than one (1) year old.
Zooplankton	Free-floating aquatic animals.

APPENDIX D
MONITORING STATIONS
(ORDERED BY INTERAGENCY NUMBER)

INTERAGENCY (I-A) NUMBER	RIVER KILOMETER INDEX (RKI) NUMBER	STATION NAME
	RMKL020(?)	NORTH FORK MOKELUMNE RIVER NEAR WALNUT GROVE (EXACT LOCATION NOT SPECIFIED)
	ROLD19 (?)	OLD RIVER NEAR HOLLAND TRACT (EXACT LOCATION NOT SPECIFIED)
	ROLD32	OLD RIVER AT INDIAN SLOUGH
	ROLD51	OLD RIVER AT WESTSIDE IRRIGATION DISTRICT INTAKE
	RSAC124	SACRAMENTO RIVER AT WALNUT GROVE
	RSAC155	SACRAMENTO RIVER AT FREEPORT
	RSAN050	SAN JOAQUIN RIVER AT TURNER CUT
	RSAN061	SAN JOAQUIN RIVER AT STOCKTON
	RSAN062	SAN JOAQUIN RIVER AT ROUGH AND READY ISLAND
	SLSBT11	STEAMBOAT SLOUGH AT SUTTER SLOUGH
D-02	RSAC063	SUISUN BAY AT SEAL ISLANDS (PORT CHICAGO)
D-06	RSAC056	SUISUN BAY AT MARTINEZ
D-07	LSBB11	GRIZZLY BAY DOLPHIN 2.5 KM. NORTH OF GARNET POINT
D-07 (NEAR)	SLMZU01	MONTEZUMA SLOUGH NEAR MOUTH
D-28A	ROLD21	OLD RIVER NEAR RANCHO DEL RIO
MD-04	CFTRN1	TURNER CUT NEAR MCDONALD ISLAND BRIDGE
P-08	RSAN056	SAN JOAQUIN RIVER AT BUCKLEY COVE
S-10	SLSUS18	SUISUN SLOUGH AT BOYNTON SLOUGH
S-17	SLCRD07	CORDELIA SLOUGH AT IBIS CUT
S-31	SLSUS01	SUISUN SLOUGH NEAR MOUTH
S-32	SLCRD05	CORDELIA SLOUGH ABOVE SOUTHERN PACIFIC R.R. CROSSING AT CYGNUS
S-35 (NEW)	SLGYR03	GOODYEAR SLOUGH AT MORROW ISLAND CLUBHOUSE
S-36	SLSUS00	SUISUN SLOUGH AT MOUTH
S-48	SLMZU10	MONTEZUMA SLOUGH AT CUTOFF SLOUGH
S-63	SLDEN01	DENVERTON SLOUGH
S-64 (NEW)	SLMZU25	MONTEZUMA SLOUGH AT NATIONAL STEEL
S-75 (OLD)	SLGYR04	GOODYEAR SLOUGH 1.3 MILES SOUTH OF MORROW ISLAND [DRAINAGE] DITCH AT PIERCE

APPENDIX D
MONITORING STATIONS
(ORDERED BY INTERAGENCY NUMBER)

INTERAGENCY (I-A) NUMBER	RIVER KILOMETER INDEX (RKI) NUMBER	STATION NAME
S-93	SLMCYO (?)	HILL SLOUGH (EXACT LOCATION NOT SPECIFIED)
S-94	SLSUS07	SUISUN SLOUGH AT HUNTER CUT

APPENDIX D
MONITORING STATIONS
(ORDERED BY RIVER KILOMETER INDEX)

INTERAGENCY (I-A) NUMBER	RIVER KILOMETER INDEX (RKI) NUMBER	STATION NAME
MD-04	CFTRN1	TURNER CUT NEAR MCDONALD ISLAND BRIDGE
D-07	LSBB11	GRIZZLY BAY DOLPHIN 2.5 KM. NORTH OF GARNET POINT
	RMKL020(?)	NORTH FORK MOKELUMNE RIVER NEAR WALNUT GROVE (EXACT LOCATION NOT SPECIFIED)
	ROLD19 (?)	OLD RIVER NEAR HOLLAND TRACT (EXACT LOCATION NOT SPECIFIED)
D-28A	ROLD21	OLD RIVER NEAR RANCHO DEL RIO
	ROLD32	OLD RIVER AT INDIAN SLOUGH
	ROLD51	OLD RIVER AT WESTSIDE IRRIGATION DISTRICT INTAKE
D-06	RSAC056	SUISUN BAY AT MARTINEZ
D-02	RSAC063	SUISUN BAY AT SEAL ISLANDS (PORT CHICAGO)
	RSAC124	SACRAMENTO RIVER AT WALNUT GROVE
	RSAC155	SACRAMENTO RIVER AT FREEPORT
	RSAN050	SAN JOAQUIN RIVER AT TURNER CUT
P-08	RSAN056	SAN JOAQUIN RIVER AT BUCKLEY COVE
	RSAN061	SAN JOAQUIN RIVER AT STOCKTON
	RSAN062	SAN JOAQUIN RIVER AT ROUGH AND READY ISLAND
S-32	SLCRD05	CORDELIA SLOUGH ABOVE SOUTHERN PACIFIC R.R. CROSSING AT CYGNUS
S-17	SLCRD07	CORDELIA SLOUGH AT IBIS CUT
S-63	SLDEN01	DENVERTON SLOUGH
S-35 (NEW)	SLGYR03	GOODYEAR SLOUGH AT MORROW ISLAND CLUBHOUSE
S-75 (OLD)	SLGYR04	GOODYEAR SLOUGH 1.3 MILES SOUTH OF MORROW ISLAND [DRAINAGE] DITCH AT PIERCE
S-93	SLMCYO (?)	HILL SLOUGH (EXACT LOCATION NOT SPECIFIED)
D-07 (NEAR)	SLMZU01	MONTEZUMA SLOUGH NEAR MOUTH
S-48	SLMZU10	MONTEZUMA SLOUGH AT CUTOFF SLOUGH
S-64 (NEW)	SLMZU25	MONTEZUMA SLOUGH AT NATIONAL STEEL
	SLSBT11	STEAMBOAT SLOUGH AT SUTTER SLOUGH
S-36	SLSUS00	SUISUN SLOUGH AT MOUTH

APPENDIX D
MONITORING STATIONS
(ORDERED BY RIVER KILOMETER INDEX)

INTERAGENCY (I-A) NUMBER	RIVER KILOMETER INDEX (RKI) NUMBER	STATION NAME
S-31	SLSUS01	SUISUN SLOUGH NEAR MOUTH
S-94	SLSUS07	SUISUN SLOUGH AT HUNTER CUT
S-10	SLSUS18	SUISUN SLOUGH AT BOYNTON SLOUGH

Appendix F

NOTICE OF FILING

TO: Any Interested Person

FROM: State Water Resources Control Board, Division of Water Rights
P.O. Box 2000
Sacramento, CA 95810

SUBJECT:	Notice of Filing Submitted under Section 21080.5 of the Public Resources Code
PROJECT PROPONENT:	State Water Resources Control Board
PROPOSED PROJECT:	Water Quality Control Plan for Salinity and Temperature for San Francisco Bay and the Sacramento-San Joaquin Delta Estuary
CONTACT PERSON:	Ronald Bachman (916) 322-9869
PROJECT LOCATION:	San Francisco Bay and the Sacramento-San Joaquin Delta Estuary (Bay-Delta Estuary)
PROJECT DESCRIPTION:	Adoption of the Water Quality Control Plan described above.

This is to advise all interested parties that the State Water Resources Control Board is going to consider the adoption of a water quality control plan for the Bay-Delta Estuary. Action on this proposed plan will be taken in accordance with Section 21080.5 of the Public Resources Code, which exempts this regulatory program from the requirement to prepare an environmental impact report under the California Environmental Quality Act (Public Resources Code 21000 et seq.), and with other applicable laws and regulations.

Copies of the substitute document, including a proposed Environmental Checklist and a discussion of reasonable alternatives and feasible mitigation measures to minimize any significant adverse environmental impacts, can be obtained from Mr. Bachman (see above).

Comments on the proposed adoption should be submitted by March 11, 1991.

Signed: Walt Pettit

Title: Division Chief
for the State Water Resources Control Board

Date: Jan 15 1991

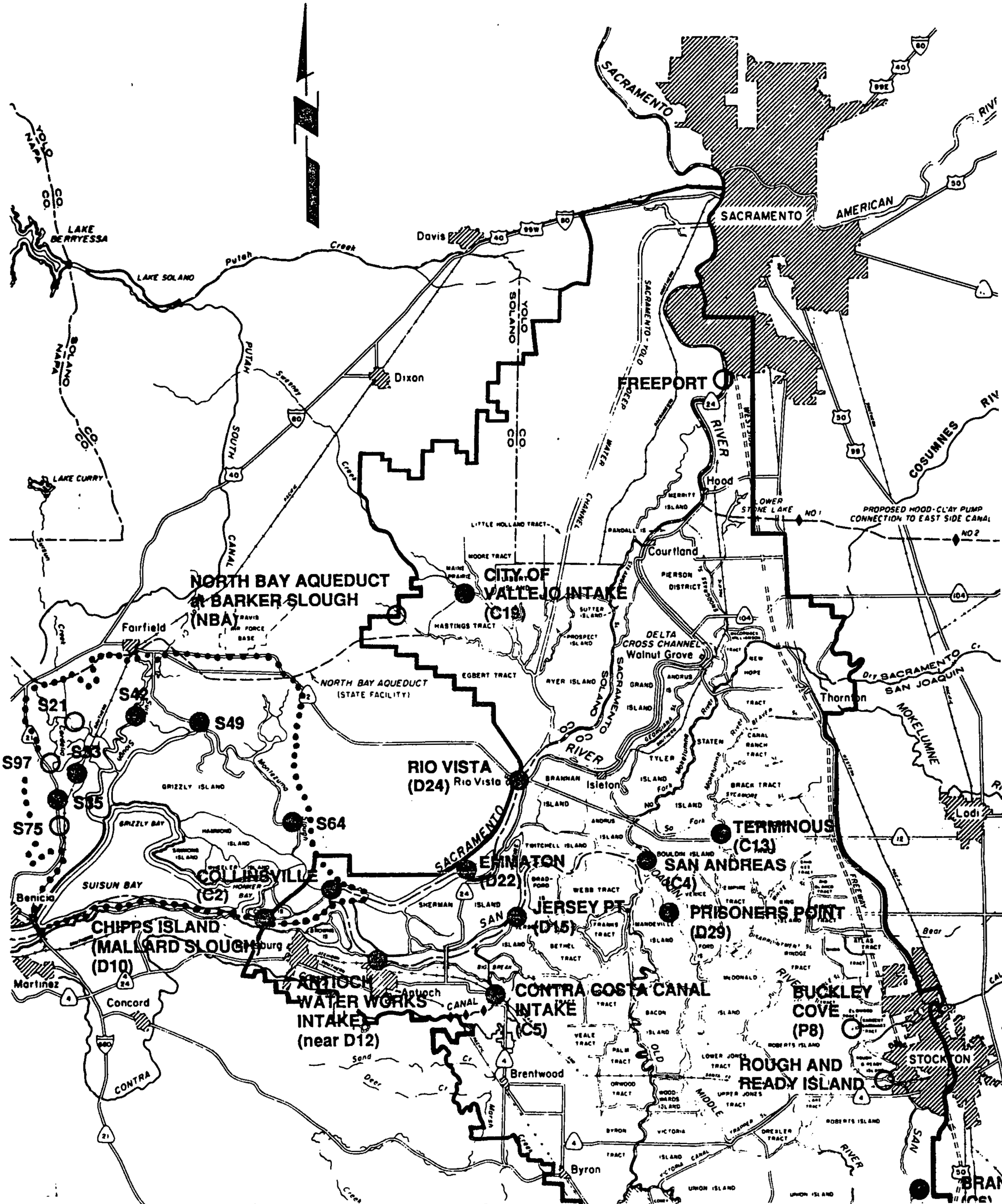
APPENDIX G
TRANSCRIPT INDEX

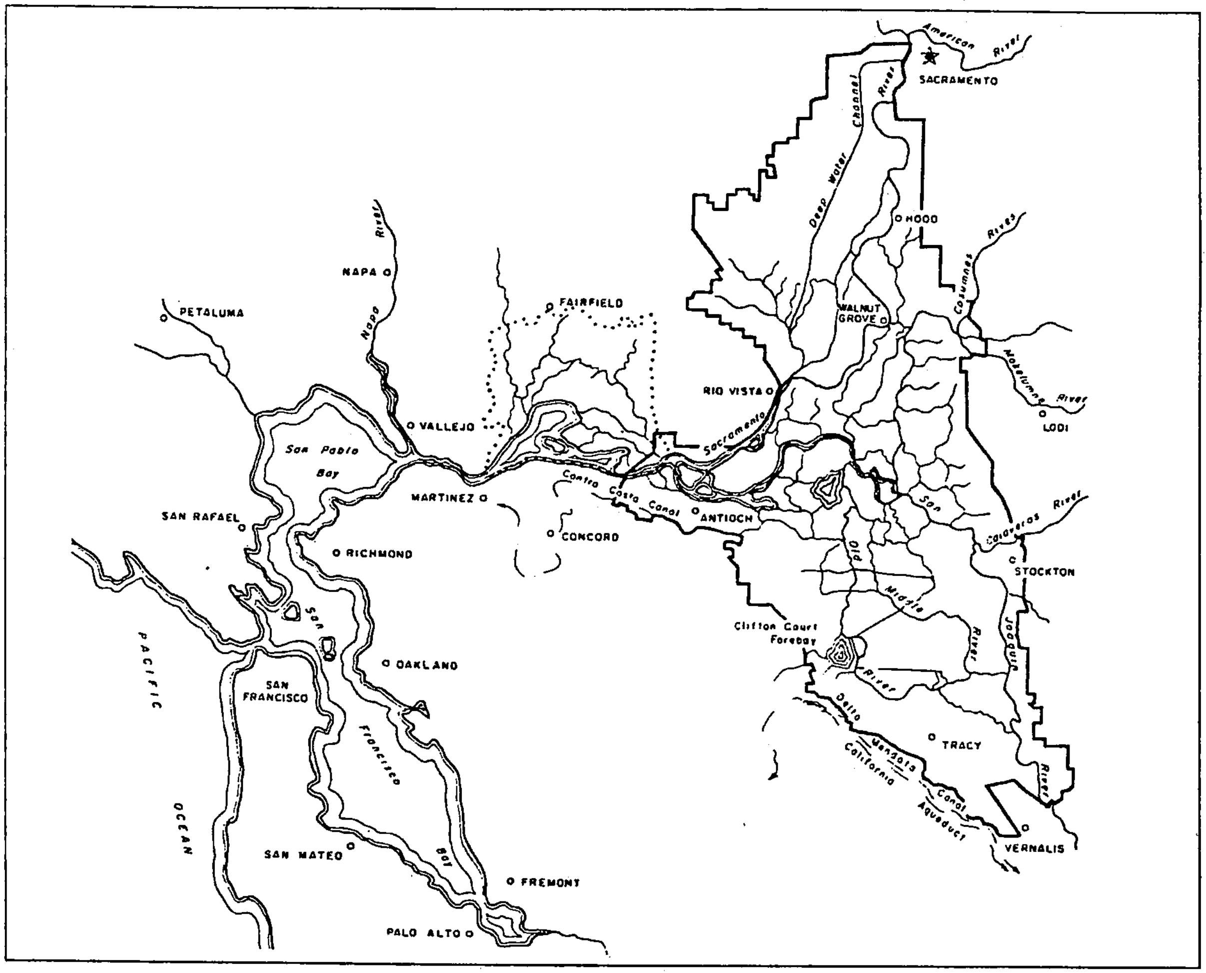
HEARING PHASE	HEARING DATE	TIME	REPORTERS VOLUME NUMBER	TRANSCRIPT SEQUENCE NUMBER
I	07/07/87	AM	I	I
I	07/08/87	AM	II	II
I	07/09/87	AM	III	III
I	07/13/87	AM	IV	IV
I	07/14/87	AM	V A	VA
I	07/14/87	AM	V B	VB
I	07/21/87	AM	VI	VI
I	07/22/87	AM	VII	VII
I	07/23/87	AM	VIII	VIII
I	07/23/87	AM	IX	IX
I	07/27/87	AM	X	X
I	07/28/87	AM	XI	XI
I	07/29/87	AM	XII	XII
I	07/30/87	AM	XIII	XIII
I	07/30/87	PM	XIV	XIVPOL
I	07/31/87	AM	XV	XV
I	08/11/87	AM	XVI	XVI
I	08/12/87	AM	XVII	XVII
I	08/12/87	PM	XVIII	XVIIIPOL
I	08/13/87	AM	XIX	XIX
I	08/13/87	AM	XX	XX
I	08/14/87	AM	XXI	XXI
I	08/15/87	AM	XXII	XXII
I	08/24/87	AM	XXIII	XXIII
I	08/25/87	AM	XXIV	XXIV
I	08/25/87	PM	XXV	XXVPOL
I	08/26/87	AM	XXVI	XXVI
I	08/27/87	AM	XXVII	XXVII
I	08/28/87	AM	XXVIII	XXVIII
I	09/08/87	AM	XXIX	XXIX
I	09/09/87	AM	XXX	XXX
I	09/14/87	AM	XXXI	XXXI
I	09/14/87	PM	XXXII	XXXIIPOL
I	09/15/87	AM	XXXIII	XXXIII
I	09/16/87	AM	XXXIV	XXXIV
I	09/21/87	AM	XXXV	XXXV
I	09/22/87	AM	XXXVI	XXXVI
I	09/23/87	AM	XXXVII	XXXVII
I	09/24/87	AM	XXXVIII	XXXVIII
I	09/29/87	AM	XXXIX	XXXIX
I	09/29/87	PM	XL	XLPOL
I	10/13/87	AM	XLI	XLI
I	10/14/87	AM	XLII	XLII
I	10/15/87	AM	XLIII	XLIII
I	10/26/87	AM	XLIV	XLIV
I	10/27/87	AM	XLV	XLV
I	10/28/87	AM	XLVI	XLVI
I	10/28/87	PM	XLVII	XLVIIPOL

APPENDIX G
TRANSCRIPT INDEX

HEARING PHASE	HEARING DATE	TIME	REPORTERS VOLUME NUMBER	TRANSCRIPT SEQUENCE NUMBER
I	10/29/87	AM	XLVIII	XLVIII
I	11/09/87	AM	XLIX	XLIX
I	11/23/87	AM	L	L
I	11/24/87	AM	LI	LI
I	11/25/87	AM	LII	LII
I	11/30/87	AM	LIII	LIII
I	12/01/87	AM	LIV	LIV
I	12/08/87	AM	LV	LV
I	12/09/87	AM	LVI	LVI
I	12/10/87	AM	LVII	LVII
I	12/14/87	AM	LVIII	LVIII
I	12/15/87	AM	LIX	LIX
I	12/21/87	AM	LX	LX
I	12/22/87	AM	LXI	LXI
I	12/29/87	AM	LXII	LXII
II	01/09/89	AM		LXIII
II	02/27/89	AM		LXIV
II	06/06/89	AM		LXV
PPD	12/04/89	AM	I	LXVIA
PPD	12/11/89	AM	II	LXVIB
WQCP	02/20/90	AM	I	LXVII
WQCP	02/20/90	PM	II	LXVIIPOL
WQCP	02/21/90	AM	III	LXVIII
WQCP	02/22/90	AM	III	LXIX
WQCP	02/26/90	AM	V	LXX
WQCP	02/26/90	PM	VI	LXXPOL
WQCP	02/27/90	AM	VII	LXX
WQCP	08/07/90	AM	I	LXXI
WQCP	08/07/90	PM	II	LXXIPOL
WQCP	08/08/90	AM	III	LXXII
WQCP	08/13/90	AM	IV	LXXIII
WQCP	08/13/90	PM	V	LXXIIIPOL
WQCP	08/14/90	AM	VI	LXXIV
WQCP	08/20/90	AM	VII	LXXV
WQCP	08/20/90	PM	VIII	LXXVPOL
WQCP	08/22/90	AM	IX	LXXVI
WQCP	08/23/90	AM	X	LXXVII
WQCP	03/11/91	AM		LXXVIII
EIRSP	03/26/91	AM	I	LXXIX
WQCP	04/02/91	AM		LXXX
EIRSP	04/08/91	AM	II	LXXXI
EIRSP	04/09/91	AM	III	LXXXII
WQCP	05/01/91	AM		LXXXIII

Appendix E: Map of Salinity Control Stations





Technical Appendix

WATER QUALITY CONTROL PLAN FOR SALINITY

San Francisco Bay/ Sacramento - San Joaquin Delta Estuary

91-16WR

May 1991

WATER RESOURCES CONTROL BOARD

STATE OF CALIFORNIA

Technical Appendix

WATER QUALITY
CONTROL PLAN FOR SALINITY

San Francisco Bay/
Sacramento - San Joaquin
Delta Estuary

Report Number, 91-16 WR

May 1991

Prepared by the Bay-Delta Section
Division of Water Rights
WATER RESOURCES CONTROL BOARD
STATE OF CALIFORNIA

TECHNICAL APPENDICES

APPENDICES FIGURES

APPENDICES FIGURES (CONTINUED)

APPENDICES TABLES

APPENDICES TABLES (CONTINUED)

CITING INFORMATION

When citing evidence in the hearing record, the following conventions have been adopted:

Information derived from the <u>TRANSCRIPT</u>:

```
T,XIX,123:09-125:20
|  |   |      |
|  |   |      └──────── Ending page and line number (can be same
|  |   |                 as the starting page) - may be omitted
|  |   |                 if a single line reference is used
|  |   └──────────── Beginning page and line number
|  └──────────── Transcript Sequence Number (see Appendix G,
|                 Transcript Index)
└──────── Transcript
```

Information derived from an <u>EXHIBIT SUBMITTED DURING PHASE I</u>:

```
SWRCB,25,45
|      |  |
|      |  └──────── Page number, table number, graph number
|      └────── Exhibit number
└────── Identifying abbreviation of the information
         source (see Appendices A & B, Abbreviations/Symbols)
```

Information derived from an <u>EXHIBIT SUBMITTED AFTER PHASE I</u>:

```
P-CCWD-3,45
|  |    | |
|  |    | └──────── Page number, table number, graph number
|  |    └──────── Exhibit number
|  └──────── Identifying abbreviation of the information
|             source (see Appendix A & B, Abbreviations/Symbols)
└──────── Phase of the proceedings
           (WQCP = Water Quality Control Plan, 2/90-Present
            EIRSP = Environmental Impact Report Scoping Phase)
```

When citing <u>REFERENCES</u> from outside of the hearing record, the following conventions have been adopted:

Information derived from published documents,
(a) in the text of the Plan:

```
Denton, 1985
|        |
|        └─── Year of publication
└──────── Name of author or agency abbreviation
```

(b) at the end of the appropriate Plan Chapter:

Denton, R.A. 1985. Currents in Suisun Bay. SWRCB, Publication No. 85-3wr. January 1985.

Complete publication source

Complete title of document cited

Publication date

Name of author or agency abbreviation

Information derived from Phase I closing BRIEFS:
(a) in the text of the Plan:

RIC,Brief,8

Page number

"Brief"

Identifying abbreviation of the information source

(b) at the end of the appropriate Plan Chapter:

Brief of the Rice Industry Committee on Pollutants in the Bay-Delta Estuary, pg. 8.

For a complete list of the abbreviations for information sources, citations and symbols used in this document, see Appendix A and B.

Appendix C is a Glossary of Terms; Appendix G is a Index of Transcripts listing Transcript Sequence Numbers.

APPENDIX 2.0

STATE BOARD AUTHORITY FOR REGULATION OF WATER IN THE BAY-DELTA ESTUARY

The State Board is responsible for formulating and adopting state policy for water quality control (WC Section 13140). The Water Code states that activities and factors which may affect the quality of waters of the state "...shall be regulated to attain the highest water quality which is reasonable considering all demands being made and to be made on those waters and the total values involved..."(WC Section 13000).

Through the basin planning process, the State and Regional Boards formulate and adopt Basin Plans specifying water quality objectives to ensure reasonable protection for designated beneficial uses of water (WC Sections 13170, 13240).

The Board's authority to conduct a new proceeding establishing water quality objectives for the Bay-Delta Estuary and to implement these objectives by amending water rights is affected by several statutes and court decisions. These include:

a. State Board authority to adopt water quality control plans. WC Section 13170.

b. Reserved jurisdiction, in permits of the CVP, SWP, and new appropriators since about 1965 within the watershed, to add specific terms and conditions.

c. Continuing authority to condition water rights. Cal. Const. Art. X, Section 2; Water Code Sections 100, 275, 1050; United States v. State Water Resources Control Board (1986) 182 Cal.App.3d 82, 129, 227, Cal. Rptr. 161.

d. Statutory authority to condition water rights for protection of all beneficial uses, for protection of the public interest, and for compliance with appropriate water quality control plans. Water Code Sections 1253, 1257 and 1258.

e. Continuing authority to reexamine water rights under the public trust doctrine. National Audubon Society v. Superior Court (1983) 33 Cal.3d 419, 447, 189 Cal.Rptr. 346.

f. The Delta Protection Act at Water Code Sections 12200-12220, the Watershed of Origin protections at Water Code Sections 11460-11463, the County of Origin protections at Water Code Sections 10505 and 10505.5, and the San Joaquin River Protection Act at Water Code Sections 12230-12233.

g. California Environmental Quality Act (CEQA) at Public Resources Code Section 21000 et seq.

h. The California Endangered Species Act at Fish and Game Code Section 2050 et seq.; the federal Endangered Species Act at 16 US Code Section 1531 et seq.

This Plan establishes or amends water quality objectives for three constituents of water in the Bay-Delta Estuary: salinity, temperature, and dissolved oxygen. In a water right proceeding that will follow adoption of this Plan, the Board will consider how and whether to implement these objectives by managing the water supply. Because of the relationship between the water quality objectives in this Plan and management of the water supply, a brief description of relevant water supply and water right laws is provided below.

In addition to general water right laws, four major water supply statutes affect the water supply to the Delta and the export of water from the Delta. These are the Delta Protection Act, the Watershed and the County of Origin provisions and the San Joaquin River Act. With the exception of the San Joaquin River Act, these statutes do not directly apply to water quality planning. However, they will affect the water right decision in which the Board will consider implementing the water quality objectives in this Plan.

The Delta Protection Act at Water Code Section 12200 et seq. provides that no water shall be exported from the Delta (1) which is necessary to provide salinity control and an adequate water supply for the users of water in the Delta (Section 12202), or (2) to which the users within the Delta are entitled (Section 12203). Section 12204. The Act contains a legislative finding that it is necessary to the peace, health, safety and welfare of the people of the state that an adequate water supply in the Delta be maintained that is sufficient to maintain and expand agriculture, industry, urban, and recreational development in the Delta area, <u>and</u> to provide a common source of fresh water for export to areas of water deficiency. Section 12201. The Act also allows substitution of a water supply to the Delta in lieu of the water supply that is provided as a result of salinity control, if substitution is in the public interest and the Delta users have no added financial burden as a result of the substitution. The delivery of water for Delta or export use is subject to the Watershed of Origin provisions and the County of Origin provisions. Sections 12201 and 12202.

The San Joaquin River Act at Water Code Section 12230 et seq. specifically protects the reach of the San Joaquin River between the Merced River and the Middle River. This law affects part of the southern Delta. While the Act focuses on the quality of water in the affected reach, the Act applies to both water quality and water rights decisions. It applies to all water diversions for which an application was filed after June 17, 1961. Section 12233. The Act declares state policy that nobody should divert water from the San Joaquin River to which the users along the protected reach are entitled. Section 12231. Further, the Act forbids the State Board and other state agencies from causing further significant degradation of the water quality in the specified reach. Section 12232.

The Watershed of Origin provisions at Water Code Sections 11460-11463 prohibit the State Water Project and the federal Central Valley Project from depriving "a watershed or area wherein water originates, or an area immediately adjacent thereto which can conveniently be supplied with water therefrom... " "... of the prior right to all the water reasonably required to adequately supply the beneficial needs of the watershed, area, or any of the inhabitants or property owners therein." Sections 11460 and 11128. While these provisions apparently have no direct effect upon the establishment of water quality objectives, they may affect the Board's implementation of the objectives in a water rights proceeding. Section 11462.

The County of Origin provisions at Water Code Sections 10505 and 10505.5 apply to water rights acquired pursuant to state-filed applications to appropriate water. The state filed numerous applications, generally with very early water right priority dates, for projects which may be needed to develop, used, or conserve the state's water resources. Section 10505, adopted 1927, provides: "No priority under this part shall be released nor assignment made of any application that will, in the judgement of the Board, deprive the county in which the water covered by the application originates of any such water necessary for the development of the county."
Section 10505.5, adopted in 1969, provides that any subsequent permit issued on a state filed application shall provide that the permit and any license issued on the permit shall not authorize the use of any water outside the county of origin which is necessary for the development of the county. These provisions, like the Watershed of Origin provisions, have no direct effect upon the establishment of water quality objectives. However, they may affect implementation of the objectives in water rights proceeding.

In addition, during the Water Right Phase of these proceedings, the Board will consider the obligations of the various water right holders whose diversions and uses of water affect the beneficial uses of the waters to the Bay-Delta Estuary. In that consideration, the Board will have to take into account the existing water right priority system, which has been established by statutory and case law in California. However, as the Court of Appeal held in U.S. v. State Water Resources Control Board (1986) 227 Cal.Rptr. 161, 189, the State Board has authority to revise water right priorities to ensure that the requirements of California Constitution Article X, Section 2 are satisfied. The water right priority system, with a few exceptions, gives first priority to riparian right holders. All riparian right holders along a stream have equal rights with one another, and must share in any shortages. Appropriative right holders generally are junior in priority to riparian right holders. As an example, the CVP and the SWP are appropriative right holders. Appropriative right holders have a right to take water in accordance with their order of priority. To illustrate, if all of the appropriative right holders lined up at a water tank in their order of priority with buckets, each one would be able to fill a bucket in turn until the tank was empty. All of those whose priority was too low to reach the tank before it was empty would get no water. Under the modern appropriative rights system, water rights receive a priority according to the date when the appropriator filed an application to appropriate water. Water Code Sections 1450, 1455. The oldest appropriations, therefore, must be satisfied before newer appropriations can get water.

Implementation of Legal Authority

Recognizing uncertainties associated with proposed project facilities to be constructed and the need for additional information on the Bay-Delta ecosystem, the State Board limited the Delta Plan in 1978 to current and near-term conditions in the Delta. The State Board stated it would review the 1978 Water Quality Control Delta Plan in about ten years. This commitment as well as recent court decisions have called for the current hearing and have expanded the scope of its proceedings.

Specifically, in 1986, the State Court of Appeal, First District, issued a decision,[1/] also known as the Racanelli or Delta Water Cases decision, addressing legal challenges to D-1485 and the Delta Plan. The court directed the State Board to take a global perspective of water resources in developing water quality objectives: The State Board's duty in its water quality role is to provide reasonable protection for beneficial uses, considering all demands made on the water. The State Board's salinity control function in the Bay-Delta should not be solely related to its water right function. Furthermore, the decision recognized that an implementation program may be a lengthy and complex process that requires significant time intervals and action by entities over which the State Board may have little or no control.

In the State Board's view, the court's decision means that the State Board must consider all relevant factors in determining whether the protection afforded a beneficial use by the objectives is reasonable. For this Plan, these factors include not only the factors specifically listed in Water Code Section 13241, but also the unique role of the Bay-Delta Estuary in the State's water supply and environment. Because of the wide distribution of water from the Delta, the State Board in developing this Plan has carefully weighed the uses of the water both within and outside the Estuary to decide whether the objectives provide reasonable protection to the beneficial uses. Also in considering the objectives, the State Board has taken into consideration the legislative policies set forth in the Water Code at Section 13000 and the State Board's Statement of Policy with Respect to Maintaining High Quality of Waters in California, adopted in 1968 in Resolution 68-16. As applied to waters for which water quality standards are required under the federal Clean Water Act, Resolution 68-16 incorporates by reference the three-prong test set forth in the federal antidegradation policy at 40 CFR 131.12(a). Order No. WQ 86-17.

In the Water Right Phase, when it considers implementation of the water quality objectives in this Plan, the State Board will use an analytic process which will include water right holders in addition to the State Water Project and the federal Central Valley Project. As the Court of Appeal observed, the principal enforcement mechanism available to the

1/ *United States v. State Water Resources Control Board (1986) 182 Cal.App.3d 82, 227 Cal.Rptr.161*

State Board to control pollution from seawater intrusion is its regulation of water rights to control diversions which cause degradation of water quality. Id., at 227 Cal.Rptr. 184. Since 1928 when the voters approved California Constitution Article X, Section 2, all water users, riparians and appropriators alike, are subject to a universal limitation that water use must be reasonable and for a beneficial purpose. This "rule of reasonable use", according to the Court, is the cardinal principle in making water right decisions. Id., at 227 Cal.Rptr. 171. According to the Court, the State Board has broad power to strike the proper balance between the interests in water quality and the export of water, in deciding whether a particular activity is reasonable. Id., at 227 Cal.Rptr. 188. The determination of reasonableness is ordinarily a question of fact. Id.

Both the State Board's authority and the court's recent decision have guided the reassessment developed in this Plan.

California Environmental Quality Act (CEQA)

Pursuant to Section 15251(g) Title 14, California Code of Regulations (C.C.R.), the State Board's Water Quality Control (Basin) Planning Program is a "certified program" by the Secretary for Resources. As a certified program it is exempt from the requirements of preparing a separate environmental document. However, preparation of basin plans under the Program remains subject to other provisions in CEQA, including discussion of alternatives to the proposed objectives and mitigation measures to avoid or reduce any significant or potentially significant effects on the environment.

This Plan identifies the competing uses of Bay-Delta waters and provides, in terms of salinity and temperature, reasonable protection for each use; it identifies alternatives and mitigation measures to avoid or reduce any significant or potentially significant effects that this Plan might have on the environment. Therefore, this Plan is a substitute for a CEQA document as set forth in 14 C.C.R. Section 15252 (see Appendix F, Notice of Filing).

APPENDIX 3.0

BASIN DESCRIPTIONS

Precipitation in California

On the average, precipitation supplies about 193 MAF per year in California with another 6 MAF coming from out-of-state sources. About 58 percent of this water is used by native vegetation and unirrigated lands; about 25 percent flows to the sea, to salt sinks, and to Nevada; about 14 percent is diverted for offstream uses; and about 3 percent goes to the natural recharge of ground water basins (calculated from information in DWR Bulletin 160-83, pg.88).

Sacramento River Basin

Physical Description

The Sacramento River Basin, Basin 5A in Figure A3.0-1, includes the westerly drainage of the Sierra Nevada and the Cascade ranges, the easterly drainage of the Coast Range, and the valley floor. The Basin covers about 26,500 square miles (16,960,000 acres) and extends from the Goose Lake Basin at the Oregon border to the American River Basin (RWQCB 5, 1975). The Basin includes the watersheds of the following major tributaries: McCloud, Pit, Sacramento, Feather, Yuba, Bear, and American rivers, and Cottonwood, Stony, Cache, and Putah creeks.

The Sacramento Valley floor ranges from 30 to 45 miles wide in the central and southern parts, but narrows to five miles at its northern end; it slopes southward from about 300 feet above sea level at the north end near Red Bluff to sea level at Suisun Bay. The crestline of the Sierra Nevada generally ranges from 8,000 to 10,000 feet, while the crestline of the Coast Range extends from 2,000 to 8,000 feet. Due to the large snowpack at higher elevations in the Basin, the greatest volume of streamflow above the reservoirs occurs during snowmelt in the spring and early summer.

Hydrology

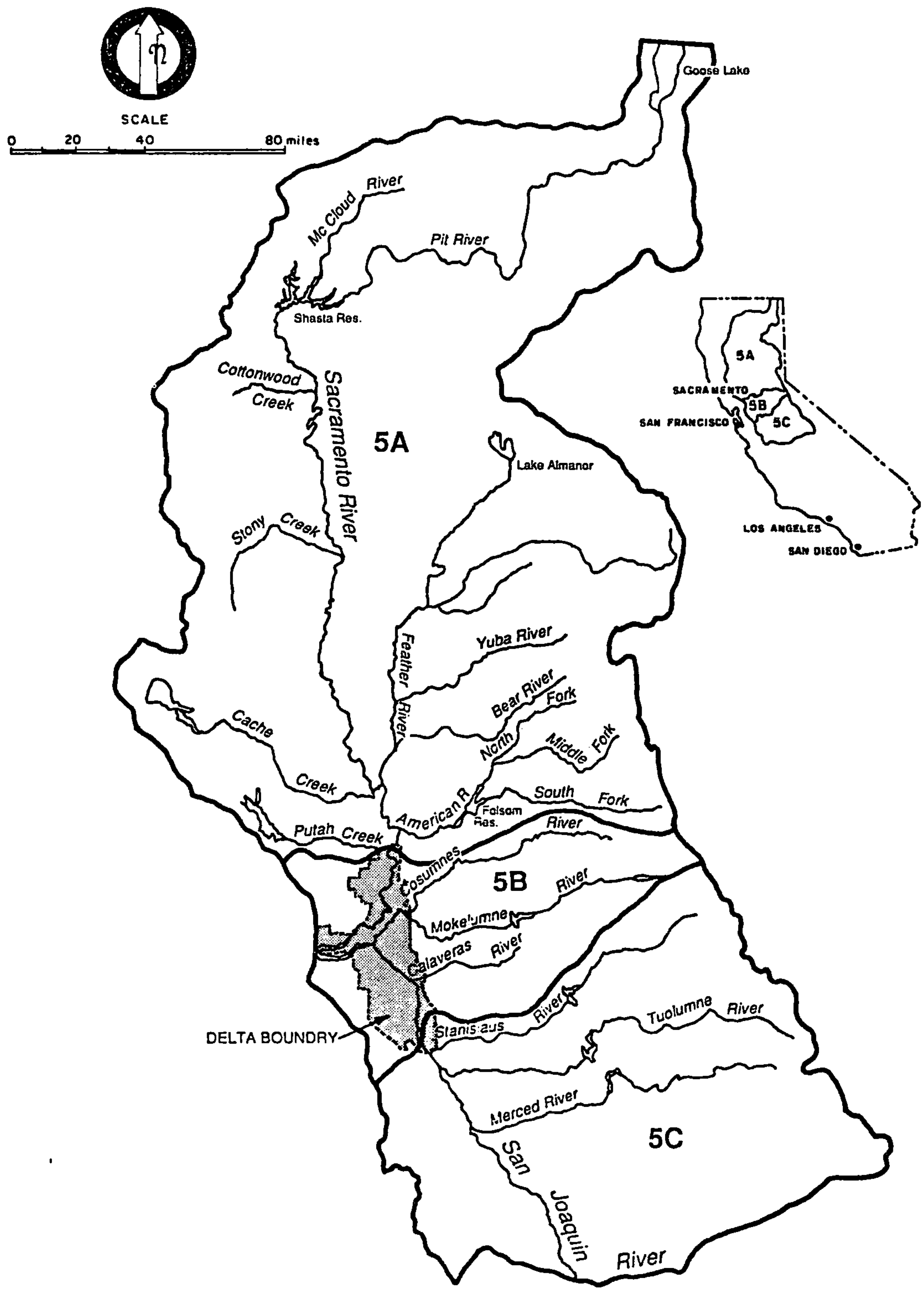
The Sacramento River Basin receives water transfers from other basins via the following projects:

- o Trinity River
- o Sly Park
- o Little Truckee Ditch
- o Echo Lake Conduit

The Basin exports water to other basins via the following projects:

- o Putah South Canal
- o Folsom South Canal
- o Tule Lake Diversion
- o North Fork Ditch
- o Folsom Lake Diversion

FIGURE A3.0-1 Boundaries of the Sacramento River (5A), Central Sierra and Delta (5B), and San Joaquin (5C) Basins (From: RWQCB 5, 1975)



The amounts of these and other interbasin transfers are shown in Figure A3.0-2 (DWR,19). The basin boundaries in this figure differ somewhat from the boundaries defined in this Plan; however, it provides a good illustration of the magnitude of interbasin water transfers from the Sacramento River Basin to other areas in California.

Water from the Sacramento River Basin enters the Delta from two major waterways, the Sacramento River near Sacramento and the Yolo Bypass just west of Sacramento. Under present conditions and in years of normal runoff, the Sacramento River Basin contributes about 70 percent of the total runoff to the Estuary (Bay and Delta) (SWRCB,3,3).

Central Sierra Basin

Physical Description

Basin 5B in Figure A3.0-1 is referred to as the Central Sierra Basin (SWRCB,3,4). This Basin includes the watersheds of the Cosumnes, Mokelumne, and Calaveras rivers. This Basin encompasses about 3,800 square miles (2,432,000 acres).

Hydrology

Introduction

The Central Sierra Basin inflow to the Delta comes from three river systems, the Cosumnes, Mokelumne and Calaveras, sometimes called the "Eastside Streams." The Central Sierra Basin receives water from the Sacramento River Basin via the:

- o Folsom South Canal, and
- o the Folsom Lake Diversion.

Water is exported from the Central Sierra Basin via the following projects:

- o Mokelumne Aqueduct
- o Sly Park, and
- o South Bay Aqueduct.

In years of normal runoff, Basin 5B contributes about five percent of the total inflow to the Delta (SWRCB,3,3).

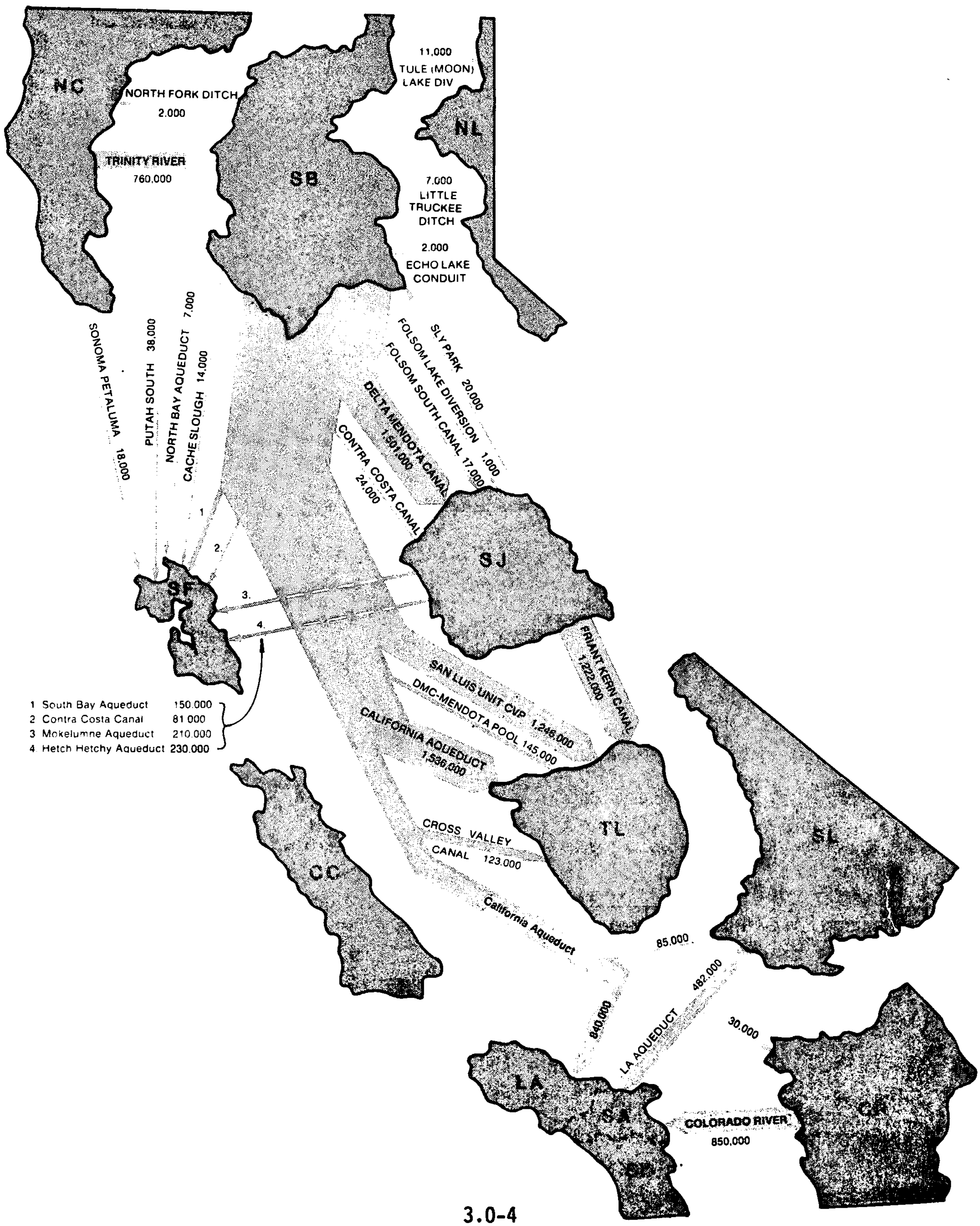
As of 1987, about 242,000 acre-feet of water (about one-third of the average annual Mokelumne River flow) were diverted into the Mokelumne Aqueduct for use in the east San Francisco Bay area (EBMUD,1,9).

San Joaquin River Basin

Physical Description

The San Joaquin River Basin, Basin 5C in Figure A3.0-1, encompasses over 11,000 square miles (7,040,000 acres) between the crests of the Sierra Nevada and Coast ranges, and stretches southward from the Delta to the drainage divide between the San Joaquin and Kings rivers. The valley

FIGURE A3.0-2 Interbasin water transfers for a 1980 level of development and the annual amounts in AF/YR (From: DWR, 19)



floor in the Basin measures about 50 miles wide by 100 miles long, and slopes from an elevation of about 250 feet at the southern end to near sea level at the northern end (RWQCB 5, 1975). In years of normal runoff, the San Joaquin River Basin now contributes about 15 percent of the total measured runoff to the Estuary (SWRCB,3,3).

The Kings River historically flowed into Fresno Slough and into the San Joaquin River. Due to upstream controls and diversions, this occurs now about once every three years (DWR,26,33). Due to this discontinuity, the Kings River is now considered to be part of the Tulare Lake Basin, Basin 5D, and not part of the San Joaquin River Basin.

Hydrology

The major tributaries in Basin 5C to the San Joaquin River are the Merced, Tuolumne, and Stanislaus rivers which originate in the Sierra Nevada. Peak streamflows above the reservoirs generally occur later in spring than the Sacramento Basin because the San Joaquin Basin mountain ranges are generally higher than those in the Sacramento Basin. Smaller tributaries, consisting of runoff from the Coast Range and/or agricultural drainage, include the following:

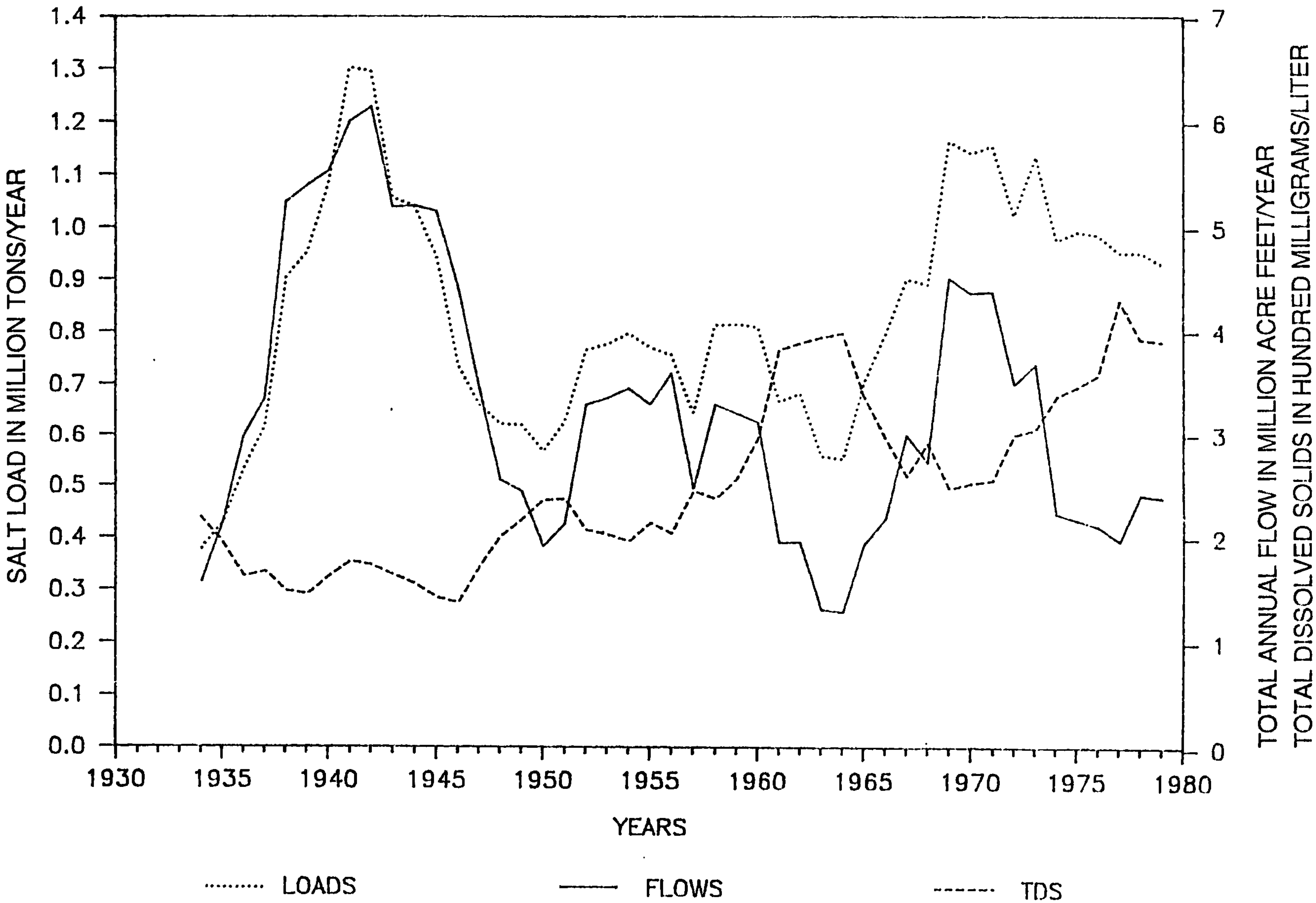
- o Salt and Mud sloughs
- o Panoche
- o Little Panoche
- o Los Banos
- o Orestimba
- o Del Puerto creeks

Water is imported into the San Joaquin River Basin from the Delta via the Delta-Mendota Canal (DMC) of the CVP and via the SWP (Oak Flat Water District). Water is exported from the Basin via the following projects (see Figure A3.0-2):

- o Friant-Kern Canal (CVP),
- o Hetch Hetchy Aqueduct, and
- o San Felipe Unit (CVP).

About 77,000 acres in the San Joaquin River Basin have subsurface agricultural drainage systems which discharge to the San Joaquin River, primarily via Mud and Salt sloughs (EDF,11,I-1). During the irrigation season and occasionally following the flushing of agricultural drainage water from duck clubs in January and February, agricultural drainage makes up a significant portion of San Joaquin River flows and constituent loads (EDF,11,V-36,V-44,V-46&V-47). The San Joaquin River contains considerably higher concentrations of several constituents (including nitrates, selenium, arsenic, nickel and manganese) than the Sacramento River (AHI,302,219,231). Figure A3.0-3 shows that the salinity has increased since 1930. The salt load for a given flow has increased since 1985 primarily due to the bypassing of agricultural drainage around the Grassland Water District directly into the San Joaquin River.

FIGURE A3.0-3 Salinity, flow and salt load in the San Joaquin River near Vernalis (5 Year running averages)(Adapted from Orlob, 1982 data)



The current water quality objective set by the Delta Plan for the San Joaquin River Basin is a monthly mean of 500 ppm TDS for the San Joaquin River near Vernalis (RWQCB,5, 1975). For the period of 1975 through 1987, the 500 ppm TDS objective was met in all but two critically dry water years, 1976 and 1977, as well as the beginning of Water Year 1978. However, this 12-year period was dominated by wet years -- six wet, two above normal, two dry, and two critical.

The operation of the Friant-Kern Canal and Delta-Mendota Canal units of the CVP began around 1950. The basin exchanges associated with these CVP units, as well as the consumptive use and reservoir storage aspects of these and other more recent projects on the eastside of the San Joaquin Valley, have significantly altered flow relationships for the San Joaquin River Basin. A comparison of this relationship for the pre-1950 period and the post-1950 period is shown in Figure A3.0-4 (EDF,11,II-30). The two regression lines in the figure are significantly different, indicating that the total amount of flow measured at Vernalis (the entry point of the San Joaquin River to the Delta) has decreased since 1950.

The Delta

Physical Description

The Delta is a roughly triangular area of about 1,150 square miles (738,000 acres) extending from Chipps Island near Pittsburg on the west to Sacramento on the north and to the Vernalis gaging station on the south (see Figure A3.0-5) (California Water Code Section 12220). This area includes those waterways above the confluence of the Sacramento and San Joaquin rivers which are influenced by tidal action, and about 800 square miles (512,000 acres) of agricultural lands which derive their water supply from these waterways. The total surface area of these waterways is over 75 square miles (48,000 acres), with an aggregate navigable length of about 550 miles. Major tributaries to the Delta include the Sacramento and San Joaquin rivers. Minor contributors include the eastside streams -- the Cosumnes, Mokelumne, and Calaveras rivers and Dry Creek -- and the Yolo Bypass.

Water is exported directly from the Delta at five major locations (identified by number on Figure A3.0-5):

- o Tracy Pumping Plant (1)
- o Clifton Court Intake (2)
- o Contra Costa Canal at Pumping Plant No. 1 (3)
- o City of Vallejo Intake at Cache Slough (4)
- o North Bay Aqueduct Intake at Barker Slough (5)
  (The City of Vallejo, although it still maintains a standby intake at Cache Slough)

Hydrology

Background

In its original condition, the Delta was a vast, flat marsh traversed by an ever-changing network of channels and sloughs that divided the area into islands (SWC,262,A2-15). "During the flood season, the Delta became a great inland lake; when the floodwater receded, the network of sloughs

FIGURE A3.0-4 Unimpaired flows versus measured flows for the San Joaquin Basin

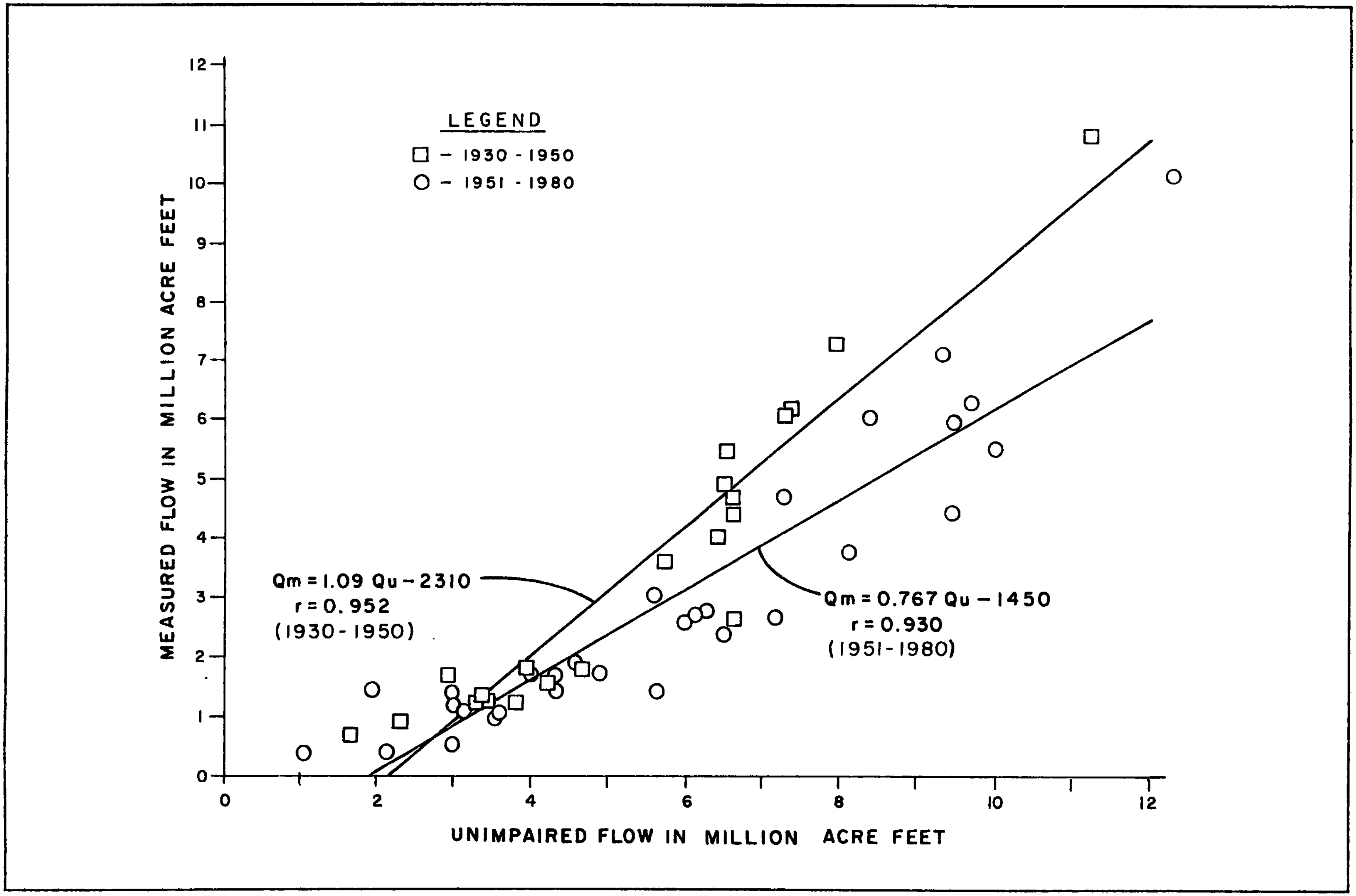
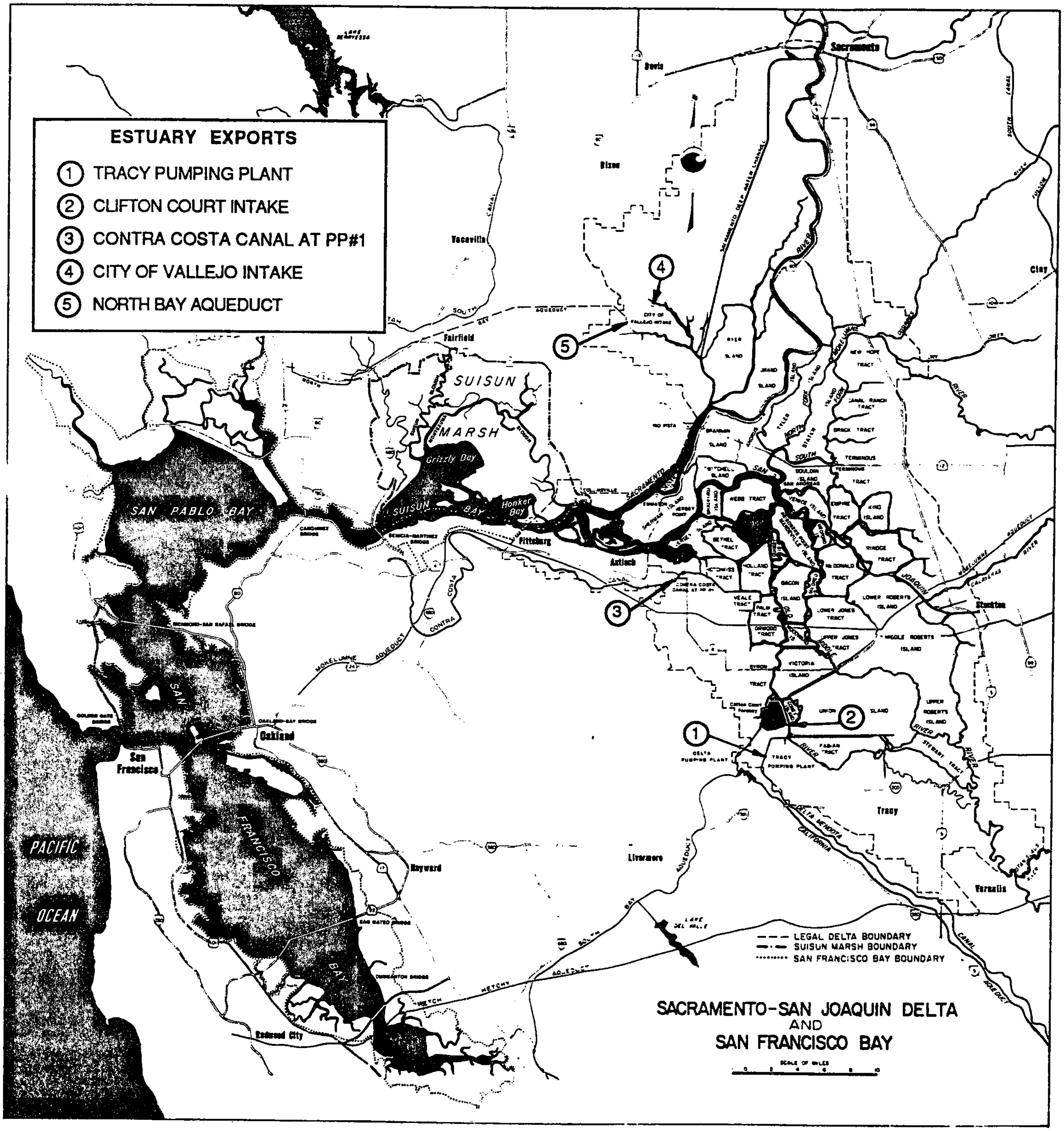


FIGURE A3.0-5 Boundary of the Bay-Delta Estuary and locations of Estuary exports
(From: SWRCB, 3, 5)



and channels reappeared throughout the marsh" (DWR,707,67). In the 1860s, reclamation began on low-lying areas, and local landowners undertook cooperative levee construction to allow the lands to be farmed. By the 1920s about 415,000 acres were completely reclaimed and in agricultural production (SWRCB,13,III-4); and "{m}any miles of entirely new channels had been dredged, and farmlands, small communities, highways and utilities were protected-- often tenuously--by 1,100 miles of levees, many of them built on peat soils" (DWR,707,67).

The export of water directly from the Delta first took place in 1940 with the completion of the Contra Costa Canal, a unit of the CVP. In 1951, water supplying the Delta-Mendota Canal began to be exported at the CVP's Tracy Pumping Plant (DWR,707,67). In the same year the Delta Cross Channel and control gates were constructed near Walnut Grove to allow a more efficient transfer of water to the Tracy pumps (SWRCB,13,III-6). With the start of operation of the State Water Project's (SWP) Harvey O. Banks Pumping Plant in 1967, Delta exports were again increased. By 1975, the combined deliveries of waters exported by both the CVP and SWP totaled 4.8 million acre-feet per year. The total CVP and SWP Delta exports are projected to reach 6.6 million acre-feet per year by the year 2000 (USBR,2,27).

Delta Flows

o Delta Inflow

Freshwater flow into the Delta comes primarily from the Sacramento and San Joaquin rivers, with small contributions from the Mokelumne and Cosumnes rivers (SWRCB,13,III-7). Under present conditions, these river systems contribute approximately 85, 10, and 5 percent, respectively, of the average annual inflow to the Delta (not the Estuary) (DWR, 1987, from DWR '1990 Level of Development Operation Model Output').

o In-Delta Flow

The flows in the Delta channels result from a combination of Delta inflows, Delta agricultural use, exports, and the counteracting force of the tides from the Pacific Ocean through the San Francisco Bay. The net flow is normally downstream, out of the Delta. However, many times the flows change direction and move back upstream on incoming tides. Tidally influenced flow reversals are a twice daily natural phenomena occurring throughout the Bay-Delta Estuary; it is only during extremely large flooding events that tidal forces are overcome throughout the tidal cycle. Such tidally-caused flow reversals occur over most of the Delta although they are often marked in parts of the Delta by the influence of Delta diversions, including export pumping (SWRCB,13,III-11). The distance of the upstream movement, and the extent of saline intrusion, vary depending on the flows in the Delta channels and the opposing force of (SWRCB,14,II-1).

o Delta Outflow

The major factors affecting Delta outflow are the tides, stream runoff, upstream and Delta channel depletions, Delta exports, upstream use and upstream reservoir operations.

Delta outflow is highly seasonal and generally is characterized by large winter inflows from rainfall runoff generated by Pacific storms, and small, relatively steady inflows during the dry summers from reservoir releases. Delta outflow commonly exceeds 35,000 cfs from December through April, whereas it is usually less than 14,000 cfs from July through October (USGS,10,6).

Flow Measurement

The net Delta outflow at Chipps Island is not directly measurable since, at times, it may be less than five percent of the flows due to the tides (SWRCB,14,IV-7). However, an estimate of net Delta outflow is important for purposes of water quality control and water resource management (SWRCB,13,III-16). The net Delta outflow at Chipps Island is usually estimated by performing a water balance at the western boundary of the Delta, Chipps Island. The water balance involves adding the total Delta inflow and Delta precipitation runoff, then subtracting Delta channel depletions and Delta exports (DWR,47,2).

DWR has estimated the daily Delta outflow at Chipps Island for water years 1956 through 1985 using the flow accounting model, DAYFLOW. DAYFLOW is also used to estimate interior Delta flow at specified locations and fish-related parameters and indices (DWR,47). Figure A3.0-6 presents the means and standard deviations of Delta outflows computed by DAYFLOW for water years 1956 through 1985 (USGS,10,6).

Another commonly used estimate of Delta outflow, especially for the daily operation of the CVP and SWP, is the Delta Outflow Index (DOI). The DOI is similar to the DAYFLOW Delta outflow but does not include the flows from smaller peripheral streams entering the Delta, such as the Mokelumne and Calaveras rivers, or the Yolo Bypass flows. Because of these differences, the DOI is considered to be less representative than the DAYFLOW Delta outflow estimate (USBR,111,16).

Delta Channel Depletion, Exports and Reverse Flow

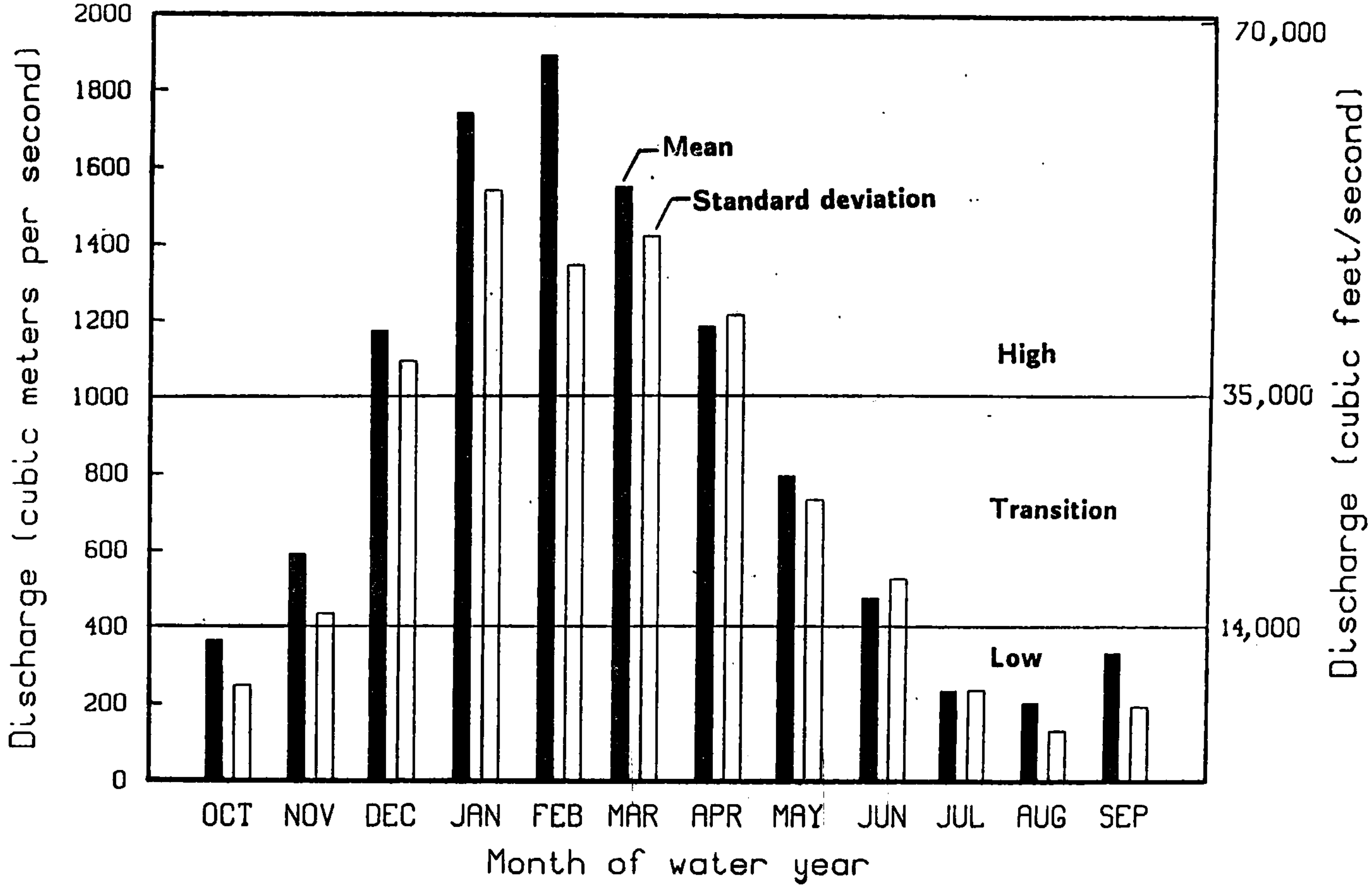
One of the critical factors in determining Delta outflow is Delta channel depletion, that is, "...the diversions of Delta channel waters via pumps, siphons, and subsurface seepage into the Delta uplands and lowlands for consumptive use by agriculture and native plants" (DWR,36,3-4)[1/]. The Delta channel depletions (not including precipitation) range from approximately 34 TAF in January to 278 TAF in July (DWR,1988,Operation Study). Currently, over 1,600 diversion locations have been identified within the Delta (T,II,189:17).

The locations of agricultural irrigation diversion and drainage return points are shown in Figures A3.0-7 (DWR,49,1) and A3.0-8 (DWR,64,1).

1/ *The consumptive use values used by the USBR and DWR to operate the CVP and SWP were fixed in the Federal-State Memorandum of Agreement dated April 9, 1969. The consumptive use values were based on: (1) a 1955 Delta land use survey; (2) estimates of consumptive use by identified crops; (3) changes in soil moisture; and (4) estimates of leaching requirements (SWRCB,13,III-16). While the consumptive use values are adjusted seasonally, they are not adjusted for water year types, thereby introducing error into the Delta outflow calculations (USBR,111,16).*

FIGURE A3.0-6

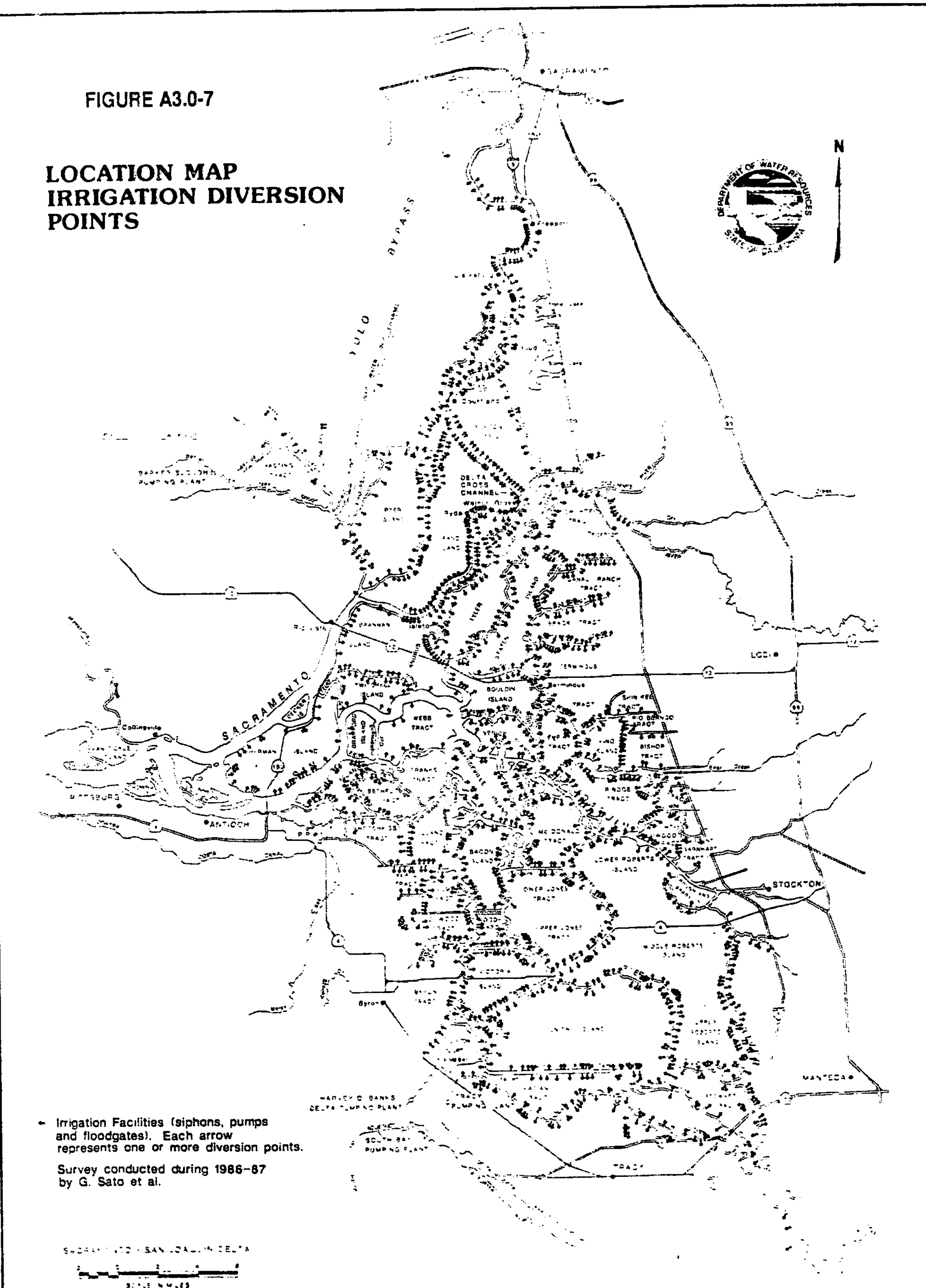
(FROM USGS EXHIBIT 10, PAGE 6)



--Means and standard deviations of net monthly discharges of the Sacramento-San Joaquin Delta into San Francisco Bay at Chipps Island, 1956-85 from estimates of the State of California (1986). Also shown are arbitrary divisions of the months into high (>1,000 m^3/s [35,000 ft^3/s]), transition (400-1,000 m^3/s [14,000-35,000 ft^3/s]), and low (<400 m^3/s [14,000 ft^3/s]) delta discharges.

FIGURE A3.0-7

LOCATION MAP IRRIGATION DIVERSION POINTS

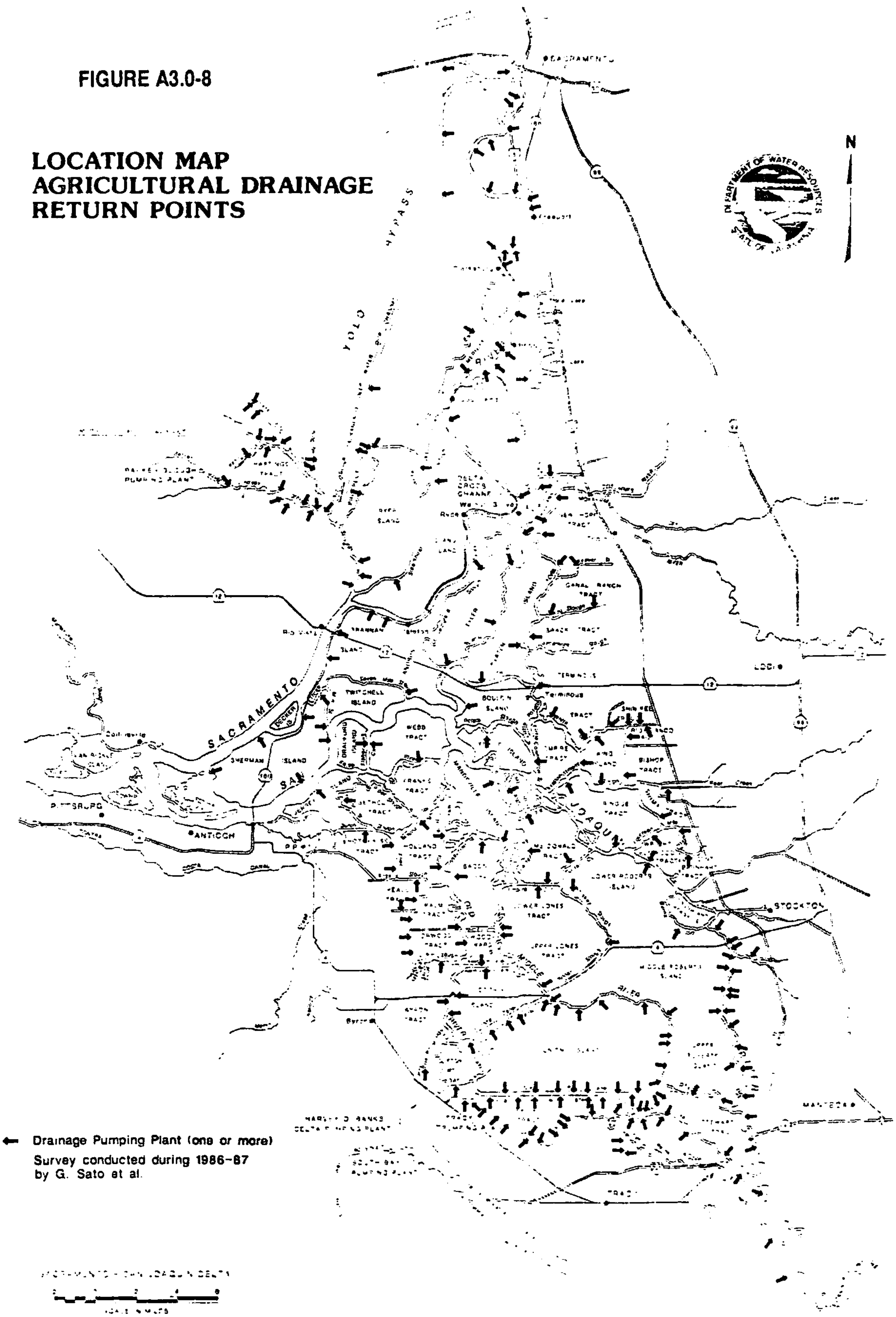


- Irrigation Facilities (siphons, pumps and floodgates). Each arrow represents one or more diversion points.

Survey conducted during 1986-87 by G. Sato et al.

FIGURE A3.0-8

LOCATION MAP AGRICULTURAL DRAINAGE RETURN POINTS



← Drainage Pumping Plant (one or more)
Survey conducted during 1986-87
by G. Sato et al.

Water supplies for export by the CVP and SWP are obtained from surplus Delta flows, when available, and from upstream reservoir releases, when Delta inflow is low and surplus flows are unavailable. Upstream reservoir releases from the Sacramento River Basin enter the Delta via the Sacramento River and Yolo Bypass. A portion of this water is then used within the Delta to meet agricultural needs, a portion is exported by various projects, and the remainder flows into San Francisco Bay as Delta outflow. Some of these releases are drawn to the CVP and SWP pumps through interior Delta channels facilitated in part by the CVP's Delta Cross Channel at Walnut Grove (DWR,707,69).

When export rates are high, the net flow of water can move in an upstream direction toward the export pumps (SWRCB,13,III-II). This is known as reverse flow. During periods of high Delta inflow and high export, there is some reverse flow, but enough water is available from the San Joaquin River, eastern Delta tributaries (Central Sierra Basin) and water transported from the Sacramento River via the Delta Cross Channel to meet export demands (Figure A3.0-9).

When there are high exports, low San Joaquin River inflows and high Delta consumptive uses, however, the normal water path changes, causing a reversal of flows around the western end of Sherman Island where the Sacramento River and the San Joaquin River meet (SWRCB,13;III-23) (Figure A3.0-10). As water travels around Sherman Island, it mixes with saltier ocean water entering as tidal inflow and is drawn upstream into the San Joaquin River and other channels by the CVP and SWP pumping plants (DWR,707,69). Figures A3.0-11 through A3.0-13 show other typical Delta flow patterns (DWR,51a-e).

Delta Flow and Salinity

Salinity is one of the major water quality factors affecting the beneficial uses of Delta water. Figure A3.0-14 shows the relationship between flow and salinity at Collinsville in the western Delta [1/]. The form of the relationship is typical of the flow-salinity relationships in the western Delta.

Upstream storage facilities, in-basin depletions, and Delta exports have reduced winter and spring Delta outflows. Releases from upstream storage facilities, on the other hand, have increased summer and fall Delta outflows (SWRCB,14,II-1). These changes in flows have correspondingly changed the extent and timing of salinity intrusion into the Delta. Figure A3.0-15 shows the maximum annual salinity intrusion into the Delta from 1920 through 1977 (DWR,60). Supplemental releases due to storage facilities since the 1940s have generally kept salinity intrusion, as indicated by the 1000 ppm chloride line in the Delta, at a point farther west, or downstream, than had been the case before that period.

1/ *Historically, the salinity of the waterways in the Delta has been expressed in chlorides (Cl) or total dissolved solids (TDS) concentrations, and, more recently, in electrical conductivity (EC). However, sometimes it is necessary to convert one unit of salinity to another. Consequently, "Unit Conversion Equations" are used to convert any one of the parameters to any of the others at various locations in the Delta using specific formulas for geographic location and water year type (DWR,61,1).*

FIGURE A3.0-9

DWR-51E

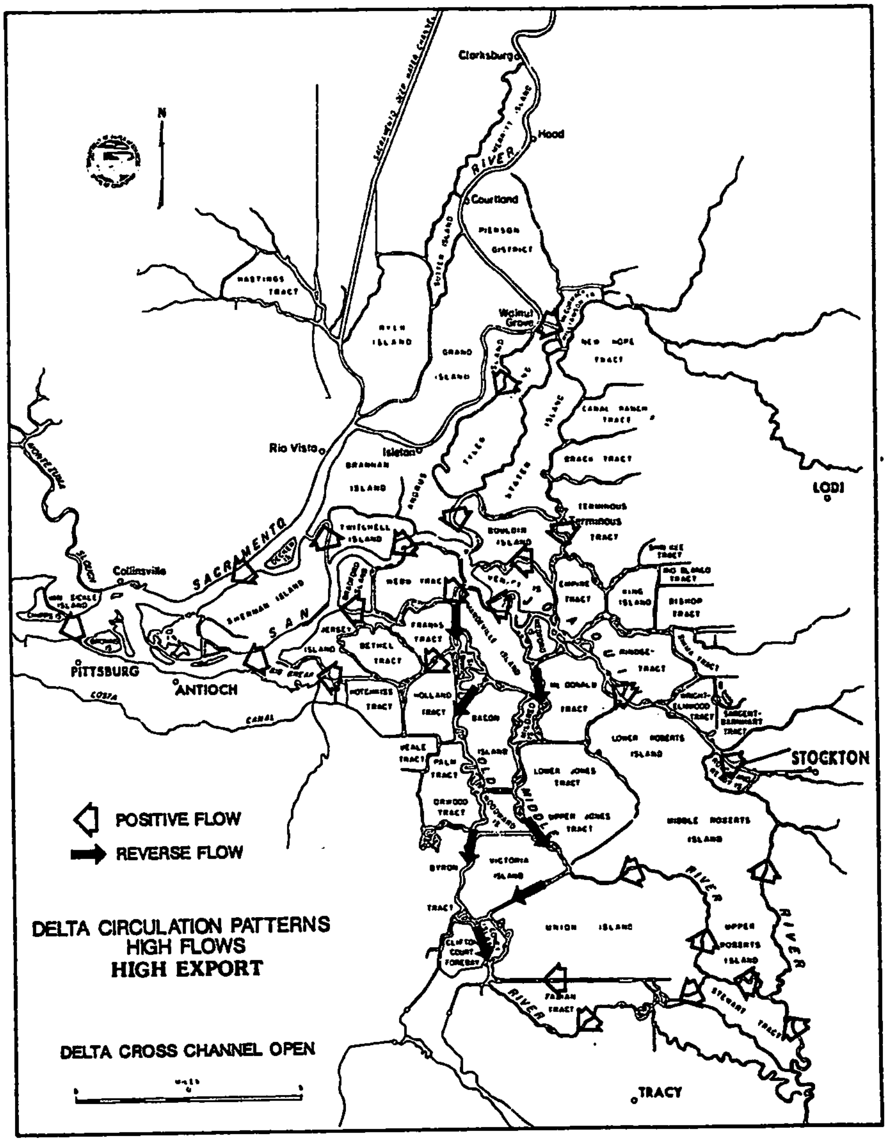


FIGURE A3.0-10

DWR-51D

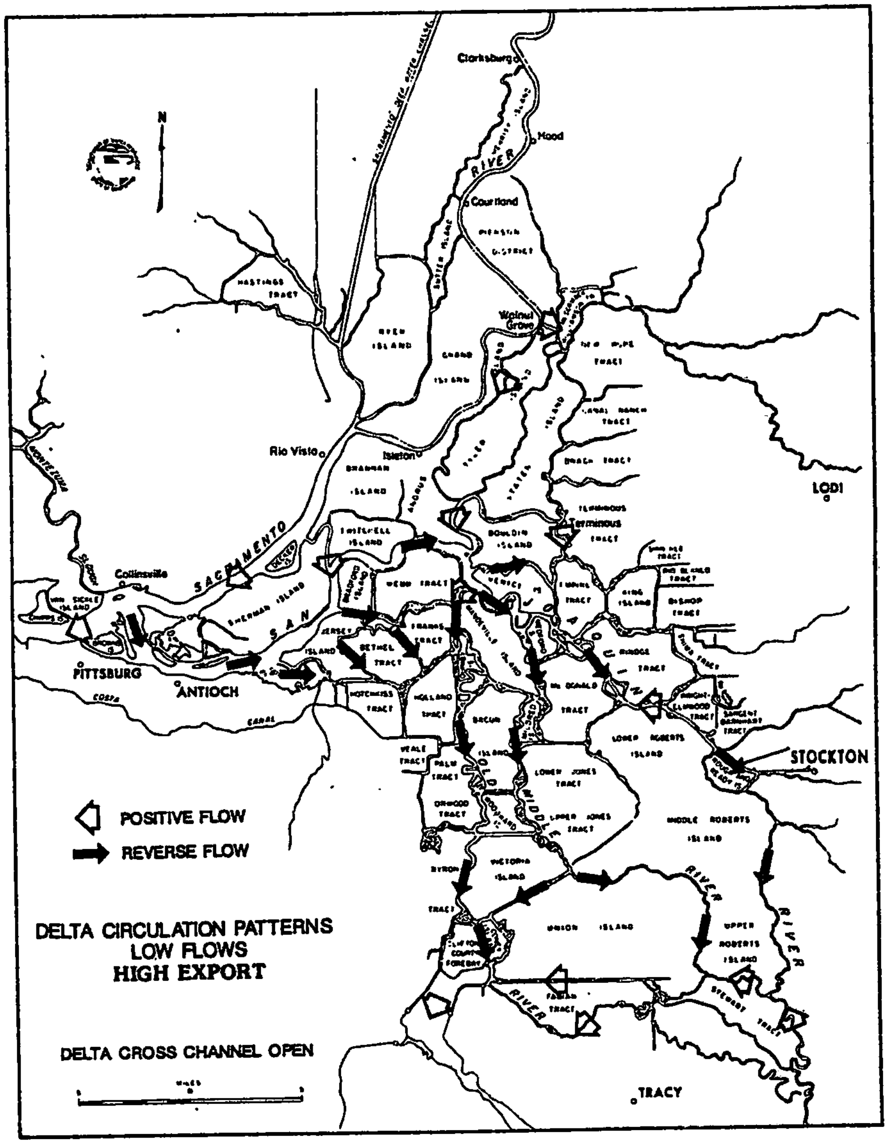


FIGURE A3.0-11

DWR-51A

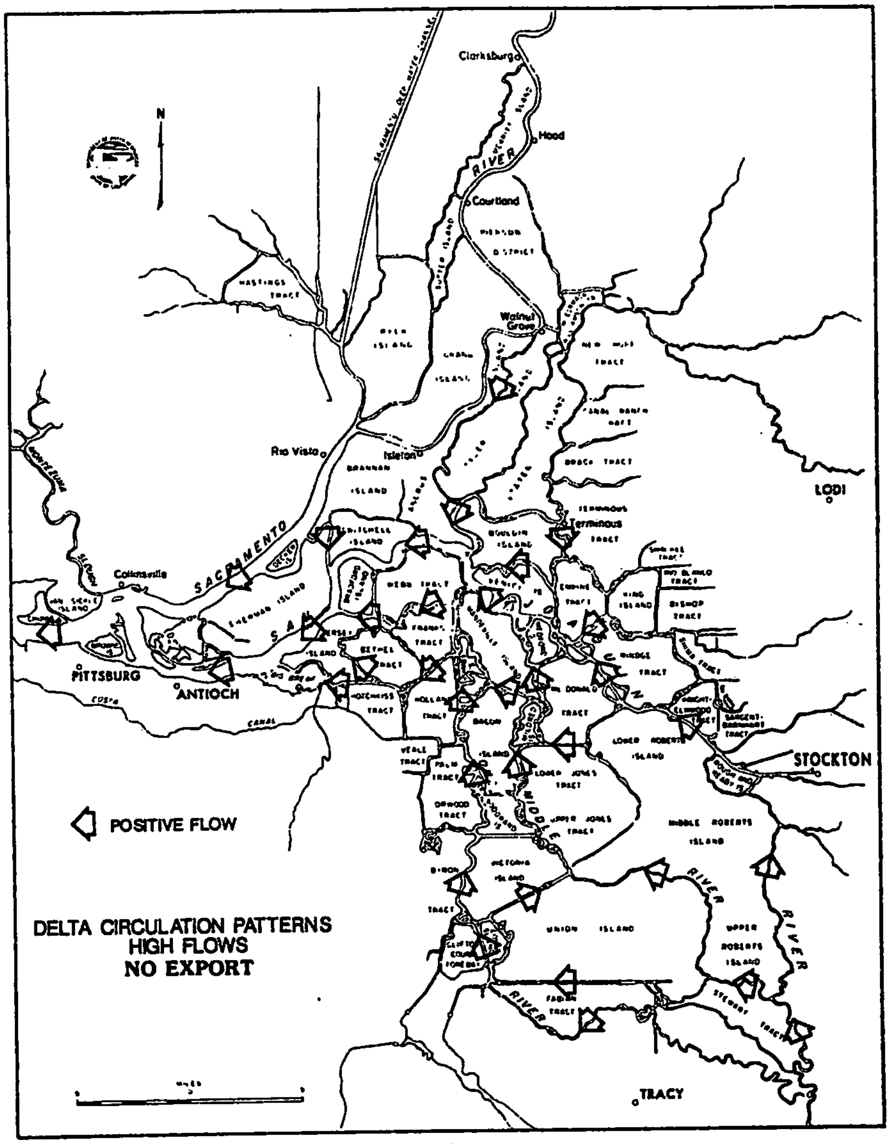


FIGURE A3.0-12

DWR-51B

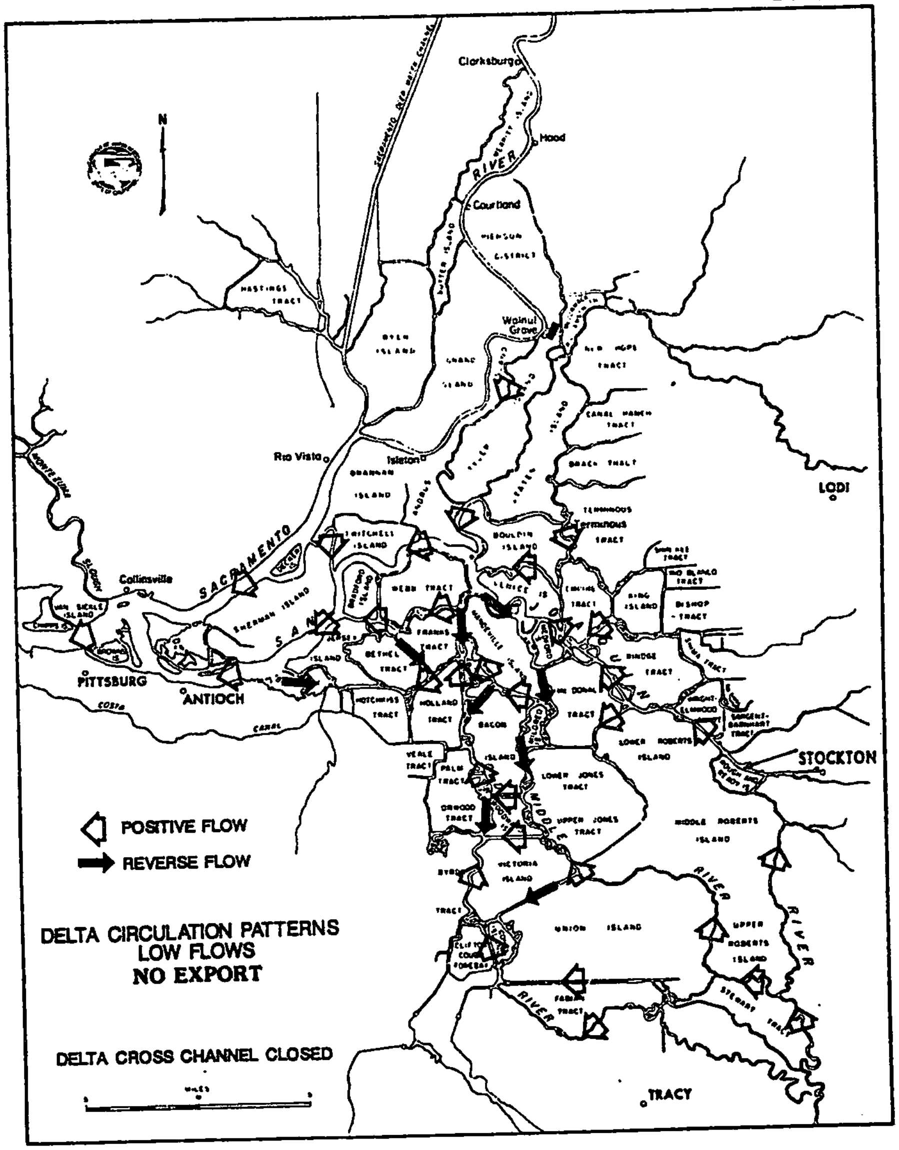


FIGURE A3.0-13

DWR-51C

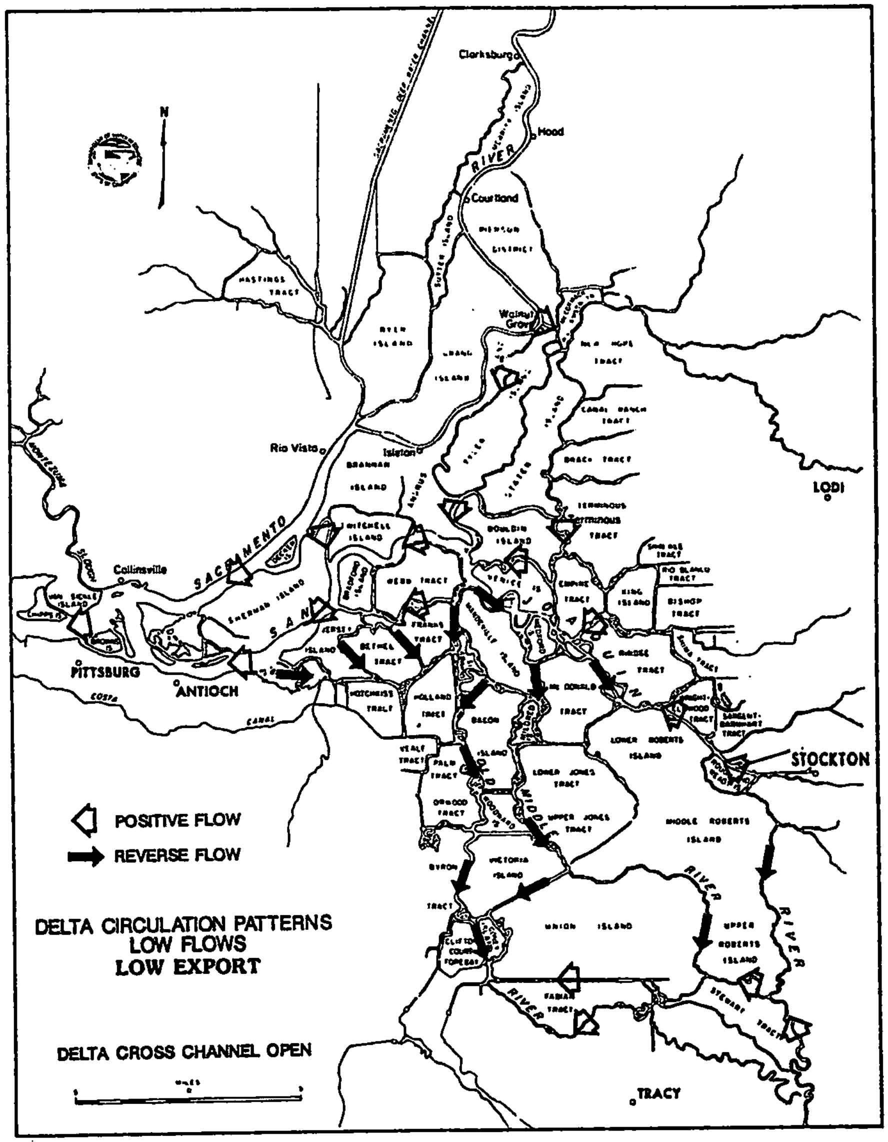
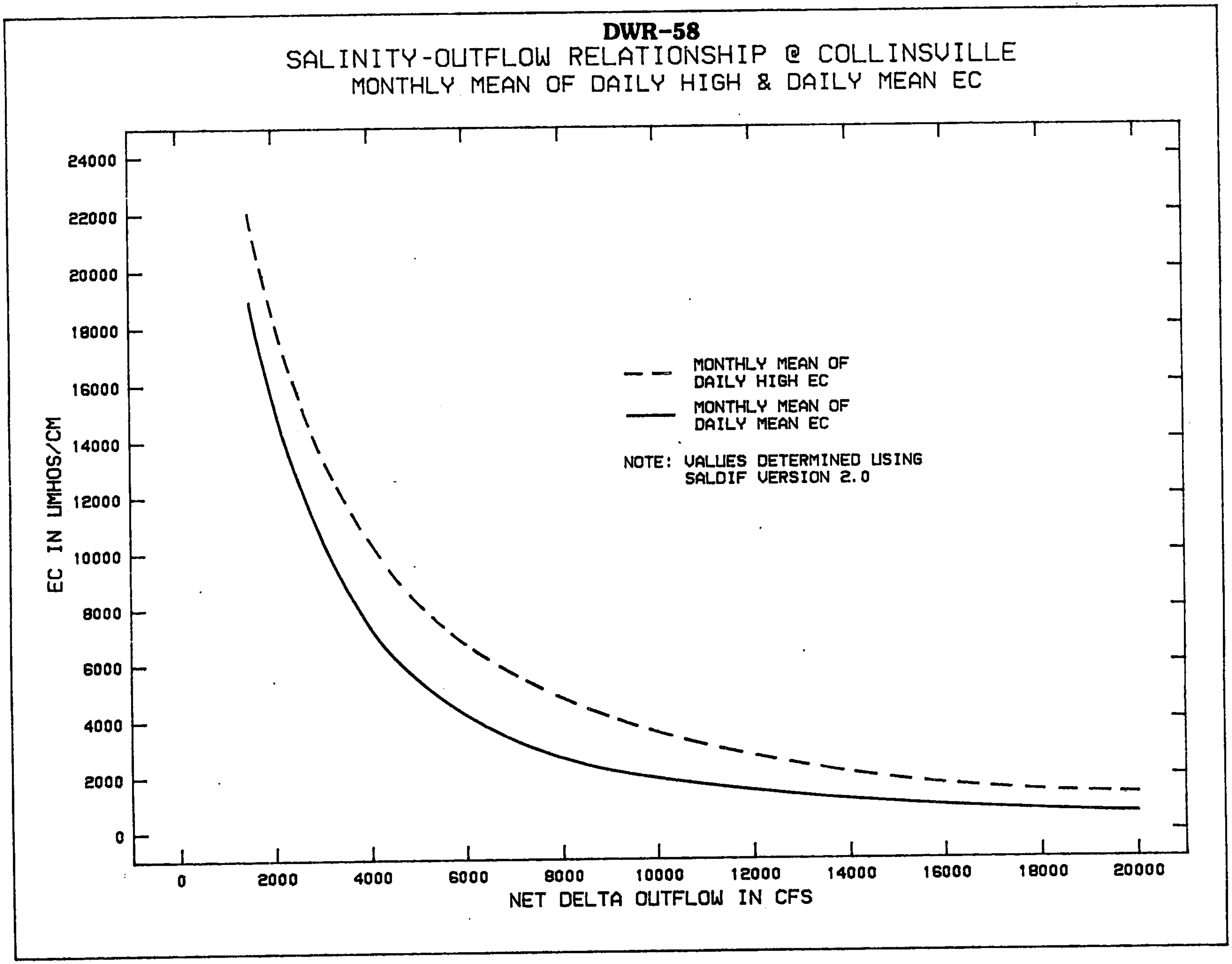
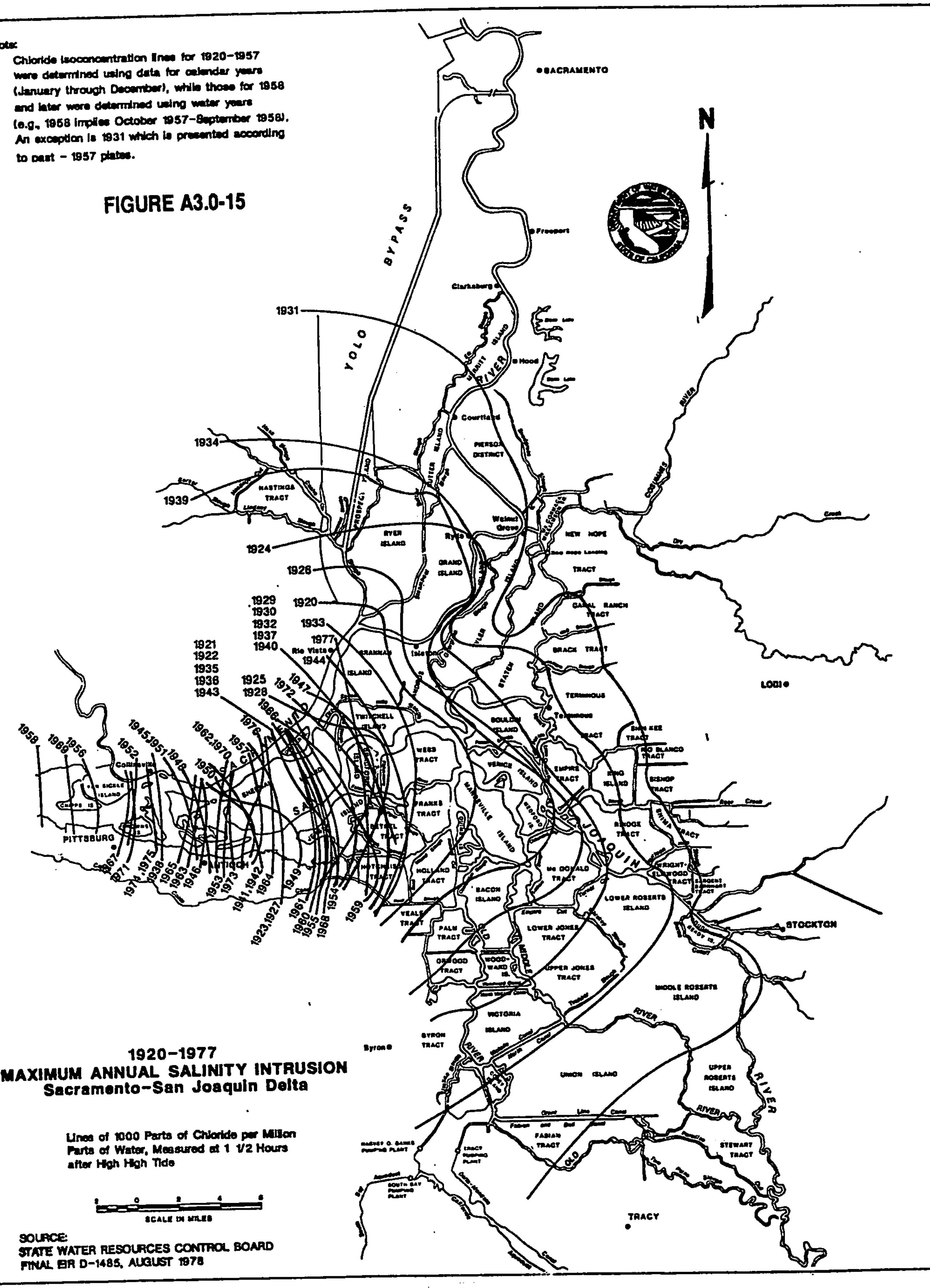


FIGURE A3.0-14



Note:
Chloride isoconcentration lines for 1920-1957 were determined using data for calendar years (January through December), while those for 1958 and later were determined using water years (e.g., 1958 implies October 1957-September 1958). An exception is 1931 which is presented according to past - 1957 plates.

FIGURE A3.0-15



1920-1977
MAXIMUM ANNUAL SALINITY INTRUSION
Sacramento-San Joaquin Delta

Lines of 1000 Parts of Chloride per Million Parts of Water, Measured at 1 1/2 Hours after High High Tide

SCALE IN MILES: 2 0 2 4 6

SOURCE:
STATE WATER RESOURCES CONTROL BOARD
FINAL EIR D-1485, AUGUST 1978

The Delta Plan currently requires only the CVP and SWP to meet specified flow and salinity standards within the Delta and Suisun Marsh (SWRCB,15,5). Figure A3.0-16 shows the estimated average monthly Delta outflows under the present level of development (DWR,30); the present level of Delta outflow is composed of three factors: minimum amounts required by D-1485 standards, carriage water, and surplus Delta outflow. Estimates of the component required by D-1485 standards are given in Table A3.0-1.

San Francisco Bay and Basin

Physical Description

The boundary of San Francisco Bay (SWRCB,3,3) extends from the Golden Gate Bridge on the west to the Delta on the east and includes areas subject to tidal action up to mean high tide, areas 100 feet landward of the mean high tide shoreline, saltponds, and managed wetlands. This definition includes the entire Suisun Marsh as part of San Francisco Bay. Suisun Marsh, as defined by Section 29101 of the Public Resources Code, includes the waterways north of Suisun, Grizzly, and Honker bays which are subject to tidal action and the adjacent lands whose management is dependent on tidal action of these waters. This definition generally follows the San Francisco Bay Conservation and Development Commission (BCDC) boundary as defined in Government Code Sections 66610 and 66611.

San Francisco Bay consists of about 805 square miles (515,000 acres) (BCDC,1982) including: 420 square miles (269,000 acres) of open water (470 square miles when saturated mud flats are included), 125 square miles (80,000 acres) of tidal marshes; 110 square miles (70,000 acres) of Suisun Marsh; 80 square miles (51,000 acres) of diked historic baylands; and 70 square miles (45,000 acres) of saltponds and other managed wetlands.

The San Francisco Bay Basin (Figure A3.0-17) is defined as the area contributing local runoff to the Bay. This description differs somewhat from the Basin Plan boundary of Region 2 (RWQCB 2, 1986), which includes the entire San Francisco Bay Basin as well as coastal area from Dillon Beach to San Gregorio. The total area of the San Francisco Bay Basin is about 3,870 square miles, or 2,477,000 acres (SWRCB,3,Appendix F). The major streams contributing to local runoff to the Bay are the Napa, Petaluma, and Guadalupe rivers, and the Alameda, Coyote, Sonoma and Walnut creeks. Water is imported to the Basin via the following water projects (see Figure A3.0-2): Mokelumne Aqueduct, Hetch Hetchy Aqueduct, South Bay Aqueduct, Contra Costa Canal, Putah South Canal, Sonoma Petaluma Aqueducts, and North Bay Aqueduct.

In years of normal runoff, the San Francisco Bay Basin contributes about ten percent of the total flow, including Delta outflow, to the San Francisco Bay (SWRCB,3,3). From 1970 through 1982, the runoff into the Bay from rainfall averaged about 57 percent of the total San Francisco Bay Basin local runoff, with the rest being municipal and industrial discharges (SWRCB,3,35; Appendix R).

FIGURE A3.0-16

PRESENT LEVEL DELTA OUTFLOW

USING 1922-1978 MONTHLY AVERAGE HYDROLOGY

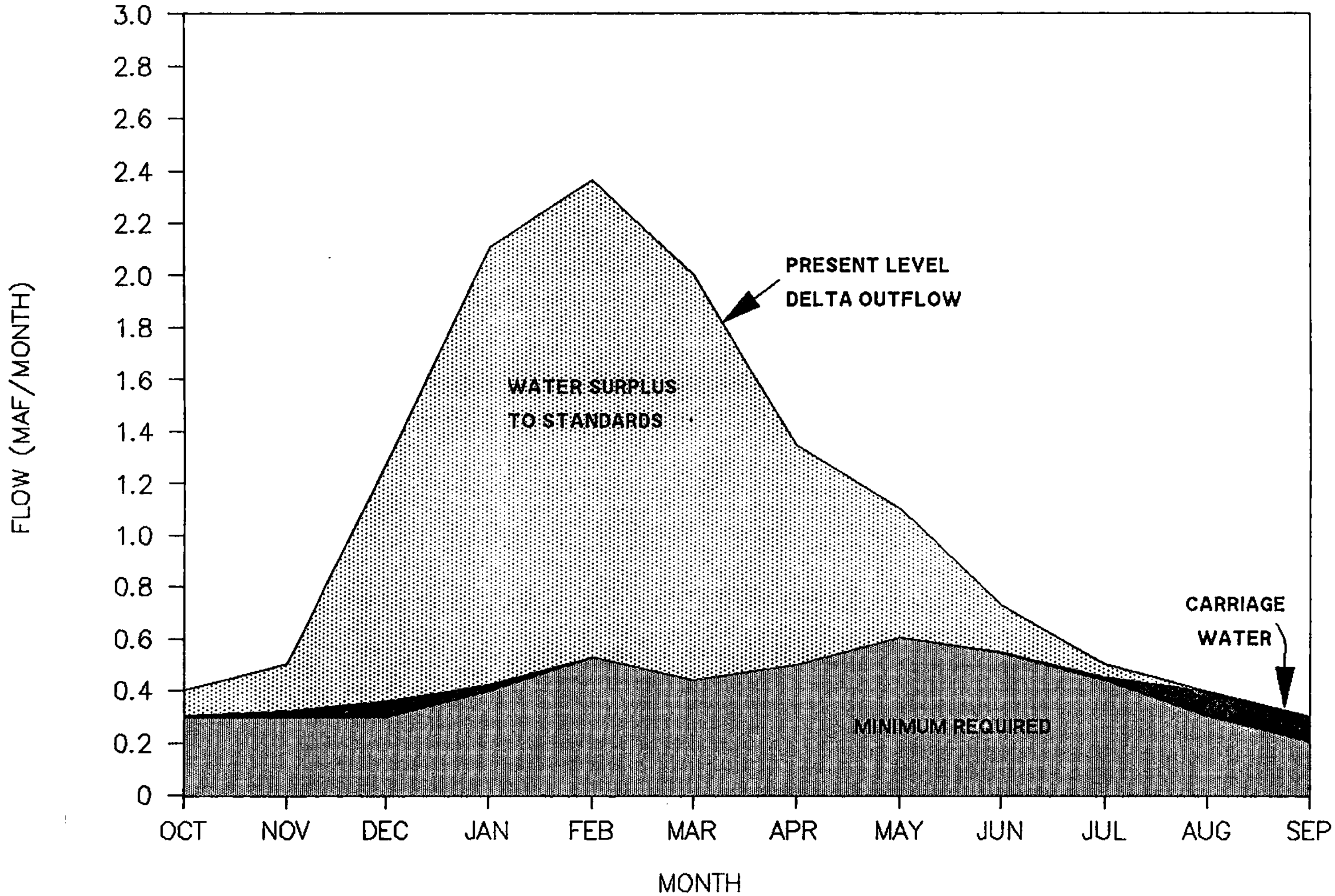


TABLE A3.0-1

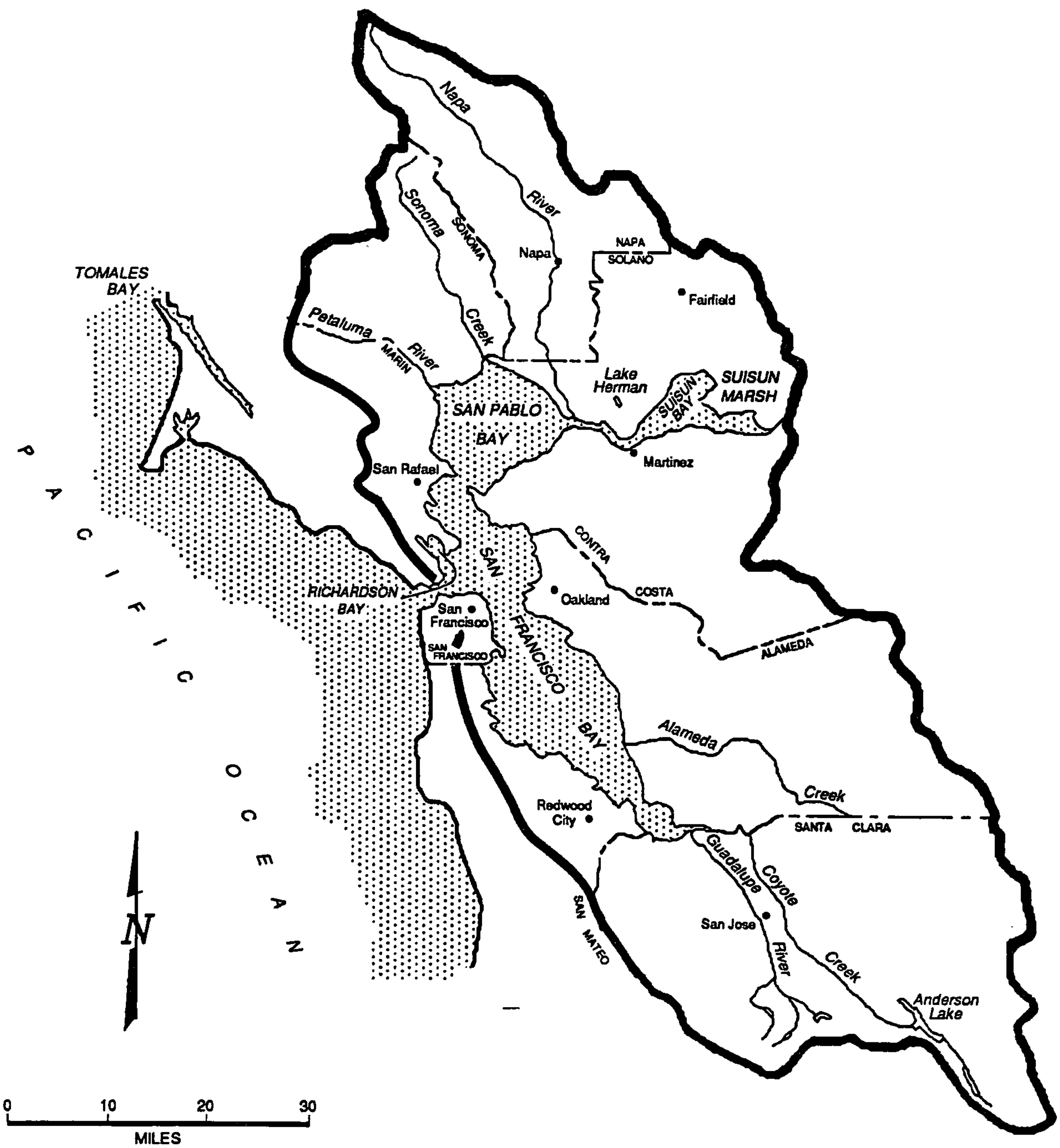
ESTIMATED DELTA OUTFLOW REQUIREMENTS
OF THE
1978 DELTA PLAN

Time Period	Delta Outflow Requirements in cfs (acre-feet)									
	Wet		Above Normal		Below Normal		Dry		Critical	
	Lower Require-ments	Upper Require-ments	Lower Require-ments	Upper Require-ments	Lower Require-ments	Upper Require-ments	Lower Require-ments	Upper Require-ments	Lower Require-ments	Upper Require-ments
January	4,500[2] (276,700)	6,600[1] (405,800)	4,500[2] (276,700)	6,600[1] (405,800)	4,500[2] (276,700)	6,600[1] (405,800)	4,500[2] (276,700)	6,600[1] (405,800)	4,500[2] (276,700)	6,600[1] (405,800)
February	10,000 (555,400)	10,000 (555,400)	4,500[2] (249,900)	12,000 (666,500)	4,500[2] (249,900)	12,000 (666,500)	4,500[2] (249,900)	6,600[1] (366,600)	4,500[2] (249,900)	6,600[1] (366,600)
March 1-17	10,000 (337,200)	10,000 (337,200)	4,500[2] (151,700)	12,000 (404,600)	4,500[2] (151,700)	12,000 (404,600)	4,500[2] (151,700)	6,600[1] (222,500)	4,500[2] (151,700)	6,600[1] (222,500)
March 18-31	10,000 (277,700)	10,000 (277,700)	4,500[2] (125,000)	12,000 (333,200)	4,500[2] (125,000)	12,000 (333,200)	4,500[2] (125,000)	6,600[1] (183,300)	4,500[2] (125,000)	6,600[1] (183,300)
April	10,000 (595,000)	10,000 (595,000)	7,600 (452,200)	7,600 (452,200)	7,600 (452,200)	7,600 (452,200)	7,600 (452,200)	7,600 (452,200)	4,500[3] (267,800)	6,700[3] (398,700)
May 1-5	10,000 (99,200)	10,000 (99,200)	7,600 (75,400)	7,600 (75,400)	7,600 (75,400)	7,600 (75,400)	7,600 (75,400)	7,600 (75,400)	4,500[3] (44,600)	6,700[3] (66,400)
May 6-31	7,600 (391,900)	14,000[4] (722,000)	7,600 (391,900)	14,000[4] (722,000)	7,600 (391,900)	11,400[4] (587,900)	7,600 (391,900)	7,600 (391,900)	3,900 (201,100)	3,900 (201,100)
June 1-15	7,600 (226,100)	14,000[4] (416,500)	7,600 (226,100)	10,700[4] (318,400)	7,600 (226,100)	9,500[4] (282,600)	7,600 (226,100)	7,600 (226,100)	3,900 (116,000)	3,900 (116,000)
June 16-20	7,600 (75,400)	14,000[4] (138,800)	7,600 (75,400)	10,700[4] (106,100)	7,600 (75,400)	9,500[4] (94,200)	4,700 (46,600)	4,700 (46,600)	3,900 (38,700)	3,900 (38,700)
June 21-30	7,600 (150,700)	14,000[4] (227,700)	7,600 (150,700)	10,700[4] (212,200)	5,400 (107,100)	9,500[4] (188,400)	4,700 (93,200)	4,700 (93,200)	3,900 (77,400)	3,900 (77,400)
July	7,600 (467,300)	10,000[4] (614,900)	6,700 (412,000)	7,700[4] (473,500)	5,400 (332,000)	6,500[4] (399,700)	4,700 (289,000)	4,700 (289,000)	3,900 (239,800)	3,900 (239,800)
August 1-15	7,600 (226,100)	7,600 (225,100)	6,700 (199,300)	6,700 (199,300)	5,400 (160,700)	5,400 (160,700)	4,700 (139,800)	4,700 (139,800)	3,900 (116,000)	3,900 (116,000)
August 16-31	2,500 (79,300)	2,500 (79,300)	2,500 (79,300)	2,500 (79,300)	2,500 (79,300)	2,500 (79,300)	2,500 (79,300)	2,500 (79,300)	2,500 (79,300)	2,500 (79,300)
September	2,500 (148,800)	2,500 (148,800)	2,500 (148,800)	2,500 (148,800)	2,500 (148,800)	2,500 (148,800)	2,500 (148,800)	2,500 (148,800)	2,500 (148,800)	2,500 (148,800)
October	4,500 (276,700)	4,500 (276,700)	4,500 (276,700)	4,500 (276,700)	4,500 (276,700)	4,500 (276,700)	3,500[5] (215,200)	4,500 (276,700)	3,500[5] (215,200)	4,500 (276,700)
November	4,500 (267,800)	4,500 (267,800)	4,500 (267,800)	4,500 (267,800)	4,500 (267,800)	4,500 (267,800)	3,500[5] (208,300)	4,500 (267,800)	3,500[5] (208,300)	4,500 (267,800)
December	4,500 (276,700)	4,500 (276,700)	4,500 (276,700)	4,500 (276,700)	4,500 (276,700)	4,500 (276,700)	3,500[5] (215,200)	4,500 (276,700)	3,500[5] (215,200)	4,500 (276,700)
Total in 1000s acre-feet	4,728	5,666	3,836	5,418	3,673	5,100	3,384	3,942	2,772	3,482

[1] When the storages at any two of Shasta, Oroville and Folsom Reservoirs are encroached in their flood control reservation.
[2] If storages are encroached (see No. 1) then 6,600.
[3] If SWP and CVP users are taking deficiencies in firm supplies then 4,500 cfs for critical year.
[4] If subnormal snowmelt then use lower limit.
[5] When project users (CVP and SWP) are taking deficiencies, otherwise 4,500 cfs.

Department of Water Resources
Division of Operations and Maintenance
March 1986

FIGURE A3.0-17 Boundary of the San Francisco Bay Basin
(From: SWRCB, 3, 12)



MAP0022

Hydrology

San Francisco Bay, excluding the Delta, but including saturated mudflats, has a total water surface area of approximately 300,000 acres or 470 square miles at mean lower low water (MLLW). The area, mean depth and volume of the subregions of the Bay are summarized in Table A3.0-2 (Cheng and Garner, 1984). The locations of the Bay's subregions are shown in Figure A3.0-18. These subregions differ from the description in the Region 2 Basin Plan (RWQCB,2,1986) and are based solely on hydrodynamics.

Table A3.0-2
BATHYMETRIC DATA FOR SAN FRANCISCO BAY
(Adapted from Cheng and Gardner, 1984)

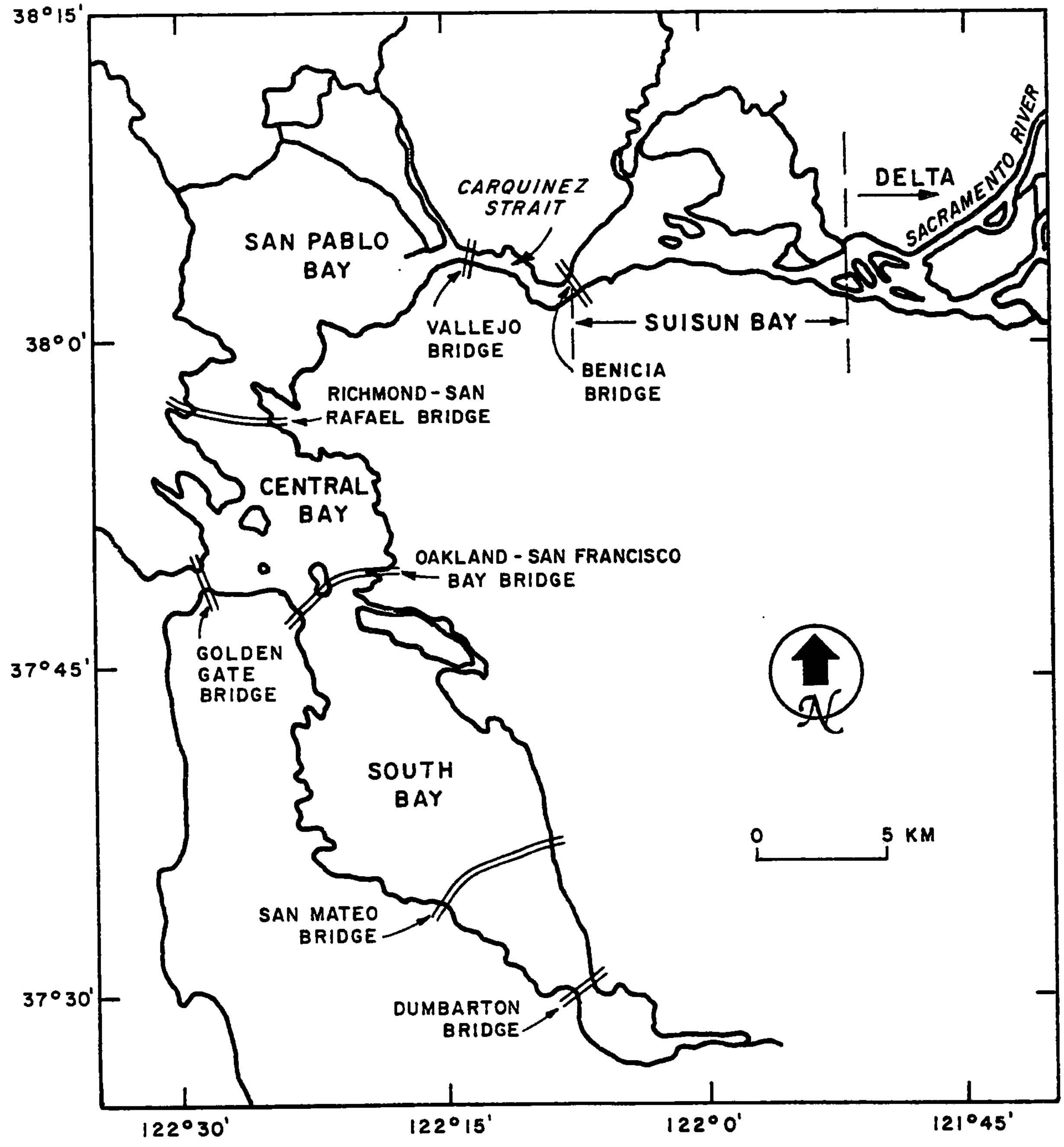
Region	Surface Area at MLLW (sq mi)	Mean Depth (ft)	Mean Volume (AF)
Central Bay	103	35	2,307,000
San Pablo Bay	105	9	605,000
Carquinez Strait	12	29	223,000
Suisun Bay	36	14	323,000
South Bay	214	11	1,507,000
San Francisco Bay (Total)	470	17	4,965,000

San Francisco Bay is unique among American estuaries in having two arms or reaches, the northern including San Pablo and Suisun bays, and the southern extending from the Oakland-Bay Bridge to Mountain View. The northern reach receives discharge from the Sacramento-San Joaquin Delta, approximately 90 percent of the freshwater inflow to San Francisco Bay. The southern reach primarily receives local runoff, storm drain and treatment plant discharges and Delta outflow in very high flow events. Between the two reaches is the Central Bay bounded by the Richmond-San Rafael, Oakland-Bay, and Golden Gate bridges. The Central Bay is deeper than either of the two reaches (SWRCB,431,18-19).

o Freshwater Inflow

Excluding water from the Delta, freshwater inflows come into the Bay primarily via the Napa and Petaluma rivers which provide local drainage to the northern part of San Pablo Bay; via Walnut Creek and Suisun Slough which enter Suisun Bay; via Pinole and Novato creeks which enter the San Pablo Bay; and via San Lorenzo, Matadero and Coyote creeks which enter the South Bay. In addition, many municipal and industrial wastewater treatment plants and combined sewer overflows contribute to the Bay inflows (SWRCB,3,11-16). Because these freshwater inflows into the Bay are small compared to Delta outflow, they are often ignored in calculations of total inflow to the Bay. In the southern portion of the South Bay, all tributary streams have intermittent, local runoff (excluding effluent) (BISF,6,56-59).

FIGURE A3.0-18 Location map of San Francisco Bay showing the four sub-regions and the Sacramento-San Joaquin Delta. (Source: Denton and Hunt, 1986)



o Tidal Exchange

Immense flows are exchanged between the bay and the ocean on tidal currents driven by the gravitational attraction between the earth, the sun and moon. Their exact size is not known (USGS,3 updated,5), but tidal flows entering San Francisco Bay at the Golden Gate Bridge have been estimated to average greater than 2.5 million cfs (BISF,6,51). Because of complex circulation eddies outside the entrance to the Bay, only a portion the water flooding in from the ocean is "new" water, i.e., water which has not entered the Bay for at least several tidal cycles (Denton and Hunt, 1986).

- Central Bay

Flood tides first entering the central Bay pass on either side of Alcatraz Island, through Raccoon Strait between the Tiburon Peninsula and Angel Island; tides then flow northwards through San Pablo Strait into San Pablo Bay and southwards beneath the Oakland-Bay Bridge into south Bay (Figure A3.0-19).

- San Pablo Bay

The main tidal flows in San Pablo Bay pass along a natural channel that runs between San Pablo Strait, then across the shallow Pinole Shoal and through Carquinez Strait to the east (Figure A3.0-20). The maximum depth in the two straits is about 83 feet, decreasing to about 20 to 25 feet over Pinole Shoal. A 600-foot-wide shipping channel, dredged to a depth of 35 feet across the shallow Pinole Shoal, provides shipping access to the Mare Island Naval Shipyard and the ports of Sacramento and Stockton. The areas north and south of the shipping channel are very shallow; one-half of the area of San Pablo Bay has a depth of less than six feet.

- Suisun Bay and Marsh

Having the smallest surface area of the four embayments, Suisun Bay is situated in the northeastern reach of San Francisco Bay between the cities of Benicia and Antioch (Figure A3.0-21). The entire Suisun Bay and Marsh area, including two subbays, Grizzly and Honker, consists of 84,190 acres, of which about 26,880 acres are bays and sloughs. The remaining 57,310 acres are diked and managed wetlands. (Approximately 45,710 acres of managed wetlands are privately-owned and used primarily for duck hunting; 10,490 acres are owned by the State of California as a waterfowl management area, wildlife refuge and public recreation area; and 1,110 acres are controlled by the U.S. Navy (SWRCB, 1978)).

The main tidal flows are along a few well-defined channels separated by islands and shallow gravel banks. During most periods of outflow from the Delta, Suisun Bay is the usual location of the estuary's 'null zone' (defined as the region in a partially or well-mixed estuary where the residual bottom currents are effectively zero). Upstream of this area there is a net downstream, or seaward, residual velocity along

FIGURE A3.0-19 Map of the Central Bay and the region immediately outside Golden Gate. The dotted line shows the 60 ft depth contour and the dashed line is the 18 ft contour. (Source: Denton and Hunt, 1986)

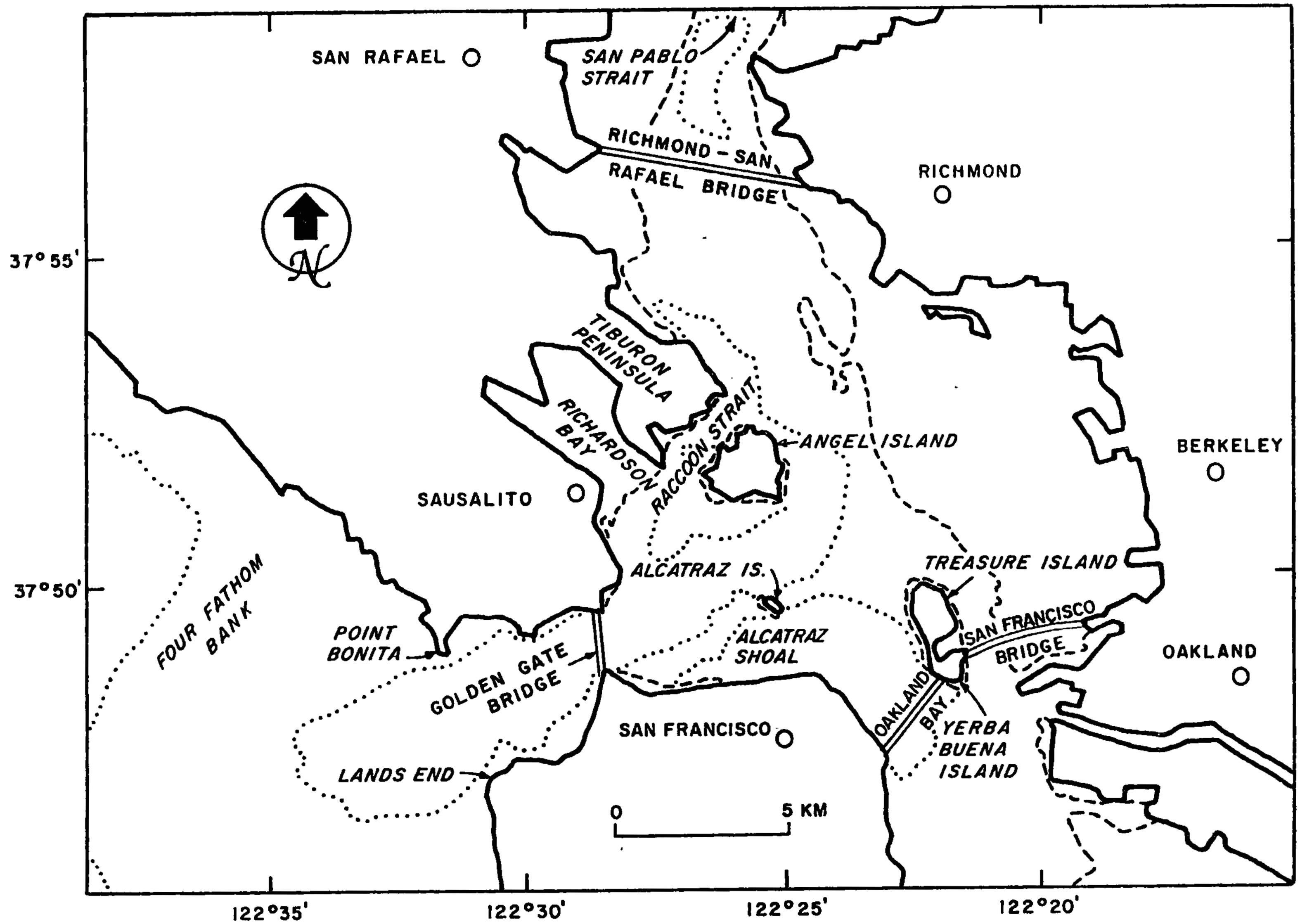


FIGURE A3.0-20 Map of San Pablo Bay. The 18 ft (5.5) depth contour is plotted as a dashed line and indicates the location of the main channel. The dotted line shows the extent of the mudflats around the bay. (Source: Denton and Hunt, 1986)

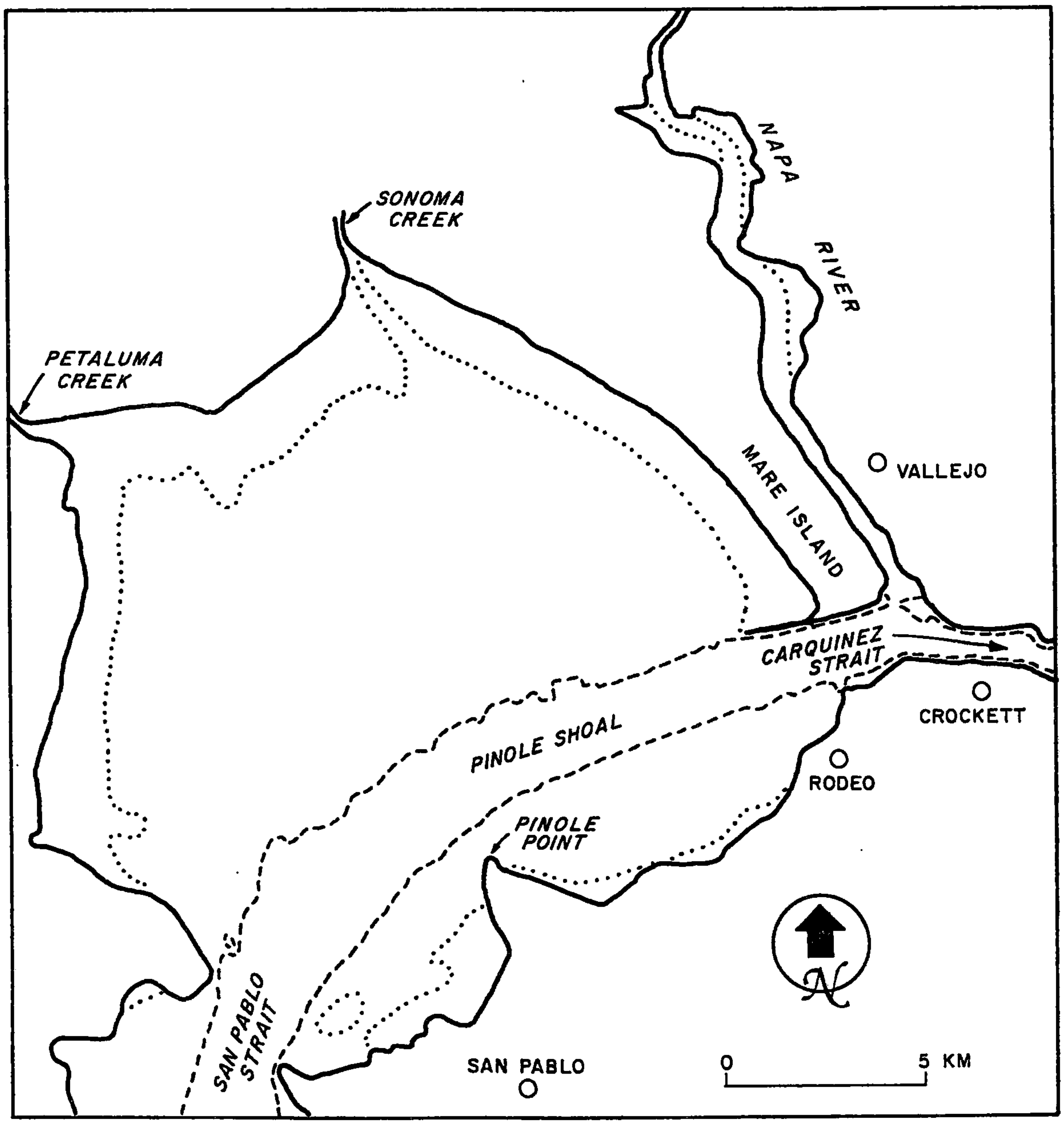
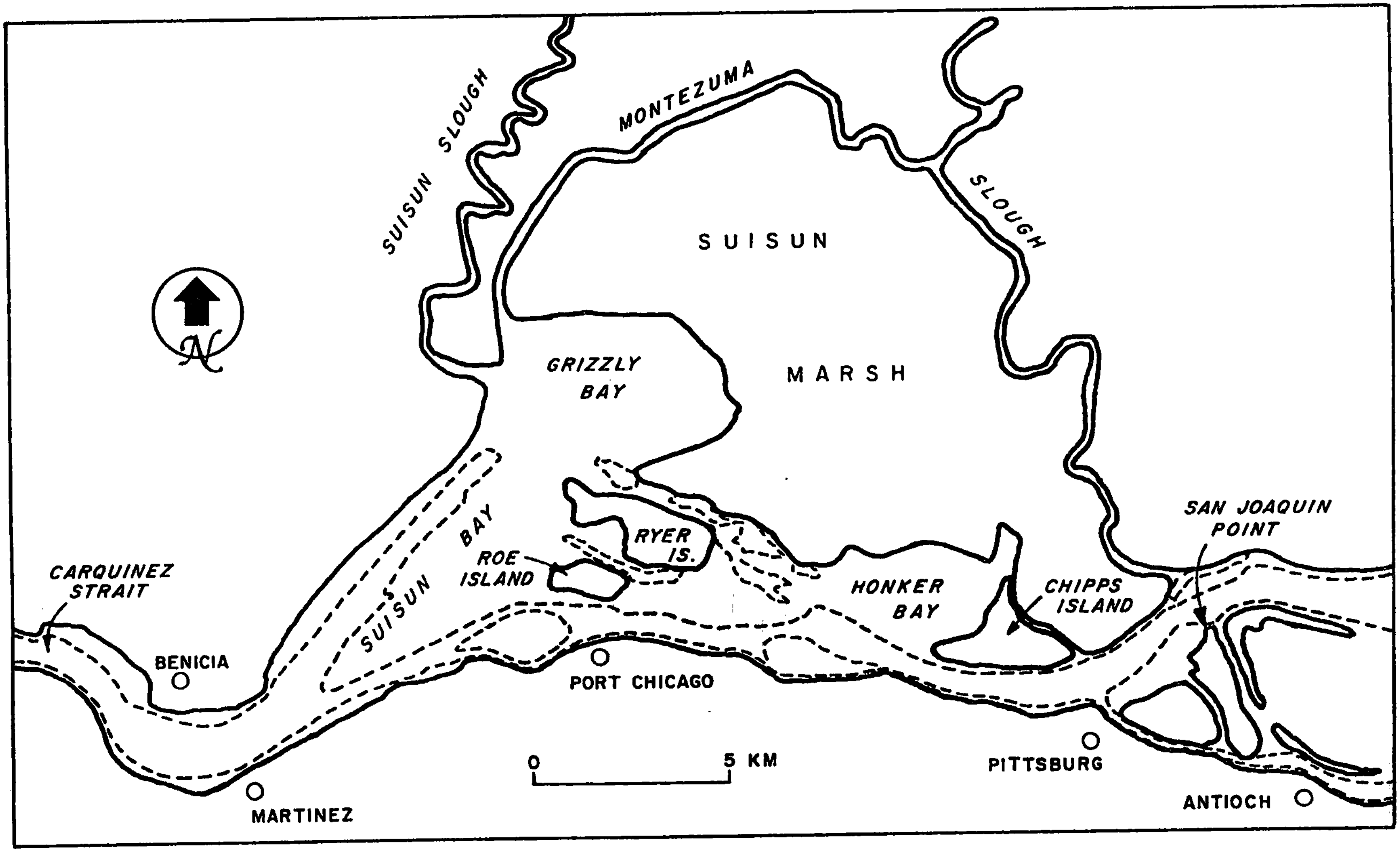


FIGURE A3.0-21 Map of Suisun Bay. The dashed line shows the 18 ft (5.5) depth contour. (Source: Denton and Hunt, 1986)



the bottom caused by river inflow. Seaward of the null zone, gravitational circulation produces a transport, for the most part toward land, of denser more saline water along the bottom. The null zone is significant because it is the theoretical upstream boundary of the entrapment zone, the area in the estuary where suspended materials, including biota, accumulate (USBR,112,407). Figure A3.0-22 is a diagram of estuarine circulation for a partially mixed estuary such as Suisun Bay; it illustrates the relationships between flows, salinities, and the null and entrapment zones (CCCWA/EDF,1,56).

The salinity of water within Suisun Bay varies seasonally with the volume of freshwater outflow from the Delta. Salinities of the water in Montezuma Slough are lower than in Suisun Bay itself for a longer period of time each year because the Slough lies further upstream and receives freshwater inflow from the Sacramento River and other tributary channels first. For the most part, low salinity water stays in the Suisun Marsh channels later in the spring and early summer, but higher salinity water remains later in the fall before the Marsh channels are flushed by increasing Delta outflows (SWRCB,1978).

By most definitions, Suisun Bay includes Suisun Marsh, located to the north of the main body of the Bay. The Marsh was a natural fresh to brackish water marsh prior to widespread reclamation for agricultural purposes in the early 1900s. However, because of increasing problems with salinity in the 1930s, the reclaimed marsh lands were gradually converted to private duck clubs and state Wildlife Management Areas.

- South Bay

The entrance to the South Bay from the Central Bay is separated by Treasure and Yerba Buena islands into two passages, one to the east that is 30 to 35 feet deep and one to the west that is 70 feet deep at the Oakland-San Francisco Bay Bridge (Figure A3.0-23). Because the South Bay receives only minor amounts of local freshwater inflows, it is essentially a tidal lagoon. Tidal currents in South Bay are greatest along the main channel on the western side of the Bay. In the South Bay, evidence suggests three distinct mixing zones exist: (1) between the Oakland-San Francisco Bay Bridge and San Bruno Shoal, a relatively shallow area with water depths of about 11 to 26 feet between Bay Farm Island and Oyster Point; (2) between the San Bruno Shoal and the San Mateo Bridge; and (3) in the area south of the San Mateo Bridge. A navigation channel, 500 feet wide and 29 feet deep, is maintained across the San Bruno Shoal.

The salinity of the South Bay remains close to the level of the ocean (33 to 35 parts per thousand) throughout most of the year, except during periods of high Delta outflow. During particularly hot, dry periods when evaporation rates are high, the South Bay can act as a "negative" estuary where salinity levels actually increase in the southern extremities (Denton and Hunt, 1986).

FIGURE A3.0-22 Diagram of Estuarine Circulation for a Partially Mixed Estuary
(Source: CCCWA/EDF, 1, Figure 12)

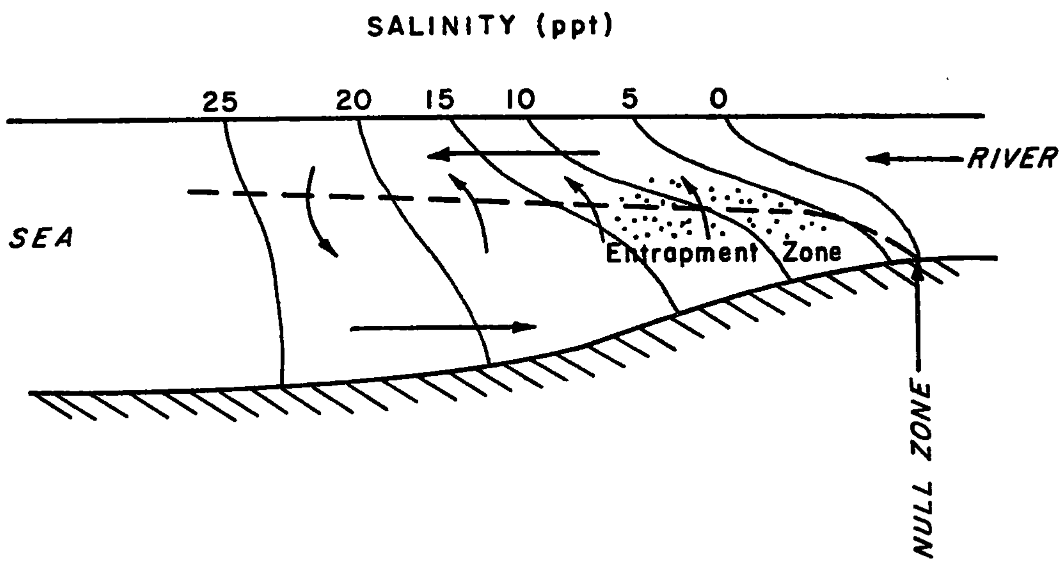
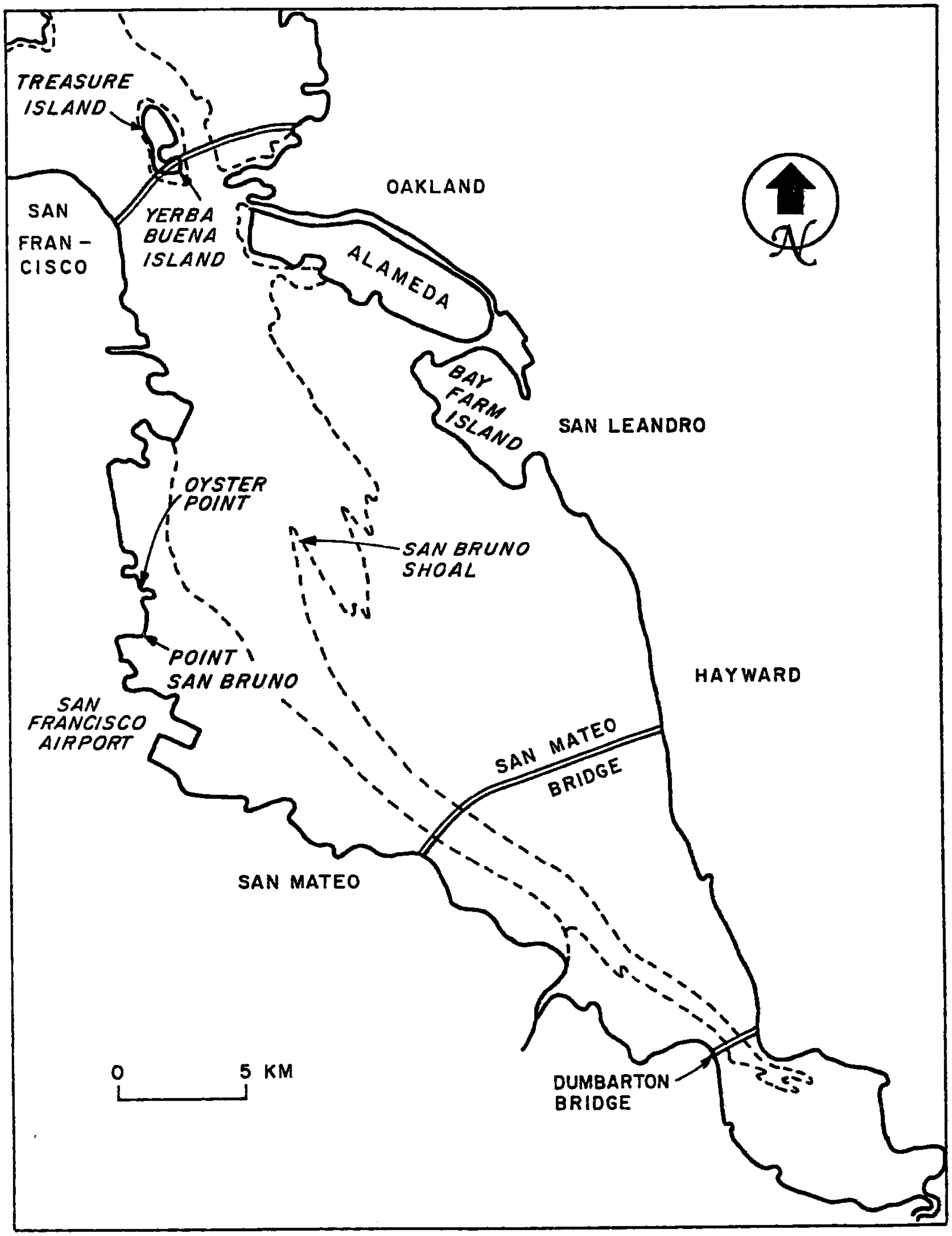


FIGURE A3.0-23 Map of the South Bay. The dashed line shows the 18 ft depth contour. (Source: Denton and Hunt, 1986)



Currents differ in the South Bay according to Delta outflows. From analyses of current data for summer wind conditions and low Delta discharges, the USGS has concluded that net currents in South Bay north of San Bruno Shoal are southward along the eastern side and northward along the western side of the Bay (USGS,3,25). Following high outflow pulse events, a lens of freshwater can spread southwards, depending on wind and tide conditions, into the Central and South Bays over more saline water that is flowing toward the ocean. This process, which is known as gravitational overturn, allows large volumes of freshwater to enter the South Bay (Denton and Hunt, 1986). The significant density difference between the two flows acts to inhibit vertical mixing. When Delta outflow subsides, reintrusion of ocean water raises the salinities in Central Bay above those in South Bay, and the direction of circulation reverses; that is, surface waters again flow seaward (USGS,3,26).

o Local Runoff

In the San Francisco Bay Basin, almost all of the local runoff comes from rainfall, with minor amounts from snowmelt runoff and groundwater depletion. However, the local runoff is somewhat depleted due to infiltration, evapotranspiration, and storage in reservoir impoundments. Unlike the areas upstream of the Bay Basin with considerable snowfall, the precipitation runoff in the Bay Basin occurs almost immediately after the precipitation events.

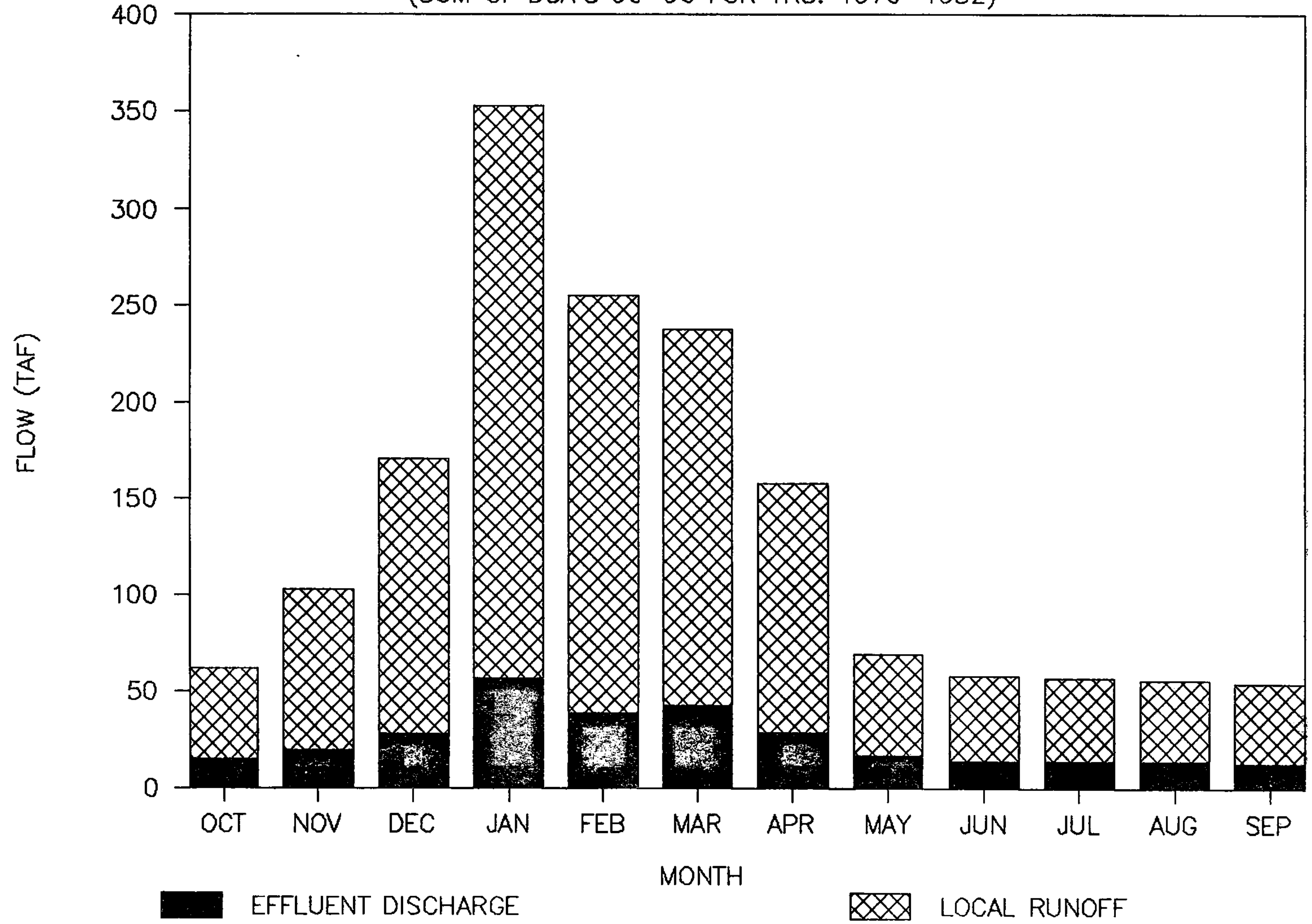
Upstream storage and regulated releases required by the Delta Plan have provided higher levels of inflow from the Delta in most of the summer months, especially in dry and critically dry years. Significant amounts of effluent from industrial and municipal sources are discharged into the Bay, but the effects of these additional flows are not known.

A variety of factors have altered the effects of Bay Basin local runoff. These include upstream reservoirs, the change in land use patterns from native vegetation to agricultural vegetation, impermeable surfaces such as concrete or asphalt, and the effects of ground water pumping. For example, the extensive expansion of streets, parking lots, and drainage conduits allow less rainfall to reach the ground water and subsequently greater amounts to flow directly into the Bay. Wastewater treatment plant discharges and water imports into the Bay Basin have also changed the locations and greatly increased the quantity of local inflows to the Bay. DWR developed a local runoff survey for separate Bay Basin hydrologic areas and a summary of wastewater discharge for the period of water years 1970 through 1982 (Figure A3.0-24) (SWRCB,3,Appendix R).

FIGURE A3.0-24

SAN FRANCISCO BAY AREA LOCAL RUNOFF

(SUM OF DSA'S 90–96 FOR YRS. 1970–1982)



APPENDIX 3.1

DESCRIPTION OF VARIOUS COMPONENTS
OF THE NEW WATER YEAR CLASSIFICATION
40-30-30 INDEX

The new water year classification, the 40-30-30 Index, is described in the main text of the Water Quality Control Plan. This appendix provides a detailed description of the following steps taken to develop this index:

- Determination of Weighting Coefficients
- Results of Regression Analysis
- Determination of Water Year Classification Breakpoints
- Verification Process
- Adjustments to Water Year Classification, and
- Source of Database

- Sacramento Basin Index (40-30-30 Index)

The modified classification splits the index into three terms. The form of the index equation is as follows:

$$\text{Index} = C1*X + C2*Y + C3*Z$$

Where: C1, C2, and C3 are weighting coefficients of 0.4, 0.3 and 0.3, respectively.

And: X = April through July Four River Unimpaired Flow (MAF)
Y = October through March Four River Unimpaired Flow (MAF)
Z = Previous year's WY Index (MAF) having a maximum cap value of value of 10 MAF.

- Determination of Weighting Coefficients

The weighting coefficients set the relative importance of each term, and so essentially control the accuracy of the index. To determine the optimal values for these coefficients, a statistical analysis was performed to establish an index equation that produced the highest correlation to water availability. Increasing the second and third term's weighting coefficients with respect to the first improved the correlation. This improvement reached a plateau after a relatively small increase and remained at that level over a wide range of weighting coefficient combinations. Choice of 0.4, 0.3, and 0.3 for the weighting coefficients, C1, C2, and C3 respectively, was based on obtaining a high degree of correlation, and a final condition that the coefficients be simple numbers so that the index would remain relatively easy to work with.

- Results of Regression Analysis

Table A3.1-1 lists some of the regression results of these statistical analyses made to determine the optimal weighting coefficients and also lists the results of regressing the water availability against Delta Plan classification availability. This comparison indicates that breaking the index into two separate hydrologic periods and adding the effect of the previous year's hydrology enhances the index's reliability.

TABLE A3.1-1
Selected Results of the Statistical Analyses to
Determine Optimal Weighting Coefficients

Classification	Weighting Coefficients(%)	R Squared Value
Proposed Modified	40 -- 30 -- 30 w/cap.1/	0.85 2/
Selected Alternatives	40 -- 20 -- 40	0.88
	40 -- 30 -- 30	0.87
Delta Plan w/new BP 3/	33 -- 67 -- 00	0.74
April through July	100 -- 00 -- 00	0.66

Figure A3.1-1 shows a plot of the Sacramento Basin Water Year (WY) Index vs. July Water Availability with the regression curve for 57 years of data, 1922 through 1978, for the optimal weighting coefficients.

- Determination of Water Year Classification Breakpoints

The Delta Plan Water Year classification defines the boundaries of five water year types: wet, above normal, below normal, dry, or critically dry. This classification defines normal Sacramento Valley inflow, the boundary between above normal and below normal, as the logarithmic mean, or fiftieth percentile, of the Sacramento Basin's Four River Index for the period 1922 through 1971. In other words, there is an equal chance that Sacramento Basin Index will either exceed or not exceed the logarithmetic mean of 15.7 million acre feet (MAF). The boundary between an above normal year and a wet year is set at the 70 percent probability, 19.6 MAF. The boundaries for dry and critically dry years, 30 percent (12.5 MAF) and 15 percent (10.2 MAF) probability, respectively, were developed by identifying the Sacramento Basin Four River Index flows which had a potential for water supply shortages or critical water supply shortages for project operations. The years DWR identified as having a potential for shortages are (DWR,1,1978 Delta Plan hearing exhibit):

- Shortages: 1926, 1930, 1932, 1944, 1947, 1949, 1955, 1959, 1960, 1961, and 1964.

- Critical Shortages: 1924, 1929, 1931, 1933, 1934, and 1939.

The drought years 1976 and 1977 occurred after this analysis was completed and so were not included as years of critical shortage.

The methodology used to determine the index breakpoints that define the boundaries of the five water year types in the Delta Plan classification, was also used to determine the breakpoints for the new classification. An updated database was used with this methodology. Changes in the database are:

1/ This classification has a cap of 10 MAF on the third term.

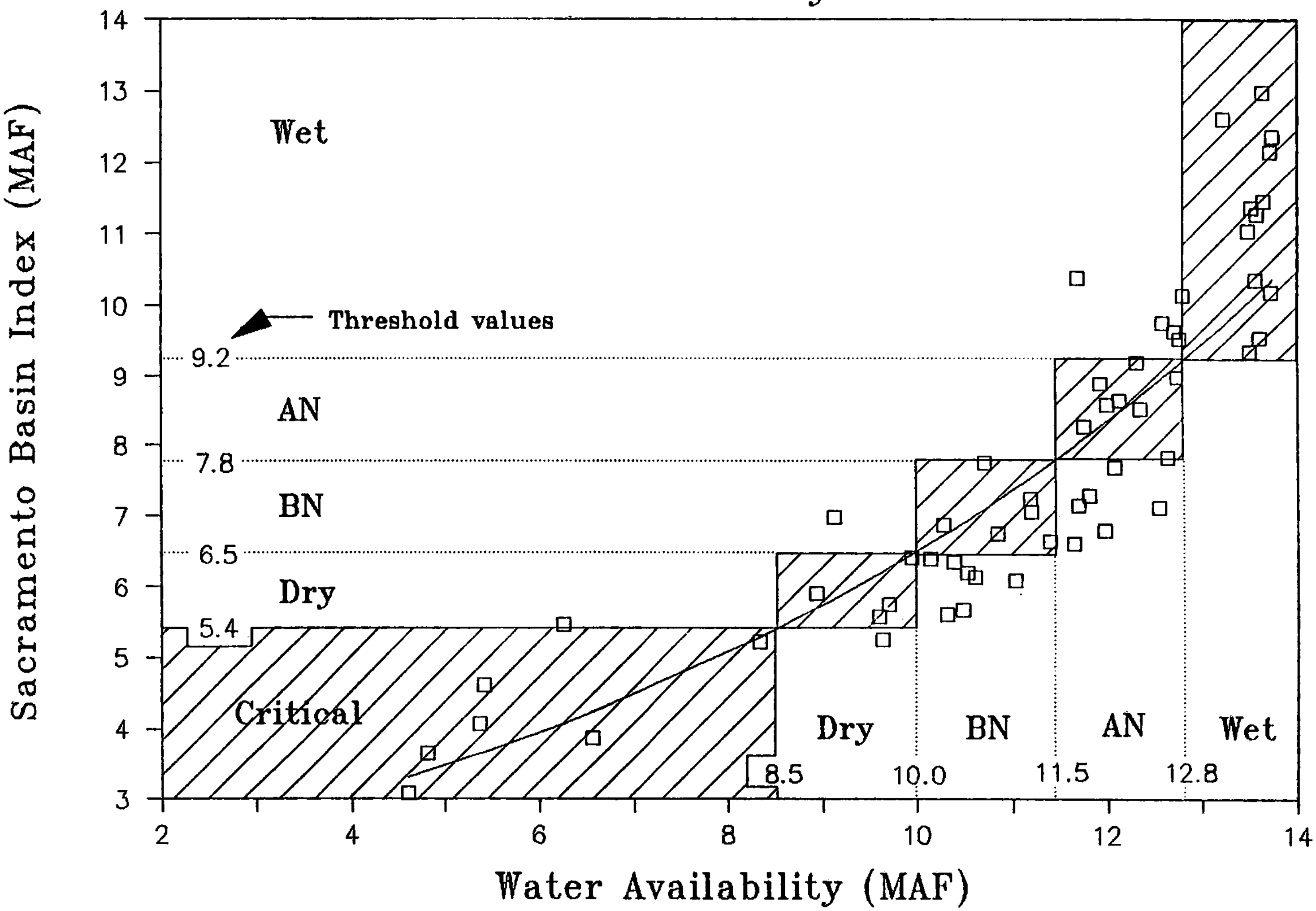
2/ The R squared value for the Proposed Modified and Selected Alternatives classifications are very similar, with the values for the latter being slightly higher. It was the consensus of the subworkgroup that the 40-30-30 w/cap Index was the preferable index.

3/ Breakpoint (BP), or threshold values are revised to reflect 1906 -- 1987 hydrology.

FIGURE A3.1-1

PLOT OF DATA POINTS, REGRESSION CURVE AND INDEX THRESHOLD VALUES FOR MODIFIED WATER INDEX 40-30-30 W/CAP

Month of July



Note: Shade areas indicate ranges where index correctly estimates water availability.
Area above shaded area indicates index over predicts amount of water availability.
Area below shaded area indicates index under predicts amount of water availability.

- An extended database, 1906 -- 1988 -- was used, and
- Two additional years with the potential for project shortages were included, 1939 and 1985.

New threshold flow levels and the percentage distributions were developed. Figure A3.1-2 shows a plot of the probability that the index value will be equal to or less than a particular value. The Delta Plan and the new classification threshold values and year type distributions are shown in Table A3.1-2.

Table A3.1-2

SACRAMENTO BASIN WY CLASSIFICATION
THRESHOLD VALUES AND YEAR TYPE DISTRIBUTION

Delta Plan Classification[1/]

Year Type	Threshold Value (MAF)	1906 -- 1988 Expected %	Expected No. Years	Actual %	Actual No. Years
W	Greater than 19.6	30	25	41	34
AN	Less than 19.6, greater than 15.7	20	17	12	10
BN	Less than 15.7, greater than 12.5	28	23	18	15
D	Less than 12.5, greater than 10.2	11	9	16	13
C	Less than 10.2	11	9	13	11

New Classification -- 40-30-30 Index

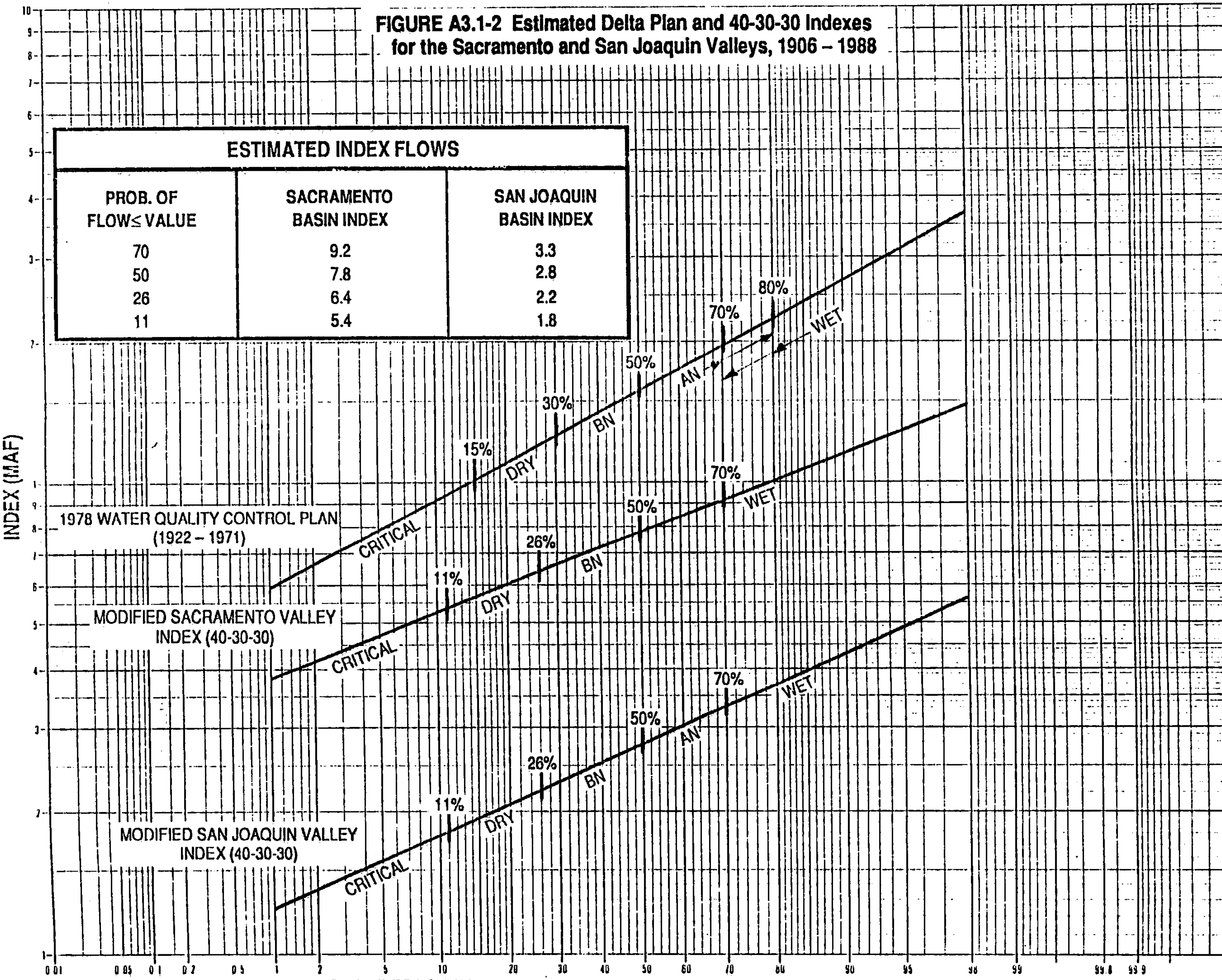
Year Type	Threshold Value (MAF)	1906 -- 1988 Expected %	Expected No. of	Actual %	Actual No. of
W	Greater than 9.2	30	25	35	29
AN	Less than 9.2, greater than 7.8	20	17	13	11
BN	Less than 7.8, greater than 6.5	26	21	20.5	17
D	Less than 6.5, greater than 5.4	13	11	20.5	17
C	Less than 5.4	11	9	11	9

o Verification Process

A study was performed to analyze how well the predicted water year type reflected the water availability for that year. Tables A3.1-3, A3.1-4 and A3.1-5 show the results of this study. The first step in this study was to determine the threshold values for water availability volume that corresponded to the threshold flow volume levels. Regression curves, one of which is shown in Figure A3.1-1 were used to calculate these amounts. Figure A3.1-1 is a plot of WY Index vs. July water availability for 57 years of data, 1922 through 1978; included is the regression curve for the plotted points. Figure A3-1.1 also illustrates the verification by showing the areas where the WY Index predicts water availability correctly and the distribution of the 57 years of index values in regard to these areas.

1/ Adjustments for subnormal snowmelt and year following critical year condition are not included in the Delta Plan classification data.

FIGURE A3.1-2 Estimated Delta Plan and 40-30-30 Indexes for the Sacramento and San Joaquin Valleys, 1906 – 1988



ESTIMATED INDEX FLOWS

PROB. OF FLOW≤ VALUE	SACRAMENTO BASIN INDEX	SAN JOAQUIN BASIN INDEX
70	9.2	3.3
50	7.8	2.8
26	6.4	2.2
11	5.4	1.8

TABLE A3.1-3
Sacramento WY Classification
40-30-30 W/CAP
April Verification

SACRAMENTO BASIN: BREAK PT.	WATER YEAR	SAC INDEX 40-30-30	Apr Total Available (TAF)	BREAK PT	YR. TYPE	DIFF.	VARIANCE
	1974	12992	18188				
	1938	12624	19437				
	1952	12383	21473				
	1958	12157	19586				
	1941	11469	18473		WET		
	1956	11376	17991				
	1942	11272	18629				
	1969	11045	19276				
	1970	10402	15060 *			-1968	11.56%
	1971	10373	17882				
	1967	10197	19284				
	1965	10153	17119				
	1943	9768	16174 *			-854	5.02%
	1963	9634	18605				
	1953	9553	17730				
	1927	9525	17113				
	1975	9353	17478				
9200				17028			
	1951	9184	15755				
	1922	8974	17518 **			490	2.88%
	1940	8879	15025 *			-248	1.46%
	1978	8630	16027		AN		
	1973	8581	15686				
	1954	8514	16442				
	1928	8272	14620 *			-653	4.27%
	1957	7832	15818				
7800				15273			
	1936	7751	13706				
	1946	7697	15658 **			385	2.26%
	1972	7292	15413 **			140	0.82%
	1968	7243	14406				
	1966	7162	15098				
	1948	7120	14732		BN		
	1923	7062	14630				
	1935	6978	11819 *			-1516	8.90%
	1937	6870	13105 *			-230	1.35%
	1945	6800	14980				
	1959	6754	14401				
	1962	6649	15127				
	1950	6618	14750				
6500				13335			
	1964	6409	13657 **			322	1.89%
	1925	6395	13180				
	1944	6347	13635 **			300	1.76%
	1960	6201	13970 **			635	3.73%
	1955	6136	13819 **			484	2.84%
	1949	6090	14104 **			769	4.51%
	1930	5899	12000		DRY		
	1926	5747	12451				
	1961	5677	13839 **			504	2.96%
	1947	5611	13588 **			253	1.48%
	1939	5583	12951				
	1932	5475	9436 *			-1928	11.32%
5400				11364			
	1976	5258	12612 **			1248	7.33%
	1929	5216	11370 **			6	0.03%
	1933	4626	7775				
	1934	4074	7578		CRIT		
	1924	3873	9110				
	1931	3660	7386				
	1977	3095	6412				
						AVG.	4.02%

* Water availability less than expected from index
** Water availability greater than expected from index

TABLE A3.1–4
Sacramento WY Classification
40–30–30 W/CAP
July Verification

SACRAMENTO BASIN: BREAK PT	WATER YEAR	SAC INDEX 40-30-30	July Total Available (TAF)	BREAK PT	YR. TYPE	DIFF.	VARIANCE
	1974	12992	13637				
	1938	12624	13216				
	1952	12383	13738				
	1958	12157	13718				
	1941	11469	13641		WET		
	1956	11376	13517				
	1942	11272	13578				
	1969	11045	13480				
	1970	10402	11678 *			-1099	8.60%
	1971	10373	13560				
	1967	10197	13722				
	1965	10153	12790				
	1943	9768	12567 *			-210	1.64%
	1963	9634	12698 *			-79	0.62%
	1953	9553	13613				
	1927	9525	12760 *			-17	0.13%
	1975	9353	13503				
9200				12777			
	1951	9184	12301				
	1922	8974	12726				
	1940	8879	11922				
	1978	8630	12116		AN		
	1973	8581	11999				
	1954	8514	12338				
	1928	8272	11754				
	1957	7832	12623				
7800				11454			
	1936	7751	10705				
	1946	7697	12073 **			619	5.40%
	1972	7292	11806 **			352	3.07%
	1968	7243	11178				
	1966	7162	11694 **			240	2.10%
	1948	7120	12536 **		BN	1082	9.45%
	1923	7062	11200				
	1935	6978	9116 *			-877	8.78%
	1937	6870	10270				
	1945	6800	11976 **			522	4.56%
	1959	6754	10833				
	1962	6649	11399				
	1950	6618	11646 **			192	1.68%
6500				9993			
	1964	6409	9936				
	1925	6395	10132 **			139	1.39%
	1944	6347	10370 **			377	3.77%
	1960	6201	10509 **			516	5.16%
	1955	6136	10592 **			599	6.00%
	1949	6090	11022 **			1029	10.30%
	1930	5899	8933		DRY		
	1926	5747	9698				
	1961	5677	10466 **			473	4.73%
	1947	5611	10308 **			315	3.15%
	1939	5583	9599				
	1932	5475	6251 *			-2256	26.52%
5400				8507			
	1976	5258	9624 **			1117	13.13%
	1929	5216	8330				
	1933	4626	5411				
	1934	4074	5364		CRIT		
	1924	3873	6557				
	1931	3660	4813				
	1977	3095	4605				
						AVG.	6.01%

* Water availability less than expected from index
** Water availability greater than expected from index

TABLE A3.1-5
Sacramento WY Classification
40-30-30 W/CAP
October Verification

SACRAMENTO BASIN: BREAK PT.	WATER YEAR	SAC INDEX 40-30-30	Oct Total Available (TAF)	BREAK PT.	YR. TYPE	DIFF.	VARIANCE
	1974	12992	9919				
	1938	12624	9553				
	1952	12383	10133				
	1958	12157	9959				
	1941	11469	9445		WET		
	1956	11376	9563				
	1942	11272	9554				
	1969	11045	9906				
	1970	10402	7873 *			-1062	11.89%
	1971	10373	9699				
	1967	10197	10137				
	1965	10153	8950				
	1943	9768	8538 *			-397	4.45%
	1963	9634	8738 *			-197	2.21%
	1953	9553	9676				
	1927	9525	8613 *			-322	3.61%
	1975	9353	9869				
9200				8935			
	1951	9184	8510				
	1922	8974	8793				
	1940	8879	7732 *			-104	1.32%
	1978	8630	8742		AN		
	1973	8581	8329				
	1954	8514	8571				
	1928	8272	7712 *			-124	1.58%
	1957	7832	8890				
7800				7836			
	1936	7751	6728				
	1946	7697	8122 **			286	3.65%
	1972	7292	8226 **			390	4.98%
	1968	7243	7695				
	1966	7162	7934 **			98	1.25%
	1948	7120	8593 **		BN	757	9.66%
	1923	7062	7684				
	1935	6978	5440 *			-1181	17.84%
	1937	6870	6608 *			-13	0.20%
	1945	6800	8220 **			384	4.90%
	1959	6754	7398				
	1962	6649	7917 **			81	1.04%
	1950	6618	7972 **			136	1.74%
6500				6621			
	1964	6409	6475				
	1925	6395	6702 **			81	1.22%
	1944	6347	6699 **			78	1.18%
	1960	6201	6889 **			268	4.05%
	1955	6136	7146 **			525	7.93%
	1949	6090	7613 **			992	14.98%
	1930	5899	5514		DRY		
	1926	5747	6097				
	1961	5677	6997 **			376	5.68%
	1947	5611	6659 **			38	0.57%
	1939	5583	6049				
	1932	5475	3489 *			-1897	35.22%
5400				5386			
	1976	5258	6422 **			1036	19.24%
	1929	5216	5229				
	1933	4626	3097				
	1934	4074	3066		CRIT		
	1924	3873	4205				
	1931	3860	2538				
	1977	3095	2577				
						AVG.	6.68%

* Water availability less than expected from index
** Water availability greater than expected from index

These water availability threshold levels define the range of water availability for each year type. If a given year's water availability fell outside its respective water availability range, then it was assumed that the water year index incorrectly predicted the water year type.

TABLE A3.1-6

Sacramento Basin WY Classification
Comparison of Verification Results for
Selected Classifications

Classification	Month	No. of Correct Predictions	No. of Incorrect Predictions	Average Variance(%)
40-30-30 Index	April	38	19	4.0
(40-30-30)	July	37	20	6.0
	October	33	24	6.7
Delta Plan WY	April	31	26	7.4
(33-67-00)	July	27	30	7.2
	October	27	30	9.6
April -- July	April	30	27	10.2
(100-00-00)	July	29	28	10.8
	October	27	30	12.8

Table A3.1-6 compares the results of the proposed new classification with other alternative classifications. The results indicate that the new classification has significantly fewer incorrect predictions and the degree of error is significantly smaller than with the Delta Plan classification.

o Adjustments to Water Year Classification

In the Delta Plan classification, two adjustments were created to account for unusual hydrologic conditions; a second classification for a year which follows a critical year, and a sub-normal snowmelt adjustment. The "year following critical year" classification was developed to account for the effects that depleted reservoir and ground water storage have on the ability of project operations to meet their demands. In this secondary classification the boundary of a wet year is raised to 22.5 MAF, an 80 percent probability of occurrence. The boundary for an above normal year remains the same at 15.7 MAF. The below normal year classification is eliminated, and the boundary between a dry and a critically dry year is raised to 12.5, the previous boundary for a below normal year. The "year following critical year" classification applies only to fish and wildlife objectives.

The sub-normal snowmelt adjustment was developed to account for unusual deficiencies in snowpack storage. This adjustment is made in years where the percentage of precipitation, in the form of snowfall, is much less than expected. Under normal conditions, a great proportion of winter precipitation is stored in the snowpack and released over a long period of time as the snowpack melts. Under sub-normal snowmelt conditions, a greater proportion of the precipitation falls in the form of rainfall and cannot be stored in the snowpack nor reservoirs and is released as uncontrolled or surplus flow. The sub-normal snowmelt adjustment applies only to the fish and wildlife objectives.

The adjustments that were necessary in the Delta Plan classification are less important in this modified classification system.

Because the effects of previous year's conditions are included in the third term of the index, the "year following critical year" modification is not necessary.

The subnormal snowmelt modification, to a large extent, is accounted for with the inclusion of the third term and with the difference in weighting coefficients between the first and second terms. DWR has identified the following years, between the period 1922 - 1978, as subnormal snowmelt years:

- Subnormal snowmelt years: 1928, 1951, 1960, 1966, 1968, 1970, and 1972.

Table A3.1-4 shows that for the month of July, after spring snowmelt has finished, the modified index correctly predicts the amount of water available during subnormal snowmelt years three out of seven times, and under-predicts the amount of water available three out of seven times. Therefore, the index does not predict more water than is available six out of seven of the subnormal snowmelt years. Only 1970's index overpredicts water availability. This indicates that subnormal snowmelt conditions are highly accounted for in the index.

A modification for subnormal snowmelt would be beneficial if it could account for unusual hydrologic conditions not predicted in the index, and not cause other errors while accomplishing this. However, the current subnormal snowmelt modification causes the 40-30-30 Index to be less accurate, and therefore is not included as an adjustment to the index.

o Source of Database

The source of the database used to develop water availability for this analysis was DWR operation study run number 62B. This operation study assumed 1990 level demands and conditions, D-1485 Delta flow and water quality standards, and the amended D-1485 Suisun Marsh standards with no facilities.

APPENDIX 3

REFERENCES

- BCDC. 1982. Diked Historic Baylands of San Francisco Bay; Findings, Source Policies, and Maps. Adopted October 21, 1982.

- Cheng, T.T., and Gardner, J.W. 1984. Tides, Tidal and Residual Currents in San Francisco Bay, 1979-1980, USGS Water Resources Investigation Report 84-4339, February 1984.

- Denton, R.A., and Hunt, J.R. 1986. Currents in San Francisco Bay--Final Report, SWRCB Publication No. 86-7wr, March 1986.

- Orlob, G.T. 1982. "Without Project" Water Quality. Memorandum from Dr. G.T. Orlob of G.T.Orlob and Associates to Diverters, South Delta Water Agency on February 10, 1982.

- RWQCB 2. 1986. Water Quality Control Plan Report, San Francisco Bay Basin (2), Part I, December 1986.

- RWQCB 5. 1975. Water Quality Control Plan Report, Sacramento River Basin (5A), Sacramento-San Joaquin Delta Basin (5B), San Joaquin Basin (5C). Volume II.

- SWRCB. 1978. Final Environmental Impact Report for the Water Quality Control Plan and Water Right Decision, Sacramento-San Joaquin Delta and Suisun Marsh, August 1978. Sacramento, California.

- 1906 through 1920--DWR Division of Planning Statewide Planning Branch, 4/14/80; 1921 through 1978--DWR Exhibit 7, except as stated below; 1969 through 1983 Sacramento River near Red Bluff--DWR California Data Exchange Center, 1/15/88; 1984 through 1987--DWR California Data Exchange Center, 1/15/88.

APPENDIX 4.0

BENEFICIAL USES OF BAY-DELTA ESTUARY WATER

Conclusions: CURRENT AND FUTURE WATER SUPPLY CONDITIONS

- The majority of surface water in California (about 55 percent) flows to the sea, into salt sinks or into Nevada.

- The watershed of the Bay-Delta is a major source of supply critical in satisfying the water needs of the entire State.

- The Bay-Delta watershed is influenced by water diversion and control. On the average about 40 percent of the flows entering the Delta are unmanaged. However, in dry years less than five percent is unmanaged.

- As California's population grows to over thirty-six million people by 2010, the adequacy of currently developed water supplies to meet the needs of a growing population, expanding economy, and the aquatic environment will diminish.

- There are about 9.2 million acres of irrigated agricultural land in California.

- Agricultural acreage is not expected to increase in the Central Valley.

- Currently developed surface water supplies do not meet existing agricultural water requirements. This is demonstrated by the fact that agricultural demands are partially being met by groundwater overdraft in the San Joaquin Valley.

- Agricultural water conservation in areas that receive water from the Delta is important but will not satisfy the State's water needs since less than 20 percent of the agricultural water demand is met by water exported from the Delta.

- Planning for municipal and industrial water needs must focus on the primary requirements of a reliable supply of drinking water.

- Reductions in reliable water supplies will have adverse impacts on the economy of the state.

- Conservation, reclamation and maximum conjunctive use of local ground water basins are important components of reliable water supplies.

- California water supplies have been affected by recent court decisions. The state's share of water from the Colorado River has been reduced to 4.4 MAF, an amount the courts will likely limit still further. Interim court decisions have reduced the city of Los Angeles' water supply from tributaries in the Mono Lake Basin by 50 to 65 TAF. Also, court decisions have limited export of ground water from the Owens Valley Basin to levels lower than originally anticipated by the City.

- **Water conservation by the Imperial Irrigation District consistent with State Board Order 88-20 could make water available for use in other parts of the state by 100,000 AF in the early 1990s, with a long-term goal of about 368,000 AF.**

- **Ground water is a resource upon which the state relies. Factors limiting the availability of that resource include toxics, overdraft, salt water intrusion and land use practices.**

4.0.1 Introduction

"'Beneficial uses' of the waters of the state that may be protected against degradation include, but are not necessarily limited to, domestic, municipal, agricultural and industrial supply; power generation; recreation; esthetic enjoyment; navigation; and preservation and enhancement of fish, wildlife, and other aquatic resources or preserves" (Porter-Cologne Water Quality Control Act, Water Code Section 13050(f)).

This chapter discusses the many beneficial uses made of Bay-Delta waters which were addressed during the Phase I hearings. Only after beneficial uses have been properly identified can appropriate water quality objectives and other control policies be established. A clear understanding of each beneficial use provides a foundation for establishing the levels of protection needed.

This Plan complements specific beneficial uses in the Basin Plans of the San Francisco Bay and Central Valley Regional Water Quality Control Boards. There are additional beneficial uses made of these waters as addressed in these Basin Plans. The beneficial uses discussed in this Plan are not therefore meant to be exclusive.

The discussion of beneficial uses has been separated into estuary and export uses. Estuarine habitat is also a specific beneficial use discussed in the Basin Plan of the San Francisco Bay Regional Water Quality Control Board. During Phase I of the proceedings, information was submitted on specific subtopics, e.g., striped bass, Chinook salmon, various human uses of the habitat. These issues are addressed here in a similar fashion. Habitat is separated into the Delta's water, generally fresh, and the Bay's waters, generally brackish and saltwater habitats, to help identify the general salinity conditions.

4.0.2 Uses of Estuary Water for Municipal and Domestic Supply Purposes Within the Estuary

Municipal and Domestic Supply (MUN) includes established uses in community or military water systems as well as domestic uses from private systems (RWQCB 5, 1975).

Current and projected MUN water use of Delta surface water is presented in Table A4.0-1. Delta cities that rely on this water are Antioch, Pittsburg, Tracy and Oakley. Pittsburg and Oakley obtain water supplies from Rock Slough via the Contra Costa Canal; Tracy obtains its supply from Old River via the Delta-Mendota Canal. Antioch diverts directly from the San Joaquin River during high flow periods when water quality is satisfactory and at other times obtains part from the Contra Costa Canal. The City of Sacramento maintains a standby diversion facility on the Sacramento River in the upper Delta, but usually diverts from two other facilities on the American and Sacramento rivers upstream of the Delta. The cities of Stockton, Tracy, Rio Vista, and other Delta communities rely to various degrees on ground water for MUN water supplies (SWRCB 5, 1978).

TABLE A4-1

MAJOR MUNICIPAL WATER DEMANDS

	1986 Population	**Water Demands (AF)**
City of Tracy	25,300	7,822 (1986)
Antioch	40,734	9,073 (1985)
Pittsburg	53,125	7,729 (1985)
Oakley County W.D.	8,436	2,128 (1985)
	Year 2000 Population	**Year 2000 Water Demands (AF)**
City of Tracy	33,000 (1990)	10,400 (1990)
Antioch	78,900	14,338
Pittsburg	59,100	12,994
Oakley County W.D.	N/A	5,153

(Table adapted from information found in City of Tracy (CT), Exhibit Nos. 2 & 3; Contra Costa Water District (CCWD), Exhibit Nos. 7, 24 & 25).

4.0.3 Industrial Beneficial Uses

Industrial use is comprised of three separate beneficial uses:

- o Industrial Service Supply (IND) "includes uses which do not depend primarily on water quality such as mining, cooling water supply, hydraulic conveyance, gravel washing, fire protection, and oil well repressurization".
- o Industrial Process Supply (PROC) "includes process water supply and all uses related to the manufacturing of products".
- o Hydroelectric Power Generation (POW) "is that supply used for hydropower generation" (RWQCB 5, 1975).

Very little information on Bay-Delta industrial use was presented in Phase I of the proceedings. Two Bay-Delta industries, Fibreboard Louisiana-Pacific Corporation (Fibreboard) and Shell Oil Company, presented testimony, but no exhibits. Contra Costa Water District (CCWD) and DWR presented exhibits and testimony, but of a limited scope. The total amount of water delivered from the Contra Costa Canal to major industrial water users in the Delta totaled 22,733 acre-feet in 1985 and 15,519 acre-feet in 1986 (CCWD,26).

4.0.3.1 Antioch-Pittsburg Area

Fibreboard, a large kraft paper mill located on the south shore of the San Joaquin River approximately five miles east of Antioch, produces linerboard, corrugating medium, and fiber board from wood chips (hearing for D-1485,RT,Vol.XVII,p.135). Fibreboard presented the only testimony supporting the need for process water with not more than 150 ppm chloride for the production of corrugated box linerboard (T,IV,92:25-93:6; T,IX,75:23,81:23). To keep the chlorinity in their linerboard (used in corregated boxes) at levels which will not corrode canned goods, Fibreboard maintains the salinity of their process water below 150 mg/l chloride (T,IX,75:23-81:23).

Fibreboard has two main sources of water, direct pumping from the San Joaquin River and CCWD. When the chlorinity in the San Joaquin River supply is higher than 150 ppm, a partial supply of water is purchased from CCWD; when the chlorinity level reaches 250 ppm, the entire supply is taken from the Contra Costa Canal (T,IX,77:23-78:6). A third, relatively minor source is ground water from two wells that provide between 500,000 and 800,000 gallons per day.

4.0.3.2 Industries Outside of the Antioch-Pittsburg Area

Shell Oil Company in Martinez, which obtains most of its water supply from the Contra Costa Canal, was the only Bay-Delta industry located outside the Antioch-Pittsburg area to present testimony during Phase I (T,IX,41:11-14). Shell Oil Company's testimony was related to reliability of supply (T,IX,46:12-13). Three other industries near Tracy, H. J. Heinz Company, Laprino Cheese and Laura Scudders, which obtain their water supply from the DMC or local ground water supplies, were identified but did not present testimony (T,IX,11:4-12; T,IX,21:21-25).

4.0.4 Estuary Agriculture Beneficial Uses

Agricultural uses include crops, orchards, and pasture irrigation, stock watering, support and vegetation for range, grazing and all uses in support of farming and ranching operations (RWQCB 5B, 1975).

4.0.4.1 Delta Agriculture

About three-quarters of the Delta land area (515,000 acres) is farmed with water from the channels and sloughs adjacent to each individual island in the Delta (DWR,304). The Delta's climate and soil permit a wide variety of crops to be grown; corn and grain are the predominant crops.

Soils in the Delta fall generally into two categories, organic and mineral. Farmed organic soils constitute 68 percent of the total cropped area and mineral soils the remaining 32 percent. Organic soils are usually found in the Delta lowlands, that is, the land area below an elevation of +5 feet mean sea level. Delta uplands are those areas above +5 feet mean sea level. Mineral soils are found in both the Delta lowlands and uplands.

Delta Organic Soils

The Delta's organic or peat soils were formed in a wetland environment that existed prior to the area's reclamation for agriculture. These peat soils were formed through the biological decomposition of marsh plants and grasses under anaerobic conditions. Current land use is constantly reducing the amount of Delta organic soils. Organic materials are no longer being deposited, while increased decomposition and oxidation from natural processes and farm practices are occurring at high rates. High winds also transport dried organic soils out of the Delta. Consequently, many of the lowland Delta islands are sinking at the rate of one to three inches per year and the actual acreage of the organic soils is also being reduced (T,LV,82:20-25).

The high permeability of organic soils and their low surface elevation compared to surrounding waterways produces high ground water table conditions. The high ground water table, along with problems associated with uneven decomposition and settlement of organic soils, makes subirrigation the primary method of water application for crop production. (Subirrigation is an irrigation technique by which water is delivered to the crop root zone by horizontal flow through the soil from the spud ditches.)

The quality of irrigation water, and the effects of rainfall and other farm practices including, possibly, winter ponding[1/], all reduce the need for leaching.

Delta Mineral Soils

Delta mineral soils were formed through deposition of sands and minerals eroded from the Sierra Nevada by various streams tributary to the Delta. These soils are generally found in the Delta uplands.

On mineral soils, the area in Figure A4-1 which is not designated as organic soil, surface irrigation is the common irrigation method. Water is applied to the soil surface, usually through furrow, sprinkler, or flood irrigation. Unlike organic soils, salts in the surface-irrigated mineral soils are brought into the soil column from the surface with the applied water. Excess salts are removed during irrigation and after harvest by applying irrigation water to flush the salt into the lower ground water table. Some leaching may also be accomplished with winter rainfall.

Delta Crop Production

Agriculture was introduced into the Delta in the 1860s and was well established by the turn of the century; it has maintained its current level since the 1920s (see Figure A4-2). Delta agriculture is important economically at both the regional and statewide level.

1/ Winter ponding, currently in use in the Delta, is the practice of flooding large agricultural field areas for the purpose of controlling weeds, and reducing salt in the upper region of the soil profile. Other benefits are recreation, and possibly salt leaching.

FIGURE A4-1 Sacramento - San Joaquin Delta
Approximate Location Of Organic Soils
(Soils With Greater Than 25% Organic Matter)
Source: DWR Bulletin 192-82, Delta Levees Investigation Dec. 1982 also DWR Exhibit 303

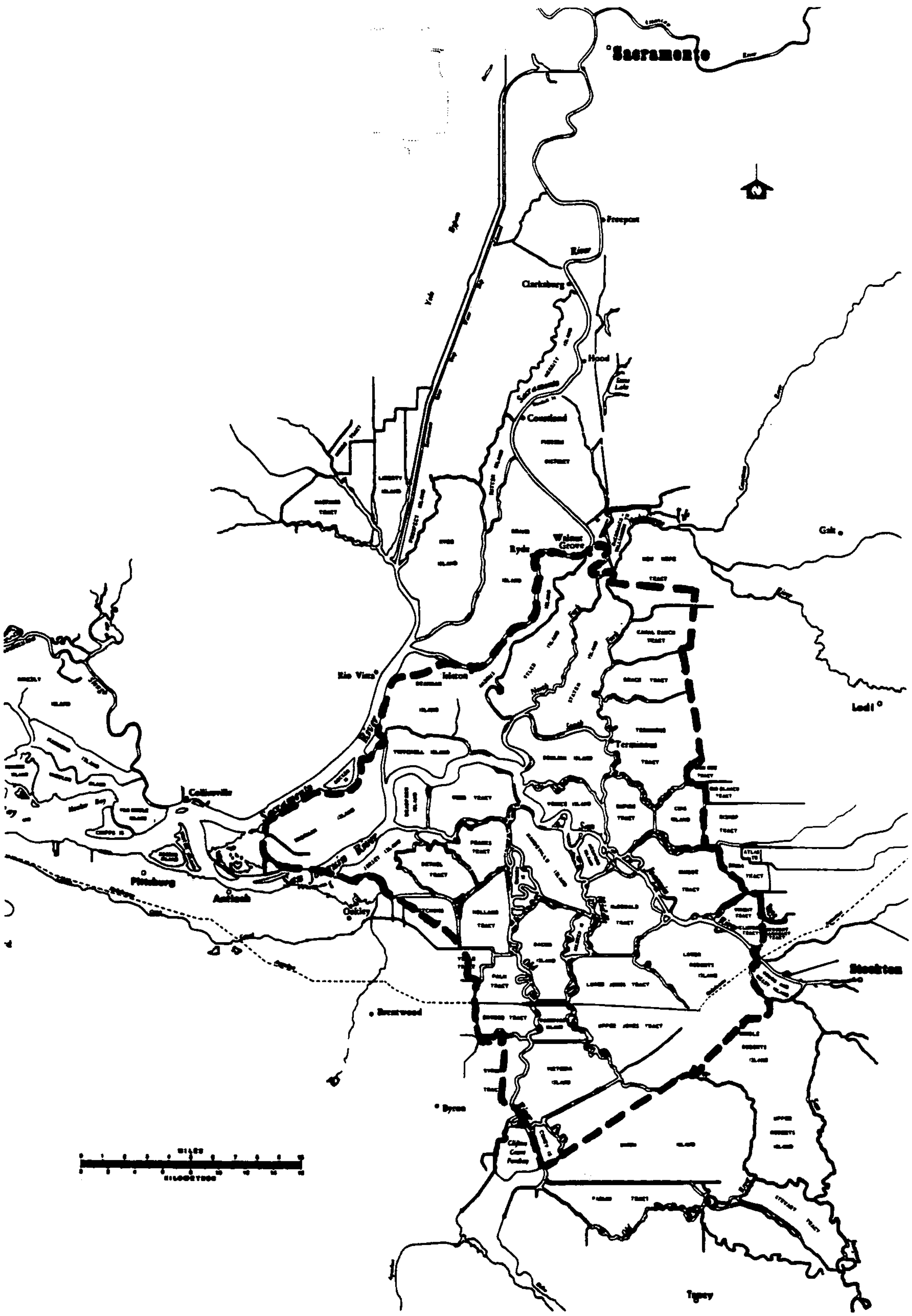


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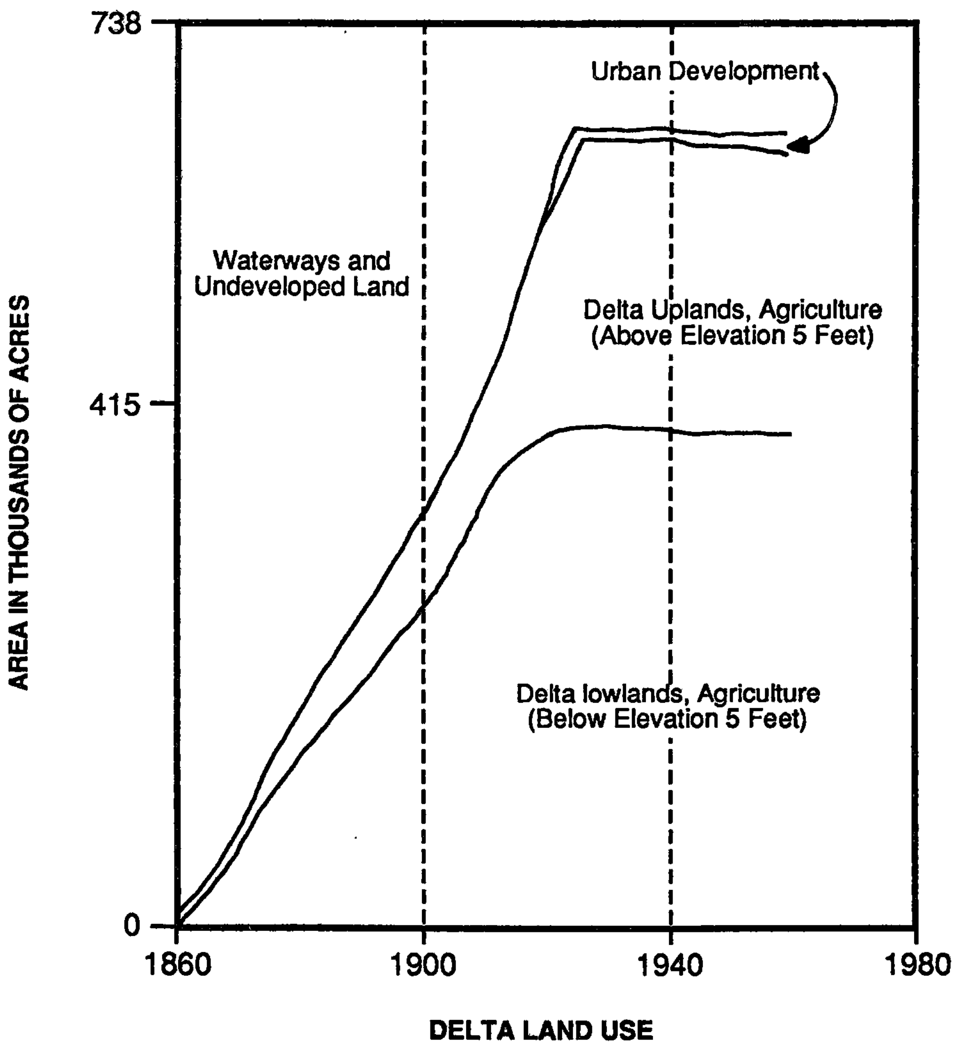
FIGURE A4-2
Delta Land Use and Dedicated Acreage



Adapted from: Bulletin 76 – Delta Water Facilities, December 1960

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Crop production information was presented by DWR for the Delta lowlands and uplands (DWR,304). Corn was the predominant crop grown in the Delta during the period 1977-84, accounting for 25.8 percent of the total cropped acreage (Table A4-2). Grain is grown on an additional 21.5 percent of the cropped acreage, followed by tomatoes, alfalfa and mixed pasture; other crops such as sugar beets, deciduous trees and safflower account for most of the remainder. Crop and livestock production in the Delta has a gross sale value of approximately $500 million (Table A4-3), with field and truck crops making up 57 percent of that total.

4.0.4.2 Bay Agriculture

Very little information was presented in the hearing sessions on agriculture outside of the legal limits of the Delta but within the boundaries of San Francisco Bay Region. Contra Costa Water District presented records showing crop production for their district (CCWD,48) (Table A4-4).

4.0.5 Beneficial Uses Made of the Estuary's Aquatic Habitat

This section discusses some of the specific data presented during Phase I as they relate to the following five major beneficial uses addressed in the current Water Quality Control Plans (Basin Plans) of the San Francisco Bay and Central Valley Regions:

- Freshwater Habitat -- which provides habitat to sustain aquatic resources for cold water (COLD) and warm water (WARM) species.
- Fish Migration (MIGR) -- which provides a migration route and temporary aquatic environment for anadromous and other fish species. This beneficial use is also subdivided for warm and cold water species.
- Fish Spawning (SPWN) -- which provides a high quality aquatic habitat suitable for fish spawning.
- Wildlife Habitat (WILD) -- which provides a water supply and vegetation habitat for the maintenance of wildlife. The two most important types of wildlife habitat are riparian and wetland habitats.

TABLE A4-2

CROP ACREAGES AND PERCENTAGES[1/] BASED ON DATA COLLECTED DURING THE PERIOD 1977--1984 FOR THE SACRAMENTO-SAN JOAQUIN DELTA (From DWR, 304)

	Lowlands & Uplands		Lowlands		Uplands	
Crop	Acre	Percent	Acre	Percent	Acre	Percent
Field Corn	132,770	25.8	107,480	30.6	25,290	15.6
Grain	110,900	21.5	81,960	23.4	28,940	17.8
Tomatoes	43,100	8.4	25,370	7.2	17,730	10.9
Alfalfa	39,770	7.7	24,350	6.9	15,420	9.5
Mixed Pasture	36,020	7.0	17,730	5.0	18,290	11.3
Sugar Beets	27,650	5.4	15,240	4.3	12,410	7.6
Deciduous	25,960	5.0	9,240	2.6	16,720	10.3
Safflower	23,530	4.6	21,060	6.0	2,470	1.5
Asparagus	23,400	4.5	21,840	6.2	1,560	1.0
Beans	17,580	3.4	4,690	1.3	12,890	7.9
Sunflower	6,630	1.3	6,050	1.7	580	0.4
Vineyard	4,870	1.0	4,150	1.2	720	0.5
Sorghum	4,580	0.9	3,600	1.0	980	0.6
Cole Crops[2/]	4,140	0.8	3,610	1.0	530	0.3
Melons	2,430	0.5	250	0.1	2,180	1.4
Sudan	2,180	0.4	710	0.2	1,470	0.9
Potatoes	2,160	0.4	2,160	0.6	0	0.0
Rice	1,810	0.4	480	0.1	1,330	0.8
Native Pasture	1,130	0.2	140	0.0	990	0.6
Misc. Truck	1,120	0.2	750	0.2	370	0.2
Lettuce	1,110	0.2	0	0.0	1,110	0.7
Onions	590	0.1	370	0.1	220	0.1
Misc. Field	510	0.1	460	0.1	50	0.0
Clover	450	0.1	440	0.1	10	0.0
Carrots	300	0.1	300	0.1	0	0.0
Peppers	250	0.0	50	0.0	200	0.1
Nursery	60	0.0	0	0.0	60	0.0
Total	515,000	100.0	352,480	100.0	162,520	100.0

1/ Percentages computed by State Board staff.

2/ Cole crops include those from the cabbage family.

TABLE A4-3

1985 ECONOMIC VALUE OF DELTA CROPS AND LIVESTOCK
(From DWR, 340)

Gross Value of Delta Area ($Million)

Agricultural Category	Lowland	Upland	Total
Field Crops	100.4	67.2	167.6
Truck Crops	76.9	34.6	111.5
Tree Fruit/ Nut & Vine	25.1	18.2	43.2
Seed & Nursery	7.9	1.8	9.7
Livestock	9.9	144.5	154.5
TOTAL	$220.2	$266.3	$486.5

TABLE A4-4

CROPS PRODUCED IN CONTRA COSTA WATER DISTRICT, 1986

Crop	Acres
Corn	10
Alfalfa	20
Irrigated Pasture	30
Other miscellaneous field crops	60
Apricots	10
Grapes*	500
Almonds*	700
Walnuts	10

* Not irrigated in 1986

o Preservation of Rare, Threatened and Endangered Species (RARE) -- which provides an aquatic habitat necessary, at least in part, for the survival of certain species established as being rare, threatened or endangered under the California Endangered Species Act (CESA).

The fishery resources of the Estuary depend upon complex ecosystems for a variety of purposes during different life stages and in different seasons and water year types. The Estuary provides habitat for the entire life cycle, or a critical portion of the life cycle, for close to 150 fish species and a vast aquatic food web of invertebrates, including shellfish and crustaceans, and planktonic organisms. The fishery provides valuable resources for many other terrestrial and aquatic wildlife species as well.

The relationship between aquatic habitat and water quality requirements has been documented for relatively few species. Studies normally focus on important commercial and recreational species such as Bay shrimp, Dungeness crab, Chinook salmon, striped bass, and American shad. There is still much debate about the relationship between water quality and quantity and the changes in fishery resources even for the well studied species.

Sections 4.0.5.1 and 4.0.5.2. summarize available information on fish, invertebrates and rare, threatened and endangered animals and plants in the Estuary. There are two major subdivisions: Section 4.0.5.1 discusses fishery habitat for species which mostly use freshwater habitat; Section 4.0.5.2 discusses those which mostly use estuarine habitat.

4.0.5.1 Delta Habitat

This section considers the habitat for species that primarily use the freshwater of the Delta upstream of Chipps Island. Suisun Bay and the other downstream estuarine areas (San Pablo, San Francisco and South bays) are discussed in Section 4.0.5.2.

Phytoplankton and Zooplankton

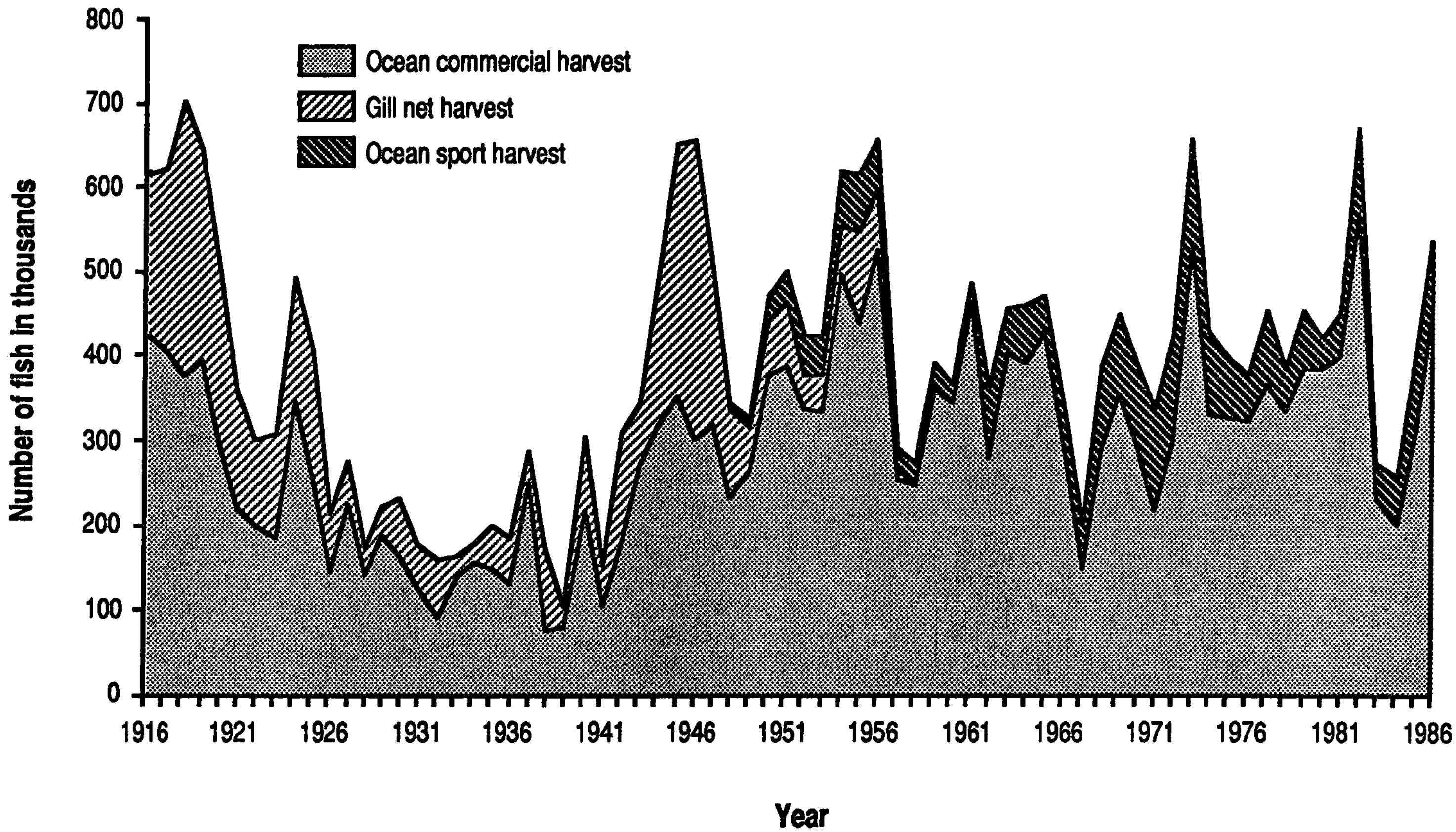
The importance of phytoplankton and zooplankton (including the opossum shrimp, Neomysis mercedis) and their place in the food chain of fish and larger invertebrates was discussed at length in Phase I of the proceedings (see, for example, DFG,28,14; T,XXXIX,15:16-19,28:13-29:14,70:19-71:8; T,XLI,52:19-53:5,59:1-4). The young of striped bass and other game fish, and all life stages of forage fish, feed on zooplankton and Neomysis (DFG,28,1), which in turn feed on smaller zooplankton and phytoplankton (DFG,28,1-4). Phytoplankton abundance is itself dependent on light, flow, salinity and nutrients. The complex interactions of these components are discussed in the hearing record.

Chinook Salmon

- Races and Migration

Chinook, or king salmon, Oncorhynchus tshawytscha, is a native, coldwater, anadromous species of major commercial and recreational importance in California. From about 1955 through 1965, Sacramento Basin Chinook salmon escapement averaged above 250,000 fish. Over the last 20 years the total number of naturally produced adult salmon has declined to around 100,000 fish while escapement of hatchery reared fish has increased to about 90,000 fish (DWR,559,74) (Figure A4-3). Annual Sacramento Basin escapement and commercial ocean harvest have become relatively stable in the last 20 years (DWR,559,47-74; USFWS,31,2). The estuarine gill net fishery for salmon was outlawed in 1957. Since then the ocean commercial troll harvest of Central Valley salmon has averaged about 324,000 fish, approximately 57 percent of all Chinook harvested in California. The ocean recreational catch has averaged close to 60,000 fish and the inland sport harvest is estimated to be about 35,000 fish (USFWS,31,103,176-179; DWR,56,57-59).

FIGURE A4-3 Estimate of annual ocean harvest of Central Valley Chinook salmon (After DWR, 561, 2, Figure III-3)



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Adult Chinook salmon migrate through the Estuary from the ocean to spawning areas in the upper Sacramento-San Joaquin River basins. Four races, all believed to be genetically distinct (USFWS,31,109), spawn in the upper Sacramento Basin (USFWS,29,4). Each race is named for the time of year when the upstream migration (run) occurs. There are fall-, late fall-, winter- and spring-runs. Some hybridization between runs, especially spring and fall runs, may have occurred due to the fact that the timing of spawning overlaps and there is less suitable spawning habitat than was historically available. The two remaining areas where significant numbers of genetically pure strains of spring-run Chinook exist are in Mill and Deer Creeks (USFWS,29,6). Because the spawning runs of the four races overlap in the upper Sacramento River, all life stages may be found in all months (see Figure A4-4). The USFWS stated that the occurrence of four races of Chinook salmon in a single river basin is unique in the United States (T,XXXV,16:24-17:1).

The fall-run, comprising up to 90 percent of all Chinook spawning in the Central Valley, migrates upstream from about late July through December (USFWS,29,5). Smaller populations of late-fall, winter-, and spring-run fish spawn in the upper Sacramento River (see Figure A4-5). The winter-run was formerly the second largest but today is the smallest (T,XXXV,22:6-14) and is now designated as an "endangered" species under the California Endangered Species Act and a "threatened" species under the federal Endangered Species Act.

The Sacramento River and its tributaries produce at least 80 percent of all Central Valley Chinook salmon (USFWS,31,1). During the years 1953-1986, the San Joaquin River Basin contributed at least 10 percent of the Central Valley salmon produced for 13 years and at least 17 percent for three years (DFG,15,Appendix 1). Prior to the closure of Friant Dam on the San Joaquin River, there was a spring-run in the upper river (DFG,15,8). Today, only the fall-run spawns in the Merced, Tuolumne and Stanislaus rivers (DFG,15,4). There are also small runs in the Mokelumne and Cosumnes Rivers (SWRCB,435,35).

o Development and Migration

The developmental stages and habitat requirements for each stage are generally the same for the four races of Chinook salmon in the Central Valley. However, the different life stages use different locations and require different habitat conditions as they develop within the Sacramento-San Joaquin River basins (see Table A4-5).

Spawning and incubation take place upstream of the Delta. Juveniles and occasionally fry rear in the Delta. While rearing, young salmon feed for about two months or more on a diet of aquatic and terrestrial insects and zooplankton (USFWS,29,4;USFWS,31,14;SWRCB,450,5-4). Peak fry abundance occurs in the Delta in February and March (USFWS,31,7). As they grow and move into the Bay habitat, <u>Neoymsis</u> (opossum shrimp), <u>Corophium</u> (an amphipod) and <u>Crangon</u> (Bay shrimp) become important prey items (SWRCB,433,113).

FIGURE A4-4 Timing of life history stages for the four races of Chinook salmon in the Sacramento River Basin (After USFWS, 29, 5, Figure 2)

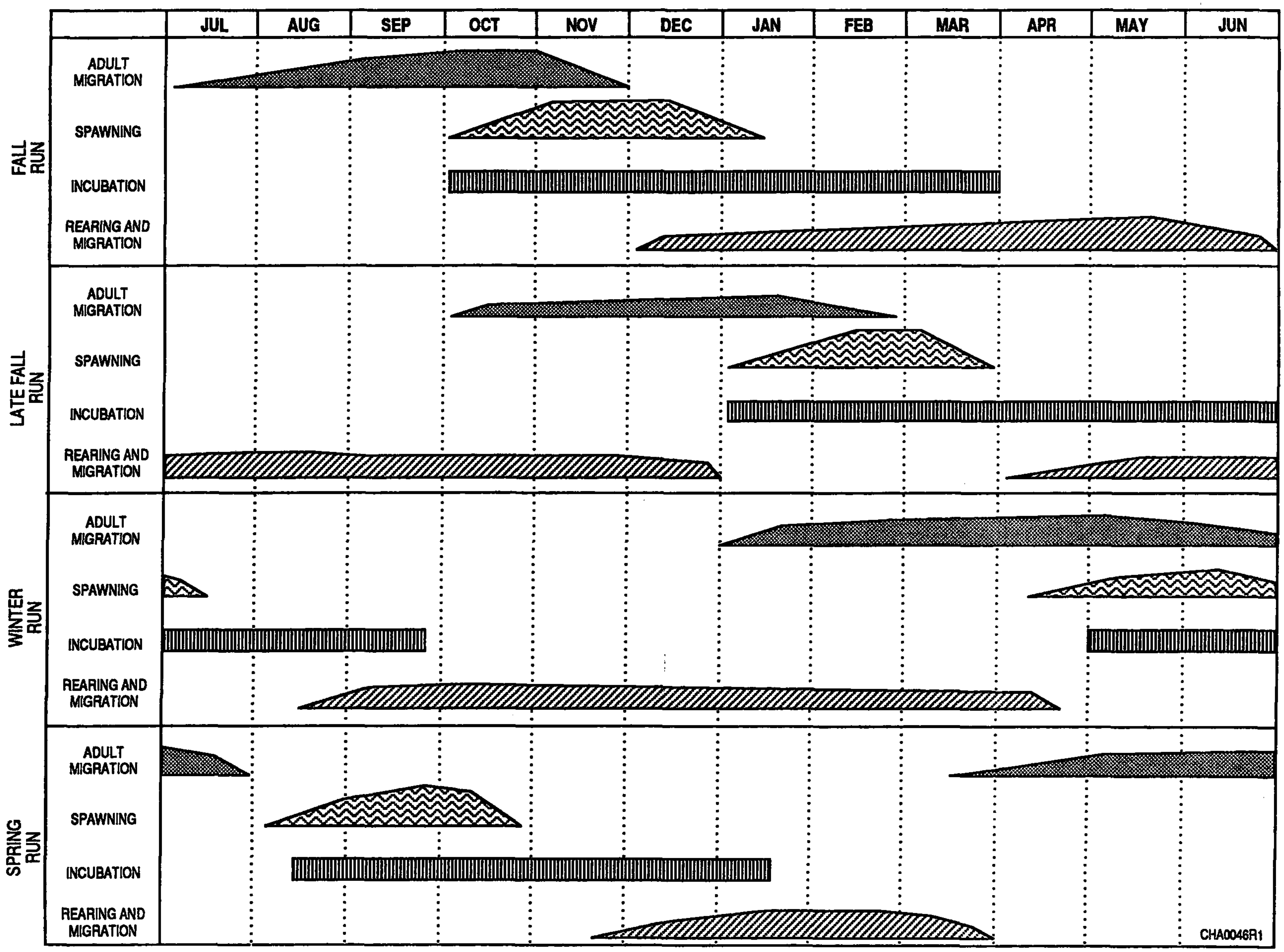
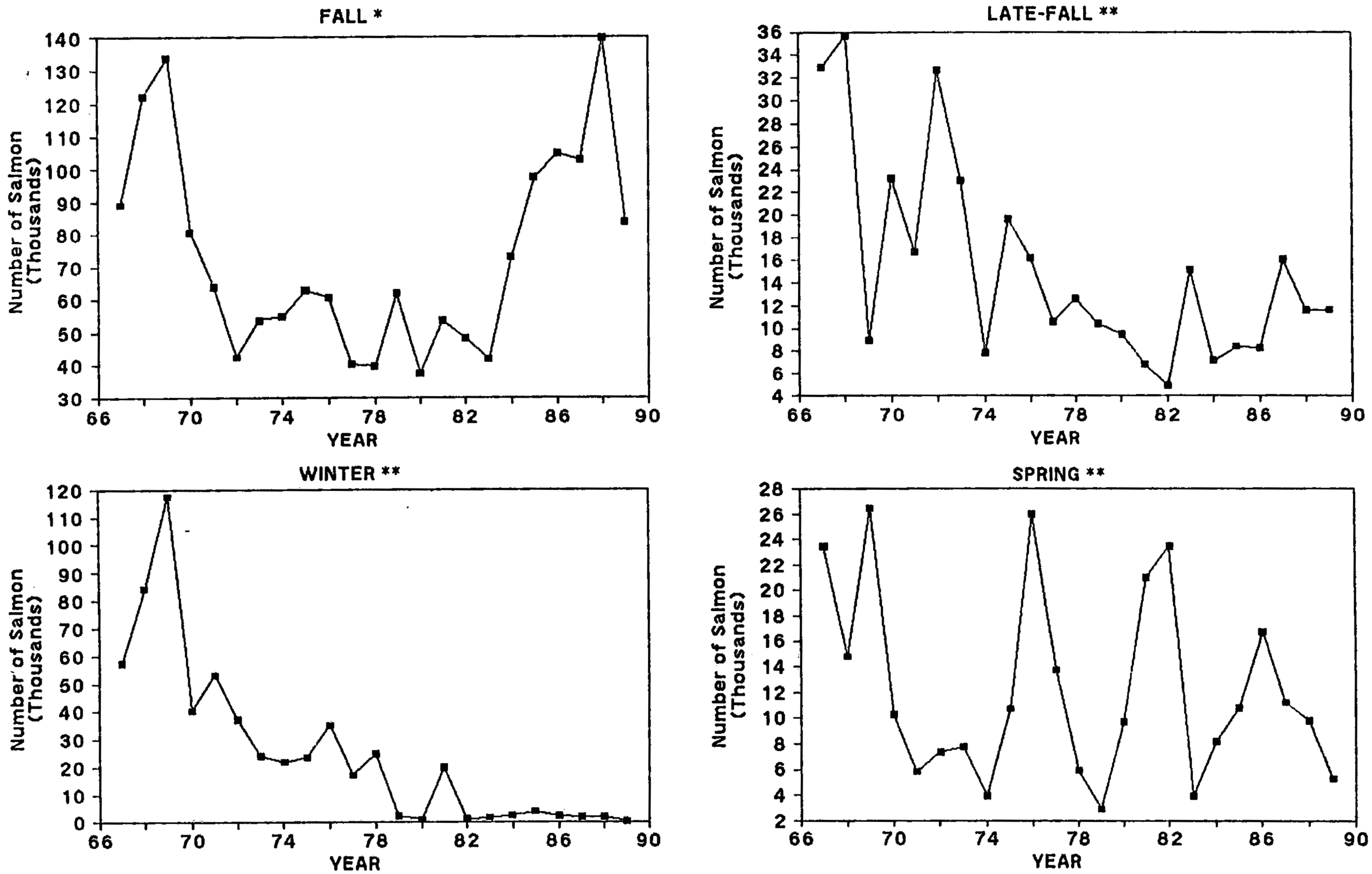


FIGURE A4-5 **Spawning escapement of the four races of Chinook Salmon in the Upper Sacramento River Basin**

(After USFWS, 29,7-10,Figures 3-6, & update from D. Painter, DFG)



* Upper Sacramento River 1967-1989

** Chinook Salmon Counts Past Red Bluff Diversion Dam 1967-1989

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TABLE A4-5 Chinook Salmon Environmental Requirements and Life History Stages

Life Stage	Location	Duration (race)	Flow	Water Quality	Other
Adult Migration	Pacific Ocean Bay-Delta to upstream	July-Dec (fall) Oct-Mar (Late-Fall) Jan-June (winter) mid Mar-Aug (spring)	Adequate flow of home stream water to locate spawning grounds and cover redds	Temperature Chinook Migration Range Optimum: 49-57.5°F Dissolved Oxygen ≥6 mg/l	
Spawning	Upper reaches of all major rivers and streams in Sacramento-San Joaquin River Basins below dams	Oct-mid Jan (fall) Jan-Apr (late fall) Apr-mid July (winter) Aug-Nov (spring)	Stable flow without extreme fluctuation sufficient to cover and aerate redds	Temperature Chinook Gen'l Spawning Range Lower Threshold: 42°F Upper Threshold: 58°F Dissolved Oxygen ≥7 mg/l	Clean gravel substrate with good circulation through redd
Incubation (Egg-Alevin)	Spawning grounds (see above)	Oct-Apr (fall) Jan-Jul (late fall) May-Oct (winter) mid Aug-mid Jan (spring)	same as above	same as above	same as above
Rearing (Fry-Junvenile)	Upstream, Delta, and upper estuary	Dec-Mar (fall) Apr-Aug (late fall) mid Aug-Nov (winter) late Nov-Jan (spring)	Stable flow to prevent stranding Can tolerate greater flows and velocities as they mature and move into deeper water	Temperature Chinook Optimum Range Lower Lethal: 32°F Upper Lethal: 79°F Preferred Range: 45-58°F Dissolved Oxygen ≥6 mg/l	Diet of aquatic and terrestrial insects, crustaceans
Smolt Migration	Downstream to Bay-Delta Estuary to Pacific Ocean	Apr-June (fall) Aug-Jan (late fall) Nov-late Apr (winter) Feb-Apr (spring)	Tolerate higher flows typical of spring snow melt or rainy season. Helps move smolts downstream	same as above (Water Quality data from Bell 1973)	Diet of Neomysis Crangon, Corophium, and aquatic and terrestrial insects (SWRCB,433,133)

Including naturally-produced fish and hatchery-reared salmon released in or above the Delta (USFWS, 31,27), the annual fall smolt run that passed Chipps Island between 1978 and 1985 was estimated to range from 10 to 50 million fish (USFWS,31,25). On the average, it takes an individual fall-run smolt three weeks to emigrate from the upper Sacramento to the ocean (one week to reach the Delta and about two weeks to pass through the Delta and Bay) (USFWS, 31,32). Smolt emigration through the Delta usually peaks in May (Figure A4-4) (USFWS,31,22). However, smolts from different tributaries leave their natal streams and move into the Delta at different times and there are year-to-year variations in the timing of emigration (USFWS,31,23). The fall run emigration from April through June (USFWS,31,17) coincides with historical flow increases caused by snow melt (DWR,561,6). Fall-run fry tend to enter the Delta with high flows following winter storms (memo from D. Stevens to H.K. Chadwick, June 19, 1989). The USFWS has determined through mark-recapture studies that fry released upstream survive better than those released in the Delta in wet years (USFWS;3,35; USFWS,2,27). San Joaquin River Basin fall-run smolts emigrate somewhat earlier during this period than Sacramento River Basin smolts (USFWS,31,23). The increase in Delta smolt abundance observed in October and November is probably the late-fall race or yearling, fall-run salmon. The winter- and spring-runs emigrate from January through March.

Peak abundance of salmon salvaged at the state's Delta pumping plant confirm this seasonal pattern of young salmon abundance in the Delta (see Figure A4-6).

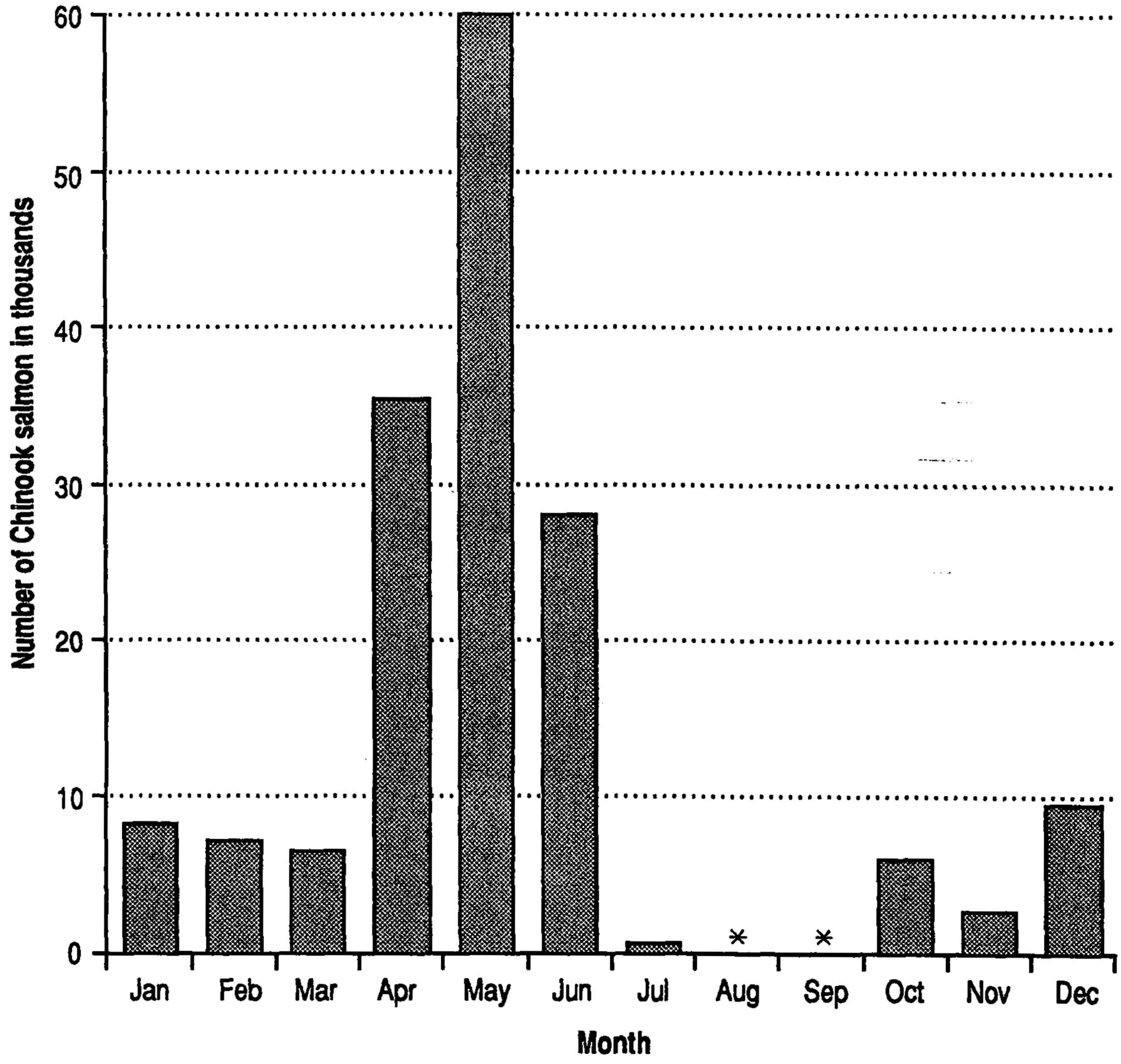
o Survival and Abundance

Smolts migrate downstream to the ocean where they mature for two or more years. Recoveries of adults in the ocean, tagged as smolts and released in Suisun Bay, indicate that only about two percent survive. Thus, 10 to 50 million smolts would produce 200,000 to 1,000,000 fish available to the ocean fishery (i.e., 10,000,000 x .02 = 200,000 adults or 2 percent survival rate from smolt entering salt water to attaining adulthood) (USFWS,31,27). The commercial harvest of Central Valley Chinook is about 350,000 to 450,000 fish (see Figure A4-3). The number of fish escaping harvest and mortality and returning to the spawning grounds each year is known as annual escapement. Survival from eggs to returning adults in a stable population was reported to average 0.04 percent (DWR,561,3). No detailed evidence was presented regarding overall survival rates for Sacramento-San Joaquin Basin Chinook salmon.

o Salmon Harvest and Economic Value

Table A4-6 shows the average estimated ocean commercial and sport catch of Central Valley Chinook salmon in California and an estimate of the proportion supported by hatchery production (DWR,559,45). The estimated 1977-1986 California commercial harvest of Chinook salmon from the Central Valley averaged well over 300,000 fish per year (USFWS,31, 177,Appendix 32), representing almost 60 percent of the total ocean catch of Chinook salmon in California during this period.

FIGURE A4-6 Mean monthly salvage of Chinook salmon at the State Water Project fish protective facility, 1968 - 1986 (From DFG, 17, Appendix , Table 4)



* about 100 fish

TABLE A4-6

Estimated Average Annual Harvest of Chinook Salmon and the Hatchery Contribution to the Catch of Central Valley Salmon

Year	Ocean Commercial Catch 1/ (1)	Commercial Catch of Central Valley Chinook 1/ (2)	Percent of Ocean Catch from Central Valley Chinook (2/1) (3)	Ocean Sport Catch of Central Valley Chinook 2/ (4)
1952-1970	558,282	320,982	57	52,157
1971-1977	564,796	309,402	55	91,608
1978-1986	560,711	333,160	59	63,866

Year	Sport + Commercial Catch of Central Valley Chinook (2+4) (5)	Ocean Commercial + Sport Catch of Hatchery Chinook 3/ (6)	Percent Hatchery Chinook in Central Valley Catch (6/5) (7)
1952-1970	373,139	7,407	2.0
1971-1977	401,010	88,603	22.1
1978-1986	397,026	141,291	35.6

1/ From DWR,561,57, Appendix A-3.

2/ From DWR,561,58-60, Appendix A-4.

3/ From DWR,559,44-45, Table III-4. The period of time covers 1957-1970 for the American River hatchery alone. Subsequent years include the Feather River hatchery production through 1984. Contributions by other Central Valley hatcheries were not determined.

The five-year average price per salmon purchased "off the boat" was estimated to be $26 in 1987. The average commercial catch for 1982-1986 was about 315,500 fish (USFWS,31,177), which translates to an average annual value of about $8.2 million per year for the commercial fishery. The ocean sport harvest averages about 60,000 fish per year (see Figure A4-3). It is estimated that $72 per day is spent for about 100,000 days of ocean recreational fishing, primarily party boat rentals, for an estimated annual value of $7.2 million (Huppert and Thomson, 1984) (BISF,40,15). USFWS presented an estimate for the inland sport harvest of Chinook salmon of 35,000 fish (USFWS,31,103). However, Meyer Resources (1985) reported the inland catch is estimated to be ten percent of the ocean sport catch (BISF,40,15), or about 6,000 fish. At a catch rate of 0.2 fish per day (USFWS,1984), the estimated angler days per year range from a high of 175,000 days (for 3,500 fish) to a low of 30,000 days (for 24,000 fish). Catch rates are highly variable. Fishing success rates may vary from an average of 0.01 fish per hour effort from Carquinez Strait to Sacramento, to an average of 0.09 fish per hour from Red Bluff to Keswick Dam. The success rates range from 0.08 to 0.72 fish per assumed 8-hour outing with the majority of the Sacramento River fish being caught on the upper portions of the river. Based on cost estimates for shore fishing ($31 per day) to boat rental (about $48/day) (BISF,40,15) the estimated annual value of the inland recreational Chinook fishery ranges from $930,000 to 1.4 million (for 30,000 angler days) and from $5.4 to $8.4 million (for 175,000 angler days). The value of Central Valley Chinook salmon harvested in California's inland and coastal waters is estimated to range from a minimum of approximately $15.8 million to a maximum of approximately $23.8 million (see Table A4-7).

Table A4-7

ESTIMATED DOLLAR VALUE OF CHINOOK SALMON CAUGHT IN CALIFORNIA

Commercial Fishery (million $)	Sport Fishery1/ (million $)	Total (million $)
	Inland	Ocean
	.387-.60	15.8-16.0
8.2		7.2
	5.4-8.4	20.8-23.8

1/ Estimates of the size of the inland fishery vary widely from 6,000-35,000 fish. Therefore the estimated dollar value was calculated for both these estimates (derived from values in BISF,40).

Striped Bass

Striped bass, Morone saxatilis, were successfully introduced into the Estuary at Martinez with the planting of about 140 fish from the Navesink River, New Jersey, on June 18, 1879. A second planting of 300 fish occurred in 1882 (BISF,58,2). The stock expanded quickly and before 1890 supported a commercial fishery that was terminated in 1935 due to a population decline (BISF,47,27). While an important recreational fishery continues to the present, recent declines have caused concern.

o Migration and Spawning

The striped bass is a warm water, anadromous fish. Most of its adult life is spent in San Francisco Bay and adjacent ocean areas (T,XLI,67:1-7). In the fall the adults migrate upstream and spend the winter in Suisun Bay and the western Delta. In spring the adults move farther upstream to spawn in the Sacramento River between Sacramento and Colusa and in the western and central Delta portion of the San Joaquin River between Antioch and Venice Island (T,XLI,67:1-16). Spawning typically occurs in the Delta from late April through May and in the Sacramento River from mid-May to mid-June (T,XLI,67:22-25). About one-half to two-thirds of the eggs that are spawned are produced in the Sacramento River, with the remainder in the Delta (T,XLI,67:20-22).

About 3 mm in diameter, striped bass eggs drift with the currents and hatch in two to three days (T,XLI,69:11-13). The larvae first subsist on the remainder of their yolk sacs and oil droplets and continue to drift until they are about six mm in length, when they start feeding on zooplankton (copepods and cladocerans) (BISF,47,35). They soon consume larger organisms, especially the opossum shrimp, Neomysis mercedis, which remains the dominant food organism through the first two years of life before the bass shift to larger food, including Bay shrimp and forage fish (T,XLI,70:1-8).

The majority of bass larvae tend to concentrate in the entrapment zone in Suisun Bay and the western Delta, although in very high flow years the entrapment zone and the larvae may be found farther down the Estuary (T,XLI,69:15-24). The lower San Joaquin River appears to be a less desirable nursery area than in former years. Higher larval mortalities here appear to be the cause for the decline of the Delta portion of the Striped Bass Index (SBI) (T,XLIII,30:17-23,31:11-15).

Striped bass represent a substantial resource throughout the Estuary, upstream on the Sacramento River, in coastal waters and in export canals and reservoirs (see Appendix Sections 4.0.9.3 and 4.0.9.5). From 1983 to 1985, sales of striped bass stamps (required by law for fishing) averaged over 560,000 per year (NOAA,1986). Annual recreational catches of striped bass (excluding reservoirs and aqueducts) vary from 100,000 to 400,000 fish (T,XLI,70:17-18), and are taken mainly from private boats or along the shoreline. Charter boats take 10 to 15 percent of the catch (T,XLI,70:25-71:17). Apart from the fishery, striped bass are valuable in the food chain of the Estuary.

Their eggs and small larvae serve as food for other fish and invertebrates. Being principal predators in the river and estuarine food chains, larger bass contribute to the control of the size of forage fish populations.

American Shad

American shad, Alosa sapidissima, is a warm water, anadromous fish species. Shad were introduced to the Delta from the east coast in the late 1800s and within ten years a commercial gill net fishery developed. Over one million pounds (lbs) per year were regularly harvested. DFG estimated that in 1917, at an average weight of three lbs per fish, almost two million shad were caught, representing about 5.8 million lbs (DFG,23,16). By the late 1940s the fishery declined, and by 1957 commercial fishing of shad ended when gill netting was prohibited to protect other fisheries (DFG,23,1; SWRCB,405,42).

Estimates from a 1976-1977 survey indicate a population of about three million American shad spawners (T,XXXIX,13:11-12; DFG,23,15). A popular shad sport fishery exists in the Sacramento, San Joaquin, American, Feather, and Yuba rivers and in the Delta. Surveys in the late 1970s indicate that between 35,000 and 55,000 angler days were spent in catching about 79,000 to 140,000 shad (DFG,23,1-2). No specific data on the value of the shad fishery are available. However, if shore fishing expenditures average about $31 per angler day (Thomson and Huppert, 1987), the total annual value ranges from $2.4 to $4.3 million.

The life history stages and habitat requirements of American shad are shown in Table A4-8. Adult shad spend three to five years in the ocean before they reach maturity (SWRCB,450,33) and enter the lower Estuary in the fall; they migrate through the Delta from about March through May to upstream spawning grounds (T,XXXIX,13:23-24), actively feeding on copepods and cladocerans, as well as Neomysis and Corophium (DFG,23,12; SWRCB,433,100). Peak adult numbers occur in the upper Delta in May (DFG,23,5).

Historically, spawning occurred throughout the tidal fresh water reaches of the San Joaquin and Sacramento rivers and upstream from about May through July. Today, the lower San Joaquin River no longer supports significant spawning activity (T,XXXIX,14:3-23). Spawning occurs primarily from May to June in the north Delta, the Sacramento River above Hood up to the Red Bluff diversion dam, and the major tributaries of the Sacramento River (DFG,23,2-4; SWRCB,450,3-3; DFG,13,21; SWRCB,405,41).

After shad spawn, the fertilized eggs sink and drift with the current until hatching about 4 to 6 days later (SWRCB,405,41). When river flows are high, more shad eggs are carried further downstream and the importance of the Delta as rearing habitat increases (T,XXXIX,15:13-15). The major shad nursery areas are located in the Feather River below the mouth of the Yuba River, the lower American River, the Sacramento River from Colusa to Sacramento, and the north Delta (DFG,23,8;T,XXXIX,15:3-15:6). Shad nursery habitat is mostly upstream from striped bass nursery habitat (T,XXXIX,49:1-49:3) and overlaps with

TABLE A4-8 --American Shad Environmental Requirements and Life History Stages (from DFG,23;DFG,13;SWRCB,405;SWRCB,433)

Life Stage	Location	Period	Flow	Water Quality	Other
Adult Migration	from Pacific Ocean through Bay-Delta to upstream freshwater tributaries	March-May	low flows reduce size of run in tributaries	temperature 57-75° F	diet is Neomysis and other zooplankton
Spawning	upper Sacramento River to Red Bluff Diversion Dam and major tributaries, North Delta, Mokelumne and Old River. Formerly San Joaquin R.	April-early July	higher flows increase numbers spawning in tributaries	63-75° F optimum = 60-70° F	spawn over sand or gravel
Egg Incubation	lower Sacramento R. below Colusa, Feather and American Rivers, Delta	May-July	higher flows carry more eggs into Delta		
Rearing	same as above	June-Sept	more juveniles produced when flows are higher		feed on terrestrial insects, zooplankton
Juvenile Emigration	Delta-Estuary to Bay or Pacific Ocean	late June-December			diet is Neomysis, Corophium, larval fish, copepods

Chinook salmon rearing areas. In rearing areas upstream from the Delta, young shad concentrate near the water surface, feeding on terrestrial insects that drop into the water from riparian vegetation (SWRCB,433,101). From about June through August in the Delta, young shad feed on zooplankton before emigrating as juveniles during September to December (DFG,23,11; SWRCB,450,3-3). Most shad emigrate by the end of their first year (DFG,23,10). However, some may remain in San Francisco, San Pablo, and Suisun bays and Suisun Marsh for a second year or may not emigrate to the ocean at all (DFG,23,10-11). According to DFG relatively few yearling shad use the Suisun Marsh channels (T,XXXIX,46:1-5).

Other Resident and Anadromous Fish

There are over 30 species of resident, warm water fishes in the Estuary (DFG,24,2), more than half of which were introduced. Most resident fish are members of one of three families: Centrarchidae, sunfish; Cyprinidae, minnows; and Ictaluridae, catfish.

o Background

These families support popular recreational fisheries in the Delta, where white catfish, Ictalurus catus, are the most commonly caught resident game fish, followed by largemouth bass, Micropterus salmoides, and then other sunfish. Statewide, sunfish, catfish and largemouth bass are the second, third, and fourth most commonly caught game fish (DFG,24,5). Non-game resident fish are important components in the estuarine food web both as predators and prey (DFG,24,6). An important introduced forage species, the threadfin shad, Dorosoma petenense, is consumed by striped bass, largemouth bass and other sunfish (SWRCB,450,3-10). Table A4-9 lists the resident species of the Estuary. Only fish of specific interest or concern are discussed below.

o Catfish

Of the four species of introduced catfish (see Table A4-9), the white catfish, by far the most numerous (DFG,24,4), supports a significant recreational fishery. In the southern Delta where EC and turbidity were greater, white catfish were the most numerous resident fish species (DFG,24,28).

o Other Anadromous Species

Several other native, anadromous fish use the Delta as a migration corridor and nursery habitat. They are the green sturgeon, Acipenser medirostris; the white sturgeon, Acipenser transmontanus: and the steelhead rainbow trout, Oncorhynchus mykiss (formerly Salmo gairdneri gairdneri) (SWRCB,405,38)(WQCP-DFG-1). Other than information presented in SWRCB exhibits, no testimony or recommendations were made in Phase I of the proceedings regarding these species' uses of the Delta.

TABLE A4-9 Fishes of the Delta
(from DFG,24 and SWRCB,450)

Cyprinidae - Minnows

Carassius auratus
goldfish (I) * +
Cyprinus carpio
common carp (I) +
Lavinia exilicauda
hitch (N) +
Mylopharadon conocephalus
hardhead (N) +
Notemigonus crysoleucas
golden shiner (I) +

Orthodon microlepidotus
Sacramento blackfish (N) +
Pimephales promelas
fathead minnow (I)
Pogonichthys macrolepidotus
splittail (N) + 1/
Ptychocheilus grandis
Sacramento squawfish (N) +

Ictaluridae - Catfish

Ictalurus catus
white catfish (I) +
Ictalurus melas
black bullhead (I) +

Ictalurus nebulosus
brown bullhead (I) +
Ictalurus punctatus
channel catfish (I) +

Centrarchidae - Sunfish

Lepomis cyanellus
green sunfish (I) +
Lepomis gibbosus
pumpkinseed (I) +
Lepomis gulosus
warmouth (I) +
Lepomis macrochirus
bluegill (I) +
Lepomis microlophus
redear sunfish (I) +

Micropterus dolomieui
smallmouth bass (I) +
Micropterus punctulatus
spotted bass (I) +
Micropterus salmoides
largemouth bass (I) +
Pomoxis annularis
white crappie (I) +
Pomoxis nigromaculatus
black crappie (I) +

Others

Catostomus occidentalis
Sacramento sucker (N) +
Hysterocarpus traski
tule perch (N) +
Menidia beryllina
inland silversides (I) +
Dorosoma petenense
threadfin shad (I) +
Percina macrolepida
bigscale logperch (I) +
Morone saxatilis
striped bass (I) +
Alosa sapidissima
American shad (I) +
Acanthogobius flavimanus
yellowfin goby (I) +
Cottus asper
prickly sculpin (N) +
Leptocottus armatus
Pacific staghorn sculpin (N) +
Oncorhynchus tshawytscha
chinook salmon (N) +

Oncorhynchus mykiss
steelhead (N) +
Gambusia affinis
mosquitofish (I) +
Gasterosteus aculeatus
threespine stickleback (N) +
Entosphenus tridentata
Pacific lamprey (N) +
Lampetra ayresi
river lamprey (N)
Mugil cephalus
striped mullet +
Hypomesus transpacificus
Delta smelt (N) + 2/
Spirinchus thaleichthys
longfin smelt (N) +
Platichthys stellatus
starry flounder (N) +
Acipenser transmontanus
white sturgeon (N)
Acipenser medirostris
green sturgeon (N)

* I = introduced; N = native; + indicates species collected in DFG's 1980-1983 electrofishing survey
1/ State species of special concern 2/ State candidate species

An intense commercial sturgeon fishery existed in the 1800s, but was closed in 1901 after the catch plummeted. The fishery reopened in 1910, was closed in 1917, and in 1954 reopened for recreational purposes only (SWRCB,430,453). Angling is popular in the Sacramento River up to Colusa, in the Delta (SWRCB,405,35-36), and in the bays. Sturgeon are taken in San Francisco Bay where they congregate to feed during the herring runs (SWRCB,430,454). Party boats reportedly harvested 2,400 sturgeon in 1967. There is no information on the recent magnitude of the fishery.

Adult steelhead migrate upstream from the ocean during the spring through fall. Spawning occurs from December through April in tributaries above the Delta. Like salmon, steelhead return home to their natal stream; unlike salmon, not all adults die after spawning. Steelhead are known to have spawned up to four or more times (SWRCB,405,60; SWRCB,450,5-7). There are several seasonal runs of steelhead migrating through the Delta (SWRCB,405,59-60; SWRCB,450,5-6). The size of the recreational fishery for steelhead adults and juveniles is unknown.

o Species of Concern

The Sacramento splittail, Pogonichthys macrolepidotus, is one of two species of special concern because its distribution is restricted to the Bay-Delta Estuary and it has recently declined in abundance (USFWS,35,1). The other, the Delta smelt, Hypomesus transpacificus, once abundant in Suisun Marsh and the Delta, has undergone a precipitous decline since the early 1970s (USFWS,35,20). Both fish have been recommended as candidate species by the USFWS to be studied to determine whether they should be added to the federal Endangered and Threatened list (USFWS,35,11)[1].

The splittail is a category 2 candidate and the Delta smelt is a category 1 candidate. (A category 1 species is one for which the USFWS has substantial information to support a proposal for listing as endangered or threatened. A category 2 species is one for which information available indicates that a proposal for listing is possibly appropriate but that the data available are not conclusive.)

A petition was submitted June 9, 1989 to the Fish and Game Commission to list the Delta smelt as an endangered species under the California Endangered Species Act. On August 29, 1989, the Commission accepted the petition and for one year the Delta smelt was a candidate species. During this time DFG staff reviewed the pertinent data and recommended that the species be listed as threatened. The Fish and Game Commission on August 31, 1990 decided that there was insufficient evidence to list the species at all and that further studies on the species should be conducted. The Delta smelt remains a species of Special Concern.

1/ *Listing refers to a process established under state and federal Endangered Species Act by which Native species are identified. Those listed are determined to be in immediate jeopardy of extinction ("endangered") or to be present in such small numbers throughout their range that they may become endangered if their present environment worsens (rare plant or threatened species) (California Fish and Game Code Sections, 7, and 2068; 16 USC Section 1531 et seq.)*

2/ *Section 670.1, Title 14, CCR and Sections 2072 and 2072 and 2072.3 of the Fish and Game Code.*

The USFWS was petitioned by the California-Nevada Chapter of the American Fisheries Society on June 26, 1990 to list the Delta smelt as an endangered species under the federal Endangered Species Act. A USFWS administrative finding on the petition request stated that substantial information was presented such that listing may be warranted. This initiates a one year review period, from the date of receipt of the petition (6/29/90), in which the USFWS will gather information on which to make a determination on whether to list the Delta smelt. Until this determination is made, its status remains a category 1 candidate species.

The information on resident freshwater species and other anadromous fish presented in the Phase I hearing was mostly descriptive. No quantitative data were presented on the relationship between population abundance, distribution and salinity regimes.

Subsequent investigations have revealed that the Delta smelt inhabit the open surface water of the Delta and Suisun Bay and live about one year. The adult Delta smelt spawn in freshwater between the months of December and April (Moyle, 1976) and most apparently die after spawning. The buoyant larvae are washed downstream until they reach the entrapment zone, where the currents keep them suspended and circulating with the zooplankton, which is their food. During the larval stage, from approximately April through June, the smelt are not yet of sufficient size to be efficient swimmers and effectively pursue their prey. Therefore, a high density of prey items in suitable habitat offers an advantageous environment for rearing (Moyle, pers. comm., 10/89). The smelt grow rapidly and within six to nine months reach adult length. In the next three months the smelt become sexually mature and move up into the freshwater to spawn. All sizes are found primarily in the main channels of the Delta and Suisun Marsh, and the open water of Suisun Bay (Moyle, 1989). Delta smelt, most of the year, are found in water of less than 2 ppt TDS (2.9 mmhos/cm EC) and occasionally are found in water up to 10 to 12 ppt TDS (14.6 to 17.5 mmhos/cm EC) (Moyle, 1989). Spawning occurs in freshwater when the water temperatures are between 7 and 15°C (44.6 to 59°F) (Wang, 1986).

4.0.5.2 Bay Habitat

Suisun, San Pablo, San Francisco and south San Francisco (South) bays are considered here. Since, for this Plan, Suisun Bay is considered to be part of the Bay, it is included here for purposes of discussion.

Fishery Habitat Protection (Entrapment Zone)

As in the freshwater portions of the Estuary, phytoplankton and zooplankton form important parts of the food chain in the more saline portions of the Estuary. Many fish rely upon the presence of copepods and cladocerans, e.g., <u>Neomysis</u>, <u>Corophium</u>, and <u>Lagunogammarus</u>. These zooplankton in turn feed upon detritus and upon phytoplankton, the primary producers. Maximum phytoplankton production for this Estuary appears to occur when outgoing freshwater and incoming ocean water mix at approximately the upstream end of Suisun Bay (USBR,111,28; USBR,112,53-70). The area just downstream of this location, known as the entrapment zone, is a concentration site for certain diatoms, detritus, <u>Neomysis</u> and other zooplankton (USBR,111,27).

The Suisun Bay normally receives enough annual fluctuation in salinity that neither marine nor freshwater filter-feeding benthic organisms could establish themselves and survive indefinitely (Nichols, 1985). However, the recently introduced benthic clam, Potamocorbula, appears to be much more euryhaline (tolerant of wide ranges in salinity), and so has been able to survive throughout the Bay. It has even penetrated upstream in the Delta as far as Rio Vista (Jan Thompson, USGS, personal communication, 1/90).

In addition to the Suisun Bay entrapment zone, a proposal was made to develop a second entrapment zone in San Pablo Bay. This second entrapment zone (or at least an area with stratified flow with a strong horizontal salinity gradient) is proposed to provide additional phytoplankton production (CCCWA/EDF,3,23).

Finally, regarding phytoplankton, a proposal was made to enhance their production in South Bay (CCCWA/EDF,4). Research has shown that the clam Macoma balthica tended to show growth rate increases consistent with microalgae availability, including phytoplankton (T,LI,181:20-182:15).

Benthic Invertebrates

"The 'benthos' is the community of invertebrate animals (worms, clams, shrimp, etc.) living on the bottom of aquatic environments. These animals consume organic matter that grows on, or settles to the bottom and in turn become food for fish and other consumers including humans" (TIBCEN,23,65). Benthic invertebrates in the Estuary tolerate a range of salinities; some prefer different flows and salinities at different life stages (DFG,59,14). There are species requiring only freshwater, species requiring a combination of salt and freshwater, and those surviving only in saltwater. For example, some species prefer fresher water during early life stages and as juveniles are found in the upper reaches of the estuary, whereas adults prefer higher salinities and occupy the Bay (DFG,59,22). Adult shrimp occupy bottom areas in their preferred habitat, while shrimp larvae are found in less saline surface layers. These behavioral differences, combined with the effects of the two-layered flow in the Bay, result in different distributional patterns of young and old shrimp (USBR,110,15). For example, Crangon spp. shrimp breed in the Bay, produce planktonic larvae which may be carried into the ocean near shore by surface water, drop down as benthic post-larvae and re-enter the estuary carried by gravitational circulation (DFG,59,23).

The following benthic organisms found in the Estuary are part of the food chain which supports popular sport or commercial fisheries and wintering waterfowl:

- mollusks, including clams (Macoma balthica, Mya arenaria, Tapes japonica, Gemma gemma, Corbicula spp.), mussels (Ischadium demissum, Mytilus edulis), oysters (Ostrea lurida), and snails (Nassarius obsoletus);

- arthropods, including amphipods (Corophium spp., Grandidierella japonica, Ampelisca milleri, Lagunogammarus spp.), shrimp (Crangon spp.), and crabs (Cancer spp.); and

- worms (Limnodrilus spp., Boccardia ligerica, Streblospio benedicti) (Markmann, 1986).

There is a pronounced "faunal break" west of Suisun Bay, where freshwater and brackish water species give way to salt-tolerant species found in San Pablo Bay (DFG,59,12).

Fishery Resources

In reporting that "sport fishing is the most popular recreational activity in the San Francisco Bay and Delta area," DFG estimated that 4.4 million recreation-days were used in this activity, with a much larger, as yet undeveloped, potential demand (DFG,59,10). Striped bass, Chinook salmon, and halibut are the most popular species caught in the Bay; other sport species include brown rockfish, surf perch, lingcod, jacksmelt, topsmelt, white croaker, shark, ray and skate.

The commercial harvest of finfish in the Bay has been limited by legislation (T,LII,19:3-20), with only herring and anchovy being taken commercially today (DFG,59,11). The herring fishery is primarily for roe which is exported to Japan. Anchovy are harvested primarily for bait. DFG estimated the commercial harvest of herring roe and shrimp from San Francisco Bay landings to have a value of $11.6 million per year (H. Chadwick, pers. comm., 12/28/87).

DFG collected 122 fish species and about 1,642,000 individual fish, including larvae, during a six-year study from January 1980 through December 1985 (DFG,59). Most species were so rare they were not analyzed further. Near bottom (demersal) habitats supported a more abundant, diverse fish community than open water (pelagic) or nearshore areas (DFG,59,6). Table A4-10 identifies the predominant species caught in each of these areas.

Many of the species which are prey for other fish or birds are permanent residents of the Bay, including gobies, topsmelt, and Pacific staghorn sculpin. The Bay also provides nursery and rearing habitat for species which are harvested commercially and recreationally (see Table A4-11). For example, the English sole and starry flounder spawn offshore but their eggs or young are carried by gravitational circulation into the Bay where they mature. Adults of other commercially important species such as Pacific herring and northern anchovy actively move into and spawn in the Bay where their young also mature (DFG,59,10).

4.0.5.3 Marine Habitat

The beneficial uses of the marine habitat include the propagation and sustenance of fish, shellfish, marine mammals, waterfowl and vegetation such as kelp.

TABLE A4-10

Most common Bay fish collected from demersal, pelagic and nearshore areas by DFG, 1980-1986
(From: DFG, 59,6)

SHORE HABITAT	PELAGIC HABITAT	DEMERSAL HABITAT
Atherinops affinis topsmelt	Engraulis mordax Northern anchovy	Spirinchus thaleichthys longfin smelt
Clupea harengus pallasi Pacific herring	Spirinchus thaleichthys longfin smelt	Engraulis mordax Northern anchovy
Engraulis mordax Northern anchovy	Clupea harengus pallasi Pacific herring	Morone saxatilis striped bass
Atherinopsis californiensis jacksmelt	Morone saxatilis striped bass	Cymatogaster aggregata shiner perch
Morone saxatilis striped bass		Parophrys vetulus English sole
Leptocottus armatus Pacific staghorn sculpin		Genyonemus lineatus white croaker
Menidia beryllina tidewater silverside		Leptocottus armatus Pacific staghorn sculpin
Clevelandia ios arrow goby		Lepidogobius lepidus Bay goby
Cymatogaster aggregata shiner perch		Citharichthys stigmaeus speckled sanddab
Micrometrus minimus dwarf perch		Acanthogobius flavimanus yellowfin goby
Acanthogobius flavimanus yellowfin goby		Platichthys stellatus starry flounder
		Clupea harengus pallasi Pacific herring

TABLE A4-11 Life history and descriptive information for the most abundant species of fish collected. (DFG,59)

Species	Species origin	Species type	Life history			Center of population	Importance of species	Preferred habitat	Use of Bay	Life stage major food source	
			Spawning time	Spawning location	Nursery area					Adult	Juvenile
Pacific herring	N	M	Fall - Winter	Bay	SSFB - SPB	Ocean	Commercial Forage	Pelagic	Spawning Nursery	P	P
Longfin smelt	N	E	Winter	Rivers	SPB	SPB	Forage	Pelagic	Nursery Residence	P	P
Pac. staghorn sculpin	N	E	Winter	Bay	Bay	CSFB - SPB	Forage	Demersal	Residence	F,B	B
Starry flounder	N	E	Winter	Ocean	SB-Delta	Ocean - Bay	Commercial Recreation	Demersal	Nursery Residence	B	B
Speckled sanddab	N	M	All Year	Ocean	Ocean - CSFB	Ocean	Forage	Demersal	Nursery	B	B
English sole	N	M	Winter	Ocean	Ocean - Bay	Ocean	Commercial	Demersal	Nursery	B	B
California tonguefish	N	M	Summer - Fall	Ocean	Ocean - CSFB	Ocean	Forage	Demersal	Nursery	B	B
Yellowfin goby	I	E	Winter	Bay	SB - Delta	SPB - SB	Forage Commercial	Demersal	Residence	B	B
Arrow goby	N	M	Spring - Summer	Bay	SSFB - SPB	SSFB - SPB	Forage	Demersal	Residence	B	B
Bay goby	N	M	Summer - Fall	Bay	SSFB - SPB	CSFB	Forage	Demersal	Residence	B	B
Topsmelt	N	M	Summer	Bay	SSFB - CSFB	SSFB	Forage	Littoral/ Pelagic	Residence	B	B
Jacksmelt	N	M	Spring - Summer	Bay - Ocean	SSFB - CSFB	Ocean	Recreation Forage	Pelagic	Spawning Nursery	F	P
Northern anchovy	N	M	Spring - Summer	Ocean	Ocean	Ocean	Commercial Forage	Pelagic	Spawning Nursery	P	P

N = native, I = introduced, E = estuarine, M = marine, SSFB = South San Francisco Bay, CSFB = Central San Francisco Bay, SPB = San Pablo Bay, SB = Suisun Bay, P = plankton, B = benthos, F = fish

The protection of marine habitat in many cases will be accomplished by measures to protect wildlife habitat. Some marine habitats may require special protection. Water quality requirements for some individual marine species are not well known (RWQCB 2, 1986).

4.0.6 Wetlands Habitat

Wetlands are those areas that are inundated or saturated by surface or groundwater that under normal circumstances support a prevalence of vegetation adapted for life in saturated soils. Wetlands include marshes, swamps, and riparian areas. Wildlife habitat is the most significant actual and potential beneficial use of wetlands (RWQCB 2, 1986).

4.0.6.1 Delta

The Delta area totals about 738,000 acres, including about 515,000 acres in agriculture; about 50,000 surface acres of meandering channels; 7,000 acres of shrub-brush and woodland riparian habitat; 7,000 acres of freshwater marsh and about 32,000 acres of urban habitat (DFG,6,1). Freshwater marsh and riparian habitat support the greatest diversity of plant and animal species (DFG,6,4). The Delta currently supports from 450,000 to 600,000 migratory waterfowl during the winter, with thousands of shorebirds and wading birds making use of the shallows of seasonally flooded fields (DFG,6,6).

Over 230 species of birds and 43 species of mammals occur in the Delta (DFG,6,1). There are also 15 reptile species and eight amphibian species reported or thought to occur in the Delta (Delta Wildlife Habitat Protection and Restoration Plan, DFG & USFWS,1986).

Migratory waterfowl in particular use spilled and unharvested corn and other grain crops, especially when Delta islands are allowed to be ponded or flooded for leaching purposes (DFG,6,4). Sandhill cranes now depend on wet or flooded pasture and cultivated grains (DFG,6,4&7). The peregrine falcons depend upon waterfowl for a major part of their diet (USFWS,17,2).

4.0.6.2 Rare, Threatened and Endangered Species

In the Delta many of the following animals are so uncommon they have been identified on official lists of rare, threatened or endangered species by wildlife agencies. Seven bird species are listed by either the state or federal government as threatened or endangered. Two more bird species are candidates for federal listing (DFG,6,3; USFWS,19, 20,21). The giant garter snake is a state-listed threatened species as well as a candidate for federal listing as either threatened or endangered (DFG,6,3; USFWS,22). Two mammals, the riparian brush rabbit and the riparian woodrat, are candidates for federal listing as threatened or endangered; three invertebrates also are federally listed as threatened or endangered and thirteen plants are listed by federal and/or state agencies as rare, threatened or endangered (DFG,6,3).

In Suisun Marsh, several sensitive[1/] plant species have been identified (CNPS,3). These are the soft bird's-beak (Cordylanthus mollis mollis), Mason's lilaeopsis (also known as the mud squill, Lilaeopsis masonii), Delta tule pea (Lathyrus jepsonii jepsonii), and Suisun aster (Aster chilensis var. lentus). The soft bird's-beak and Mason's lilaeopsis are listed by the state as "rare" and by the federal government as "candidate" species. The Delta tule pea, the Suisun slough thistle (Cirsium hydrophilum var. hydrophilum) and the Suisun aster are also federal candidate species. CNPS has testified that the California hibiscus (Hibiscus californicus) is a sensitive species even though it is not state or federally listed.

There are also several animal species in the Marsh that have been designated by the USFWS or the DFG as threatened or endangered. These are the salt marsh harvest mouse (Reithrodontomys raviventris), the California clapper rail (Rallus longirostris obsoletus), the California black rail (Laterallus jamaicensis coturniculus), and the winter-run Chinook salmon (Oncorhynchus tschawytscha). The salt marsh harvest mouse and the California clapper rail are listed as "endangered" by both the State of California and the federal government. The California black rail is listed as "threatened" by the State of California and is a federal candidate species. The winter-run Chinook salmon is listed as "threatened" by the federal government and "endangered" by the state (USFWS,17; T,XXIX,112:24-112:15; T,XXX,5:4-11; List of State and Federal Endangered and Threatened Animals in California, DFG, Revised April 1989; Notice of Findings of Sacramento River Winter-Run King Salmon, California Fish and Game Commission, May 22, 1989).

The USFWS is reviewing a petition to list the Suisun song sparrow (Melospiza melodia maxillaris) as endangered or threatened (USFWS, pers. comm., 10/89). The salt marsh common yellow throat (a bird) (Geothylpis trichas sinuosa) and the Suisun ornate shrew (Sorex ornatus sinuosus) are federal candidate species (memo from DFG to SWRCB, June 13, 1989).

The endangered salt marsh harvest mouse and the California clapper rail are also found in the tidal marshes around San Pablo Bay (USFWS,17,1; USFWS,18; USFWS,19; DFG,7,7; T,XXX,5:12-15). Both species are dependent upon dense cover composed of pickleweed and allied plant species; adjacent, higher elevation escape cover for refuge from high water is needed (DFG,7,7; DFG,7,11-12). Any expanded areas of cordgrass and pickleweed which may occur if soil salinities increase, however, will not necessarily be useful to these endangered species because the areas with adequate escape cover are limited. The black rail, a state-listed threatened species and a federal candidate species, is also found in the San Pablo Bay marshes (DFG,7,7,12; USFWS,16,4; USFWS,21). The Delta tule pea, Mason's lilaeopsis, and the soft bird's-beak are also found in the marshes of north San Pablo Bay (DFG,7,13; T,XXIX,144:25-145:1).

1/ As used in this chapter, "sensitive plants" includes state-listed "rare" and federal "candidate" species.

In San Francisco Bay, a variety of species of wildlife listed as threatened or endangered by state or federal wildlife agencies depend on Bay habitats for all or part of the year. Salt marsh harvest mice, California clapper rail, black rail, California brown pelican, and California least tern are listed (DFG,7,13). In Bay marshes, both soft bird's-beak and Mason's lilaeopsis occur near the upper reaches of the Bay.

4.0.6.3 Suisun Marsh

Suisun Marsh, with an area of 116,000 acres, including about 88,000 acres below the five-foot contour, is the largest contiguous brackish water marsh in the United States (T,XXIX,12;DFG,5,1). The major habitat types are managed marshes that are subject to controlled inundation and drainage (generally for the enhancement of waterfowl habitat) and tidal marshes that are influenced by the water regime in the channels. There are also substantial areas of habitat consisting mostly of annual grasses and weedy growth, cropland and open ground. Between 54,000 acres (T,XXX,110:AA4-5) and 57,000 acres (DFG,5,3) are marshland, of which approximately 10,000 acres are tidal marsh (T,XXX,49:21,110:5). Estimates differ, depending on the definitions used and the areas examined, as to what proportion of the marsh acreage is managed and what is tidally influenced. By all estimates, most (80 to 90 percent) of the marshland is managed for plant species considered beneficial to wintering waterfowl (DFG,5,6).

The principal waterfowl using Suisun Marsh in winter are pintail, mallard, shoveler, widgeon and green-winged teal. Mallard, gadwall, and cinnamon teal breed here. The plants which are preferred food items for wintering waterfowl are alkali bulrush, brass buttons, and fat-hen (DFG,5,9). During the remainder of the year, invertebrates are important food for pre-nesting females and broods of ducklings (DFG,5,13).

4.0.6.4 Other Tidal Marshes

San Francisco Bay's tidal marshes, ranging from fresh to salt water habitats, include 53 square miles of tidal marsh, 15 square miles of diked marsh and 55 square miles of diked ponds (DFG,7,1). Large areas of tidal wetland occur on the northeast shore of San Pablo Bay, specifically Tubbs Island, Napa and Petaluma Marsh. Diked marshes, ponds and mudflats are extensive in the South Bay (DFG,7,1).

Bay area wetlands and aquatic habitats support over half of the Pacific flyway's wintering population of such waterfowl as canvasback ducks and are very important for scaup, scoters and redhead ducks. Aquatic habitat and aquatic invertebrates are important in their contribution to the food supply of higher forms of Bay wildlife. One of the most important food items for canvasback ducks is the clam *Macoma balthica*; two other mollusks, *Mya arenaria* and *Musculus senhousia*, are also extensively eaten. These mollusks are also food for clapper rails, as are a variety of other invertebrates (DFG,7,9).

Although many Bay tidal marshes are relatively isolated from the Delta outflow of low salinity water, the nearby Bay waters are affected by stratification, gravitational circulation, and flushing induced by outflow. To the degree that mollusk and fish species and aquatic habitat productivity changes in the Bay, the value of the adjacent marshes and beaches for sensitive wildlife, such as rails, terns, and pelicans, may change (DFG,7,10-12).

4.0.7 Estuary Recreation Beneficial Use

The waters of the Estuary are used for water contact recreation, including swimming, boating, fishing, hunting, water skiing, and houseboating. The waters are also used for competitive events, marine parades and emerging activities, such as boardsailing and jetskiing (EBRPD,1-33). There are also a variety of water-oriented, non-contact activities such as sightseeing, bird watching and beachcombing, all of which depend on the esthetic or visual quality of the Estuary's waters to some degree (EBRPD,1-33).

4.0.7.1 Sacramento-San Joaquin Delta and Tributaries

Evidence was provided which projected user days and economic values for freshwater recreation in the Delta as compared to similar types of recreation at storage and export reservoirs and facilities (SWC,65,24). Freshwater-oriented recreation in the Delta was estimated to be 8.3 million user days in 1977-78, although this number includes some activities which do not depend entirely on the Delta's waters. Brackish water, ocean and estuary activities were not included in the total (SWC,66,5). Testimony and evidence were also provided which indicated that recreation visits to Estuary shoreline park facilities have been growing rapidly compared to the projections used by SWC, i.e., 122 percent in two years compared to 0.8 percent/year (T,LV,160:17-161:1; EBRPD,24,T1). Millions of user days and daily values of $20 or more per user for water use are calculated for each recreational user of Estuary water (BISF,38,T4). An extrapolation of old studies of Delta recreation has generated estimates in the range of 13 million recreation-days annually (PICYA,2,51). Testimony by SWC suggested that these estimates were high and should be reduced to 6.95 million. No current information based on recreation use studies during this decade is available (T,LV,137:13-16).

4.0.7.2 Suisun Marsh and Carquinez Strait Area

Some evidence was submitted on the recreational use of the Suisun Marsh or Carquinez Strait area of the Bay-Delta Estuary. BAAC submitted evidence inferring that bird watching goes on in the Suisun Marsh (BAAC,20;26;27). From evidence submitted by EBRPD, estimated recreation at its Contra Costa shoreline facilities (Antioch and Martinez shoreline) increased greatly between 1981 and 1987, growing from 84,000 visitors to 287,000 visitors, or about 340 percent in six years (EBRPD,34,T1). Although there is little evidence linking the number of visitors in this reach to water quality, both BAAC and EBRPD expressed concern that visitors to these recreational areas would experience losses of the value they place on wildlife and fish resources, which might be harmed if flow decreased and salinity increased (T,XXX,45:12-23; T,LV,184:15-25,185:1-2).

The recreational use of EBRPD units with water quality problems Point Isabel and San Leandro Bay, increased from 71,000 users in 1981 to 487,000 users in 1987, an increase of over 680 percent (EBRPD,34,T1). This occurred despite serious heavy metal contamination at these beaches. In comparison, the use of the nearby, unpolluted Hayward and Miller-Knox shorelines has grown from 21,000 users in 1981 to 196,000 in 1987, an increase of 930 percent. There was no specific information on the features which prompt users to attend the various park units, nor on the method by which use estimates were made. Moreover, it is noteworthy that users did not avoid contaminated sites, and it does not seem reasonable to suppose that a moderate change (of one or two parts per thousand) in salinity would substantially change future recreational use. This might not be true if the change were such as to convert a freshwater beach to saltwater; however, no data are in the record on this subject.

4.0.7.3 San Francisco Bay Basin

The Basin Plan for Region 2, the San Francisco Bay Basin, identifies most of the same forms of recreation as the Delta. Recreational uses are also identified for the Pacific Ocean and the San Francisco Bay system and all other surface waters (RWQCB 2, 1986). Water-oriented recreation in the San Francisco Bay area was estimated to total over 127 million user-days (BISF,38,T3).

4.0.8 Other Beneficial Uses

4.0.8.1 Navigation

Navigation in the Estuary includes commercial, naval, and recreational activities. There are seven major ports in the Estuary (San Francisco, Oakland, Alameda, Redwood City, Richmond, Stockton, and Sacramento), serving more than 5,000 ships annually (NOAA, 1986,8); there are also numerous oil transfer terminals located between Richmond and Suisun Bay. In 1984, imports at the Estuary's seven major ports were worth $10,419,000, while exports were worth $6,295,000 (NOAA, 1986). Six million tons of cargo have been transported annually in the Stockton and Sacramento deep-water ship channels (DWR, 1987). In 1985 there were 143,646 recreational boats registered in the nine counties surrounding San Francisco Bay (NOAA, 1986), and about 82,000 pleasure boats were registered in the Delta area (DWR, 1987). These Delta area boaters are served by more than 8,500 berths, 119 docks and 27 launching facilities (DWR, 1987).

4.0.8.2 Dilution of Pollutants

Freshwater flows to dilute pollutants in the Estuary and upstream was a subject of considerable testimony during Phase I. Under both the Porter-Cologne Act (Section 13050(f)) and EPA Regulations (40 CFR131.10(a)), neither waste disposal or transport nor waste assimilation can be designated as beneficial uses. This does not, however, preclude the State Board from addressing any action(s) which may have curtailed the natural assimilative capacity of the Estuary.

4.0.9 Uses of Water Exported From the Bay-Delta Estuary

The following sections address water use in the areas of export, that is, the areas defined for purposes of this Plan as being outside the legal boundary of, and receiving water diverted from, the Bay-Delta Estuary.

4.0.9.1 Municipal and Industrial Uses

Most of California's population lives in semi-arid areas where population and industrial expansion have exceeded the ability of many communities to meet their water needs with local sources. Local as well as distant communities have seen the Estuary's waters as a means to meet their needs.

Municipal and Industrial (M&I) water exports to local areas outside the Estuary began in 1929 when EBMUD initiated the first export of Delta supplies by diverting Mokelumne River water through its Mokelumne Aqueduct to Alameda and Contra Costa counties. In 1934 San Francisco began diverting water from the Tuolumne River through the Hetch-Hetchy Project for use in San Francisco, San Mateo, and Alameda counties. In 1940 the Contra Costa Canal (CCC), the first unit of the CVP, was completed and began supplying water to the Antioch-Pittsburg area. The City of Vallejo began importing Delta surface water from Cache Slough in 1953. USBR began diverting Putah Creek water via the Putah South Canal to Fairfield and Benicia in 1957. In 1965 the South Bay Aqueduct of the SWP began exporting an interim supply of Delta water from the Delta-Mendota Canal (DMC) to Alameda and Santa Clara counties. The North Bay Aqueduct Phase II facilities of the SWP divert Delta waters from Barker Slough tributary to Lindsey and Cache sloughs, and connect to the Phase I facilities just west of Cordelia to deliver water to Solano and Napa counties (DWR,207,1-7).

The first exports to distant municipalities began in 1968 when the federal CVP began exporting water to Coalinga, Huron and Avenal through the DMC and San Luis Canal (DWR,204,1). In 1971 the SWP's California Aqueduct began exporting water to southern California through the Edmondston Pumping Plant over the Tehachapi Mountains (DWR,207,1-7).

CVP M&I deliveries in 1986 were estimated 381,204 AF with a projected delivery in the year 2010 of 936,072 AF (Table A4-12) (USBR, 1987). In 1985, SWP M&I deliveries were approximately 1,008,000 AF (Table A4-13) (DWR,461,1). No estimate of SWP projected deliveries to southern California for M&I use was presented. Table A4-14 lists state and federal water transfer facilities and the areas each serve.

Population and economic projections indicate growing M&I water demands. The Department of Finance has estimated that the state population will increase from 27,000,000 people in 1986 to 36,280,000 people in 2010 (DOF, 1987). Of this, the population of the six most populated counties in southern California--Ventura, Los Angeles, Orange, Riverside, San Bernardino, and San Diego--are expected to increase from a 1986 level of 15,290,000 people to 20,220,000 in 2010 (SWC,6,7). The expected additional M&I demand for Bay-Delta water supply is a result both of the loss or degradation of alternative water supplies and of increases in population (SWC,4,6).

TABLE A4-12
MUNICIPAL AND INDUSTRIAL WATER CONTRACTS
CENTRAL VALLEY PROJECT
(acre-feet)

Sacramento Valley and American River Service Areas			
Contracting Entity	Contract Maximum a/	1986 Deliveries b/	Projected 2010
Bella Vista WD d/	7,000	2,060	7,000
City of Folsom d/	22,000	15,042	22,000
City of Redding d/	21,000	10,424	21,000
City/Redding(Buckeye)	6,140	2,320	6,140
City/Redding(Buckeye)	40	40	0
City of Roseville	32,000	11,591	32,000
City/Sacramento(AmRv) d/	326,000	71,331	227,500
City/Sacramento(SacRv) d/	above	18,896	above
Clear Creek CSD	10,300	1,346	6,400
County of Colusa	40	40	40
Diamond International	510	0	510
Diamond International d/	425	425	425
East Bay MUD	150,000	0	20,000
East Yolo CSD	9,290	0	8,860
El Dorado ID	2,875	3,006	2,875
El Dorado ID	7,500	1,540	7,500
Elk Creek CSD d/	100	96	100
Folsom Prison d/	4,000	1,432	4,000
Foresthill PUD	2,500	1,084	2,500
G. W. Williams	130	0	130
Keswick SD	500	140	300
Lake CA (Rio Alto)	200	200	200
Louisiana Pacific	25	26	25
Mather AFB (Temporary)	350	271	350
Mountain Gate	350	457	350
Napa Co. FCWCD	7,500	3,167	1,500 e/
Parks & Recreation d/	5,000	15	15
Placer Co. Water Ag. d/	150,000	4,921	75,000
Riverview Golf Club d/	280	280	280
San Juan Suburban WD	5,600	7,840	5,600
San Juan Suburban WD d/	33,000	23,100	33,000
Shasta County WA	5,000	162	2,800
Shasta CSD	1,000	602	1,000
Shasta Dam PUD	3,227	1,573	3,227
So. Cal. Water Co. d/	10,000	1,612	10,000
Sacramento MUD	7,500	3,167	1,500
Summit City PUD	1,170	300	1,170
U.S. Forest Service	10	10	10
TOTAL SACRAMENTO AND AMERICAN RIVER*	832,562	188,516	505,307

San Joaquin Valley Service Areas			
Contracting Entity	Contract Maximum a/	1986 Deliveries b/	Projected 2010
Arvin Edison WSD	500	0	500
Arvin Edison (Cross Val.)	500	0	500
Broadview WD	20	23	20
City of Avenal	3,500	1,257	3,500
City of Coalinga	10,000	6,000	10,000
City of Fresno	60,000	45,000	60,000
City of Huron	3,000	828	3,000
City of Lindsay	2,500	2,021	2,500
City of Orange Cove	1,400	422	1,400
City of Tracy	10,000	5,734	10,000
Contra Costa WD	195,000	124,386	195,000
County of Madera	200	30	200
County of Tulare	1,345	1	1,345
Fresno County WW#18	150	59	150
Musco Olive Prod. (temp)	- -	0	- -
Pacheco WD	80	12	80
Panoche WD (DMC)	37	18	37
Panoche WD (SLC)	63	23	63
San Benito WD	8,250	0	6,680
Santa Clara WD	128,700	0	117,200
San Luis WD (DMC)	140	109	140
San Luis WD (SLC)	440	387	440
State of California	10	10	10
Stockton-East WD	10,000	0	8,000
Tracy Golf Club-CA (temp)	- -	451	- -
Westlands WD	10,000	5,917	10,000
TOTAL SAN JOAQUIN*	445,835	192,688	430,765
TOTAL SACRAMENTO AND SAN JOAQUIN*	1,278,397	381,204	936,072

* Note: Original USBR sum differs from total column summation.

a/ Quantity is a contract maximum or is projected M&I use within a combination M&I/agricultural water service contract.
b/ Deliveries may include water transferred from other contrators or purchased under provisions of the contract and may therefore be higher than contract maximum.
c/ Includes Solano FCWCD and Napa Co. FCWCD of Solano Project
d/ Contract includes water rights; no payment is made to the United States for water rights water.
e/ Present use includes City of Napa which will cease when North Bay Aqueduct completed.

Source: USBR, Factsheet: "Exhibits and Testimony before SWRCB, Bay-Delta Hearing, 1987", 1987

TABLE A4-13

SWP WATER DELIVERIES FOR AGRICULTURE, MUNICIPAL AND INDUSTRIAL USES, RECREATION USE AT SWP FACILITIES AND HYDROELECTRIC ENERGY, 1962 to 1985.

Year	Water Delivered (Acre-Feet)							Recreation Supported (Recreation Days) /b	Hydroelectric Energy Generated (megawatt-hours) c/
	Entitlement Water			Other Deliveries					
	Municipal & Industrial Use	Agricultural Use	Total	Municipal & Industrial Use	Agricultural Use	Other Water a/	Total Delivery		
1962						18,289	18,289	30,000	
1963						22,456	22,456	105,000	
1964						32,507	32,507	331,600	
1965						44,105	44,105	449,800	
1966						67,928	67,928	482,700	
1967	5,747	5,791	11,538	0	0	53,605	65,143	455,200	
1968	46,472	125,237	171,709	10,000	111,534	14,777	308,020	931,300	628,000
1969	34,434	158,586	193,020	0	72,397	18,829	284,246	1,554,800	2,614,000
1970	47,996	185,997	233,993	0	133,024	38,080	405,097	1,804,800	2,679,000
1971	85,286	272,054	357,340	2,400	293,619	44,127	697,486	2,085,900	3,302,000
1972	181,066	430,735	611,801	22,205	401,759	73,127	1,108,892	1,971,200	1,922,000
1973	293,824	400,564	694,388	3,161	293,255	43,666	1,034,470	2,502,000	3,298,000
1974	418,521	455,556	874,077	4,753	412,923	48,342	1,340,095	4,073,600	4,672,000
1975	641,621	582,369	1,223,990	21,043	601,859	67,170	1,914,062	4,189,300	3,159,000
1976	818,588	554,414	1,373,002	32,488	547,622	116,962	2,070,074	4,239,600	2,131,000
1977	280,919	293,236	574,155	0	0	390,176	964,331	3,951,900	958,000
1978	742,385	710,314	1,452,699	3,566	13,348	122,916	1,592,529	5,773,700	2,882,000
1979	690,659	969,237	1,659,896	66,081	582,308	189,396	2,497,681	5,298,700	2,485,000
1980	730,545	799,204	1,529,749	19,722	384,835	48,590	1,982,896	5,701,900	2,988,000
1981	1,057,273	852,289	1,909,562	12,000	896,428	283,849	3,101,839	6,017,800	3,358,000
1982	928,721 e/	821,303	1,750,024	0	215,873	155,820 e/	2,121,717	6,187,700	5,097,000
1983	483,499	701,370	1,184,869	0	13,019	188,596	1,386,484	5,838,200	5,419,000
1984	723,468 f/	865,043	1,588,511	3,663	259,254	387,505 f/	2,238,933	6,273,100	3,368,000
1985	998,138	1,002,915	2,001,053	9,638	292,372	414,566	2,717,629	6,639,800	3,227,000
Total d/	9,209,162	10,186,214	19,395,376	210,720	5,525,429	2,885,384	28,016,909	76,889,600	54,187,000

a/ Includes preconsolidation repayment water, emergency relief water, regulated delivery of local supply, non-SWP water delivered to Napa County FC&WDC through SWP facilities conveyance of CVP water (including Decision 1485 water), recreation water, and demonstration ground water fill withdrawal.
b/ A recreation day is the visit of one person to a recreation area for any part of one day.
c/ Includes SWP share of generation from Hyatt-Thermalito, San Luis, Devil Canyon, Warne, and Castaic Powerplants.
d/ In addition, SWP dams have prevented millions of dollars worth of flood damage.
e/ Revised and corrected from, Bulletin 132-85 to reflect 557 acre-feet of 1978 exchange water (MWDSC Basin) changed from other water to municipal and industrial use entitlement water.
f/ Revised and corrected from, Bulletin 132-85 to reflect 126 acre-feet of 1982 exchange water (MWDSC Basin) changed from other water to municipal and industrial use entitlement water.

(DWR.461)

TABLE A4-14

DELTA DRINKING WATER DIVERSIONS
AND AREAS SERVED
(From SWC, 76, 6)

DIVERSION POINT (Transfer Facility)	Area Served
State Facilities	
Barker Slough[1/] (North Bay Aqueduct)	Solano-Napa County Fairfield Vacaville Vallejo Benicia Napa American Canyon
Clifton Court (South Bay Aqueduct)	Livermore Valley Alameda CWD Santa Clara Valley WD
(California Aqueduct)	Avenal[2/] Coalinga[2/] Kern County WA Antelope Valley MWDSC San Diego CWA Crestline-Lake Arrowhead San Bernardino Valley Palm Springs Indio
Federal Facilities	
Rock Slough (Contra Costa Canal)	Concord Oakley Pittsburg Antioch Martinez Pleasant Hill Walnut Creek
Old River (Delta-Mendota Canal)	Tracy Huron Dos Palos

1/ Cache Slough is used as an alternative diversion point for this transfer.

2/ CVP contractor served from joint-use facilities of the California Aqueduct.

In the future the SWP and the CVP plan to expand deliveries to new areas and to areas experiencing increased need. SWP is studying a Coastal Branch which will supply water to Santa Barbara and San Luis Obispo counties, and an East Branch enlargement which will increase deliveries to the eastern part of the Metropolitan Water District's service area, and to San Bernardino County and the Antelope Valley. CVP is studying an extended San Felipe Branch which will supply water to Monterey and Santa Cruz counties, as well as an American River Aqueduct which will increase deliveries to EBMUD's service area in the Bay Area. SWP is also planning additional transfer and storage facilities at these locations that will increase its water distribution capabilities: the Kern Water Bank, Los Banos Grandes Reservoir, the South Delta, the North Delta Facilities, and additional pumps at the Delta Pumping Plant (DWR,707,42-53).

4.0.9.2 Agriculture

There were about 9.5 million acres of irrigated agricultural land in California in 1980. The Central Valley (not including the Delta) contained approximately 6.9 million acres of this total (DWR, 401,29; DWR,304).

The CVP and SWP export water from the Estuary to support many farming and ranching operations (RWQCB 5, 1975). The main area of agricultural use of export waters is the San Joaquin Valley; three of its counties, Fresno, Kern, and Tulare, ranked first, second, and third in the nation in gross cash receipts from annual farm marketing in 1982 (CVAWU,41). The CVP exports water primarily for agricultural use to the San Joaquin Valley, with smaller amounts exported to other areas (see Table A4-15).

By 1970 the entitlement of agricultural contractors (including exchange contractors1/) to CVP export waters totaled over two million AF/yr (CVPWA,10-1). With the addition of the Cross Valley Canal Unit and expansion of the San Luis Unit, the 1980 total was almost 2.5 million AF/yr (CVPWA,10-1).

TABLE A4-15

CVP EXPORT AREAS

Export Area	**CVP Unit**
San Joaquin Basin	Delta Mendota Canal San Luis Mendota Pool
Tulare Lake Basin	San Luis Cross Valley Canal
Contra Costa County	Contra Costa Canal
Santa Clara & San Benito Counties	San Felipe Unit

1/ Exchange contractors formerly diverted from the San Joaquin River, but exchanged their diversion rights for a contract that granted more consistent water supplies from the DMC. The maximum contractual entitlement of these users is 0.84 million AF/yr (USBR,1987).

During the 1985 Water Year, the various units of the CVP exported a total of about 2.79 million AF of water to serve 1.22 million acres (Table A4-16).

TABLE A4-16

AGRICULTURAL WATER EXPORTS AND SERVICE AREAS
BY CVP UNIT FOR THE 1985 WATER YEAR

CVP Unit	Water Exported (AF)	Area Served (ac)
Delta Mendota Canal (including exchange contractors)	1,050,000 (CVPWA,11;USBR, 1984;USBR,1985)	356,000 (T,XXVI,186:6-8,11-17)
San Luis	1,545,000 (CVPWA,11)	698,000 (T,XXVI,186a:24)
Mendota Pool	94,000 (CVPWA,11)	42,000 (T,XXVI,187:14)
Cross Valley Canal	102,000 (Schafer, 1988)	125,000 (CVPWA,11(b)-3)
Contra Costa Canal	895 (T,XXVI,185:16-21)	
TOTAL	2,792,000	1,221,000

The recently completed San Felipe Unit began deliveries in mid-1987, two contracts for which have been executed totalling 68,600 AF/yr (T,XXVI,194:2-8). The projected water use by the existing CVP contractors is not expected to differ substantially from the 1985 Water Year level (T,XXVI,208:6-8). However, additional CVP supplies are needed to help solve ground water overdraft if present uses are maintained (T,XXVI,209:6-13).

SWP exports water for agricultural use via the California Aqueduct to Oak Flat WD in the San Joaquin Basin, to the Tulare Lake Basin and to southern California, and via the South Bay Aqueduct to Santa Clara and Alameda counties. The volume of SWP deliveries to the 13 southern California contractors for agricultural use was not identified in the hearing record. The annual SWP exports for agricultural use (excluding southern California) increased from about 237,000 AF in 1968 to about 1.3 million AF in 1985 (DWR,461). The future demand for exported SWP water for agriculture should not change substantially from this 1985 amount (DWR,707,11). However, additional SWP supplies are needed to help solve ground water overdraft (SWC,412,5).

The main change in agricultural production in the San Joaquin Valley since 1955 has been the increased acreage devoted to the production of vegetables, fruits and nuts (CVAWU,26). The acreage of vegetables increased from about 250,000 acres in 1955 to almost 400,000 in 1985. The acreage devoted to the production of fruits and nuts increased from about 550,000 acres in 1955 to about 1,300,000 acres in 1985 (CVAWU,26). The acreages of field crops and seeds in the San Joaquin Valley have remained relatively stable since 1955. Overall, the acreage devoted to these four major commodity groups (vegetables, fruits and nuts, field crops, and seeds) in the San Joaquin Valley has increased about 25 percent from 1955 to 1985, from about 3.7 million acres to about 4.6 million acres (CVAWU,26).

In 1985, the CVP units listed in Table A4-16 delivered over 2.7 million AF of water to over 1.2 million acres in the export areas of the San Joaquin Valley to produce crops with a gross value of about $1.2 billion (CVPWA,12&13; EDF,11,G-148) (Table A4-17). These numbers do not include the contribution from the Friant-Kern Canal, Madera Canal, or Millerton Lake units of the CVP. These units are considered to be in the upstream areas of the San Joaquin Valley, not the export area.

In 1985, the SWP delivered over 1.3 million AF of water to about 445,000 acres of the San Joaquin Valley to produce crops with a gross value of about $431 million (DWR,489h) (Table A4-18). These numbers do not include the agricultural uses of water in southern California.

TABLE A4-17

MAJOR CROPS GROWN IN THE CVP EXPORT AREA
BY ACREAGE AND APPROXIMATE GROSS CASH VALUE
(from DWR, 489 h)

Crop	**Acreage[1/] (thousands of acres)**	**Gross Cash Value[2/] (millions of dollars)**
Cotton	446	357
Alfalfa	104	66
Wheat	87	22
Tomatoes	84	125
Melons	51	128
Barley	42	6
Other	407	529
TOTAL	1,221	1,200

1/ CVPWA,12; EDF,11,G-148

2/ CVPWA, 12&13; EDF,11,G-148. Values of an average crop ($/acre from CVPWA 12&13) are multiplied by crop acreages for the exchange contractor area (from EDF,11,G-148) to get appropriate cash value.

TABLE A4-18

MAJOR CROPS GROWN IN THE SAN JOAQUIN VALLEY PORTION
OF THE SWP EXPORT AREA
BY ACREAGE AND GROSS CASH VALUE
(From DWR,489 h)

Crop	**Acreage (thousands of acres)**	**Gross Cash Value (millions of dollars)**
Cotton	210	154
Alfalfa	40	27
Almonds	35	26
Wheat	30	9
Pistachios	18	28
Wine grapes	18	13
Table Grapes	6	28
Oranges	4	19
Carrots	5	18
Other	79	109
TOTAL	445	431

Since water usage and acreage for livestock, poultry, and dairy production were not separately identified in the hearing record by CVP or SWP export areas, an accurate account of the effect of export water on the market values of these products cannot be given. In addition, because these areas often use supplemental water supplies from ground water and local sources, only a part of the value of agricultural production in the export area can be directly attributed to project exports. An indirect indication, however, can be made from the fact that the market value of livestock, poultry and dairy products for the entire San Joaquin Valley in 1982 was over half the value of all crops (CVAWU,28):

	1950	**1969**	**1982**
Crops	$455 million	$933 million	$4,039 million
Livestock, Poultry Dairy	$199 million	$751 million	$2,053 million

4.0.9.3 Fishery Habitat

Export fishery habitat consists primarily of the reservoirs and conveyance channels used for movement and storage of Bay-Delta water south of the Delta. In all cases this habitat may be classified as warm water fishery habitat. The major facilities discussed here and in Section 4.0.9.5 (Export Recreation) are:

o San Joaquin Valley and San Francisco Bay Area

Delta-Mendota Canal, San Luis Canal, Edmund G. Brown California Aqueduct, Lake Del Valle, Bethany Reservoir, San Luis Reservoir (and O'Neill Forebay), and Los Banos Grandes Reservoir.

o Southern California

West Branch California Aqueduct (Pyramid Lake, Castaic Lake), East Branch California Aqueduct (Silverwood Lake, Lake Perris) (SWC,65,6).

Recreational access at all SWP facilities is shown in Figure A4-7 (SWC,65,6). Expansion of this habitat will not occur unless additional facilities are built (e.g., Los Banos Grandes Reservoir) (DWR,707).

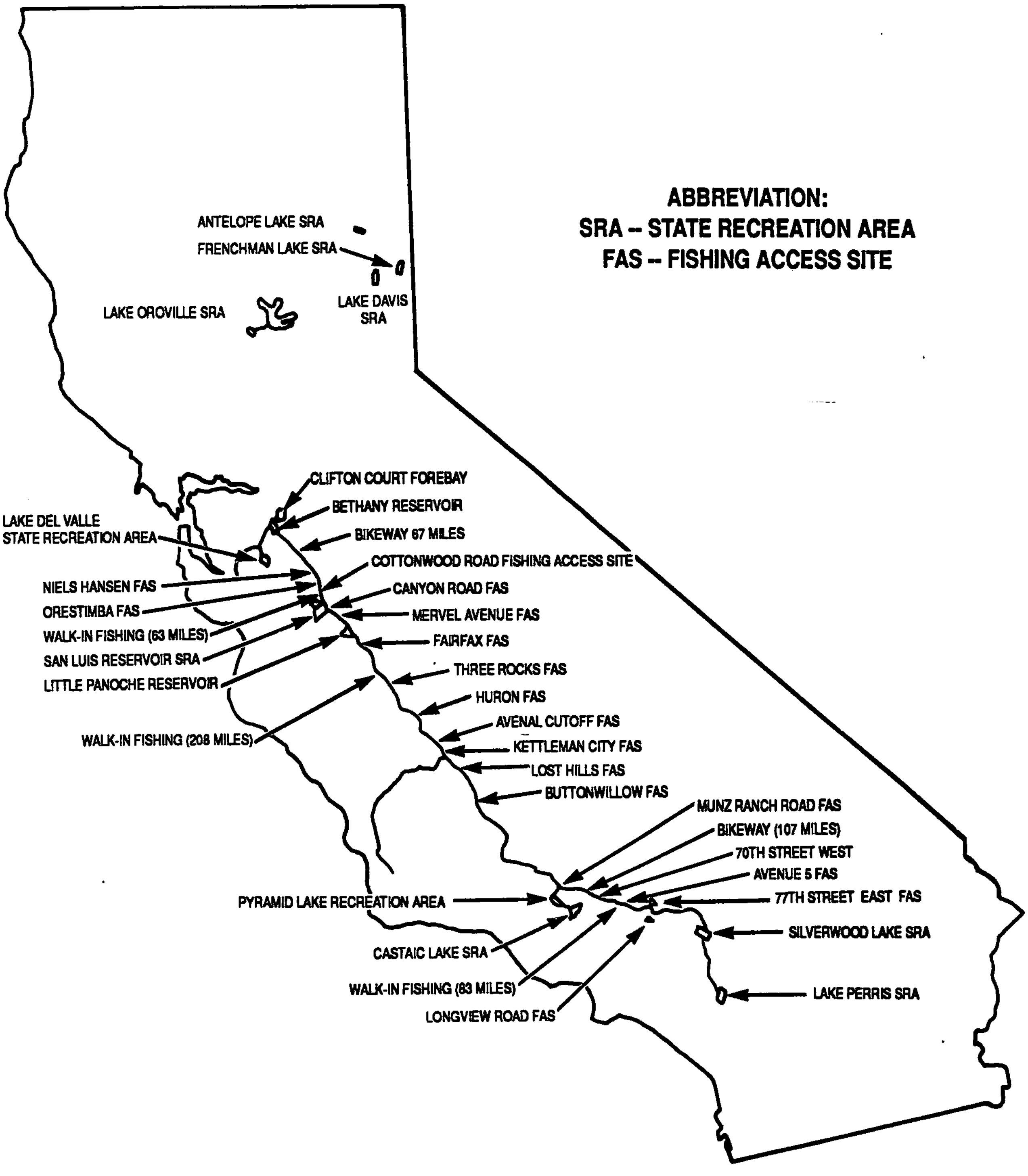
Some of the eggs and larvae of some fish entrained into the export pumps survive and develop in the aqueducts and some of the reservoirs such as Bethany Reservoir and San Luis Reservoir (and O'Neill Forebay) (SWC,65,45). The hearing record is unclear whether these populations are self-sustaining or are maintained by additional entrainment. In other reservoirs, the majority of fish are planted for recreational fishing (SWC,65,47) (see Section 4.0.9.5). (It was inferred from SWC,65,47 that DFG plants the fish in these reservoirs, but no direct evidence was presented.) No information was presented on which species are planted, or what percent of total statewide fish planting is dedicated to SWP facilities.

The aqueducts tend to provide a relatively stable habitat for fish because the export water quality is determined by municipal and industrial standards, and because water depth in the aqueducts does not change. In some reservoirs, such as San Luis, the habitat may change significantly due to either seasonal variation in temperature or drawdown to meet water demands. The San Luis Reservoir recreational storage objective for Labor Day is 6,900 acres of surface area, or approximately half the surface area of the full reservoir (DWR,708,14). This converts to an 83 percent reduction in storage and, therefore, a significant reduction in fishery habitat. Other reservoirs, especially the terminal SWP reservoirs in southern California, are operated to retain more stable water levels because of the level of recreational activity on them (T,XXXIX,122:2-9) and the potential need as an emergency water supply in the event of an aqueduct outage. DWR presented the specific operating criteria for their facilities (DWR,708).

4.0.9.4 Export Wetland Use

Water exported from the Sacramento-San Joaquin watershed provides some marsh and riparian habitat wherever it is delivered. Examples of important wildlife uses may be found in a number of export areas (SWRCB,14,III-9). Water in SWP reservoirs and in wildlife areas in southern California provides aquatic habitat where there might formerly have been none or replaces wetland habitat which was damaged or destroyed by earlier urbanization or water development. Substantial waterfowl habitat is maintained with DMC water in the Grassland Water District, an area that formerly received water from San Joaquin River overflows and agricultural return flows which ceased when Friant Dam began operations (EDF,11,II-2).

FIGURE A4-7 State Water Project Recreation Developments
(From: SWC, 65,6)



SOURCE: DWR BULLETIN 132-86

CHA0048

4.0.9.5 Export Recreation

The aqueducts and reservoirs in the SWP1/ facilities are used for recreation in both central and southern California. Fishing and bicycle riding are the main activities along the aqueducts, and numerous fishing access points are available along them (SWC,65,6) (see Figure A4-7). The reservoirs are used for a wide variety of water-contact and non-water contact activities, including fishing, swimming, boating, waterskiing, camping, picnicking and bird watching (SWC,65,5). About five million visitors used the SWP facilities south of the Delta in 1985, and they spent an estimated $95 million to travel to and use these sites (SWC,65,7,14). More than one million game fish were stocked in 1985 (SWC,65,7) to support recreational fishing activity in the four southern California SWP reservoirs. No evidence was presented on alternative sites for freshwater recreation in southern California.

1/ Discussion is limited to recreational activities directly related to export facilities of the SWP. No information was provided on recreation at CVP export facilities other than those used jointly by the CVP and SWP, which are included in the SWP descriptions. These facilities are listed in Section 4.0.9.3 (Export Fishery Habitat).

APPENDIX 4

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APPENDIX 5.0
ADVOCATED LEVELS OF PROTECTION

The objectives advocated by various parties for the protection of beneficial uses of Bay-Delta waters are discussed below.

5.0.1 Municipal and Industrial

5.0.1.1 Salinity and Sodium

<u>Advocated Levels of Protection</u>

The following organizations have recommended that the D-1485 objectives be retained in total or in part to protect M&I use (DWR,280; T,LIX,189:1-7; T,VI,125:4-15). Modifications to D-1485 M&I standards were recommended by DWR, USBR, SWC, MID/TID, CVPWA and CCWD. DWR and USBR are unified in their recommended modifications; SWC's recommended modifications are similar to those made by DWR and USBR. The parties' recommendations, presented in Table 5-5, are:

o DWR and USBR

Eliminate the 250 mg/l maximum mean daily chloride quality standard at Cache Slough. The City of Vallejo will divert water from the newly finished North Bay Aqueduct; the Cache Slough diversion point will only be used as a secondary M&I supply source (DWR,280).

Add a quality objective at the North Bay Aqueduct intake at Barker Slough. The recommended objective would be set at a maximum mean daily chloride level of 250 mg/l for all water year types. Barker Slough is an M&I diversion point for Napa, Vallejo, and Sonoma counties (DWR,280).

o DWR, USBR, SWC, MID/TID, and CVPWA

Eliminate the 150 mg/l chloride quality standard at both the Antioch Water Works Intake on the San Joaquin River and the Contra Costa Canal Intake at Rock Slough. This standard is set to protect industrial uses in the Antioch-Pittsburg area. The recommendation to eliminate this standard is based on the evidence indicating that diversion of water for industry of this quality at Antioch is not reasonable when considering the Delta outflow required to maintain it (DWR,280; T,LIX,149:12-20; WQCP-MID/TID-7, 13; WQCP-CVPWA-205,2).

Add quality objectives at Old River near Rock Slough and Cache Slough near Junction Point. The recommended objectives would be set at a maximum mean daily chloride level of 250 mg/l for all water year types. These objectives will help in determining an "allocation of responsibility" for meeting the standard at the Contra Costa Canal Intake, the North Bay Aqueduct Intake, and the City of Vallejo Intake (DWR,280; T,VI,97:8-19; T,LIX,213:8-214:8; WQCP-DWR-14,7).

- o CCWD

  A goal of providing the "best achievable" water quality for drinking water supplies should be promoted (WQCP-CCWD-20,8).

  Retain the 150 mg/l chloride objective for protection of M&I use, including disinfection by-product concerns, as specified in the Delta Plan (WQCP-CCWD-20,1).

  Add a 50mg/chloride objective for the protection of M&I use for portions of all years, except during prolonged droughts (WQCP-CCWD-20,1).

  Add a quality objective at the site of the future intake to the Kellogg/Los Vaqueros Reservoir. The location of the intake has not yet been determined. The recommended objective would be set at a maximum chloride level of 50 mg/l for the months of April through June (T,VII,57:1319; T,VII,118:16-120,9).

Fibreboard Louisiana-Pacific Corporation (Fiberboard), a witness for CCWD, presented the only testimony that supported the need for process water containing not more than 150 ppm chloride for the production of linerboard (T,IX,75:23-81:23). To keep the chlorinity in their linerboard (used in corregated boxes) at levels which will not corrode canned goods, this process water is kept below 150 mg/l chloride (T,IX,75:23-81:23). When the chlorinity in the San Joaquin River supply is higher than 150 mg/l, a partial supply of water is purchased from CCWD; when the chlorinity level reaches 250 mg/l, the entire supply is taken from the Contra Costa Canal (T,IX,77:23-78:6).

5.0.1.2 Trihalomethanes (THMs) and other Disinfection By-Products (DBPs)

Advocated Levels of Protection

Parties who presented testimony and exhibits on the issue of THMs included CCWD, DWR, EBMUD, SWC, the Palmdale Water District, and the cities of San Francisco, Tracy, Avenal, Coalinga and Huron.

The following alternatives were discussed by the parties cited during and after the Phase I hearings.

- o SWC, CCWD, and California Urban Water Agencies

  Several alternatives for source control of THMs were put forth.

- Discharge Delta island agricultural drains downstream of the Delta to eliminate the contribution of THM precursor materials from the Delta islands (T,XLVI,141:11-142:10).

- Take Municipal and Industrial water supplies from tributary streams above the Delta (T,XLVI,136:7-13; Brown and Caldwell, 1989, 4-35).

- Treat the Delta island agricultural drainage before discharge into the surrounding channels (Brown and Caldwell, 1989, 4-35).

Chlorine is currently the disinfectant of choice for most municipalities (T,VI,129:5-16). In order to meet the anticipated EPA treated drinking water quality standards for THMs and DBPs, municipalities may be required to modify present treatment plants, construct major new facilities, and apply new technology to achieve more stringent levels of treatment (T,XLVI,121:22-122:16). Two possible revised treatment scenarios were discussed:

- Disinfect with ozone followed by chloramination to maintain a disinfectant residual in the distribution systems used to distribute domestic water. However, ozonation of water with high levels of bromide or TOC can still produce DBPs of health concern concentration levels; or

- Use granular activated carbon (GAC) adsorption to remove dissolved organics followed by disinfection with chlorine. However, data were presented which indicate that GAC absorption for removing THM precursors from Delta water may be "extraordinarily high". Furthermore, it was stated that GAC would require frequent regeneration and that California air quality standards may not allow siting of GAC regeneration furnaces in the state (T,46,138:5-142:10;WQCP-SWC,601,12-18).

o Metropolitan Water District of Southern California (MWD)

  MWD discussed the possibility of the State Board developing a water quality objective for THM precursors in Delta water that is to be used for domestic purpose (T,XLVI,142:3-5), thus shifting the burden of treatment for THMs from the domestic water supplier to the source of the THM precursors.

o Delta Municipal and Industrial Water Quality Workgroup

  The Delta M&I Workgroup submitted several statements on THMs in its October 1989 draft report to the Board although there were dissenting opinions voiced by members representing organizations in the workgroup.

  Bromide and chloride are correlated in Delta waters; thus, a chloride objective can be set for the purpose of maintaining sufficiently low levels of bromide to ensure that treated domestic water supplies do not contain excessive levels of brominated THMs or other brominated DBPs.

  Future EPA MCLs for treated domestic water supplies may be more stringent, and will be difficult to meet unless bromide levels in raw water supplies from the Delta are less than 0.15 mg/l (corresponding to chloride levels below 50 mg/l).

Total organic carbon (TOC) in water supplies contributes to production of THMs as well as that of other DBPs in water treatment plants. A reduction in Delta water TOC levels will aid in meeting expected drinking water MCLs for THMs and DBPs.

Agricultural drains, Delta channels and tributary streams are sources of the TOC and THMFP levels in raw domestic water supplies taken from the Delta. THMFP levels in Delta agricultural drain waters often exceed the THMFP levels in adjacent channels by factors of ten or more.

Data collected at the water treatment plants of several of the members of the Workgroup show definite relationships between raw water bromide levels and treated water levels for several DBPs. On the basis of those relationships and the bromide to chloride correlation observed in Delta water, the Workgroup recommended that a 50 mg/l chloride water quality objective, when feasible, be set for Delta Municipal and Industrial water supply intakes for the purpose of maintaining bromide levels below 0.15 mg/l.

The Workgroup recognizes that meeting a 50 mg/l chloride water quality objective throughout the Delta at all times is not feasible under all water supply conditions with the physical distribution and storage facilities presently available to the major water suppliers (e.g., DWR and USBR) or the water purveyors (e.g., CCWD, MWD, EBMUD). Because of their ability to store high quality water for subsequent blending with waters of lesser quality, various proposed facilities, such as the Buckhorn, Los Vaqueros and Los Banos Grandes offstream storage reservoirs, may help reduce the period of time the recommended 50 mg/l chloride water quality objective would need to be met in the Delta. However, not all M and I users of Delta water have access to offstream storage facilities to receive such benefits. Other facilities and solutions should be studied and evaluated to help determine a strategy for meeting the recommended 50 mg/l chloride objective.

Several parties to the Workgroup recommended that, in the short term, salinity levels be provided at the Delta water supply intakes which are less than or equal to those achieved under current water quality objectives.

o California Department of Water Resources

During Phase I of the Bay-Delta proceedings, DWR recommended that the construction of Delta facilities should be considered as potential means to improve project (SWP and CVP) operational flexibility and export water quality. The facilities recommended for consideration were North and South Delta channel improvements, enlargement of Clifton Court Forebay, relocation of the Contra Costa Canal Intake, and additional pumping capacity at the Harvey O. Banks Pumping Plan.

DWR did not concur with the Delta M&I Workgroup statements, based on the following four points:

- EPA's Strawman Rule for THM standards is very preliminary, and it is premature to use this "rule" as the basis for making Delta water supply decisions of great importance to California.

- DWR disagrees with the recommendation to set a chloride objective for the purpose of maintaining sufficiently low levels of bromide. The reason for this is that chloride is added to surface waters by activities such as the use of fertilizers. Chloride is also leached from soils and is contributed by shallow ground water. There is no reason to believe that these sources of chlorides also add bromides in the classic seawater ratio of .003 BR:Cl. Therefore, the chloride vs. bromide relationship may vary significantly at different locations in the Delta.

  Significant data are only now being collected to prove or disprove this relationship. Also, new technology now makes direct bromide measurements practical; therefore, bromides should be specifically addressed in the salinity plan.

- Meeting a 50 mg/l chloride objective at M&I stations with the present configuration of the Delta would reduce critical period water supplies by over 1 million acre-feet per year.

- DWR recommends against setting a total organic carbon objective because their data indicate that TOC and THM formation potential often do not correlate well.

5.0.2 Agriculture

Advocated Levels of Protection

o Central Delta Water Agency (CDWA)

Water Quality Objectives:

The agricultural water quality objectives for the Delta should be set at a minimum water quality of 0.45 mmhos/cm EC year round except for "relaxations" in the drier months of drier years. The objective should not require a "leaching regimen" more rigorous than "winter flooding" or "fall subirrigation" more frequently than once in three years (CDWA,Brief,26-27).

Monitoring Locations:

The CDWA requests that monitoring stations be established at Old River near Holland Tract or Rancho Del Rio and on Turner Cut near McDonald Island Bridge, in addition to those previously established by the Delta Plan at Emmaton, Jersey Point, San Andreas Landing and Terminous (CDWA,Brief,27).

- o Central Valley Project Water Association (CVPWA)

  Water Quality Objectives:

  The Delta Corn Study provides adequate data from which to establish salinity objectives for Delta agriculture. (WQCP-CVPWA-205,3).

  Objectives should be established at 1.5 mmhos/cm EC for the April 1 through August 15 period at Emmaton and Jersey Point. This objective should be adjusted to 2.78 mmhos/cm EC at Emmaton, and 2.20 mmhos/cm at Jersey Point in critical water years. No objectives need be established for the areas of the Delta covered by contracts with the Department of Water Resources. DWR currently meets the Delta Plan standards in contracts with ECCID and NDWA (CVPWA,Brief,49; WQCP-CVPWA-205,14).

- o Contra Costa Water Agency (CCWA)

  Water Quality Objectives:

  To achieve a 100 percent yield of corn, CCWA recommends that the EC water quality standard necessary be set at 0.45 mmhos/cm for organic soils in the Delta (CCWA,Brief,17).

- o Contra Costa Water District (CCWD)

  Water Quality Objectives:

  Agricultural discharges in the Delta should be monitored and regulated. (WQCP-CCWD-20,1).

- o Delta Tributaries Agency Committee (DTAC)

  Water Quality Objectives:

  DTAC recommends that the Delta Plan agricultural standard for the Central Delta be relaxed and that it range from 1.5 to 2.5 deciSiemens/meter in all but critical years (one deciSiemen/meter is equal to one mmho/cm EC). No objectives were suggested for critical years (DTAC,Brief,6).

  Leaching Objectives:

  Water quality standards should be carefully established "to provide fall leaching water at the levels needed to leach a necessary minimum amount of salt from the crop root zone of Delta soils, but such leaching standard should be related to the quantity of water available for such leaching" (DTAC,Brief,6-7).

Southern Delta Objectives:

DTAC recommends that the Board impose a short timetable for completion of the negotiations between SDWA, DWR, and USBR. Pending completion of such an agreement, the Board should require elimination of reverse flows in the San Joaquin River which are attributable to export pumping, and require continuance of Delta Plan standards (DTAC,Brief,6-7).

- Department of Water Resources (DWR)

Water Quality Objectives:

"Water quality objectives for the western and central Delta should be based upon the results and information derived from the Corn Study" (DWR,Brief,28). No specific numerical water quality criteria were recommended.

Monitoring Locations:

DWR recommends that specific Delta agricultural objectives for the irrigation season should be adopted for the following locations: (1) Sacramento River at Emmaton; (2) San Joaquin River at Jersey Point; (3) Mokelumne River at Terminous; (4) San Joaquin River at San Andreas Landing; and (5) Cache Slough near Junction Point (DWR,Brief,30-31). Furthermore, the water quality objective at Emmaton should be eliminated when overland water supply facilities are developed for Sherman Island (DWR,Brief,32). The objective would be moved to the intake of the overland facilities.

Southern Delta Objectives:

Negotiations should be completed among the DWR, USBR, SDWA to provide permanent solutions to the problems of local water level, water quality and circulation in the southern Delta (DWR,Brief,32).

- North Delta Water Agency (NDWA) and East Contra Costa Irrigation District (ECCID)

Water Quality Objectives:

NDWA and ECCID recommend that no change be made in Delta agricultural water objectives which would impair the contractual rights and obligations embodied in the contracts among NDWA, ECCID, and DWR (NDWA,Brief,2). These standards are outlined in summaries of testimony for ECCID and NDWA.

- South Delta Water Agency (SDWA)

  SDWA advocated two sets of recommendations. The first are recommendations with no southern Delta facilities (SDWA,115,1-2). The second are recommendations with southern Delta facilities (SDWA,116,1-2).

  Water Quality Objectives (Without Facilities):

  SDWA recommends that water quality at any monitoring point should not exceed an average of 400 mg/l TDS for the period March 1 through September 30 and must not exceed 400 mg/l TDS on a seven-day running average between March 1 through June 30 and 500 mg/l TDS seven-day running average between July 1 and October 31. A TDS of 550 mg/l would be the maximum permissible seven-day running average between November 1 and February 28 (T,XV,31:15-31:23).

  SDWA also recommended that the minimum monthly flow at Vernalis be adequate to maintain the above water quality.

  Monitoring Locations (Without Facilities):

  SDWA proposes monitoring for water quality in the San Joaquin River near Vernalis, Mossdale, the bifurcation of Middle River and Old River, Middle River at Howard Road Bridge, San Joaquin River at, or near, the former location of Brandt Bridge, Old River at Tracy Boulevard, and Old River at Westside Irrigation District intake (SDWA,115,1).

  Water Quality Objectives (With Facilities):

  "Water quality required at the inflow points would be specified as a function of net daily inflow rate and of channel depletion by months for the channel reaches receiving water from each inflow point. The values would be initially determined by mathematical modeling of the system to give water quality equivalent to the no barrier standards. The required net daily inflow rates at each inflow point would be in accordance with a monthly schedule sufficient to maintain the required unidirectional net daily flow in each channel reach" (SDWA,116,2).

  Monitoring Locations (With Facilities):

  "Water quality would be monitored at Vernalis, on the downstream (intake) side of each barrier, at the former location of Brandt Bridge on the San Joaquin River north of Old River, and at Tracy Boulevard on Grant Line Canal. Flow would be measured at Vernalis and through each barrier" (SDWA,116,1-2).

- State Water Contractors (SWC)

  Western and Interior Delta:

  The State Water Contractors believe that the Corn Study provides adequate data, and the State Board should use the Corn Study as a basis for setting new salinity objectives in the western and interior

Delta. Western Delta agriculture can be protected at full yield with a 1.5 mmhos/cm EC applied water objective, in combination with winter leaching operations and rainfall to maintain the soil salinity below the corn salt tolerance level prior to planting. In critical hydrological years, the applied water objective should be relaxed to 2.78 mmhos/cm EC at Emmaton and 2.20 mmhos/cm EC at Jersey Point for the growing season. New objectives should be based on a 28-day running average to coincide with the lunar cycle.

With regard to the protection of Delta agriculture in the interior Delta, the existing D-1485 agriculture salinity objective of 0.45 mmhos/cm EC at San Andreas Landing and Terminous should be maintained, at least until completion of the leaching studies discussed below. The 14-day running average in D-1485 should be changed to a 28-day running average.

Additional leaching studies initiated in the DWR-sponsored Western/Interior Delta Agriculture Workgroup are needed. The new leaching studies are appropriately focusing on the cost and effectiveness of existing leaching practices that growers have described in the workshop sessions. A winter leaching objective is not needed for reasonable protection of Delta agriculture.

Monitoring Locations:

The measuring station at Emmaton in the Sacramento River should be relocated to Three Mile Slough upon completion of overland water supply facilities to serve Sherman Island (SWC,Brief,I-43).

Southern Delta:

"The 1978 Delta Plan southern Delta salinity objectives should <u>not</u> be implemented."

Better water quality for the interior stations within the southern Delta will probably be obtained by implementing the agreement (between SDWA, the Bureau, and DWR) that will provide a permanent solution to the southern Delta's water level and quality problems. Therefore, the State Board can be assured the three-party agreement will provide the water quality protection needed within the southern Delta.

- Bureau of Reclamation with support from the U.S. Department of Interior

Western and Interior Delta:

The results of the Corn Study, presented in Phase I of these hearings, supports an objective of 1.5 mmhos/cm EC. (WQCP-USBR-126,1).

Southern Delta:

The USBR presented testimony on the leaching requirements for beans, fruit and nuts, vineyards, corn and alfalfa, the five most salt-sensitive crops grown in the Delta uplands (USBR,10A&10B; USBR,14A&14B). From these leaching requirements, average irrigation season water quality objectives of 800 mg/l TDS in a normal water year and 600 mg/l TDS in a dry one were developed for Delta agriculture (T,XV,139:15-139:21). USBR did not formalize these requirements into recommendations (T,XV,140:3-140:9).

5.0.3 Fish and Wildlife Beneficial Uses

5.0.3.1 Fishery Habitat Protection (Entrapment Zone) in the Bay-Delta Estuary

Advocated Levels of Protection:

o CCWA/EDF

CCWA/EDF recommend that the entrapment zone be maintained in upper Suisun Bay for maximum phytoplankton abundance. The recommended objective is a 28-day tidally-averaged mean bottom salinity at Chipps Island of 2 ppt TDS or less from April through September, except in a one-in-twenty dry year. This objective would result in a maximum habitat area occurring (CCWA/EDF,1).

They also suggest that a flow objective be set for the period from April through June to position a second entrapment zone in San Pablo Bay. This objective would apply in all years except those when the unimpaired Delta outflow for the prior October through March period is less than the 30-percentile dry year, as determined by the average October-through-March unimpaired Delta outflow (CCWA/EDF,3).

CCWA/EDF concluded that grazing by benthic organisms can have a significant inhibiting effect on the standing crop depending upon the relative rates of removal versus the rates of production (T,XLVI,29:8-10). In order to limit the intrusion of marine benthic organisms into Suisun Bay, CCWA/EDF recommend that the tidally-averaged bottom salinity at Martinez should be less than 5 ppt over at least a 28-day period between October and April (CCWA/EDF,2). The standard would not apply in the event of a one-in-20 dry year as determined by unimpaired Delta outflow (CCWA/EDF,2).

5.0.3.2 Chinook Salmon

Advocated Levels of Protection

Most of the parties presenting testimony on Chinook salmon agreed that specific causes of salmon mortality upstream and in the Delta should be addressed to improve survival rates of juvenile fish. The major differences dealt with: (1) when, where, and what actions should be taken; and (2) which factors were the most influential on adult and/or young salmon survival and production. Only the fishery agencies and environmental groups presented proposed levels of protection that differed significantly from current State Board objectives.

The primary factors identified by the USFWS, DFG and others that improve smolt survival in the Delta are: (1) higher spring flows, (2) water temperatures below the stressful range of about 66° to 68°F, (3) minimizing the adverse impacts of water diversion that transport Sacramento Basin fish through the Delta Cross Channel and Georgiana Slough, (4) minimizing reverse flows that transport San Joaquin Basin fish away from their normal migration routes to CVP and SWP export pumps, and (5) minimizing diversions into upper Old River in the San Joaquin River Delta (T,XXXVI,156:21-23; USFWS,31,62).

Following the September 1987 testimony on Chinook salmon, a five-agency working group was formed to begin discussions on how to deal with problems identified at that time. Membership includes staff from the USFWS, DFG, NMFS, USBR, DWR, and consultants from these agencies (T,XLIII,78:12-23). Other groups such as the SWC and DTAC have participated in the discussion and planning process. A document summarizing the general goals listed possible actions to achieve these goals (DFG,65).

The goal set forth by the five-agency working group is to "...analyze actions which will improve the survival rates of juvenile salmon migrating downstream through the Sacramento or San Joaquin Rivers and the Delta" (DFG,65,2). The group plans to evaluate the cost and effectiveness of various actions proposed to increase salmon survival (DFG,65,2). These actions included evaluation of ways to increase or modify: current Delta flows, physical structures and/or operational changes to enhance survival and food supplies and to decrease diversion losses, and water temperatures (DFG,65,4-5).

The positions of the various parties on water quality and related issues with regard to Chinook salmon in Phase I of the hearings are summarized below.

- SWC (SWC,201,22-27; T,LIX,170:7-173:13)

  SWC recommended current striped bass flow standards be maintained as the salmon flow objectives until adequate data are available to determine whether changes are required.

  SWC also recommended that the State Board adopt a salmon-management program including: short-term measures to increase the number of salmon spawning in the streams and rivers of the Central Valley; a comprehensive program of research, monitoring and full scale testing to provide the basis for developing a long-term program to achieve the goals.

- DWR (T,XLIII,219:2-221:8)

  Having presented data on the impacts of elevated temperatures on smolt survival, DWR did not propose any modifications in operation or flows in the Delta to minimize the impacts. DWR recommended that the existing striped bass standards should be the salmon standards.

- o USBR (T,LXI,120:24-131:6)

  USBR recommended: An increase in natural salmon production; development of a system-wide management plan that addresses conditions in all salmon habitats; structural solutions, such as screens, to improve Delta survival instead of flow increases since structural solutions would minimize impacts on other beneficial uses; continuation of interagency studies and refine monitoring to determine effectiveness of new programs; operational flexibility to respond to recommendations of the five-agency salmon group, and no change in existing standards until the recommendation of the five-agency salmon group can be evaluated.

- o DTAC, TID/MID (DTAC,Brief,9-14)

  DTAC and TID/MID recommended that the smolt survival index not be used as a standard. Field studies using wild salmon should be carried out to address the effects of temperature on salmon survival and DFG, USFWS and NMFS should examine the effects of fishery management policies on salmon escapement.

- o USFWS (USFWS,31,31d-j and 47)

  USFWS recommended: The protection of Sacramento Basin fall-run smolts from April 1 through June 30 and San Joaquin Basin smolts from April 1 through June 15; the elimination of reverse flows during smolt emigration; the prevention of delays to adult migrants; and maintenance of unobstructed migration routes. Survival goals could be achieved by a combination of flow, operational and physical modifications. USFWS also recommended that the dissolved oxygen levels be maintained above 5 mg/l between Stockton and Turner Cut in the San Joaquin River in the fall months. No other participants made specific recommendations in regard to dissolved oxygen levels in either the San Joaquin or Sacramento rivers.

  The USFWS recommended that salmon not be diverted from the Sacramento River at Walnut Grove, from the San Joaquin River at its junction with Upper Old River, and that water temperature be decreased to protect Delta salmon if it can be accomplished with a net benefit to fish.

- o NMFS (T,LXI,22:24-28:4)

  NMFS recommended that: In the Sacramento River system, Delta smolt survival for all four races should be that which occurred under 1940 levels of water development; the Plan should contain a blend of physical and operational management measures as well as some increment of flow increase to improve smolt survival; and interim standards should be established for the San Joaquin River System to improve salmon production.

- o DFG (T,XLIII,76:24-80:24; DFG,64 and 30)

  DFG recommended that: survival of each race in the Delta should be based on 1940 historical levels; survival rate for Sacramento Basin fall-run salmon should be based on the USFWS flow to survival relationship in Exhibit 31; flow reversal should be eliminated by 1995 in the San Joaquin River and in Old and Middle rivers; survival levels in the San Joaquin River should also be based on historical levels (but these still need to be defined); and physical and operational measures should be considered to achieve protection.

- o BISF (BISF,Brief,85-86 and 93-98)

  BISF recommended that there should be objectives for wet, median, and dry year spring flows at levels greater than D-1485; and that outflows could be reduced in dry years provided compensating flows are available in other years. BISF also supported other measures proposed by USFWS.

5.0.3.3 Striped Bass

<u>Advocated Levels of Protection</u>

The issue of what to do about the decline in striped bass dominated much of the exhibits and testimony in Phase I and the Water Quality Phase, and the debate continues. Two main positions have evolved out of the debate. The first position is that there is still not enough known about the cause(s) for the decline of striped bass or that causes other than water quality problems are responsible for the decline; therefore, the current objectives should remain in effect. In particular, greatly enhanced springtime flows, as advocated by DFG, USFWS and other participants in Phase I, should not be instituted at this time, but other interim measures, such as increased hatchery production, should be implemented (SWC,203,4-5).

The second position is that, for whatever reasons, the striped bass are in serious decline and something substantial needs to be done now, even if we do not know all the answers. In particular, the current objectives are not providing adequate protection and should be modified to provide increased springtime Delta outflow and greater curtailments of spring and early summer exports for protection of young bass (USFWS,47,5; DFG,64,6; WQCP-USFWS-5).

The recommendations proposed by the participants fall into three major categories: flow and diversions, salinity and temperature, and "other". This third category includes operational changes, monitoring, physical facilities, special studies, changes in fishing regulations, control of pollution sources, and other non-water quality, non-flow recommendations. The only recommendations discussed here are those relating to development of salinity and temperature objectives.

- o Salinity

  For striped bass, the major issue relating to salinity was the establishment and maintenance of a suitable spawning area in the lower San Joaquin River. Current D-1485 objectives establish a spawning area between Antioch and Prisoners Point. DFG data show that striped bass do not migrate upstream into the eastern Delta past locations where the EC is greater than 0.55 mmhos/cm (DFG,25,44-46). In addition, the majority of striped bass apparently prefer to spawn in water of less than 0.3 mmhos/cm EC. DFG has testified that the formation of a salinity barrier in the mainstem San Joaquin River above Venice Island tends to restrict spawning runs and spawning activity in that area (T,XLI,68:1-69:10). DFG also testified that historically striped bass did spawn above the Delta in the San Joaquin River system, but this activity has diminished due to reduced flows and degraded water quality (T,XLII,56:5-19).

  No participant other than DFG discussed the spawning zone salinity issue in Phase I (except indirectly by recommending continuation of the current D-1485 objectives). Those participants who wanted to make changes in these objectives recommended increases in Delta outflow or reductions in allowable export levels, rather than salinity changes. The spawning zone issue received considerably more discussion in the February 1990 Workshop and the August 1990 hearing. The water development community generally opposed any significant changes in the present objectives at this time, while DFG and USFWS agree that expansion of the habitat would be desirable. Salinity protection discussions are found in Section 5.6.2 and in Appendix 5.4.5.

- o Temperature

  No participant advocated any temperature protection objectives for adult bass migration or spawning, or for young bass survival. A review of two DWR exhibits and other relevant information on temperature effects on striped bass is presented in Appendix 5.4.6.

5.0.3.4 American Shad

Advocated Levels of Protection

TIBCEN and USFWS recommended flows for protection of American shad; USFWS also recommended certain operational modifications to provide additional protection. BISF made no specific recommendations for American shad, but did recommend flows for the entrapment zone to provide adequate food. USBR recommended more comprehensive management of the system for protection of American shad and other resources (USDI,Brief,24). All other participants either made no recommendation or indicated that current objectives, or new objectives advocated for the protection of striped bass, would also provide adequate protection for shad. None of the proposed objectives were for salinity or temperature, except as related to the current D-1485 objectives for protection of striped bass spawning habitat.

5.0.3.5 Delta Smelt

Advocated Levels of Protection

No specific recommendations for water quality objectives for the Delta smelt were discussed during Phase I.

Since conclusion of the Phase I hearings, a petition has been filed with the California Fish and Game Commission requesting that Delta smelt be added to the list of endangered species under the California Endangered Species Act (See Appendix 4.0.5.1). The Delta smelt was a candidate species for the state endangered species list for one year. DFG reviewed the petition and pertinent data and recommended that the species be listed as threatened. The Fish and Game Commission at the August 31, 1990 meeting decided that there was insufficient evidence to list the species. Consequently, the Delta smelt presently has no legal status under the California Endangered Species Act. Under the federal Endangered Species Act (Federal Register, Volume 154, No. 4) the Delta smelt is listed as a category 1 species. USFWS was petitioned in June, 1990 to list the Delta smelt as a federal endangered species. (See Appendix 4.0.5.1). A number of possible factors in the Delta could be contributing to the population decline. However, the petition recommended that the "... best and probably only way of preventing it (Delta smelt) from becoming extinct is to maintain high enough freshwater outflow through the Delta to keep the entrapment zone in Suisun Bay during March, April, May and June for most years. The entrapment zone should not be upstream from Suisun Bay for more than two years in a row" (Moyle and Herbold, 1989).

5.0.4 Suisun Bay Wildlife Habitat Beneficial Use

5.0.4.1 Suisun Marsh

Advocated Levels of Protection

o DWR, USBR, DFG, SRCD--Suisun Marsh Preservation Agreement (SMPA)

  At the Phase I hearing addressing wildlife, DWR provided testimony and exhibits describing the measures taken by DWR, USBR, DFG and SRCD (called the Four Parties) to meet the Delta Plan requirements (DWR,503; 504; 506A; 506B; 507A; 507B; 508A; 508B; 509; 510; 511; 512; 513; 514; 517 A-B; 518; 519; 520 & 521). The measures included the Plan of Protection for the Suisun Marsh, Suisun Marsh Preservation Agreement, Mitigation Agreement, and Monitoring Agreement. (See Table A5.0-1 and Figure A5.0-1 for the water quality control stations and "standards", respectively, in the SMPA.)

o BCDC

  BCDC proposed that the Board revoke its decision of December 5, 1985, which amended the standards compliance schedule in D-1485 and changed monitoring locations (BCDC,5,31; T,XXIX,238:22-25). The BCDC testimony also proposed an additional standard to protect tidal marshes adjacent to Suisun Bay (BCDC,5,T4; T,XXIX,239:25-240:2). It is BCDC's position that the Board's 1985 amendments to D-1485 reduced

Table A5.0-1

SUISUN MARSH PRESERVATION AGREEMENT WATER QUALITY CONTROL STATIONS

Sacramento River at Collinsville	C-2 RSACO81	
Montezuma Slough at National Steel, 3 mi south of Miens Landing	S-64 SLMZU25	effective Oct 1,1988
Montezuma Slough near Beldon Landing (0.35 mi east of Grizzly Island Bridge)	S-49 SLMZU11	

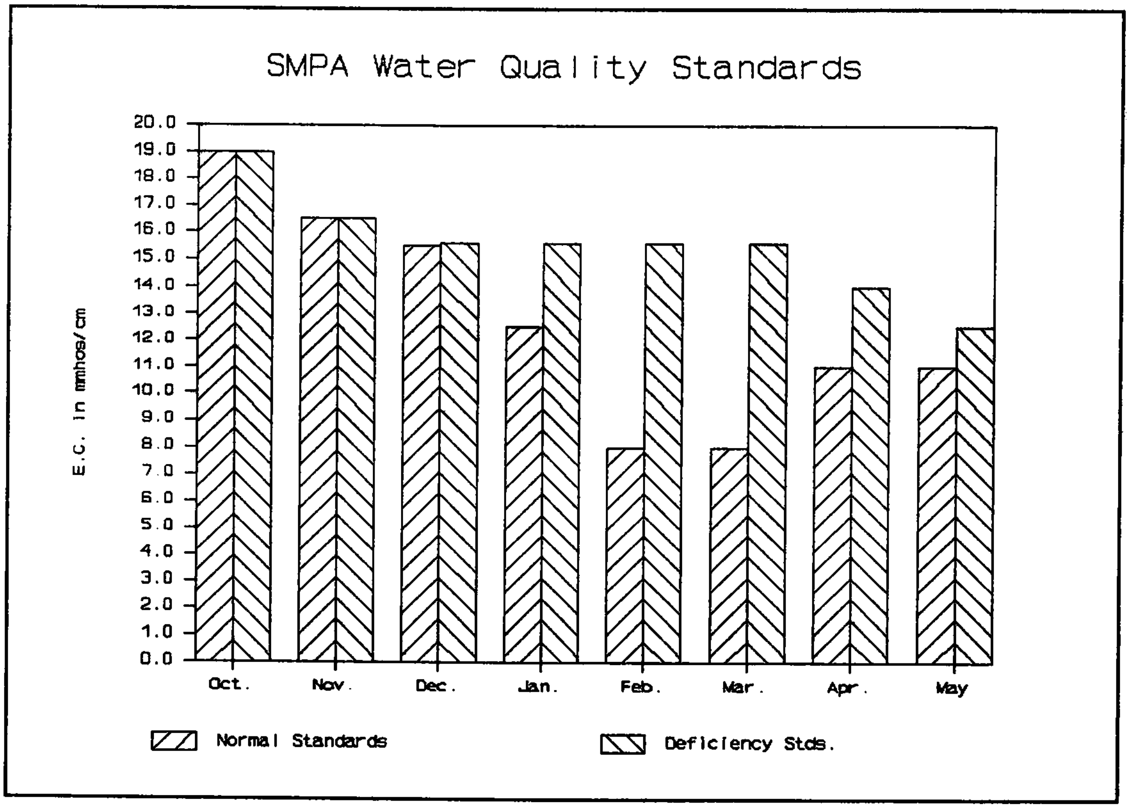
Chadbourne Slough at Chadbourne Road	S-21 SLBCN01	
and		
Cordelia Slough 500 ft west of S.P.R.R. crossing at Cygnus	S-33 SLCRD04	effective Nov 1,1992
or		or
Chadbourne Slough at Chadbourne Road	S-21 SLBCN01	effective Nov 1,1994
and		
Cordelia Slough at Cordelia-Goodyear Ditch	S-97 SLCRD06	

Goodyear Slough at Morrow Island Clubhouse	S-35 SLGYR03	effective Nov 1,1992
or		or
Goodyear Slough, 1.3 mi south of Morrow Island Ditch	S-75(old) SLGYR04	effective Nov 1,1995

Suisun Slough, 300 ft South of Volanti Slough	S-42 SLSUS12	effective Nov 1,1998
Water Supply Intake locations for Water-fowl Manangement Areas on Van Sickle Isl. and Chipps Isl.	No Locations specified	

revised Sep 5, 1990

Figure A5.0-1



Month	SMPA-Normal Standards (Mean Monthly High Tide, E.C. in mmhos/cm)	SMPA-Deficiency[1] Standards (Mean Monthly High Tide, E.C. in mmhos/cm)
Oct.	19.0	19.0
Nov.	16.5	16.5
Dec.	15.6	15.6
Jan.	12.5	15.6
Feb.	8.0	15.6
Mar.	8.0	15.6
Apr.	11.0	14.0
May	11.0	12.5

[1] SMPA Article 1(f): "Deficiency Period" shall mean (1) a Critical Year following a Dry or Critical Year; or (2) a Dry Year following a year in which the Four Basin Index was less than 11.35; or (3) the second consecutive Dry Year following a Critical Year.

SMPA Article 1(r): "Wet Year", "Above Normal Year", "Below Normal Year" and "Subnormal Snowmelt Year" are as defined in Footnote 2 of Table II of D-1485 as adopted by the SWRCB in August 1978. "Critical Year" and "Dry Year" are also as defined in Footnote 2 of Table II of D-1485 except that runoff for the remainder of the water year shall be assumed to be equal to the lower value of the 80 percent probability range, as shown in the most recent issue of Bulletin 120, "Water Conditions in California".

protection for unmanaged tidal marshes and delayed the implementation of measures to protect water quality and beneficial uses in the managed wetlands of the Suisun Marsh (BCDC,5,5). BCDC contends that approximately 40 percent of the 10,000 acres of unmanaged tidal brackish marshes around Suisun Bay which were originally protected by the Delta Plan are not protected under present conditions (BCDC,5,12; BAAC,4; USFWS,17;18;19;20).

o BAAC

BAAC recommended a flow and salinity standard which provides greater protection for brackish water tidal marshes than does the Delta Plan (T,XXX,52:6-22). In addition, they recommended that salinity objectives for water quality in tidal marshes (levels not specified) be set for summer rather than ending in May (T,XXX,54:10-21). The position of BAAC was that the brackish water marshes have already been degraded and they would like to see them improved and restored more toward their natural condition, which would require more stringent salinity standards (T,XXX,94:20-95:2). The BAAC testimony did not explicitly state what those freshwater flows or what salinity standards should be to adequately approach natural conditions.

5.0.4.2 Wildlife Habitat in Other Tidal Marshes

Advocated Levels of Protection

o DFG

The DFG testified that they do not expect reductions in Delta outflow to change the vegetative character of the tidal marshes in the central or southern portions of San Francisco Bay. Those tidal marshes are already fairly saline and support mostly pickleweed or cordgrass. They testified that the marshes around the periphery of San Pablo Bay, which contain some rare plants, could be subject to some harmful impacts if there were significant reductions in outflow. (DFG did not indicate whether peak or annual outflow reductions are under consideration.) They also stated that the marshes around Suisun Bay, including those on the southern shore from about Martinez to Pittsburgh would likely change from the existing emergent brackish water vegetative pattern to one more characteristic of saline marshes. The degree of change would depend upon the magnitude of the change in Delta outflow (T,XXIX,146:17-148:3). DFG did not propose any water quality objectives to address this possible change in vegetative character.

o BCDC and EDF

BCDC and EDF proposed salinity objectives to protect the brackish water tidal marshes around Suisun Bay (BCDC,5,T4; EDF,19,A). They proposed that the monthly average of the daily high-high tide electrical conductivity be no more than 15 mmhos/cm during February and March, 18 mmhos/cm during April, and 20 mmhos/cm during May. BCDC proposed that these salinity objectives be met at the following locations: Martinez, the mouth of Suisun Slough at Grizzly Bay, Port Chicago, and Chipps Island. The salinity objectives for February and March would apply at all stations during all water year types except for the 1-in-10 dry year; the objectives for April and May would apply in all water year types (BCDC,5,T4).

- BAAC

BAAC maintains that the brackish water marshes have already been degraded and they would like to see them improved and restored more toward their natural condition, which would require more stringent salinity standards than the present objectives (T,XXX,94:20-95:2). BAAC did not indicate how the brackish marshes fared during historical dry periods such as 1928 to 1934.

BAAC recommended that flow and salinity objectives be set to provide greater protection for brackish water tidal marshes than does the Delta Plan (T,XXX,52:6-22). In addition, they recommended that the salinity objectives for water quality in tidal marshes (the levels are not specified) be set for summer rather than ending in May (T,XXX,54:10-21). The BAAC testimony did not explicitly state what freshwater flows or what salinity standards should be to adequately approach natural conditions.

5.0.5 Benthos

Advocated Levels of Protection

The benthic grazing hypothesis was proposed to explain the low phytoplankton and zooplankton populations during the 1976-1977 drought (CCWA/EDF,7,385). In Suisun Bay, the benthic salt-tolerant, filter-feeding population (especially *Mya arenaria*, which increased ten-fold compared to non-drought conditions) apparently become sufficiently abundant to be capable of filtering the equivalent of the entire volume of Suisun Bay in a day.

With this amount of feeding, it is hypothesized that benthic filter-feeders consumed virtually all phytoplankton and nutrient material in the water column. The pelagic (open-water) food web, which is based on phytoplankton, was therefore replaced by the benthic food web (CCWA/EDF,7,386). CCWA/EDF is concerned this phenomenon would occur more frequently in the future with additional water development and exports. To address these concerns, CCWA/EDF proposed a 28-day tidally-averaged, bottom salinity of 5 ppt at Chipps Island in upper Suisun Bay to repel salt-tolerant benthic organisms from the entrapment zone area in Suisun Bay (T,LIV,316:16-317:3). This objective would apply from October through April in all years, except the one-in-twenty dry year (T,LIV,258:20-259:1; EDF,Brief,7). No comparable objective was proposed for San Pablo Bay (T,LIV,259:13-14). No participant proposed specific temperature or salinity objectives for the protection of the benthos.

5.0.6 Other Beneficial Uses

Other beneficial uses of the Estuary include navigation and contact and noncontact water recreation. Uses that are part of noncontact water recreation also include esthetic appreciation and educational and scientific study (RWQCB5, 1975, 5B, I-2-2).

5.0.6.1 Navigation

<u>Advocated Levels of Protection</u>

Commercial Navigation -- no advocate for commercial navigation presented any testimony during Phase I of the proceedings.

Recreational Navigation -- PICYA recommended that there be improvements at the Delta Cross Channel for boat passage, protection of existing unleveed Delta islands, and maintenance of through navigation (PICYA,4), but these are not related to salinity or temperature objectives.

5.0.6.2 Estuary Recreation Beneficial Use

<u>Advocated Levels of Protection</u>

- EBRPD

  EBRPD submitted testimony and exhibits which showed that there has been rapid growth (122 percent increase in two years) in water-oriented recreation within their jurisdiction (EBRPD,34,1).

  EBRPD and PICYA emphasized their common interest in having abundant supplies of uncontaminated fish to provide boaters and fishers with an opportunity to experience successful fishing (PICYA,1,3; EBRPD,34,3).

- SWC

  No explicit objectives were proposed by SWC for the protection of recreational uses in the Estuary. SWC argued instead that increased diversions would have no effect on recreational fishing in the Bay-Delta, and would be to the state's economic advantage because of higher recreational values in Southern California (SWC,66,12).

- BISF

  BISF submitted exhibits and testimony regarding recreational uses of the San Francisco Bay area (BISF,38,T2; T,XXX,174:29), and identified the values of a variety of water-oriented recreational activities from the California State Parks and Recreation Department's PARIS model (BISF,38,T3).

5.0.6.3 Export Recreation and Export Fishery Habitat

<u>Advocated Levels of Protection</u>

No participant proposed any salinity or temperature objectives for export recreation or export fishery habitat distinct from the levels provided by the protection of municipal and industrial uses.

5.0.6.4 Export Agriculture

<u>Advocated Levels of Protection</u>

No specific water quality objectives were advocated for export agriculture during Phase 1 of the proceedings. Tolerances, in terms of EC, to salinities of several crops grown in export areas was presented by DWR (DWR,327). The crops addressed will theoretically experience reduced yields if the irrigation water exceeds these salinity tolerances.

APPENDIX 5.1
TRIHALOMETHANES (THMs)

5.1.1 Types of THMs

Four different types of THMs, compounds consisting of a carbon atom combined with one hydrogen atom and three halogen atoms (usually, chlorine or bromine), are commonly created in drinking water when it is disinfected (T,VI,38:5-8). Combinations of the halogens can exist in all four possible permutations: chloroform, (containing three chloride ions), bromodichloromethane (one bromide and two chloride ions), dibromochloromethane (two bromide and one chloride ions), and bromoform (three bromide ions) (T,VI,45:11-17).

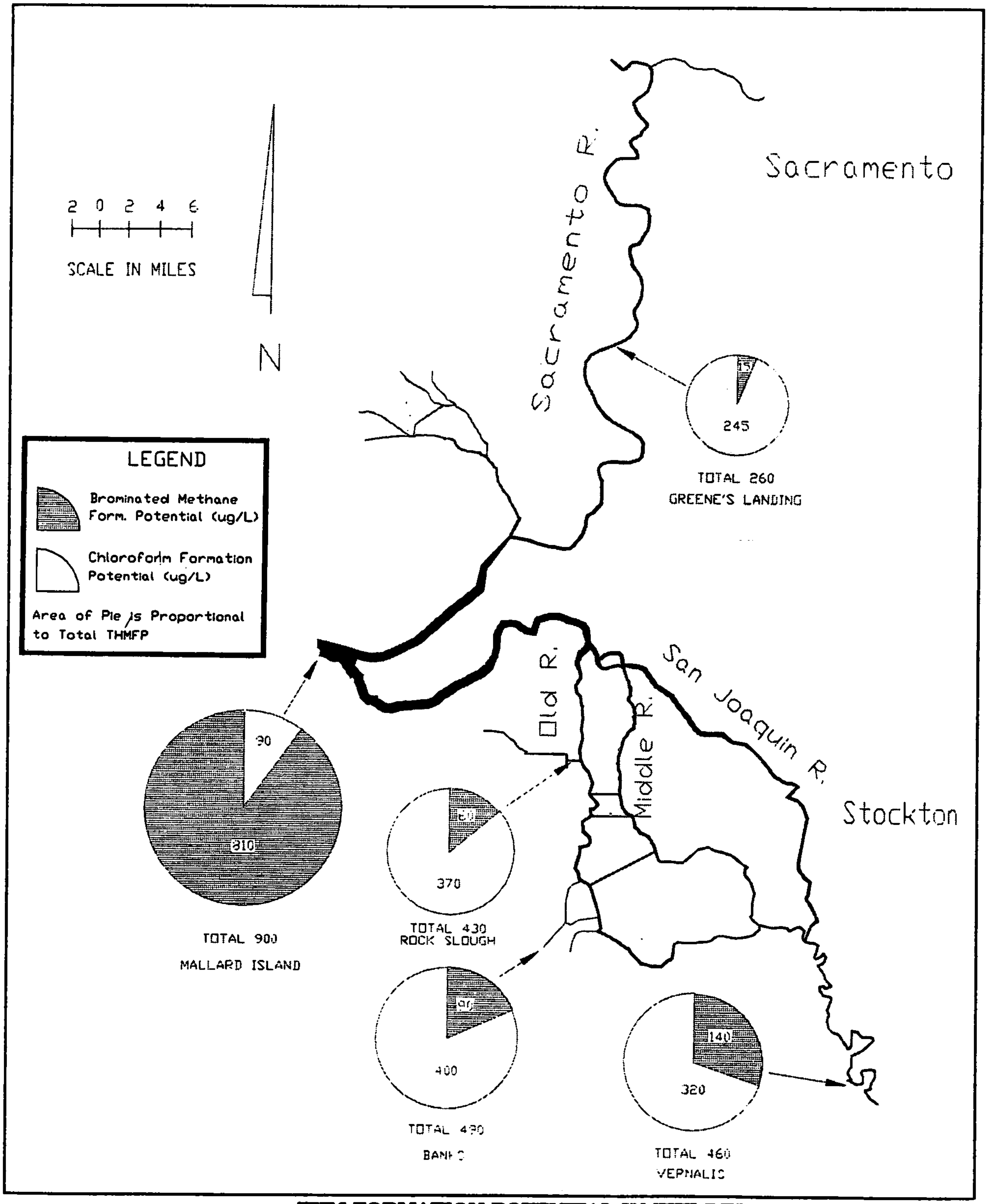
5.1.2 Trihalomethane Formation Potential (THMFP)

In order to evaluate alternative water supplies, suppliers of domestic water have developed analytical techniques to determine the potential of a water supply to produce THMs within the utility's water distribution system. The analytical techniques measure the trihalomethane formation potential (THMFP) of the water. The techniques for determining the THMFP of a water sample have not been standardized, nor can the THMFP of a raw water supply correlate directly to THM concentrations of the water in a distribution system after water treatment. However, lower THMFP levels in source water do indicate lower THM concentrations after water treatment.

Based upon data from the Interagency Delta Health Aspects Monitoring Program (IDHAMP), the THMFP of water increases as it travels across the Delta (DWR,225). The 50 percent probability of occurrence values for THMFPs in Cache Slough, Rock Slough, Delta-Mendota Canal, Clifton Court, and H.O. Banks Pumping Plant are 740, 430, 440, 450, and 480 ug/l, respectively. The levels in the Sacramento River at Greens Landing and the San Joaquin River near Vernalis (the principle Delta source of fresh water) are 250 and 450 ug/l, respectively. Using these values, the THMFP of water moving across the Delta increased by approximately 170 ug/l (SWC,204,11-15). Although a significant correlation has not been developed between the THMFP of a source water and the THM concentration of the treated water delivered to a domestic user, the THMFP levels present in Delta waters are nonetheless a significant water treatment issue to users of Delta water (T,XLVI,122:17-142:10).

Figures A5.1-1, A5.1-2 and A5.1-3 show the THM formation potential (THMFP) in the Delta for a 5-year median, 1983-1987 (Figure A5.1-1); under low flow conditions, October 1985 (Figure A5.1-2); and under high flow conditions, March 1986 (Figure A5.1-3). Five key water quality stations located in the Delta are shown in these figures. Each station is represented by a pie chart that is divided into two portions. The shaded portion shows the fraction of the total that contains brominated THMFPs; the unshaded portion shows the fraction that contains only chloroform. The Mallard Island station in Figures A5.1-1 and A5.1-2 indicates that seawater is the primary source of bromide ions.

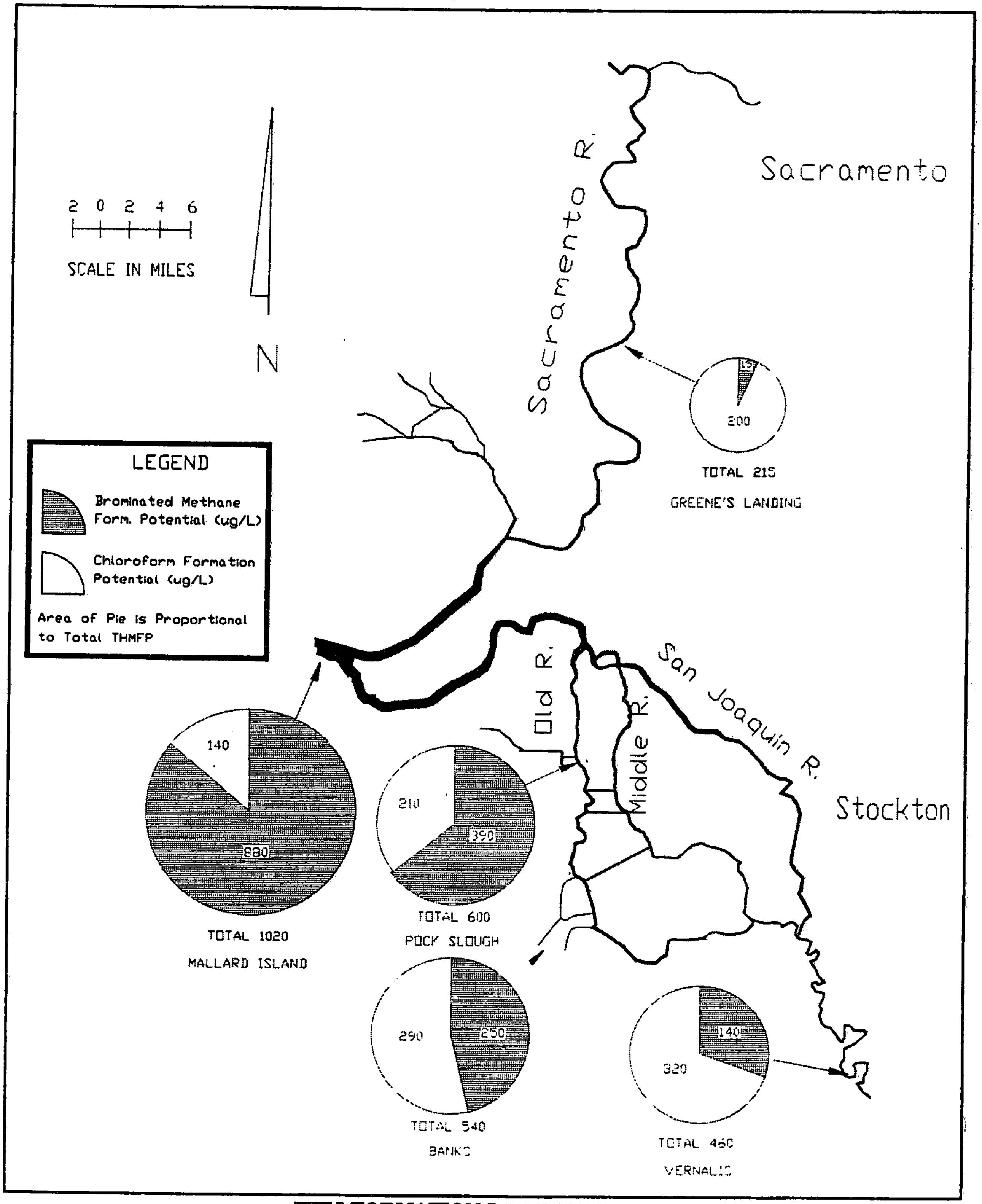
Figure A5.1-1



THM FORMATION POTENTIAL IN THE DELTA, 5-YEAR MEDIAN, 1983-1987

(From DWR: The Delta as a source of drinking water)

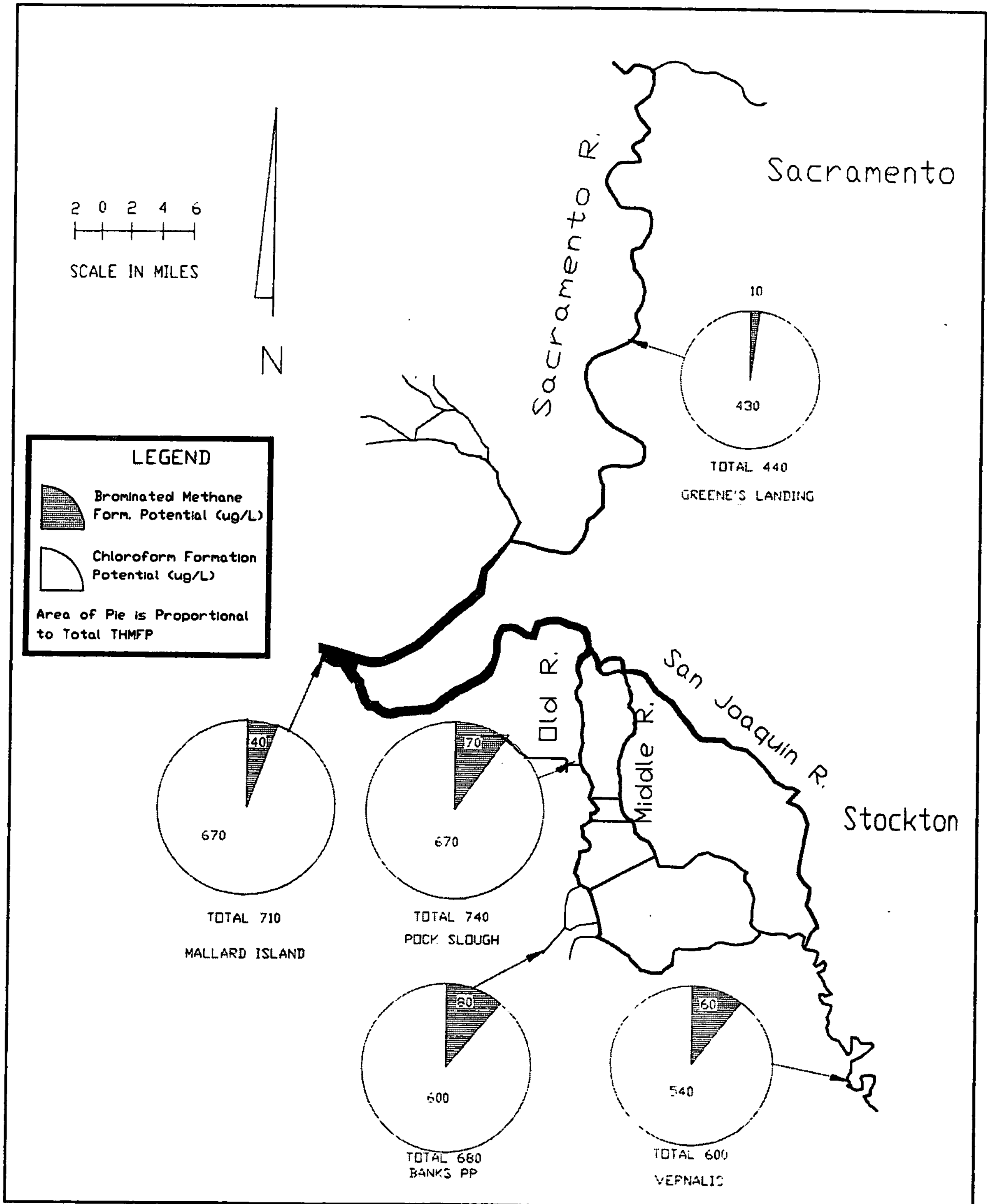
Figure A5.1-2



THM FORMATION POTENTIAL IN THE DELTA UNDER LOW FLOW CONDITIONS , OCTOBER 1985

(From DWR: The Delta as a source of drinking water)

Figure A5.1-3



THM FORMATION POTENTIAL IN THE DELTA UNDER HIGH FLOW CONDITIONS, MARCH 1986

(From DWR: The Delta as a source of drinking water)

result in the production of disinfection by-products (DBPs) other than THMs. For example, ozone reacts with bromine to form bromate and hypobromous acid, which in turn reacts with dissolved organics to form bromoform (Daniel, 1989).

5.1.4 Human Health Effects

Although EPA is currently evaluating the cancer risk of THMs as a class of chemicals, each brominated THM has already been classified as a probable or possible human carcinogen by the EPA (Delta M&I Workgroup Report, Appendix A, M. McGuire and S. Krasner, MWD). Also, it is currently believed that brominated THMs pose a greater hazard to human health than the totally chlorinated THM (chloroform) (Delta M&I Workgroup Report, 1989, p.5).

5.1.5 Water Treatment Problems

All conventional treatment processes, including chlorination, chloramination and ozonation, result in the production of brominated THMs and other brominated DBPs when bromide ions are present (Delta M&I Workgroup, p.3). When both organic matter and bromide ions exist in water, THM concentrations increase more rapidly during or after chlorination compared to water without bromide ions (T. Aizawa et al., "Effect of Bromide Ions on Trihalomethane Formation in Water" - Aqua, Vol. 38, pp. 165-175, 1989). Some of the conclusions drawn by Aizawa include:

1. When water containing bromide ions is chlorinated, brominated THMs are formed preferentially. The major factors in the formation of brominated THMs are bromide ion concentration, pH and water temperature. The pH affects the dissociation of chlorine in water and determines its oxidized ratio with bromide.

2. In the reaction of THM formation, chloroform concentration was reduced in proportion to bromide ion concentration. However, the concentration of total THM increases with the augmentation of bromide ions with the same amount of chlorine dosage. The increase in total THM concentration is up to two times higher than in the absence of bromide ions.

3. Even when residual chlorine is not present, the THM intermediates, once formed, are hydrolyzed depending on the pH and water temperature. The stability of the chlorinated intermediate and the brominated intermediate are different. The intermediates which contain greater amounts of bromide show a greater extent and a faster rate of hydrolysis.

These findings parallel those reported by participants of the Delta M&I workgroup after they analyzed the relationships among chloride, bromide, total THM concentrations. For example, data from the Metropolitan Water District's Mills and Jensen Water Treatment Plants for 1985 to 1989 (Tables A5.1-1 and A5.1-2) indicate that both the bromide level and concentration of brominated THMs increased as water supply chloride levels increased. The total THM concentration

Figure A5.1-2 shows that the brominated THMFPs measured during October 1985, increased to three times the median value at Harvey O. Banks Pumping Plant and six times the median value at Rock Slough, as a result of seawater intruding into the Delta during low flow conditions. However, the brominated THMFP values in the Sacramento and San Joaquin rivers remained near median values. In contrast, Figure A5.1-3 (THMFP under high flow conditions) shows that the brominated THMFP at the export pumps is reflected by the influences of both seawater and the San Joaquin River (IDHAMP - Summary of Monitoring Results, 1983 to 1987).

Of the total median brominated THMFP concentrations from the Sacramento and San Joaquin rivers only, the San Joaquin concentrations are nine times greater than those in the Sacramento River. The sources of bromides in the San Joaquin River are not known. Possible sources are connate water, from marine sediments found in the San Joaquin drainage, and bromide-containing Delta water used in San Joaquin agriculture (IDHAMP - Summary of Monitoring Results, 1983 to 1987).

5.1.3 Bromide Ions

Bromide ions are present in seawater, typically at concentrations about 0.003 times the concentration of chloride ions. Measurements by agencies using Delta water for raw drinking water show a relationship of this same type. MWD developed the following linear regression, equation relating bromide and chloride ions for SWP water delivered to their service area:

$$Br^- = 0.00289\,(Cl^-) + 0.00671$$

Where;

Br^- = The bromide ion concentration, in mg/l, and
Cl^- = The chloride ion concentration, in mg/l

The correlation coefficient for the above equation is definitely significant ($r = 0.955$) (Krasner, 1989, p. 3). An apparent second, though less significant, source of bromide ions is connate ground water which enters the San Joaquin River upstream of Vernalis (Jung, 1989, p. 6). Some connate waters with relatively high bromide levels exist beneath at least two Delta islands (i.e., Bouldin Island and Empire Tract) and may contribute bromide ions to the agricultural discharges from those islands (Winkler, 1989; DWR,225,22).

The difficulties with bromine arise for two reasons: one is due to its molecular weight, the other is due to the chemistry of bromine. The atomic weight of bromine is approximately twice that of chlorine, so the substitution of bromine for chlorine in a molecule increases the molecular weight. Drinking water standards are set on a weight basis. Thus, the existing EPA 100 ug/l THM water quality standard that is met when no bromine is present may not be met if a significant amount of bromine is substituted for chlorine (without changing anything else) (Delta M&I Workgroup, 1989, p. 4.). Chemical reactions involving bromine in water treatment systems which do not use free chlorine can

TABLE A5.1-1
Mills Plant THM Results*

TTHMs µg/L	Date	Plant Influent: Temp. °C	EC µmho/cm	Cl^- mg/L	Br^- mg/L	Plant Effluent: $CHCl_3$ µg/L	$CHCl_2Br$ µg/L	$CHClBr_2$ µg/L	CHB· µg/
	5/7/85			35					
63	5/16/85##	17	357			30	21	11	1
90	5/8/86	15	493			25	32	28	5
	5/13/86			68					
	4/28/87			50	0.17				
78	5/7/87	18	472			29	29	18	2
	5/10/87			59					
	4/11/88			98					
99	4/28/88	16			0.28	8	25	50	16
	5/3/88			105					
79	5/9/89	20	454	75	0.23	19	29	26	5

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*Treatment plant: pre-chlorination/post-ammoniation.

##Free chlorine only.

Reference: Delta M & I Workgroup Report, Appendix A

TABLE A5.1-2
Jensen Plant THM Results*

TTHMs	Date	Plant Influent			Plant Effluent				
		Temp.	EC	Cl^-	Br^-	$CHCl_3$	$CHCl_2Br$	$CHClBr_2$	CHBr
µg/L	Date	°C	µmho/cm	mg/L	mg/L	µg/L	µg/L	µg/L	µg/l
46	8/15/85	18	447			20	16	9	1
	8/85 CMP			35					
48	11/14/85	18	451			15	17	14	2
	11/85 CMP			45					
64	11/6/86	18	522			12	21	25	6
	11/86 CMP			69					
	11/2/87				0.13				
63	11/12/87	18	486			17	21	21	4
	11/87 CMP			58					
78	11/3/88	20	651	100	0.28	7	18	35	18
	5/9/89			131	0.39				
	6/89 CMP			123					
	7/89 CMP			125					
103	7/18/89##	16				4	18	43	38

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*Treatment plant: pre-chlorination/post-ammoniation.

##Free chlorine only.

CMP = monthly composite sample.

Reference: Delta M & I Workgroup Report, Appendix A

increased to approximately 100 ug/l; this forced MWD to change its disinfectant from chlorine to chloramines. As chloride concentrations increase in Delta water, the accompanying increases in bromide concentrations result in higher total THM formation upon disinfection (Delta M&I Workgroup - S.Krasner). Data presented by researchers (Krasner, McGuire et al., AWWA Journal, August 1989; also Delta M&I Workgroup Report, Appendix A, Krasner, MWD) indicate that elevated levels of bromide result in THM concentrations that are close to, or in excess of, current standards.

Theoretically, the Delta water THM problem could be resolved through removing either the bromide ions or total organic carbon (TOC) from the water prior to treatment or the THMs after treatment. However, there are no conventional treatment methods that will efficiently and economically remove THM precursors, TOC, bromide ions or THMs. Conventional treatment methods include chlorination, chloramination and ozonation; these can be used in various combinations to limit the formation of THMs. In the process of disinfection, however, these technologies will cause the formation of other DBPs (Delta M&I Workgroup Report, p.3).

While mentioned above under conventional treatment, ozonation/post-chloramination is considered to be an advanced water treatment technology by some members of the water treatment community and of the Delta M&I Workgroup. Other non-conventional or advanced water treatment technologies include ultra-filtration, reverse osmosis, granular activated carbon (GAC), and PEROXONE. These technologies are discussed below:

- Ozonation/post-chloramination is considered to be the treatment of choice at many water treatment plants. This treatment method will result in reduced THM concentrations in delivered water, particularly if bromide ions are not present in the source water. However, the use of ozone will result in the formation of other DBPs which are currently under regulatory consideration. The Delta M&I Workgroup concluded that ozonated water containing high bromide levels will result in the production of brominated THMs. Based on information submitted in the Workgroup report, it appears that ozonation/post-chloramination may be a viable water treatment technology if a revised EPA objective (standard) for THMs is around 50 ug/l.

  Information recently obtained by the State Board (pers. comm. with P. Daniel and P. Meyerhofer of Camp, Dresser, and McKee, Inc.) suggests that water treatment using ozonation/chlorination with the addition of a trace amount of ammonia upstream of the ozone contactor may result in very low THM levels, less than 3 ug/l. Other DBPs produced are similarly low. Water spiked to a 2.0 mg/l bromide level corresponds to approximately a 690 mg/l chloride level when back calculated using the bromide/chloride ion concentration relationship. However, inaccuracies are magnified when using the relationship at levels being discussed.

Uncertainties exist using the ozonation/chlorination/ammoniation water treatment method. The work completed to date is very preliminary and thus far no conclusions can be drawn. Additional uncertainties include:

- Bromamine, a DBP may form as a result of ammonia reacting chemically with bromide. The extent of this reaction and resultant odor threshold of the bromamine are unknown at this time.

- Ammonia may act as a source of nitrogen for bacterial growth, resulting in high regrowth. Further investigation is needed.

MWD's estimated capital costs for conversion to ozone treatment is $300 million. Estimated total annual cost for conversion to ozone (amortized capital costs and operations and maintenance costs) are approximately $67.5 million. (Delta M&I Workgroup Report, Appendix A, S. Krasner, MWD.) Table A5.1-3 shows the costs for adding ozone treatment to existing water treatment plants.

- o Theoretically, it may be possible to remove the bromide ion and TOC prior to disinfection by ultra-filtration. However, according to the Delta M&I Workgroup Report, "...ultra-filtration has not been used in full-scale at any major United States plant and is too new a technology to be relied upon to meet the needs of the next five to ten years" (S. Krasner, Delta M&I Workgroup Report, p.9).

- o Reverse osmosis could theoretically eliminate the THM and DBP problems even with the current TOC and bromide levels found in Delta source waters. However, the associated costs would be very high. MWD claims it would cost about $0.5 billion to convert 150,000 AF of Delta quality water to quality similar to that of the Mokelumne River and approximately $3 billion for MWD's total supply (pers. comm., D. Clemmer, MWD). This estimate does not include the associated costs for brine disposal which absorbs about 10 to 15 percent of the delivered water supply (pers. comm., J. Gaston).

- o Granulated Activated Carbon (GAC), according to the Delta M&I Workgroup Report, will not remove inorganic ions such as chlorides or bromides; however, simulated distribution testing indicates that it will remove organic THM precursors (TOC) to levels that would produce 5 to 10 ug/l THMs. (The simulated distribution system test was developed by MWD to mirror actual treatment conditions that would be found in a water treatment plant). A study completed by MWD which focused on the reduction of THMs and other DBPs to very low levels, concluded that GAC is an expensive way to control THMs. The siting of GAC regeneration furnaces in southern California would present a problem due to the atmospheric emissions of toxic by-products. MWD has estimated that the approximate costs for conversion of its treatment facilities to GAC technology would be $1.3 billion in capital costs and $421 million in yearly total

TABLE A5.1-3
Cost for existing surface water treatment plants to add ozone treatment

AGENCY	PLANT NAME	DESIGN FLOW MGD	CAPITAL COST $Million	AMORITIZED CAPITAL $Mil/yr.	O & M COST $Mil/yr.	TOTAL COST $Mil/yr.
Alameda CFCWOD, Zone 7	Patterson Pass	14	$4.2	$0.42	$0.41	$0.84
Alameda CFCWOD, Zone 7	Del Valle	18	$4.9	$0.50	$0.47	$0.97
Alameda CWD		10	$3.3	$0.34	$0.30	$0.64
American Canyon WD		2	$1.1	$0.12	$0.17	$0.28
Antelope Val/East Kern	Eastside	3	$1.5	$0.15	$0.19	$0.35
Antelope Val/East Kern	Rosamond	14	$4.2	$0.42	$0.41	$0.84
Antelope Val/East Kern	Quartz Hill	28	$6.6	$0.67	$0.61	$1.28
Antioch		16	$4.5	$0.46	$0.44	$0.91
Avenal		2	$1.1	$0.12	$0.17	$0.28
Benicia, City of		10	$3.3	$0.34	$0.30	$0.64
Castaic Lake Water Agen.	Earl E. Schmidt	12	$3.8	$0.38	$0.39	$0.77
Coalinga		12	$3.8	$0.38	$0.39	$0.77
Contra Costa WD	Bollman	90	$14.4	$1.47	$1.66	$3.13
Crestline-Lake Arrow.	Crestline-Lk.Arrow	5	$2.1	$0.21	$0.22	$0.43
Fairfield	Waterman	22	$5.6	$0.57	$0.53	$1.10
Fairfield	Fairfield	30	$6.9	$0.70	$0.64	$1.34
Huron		2	$1.1	$0.12	$0.17	$0.28
Kern Co WA, ID #4		28	$6.6	$0.67	$0.61	$1.28
Martinez, City of		12	$3.8	$0.38	$0.39	$0.77
Metropolitan WD SoCal	Mills	236	$27.5	$2.80	$3.60	$6.39
Metropolitan WD SoCal	Skinner	554	$48.5	$4.94	$8.02	$12.96
Metropolitan WD SoCal	Jensen	870	$65.6	$6.68	$13.55	$20.24
Metropolitan WD SoCal	Weymouth	500	$45.3	$4.62	$7.74	$12.36
Metropolitan WD SoCal	Diemer	710	$57.3	$5.84	$9.68	$15.52
Napa	Hennessey	20	$5.3	$0.54	$0.50	$1.04
Naval AS-Lemoore		8	$2.9	$0.29	$0.28	$0.57
Oakley		6	$2.4	$0.24	$2.49	$2.73
Palmdale		12	$3.8	$0.38	$0.39	$0.77
Pittsburg		12	$3.8	$0.38	$0.39	$0.77
Santa Clara VWD	Penitencia	40	$8.4	$0.85	$0.83	$1.68
Santa Clara VWD	Rinconada	75	$12.8	$1.30	$1.24	$2.54
Santa Clara VWD	Santa Teresa	100	$15.5	$1.58	$1.94	$3.51
Tracy		12	$3.8	$0.38	$0.39	$0.77
Vallejo		5	$2.1	$0.21	$0.22	$0.43
Vallejo		30	$6.9	$0.70	$0.64	$1.34
	T O T A L S :	3520	$394	$40.18	$60.35	$100.53

AMORTIZED COST AT 8% AND 20 YEARS

Reference: Delta M & I workgroup report, Appendix A

costs (amortized capital costs plus operations and maintenance costs). This is based on meeting a revised total THM maximum contaminant level (MCL) of 25 ug/l (Delta M&I Workgroup Report, Appendix A, S. Krasner, MWD).

The SWC have also estimated costs for meeting GAC technology. They estimate $2 billion in capital costs and $344 million in operations and maintenance costs per year for a total annual cost of $549 million (Table A5.1-4). This would yield an aggregate cost of $140/AF (T,XLVI,138:5-10). It was not made clear what THM MCL level this technology could meet.

- o PEROXONE is the combination of ozone and hydrogen peroxide. Delta M&I Workgroup participants believe that this technology shows promise for disinfection, oxidation of taste and odor compounds, and control of DBPs. Costs associated with this technology are lower than the others previously discussed. MWD has estimated that the approximate costs for conversion to PEROXONE would be $200 million. The effectiveness and reliability of PEROXONE have yet to be demonstrated at full scale. The Delta M&I Workgroup Report (Appendix A, S. Krasner, MWD) states that unresolved questions remain concerning how large-scale hydraulic mixing systems will affect the reactions between hydrogen peroxide and ozone, and whether disinfection efficiencies demonstrated in pilot-scale studies can be confirmed at full-scale. MWD is proceeding with plans to test PEROXONE at a 5.5 mgd demonstration treatment plant, the results of which should be available in 1992 (Delta M&I Workgroup Report, p.9).

5.1.6 Regulatory Problems

DBPs were not recognized as potential human health hazards present in treated drinking water in the 1978 Delta Plan and subsequent triennial reviews. Information on the subject was not available at that time. Currently, limited information is available. In summary, this information is limited to the general facts that DBPs are formed as a result of disinfecting drinking water; that DBPs are suspected human health hazards; and that DBPs will likely be regulated by EPA in the near future, around 1994. DBPs are being addressed here in recognition of the fact that, while much uncertainty exists regarding their formation and health effects, the minimization of DBPs should be considered in the search for any long-term solution regarding Delta drinking water quality.

Every chemical disinfectant currently being used produces DBPs (Delta M&I Workgroup Report, Appendix A; S. Krasner, MWD). The EPA is currently considering the establishment of MCLs for certain DBPs and for disinfectants used to treat drinking water supplies. MCLs for disinfectants and for DBPs are scheduled to be proposed in late 1991 and finalized in fall 1992, barring development of new information that would require reevaluation and additional time for public comment. Under this time schedule, compliance by water districts would be required in 1994 (Delta M&I Workgroup Report, Appendix A; S. Clark, EPA).

TABLE A5.1-4
Cost for existing surface water treatment plants to add GAC

AGENCY	PLANT NAME	DESIGN FLOW MGD	CAPITAL COST $Million	AMORITIZED CAPITAL $Mil/yr.	O & M COST $Mil/yr.	TOTAL COST $Mil/yr.
Alameda CFCWOD, Zone 7	Patterson Pass	14	$16	$1.6	$1.5	$3.1
Alameda CFCWOD, Zone 7	Del Valle	18	$19	$1.9	$1.9	$3.8
Alameda CWD		10	$13	$1.3	$1.1	$2.4
American Canyon WD		2	$6	$0.6	$0.3	$0.9
Antelope Val/East Kern	Eastside	3	$7	$0.7	$0.4	$1.1
Antelope Val/East Kern	Rosamond	14	$16	$1.6	$1.5	$3.1
Antelope Val/East Kern	Quartz Hill	28	$25	$2.5	$2.9	$5.4
Antioch		16	$17	$1.7	$1.7	$3.4
Avenal		2	$6	$0.6	$0.3	$0.9
Benicia, City of		10	$13	$1.3	$1.1	$2.4
Castaic Lake Water Agen.	Earl E. Schmidt	12	$14	$1.4	$1.3	$2.7
Coalinga		12	$14	$1.4	$1.3	$2.7
Contra Costa WD	Bollman	90	$61	$6.2	$9.1	$15.3
Crestline-Lake Arrow.	Crestline-Lk.Arrow	5	$9	$0.9	$0.6	$1.5
Fairfield	Waterman	22	$21	$2.1	$2.3	$4.4
Fairfield	Fairfield	30	$26	$2.6	$3.1	$5.7
Huron		2	$6	$0.6	$0.3	$0.9
Kern Co WA, ID #4		28	$25	$2.5	$2.9	$5.4
Martinez, City of		12	$14	$1.4	$1.3	$2.7
Metropolitan WD SoCal	Mills	236	$139	$14.1	$23.9	$38.0
Metropolitan WD SoCal	Skinner	554	$282	$28.7	$51.9	$80.6
Metropolitan WD SoCal	Jensen	870	$394	$40.1	$83.5	$123.6
Metropolitan WD SoCal	Weymouth	500	$264	$26.9	$47.4	$74.3
Metropolitan WD SoCal	Diemer	710	$346	$35.2	$69.7	$104.9
Napa	Hennessey	20	$20	$2.0	$2.1	$4.1
Naval AS-Lemoore		8	$11	$1.1	$0.9	$2.0
Oakley		6	$10	$1.0	$0.7	$1.7
Palmdale		12	$14	$1.4	$1.3	$2.7
Pittsburg		12	$14	$1.4	$1.3	$2.7
Santa Clara VWD	Penitencia	40	$32	$3.3	$4.1	$7.4
Santa Clara VWD	Rinconada	75	$52	$5.3	$7.6	$12.9
Santa Clara VWD	Santa Teresa	100	$66	$6.7	$10.0	$16.7
Tracy		12	$14	$1.4	$1.3	$2.7
Vallejo		5	$9	$0.9	$0.6	$1.5
Vallejo		30	$26	$2.6	$3.1	$5.7
	T O T A L S :	3520	$2,021	$205.0	$344.3	$549.3

AMORTIZATION AT 8% AND 20 YEARS

Reference: Delta M & I workgroup report, Appendix A

Table A5.1-5 lists some of the disinfectants and DBPs considered for MCLs and maximum contaminant level goal (MCLGs) by EPA. If a contaminant is a known or possible human carcinogen, then the MCLG is set at zero. A balance of the health risk of DBPs with the health risks of microbial disease is established by EPA when considering establishment of MCLs. The following narrative is derived from Appendix A of the Delta M&I Workgroup Report, as presented by J. Orme, EPA.

According to EPA, classes of DBPs rather than the individual compounds themselves will probably be regulated in much the same way as THMs. MCLs will likely continue to be considered on a mass per volume basis.

Much uncertainty exists concerning the hazards to human health posed by these disinfectants. For example, chlorine has been used as a disinfectant for nearly eighty years without undergoing rigorous toxicological testing to determine its effects on human health from ingestion. Studies indicate that chlorine can affect kidneys and thyroid hormone levels of laboratory animals. A weak correlation has also been established between consumption of chlorinated surface water and bladder cancer in humans. Chlorine dioxide affects red blood cells and appears to have developmental and neurotoxic effects. Chloramines affect the organ weights of rats and mice. Additional risk assessment studies for these disinfectants are underway.

TABLE A5.1-5
SOME DISINFECTANTS AND DISINFECTION
BY-PRODUCTS CONSIDERED FOR DEVELOPMENT OF MCLGs AND MCLs

Disinfectants

Chlorine
Chlorine Dioxide
Chloramine
(Ozone is not being considered because no residual is left upon which to base an MCL)

Disinfection By-Products

Trihalomethanes: Chloroform
Bromoform
Bromodichloromethane
Dibromochloromethane
Chlorinated Acetic Acids/Brominated Acetic Acids
Chlorinated Alcohols
Chlorinated Aldehydes
Chlorinated Ketones
Chlorite and Chlorate
Haloacetonitriles
Chlorophenols
Chloropicrin
Cyanogen Chloride
Iodide, Iodate
Bromide, Bromate
MX

Reference: M&I Workgroup Report, Appendix A

Brominated THMs have been classified as a probable or possible human carcinogen by EPA. Chloroform is still suspected to be a carcinogen. Chlorinated acetic acids have been found to occur in concentrations equal to THMs. Animal studies suggest that certain species of the chlorinated acetic acids are potent neurotoxins and may also be carcinogenic. Based on animal studies, haloacetonitriles are believed to be carcinogenic. Health hazards associated with chloropicrin are currently under study. Although health effect information on cyanogen chloride is limited, it was used as a nerve gas agent in World War I. MX is known as a highly unstable potent mutagen. Studies on this chemical continue.

The formation of DBPs is dependent upon several variables: bromide concentration, oxidant concentration, contact time, the presence of dissolved organics, temperature, and pH. In short, every method of water treatment has advantages and disadvantages. In a recent DBP survey of 35 utilities conducted for the California Department of Health Services by the EPA, it was found that THMs measured by weight, were the largest class of DBPs found. The next significant class found were the haloacetic acids, followed by the aldehydes. Of the 35 utilities in the study, only three employed ozone, yet almost all had detectable levels of formaldehyde and acetaldehyde. (Aldehydes were initially discovered as by-products of ozonation; however, they also appear to be caused by chlorination) (AWWA Journal, August 1989).

Ozonation/chloramination is frequently mentioned by many water treatment plant managers as the alternative treatment of choice for reduction of THMs. Ozone alone should not produce chloroform or other chlorinated DBPs. However, if bromide ions are present in the source water, ozonation will cause the formation of hypobromous acid, which will react with organic precursor material to form brominated forms of THMs. In addition, chloramination tends to increase the formation of cyanogen chloride at the same time it decreases the formation of THMs (Delta M&I Workgroup Report, Appendix A; M. McGuire and S. Krasner, MWD).

APPENDIX 5.2
ANALYSIS OF CORN YIELD TO VARIATIONS IN APPLIED WATER AND LEACH WATER SALINITY

To ensure a reasonable level of protection for western and interior Delta agriculture information is needed in the following three areas:

1. The impacts of irrigation and leaching water quality on crop yield,

2. The economics of implementing various leaching practices, and

3. The practicality of implementing and the effectiveness of various leaching practices.

The Corn Study developed information on the impacts of irrigation and leaching water quality on corn yield, only limited information on the practicality of implementing and the effectiveness of specialized leaching practices, and no information on the practicality, effectiveness, and economics.

Although insufficient information is available to set a water quality objective, it is important to discuss the progress made in the first area, impacts of irrigation and leaching water quality on corn yield.

- Salinity Requirements for Corn

  Salinity requirements to maximize the yield of corn grown on organic subirrigated soils are based on the testimony and exhibits from Phase I and the results of a modified DWR DELCORN model (modified DELCORN). This body of information indicates that corn yield is affected by both short-term water quality and long-term, average water quality. Evidence indicates that in order to maintain maximum corn yield, in the short-term, the maximum 14-day running average of daily average salinities of applied water should be no more than 1.5 mmhos/cm EC from April 1 through July 31. After July 31 salinity levels may rise to a level of up to 6.0 mmhos/cm EC without affecting yield (SWRCB,24,1). Proper corn yield also requires long-term average irrigation water quality maintain soil salinity at a level requiring a particular frequency of pond leaching[1/]. The frequency of pond leaching is determined by considering the practicality and the economic effects of the farming practices needed to maintain maximum corn yield.

1/ Pond leaching is that practice which is performed by constructing berms around an area and flooding the area. Following an extended period of flooding, the field is drained to prepare for cropping. Drainage ditches and drainage pumps are assumed to be in operation throughout the leaching period (DWR,334,2). Pond leaching occurs in the months of December through February when the previous irrigation seasons's average saturated soil extract salinity (ECe) exceeds 2.1 mmhos/cm EC.

To help determine this long-term average water quality objective, the modified DELCORN model was used to identify possible alternative levels of irrigation and leaching objectives needed to protect western and interior Delta agriculture. DWR's DELCORN model's algorithm uses Hoffman's equations, which were presented as SWRCB evidence in Phase I of the Hearing (SWCRB,23-30). These equations describe the relationships between seasonally applied water quality, soil salinity, and yield. DWR's DELCORN model applies a 57-year hydrology to these equations at a number of locations in the western and interior Delta to simulate a history of soil salinities and subsequent yields. The DWR DELCORN model has gained general acceptance, with some reservations. The model is believed to overestimate the frequency that leaching is required. A comparative impact analysis is therefore considered more reliable than a predictive study.

o Description of Comparative Impact Analysis

The modified DELCORN model was used to develop pond leaching frequency curves for the comparative impact analysis. Each curve identifies a set of combinations of irrigation and pond leach water quality needed to maximize corn yield, given a particular hydrologic condition.

Inspection of these curves illustrates the importance to agriculture of a factor generally overlooked, that is, "umbrella protection". Western and interior Delta agricultural water quality is not only determined by agricultural water quality objectives, but much of the time by the incidental effect of unregulated flow releases and objectives protecting other beneficial uses. These incidental benefits are given the term "umbrella protection". Most of the time umbrella protection controls agricultural water quality in the western and interior Delta. The following analysis determines that the factor controlling the quality of water that agriculture receives will not be the long-term average water quality objective, but either the umbrella protection or the 1.5 mmhos/cm EC maximum irrigation water quality objective over the irrigation season.

o Comparative Impact Analysis of Irrigation and Leaching Water

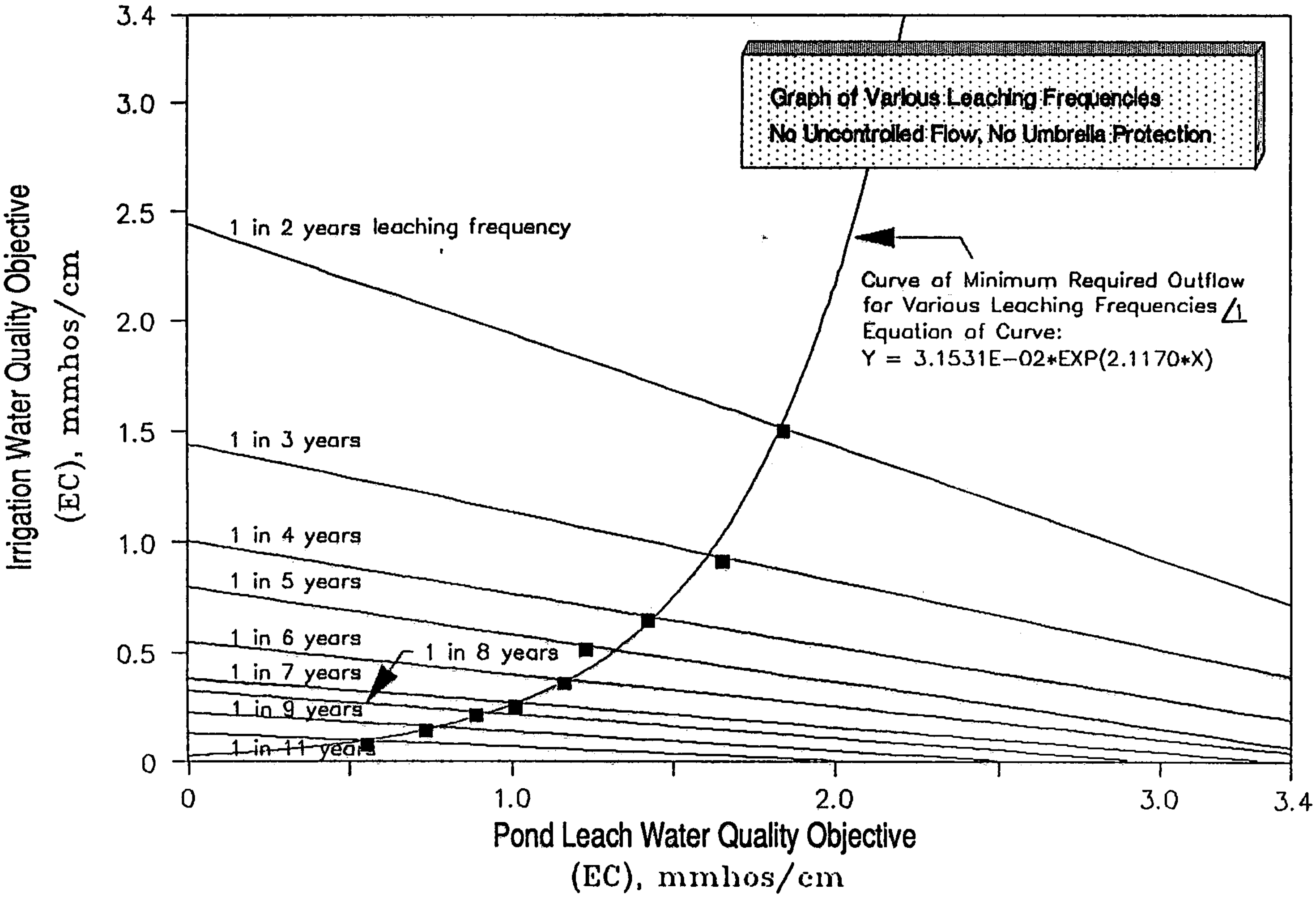
Figure A5.2-1 shows the estimated pond leaching frequencies that are required if there is no umbrella protection. A wide range of combinations of irrigation and pond leach water quality can be used to attain a particular leaching frequency. For a given leaching frequency the optimal EC concentration to obtain the objectives with the minimum Delta outflow is shown by the intersection of the appropriate leaching frequency curve and the minimum required outflow curve (see Figure A5.2-1). Figure A5.2-2 shows the estimated pond leaching frequencies that are required if uncontrolled reservoir releases and Delta Plan level umbrella protection are available. Figure A5.2-3 shows present level of development or base condition impacts for a 57-year hydrology.

The curves shown in Figures A5.2-1 and A5.2-2 and information from Figure A5.2-3 are used in a comparative analysis to determine the relative effects between the current or base condition and various other levels of protection, based on frequency of leaching. In this comparative analysis, a base condition and two alternative conditions are chosen. These alternative conditions are then compared to the base condition to arrive at an incremental effect.

FIGURE A5.2-1

IRRIGATION VS. POND LEACH WATER QUALITY AT EMMATON FOR MAXIMUM YIELD

DATA GENERATED USING DWR'S DELCORN MODEL

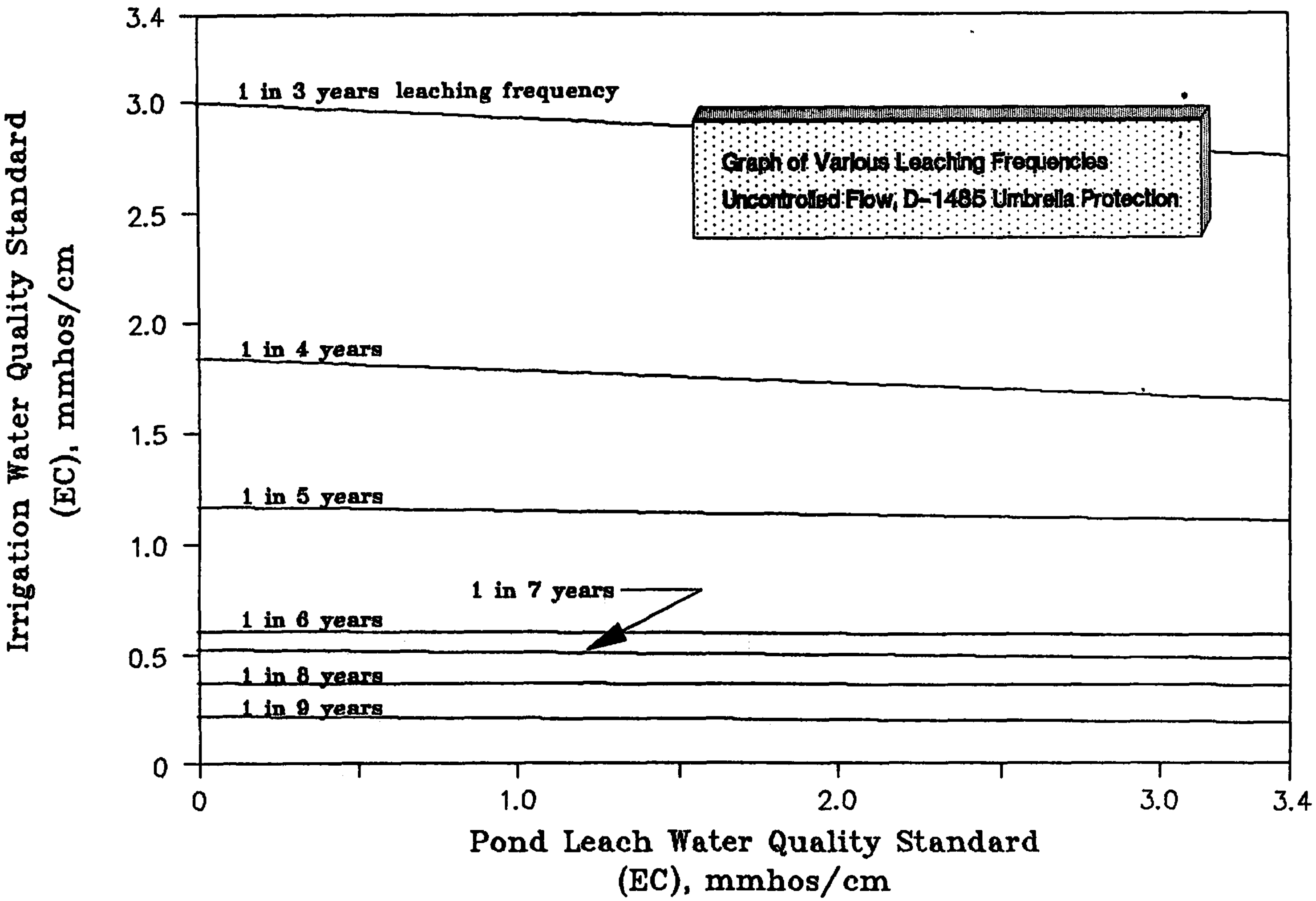


Δ1 For a given leaching frequency the optimal concentrations (EC) to obtain the objectives with minimum flow is shown by the intersection of the flow curve and the appropriate frequency curve.

FIGURE A5.2-2

IRRIGATION VS. POND LEACH WATER QUALITY AT EMMATON FOR MAXIMUM YIELD

DATA GENERATED USING DWR'S DELCORN MODEL

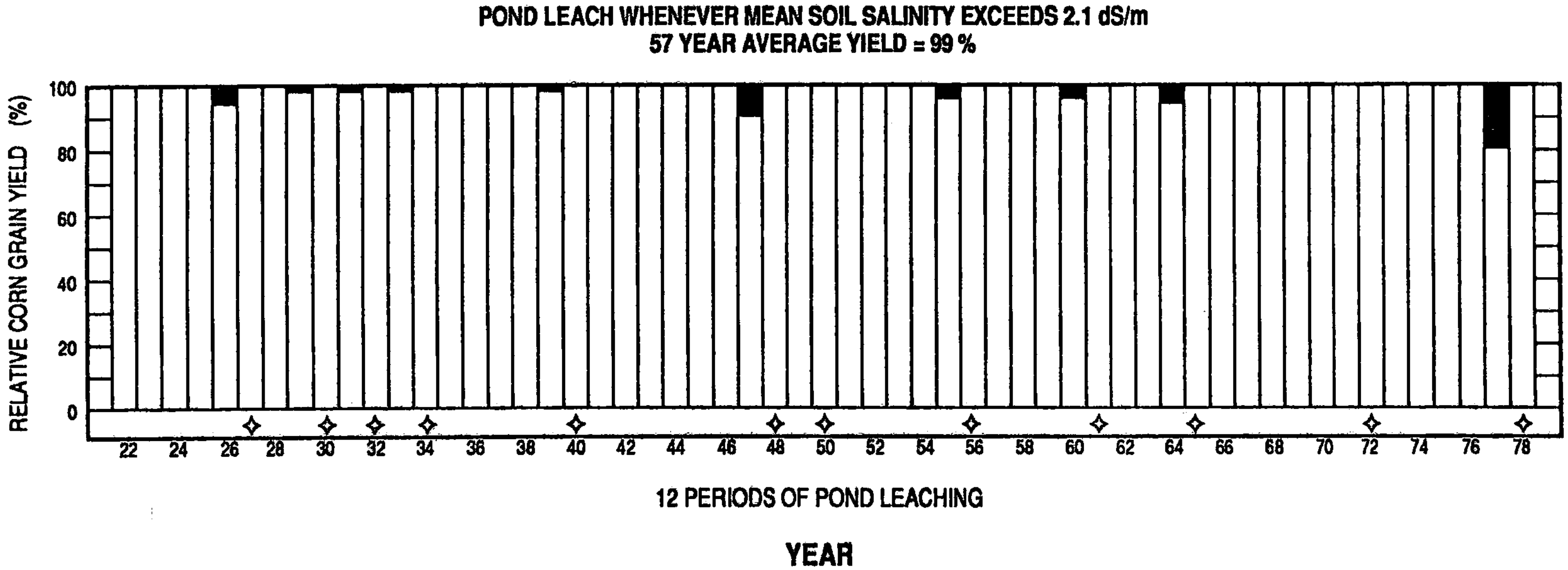


PRELIMINARY
SUBJECT TO REVISION

FIGURE A5.2-3 Variation in Corn Yield With Different Leaching Practices at Emmaton

Assuming 1990 Level of Development Hydrology
Meeting D1485 Standards (Study A)

(Corrected Pond Leaching Equation Incorporated)



LEGEND:
✧ = Pond Leaching Performed

From DWR Subworkgroup Handout

CHA0043R1

The current objectives, including umbrella protection, were chosen as the base condition for this comparative analysis. DWR provided this information from a model simulation (see Figure A5.2-3). The results indicate that, under this base condition, pond leaching would be required 12 times during this 57-year period, approximately once every five years.

The first alternative level of protection studied was that level of salinity, assuming Delta Plan umbrella protection, for which the frequency of leaching was the same as for the base condition; once in five years. This level of salinity can be determined by looking at the plot of curves in Figure A5.2-2. From these curves it can be seen that a short-term maximum irrigation salinity objective of approximately 1.2 mmhos/cm EC and virtually any level of leach water quality will achieve a pond leaching frequency of once in five years. In comparison, this frequency is the same one that was achieved under the base or current condition. This comparative analysis indicates that setting a short-term maximum irrigation water quality objective of 1.2 mmhos/cm EC and no leach water quality objective will provide the same protection to western and interior Delta agriculture as the base condition, that is, the present level.

The second alternative level of protection studied assumed Delta Plan umbrella protection, and a salinity level for irrigation of 1.5 mmhos/cm EC, the indicated short-term maximum allowable salinity for irrigation water quality. Figure A5.2-2 indicates the effect would be to increase the pond leaching frequency to approximately once in four years. At this level of salinity, approximately one to two more periods of pond leaching would be required during the historical 57-year period as compared to the one in five year leaching frequency condition, or base condition.

This second comparative analysis, evaluating the incremental difference between the second alternative's short-term objective at a threshold level of 1.5 mmhos/cm EC and the base condition, indicates that the controlling factor will not be the average water quality objective, but will be either the umbrella protection or the maximum short-term irrigation water quality objective.

APPENDIX 5.3
CHINOOK SALMON

Numerous and complex field and laboratory studies have been conducted to determine how temperatures affect Chinook salmon. The survival results of field studies, when compared to temperature data, differ from the literature on temperature tolerance experiments. The field studies indicate a roughly linear relationship between smolt survival and temperature, whereas, the lethal temperature tests indicate curvilinear and threshold relationships (WQCP-USFWS-0,3; WQCP MID/TID-1; WQCP-SWC-605). The laboratory studies control the conditions to which the fish are subjected and the responses of the fish are generally attributable to those conditions. In the field studies, the fish subjected to high water temperatures may die either directly due to the temperatures or indirectly due to becoming more susceptible to the hazards of predation, entrainment, etc., because of the temperatures. The following testimony and evidence describe the influence of temperatures and other conditions on Chinook salmon.

- Chinook salmon are a cold water species and water temperatures below 60°F are required for spawning and the survival and growth of eggs and fry (USFWS,29,4; USFWS,31,4;T,XXXV,43:68). The virulence of many diseases affecting Chinook salmon is reduced when temperatures are below 60°F (USFWS,29,23). Juvenile emigrants (smolts) can tolerate water temperatures somewhat higher than 60°F but above about 65°F a variety of stress effects occur (DWR,562,3; DWR,563,1-3; USFWS,31,4 and 42; DFG,15,23-27). Water temperatures above 18°C (64.4°F) are usually considered undesirable for Chinook juveniles (USFWS,31,38). At temperatures of about 68°F or more, smolts are highly stressed (DFG,15,25-26); 76°F is lethal (USFWS,31,42).

- Sublethal or stressful temperatures can cause increased susceptibility to disease, predation and entrainment (Letter from DFG to SWRCB dated August 9, 1989).

- Laboratory studies have shown that a salmon smolt's tolerance of elevated temperatures is improved when food supply is optimal (DWR,563,1-3). DWR's consultants testified that DFG's records indicate that the abundance of Neomysis, one of the primary foods of emigrating salmon (T,XXXVII,207:23-25), has decreased significantly in the last 20 years (T,XXXVII,207:25-208:1) and that upstream and estuarine food supplies may be poor. Taken together, these conditions could aggravate the effects of higher temperatures during emigration (T,XXXVII,207:3-9).

- Acclimatization increases the short-term temperature stress tolerance. Survival in elevated temperatures will depend upon the temperature to which the fish are acclimatized and factors contributing to the response of the fish may include ration or nutrition, salinity and size (DFG,15,23).

- Survival in both the Sacramento and San Joaquin basins may be reduced when spring water temperatures are above the stressful range of 66 to 70°F (T,XXXVI,159:17-20; DWR,562,60; T,XXXVI,150:24-151:11; DFG,15,26-27).

- Available information indicates that temperatures are not optimal in the San Joaquin and Sacramento rivers, especially during smolt outmigration in May and June (USFWS,31,144). The USFWS found smolt survival in the Delta decreases as water temperatures increase between the City of Sacramento and Suisun Bay (USFWS,31,42).

- Upstream factors identified as contributing to the decline in natural salmon production include loss of habitat from construction and operation of dams and diversion (T,XXXV,25:20-23; DFG,15,8; T,XXXV,33:7-37:12). Stressful (sublethal) to lethal water temperatures, reduced or fluctuating flows, and harmful concentration of toxins are also factors (USFWS,29; DWR,561).

High water temperatures are associated with increased smolt mortality; however, other conditions in the Delta, such as flow, direction of flow, food availability and migration paths, may also influence their survival (USFWS,31,254,138) (USFWS, 1988). The results of the USFWS smolt survival studies indicate that variable rates of mortality occur between 60 and 75°F depending upon the location where the smolts were released (USFWS, 1988).

Chinook salmon smolts were marked and released at the various sites and recaptured at Chipps Island. Variables that may have also influenced survival include the temperature differences between the hatchery truck, the temperature at the release site, and the duration of exposure to the elevated temperatures. The survival index is useful as a reflection of trends and general magnitude of change in survival as conditions change.

The following table is a summary of predicted smolt survival indices in the Sacramento River Delta during the spring under various export levels, percent of flow diverted through the Delta Cross Channel and under various water temperatures (Predicted Appendix Table 5.3-1).

Fall-run Chinook salmon:

Fall-run Chinook salmon are affected by temperatures in the fall during the upstream migration and in the spring during the outmigration. When inflows are high, fall-run Chinook fry rear in the upper Estuary from approximately January to March. Fall-run smolts emigrate from approximately April through June, and the adults migrate upstream from August through November. The temperature impact in the Delta on the fall-run smolts occurs during the late spring, May and June, when water temperatures are warming (T,XXXVII,226:15-20).

Appendix Table 5.3-1
Survival Indices for Chinook Salmon
Smolts Migrating through the Sacramento
River Delta Under Varied Water Temperatures,
Percent Diverted at Walnut Grove and CVP/SWP
Export Rates (WQCP-USFWS-0).

Export Rate 2,000 cfs	Temperature (°F)					
Percent Diverted	60	62	64	66	68	70
0	0.64	0.51	0.4	0.3	0.22	0.15
30	0.57	0.46	0.36	0.27	0.2	0.14
70	0.47	0.39	0.3	0.23	0.18	0.12
Export Rate 6,000 cfs	**Temperature (°F)**					
Percent Diverted	60	62	64	66	68	70
0	0.64	0.51	0.4	0.3	0.22	0.15
30	0.52	0.41	0.32	0.24	0.17	0.11
70	0.36	0.28	0.21	0.16	0.11	0.07
Export Rate 10,000 cfs	**Temperature (°F)**					
Percent Diverted	60	62	64	66	68	70
0	0.64	0.51	0.4	0.3	0.22	0.15
30	0.47	0.37	0.28	0.21	0.15	0.1
70	0.25	0.18	0.13	0.09	0.07	0.04

The various life stages of the Chinook salmon occurring in the lower reaches of the Sacramento River during the high temperature months are:

	May	June	July	August	September	October
Fall-run	smolts	smolts	--	adults	adults	adults
Late Fall-run	smolts	smolts	--	--	smolts	smolts/ adults
Winter-run	adults	adults	--	--	(fry)1/	(fry)
Spring-run	adults	adults	--	--	--	

(Letter to SWRCB from DFG, August 9, 1989; USFWS,29,5,Figure 2).

Also, see Figure A4-4 on page 4.0-14 of this Appendix.

1/ *"Young winter-run salmon potentially could enter the estuary as early as September following early storms".*

APPENDIX 5.4
STRIPED BASS

5.4.1 Methods to Assess the Population Levels of Striped Bass

Adults:

1. Petersen Estimate--Mark and recapture method; 1969 to present; sampled at specific stations in Delta and Sacramento River; creel census (see below) contributes data from San Francisco Bay and ocean areas; statistical analysis of number of fish recaptured which were marked previously.

2. Catch Per Unit Effort (CPUE) Index--Index of population based on number of fish caught per standardized unit of time; same locations as for Petersen estimate; 1969 to present except 1977, 1978, and 1981; possibly more reliable than Petersen estimate (DFG,25,Appendix 1).

3. Tag Returns--1958 to present, except 1962-1964 and 1967-1968; analysis of tags returned by fisherman; provides basis for comparison of fishing vs. "natural" mortality.

4. Party Boat Census--Monthly reports submitted by party boat operators, required since 1938, plus direct sampling by creel census since 1970's; provide information on numbers of fish caught, number of angler-days, per cent of total catch by party boats, length and age composition, and related information.

5. Creel Census--Surveys of shorelines, minor piers, and private and party boats; begun 1969, continued most years since, with increased effort in recent years with Striped Bass Stamp Fund support; locations surveyed, particularly ports, vary depending on catch success; provides data on catch rates, fish sizes, proportion of population which is tagged (part of Petersen Estimate process), and other information.

Eggs, Larvae and Juveniles:

1. Petersen Fecundity Estimate--Annual since 1977; combines Petersen population estimate with fecundity (egg number) data from Striped Bass Health Monitoring Program, with certain correction factors (age and number of fish spawning), to estimate total number of eggs produced.

2. CPUE Fecundity Index--Uses same procedure as above except that uses catch per unit effort (CPUE) index value for number of spawning females rather than Petersen estimate.

3. Egg and Larva Survey--Area sampled is variable but standardized in recent years to Suisun Bay, central and western Delta, and Sacramento River to Colusa; 1966-1973, 1975, 1977, 1984-1986, 1988-1990; intensive sampling at 75 stations in spring to monitor number, growth, movement and mortality of larvae up to about 14 mm in length; Sacramento River stations also monitor egg abundance and movement (but these stations not sampled in 1988 to 1990).

4. Tow Net Survey--1959 to present, except 1966; Delta and Suisun Bay; biweekly sampling at 30 to 40 stations in summer until average length of young bass exceeds 38 mm length; provides index of abundance (actual Striped Bass Index, or SBI) and distributional information.

5. Midwater Trawl--Throughout Bay-Delta Estuary up to Rio Vista and Clifton Court Forebay; 1967 to present except 1974 and 1979; typically monthly tows between September and December at a variable number of stations; gives measure of young-of-the-year abundance; more variable than SBI, but correlates well with it.

Related Surveys:

1. Salvage Records--Provides numbers of fish salvaged from Skinner Fish Protective Facility in SWP Clifton Court Forebay, and from Tracy Fish Facility at CVP Tracy Pumps intake channel; Skinner reports annual from about 1970 to present, Tracy records back to 1950's; provide general estimates of population trends and densities based on numbers salvaged over time.

2. Striped Bass Health Monitoring Program--1978 to present, not all years; 1984 to 1988 under consistent format; analysis of tissues of 40 prespawning adult female fish from Rio Vista and Antioch; provides samples for fecundity data; program undergoing extensive review at the present time.

3. Other--Various other special purpose studies which provide special information on striped bass (Export Curtailment Study, gut content analysis, summer die-off monitoring, etc.).

5.4.2 Striped Bass Index (SBI)

The striped bass populations in the Estuary have declined substantially in recent years, in terms of numbers of both adult and young bass. The D-1485 objectives have not maintained the SBI at the "without project" predicted index level of 79, the expected level of protection under these objectives; nor have they stopped the decline which had begun to become evident even before the objectives were established. Based on a mathematical relationship (predicted SBI) developed by DFG, the actual SBI under the D-1485 objectives for the period 1979-1985 should have averaged about 69 (corrected from DFG,25,134-136 after consultation with DFG staff). In fact, during those years the actual SBI averaged 22.4, about one-third of the predicted SBI (corrected from DFG,25,136). For the period 1979-1990, during which the D-1485 objectives have been in effect, the predicted SBI average is 60.95, while the actual SBI average is 19.1; or 31.3% of the predicted value (Table A5.4-1).

The actual SBI is a value obtained after extensive field sampling and measuring of young striped bass each summer. This value is a measure of the relative abundance of young striped bass in the Estuary when the average length of the young-of-the-year population is 38 mm (1.5 inches). It is called an index because it is a relative value and is not directly translatable into an absolute value of the number of young bass in the Estuary. However, it is a legitimate and relatively sensitive measure of

TABLE A5.4-1
ACTUAL AND PREDICTED STRIPED BASS INDEX VALUES

YEAR	YEAR TYPE (1)	DATE SET	DELTA INDEX	SUISUN INDEX	TOTAL INDEX	DELTA % OF TOTAL	DELTA INDEX (2)	SUISUN INDEX (2)	TOTAL INDEX (2)	ACTUAL % OF PRED.
		ACTUAL INDEX					PREDICTED INDEX			
1956	W	-	-	-	-	-	47.1	53.6	100.6	-
1957	BN	-	-	-	-	-	44.1	39.4	83.6	-
1958	W	-	-	-	-	-	42.3	56.2	98.5	-
1959	D	JULY 12	30.7	3.0	33.7	91.1	35.2	-7.9	27.3	123.4
1960	BN/SS	JULY 17	32.0	13.6	45.6	70.2	41.3	8.9	50.2	90.8
1961	D	JULY 21	25.2	6.4	31.6	79.7	37.9	3.2	41.1	77.0
1962	BN	JULY 26	46.8	32.1	78.9	59.3	42.5	32.0	74.5	105.9
1963	W	AUG 03	38.2	43.5	81.7	46.8	37.8	45.7	83.5	97.8
1964	D	AUG 02	54.7	20.7	75.4	72.5	39.2	19.9	59.1	127.5
1965	W	JULY 31	49.4	67.8	117.2	42.2	40.1	43.6	83.7	140.0
1966	BN/SS		NOT DETERMINED				36.3	6.2	42.5	-
1967	W	AUG 12	35.1	73.6	108.7	32.3	33.8	57.3	91.1	119.3
1968	BN/SS	JULY 19	39.6	17.7	57.3	69.1	26.3	15.4	41.8	137.2
1969	W	AUG 09	33.6	40.2	73.8	45.5	34.5	55.9	90.4	81.6
1970	W/SS	JULY 18	36.6	41.9	78.5	46.6	34.7	28.7	63.4	123.8
1971	W	AUG 11	24.6	45.0	69.6	35.3	30.8	50.1	81.0	86.0
1972	BN/SS	JULY 25	13.4	21.1	34.5	38.8	10.8	22.4	33.2	103.9
1973	W	JULY 15	15.6	47.1	62.7	24.9	21.9	29.5	51.3	122.2
1974	W	JULY 22	17.4	63.4	80.8	21.5	15.1	46.8	61.9	130.6
1975	AN	JULY 30	23.4	42.1	65.5	35.7	30.8	50.4	81.2	80.7
1976	C	JULY 16	21.1	14.8	35.9	58.8	24.3	19.2	43.5	82.5
1977	C	JULY 24	8.3	0.7	9.0	92.2	37.1	7.0	44.1	20.4
1978	W	JULY 23	16.5	13.1	29.6	55.7	29.6	32.0	61.6	48.1
1979	D	JULY 19	5.4	11.5	16.9	32.0	25.3	36.9	62.2	27.2
1980	W	JULY 15	2.8	11.2	14.0	20.0	31.5	46.6	78.2	17.9
1981	D	JULY 02	15.4	13.7	29.1	52.9	34.4	24.7	59.0	49.3
1982	W	JULY 30	9.5	39.2	48.7	19.5	25.4	53.8	79.2	61.5
1983	W	AUG 05	1.2	14.2	15.4	7.8	17.3	57.1	74.4	20.7
1984	W/SS	JULY 13	6.3	20.0	26.3	24.0	26.8	40.1	66.9	39.3
1985	D	JULY 16	2.2	4.1	6.3	34.9	21.8	25.4	47.2	13.4
1986	W/SS	JULY 09	23.8	41.1	64.9	36.7	29.5	38.0	67.5	96.2
1987	C	JUNE 22	7.3	5.3	12.6	57.9	22.9	15.4	38.3	32.9
1988	C	JULY 24	3.9	0.7	4.6	84.8	17.2	12.8	30.0	15.3
1989	(3) BN	JULY 11	3.1	2.0	5.1	60.8	26.1	31.4	57.5	8.9
1990	C	JULY 18	2.8	1.5	4.3	65.1	(4) 36.6	24.7	61.3	7.0

NOTES: 1 = D-1485 YEAR TYPE (W = WET; AN = ABOVE NORMAL; BN = BELOW NORMAL; D = DRY; C = CRITICAL; SS = SUBNORMAL SNOWMELT)

2 = PREDICTED INDEX BASED ON REGRESSION OF ACTUAL ABUNDANCE, OUTFLOWS AND DIVERSIONS FOR THE YEARS 1959 TO 1976, EXCEPT 1966 (ACTUAL SBI NOT DETERMINED) AND 1972 (ANDRUS ISLAND FLOODING)

3 = DRY YEAR TYPE FOR FISH AND WILDLIFE OBJECTIVES; VALUES CORRECTED FROM THOSE PRESENTED IN EXHIBIT WQCP-DFG-2 (PERS. COMM., LEE MILLER, DFG, 09/06/90)

4 = 1990 PREDICTED INDEX VALUES BASED ON PRELIMINARY FLOW DATA

the change in abundance between years. The actual SBI tends to underestimate the young bass abundance in very high outflow years because many of the fish are carried downstream beyond the DFG sampling stations. The influence of high flow in recent years, especially in 1983 and perhaps to some extent in 1982, may have induced a small portion of the total decline in the actual SBI observed in the last decade. The large declines measured in dry years would not be so affected, however. Changing the station locations might provide a better measure in wet years, but would complicate calculation of index values and comparison between years. (The actual SBI has been measured every year since 1959, except 1966.)

The actual SBI is the sum of two separate indices: the Suisun Bay index and the Delta index (Table A5.4-1; Figure A5.4-1). The proportion of young bass in the Delta and in Suisun Bay depends on flow; in years with higher outflow, a higher proportion of young bass are usually found in Suisun Bay (Don Stevens, DFG, pers. comm., 1989). This general pattern existed through the 1960's. Analysis of the actual SBI data indicates a substantial shift in the distribution and abundance patterns of young striped bass in recent years. In the early 1970s the actual SBI declined, in large part because the Delta index began to contribute a much smaller proportion of the total index regardless of flow conditions (Figure A5.4-2). After the 1976-77 drought, the Delta index contributed a high proportion of the total index only in very dry years when very few young bass were able to be moved into Suisun Bay, and total numbers of young bass were at record low levels.

There has been considerable confusion in the testimony in Phase I concerning whether the SBI in D-1485 has "worked" or "failed". The reason is that the D-1485 objectives were based on a <u>predicted</u> SBI, a mathematical formula based on the relationship of the historical record of young bass abundance (actual SBI) to spring Delta outflow and exports. This formula provided a prediction of what the SBI ought to be each year, given certain flow and export conditions; it was used to develop the export and outflow requirements in D-1485. The discrepancy between the predicted and the actual SBI is the reason that some participants stated that "the SBI has failed". However, the <u>actual</u> SBI has not failed, even if it may somewhat underestimate the abundance of young fish in very wet years. It continues to provide a comparative measure of young bass abundance among years.

Various reasons have been proposed for the failure of the predicted SBI. For example, the State Water Contractors suggest that the reason for the failure is that the underlying assumptions are still correct, but "that factors in addition to flow are contributing to the problems experienced by striped bass" (WQCP-SWC-608,51). However, a strong argument can be made that the predicted SBI model has been used outside the range of flows and diversion rates from which it was derived. The original relationship among outflows, diversions and the predicted SBI was based on data developed during the period 1959-1970. During this period, exports in the spring months were primarily by the CVP Tracy pumps, and several major upstream storage projects (Oroville and New Melones reservoirs) had not been completed or had not yet had a significant effect on the Delta. As shown in Table A5.4-2 and Figure A5.4-3 total Delta exports were

FIGURE A5.4-1 STRIPED BASS INDEX

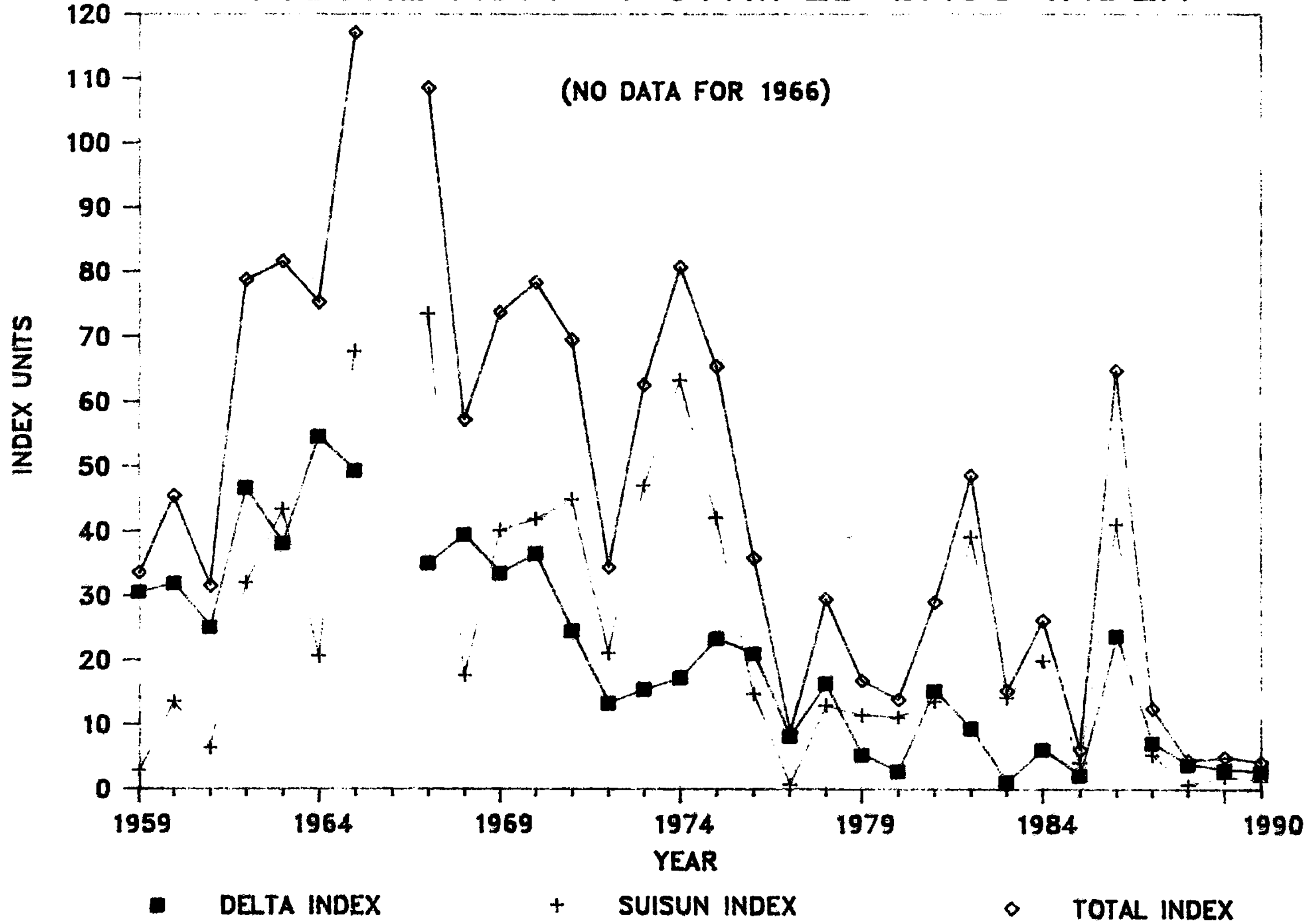
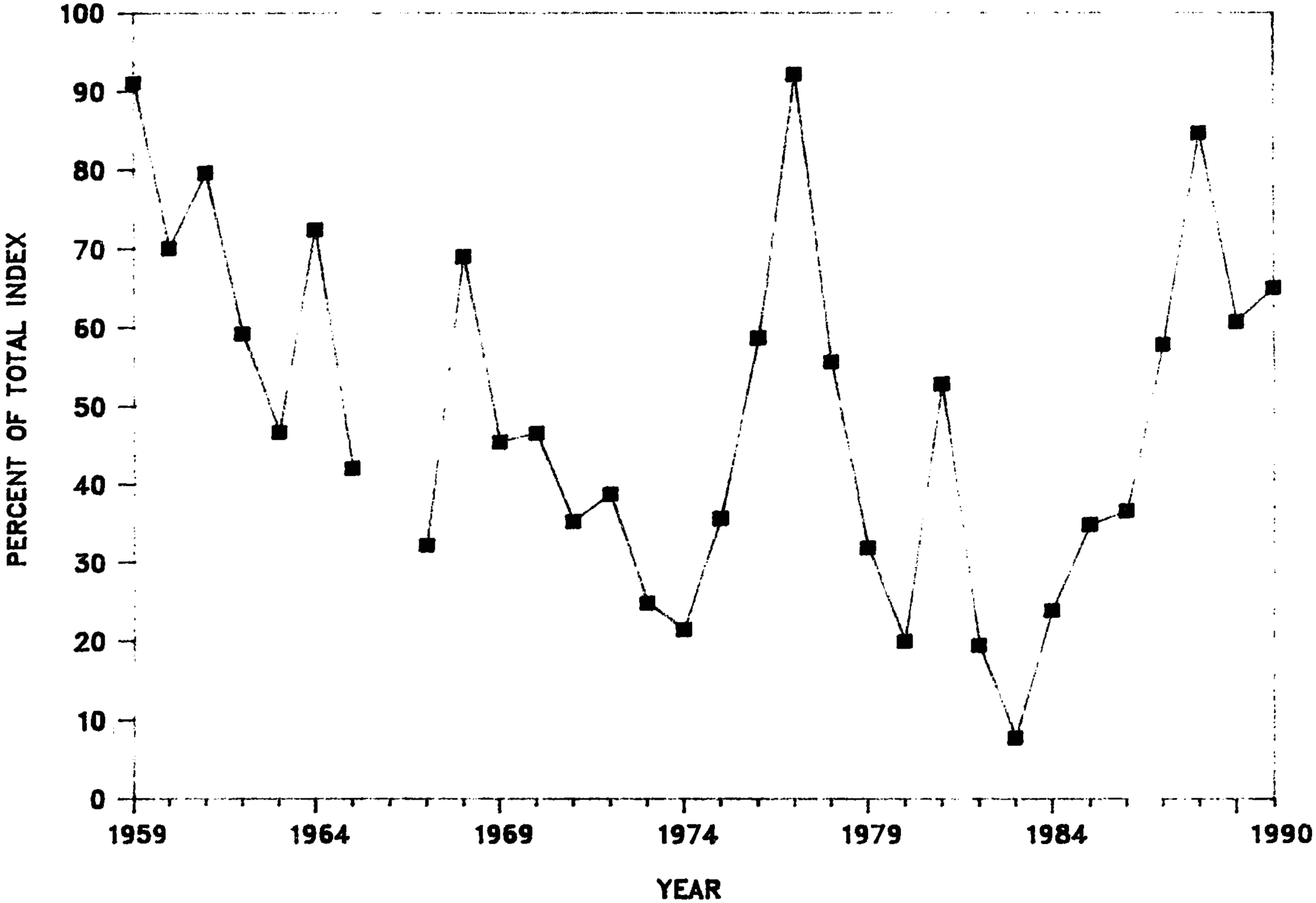


FIGURE A5.4-2
DELTA STRIPED BASS INDEX



relatively constant at about 3,500 cfs during the April through July period. However, during the 1971 through 1976 period, when the decline in the Delta portion of the SBI began to become apparent, total exports for the April through July period increased to an average of nearly 5,900 cfs. Part of this increase was due to a series of experiments to test the effects of increased pumping on striped bass survival (Don Stevens, DFG, pers. comm., 1/90). The data developed during the 1959 through 1976 period were used to develop both the predicted SBI and the 1978 D-1485 objectives. During the fifteen years of data between 1959 and 1976 (no sampling in 1966, and 1972 data were not used because of the Andrus Island flooding), average exports in the April through July period exceeded 6,000 cfs only twice (1973 and 1974), or thirteen percent of the years. On the other hand, during the twelve years that the D-1485 objectives have been in effect, average April through July exports have exceeded 6,000 cfs in seven years, or 58 percent of the years. The average April through July exports during the years under D-1485 objectives were 6452 cfs, or about 50 percent higher than the period 1959 through 1976.

DFG offers substantial additional evidence that the influence of spring outflow and export rates on young striped bass abundance may be substantially greater than previously believed, and that the high export rate experiments in the early 1970's may have helped to trigger the low abundance values seen in the late 1970's and 1980's (WQCP-DFG-3,26).

5.4.3 Possible Reasons for the Striped Bass Decline

Many reasons have been proposed to explain the decline in striped bass abundance. In 1982, the Striped Bass Working Group, composed of Interagency staff and outside consultants, examined the available data and proposed four major hypotheses for the decline. These were:

- inadequate food supply for the young bass,
- direct entrainment losses in diversions and changes in Delta hydrology due to diversions and exports,
- toxic substances, and
- lack of sufficient striped bass eggs.

These four hypotheses served as the basis for the exhibits and testimony of DFG (DFG,25) and SWC (SWC,203) in Phase I. Since then, considerable additional discussion and data analysis have resulted in an expanded and refined list of possible causative factors. This list is discussed in a new DFG report (Department of Fish and Game, 1989). The more recent 1990 DFG draft report (WQCP-DFG-3) specifically addresses the decline of the bass . The major points of the Management Plan and the 1990 report are similar and summarized below. While all the causes listed in the DFG Plan are summarized below, it is likely that only a few factors are the probable causes for the majority of the recent decline: reduced inflow and outflow; diversions; pollutants; and introduction of exotic organisms, especially as related to food-chain disruptions.

TABLE A5.4-2. TOTAL DELTA EXPORTS, CFS; SWP, CVP, AND CCC
(Diversions to Byron-Bethany Irrigation District, North Bay Aqueduct, and City of Vallejo not included)

YEAR	APRIL	MAY	JUNE	JULY	TOTAL	A-M-J-J AVG	M-J-J AVG
1953	1422	2110	2312	2904	8748	2187	2442
1954	2052	1371	3000	3292	9715	2429	2554
1955	2283	2447	3194	3205	11129	2782	2949
1956	704	423	1179	3248	5554	1389	1617
1957	2353	2186	3277	3591	11407	2852	3018
1958	152	599	772	2931	4454	1114	1434
1959	2757	2661	3564	4005	12987	3247	3410
1960	2605	2688	3825	4095	13213	3303	3536
1961	2900	2837	3992	4656	14385	3596	3828
1962	2761	2963	3799	4229	13752	3438	3664
1963	1231	2774	3543	4198	11746	2937	3505
1964	3065	3261	3795	4619	14740	3685	3892
1965	1204	3193	3694	4361	12452	3113	3749
1966	3108	3381	4075	4597	15161	3790	4018
1967	1207	1921	2162	2697	7987	1997	2260
1968	5380	5611	4708	5168	20867	5217	5162
*1969	3212	3270	2494	3382	12358	3090	3049
1970	4653	4012	4997	5227	18889	4722	4745
1971	4431	4549	5768	6509	21257	5314	5609
*1972	6356	6495	5350	5074	23275	5819	5640
1973	3352	6501	7355	7693	24901	6225	7183
1974	4203	7130	9130	10691	31154	7789	8984
1975	6304	5583	4520	5184	21591	5398	5096
1976	5037	5488	4152	4109	18786	4697	4583
**1977	1295	2987	739	845	5866	1467	1524
1978	3271	3058	7621	8088	22038	5510	6256
1979	5882	6245	6341	9339	27807	6952	7308
1980	5343	4630	5961	6869	22803	5701	5820
1981	8090	4478	4032	7046	23646	5912	5185
1982	9603	5994	3935	4032	23564	5891	4654
1983	3814	3293	5010	5207	17324	4331	4503
1984	7685	5929	6165	9457	29236	7309	7184
1985	7342	6215	6530	9465	29552	7388	7403
*1986	4696	6260	6177	8607	25740	6435	7015
1987	7021	5313	5184	8953	26471	6618	6483
1988	8577	6164	6007	8247	28995	7249	6806
1989	10435	6198	5240	9539	31412	7853	6992
***1990	9743	3487	3591	6335	23156	5789	4471
AVERAGE	4356	4045	4400	5571	18372	4593	4672

AVERAGES	APRIL-JULY	MAY-JULY
1953-1967	2791	3058
1968-1990	5768	5724
1979-1990	6452	6152
1953-1990	4593	4672
1959-1970	3511	3735
1959-1976	4299	4551
1971-1976	5874	6182

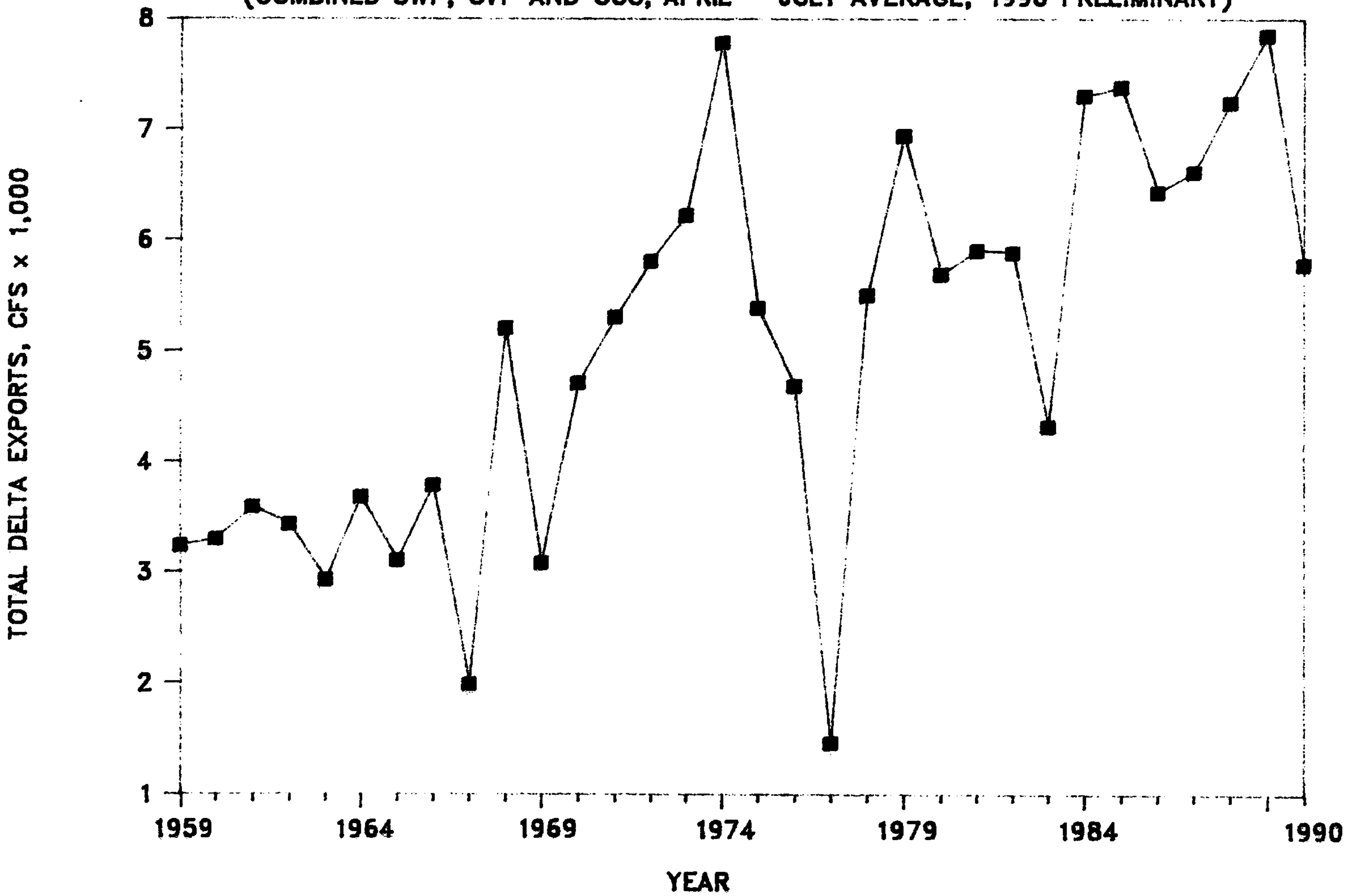
* = Values different from DAYFLOW; effects of island flooding and dewatering not included

** = SWP and CVP impose deficiencies in deliveries

*** = SWP and CVP impose deficiencies in deliveries; California Aqueduct unavailable May 1 to mid-July for repairs; preliminary values, from CVP Operations Office, 09/05/90

FIGURE A5.4-3. TOTAL DELTA EXPORTS

(COMBINED SWP, CVP AND CCC; APRIL - JULY AVERAGE; 1990 PRELIMINARY)



1. Delta and Upstream Water Diversions

Seven separate water diversion operations in and above the Delta impact striped bass. These impacts include: direct entrainment of eggs and young, losses during salvage from fish screens, increased predation at screens and at release points for salvaged fish, disruption of migration routes, translocation of Sacramento River eggs and young into the central Delta, and disruption of young bass food supplies (plankton).

The major sources of water diversions in and above the Delta are:

- o The SWP Delta pumps, rated at 6,300 cfs, with construction underway to expand capacity to 10,300 cfs in the early 1990's;
- o the CVP Tracy pumps, rated at 4,600 cfs;
- o the Contra Costa Canal pumps, with a diversion capacity of 350 cfs;
- o the North Bay Aqueduct pumps, rated at 175 cfs;
- o the Pittsburg and Contra Costa PG&E power plants, with a combined intake capacity of about 4,600 cfs;
- o approximately 1,600 to 1,800 unscreened agricultural diversions and subsurface seepage in the Delta, which may divert up to 4,500 cfs in July; and
- o an undetermined number of agricultural, municipal and industrial diversions above the Delta on the Sacramento and San Joaquin rivers and their tributaries.

2. Reduced Delta Outflows

Extensive water development and conservation projects, combined with water exports, have changed the pattern of Delta outflows, especially by outflow reductions during the spring and early summer months critical to spawning and young bass survival. Striped bass are affected in several ways: spawning habitat is reduced, the time required to move young to nursery areas is increased, the nursery habitat is restricted, food (plankton) production is reduced, and the effects of exports on translocation and reverse flows is enhanced. Combined with armoring (riprapping) of upstream and Delta levees, upstream development may result in increased water clarity in the Delta, which may also cause increased predation on striped bass eggs and young.

3. Low San Joaquin River Flows

Low river flows combined with high dissolved solids levels, caused primarily by agricultural return flows, produce a salinity barrier in the Stockton area, which inhibits upstream migration by adults and reduces spawning habitat. Reduced San Joaquin River flow also exacerbates the effects of export operations and reduced Delta outflows by enhancing cross-Delta flows and reverse flows in western, central and southern Delta channels.

4. Water Pollution

Toxic organic chemicals (petrochemicals and pesticides) and toxic trace elements (mercury, selenium, copper, cadmium, zinc, etc.) may have acute or chronic effects on adults, eggs and young of striped bass, or on their food chain. Pollutant-caused stress or other physiological dysfunction may also reduce resistance to diseases, parasites, predators and adverse environmental conditions.

5. Navigation Structures, Dredging and Spoil Disposal

Activities related to channel maintenance are primarily water quality issues, due to resuspension of toxic materials. However, related effects -- such as excessive turbidity; abrasion of fish gills and other body parts; disruption of food chains; disturbance of migration, spawning and feeding; and loss of habitat -- may also result from navigation maintenance activities.

6. Filling of Estuary Tidelands

Filling of open water areas reduces bass and bass-food habitats and reduces the tidal prism in the Estuary. Reducing the tidal prism reduces the pollutant flushing capability of the Estuary, which may result in water quality problems for the bass or its food chain.

7. Illegal Take and Poaching

The striped bass population is affected to an unknown degree by the illegal taking of bass by means of catching more than legal limits, taking undersize fish, and using nets.

8. Diseases and Parasites

Diseases and parasites stress, debilitate or kill both young and adult striped bass. The incidence and severity of these problems are affected by toxic substances, food availability and other factors. The Striped Bass Health Monitoring Program has not demonstrated any distinct patterns of decreases in health or increases in parasitism in Bay-Delta Estuary fish since monitoring began in 1978.

9. Annual Die-off of Adult Bass

Almost every year there is a summer die-off of adult bass in the Carquinez Strait area. The cause is unknown, but may be related to liver dysfunction, possibly caused by toxic organic pollutants.

10. Commercial Bay Shrimp Fishery

The distributions of juvenile bass and market-size bay shrimp overlap considerably in various parts of the Estuary. Young bass are killed during shrimp netting operations. Regulations have been changed to reduce this incidental kill, but further information is required to determine the extent of the problem.

11. Exotic (Introduced) Aquatic Organisms

Various species of fish and invertebrates have been introduced into the Estuary from other areas. Some of these introductions, such as striped bass and American shad, were planned; the resources were managed to develop and maintain these fisheries. Other introductions were not planned. These unauthorized introductions of exotic species, primarily through the dumping of ballast water from foreign shipping, have had harmful effects on striped bass and their food supply. For example, the yellowfin goby, Acanthogobius flavimanus, feeds voraciously on invertebrates and small fish, and so may compete with striped bass for food; it may also prey on small bass. Introduced oriental zooplankton species have experienced explosive population growth in the upper portions of the Estuary in the last decade, and preliminary tests suggest that at least one species is less suitable as a food source for striped bass than the native copepod, Eurytemora affinis. The rapid establishment of the introduced clam, Potamocorbula amurensis, with its high water-filtering rates, may be having significant impacts on phytoplankton and zooplankton abundance in the striped bass nursery areas in Suisun Bay. Once established, it is virtually impossible to eradicate aquatic animal species from as open and complex an environment as the Estuary.

12. Overfishing[1/]

Overfishing is not viewed at present by DFG as a cause of the decline because anglers harvest only 15 to 25 percent of the adult population annually. This is viewed as being "well within safe limits for a typical striped bass population" (DFG, 1989,p.31). The more restrictive fishing regulations enacted in 1982 should have reduced the catch somewhat, but since there is no control on the number of striped bass anglers or the number of individual fishing days, the effect is not known.

13. Genetic or Other Unknown Factor [1/]

Because of the decline of several distinct populations of striped bass across the country in a short span of time, there has been some thought that a common factor, such as a genetic link, might be involved. In addition, the Bay-Delta population originated from a very small stock, with presumably limited genetic diversity. Therefore, this population could be less resilient in the changing environment of the Estuary than would be the case with a larger gene pool.

1/ *Not included as factors by DFG (DFG, 1989).*

5.4.4 Export Area Striped Bass Fishery

In evaluating the decline of striped bass, it should also be noted that the measurements of the decline apply to the Estuary only. Substantial numbers of eggs and larvae are exported from the Estuary by the CVP and SWP systems. These provide the basis for a sustained striped bass fishery throughout the San Joaquin Valley and even in the SWP terminal reservoirs in southern California. Unfortunately, there are few data available on the size or condition of these populations, or how these populations have been affected by changes in the Estuary. DFG testified (T,LXVIII,III,63:15-22) that those fish in the export facilities do not support the estuarine fishery, nor are they part of it, except that nearly all of those fish originated in the Estuary. The development of this fishery in the export facilities is a by-product of the CVP and SWP systems, but should not be viewed as partial mitigation for the impacts of the export systems on the Estuary striped bass population. As the Estuary population declines, these export area populations may also be expected to decline, as they are probably not self-sustaining by means of successful spawning in the aqueducts or reservoirs.

5.4.5 Discussion of Issues Associated with Striped Bass Spawning in the San Joaquin River

In the August 1990 Workshop, the SWC presented an analysis of several issues related to striped bass spawning. Dr. Charles Hanson made a series of points about the validity and applicability of the data presented in previous sessions and in the June 1990 Revised Draft Plan. These points reflect the concerns of other participants which were presented at both the February and August Workshops. These points may be summarized as follows:

(1) management of stream temperature for salmon protection could affect striped bass spawning (T,LXXV,VII,85:7-86:3);

(2) most spawning data support the contention of DFG researchers that bass prefer to spawn in fresh water (less than 200 mg/l TDS (=0.35 mmhos/cm EC)), but two years (1968 and 1972) show that spawning occurred in higher salinity waters (WQCP-SWC-623B);

(3) the spawning area in the Delta appears to be fairly constant regardless of apparent EC (WQCP-SWC-623C);

(4) no consistent pattern of egg survival and salinity could be determined; once the eggs are hardened, there is no apparent relationship between survival and incubation salinity;

(5) there were no consistent differences in egg survival between the Sacramento and San Joaquin rivers, and no consistent relationship between egg survival and San Joaquin River flow, or Delta outflow;

(6) expanding the spawning area upstream of Prisoners Point on the San Joaquin River may expose eggs and young to additional entrainment from the SWP and CVP pumps (T,LXXV,VII,106:11-18).

Based on their analysis, the SWC concluded that striped bass reproductive success in the San Joaquin River and the Delta is not a water quality problem in the range of salinities found in the present spawning area (T,LXXV,VII,107:22-108:5).

The analysis provided by the SWC makes several interesting and important points; these points require some additional discussion, however. Each point listed above will be considered in turn.

(1) Concerns about temperature control for salmon detrimentally affecting striped bass are probably unfounded. The temperatures proposed for salmon protection (66-68°F), are well above those associated with the onset of striped bass spawning (59-61°F). Turner (1976) noted that in the years 1963, 1964 and 1965, almost 90 percent of spawning occurred in water temperatures between 63°F and 68°F.

(2) The two years (1968 and 1972) in which significant spawning occurred in water more saline than 200 mg/l TDS (=0.35 mmhos/cm EC) were years in which salinity intruded into the spawning area, as Turner noted (1976, p. 112). He further noted (1976, p. 118) that "striped bass universally spawn in essentially freshwater, although in a number of estuaries they do spawn immediately upstream of the limits of ocean salinity intrusion, as they do in the lower San Joaquin River". If they cannot move farther upstream due to the Prisoners Point salinity barrier, then substantial spawning will occur in somewhat more saline water, as seen in 1968 and 1972. Possible effects of this are discussed below in relation to egg hardening (No. 4).

(3) While the spawning area in the Delta does appear to be fairly constant, based on examination of WQCP-SWC-623C, what is not indicated on the exhibit is that in at least five of the seven years indicated (1968-1972), no sampling was conducted above Prisoners Point. Even if the bass did spawn farther upstream, the data would not reflect it. In addition, the use of Delta outflow as a surrogate for EC may not be appropriate, since most Delta outflow is from the Sacramento River. Higher outflow does not necessarily mean low EC in the upper San Joaquin River.

    There are related issues concerning this discussion of spawning area. First, as noted, if water quality above Prisoners Point is such that the fish cannot move upstream, then of course they will spawn in whatever habitat is available to them. Second, the smaller channels with faster currents in the upper river would tend to move eggs relatively quickly downstream into the wider channels of the lower river, where slower currents and tidal action would tend to concentrate the eggs, thus suggesting that a higher percentage of spawning might be occurring there than would actually be the case.

    Third, the lack of tag returns from adult striped bass from the San Joaquin River above Prisoners Point is also used as evidence that the fish are not using this area. If the water quality prohibits upstream migration, then fish will, in fact, not be caught there. Tag returns also indicate where fish are being caught, not where all the fish are. If the fishing for bass is known to be good in a particulate area, then the tag returns will reflect that increased fishing pressure. Tag returns are not an unbiased sampling tool. DFG testified that fishing used to be much better for striped bass in the San Joaquin River system than it is at present (T,XLII,55:16-56:19).

Finally, as discussed by Mr. Chadwick (DFG) and Dr. Hanson (SWC) (T,LXXV,VII,111:3-14), regular exposure to higher salinity water in a spawning area could cause striped bass to desert that area or use it less. It is possible that striped bass have largely abandoned the upper San Joaquin River as a spawning area.

(4) The point about high egg survival even in saline water once the eggs are hardened is important. The key is that the eggs were first hardened in fresh water. While the data suggest that EC's normally found in the Delta are comparable to the laboratory experimental salinity range, EC intrusion during deficiency period relaxations could result in less effective hardening of the eggs. This may result in lower survival as water temperatures increase (see Appendix 5.4.6). Additional work in this area may be warranted.

(5) The SWC analysis showed no consistent differences in egg survival between the Sacramento and San Joaquin rivers (WQCP-SWC-623H). This conclusion was based on DFG data (DFG, 1988, T21). However, this same report (Table 16) showed that the average percent of live eggs collected over six years (1972, 1975, 1977, 1984, 1985, 1986) in the Sacramento River was 58.5 percent, while in the San Joaquin River it was 41.5 percent, or 29 percent less than the Sacramento River. Taken together, the data indicate that egg survival, once development has begun, is not consistently different, but that the number of eggs laid which are viable is substantially lower in the San Joaquin River. This suggests that the present spawning habitat or other conditions in the San Joaquin River may result in lower spawning success.

Exhibit WQCP-SWC-623K shows no relationship between percent of live eggs and either April Vernalis flow or April Delta outflow. It should be noted that no more than 30 percent of total spawning occurred during April in any of the six years included (see Water Quality Control Plan, Table 5-2, p. 5-31).

(6) The concern about increased entrainment of eggs and young due to SWP and CVP facilities should spawning habitat be expanded to Vernalis has been raised by various parties. It is argued that the present condition, while far from ideal, at least may provide some protection against the influence of the pumps for some of the Delta population. No evidence was presented to support this position.

A few final comments are appropriate. As noted, the DFG data used in these analyses are taken at various locations, with different kinds of gear, and for different purposes. Therefore, these data must be cautiously interpreted. Experimental data are limited, and definitive field tests are difficult to complete successfully. Additional data are required on the actual effects of salinity (and other factors) on spawning and survival of eggs and young. For example, the variations in survival which appear to occur in the 0.3-0.8 mmhos/cm EC range are crucial to our understanding of what striped bass in the San Joaquin River really need.

5.4.6 Effects of Temperature on Striped Bass Adults, Eggs and Young

The effects of temperature on adult striped bass appear to primarily involve the range of temperatures at which spawning occurs. High water temperatures may occasionally appear to inhibit spawning, but a review of historical spawning patterns indicates that spawning is more often delayed by low temperatures. Since spawning correlates with increasing temperatures, it appears that most spawning is completed before the upper end of the suitable temperature range occurs.

DWR presented a review of the migration patterns of adult striped bass as related to temperature, especially the "thermal niche" hypothesis, which suggests that striped bass migrate in response to selection for a specific temperature range (DWR,608). No pattern of temperature selection was noted for adult bass in the Estuary. However, the first-year tag return data used in the analysis did demonstrate a changing pattern of bass migration, with a smaller proportion of the population migrating down into the lower Estuary and the ocean than in earlier years. DFG also reviewed the data and, while not concluding that there was no relationship, did not recommend any specific temperature objectives (DFG,25,24-26).

DWR exhibit 607 discusses the possible effects of high water temperature on survival of eggs and young of striped bass in the Delta and in the Sacramento River (DWR,607). The report indicates that optimal temperature ranges for eggs and young are 16° to 20°C (62°-68°F), and that reduced survival occurs below 14°C (57°F) and above 23°C (73.4°F). The report concludes that low temperatures are not a problem in the spawning areas, since adults spawn at temperatures above 15°C (59°F), and the water in the Delta tends to remain warm throughout the spawning period. Likewise, the temperature range in the Delta stays below the upper limit during the spawning and early development period. The report indicates that, in some years, there may be some losses due to high water temperatures in the Sacramento River, especially of eggs and young larvae of late spawning fish. DWR's analysis of the recent spawning pattern suggests that these losses represent only a few percent of the total Sacramento River spawn, and are not significant. No recommendations for temperature controls on the Sacramento River for protection of striped bass were proposed by DWR or any other participant. However, the report noted that potential effects of high temperatures on older larvae (beyond the yolk-sac stage) were not examined, and that Suisun Bay and Delta temperatures exceeded 23°C (73.4°F) by early July in 1981, 1984 and 1985.

The major impact that temperature may have on developing eggs and larvae is the rate of development. Albrecht (1964) noted that the rate of yolk absorption at 75°F was twice as fast as at 62-64°F. Thus, presence of food in the water column may be more critical at warmer temperatures, and lack of food may lead to higher rates of starvation, which is one of the suggested major causes for the decline in the SBI. Turner and Farley (1971) found that a combination of higher temperatures (72°F) and higher salinity (1,000 mg/l TDS) resulted in no egg survival. However, "hardening" of the eggs (formation of a vitelline membrane around the egg after fertilization) in fresh water rather than in saline water resulted in much higher survival when the eggs were subsequently exposed to higher water temperatures and more saline conditions. Given that water temperatures have exceeded the upper limits of the survival range (23°C; 73.4°F) in early June in several recent years (DWR,607,15), the maintenance of low salinity in the Delta spawning area in low flow years may be critical to the survival of more eggs.

APPENDIX 5.5
THREATENED, ENDANGERED AND CANDIDATE SPECIES

5.5.1 Animals

The salt marsh harvest mouse, the Suisun ornate shrew, and the California clapper rail are found primarily in the more saline areas of Suisun Marsh where pickleweed is common. The DFG testified that they do not expect these species to be adversely affected by an increase in channel water salinity in the marsh (T,XXIX,168:13-16).

The California black rail is found in saltwater, brackish, and freshwater marshes. Direct loss of habitat by conversion of marshes to other land uses is thought to be the primary reason for its decline (DFG, 1988 Annual Report on the Status of California's State Listed Threatened and Endangered Plants and Animals, p.28). No information was presented to indicate how the black rail may respond directly to changes in the salinity regime. The black rail requires high tide refuges with considerable vegetative cover to hide from predators when its usual feeding areas are inundated. These refuges are not common in the Suisun Bay marshes. Unless it occurred immediately adjacent to these refuge areas, expansion of the more salt-tolerant vegetation would not result in significant increases in available habitat (T,XXX,41:4-19). DFG indicated that they do not expect changes in the vegetation patterns in the bird's range to significantly affect the black rail (DFG,7,12).

The salt marsh yellow throat is a subspecies of the common yellow throat. BAAC testified that there would be negative impacts on this bird from increased salinity in the Suisun Bay marshes. However, BAAC also stated that there is a question as to which subspecies is found in Suisun Marsh (T,XXX,39:12-28).

The Suisun song sparrow is typically found in brackish tidal marshes. DFG estimates that less than 10 percent of the historically available habitat still exists, and that is in disconnected fragments and narrow strips. Increases in salinity would further reduce the available habitat (DFG, 1988 Annual Report, pp. 40-41).

Adult winter-run Chinook salmon migrate upstream through Suisun Bay and Marsh between November and April. Young smolts from the subsequent spawning are found in Suisun Bay from about November to late April. An analysis of the water quality needed for salmon is found in Section 5.5.2 of the Plan.

Delta smelt are found primarily in the fresher water of the Delta and Marsh. An analysis of the water quality objectives needed for the smelt is found in Section 5.8.2 of the Plan.

The monitoring requirements in the 1978 Delta Plan for the Suisun Marsh do not specifically address rare, threatened, or endangered species, although by inference the plan of protection (Marsh Plan) required in D-1485 term 7(a) is intended to ensure protection of all Marsh wildlife. There are a number of federal candidate species being studied for possible listing. While federal candidate species receive no special legal protection, they must be considered during analysis of this Plan because they may be proposed for listing at any time and would then gain protection under the federal Endangered Species Act (T,XXX,7:4-13,8:24-9:3). (Note: A state "candidate" species is, like a federal "proposed" species, being actually under full review for listing and is protected under the California Endangered Species Act.) If federal candidate species are listed, the possible effects of the water quality objectives on those species must be analyzed. If the effects are adverse, either the water quality objectives must be changed or mitigation measures must be devised to eliminate the adverse effects. Part of the triennial review of the water quality control plan will be to review the effects on threatened and endangered species to determine if the water quality objectives are providing adequate protection. This review would be the most likely forum for any necessary revisions of the objectives.

5.5.2 Plants

Suitable pore water salinity ranges from zero to minus five megapascals (MPa) (comparable to a range of zero to four parts per thousand (ppt) salinity, or zero to 6.25 mmhos/cm EC) for the five sensitive plants species. The California hibiscus and Delta tule pea, which are freshwater plants, can tolerate zero to minus two megapascals and Mason's lilaeopsis and Suisun aster, which tolerate somewhat brackish conditions can tolerate minus two to minus three MPa in Suisun Marsh (comparable to four to six ppt salinity, or 6.25 to 9.36 mmhos/cm EC) (T,XXX,76:5-23). On the other hand, soft bird's-beak, which grows in saline areas, could tolerate minus four to minus five MPa (comparable to 8 to 10 ppt salinity, or 12.5 to 15.6 mmhos/cm EC). These are maximum pore water potentials and should not be reached until after the March to July growing season (T,XXX,79:12-14).

DFG developed a method for producing desired soil salinities in the managed wetlands based on surface water quality and timing of applied water (DFG,5,T3). Though we recognize that the ratios of surface water salinity to pore water salinity may be different for unmanaged wetlands, until special studies are completed the use of the DFG method is warranted.

Increased salinity in tidally influenced channels would cause increased physiological stress on plants, resulting in decreased reproduction and productivity, eventually leading to changes in the plant and dependent animal community (CNPS,4,5-8). Water quality objectives allowing higher salinity levels than at present would likely increase plant stress, decrease photosynthetic productivity of marsh plants, kill salt-sensitive plant species, retard growth of new plants, and reduce plant species diversity (CNPS,4,10; T,XXX,68:20-70:20). The Mason's lilaeopsis, the California hibiscus, the Delta tule pea, and the Suisun aster would be adversely affected by changes in flow or salinity in the Suisun Marsh area (CNPS,3; T,XXX,66:11-67:13). The soft bird's-beak is a salt marsh plant and would not be stressed unduly if salinity increased; the other species would be less likely to survive, would have reduced growth or seed production, or would become less numerous (T,XXX,70:19-23). The CNPS testified that in recent years freshwater flow to the Suisun Marsh has been insufficient to prevent reductions in productivity even during normal years (T,XXX,79:15-20).

Once a population of a rare species is eliminated, it is very unlikely to be re-established because of the scarcity of seed sources (T,XXX,81:22-24). Thus, although common species, such as alkali bulrush, may be adequately protected or able to recover from a period of exposure to higher salinities during a critical or dry water year, sensitive species would be at risk. A salinity objective would need to be set at a level which permits the sensitive species to sustain normal survival, productivity, and germination.

APPENDIX 5.6
SUISUN MARSH PRESERVATION AGREEMENT -- TECHNICAL ANALYSIS

In 1928 a report was prepared describing the salt water problem in the San Francisco Bay and Sacramento-San Joaquin Delta (Means, 1928). By this date the combined effects of upstream diversions for irrigation during the summer had significantly increased the salinity of the water in Suisun Bay, which was ordinarily a fresh water body (Means, 1928, p. 10). Between 1902 and 1920 the area irrigated in the Central Valley increased manyfold (Means, 1928, p. 11). By 1928 constructed reservoir capacity in the "Golden Gate watershed" totaled approximately 4,000,000 acre-feet, with another 5,400,000 acre-feet of capacity being considered (Means, 1928, pp. 12-13). Nearly all of these reservoirs were used for irrigation within the watershed and for power generation. There was little out-of-basin transport.

It is obvious from the brief historical summary above that the initial increase in salinity of Suisun Bay occurred prior to the construction of the CVP and the SWP; in fact, salinity control in the Delta was one of the justifications for the CVP.

Export water from the Delta watershed to other parts of California commenced in the late 1950's, e.g., D-935, D-990. A series of hearings held by the State Board in the 1960's and 1970's to establish operating conditions for the CVP and the SWP led to the preparation of the 1978 Delta Plan and Water Right Decision 1485.

The permanent standards for wildlife protection in the 1978 Delta Plan, were also included in D-1485 (adopted August 1978).

The State Board determined that immediate compliance with the permanent standards for Suisun Marsh solely by fresh water outflow would be an unreasonable use of water. It was stated in the 1978 Delta Plan that "[t]he interim standards do not provide complete protection to Suisun Marsh. The interim standards require some modification of [state and federal] project operations to benefit the Marsh, but rely primarily on the occurrence of uncontrolled outflows to protect the Marsh until 1984" (1978 Delta Plan, p. VI-12).

The State Board expected DWR and USBR to complete the construction of facilities to protect Suisun Marsh habitat by 1984. D-1485 required water right permittees DWR and USBR, in cooperation with other agencies, to develop a plan for protection of the Suisun Marsh (Marsh Plan) by July 1, 1979. This Marsh Plan was to provide a monitoring network, construction of physical facilities, operation and management procedures for the facilities and assurances by land managers to maintain the Marsh as a brackish water wetland (SWRCB,1978,26). DWR and USBR were required to manage the Marsh to produce high quality feed and habitat for waterfowl and other wildlife and to implement the Marsh Plan for full protection of the Marsh by October 1, 1984 (SWRCB,1978,26-27). The final Plan of Protection for Suisun Marsh (Plan of Protection) (DWR,511) was completed in February 1984. When D-1485 was amended in 1985, the Board granted extensions of time and modifications to monitoring locations in the water right permits of the SWP and CVP (DWR,505); these same changes were not made in the Delta Plan. The interim standards have remained in effect until the present.

After the Plan of Protection was completed, DWR, USBR, DFG, and the Suisun Resource Conservation District (SRCD) negotiated a set of three agreements concerning the managed wetlands. One of these, the Suisun Marsh Preservation Agreement (SMPA), was designed to provide the managed wetlands of the Suisun Marsh with water quality suitable for the production of those particular marsh plants (especially alkali bulrush and fat hen) which are important food for waterfowl (T,XXIX,15:17-20,32:23-33:1,106:14-21,116:5-10). The water quality standards in the SMPA differ from the standards proposed in the 1984 Plan of Protection in using a different definition for "Dry" and "Critical" years for determining when the "Deficiency Standards" would be imposed on the Suisun Marsh. The 1984 Plan of Protection used the definitions in the 1978 Delta Plan; the SMPA modified the definition (see footnote to Figure A5.0-1), decreasing the predicted level of precipitation for the remainder of a water year and increasing the number of "Dry" and "Critical" years predicted for the Marsh. The State Board does not know the environmental effects of this difference.

The Biological Assessment prepared for the Plan of Protection and subsequently used for the SMPA was completed in 1981. The focus of the analysis was on the direct impacts of physical structures (e.g., Suisun Marsh Salinity Control Gate) on the salt marsh harvest mouse and the California clapper rail (the only species then on the threatened and endangered species lists). During the informal consultation process for this Plan, DFG pointed out that there have been changes in the situation since 1981 that indicate a new biological assessment is required. Since the 1981 biological assessment was prepared, additional species have been listed as rare, threatened or endangered in the Suisun Marsh area. There are also other species, e.g., federal candidate species, that, while they are not listed under the federal and state Endangered Species Acts, must be considered; harming them would be considered a significant effect on the environment (CEQA Guidelines, Sections 15064 and 15065). See Section 5.10 and Appendix 4.0 for a more complete discussion of these issues.

The plan of protection prepared by the Four Parties (DWR, DFG, USBR, SRCD) is not fully consistent with the 1978 Delta Plan. According to testimony, the Four Parties have signed an agreement to implement the plan of protection, including the monitoring they have developed (T,XXIX,27:7-23). The agreement binds the parties to petition the Board to find that the actions are appropriate to protect the Marsh and to substitute the proposed standards for the 1978 Delta Plan standards (DWR,506A,16-17).

The standards in the SMPA differ from the 1978 Delta Plan in several ways. One of the most significant differences is the use of a special set of definitions for water year types that applies to fish and wildlife protection beneficial uses (DWR,506B,1(r)). This set of definitions was not included in the Plan of Protection in 1984; it has not been subjected to analysis under CEQA and was not considered in the biological assessments done under CESA and ESA. The SMPA in its "Initial Standards" (DWR,506B,3(a)(ii)) uses a "minimum 14-day running average" of the Delta Outflow Index instead of the Delta Plan's "minimum daily" index in one of the Chipps Island's outflow standards (SWRCB,1978,TVI-1). Another difference is the elimination of two monitoring stations, one in Grizzly Bay at the mouth of Montezuma Slough and another at the mouth of Suisun Slough (S-36), and the relocation of some of the other stations further inland (SWRCB,1978; DWR,506B,TII and Fig.1; DWR,509,510; T,XXIX,17:24-25,49:20-50:12) as well as the rescheduling of the construction of the facilities called for in the SMPA (DWR,505,521). The use of deficiency standards is also new to the SMPA (DWR,506B,3(c); T,XXIX,18:20-22,19:25-21:1,34:16). These factors taken together could increase the salinity in the western and "fringe" areas of the legally-defined Suisun Marsh provided under the SMPA compared to the 1978 Delta Plan (T,XXIX,16:25-17:1,40:23-44:3,45:1-46:7,47:3-48:3).

APPENDIX 5
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APPENDIX 6.1
ANALYSIS ASSUMPTIONS FOR WATER SUPPLY IMPACTS

This section discusses the assumptions and operations criteria used in operation studies to help analyze the effects of the various alternatives examined in this Plan. Only the major assumptions used in the operation studies are summarized.

1. The following hydrologic base represents the average monthly flow and salinity conditions in the Bay-Delta Estuary under the 1978 Delta Plan.

    o 1990 level-of-development 1922-1978 Delta flows

2. All of the Estuary's water quality objective locations were assigned to the Sacramento River system 40-30-30 hydrologic classification, except the following locations, which were assigned to the yet to be developed San Joaquin River system 40-30-30 hydrologic classification:

    o San Joaquin River near Vernalis

    o San Joaquin River at the former location of Brandt Bridge

    o Bifurcation of Old and Middle rivers

    o Old River at Tracy Road Bridge

3. The Delta flow and salinity conditions necessary to meet objectives can be achieved through controlling flow, exports, or gate operations at the Delta "control points". The Delta control points, which are illustrated in Figure A6.1-1, are as follows:

    o Chipps Island
    o San Joaquin River near Vernalis
    o Sacramento River at Sacramento
    o The Banks and Tracy Pumping Plants
    o The Delta Cross-Channel near Walnut Grove

4. The following basic equations apply for the hydrologic base:

    o The Delta outflow at Chipps Island, DO is defined as follows:

    $$DO = DI - NETCU - VALDIV - TOTEXP \qquad (1)$$

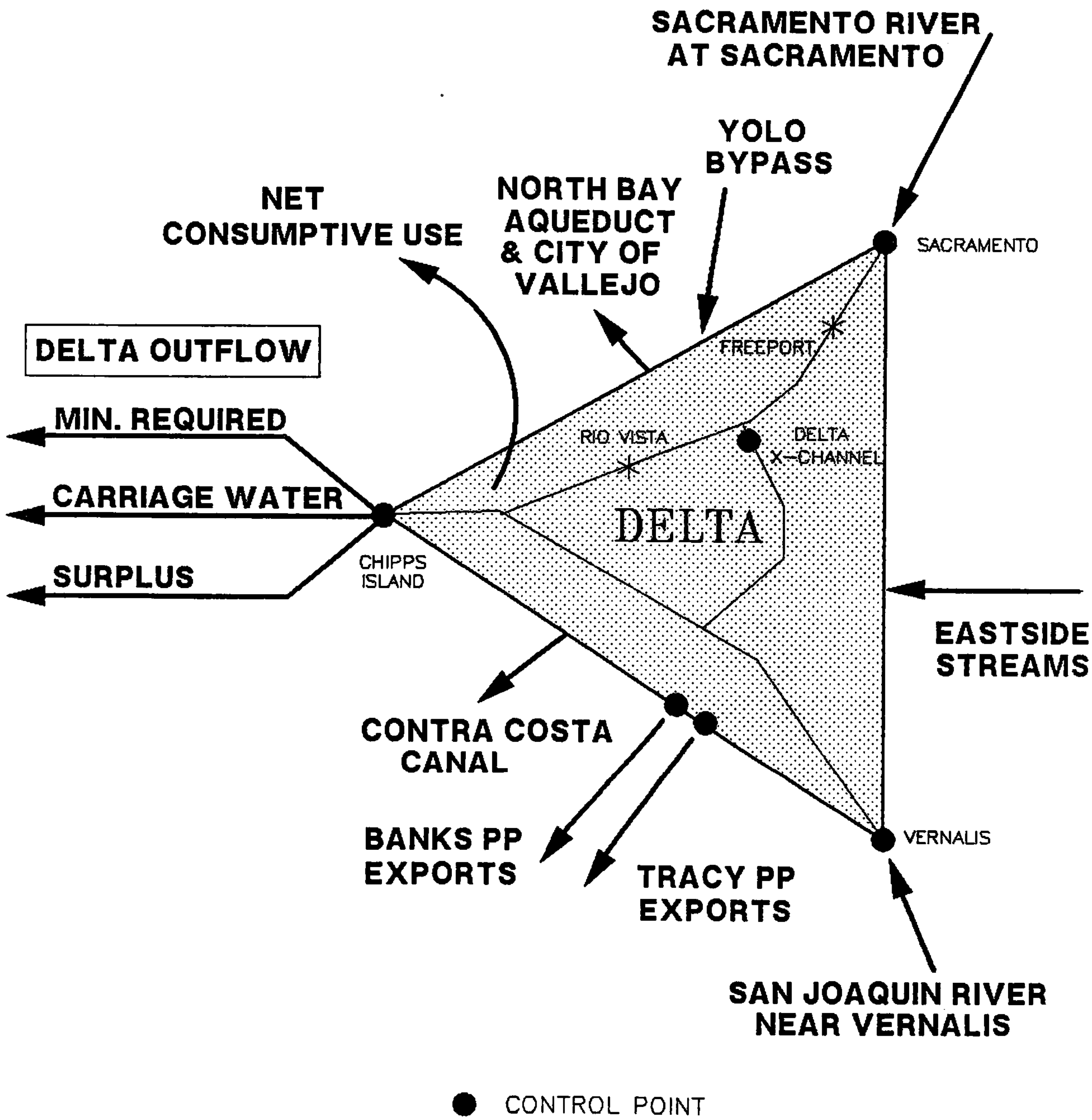
    Where: DI = Delta inflow
    NETCU = Net Delta consumptive use
    VALDIV = City of Vallejo diversions
    TOTEXP = Total CVP and SWP Delta exports

    o The Delta inflow, DI, is defined as follows:

    $$DI = SAC + YOLO + SJR + EAST \qquad (2)$$

FIGURE A6.1-1

DELTA HYDROLOGIC SCHEME USED IN THE WATER SUPPLY IMPACT ANALYSIS



Where: SAC = Sacramento River at Sacramento flow (including return flow from depletion area 21)
YOLO = Yolo Bypass flow
SJR = San Joaquin River at Vernalis flow
EAST = Eastside tributaries' flow (Mokelumne, Cosumnes, and Calaveras rivers)

- The net consumptive use, NETCU, is defined as follows:

  NETCU = CU - PREC (3)

  Where: CU = Delta consumptive use
  PREC = Delta precipitation

- The City of Vallejo diversions, VALDIV, are the Delta diversions by the City of Vallejo.

- The total CVP and SWP Delta exports, TOTEXP, is defined as follows:

  TOTEXP = BANKS + TRACY + CCC + NBA (4)

  Where: BANKS = Total Banks Pumping Plant exports
  TRACY = Tracy Pumping Plant exports
  CCC = Contra Costs Canal exports
  NBA = North Bay Aqueduct exports

- The Delta outflow, DO, can also be divided into three components:

  DO = MINRQDO + CWDO + SURPDO (5)

  Where: MINRQDO = Minimum required Delta outflow at Chipps Island
  CWDO = Carriage water requirement at Chipps Island
  SURPDO = Surplus Delta outflow at Chipps Island

5. BASIC DWRSIM ASSUMPTIONS

The No-Action Alternative was used as a base for comparison with the other alternatives.

- 1990 level hydrology and upstream area depletions and the study period for October 1921 through September 1978.

- Minimum Delta outflow requirements to meet SWRCB D-1485 standards, assuming the interim Suisun Marsh criteria.

- Carriage water requirements based on allowable export/salinity repulsion curves for Rock Slough, designed to maintain a water quality of 150 ppm or 250 ppm of chloride as per D-1485. (Actual values used in the study are 130 ppm and 225 ppm respectively, to provide an operational buffer.)

- CVP/SWP sharing of responsibility for the coordinated operation of the two projects is maintained per the Coordinated Operations Agreement, with storage withdrawals for in-basin use split 75 percent CVP/25 percent SWP and unstored flow for export split 55 percent CVP and 45 percent SWP.

- CVP Operations Criteria:

  - Trinity River minimum fish flows below Lewiston Dam are 340/220/140 TAF per year using the Shasta criteria, per the recent 1981 agreement with the USFWS.

  - Sacramento River minimum fish flows below Keswick Dam reflect the criteria specified in the USBR agreement with DFG (as modified by letter agreement of October 8, 1981). This flow ranges between 2,300 to 3,900 cfs per Shasta criteria and depends on the time of the year.

  - Sacramento River navigation flows are maintained at 4,000 cfs (April-October) or 3,000 cfs (November-March) at Wilkins Slough. Flows are modified/reduced in critical water years.

  - American River minimum fish and recreation flows are maintained per USBR operations criteria (1,500 to 2,000 cfs) as long as sufficient storage is available in Folsom Reservoir. In dry and critical years, minimum flows may be reduced to SWRCB D-893 requirements (250 to 500 cfs) in order to maintain minimum storage levels in Folsom Reservoir.

  - The San Joaquin River water quality standards at Vernalis are maintained as described below (see New Melones Operations Criteria in the Base Case Studies).

  - 1990-level CVP annual demands in TAF/Year are as follows:

Contra Costa Canal	120
DMC and Exchange	1,609
CVP San Luis Unit	1,331
Cross Valley Canal	128
San Luis Interim Deliveries	140
San Felipe Unit	104
Total CVP Delta Exports	3,432
Folsom South Canal	65
Other American River Demands	288

  - CVP agricultural deficiencies are imposed as follows:
    25 percent in years 1924, 1931, 1932, 1933, and 1934; and 50 percent in 1977.

  - CVP Tracy Pumping Plant capacity is 4,600 cfs, but constraints along the Delta-Mendota Canal can limit export capacity. Pumping is also limited to 3,000 cfs in May and June in accordance with D-1485 criteria for striped bass survival.

  - Wheeling of CVP water through SWP facilities to San Luis Reservoir is permitted only when unused SWP Banks Pumping Plant capability is available. Annually, the amount of CVP water wheeled is limited to the sum of (1) what is needed to offset the CVP Tracy Pumping Plant's compliance with the D-1485 criteria; and (2) the amount needed to meet the 128 TAF/year CVP Cross Valley Canal demand.

- SWP Operations Criteria

  - Feather River fishery flows are maintained per the agreement between DWR and the DFG (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, with lower minimum flows allowed in dry/critical years.

  - Sherman Island Overland facility is assumed to be in operation, satisfying the water quality requirements specified in the DWR contract with the North Delta Water Agency.

  - SWP Banks Pumping Plant average monthly capacity with existing pumps is assumed to be 6,240 cfs. Pumping is also limited to 3,000 cfs in May and June, and 4,600 cfs in July to comply with D-1485 criteria for striped bass survival. Additionally, SWP pumping is limited to 2,000 cfs in May and/or June when storage withdrawals from Lake Oroville occur (January 5, 1987 Interim Agreement between DWR and DFG).

  - 1990-level SWP annual export demands (TAF/year) are developed from the State Water Project Analysis Office's long-range projections from Bulletin 132-88, as tabulated below:

	Entitlement Request	Scheduled Surplus
North Bay Aqueduct	27	0
South Bay Aqueduct	186	2
SWP Dos Amigos demand	2,954	219
Total Demands	3,167	221
Agricultural portion	1,241	221
M&I portion	1,857	0
Recreation and losses	69	0

- Water Year Classifications

  - The 1978 Delta Plan classification was used in the no-action alternative.

  - The new (40-30-30) water year classification (including subnormal snowmelt) proposed by the Water Year Classification Subworkgroup was used in all studies, except the no-action alternative.

  - The 1978 Delta Plan classification was used in the Suisun Marsh in all studies.

- New Melones Operations Criteria in the Base Case Studies (From WQCP-DWR-4A)

  The operations criteria used in modeling New Melones Reservoir for the Bay-Delta operation studies is based on the State Water Resources Control Board's Decision 1422 and two succeeding agreements as summarized below:

- In April 1973 the State Water Resources Control Board issued the "New Melones Project Water Rights Decision", D-1422. This decision requires an annual New Melones release of up to 98,000 acre-feet for the maintenance of fish and wildlife. In addition, the Decision has a provision requiring additional releases of up to 70,000 acre-feet per year to maintain 500 ppm total dissolved solids at Vernalis year-round.

- The first agreement is the October 1986 interim agreement between the South Delta Water Agency, the U.S. Bureau of Reclamation, and the California Department of Water Resources. The provisions of this agreement which are modeled are as follows:

  1. Flows of the San Joaquin River at Vernalis will be maintained at not less than 500 cfs.

  2. The salinity of the San Joaquin River at Vernalis will be maintained at 450 ppm TDS or better for the irrigation season (April - October) and 500 ppm TDS or better for the remainder of the year (November - March).

  3. Flows of the San Joaquin River at Vernalis will be maintained at not less than the following monthly volumes (TAF/month):

OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
37	31	30	30	30	30	35	44	49	69	64	45

  4. The releases from New Melones required to meet the above criteria are limited to a maximum of 150,000 acre-feet per water year in addition to the releases made to maintain fish and water quality in accordance with D-1422.

- The second agreement is the June 1987 agreement between the California Department of Fish and Game and the U.S. Bureau of Reclamation which sets interim instream fish flows on the Stanislaus River below New Melones Reservoir. This agreement provides for a minimum annual Stanislaus River fish flow at 98,300 acre-feet and a maximum of 302,100 acre-feet. The actual required fish flow for any given year is based upon the available water supply for that year.

APPENDIX 6.2
D-1485

The final parameter under the Base condition is flow. Flow objectives are held constant for each alternative. These flow objectives include stream flows (Salmon Migration), Delta Outflow (Striped Bass Survival and Suisun Marsh) and diversions (Operational Constraints), some of which variable depending on year type. The water year classification system used is based on the "Four Rivers Index" for the period of 1922-1971.

In D-1485, the objectives for M&I beneficial uses were set at a maximum mean daily 250 mg/l chloride at the Contra Costa Canal Intake at Pumping Plant No. 1 with an additional maximum mean daily chloride level equal to or less than 150 mg/l a minimum of 42 to 66% of time, depending on the water year type.

The western/interior Delta agricultural objectives range from a maximum 14-day running average mean daily EC (mmhos/cm) of 0.45 on April 1 up to 2.78 EC on August 15 depending on the location and year type. This objective is based on the University of California (UC) exhibits which used estimates of the water quality needed to provided 100 percent corn yield in this region's subirrigated organic soil. The southern Delta agricultural objectives are based on the 1990 agreement between the USBR and SDWA. The base objectives, 450 TDS from April 1 to October 31 and 500 TDS from November 1 to March 31, are in effect until the ultimate conditions are phased in. The southern Delta agricultural objectives do not vary with year type. In D-1485, there were no water quality objectives for export agriculture.

The Striped Bass objective at Antioch was 1.5 mmhos/cm EC from April 15 to May 5 in all water years and ranged from 1.5/cm up to 25.2 EC in years when the projects impose deficiencies in firm supplies. At Prisoners Point for the protection of Striped Bass spawning, the average mean daily EC is not to exceed an EC of 0.55 from April 1 to May 5 in all year types.

The Suisun Marsh objectives for the protection of wildlife includes the interim objectives of a maximum running average of mean daily 12.5 mmhos/cm EC from January through May up to 15.6 mmhos/cm from October through December in dry or critical years with deficiencies plus the amended D-1485 (SMPA) interior Delta objectives of 8.0-19.0 EC depending on the month, to be phased in. At the time D-1485 was adopted no objectives were developed for the tidal marshes or rare, threatened and endangered species.

Water quality objectives for the protection of Chinook salmon were not included in D-1485. The Region 5 Basin Plan includes temperature and dissolved oxygen objectives. The Basin Plan water temperature objective specifies a 68°F water temperature objective from Hamilton City to the I-Street Bridge on the Sacramento River "when temperature increases will be detrimental to the fishery". The water temperature objectives in the Basin Plan apply to "controllable factors". The Region 5 Basin Plan specifies that dissolved oxygen concentrations shall not be reduced below: "7.0 mg/l in the Sacramento River below the I-Street Bridge and in all Delta water west of the Antioch Bridge; and 5.0 mg/l in all other Delta waters except for those bodies of water which are constructed for special purposes and from which fish have been excluded or where the fishery is not important as a beneficial use".

APPENDIX 6.3
OPERATION STUDIES

The water supply impacts are defined as the change in base flows, exports, or storage caused by the implementation of the alternative sets of water quality objectives. The base condition incorporates a present (1990) level of development operations study that uses the water quality standards of the 1978 Delta Plan and the New Melones Reservoir criteria as the controlling Delta criteria.

The alternatives were evaluated using DWR's Planning Simulation Model, DWRSIM, a generalized computer model designed to simulate the operation of the CVP and SWP project reservoirs and conveyance facilities. These operation studies are conducted on a monthly time basis and use the historical 57-year hydrologic sequence of flows from water years 1922 through 1978. In addition, these studies account for system operational objectives, physical constraints, and legal and institutional statutes or agreements. These parameters include requirements for flood control in system reservoirs, hydropower generation, pumping plant capacities and limitations, and minimum Delta operations to meet water quality objectives. A more detailed description of the DWRSIM model as well as the operations criteria used in the operation studies is presented in Appendix 6.1.

Operation studies are run with adjustments to the combined CVP-SWP system only. The local non-project reservoirs upstream of the Delta and the CVP Friant Reservoir on the San Joaquin River are pre-operated or have a "predetermined" operation throughout the simulation period. They are not operated to meet Delta objectives. Therefore, the combined CVP-SWP system acts as a surrogate to reflect the water supply impacts of the alternatives.

Since the SWP and CVP provide the major reservoir storage in the Sacramento River Basin, the DWRSIM model provides a reasonable simulation of the flow of the Sacramento River inflow to the Delta. As indicated above, all of the reservoirs in the San Joaquin River Basin, except New Melones, are "pre-operated". The results of these pre-operations are used to prepare the San Joaquin Basin input data for DWRSIM. Most, if not all, of these pre-operations were produced from 15 to 20 years ago and may not be representative of present level reservoir operations. As a result, the estimates of Delta inflow from the San Joaquin River produced by DWRSIM may not be representative of conditions and therefore, should be used only with these constraints in mind.

The operations studies utilize a complex series of assumptions, especially with respect to Central Valley hydrology and Delta flow/salinity relationships. DWR and others are conducting ongoing evaluations of the assumptions using information from the field and new analytical techniques. Revisions to assumptions underlying the operations studies are probable during the current hearing proceedings. The degree to which new assumptions may alter estimated water supply impacts or the conclusions drawn from operations studies is not known.

The water supply impacts, which are shown in the Table A6.3-1, are the changes in the following parameters:[1/2]

- o San Joaquin River Inflow
- o Sacramento River Inflow
- o Combined Total Delta Outflow plus Exports
- o Project Deliveries

Project deliveries impacts are combined changes in CVP-SWP deliveries and reservoir storage, this value is called the change and is defined as follows:

1) The total change in project deliveries, plus

2) 0.7 times the net change in storage of Sacramento basin project reservoirs during the period, plus

3) The net change in storage of San Joaquin basin reservoirs during the period, plus

4) The net change in storage of San Luis Reservoir during the period.

The storage change adjustment of 0.7 for the Sacramento Basin reservoirs is to approximate the loss to carriage water that would occur if water is released from storage for export in the Delta during balanced conditions. No carriage water correction is necessary for storage releases from the San Joaquin Basin reservoirs.

The total water supply impact of each alternative is the sum of the impacts due to the new 40-30-30 classification and the water quality objectives. The new classification is presented separately, however, to differentiate between the water supply impacts due to the classification and those due to changes in the objectives.

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1 *Table 6-2 also lists "Other Flows", which is included to provide a complete Delta flow balance. In all studies, these Other Flows are assumed not to change.*

2 *The reader is cautioned that the change in average annual critical period deliveries is not a totally accurate reflection of change in "project yield" as the initial reservoir storages beginning the critical period may differ between studies.*

TABLE A6.3-1
AVERAGE ANNUAL AND APRIL-JULY WATER SUPPLY IMPACTS
OF THE ALTERNATIVE SETS OF WATER QUALITY OBJECTIVES

WATER SUPPLY PARAMETERS	BASE CONDITIONS (TAF)		CHANGE IN BASE CONDITIONS NEEDED TO MEET OBJECTIVES [1] ALTERNATIVE [2]							
			1A (A7)		1B (B7)		2 (L7)		3 (H7)	
	Yearly Avg	Apr–Jul Avg	Yearly Avg	Apr–Jul Avg	Yearly Avg	Apr–Jul Avg	Yearly Avg	Apr–Jul Avg	Yearly Avg	Apr–Jul Avg
Average (Based on 1922–78 period)										
San Joaquin River Inflow	1996	624	0	0	0	0	0	0	1	21
Sacramento River Inflow	15624	5087	0	0	–6	–16	–9	–73	–6	–37
Total Delta Exports [5]	6295	1762	0	0	4	1	50	20	–1	3
Other Flows/Diversions [6]	1652	–211	0	0	0	0	0	0	0	0
Total Delta Outflow [7]	12977	3738	0	0	–10	–17	–59	–93	–4	–19
Min Req Delta Outflow	4702	2087	0	0	–34	–31	–153	–121	–32	–27
Carriage Water	390	48	0	0	1	0	–69	–24	0	–5
Surplus Delta Outflow	7885	1604	0	0	22	13	162	52	26	13
Dry Period (May 1928–Oct 1934)										
San Joaquin River Inflow	1153	315	0	0	0	0	0	0	–6	29
Sacramento River Inflow	8890	3141	0	0	–21	–23	–47	–36	–18	–51
Total Delta Exports [5]	5290	1448	0	0	6	1	63	12	–11	–6
Other Flows/Diversions [6]	–726	–645	0	0	0	0	0	0	0	0
Total Delta Outflow [7]	4027	1363	0	0	–27	–24	–110	–48	–13	–16
Min Req Delta Outflow	3232	1309	0	0	–33	–26	–51	–78	–16	–9
Carriage Water	401	46	0	0	7	2	–172	–25	3	–7
Surplus Delta Outflow	393	9	0	0	1	0	113	56	1	0
Project Deliveries [8]	5443	N/A	0	N/A	19	N/A	77	N/A	–33	N/A
Wet										
San Joaquin River Inflow	3060	1120	0	0	0	0	0	0	0	11
Sacramento River Inflow	22960	7507	0	0	38	6	127	–10	39	–4
Total Delta Exports [5]	6693	1845	0	0	1	–1	37	10	6	4
Other Flows/Diversions [6]	5244	390	0	0	0	0	0	0	0	0
Total Delta Outflow [7]	24571	7172	0	0	37	7	90	–20	33	3
Above Normal										
San Joaquin River Inflow	2069	618	0	0	0	0	0	0	–5	14
Sacramento River Inflow	17511	5258	0	0	–84	–58	–161	–166	–86	–78
Total Delta Exports [5]	6558	1878	0	0	4	2	26	4	7	5
Other Flows/Diversions [6]	1880	–141	0	0	0	0	0	0	0	0
Total Delta Outflow [7]	14902	3857	0	0	–88	–60	–187	–170	–97	–69
Below Normal										
San Joaquin River Inflow	1680	410	0	0	0	0	0	0	6	25
Sacramento River Inflow	13274	4336	0	0	–3	–17	–29	–104	–8	–41
Total Delta Exports [5]	6468	1860	0	0	10	7	49	12	–1	8
Other Flows/Diversions [6]	120	–460	0	0	0	0	0	0	0	0
Total Delta Outflow [7]	8606	2426	0	0	–13	–24	–78	–116	–1	–24
Dry										
San Joaquin River Inflow	1201	290	0	0	0	0	0	0	–4	27
Sacramento River Inflow	10771	3757	0	0	–19	–25	–138	–185	–24	–61
Total Delta Exports [5]	6016	1705	0	0	5	0	107	66	–3	–3
Other Flows/Diversions [6]	–461	–581	0	0	0	0	0	0	0	0
Total Delta Outflow [7]	5495	1761	0	0	–24	–25	–245	–251	–25	–31
Critical										
San Joaquin River Inflow	1288	397	0	0	0	0	0	0	1	33
Sacramento River Inflow	8342	2686	0	0	–5	0	87	125	6	–18
Total Delta Exports [5]	5186	1346	0	0	1	0	17	–8	–15	–11
Other Flows/Diversions [6]	–865	–662	0	0	0	0	0	0	0	0
Total Delta Outflow [7]	3579	1075	0	0	–6	0	70	133	22	26

FOOTNOTES:

[1] Change in base conditons = Alternative minus Base; Positive values indicate an increase in flow or export.

[2] The letter/number combination in parentheses below the alternative numbers identify the corresponding DWR operation study.

[3] Alternative 1B is the base case (1A) with the new 40–30–30 water year classification.

[4] Operation studies P7, K7, and N7 use an M&I objective of 40 mg/l chlorides to provide an operational buffer.

[5] Total Delta Exports include Contra Costa Canal, North Bay Aqueduct, and Banks and Tracy Pumping Plants.

[6] Other Flows/Diversions include Net Delta Consumptive Use, City of Vallejo diversions, Yolo Bypass inflow, and East Side Streams inflow. The Base Conditions values are negative when the Net Consumptive Use plus the City of Vallejo diversions are greater than the Yolo Bypass inflow plus the East Side Streams inflow.

[7] Total Delta Outflow equals the San Joaquin River Inflow + Sacramento River Inflow – Total Delta Exports + Other Flows/Diversions.

[8] Project Delivery Index is the sum of critical period deliveries change plus 70 percent of net critical period storage in the Sacramento River Basin and 100 percent of the net critical period storage change in San Joaquin River Basin and San Luis Reservoir divided by 6.5 years. In all studies, the current "surplus" water in New Melones Reservoir is assumed to be available for Delta objectives.

TABLE A6.3-1(Cont.)
AVERAGE ANNUAL AND APRIL-JULY WATER SUPPLY IMPACTS
OF THE ALTERNATIVE SETS OF WATER QUALITY OBJECTIVES

WATER SUPPLY PARAMETERS	BASE CONDITIONS (TAF)		CHANGE IN BASE CONDITIONS NEEDED TO MEET OBJECTIVES [1] ALTERNATIVE [2]					
			4 (P7) [4]		5 (K7) [4]		6 (N7) [4]	
	Yearly Avg	Apr-Jul Avg	Yearly Avg	Apr-Jul Avg	Yearly Avg	Apr-Jul Avg	Yearly Avg	Apr-Jul Avg
Average (Based on 1922-78 period)								
San Joaquin River Inflow	1996	624	1	21	9	86	150	290
Sacramento River Inflow	15624	5087	-8	-85	-8	-127	-6	-179
Total Delta Exports [5]	6295	1762	-207	-57	-399	-123	-674	-224
Other Flows/Diversions [6]	1652	-211	0	0	0	0	0	0
Total Delta Outflow [7]	12977	3738	200	-7	400	82	818	335
Min Req Delta Outflow	4702	2087	59	-27	-35	-23	1638	348
Carriage Water	390	48	321	6	697	54	-154	-28
Surplus Delta Outflow	7885	1604	-182	13	-263	48	-667	12
Dry Period (May 1928-Oct 1934)								
San Joaquin River Inflow	1153	315	-6	29	58	91	247	273
Sacramento River Inflow	8890	3141	-19	-190	-9	-223	-4	-183
Total Delta Exports [5]	5290	1448	-364	-147	-984	-393	-1078	-321
Other Flows/Diversions [6]	-726	-645	0	0	0	0	0	0
Total Delta Outflow [7]	4027	1363	339	-14	1033	261	1321	411
Min Req Delta Outflow	3232	1309	82	-9	-16	-9	1760	444
Carriage Water	401	46	335	-5	1107	233	-211	-23
Surplus Delta Outflow	393	9	-77	0	-58	37	-229	-9
Project Deliveries [8]	5443	N/A	-366		-1075		-1339	
Wet								
San Joaquin River Inflow	3060	1120	0	11	-75	13	-69	184
Sacramento River Inflow	22960	7507	-6	-6	11	-13	-11	-37
Total Delta Exports [5]	6693	1845	-87	1	-120	2	-242	-8
Other Flows/Diversions [6]	5244	390	0	0	0	0	0	0
Total Delta Outflow [7]	24571	7172	121	4	56	-2	162	155
Above Normal								
San Joaquin River Inflow	2069	618	-5	14	-28	84	199	332
Sacramento River Inflow	17511	5258	-88	-97	-92	-111	-84	-93
Total Delta Exports [5]	6558	1878	-99	-11	-221	-47	-235	-31
Other Flows/Diversions [6]	1880	-141	0	0	0	0	0	0
Total Delta Outflow [7]	14902	3857	6	-72	101	20	350	270
Below Normal								
San Joaquin River Inflow	1680	410	6	25	73	146	285	391
Sacramento River Inflow	13274	4336	-5	1	-3	-79	32	-144
Total Delta Exports [5]	6468	1860	-226	-15	-312	-38	-672	-181
Other Flows/Diversions [6]	120	-460	0	0	0	0	0	0
Total Delta Outflow [7]	8606	2426	227	41	382	105	989	428
Dry								
San Joaquin River Inflow	1201	290	-4	27	48	115	184	261
Sacramento River Inflow	10771	3757	-26	-214	-47	-304	44	-471
Total Delta Exports [5]	6016	1705	-316	-136	-625	-219	-1442	-692
Other Flows/Diversions [6]	-461	-581	0	0	0	0	0	0
Total Delta Outflow [7]	5495	1761	286	-51	626	30	1670	482
Critical								
San Joaquin River Inflow	1288	397	1	33	62	103	307	362
Sacramento River Inflow	8342	2686	3	-209	100	-203	-61	-191
Total Delta Exports [5]	5186	1346	-396	-195	-1049	-502	-909	-249
Other Flows/Diversions [6]	-865	-662	0	0	0	0	0	0
Total Delta Outflow [7]	3579	1075	400	19	1211	402	1155	420

FOOTNOTES:

[1] Change in base conditons = Alternative minus Base; Positive values indicate an increase in flow or export.

[2] The letter/number combination in parentheses below the alternative numbers identify the corresponding DWR operation study.

[3] Alternative 1B is the base case (1A) with the new 40-30-30 water year classification.

[4] Operation studies P7, K7, and N7 use an M&I objective of 40 mg/l chlorides to provide an operational buffer.

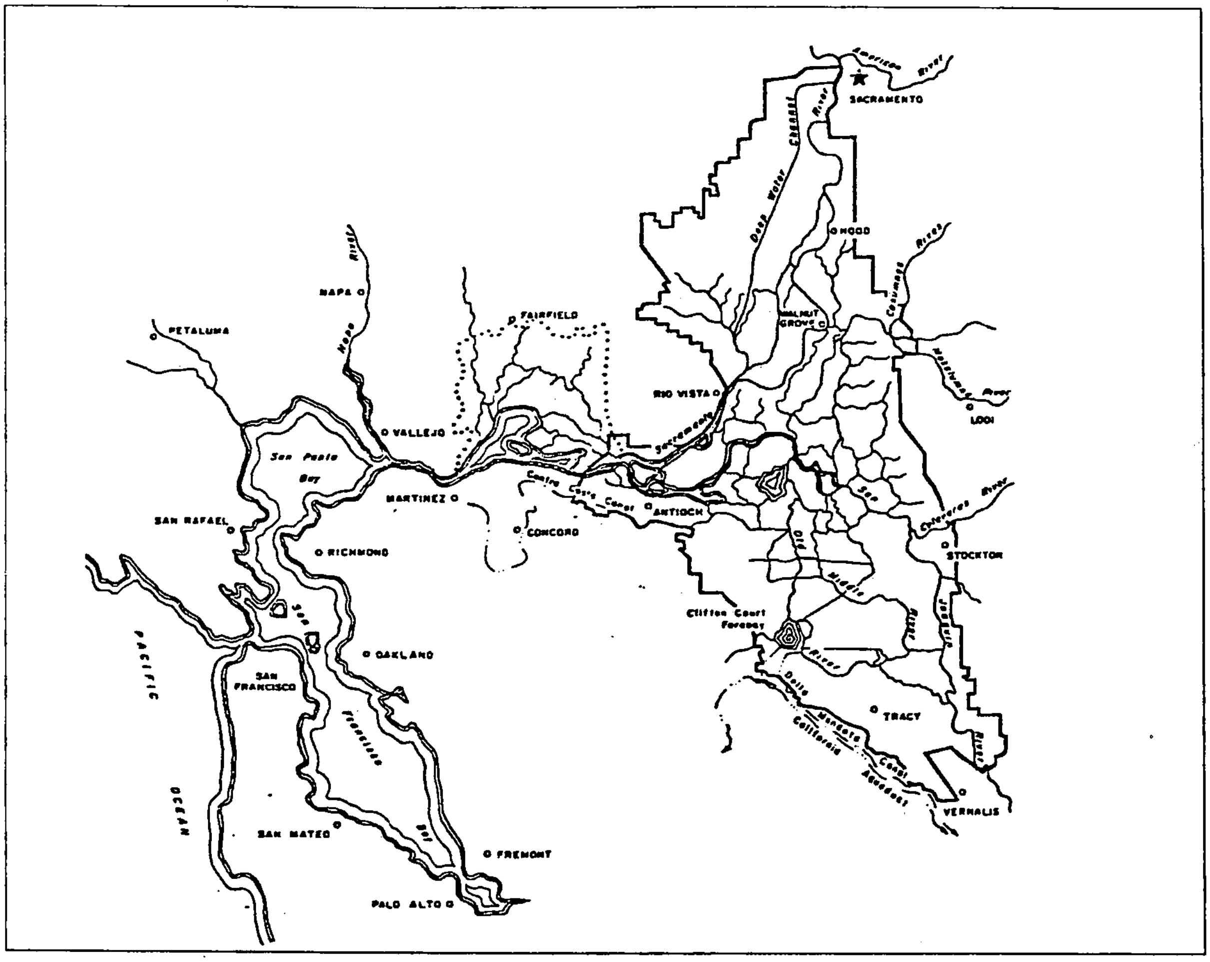
[5] Total Delta Exports include Contra Costa Canal, North Bay Aqueduct, and Banks and Tracy Pumping Plants.

[6] Other Flows/Diversions include Net Delta Consumptive Use, City of Vallejo diversions, Yolo Bypass inflow, and East Side Streams inflow. The Base Conditions values are negative when the Net Consumptive Use plus the City of Vallejo diversions are greater than the Yolo Bypass inflow plus the East Side Streams inflow.

[7] Total Delta Outflow equals the San Joaquin River inflow + Sacramento River inflow - Total Delta Exports + Other Flows/Diversions.

[8] Project Delivery index is the sum of critical period deliveries change plus 70 percent of net critical period storage in the Sacramento River Basin and 100 percent of the net critical period storage change in San Joaquin River Basin and San Luis Reservoir divided by 6.5 years.

In all studies, the current "surplus" water in New Melones Reservoir is assumed to be available for Delta objectives.



Appendix

RESPONSES TO COMMENTS ON THE DRAFT WATER QUALITY CONTROL PLAN (January 1991)

San Francisco Bay/ Sacramento - San Joaquin Delta Estuary

91-17WR

April 1991

WATER RESOURCES CONTROL BOARD

STATE OF CALIFORNIA

Appendix

RESPONSES TO COMMENTS ON THE DRAFT WATER QUALITY CONTROL PLAN (January 1991)

San Francisco Bay/ Sacramento - San Joaquin Delta Estuary

Report Number, 91-17 WR

May 1991

Prepared by the Bay-Delta Section
Division of Water Rights
WATER RESOURCES CONTROL BOARD
STATE OF CALIFORNIA

Preface

"RESPONSES TO COMMENTS"

The State Board wishes to thank the participants for submitting comments on the January 1991 Draft Water Quality Control Plan for Salinity for the San Francisco Bay-Delta Estuary.

The "Responses to Comments" document distributed in this mailing summarizes the comments received on the January 1991 Draft Plan. Responses to these comments are divided into two sections (which are in turn organized by chapters of the Plan): the first lists the comments and responses that resulted in changes in the Draft Plan; the second lists those which resulted in no changes. These responses to comments were made available at the April 2, 1991 Board Meeting. Only the format of presenting the responses has been changed in this document.

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SECTION I

Comments that Resulted in Changes in Text of the Plan

General Comments

Chinook-Temperature Objectives

Comment: Various agencies consider the temperature objectives to be generally impractical and unreasonable and note that the Plan includes the exclusion of reservoir releases as a controllable factor. USBR believes that facilities to improve salmon passage through the Delta are actions that need to be considered in the evaluation of alternatives to meet the various beneficial uses and suggests that such facilities be identified and studied by appropriate work groups (WQCP-USBR-129A, Page 2, last paragraph, Page 3, first paragraph; WQCP-SWC-631,2, first para.; WQCP-DWR-25, Page 4, third paragraph).

Response: The wording of the fall-run Chinook salmon temperature objective is going to be changed as follows:

Change in text:
"The daily average water temperature shall not be elevated by controllable factors above 68°F from the I Street Bridge to Freeport of the Sacramento River, and at Vernalis on the San Joaquin River between April 1 through June 30 and September 1 through November 30 in all water year types."

Response: The wording of the winter-run Chinook salmon temperature objective is going to be changed as follows:

Change in text:
"The daily average water temperature shall not be elevated by controllable factors above 66°F from the I Street Bridge to Freeport on the Sacramento River between January 1 through March 31."

This wording will be inserted in the following places in the text and tables of the Plan:

Tables 1-1, 5-5 and 6-3; and Pages 1-13, 5-15, and 5-25.

Response: To address the concerns expressed above, other changes will also be included.

1) Table 1-1, Page 8 of 8

Change in text:
"Based on the record in these proceedings, controlling temperature in the Delta utilizing reservoir releases does not appear to be reasonable, due to the distance of the Delta downstream of reservoirs and uncontrollable factors such

ambient air temperature, water temperatures in the reservoir releases, etc. For these reasons, the State Board considers reservoir releases to control water temperatures in the Delta a waste of water; therefore, the State Board will require a test of reasonableness before consideration of reservoir releases for such a purpose."

2) Table 5-5, Page 28 of 28

Change in text:
"Based on the record of these proceedings, controlling water temperature in the Delta utilizing reservoir releases does not appear to be reasonable, due to the distance of the Delta downstream of reservoirs and uncontrollable factors such as ambient air temperatures in the reservoir releases, etc. For these reasons, the State Board considers reservoir releases to control water temperatures in the Delta a waste of water; therefore, the State Board will require a test of reasonableness before consideration of reservoir releases for such a purpose."

3) Table 6-3, Page 8 of 8

Change in text:
"Based on the record in these proceedings, controlling temperature in the Delta utilizing reservoir releases does not appear to be reasonable, due to the distance of the Delta downstream of reservoirs and uncontrollable factors such as ambient air temperature, water temperatures in the reservoir releases, etc. For these reasons, the State Board considers reservoir releases to control water temperatures in the Delta a waste of water; therefore, the State Board will require a test of reasonableness before consideration of reservoir releases for such a purpose."

4) Page 1-13

Change in text:
"Controllable water quality factors are those actions, conditions, or circumstances resulting from human activities that may influence the quality of the water of the State, that are subject to the authority of the State Board, or the Regional Board, and that may be reasonably controlled. Based on the record in these proceedings, controlling temperature in the Delta utilizing reservoir releases does not appear to be reasonable, due to the distance of the Delta downstream of reservoirs and uncontrollable factors such as ambient air temperature, water temperatures in the reservoir releases, etc. For these reasons, the State Board considers reservoir releases to control water temperatures in the Delta a waste of water; therefore, the State Board will require a test of reasonableness before consideration of reservoir releases for such a purpose."

5) Page 5-15

Change in text:
"Controllable water quality factors are those actions, conditions, or circumstances resulting from human activities that may influence the quality of the water of the State, that are subject to the authority of the State Board, or the Regional Board, and that may be reasonably controlled. Based on the record in these proceedings, controlling temperature in the Delta utilizing reservoir releases does not appear to be reasonable, due to the distance of the Delta downstream of reservoirs and uncontrollable factors such as ambient air temperature, water temperatures in the reservoir releases, etc. For these reasons, the State Board considers reservoir releases to control water temperatures in the Delta a waste of water; therefore, the State Board will require a test of reasonableness before consideration of reservoir releases for such a purpose."

6) Page 7-4

Change in text:
Delete "Chapter 5" and insert "Section 5.5.2.5".

Suisun Marsh

Comment: The Plan deletes salinity objectives for Suisun Marsh (WQCP-SCLDF-1, page 9, point IV.).

Response: The following wording will be added to the Plan for clarification of the status of the objectives that apply to Suisun Marsh.

Change in text:
"In regard to the Suisun Marsh, the water quality objectives for Suisun Marsh are unchanged from the 1978 Delta Plan. The implementation vehicle, Water Right Decision 1485 (D-1485), was amended in 1985 to change (or delete) some monitoring stations and to revise the schedule for implementation. The DWR, USBR, DFG, and Suisun Resource Conservation District (SRCD) have signed and adopted a set of three agreements concerning the Suisun Marsh. These are the Suisun Marsh Preservation Agreement (SMPA), the Monitoring Agreement, and the Mitigation Agreement. The SMPA contains water quality standards for the managed marshes of Suisun Marsh which the four signatories would like the State Board to adopt as water quality objectives. The Mitigation Agreement describes the physical facilities that the four signatories have agreed would serve the managed marshes in order to maintain production of preferred waterfowl food plants. The facilities built so far, including the Suisun Marsh Salinity Control Gates (previously called the Montezuma Slough Control Structure), have changed the physical regime in the Marsh.

Revised water quality objectives incorporating the SMPA (with any modifications necessitated by the biological assessment) will be adopted by the State Board after the biological assessment (discussed in Section 7.4.2.6) is completed. Until that time, the water quality standards in the amended D-1485 will continue to be implemented; see Table 1-2 for a summary of these standards."

Specific Comments

Page 1-4, last sentence; continuing on to p.1-5;

Comment: Change trihalomethanes to disinfection by-products (WQCP-SWC-632,7-14).

Response: Comment noted.

Change in text:
"The existence of disinfection by-products, caused by the treatment of water containing bromides that naturally occur in ocean water and containing organic materials that result from decomposition..."

Page 1-4

Comment: The description of reverse flows should include the San Joaquin River above the confluence of the Mokelumne River, and Old and Middle rivers (WQCP-DFG-5,1).

Response: Agree.

Change in Text:
"...reverse flows in various reaches of the San Joaquin River, Old River, Middle River and other Delta channels, caused by the CVP, SWP, CCC and local agricultural diversion pumps; and..."

Page 1-6

Comment: More stable funding is required for the entire Interagency Ecological Study Program, not just DFG (WQCP-USFWS-7,3).

Response: Agree. Text will be changed. The State Board on two occasions has attempted to improve funding for this program through the legislature, but was unsuccessful.

Change in text:
"Since planning and executing studies of the Estuary require DFG to work closely with the other member agencies of the IESP, more stable and consistent funding of all IESP programs is required to achieve maximum benefits from these studies and to achieve effective Estuary management."

Page 1-7, Water Resources Management

Comment: Add the following or a second paragraph to page 1-7.
" A process being called Urban Water Conservation Best Management Practices (BMP) is being developed by urban water suppliers, environmental organizations, and other public interest groups statewide. The BMP process represents a consensus among the above groups on an appropriate resolution of the urban water conservation for these Bay-Delta hearings. The State Water Resources Control Board encourages such consensus recommendations." (WQCP-SWC-633,3).

Response: We agree with the comment in general.

Change in text:
"A process being called Urban Water Conservation Best Management Practices (BMP) is being developed by urban water suppliers, environmental organizations, and other public interest groups statewide. The BMP process represents a consensus among the above groups on the issue of urban water conservation for the Bay-Delta hearing. The State Water Resources Control Board encourages such consensus recommendations."

Page 1-7, Proposed Review of Striped Bass Fishing Regulations

Comment: Pages 1-7, 1-18, 7-20 - Board has responsibility to set water quality and water rights objectives to protect public trust resources, without regard to how the harvest of those resources is regulated by other agencies. No evidence that present management practices interfere with the Board's ability to carry out its duties. No conceptual relationship between water conservation measures and the regulation of public trust resource harvest. Request these references be removed (WQCP-DFG-5,5).

Comment: Pages 1-7, 1-18, 7-20 - Inappropriate to include fish harvest management changes as a Water Resource Management tool; is not the responsibility of the Board to manage fish harvests. The State Board has responsibility to set water quality and water right objectives to protect public trust resources regardless of how are managed (WQCP-NMFS-1,2-3).

Comment: Page 1-7 - A change in fishing regulations is a poor choice for a reasonable choice in water resources management when the problem of low populations is habitat damage rather than inappropriate fishing regulations (WQCP-USFWS-7,3).

Response: We agree that discussion of fishing regulations in the context of water management options is not appropriate, and it will be deleted. We also agree that setting water quality standards to protect habitat should be independent of fishery management decisions. However, the Board believes it appropriate to recommend, at least for consideration by other agencies as part of an overall implementation plan, temporary changes in fishery harvest regulations.

Change in text:
"Temporary changes in fishery harvest regulations should be considered as part of an overall short-term approach to improve the situation until longer-term measures may be instituted. The Board does not believe such measures should substitute for its own responsibilities to provide suitable habitat."

Page 1-10; eighth bullet, of the Plan:

Comment: Sentence should indicate that planning for M&I water needs must focus on requirements of a reliable supply of high quality drinking water at an affordable cost (WQCP-SWC-632,7-14).

Response: Comment noted.

Change in text:
"... a reliable supply of high quality drinking water..."

Page 1-11 "Salinity Requirements..."

Comment: General conclusions should be added adopting the concept of best available source for drinking water, and recognizing the need to develop a program to reduce the impacts of THM precursors from Delta agricultural drains. (Suggested language is included) (WQCP-SWC-632,4).

Response: Agree; Suggested language will be included.

Change in text:
"There is a need for water from the best available sources to meet the drinking water need of all Californians. There is a need to design and implement a comprehensive trihalomethane formation potential (THMFP) monitoring program, and to develop best management practices, or other appropriate means, to control discharges of THMFP."

Page 1-11; third bullet; last sentence:

Comment: Currently states that "deleting the 150 mg/l objective could result in increased bromide concentrations and substantially increased treatment costs". Should be revised to read that decreasing the objective could result in increased bromide concentrations and increased salinity and consumer complaints due to the salty taste in the water. (WQCP-SWC-632,1-7).

Response: Agree.

Change in text:
"... increased bromide concentrations and increased salinity and consumer complaints due to the salty taste in the water. (WQCP-SWC-632,1-7). (5.1)

Page 1-11; sixth, seventh and eighth bullets and p. 5-5; second, third and fourth bullets (language is similar for all referenced bullets); p. 5-6, following the fourth paragraph: p. 5-7; Item No. 2 and Item No. 3: p. 5-8; Item No.3 and Item No. 8: p. 6-12; Section 6.2.3.2:

Comment: Suggest deleting all referenced bullets and adding new paragraphed language. The proposed language includes a discussion on the contribution of agricultural drainage from Delta islands, and requests the State Board, DWR and USBR to develop measures, costs and an implementation schedule to achieve a chloride objective of 50 mg/l at all Delta M&I intakes. A report on the subject is to be prepared by March 1992. The proposed language also states that as a result of the new and existing drinking water regulations, water utilities treating Delta water will continue to violate and increase the rate of violation of those standards due to current Delta water quality (WQCP-SWC-632,1-7).

Response: Disagree with deleting the referenced bullets in favor of the proposed language. However, agree with revising the seventh bullet on p. 1-11 (the third bullet on p. 5-5).

The proposed language concludes that agricultural drainage from Delta islands contributes 40 to 45 percent of the THMFP in the Delta during irrigation months, and 38 to 52 percent during the winter leaching period in water year 1988 (emphasis added). Including this information as a conclusion in the Plan would be misleading. The information provided is based on a first estimate, has not been confirmed, is for one single dry water year, and covers the entire Delta as opposed to a particular location such as the Clifton Court Pumping Plant. As such, the information should be considered preliminary (Bruce Agee, DWR, pers. comm.).

The proposed language also indicates that water utilities treating Delta water currently violate drinking water standards and that this rate of violation will increase as a result of new water regulations. This language is misleading. Violations of current drinking water standards by water utilities occur very infrequently, certainly not on a consistent basis as the proposed language seems to imply. Also, it is not a certainty that new drinking water regulations will result in stricter standards (see Contact Report dated March 15, 1991 re. conversation between Leo Winternitz, SWRCB; Bruce Macler, EPA; and Alexis Milea, DHS).

The proposed language states that the DWR and USBR will work with the SWRCB to develop measures, costs and an implementation schedule to achieve a chloride objective of 50 mg/l at all Delta M&I intakes, and to prepare a report by March 1992. This issue is a subject for the Scoping Phase and therefore it is premature as a conclusionary action for this Plan.

SWC recommends deleting the seventh bullet on p. 1-11, (third bullet on p. 5-5) because the statement directly links DBP regulations and salinity, implying that drinking water quality is the only consideration for salinity revisions. Disagree with deleting the bullet but agree that the statement should be revised.

Change in text:
"If drinking water standards on DBPs are revised, the State Board will consider modifying existing salinity objectives."

Page 1-11; last bullet, and p. 5-5; fifth bullet (language is similar in both bullets):

Comment: The statements indicate that municipal water supply agencies have sufficient power to control chloride and bromide levels in the Delta, and this is not the case. Language is suggested to correct this impression. Language includes actions that drinking water supply agencies could take to try meeting a 50 mg/l chloride objective (WQCP-SWC-632,1-7).

Response: Comment noted.

Change in text:
... "encouraging DWR and the USBR to work with the SWRCB to ensure development of facilities to make maximum use of uncontrolled flows through off-stream storage,
encouraging those agencies to move water supply intakes to better locations,
working with the State and Regional Boards to eliminate problem discharges within the Delta,
continuing the development of alternative water treatment technologies." (5.2).

Page 1-13

Comment: Suggest adding "poaching" to the factors affecting striped bass abundance. Suggest finding should read "...and recreational angler harvest, and illegal poaching." (WQCP-SWC-631,2,12).

Response: Agreed. Comment noted.

Change in text:
"...recreational angler harvest, and illegal poaching."

Page 1-14, Marshes, first paragraph

Comment: The name "Montezuma Slough Control Structure" should be replaced, wherever it occurs in this Plan, with the name "Suisun Marsh Salinity Control Gate" (WQCP-DWR-24,11).

Response: Comment noted.

Change in text:
The name "Montezuma Slough Control Structure" will be replaced, wherever it occurs in this Plan, with the name "Suisun Marsh Salinity Control Gate" (WQCP-DWR-24,11).

Page 1-14

Comment: Unclear how closure of the Delta Cross Channel gates can cause south Delta entrainment. In some cases it can reduce Sacramento River losses (WQCP-USFWS-7,3).

Response: Agree. The footnote will be reworded.

Change in text:
"Entrainment means primarily the effects of project operations, such as operation of the Delta Cross Channel gates, export pumping, and reverse and low river flows, plus local non-project diversions."

Page 7-21

Comment: It should be made clear that the first paragraph refers to the Sacramento River Water Year Classification (WQCP-CVPWA-210,36-37).

Response: Agree.

Change in text:
Page 7-21, Section 7.5.3.1., para 1, and Page 1-15, Section 1.6, para 1, will be amended as follows: "The current <u>Sacramento River Basin Water Year Classification</u>..."

Pages 1-15 fourth bullet and Page 7-9 fifth paragraph immediately following Section 7.4.2.1.

Comment: The language in these sections should be revised to strengthen the direction to the Central Valley Regional Board relative to actions needed regarding the Delta island drains. The Regional Board should be directed to take firm action regarding the Delta drains. These tasks are to begin in the Rock Slough and Clifton Court Forebay areas (WQCP-SWC-632,1-7).

Response: Agree with the intent to strengthen direction to the Central Valley Board and with the proposed language revisions.

Change in text:
".....Central Valley Regional Board shall require the development and implementation of best management practices or other means to appropriately control these discharges."

Page 1-16, last para.

Comment: USBR suggests that the wording of this sentence should be changed to include all runs of Chinook salmon (WQCP-USBR-129B, Page 1, paragraph 4).

Response: The sentence will be changed.

Change in text:
"Analysis is needed of the effectiveness of various means to control factors which will help maintain cooler water in the Sacramento and San Joaquin rivers and their tributaries for the protection of all runs of Chinook salmon."

Page 1-17

Comment: USFWS states that the paragraph on temperature monitoring should also indicate how the temperature data is to be used (WQCP-USFWS-7, Page 3, 6th specific comment).

Response: The following sentence will be added to the referenced paragraph (and to Page 7-8, section 7.3.2.3, first paragraph).

Change in text:
"The temperature data collected are to be submitted to the State Board which will then make a determination whether controllable factors should be controlled."

Page 1-17, Estuarine Habitat, first paragraph

Comment: It was suggested that the second sentence be changed to read:

"Relatively few investigators have been able to specifically quantify the lower level of conditions that protect the beneficial uses." (WQCP-USFWS-7,3)

Response: The text in the Plan will be changed as suggested.

Change in text:
"Relatively few investigators have been able to specifically quantify the lower level of conditions that protect the beneficial uses."

Page 1-17, Scoping and Water Right Issues (7.5), first paragraph

Comment: The Board should modify the language in this paragraph to reflect the fact that the burden of compliance monitoring will also need to be distributed (WQCP-SWC-633,5).

Response: The first paragraph will be changed.

Change in text (changed and added language underlined):
"Only a few parties are <u>currently</u> responsible for meeting water quality and flow requirements <u>and for compliance monitoring activities</u> within the Delta. <u>The Board requests that information be developed on how</u> <u>these</u> burdens should be distributed ...."

Page 1-19, Entrapment Zone (7.5.3.3), and Page 7-22, Section 7.5.3.3, introductory paragraph

Comment: USFWS did not agree with the qualifying phrase "if any" in the statement and that "the statement should simply read as follows: 'Studies are needed to better define the linkage between...' (WQCP-USFWS-7,7). DWR, SWC, and CVPWA stated that the later references to the linkage of fish productivity to the entrapment zone do not include the qualifier; they claim that there is no linkage at all (WQCP-DWR-24,14; WQCP-SWC-631,1; WQCP-SWC-633,5-6; WQCP-CVPWA-210,11).

Response: The degree of linkage is what is in doubt. The language in the Plan, on pages 1-19 and 7-22, will be changed.

Change in text:
"Studies are needed to better define the degree of linkage between the location and productivity of the entrapment zone and the effects on the population levels of important fish species." [new words underlined]

Page 5-1, Section 5.0.1, paragraph 3

Comment: The second sentence implies that the South Delta negotiated agreement will be accepted as the South Delta water quality objectives. The sentence should be reworded to read as follows: "Development of objectives for the South Delta will commence upon receipt of a negotiated agreement between..."(WQCP-USFWS-7,4).

Response: This statement referes to implementation of the 1978 Delta Plan objectives, not the Draft Plan objectives. This sentence will be clarified.

Change in text:
"Implementation of the Delta Plan objectives for the Southern Delta were initially postponed until suitable circulation and water supply facilities were completed. Implementation of these objectives was further delayed at the request of the South Delta Water Agency (SDWA), USBR, and DWR, awaiting the results of continuing negotiations among these three agencies."

Page 5-7; Item No.6

Comment: Question the need to study the chloride/bromide relationship in the Delta unless there is evidence that another, as yet undiscovered, bromide source is expected to exist (WQCP-SWC-632,7-14).

Response: Agreed.

Change in text:
"A major source of bromide ions in Delta waters is sea water and a relationship has been documented to exist between chloride levels and bromide levels in sea water."

Pages 5-9 and 5-12

Comment: Meeting agricultural objectives at interior South Delta stations is contrary to the intent of the negotiated contract. With the contract in place, the water quality objectives should only apply to the station at Vernalis. The proposed objectives are infeasible and, therefore, should not be included (WQCP-DWR-24,7; WQCP-SWC-630,3-4; WQCP-CVPWA-210,10).

Response: Evidence has not been shown that it is impossible to meet the interior agricultural objectives. Implementation will look at not only Project operations but other various solutions, including; non-Project operations, a salt-reduction program, and physical facilities. The following wording replaces that which describes the southern Delta portion of Section 7.2.2.2 on page 7-3 of the Plan.

Change in text:
"o Southern Delta
The implementation plan is comprised of two interim stages and a final stage.

Interim Stage 1 -- 500 mg/l mean monthly TDS all year at Vernalis.

Interim Stage 2 -- (to be implemented no later than 1994) 0.7 mmhos/cm EC April to August 31, 1.0 mmhos/cm EC September 1 to March 31; 30-day running average at Vernalis and Brandt Bridge, with water quality monitored at three current interior stations -- Mossdale, Old River, near Middle River and Tracy Road Bridge; and an additional interior monitoring station on Middle River at Howard Road Bridge.

Final Stage -- (to be implemented no later than 1996) 0.7 mmhos/cm EC April to August 31, 1.0 mmhos/cm EC September 1 to March 31; 30-day running average at Vernalis and Brandt Bridge on the San Joaquin River, with two interior stations at Old River near Middle River and Old River at Tracy Road Bridge. Monitoring stations will be at Mossdale at head of Old River and Middle River at Howard Road Bridge."

or

If a three-party contract has been implemented among DWR, USBR and the SDWA, that contract will be reviewed prior to implementation of the above and, after also considering the needs of other beneficial uses, revisions will be made to the objectives and compliance/monitoring locations noted above, as appropriate.

The above change will also be reflected in Tables I-1, 5-5 and 6-3, and 7.2.2.2 text.

Page 5-9

Comment: The Framework Agreement has been superceded by the terms of the draft contract (WQCP-USBR-129A,2).

Response: Agree. The WQCP, Page 5-9, Section 5.3.1.3, "Southern Delta" first paragraph, third bullet, will be edited.

Change in text:
"o The terms of the draft contract for settling litigation brought by the SDWA against the USBR and DWR."

Pages 5-14 and 5-15, Section 5.4.1

Comment: It was suggested that an item about Potamocorbula be added to the list of recent changes in the Delta found on page 5-14 (WQCP-SWC-631,3-4; WQCP-CVPWA-210,11).

Response: The following item will be added (and the format of items 3 and 4 modified as needed).

Change in text:
" 5. The introduction and rapid increase in numbers and range of the Asian clam Potamocorbula and its possible adverse effects on phytoplankton and zooplankton abundance."

Page 5-16 para. 1

Comment: CVPWA comment includes a suggested revision of the first sentence: Various water quality conditions, such as temperature, dissolved oxygen (DO) and salinity, affect Chinook salmon survival in the Delta (WQCP-CVPWA-210, Page 12, last paragraph; WQCP-SWC-631, Page 5, paragraphs 3 and 4).

Response: The referenced sentence will be changed to read as follows:

Change in text:
"Various water quality conditions can affect Chinook salmon survival in the Delta. The water quality variables under consideration were temperature, dissolved oxygen (DO) and salinity."

Page 5-19, Sec. 5.5.2.1 para. 1

Comment: USFWS recommends wording changes describing the time periods of the temperature objective in terms of salmon life stages; it states that the sentence, regarding the ability and options to attain a desired temperature objective have not been fully investigated, is misleading because USBR temperature modelling shows that flow does reduce temperature (WQCP-USFWS-7,Page 5, paragraph 3).

CVPWA suggests that 1) the paragraph be rewritten and provides the suggested revision, states 2) among other things that there are no winter-run Chinook in the San Joaquin River (WQCP-CVPWA-210, Page 16, last paragraph).

Response: Regarding the wording describing the time periods: wording changed. The first sentence should be reworded for clarification. Regarding the sentence on the ability and options to attain the temperature objective: This is not meant to be misleading, evidence was presented that showed it is not feasible to use only flow to achieve the temperature objectives. If flow is to be used at certain times of the year during certain water year types that evidence needs to be presented to the State Board (see IV. Controllable Factors: response to comments A. and B.).

Change in text:
"The critical periods for fall- and winter-run Chinook salmon in the lower Sacramento and San Joaquin Rivers are between December 1 and June 30 and September 1 and November 30 of each year, because these encompass the spawner migration and the juvenile outmigration phases through this area (See Appendix 5.3, Chinook Salmon)."

Page 5-19, Page 5-24

Comment: EPA notes that the text states that increased flows could have an effect on temperatures, however there is no explanation given for excluding reservoir releases from "controllable factors". The plan recommends the temperature objectives be subject to "controllable factors". This should not be an explicit part of the objective but part of the Program of Implementation (WQCP-EPA-1, Page 2, paragraphs 2-4; WQCP-SCLDF-3, Page 1).

Response: Please see response to USBR comments in GENERAL COMMENTS, Chinook-Temperature Objectives which includes changes in the text (pages, I-1 and I-2).

Page 5-22

Comment: DFG considers the objectives for fish and wildlife reasonable except for the 66°F objective for the winter run Chinook salmon because it implies that it would be acceptable to warm the river during the winter. Because there is no evidence that a temperature problem exists from January to March, it is recommended that the objective be deleted. (WQCP-DFG-5, Page 2, paragraph 1; WQCP-USFWS-7,Page 5, paragraph 4 (no page reference for the Plan); WQCP-CVPWA-210, Page 12, paragraph 4-5 (Page 5-15); WQCP-CVPWA-210, Page 20, last two paragraphs (Page 5-22); and WQCP-CVPWA-210, Page 23, paragraph 2 (Page 5-26)).

Response: The temperature objective for winter run is to provide protection for a listed species during the time when they are most likely to be in the Delta. If additional information is provided that more precisely defines the timing of their migration through the Delta and their temperature requirements while in the Delta, this information can be incorporated into the triennial review process.

Change in text (the following wording will be inserted into Page 5-22 of the Plan):
"The winter-run Chinook salmon temperature objective is a cap to prevent water temperature from going higher than the present temperatures in the Delta. It is not a goal. This objective is just one of several ways of providing protection from elevated water temperatures. Other such protection measures include the Thermal Plan (see in Section 5.5.25) and the State Board "anti-degradation policy", "Statement of Policy With Respect to Maintaining High Quality of Water in California", Resolution 68-16."

Page 5-26

Comment: DWR states that even with the installation of the temporary rock barrier at the head of Old River, a dissolved oxygen (DO) level of 6 mg/l cannot be maintained September 1 through November 30 in the San Joaquin River near Stockton (WQCP-DWR-12). More description is needed of the many factors not related to the SWP and CVP operations that contribute to the DO problem, including: 1) the recently deepened ship channel; 2) the enlarged turning basin at the Port of Stockton; 3) the Stockton Sewage Treatment Plant; 4) upstream BOD sources; and 5) commercial use of the dead-end portion of the ship channel, where the DO often falls to zero. The Plan of Implementation should specify how this objective will be met. Two methods are suggested for improving DO levels; additional methods should be considered (WQCP-DWR-24, Page 11, last paragraph-Page 12, paragraphs 1-2; WQCP-DWR-25, Page 4, last paragraph;) (WQCP-CVPWA-210, Page 23, last paragraph-Page 24; WQCP-CVPWA-210, Page 35).

Response: The text (Page 5-23, paragraph 3) will be amended to include the following sentences.

Change in text:
"Factors that may contribute to the low levels of dissolved oxygen, in addition to low flows in the San Joaquin River during the fall months, include: 1) the recently deepened ship channel; 2) the enlarged turning basin at the Port of Stockton; 3) the Stockton Sewage Treatment Plant; 4) upstream BOD sources; and 5) commercial use of the dead-end portion of the ship channel.

Measures to implement this objective include the following: 1) regulation of the effluent from the Stockton Sewage Treatment Plant and other upstream discharges contributing to the BOD load; 2) install the temporary barrier or additional barriers as may be needed, 3) investigate mechanical or chemical methods to oxygenate the water at critical points along the river channel, and 4) increase flow in the San Joaquin River. A decision on the precise implementation measures will be made during the forthcoming proceedings."

Page 5-30

Comment: The text does not explain how estimates of spawning activity were determined for the table on this page (WQCP-SWC-631,13).

Response: The text in Section 5.6.2.1 will be modified to explain the procedure.

Change in text:
"The percent of spawning activity assumed protected under each alternative in the table above is determined directly from Table 5-2. The range of percent spawning activity protected is simply the amount of spawning activity measured (i.e.,

percent of total eggs collected) by the end date of each alternative. There is assumed to be relatively little spawning which occurs before about April 14 each year, so the absence of ramping (i.e., appropriate salinity from April 1 rather than ramping flows to April 15) was assumed to add only about 5 percent additional spawning activity protection over that provided by ramping. The relative lack of data before April 15 makes this somewhat speculative, but in any case it is probably not significant."

Antioch and Prisoners Point Spawning and Relaxation Objectives

Pages 5-27 through 5-35

Comment: Page 5-27 to 5-28 - The scientific basis for the 1.5 EC objective at Antioch is not described in the Plan (WQCP-EPA-1,5).

Comment: Page 5-27 to 5-34 - The objective of 1.5 EC at Antioch is not supported by the evidence. The record shows that spawning standards should be less than 0.33 mmhos/cm. The standards should be expanded to designate specific river segments, rather than just specific points (WQCP-SCLDF-1,6).

Comment: Page 5-32 to 5-33 - The striped bass spawning standard in the central Delta is set at a single location (Prisoners Point) (WQCP-CWPC-1,8).

Comment: Page 5-32 to 5-33 - The benefits of the proposed change in the Prisoners Point objective from 0.55 to 0.44 mmhos/cm are not supported by data (WQCP-DWR-24,13).

Comment: Page 5-30 to 5-32 - The relaxation provision is incorrectly tied to the Suisun Marsh D-1485 standard at Chipps Island (WQCP-SWC-630,6-7).

Comment: Page 5-30 to 5-32 - Even with a relaxation to an Antioch EC of 4.4 mmhos/cm, ten to fifteen miles of spawning habitat would still remain (WQCP-SWC-630,8).

Comment: Page 5-32 to 5-33 - No evidence that striped bass spawning is being adversely impacted by current objective of 0.55 mmhos/cm at Prisoners Point, and it should be retained (WQCP-SWC-630,9).

Comment: Page 5-27 - The statement "deficiencies in firm supplies and the level of protection afforded by the striped bass spawning objective should be correlated" is unclear (WQCP-USFWS-7,5).

Comment: Page 5-30 - No technical basis exists for estimating the length of spawning habitat in the San Joaquin River when Antioch EC is 25.2 mmhos/cm. Very little biologically-based information available to relate spawning and Antioch EC and deficiencies (WQCP-SWC-631,13).

Comment: Page 5-35 - There is no scientific evidence to justify changing the D-1485 relaxation provision to 3.7 mmhos/cm EC. No justification to retain a relaxation provision beyond 3 MAF (WQCP-CVPWA-210,26).

Comment: (Page 6-20 also) - Agrees that considerable uncertainty regarding potential benefits of striped bass salinity objectives. Arthur's work shows "ample production of striped bass eggs and larvae". Significance of various findings should be determined prior to making any final determinations on salinity objectives (WQCP-CVPWA-210,33).

Response: (Since all of this response will also be used for changes in text, each change will be labeled as to where in the Plan it will be inserted).

Change in text, Page 5-30:
"The present Antioch standard of 1.5 mmhos/cm EC was primarily designed, as is described in Section 5.6.1.1, to provide a suitable spawning habitat <u>upstream</u> of Antioch, not at the Antioch location itself. According to the recollection of Don Stevens of DFG (pers. comm., 3/91), Antioch was chosen as a monitoring point because a salinity monitoring station was already established at the Antioch Water Works. The use of 1.5 mmhos/cm EC at Antioch for spawning protection appears not to be generally appropriate, since DFG's own testimony indicates that striped bass prefer to spawn in freshwater, and that a spawning objective of 0.44 mmhos/cm EC represents the "best scientific evidence" of the water quality needed to restore spawning in the historical spawning area of the San Joaquin River (WQCP-DFG-4,9) (see Section 5.6.2.3). However, the Antioch water quality objective may continue to serve the purpose of being an ultimate delimiter of spawning habitat; the Antioch objective can also be considered an "implementing measure" since maintaining that objective should produce less saline, and thus more suitable habitat, upstream of Antioch in the San Joaquin River. DFG has observed some spawning in the Antioch to Jersey Point reach, sometimes in EC's of 1.5 mmhos/cm or higher, in some very dry years (1972 and 1977). Laboratory studies also indicate that egg survival is not affected adversely in water with EC's up to 1.5 mmhos/cm (DFG,25,46). These conditions have typically produced some of the lowest abundance indices, however. We also agree that the striped bass spawning objectives, as proposed, do not in fact designate a spawning reach, but only a single location (Prisoners Point) where appropriate salinities for the majority of spawning, as determined by DFG, are required to be present."

Change in text, Page 5-32:
"As several participants have pointed out, there is considerable confusion about the appropriateness of the proposed relaxation criteria, in terms of what salinity is appropriate at Antioch for various deficiency levels. As has been discussed, the 1978 Delta Plan and EIR based the relaxations on a salinity/flow relationship for the Sacramento River, which was assumed to be applicable to the San Joaquin River as well. In addition, the theoretical extent of salinity degradation was supposedly limited to a maximum of 3.7 mmhos/cm EC because of the Chipps Island Suisun Marsh standard. The entire process is built on a series of artificial relationships which are unrelated to the main issue at hand, which is the establishment and maintenance of suitable spawning habitat for striped bass in the San Joaquin River and the relaxation of that habitat requirement when water project firm deliveries are reduced.

The State Board continues to believe that, as stated in its conclusions on striped bass (Section 5.6), the "[d]eficiencies in firm supplies and the level of protection afforded by the striped bass spawning objective should be correlated". The present deficiency schedule does not do that, since no specific relationship between extent of habitat and change in salinity intrusion has been made. The present relationship is based on a Sacramento River salinity/flow relationship. Several participants have appropriately questioned the basis for this relationship.

In 1990, the projects declared a deficiency and invoked the relaxation provision. Despite compliance with other D-1485 standards, the theoretical expected Antioch maximum EC of 3.7 mmhos/cm was exceeded. In addition, monitoring data from 1990 suggest that EC's greater than 0.44 mmhos/cm occurred throughout nearly all of the striped bass spawning area, not simply at the downstream end.

The State Board would like to relate deficiencies to spawning area in a direct, measurable way: by simply making increases in deficiencies directly related to the shortening of the length of river reach in which suitable spawning habitat will be required to be maintained. The Board believes this approach would have a negligible effect on water supplies during most years because D-1485 provides some umbrella spawning protection upstream of Antioch by means of the central and western Delta agricultural standards. These standards are presently under review, and the required water quality at some locations may be reduced (salinity increased). By establishing a separate spawning habitat objective, no re-evaluation of the effects of water quality degradation on striped bass habitat will be required. The present agricultural water quality objective includes a level of 0.45 mmhos/cm EC at Jersey Point from April 1 to August 15 (in all but critical years). This objective essentially duplicates the current EC and starting date requirements for striped bass spawning protection. In Section 7.5.2.4, Program of Implementation, we outline a proposal for evaluation of the concept of establishment of a specific spawning protection zone, and a directly related relaxation provision."

Change in text, Page 6-20:
"Various participants have argued that there is no evidence that striped bass spawning habitat is limiting, and that striped bass have been observed to spawn in water with salinity higher than 0.44 mmhos/cm EC. Laboratory tests also suggest that eggs can survive and hatch in higher salinity water (see Section 5.6.2.1). On the other hand, observations on other striped bass populations indicate that, given a choice, all prefer to spawn above the limits of seawater intrusion. In the San Joaquin River, upstream salinity barriers appear to inhibit their ability to move entirely out of the effects of ocean salinity. We agree that the evidence for whether spawning habitat is limiting for striped bass, and what the maximum allowable salinity might be, is not definitive, particularly when comparing laboratory and field observations. However, we also recognize that spawning success, as measured by survival of eggs and young bass, is inextricably linked to the effects of flows, toxics, and other factors, so that distinguishing the effects of spawning habitat salinity alone may be impossible. Additional studies and data analysis on actual spawning conditions, spawning locations in different year types, and spawning success are sorely needed. We invite all participants to evaluate this question further, and we propose that a thorough review of this objective be undertaken at the next Triennial Review of this Plan (see Program of Implementation, Section 7.5.2.4)."

Change in text, Page 7-20:
"To make certain that the State Board develops water quality objectives that are based on sound scientific data, and which are appropriately protective of striped bass spawning habitat, we request DFG to analyze the protective values of setting up a specific spawning habitat zone of 0.44 mmhos/cm EC, or some other more appropriate EC value, in the river reach between Jersey Point and Prisoners Point. Analysis of historical springtime EC data indicates that 0.44 mmhos/cm EC at Jersey Point would apparently maintain an EC at Antioch of just about 1.5 mmhos/cm, which DFG would like to retain. DFG should also analyze the possibility and the effects of relating a relaxation provision to declared deficiencies. Specifically, DFG should be prepared to discuss the effects of reducing the spawning habitat by moving the downstream end of the spawning habitat reach upstream from Jersey Point a distance proportional to the percent reduction in delivery of firm supplies, along the lines proposed in the table below. In the remaining reach, the 14-day running average of the mean daily EC would be no more than 0.44 mmhos/cm EC for the period April 1 to May 31, or until spawning has ended.

Percent Delivery Reduction Reduced	Percent River Reach
0	0
1-10	10
11-20	20
21-30	30
31-40	40
>40	40

Deficiencies are defined as deficiencies in firm supplies declared by a set of water projects representative of the Sacramento River and San Joaquin River watersheds. The specific projects and amounts of deficiencies would be defined in subsequent phases of these proceedings.

DWR should be prepared to discuss the potential effects, i.e., water costs, that would result if the State Board were to adopt water quality objectives as outlined above. The Board would like to hear from USBR, USFWS and any other interested parties on this subject at the next Triennial Review."

Page 5-38 to Page 5-42

Comment: DWR states that the Plan relies heavily on the work of Moyle and Herbold for the Delta smelt analyses and that other authors (SWC, DWR and DFG) provide a more thorough and up-to-date analysis (WQCP-DWR-24, page 13, last paragraph).

Response: Between the text of the Plan and the Technical Appendix, there were ten references used for the Delta smelt analysis. Of these, Moyle was sole or primary author of four of these, one of which was a 1990 publication. Of the other six not authored by Moyle, three were published in 1990 which were analyses by SWC, USFWS and DFG.

Exhibit WQCP-USFWS-7 submitted to the State Board on March 11, 1991, contained an additional reference for Delta smelt (Moyle, Williams, and Wikramanayake 1989) which has been reviewed and included in the Plan.

Changes in text:

Add the following publications to the list of references:

Moyle, P.B., J. E. Williams, and E. D. Wikramanayake. 1989. Fish species of special concern of California. Final report prepared for State of California, Department of Fish and Game, Inland Fisheries Division, Rancho Cordova, California. 222 pp.

State Water Contractors. 1990. Response to the State Water Contractors to the petition to list Delta smelt as an endangered species. Report submitted to the Natural Heritage Division, California Department of Fish and Game.

Add the following reference as a footnote to Table 5-3 and Figure 5-4 in the Plan: Stevens, D. E., L. W. Miller and B. C. Bolster. 1990. Report to the Fish and Game Commission: A status review of the Delta smelt (Hypomesus transpacificus) in California. Department of Fish and Game.

Page 5-39, paras. 2 and 3

Comment: SWC suggest wording be included that DFG (1990) states that the population of Delta smelt is currently stable and provides additional language describing the population trends (WQCP-SWC-361, Page 16, paragraphs 3 and 4).

Response: The statement that the population is increasing is misleading. The following sentences will be added to the referenced paragraph.

Change in text:
"DFG (1990) stated that like the summer townet survey, the fall midwater trawl survey indicates that abundance of Delta smelt has been highly variable and has suffered a major decline. Bay survey catches show a striking decline in Delta smelt abundance after 1981, and since 1981 there has been an irregular but persistent decline. Part of this is due to the fact that the four of the last five years were low flow years and the population has been concentrated in the Delta. In the seine survey, the lowest average catches of adult Delta smelt occurred in 1980 and 1984-1989. The persistent low catches from 1984-1989 are consistent with the population decline exhibited by the midwater trawl and summer townet surveys. The DFG concluded that "the relatively stable, albeit low, population is not in imminent danger of extinction, however, the Delta smelt may well "become an endangered species in the foreseeable future.""

Page 5-42, para. 4

Comment: SWC suggest including mention of details and cost of proposed studies (WQCP-SWC-361, Page 18, paragraph 1).

Response: The following sentence will be added to the 4th paragraph after the second sentence:

Change in text:
"Further studies are proposed for determining with greater accuracy, the abundance and the factors affecting Delta smelt abundance, in the Delta."

Table 5-5, Page 6 of 28; and Appendix, Page 5.0-7

Comment: The WQCP incorrectly states DWR's advocated level of protection. DWR's previous leaching recommendations are withdrawn and should be deleted from the WQCP (WQCP-DWR-24,9).

Response: Agree. The WQCP will be revised to show DWR's correct advocated level of protection for western and interior Delta agriculture.

Change in text:
Table 5-5, page 6 of 28, "Advocated Levels" DWR's indicated recommendation for a winter ponding objective at Cache Slough and San Andreas Landing is deleted. Appendix, page 5.0-7, third paragraph, titled "Winter Ponding Objective": title and paragraph will be deleted.

Page 6-3

Comment: Footnote 3 of Table 6-1 is misleading in that Alternative 3 is described with a goal of 0.15 mg/l bromide. However, this standard is not modeled in the supporting Study H7 (WQCP-DWR-24,3).

Response: Footnote 3 will be revised by adding "This goal, however, was not modeled as part of alternative 3."

Comment: Footnote 6 of Table 6-1 contains approximate total dissolved solids to electrical conductivity instead of exact values (WQCP-DWR-24,3).

Response: The exact conversion values, as presented by DWR, will be used in footnote 6.

Change in text to reflect above.

Pages 6-4 and 6-14

Comment: The discussion of the impacts of the proposed objectives on water supply is incomplete. It does not even consider the impacts of any changes in the Suisun Marsh objectives, interior south Delta objectives or the Antioch relaxation provision for striped bass. It is not possible to determine whether the proposed objectives are "reasonable" as required by law without knowing the ultimate water cost (WQCP-SWC-633,2,14).

Response: As recommended by SWC, the following will be added as the last paragraph of section 6.2.

Change in text:
"It must be recognized that the impacts shown on Table 6-2 and Figures 6-2 and 6-3 and discussed in the following pages do not include the potential impacts on water supply of meeting any changes in current Suisun Marsh objective, the revised Antioch relaxation provisions for striped bass or the objectives for interior stations in the south Delta. Each of these objectives could cause a reduction in water available for other beneficial uses. When the impact of one or more of these objectives is known, the Board will review such objectives for reasonableness and amend them, if necessary."

In addition, the following will be added to beginning of paragraph 1 of section 6.2.3.6.

Change in text:
"Without considering the potential impact of meeting the revised Antioch relaxation provision for striped bass and the interior objectives in the south Delta, and assuming that the existing Suisun Marsh standards are not revised,..."

Change in text:
Delete "increases" and insert "decreases."

The following will replace the second paragraph.

Change in text:
"The principal reason for the decrease in Delta outflow is the new 40-30-30 year type, which allowed for more water to be stored in the Sacramento River Basin."

The last paragraph will be amended.

"The level of impact on water supplies of this alternative, <u>not including the impact of the striped bass relaxation provision and the interior south Delta objectives,</u> is less than ..."

Page 6-5, 6-7, 6-8, 6-11 and 6-18

Comment: Tables 6-2 and A6.3-1, and Figures 6-2 and 6-3. contain incorrect values for the Sacramento River Inflow, Total Delta Exports, and Total Delta outflow (WQCP-DWR-24; Chapter 6, Page 6-5, Page 6-7, Page 6-8, Appendix Pages 6.3-3 and 6.3-4).

Response: The State Board errata presented on March 11, 1991, shows the correct values for the Plan. Table A6.3-1 and the text will be revised accordingly.

Change in text, 6-11
Delete "39" and insert "59"
Delete "56" and insert "110"
Delete "42" and insert "50"
Delete "51" and insert "63"

Change in text:
(Page 6-18)
Delete "682" and insert "674"
Delete "1090" and insert "1078"
Delete "21" and insert "20"

Page 6-10

Comment: The 3.0 mmhos/cm EC relaxation for western and interior Delta agriculture applies to the first 15 days in August of critical years in the model simulation (WQCP-DWR-24,9; WQCP-SWC-633,14).

Response: Page 6-10, Section 6.2.2, second sentence, will be changed.

Change in text:
"...and adjusted to 3.0 mmhos/cm EC from August 1 through August 15 in critical years."

Page 6-11, first paragraph

Comment: It is not clear what this paragraph is supposed to say. It appears that drinking water and fishery issues have been mixed. Recommended wording suggested (WQCP-SWC-632,7-14).

Response: Agree with new recommended language:

Change in text:
"As new and pending drinking water standards take effect the water quality objectives in Alternative 2 may result in negative impacts for purveyors of Delta water. These negative impacts may take the form of violation of State and Federal drinking water standards for Disinfection By-Products. It is not possible to accurately quantity those impacts at present."

Page 6-13 para. 3

Comment: SWC suggest removing the reference to the USFWS smolt survival index based on flow (WQCP-SWC-631, Page 20, paragraph 4 and 5).

Response: The use of this equation, along with other analyses that may be conducted in the future, is valid insofar as the relationship between flow and smolt survival has been used to indicate an overall relative response in smolts survival to changes in flow, water temperature, diversion fraction and total exports.

Change in text:
"Using the smolt survival index for the Sacramento River (USFWS) ... smolt survival index would be greater than 0.50 would be in wet years. Above normal water years would provide an average survival index of 0.42 and the remainder of the year types less than 0.30."

Page 6-13, para. 3

Comment: CVPWA suggests deleting the sentence stating that no estimates have been made on the additional flow required to improve dissolved oxygen (WQCP-CVPWA-210, Page 31-Page 32, paragraphs 1-2).

Response: Referenced sentence (Page 6-13, section 6.2.3.4., paragraph 3, third sentence) should read as follows:

Change in text:
"A partial analysis estimating the flow required (September and November only) to change the dissolved oxygen level 1 mg/l using a multiple regression analysis was submitted. Further analysis of the impacts of the water quality objectives will be made in the forthcoming proceedings."

Page 6-14

Comment: The date should be May 31, not May 30 (WQCP-SWC-633,15).

Response: Agree. Text will be corrected.

Change in text:
"... to May 31."

Page 6-14

Comment: Paragraphs 2 and 4 both describe the water regime under Alternative 3, but the statements are confusing and contradictory (WQCP-USFW-7,6).

Response: We agree. Paragraph 2 reflected spring conditions only, while paragraph 4 referred to annual water supply impacts. However, both statements are incorrect; newer model runs, the results of which were presented as SWRCB errata at the March 11 hearing, show different impacts and flows.

Change in text:
" The model run used to simulate Alternative 3 assumes some increase in San Joaquin River flow, little change in exports, reduced Sacramento River flow and reduced Delta outflow. The impacts on indirect protection for eggs and young under this alternative, as modeled, are unclear."

Page 6-15; First paragraph and second paragraph, second sentence: p. 6-22; first full paragraph below the bullets, second sentence:

Comment: The language does not completely state the impacts on water supplies. Recommended wording is suggested (WQCP-SWC-632,7-14).

Response: Comments noted. Language will be revised accordingly.

Change in text:
(Page 6-15, first paragraph)

"The impact of setting a 50 mg/l chloride objective at Banks Pumping Plant will be to lower chloride levels at the Contra Costa Canal intake to less than 140 mg/l if seawater intrusion were the primary source of the chlorides. The chloride levels at the Banks Pumping Plant will be improved significantly; the lower salinity levels in SWP water delivered via the Banks Pumping Plant will enhance reclamation efforts and will improve the taste of the water and reduce corrosion."

(Page 6-15, second paragraph, second sentence)

"This positive effect at Banks Pumping Plant may result in lower THM formation potential in the water at Rock Slough."

Page 6-16

Comment: Additional Delta outflow could come from a reduction in upstream diversions instead of, or in addition to, reduced exports. A suggested revision would be "Like Alternative 4, the primary source of this additional water is from a corresponding reduction in exports <u>and/or reduction in upstream diversion and use.</u>" (WQCP-DWR-24; Chapter 6)

Response: Implementation of these objectives will be better defined in the Water Right Phase of the proceedings. For simplicity, the operation studies assumed that all reductions would come from exports. The wording will be revised as suggested.

Change in text:
"Like Alternative 4, the primary source of this additional water is from a corresponding reduction in exports <u>and/or reduction in upstream diversion and use.</u>"

Page 6-20, Table 6-3, page 5 of 8

Comment: The following clause needs to be inserted (WQCP-DWR-24,13).

Response: We agree. Table will be changed.

Change in text:
"Relaxation Provision -- replaces the above Antioch and Chipps Island Standard whenever the projects impose deficiencies in firm supplies".

Page 6-22, paragraph 1, sentence 3

Comment: This sentence should be revised as follows to more accurately state the impact of Alternative 4 on M&I use; "Alternative 4 would provide <u>positive, but</u> unquantified benefits with respect to M&I use (WQCP-SWC-633,16)."

Response: Agree. The WQCP will be amended as indicated in the SWC's comment.

Change in text:
"Alternative 4 would provide positive, but unquantified benefits with respect to M&I use."

Page 7-3, Section 7.2.2.2, "South Delta"

Comment: All stage 1,2,and 3 objectives should be identified (WQCP-CVPWA-210,34; WQCP-EPA-1,1).

Response: Change in text to reflect new wording in Section 5.3.1.3 (5-9).

Page 7-8, top of page [Section 7.3.1 General {Compliance Monitoring}]

Comment: The general monitoring surveys discussed in this paragraph should be expanded to include wildlife as well as fisheries (WQCP-DFG-5,4).

Response: The first sentence of this paragraph will be changed.

Change in text (changed and added wording underlined):
"o Conduct ongoing and future monitoring surveys recommended by DFG and concurred with by the State Board, concerning food chain relationships and fish and wildlife impacts as they are affected by implementation of this Plan."

Page 7-8, paragraph 5, last sentence

Comment: SWC proposes wording changes (WQCP-SWC-631, Page 23, paragraph 2-5).

Response: These changes will be made.

Change in text:
change "DWR/USBR" to "USGS"

Page 7-9; Section 7.4.2.1, second paragraph:

Comment: Contrary to what is stated in the Plan, a Disinfection By-Product Workgroup has, to this date, not yet been formed (WQCP;DWR; Oral Comment 3/11/91).

Response: Agree.

Change in text:
"A disinfection by-product (DBP) Workgroup has not been formed..."

Pages 7-9 to 7-18, Section 7.4 Special Studies and Reviews

Comment: There is agreement about the need for special studies as outlined in this section and concerns about the limits that resources -- time, personnel, and money -- put on being able to implement this ambitious set of tasks (WQCP-USBR-129A,3; WQCP-SWC-631,24; WQCP-CVPWA-210,36).

Response: The following rewording will be added to Page 7-15.

Change in text:
"There is a need to develop a list of priorities among routine and special studies and a more detailed definition of what each study's goal(s) should be. The forum for the technical scientific studies (biological, hydrodynamic, etc.) would be the Interagency Ecological Study Program. Other studies that do not fit into the Program could be undertaken by contract to a consultant or through a work group."

Comment: There is a typographical/editing error on page 7-15, numbered paragraph 3 (WQCP-DWR-24,14).

Response: The first sentence will be changed.
(added wording underlined):

Change in text:
"3) The interagency programs, <u>including</u> the Suisun Marsh Fish Monitoring Program and the Neomysis/Zooplankton Survey<u>,</u> are on-going; ..."

Page 7-10; second paragraph, second sentence:

Comment: Results of research and recommended actions by a Disinfection By-Product workgroup cannot be completed by 1/1/92, primarily because research on water treatment technologies is an on-going process. Recommended language is that "progress of research and recommended actions be reported by January 1, 1992" (WQCP-SWC-632,7-14).

Response: Comment noted. Language will be revised accordingly.

Change in text:
"... "progress of research and recommended actions be reported by January 1, 1992".

Page 7-11

Comment: SWC proposes wording changes (WQCP-SWC-631, Page 23, paragraph 2-5).

Response: These changes will be made.

Change in text:
1) Page 7-11, 1st paragraph, last sentence: change April and May to during April through June;
2) Paragraph 2, first sentence: include striped bass after both references to salmon and delete steelhead; and
3) Paragraph 3, last sentence: delete sentence.

Page 7-11

Comment: USFWS comments are: 1) June should be included in the last sentence, 2) the Consumnes River should be changed to the Calaveras River, and 3) are other smolt survival studies, besides the ones listed, to be considered (WQCP-USFWS-7, Page 7, paragraph 2-4)?

Response: Text will be changed.

Change in text:
1) (Same page, paragraph 3, third sentence) "Consumnes will be changed to 'Calaveras'; and
2) "All appropriate studies will be considered; the list of studies was not meant to be exclusive."

Page 7-13

Comment: DFG states that it is not accurate to say that species are often misidentified and they are confident that quality control is sufficient for the enumeration of trends in species composition, etc (WQCP-DFG-5;Page 4, #1).

Response: In response to the comment, the text of the Plan (Page 7-13, last paragraph) will be modified as follows:

Change in text:
"Historical SWP and CVP data on Delta smelt salvage has not been very reliable. DFG is confident that, currently, quality control is sufficient for the enumeration of trends in species composition. DFG will be assuming responsibility for enumerating fish at the SWP facility this next year. Improvements in procedures will be made in the future. Salvage data on Delta smelt from both facilities, including sampling methods, should be submitted during the forthcoming proceedings."

Page 7-13

Comment: SWC suggest change to the sentence addressing DFG investigations in 1991 (WQCP-SWC-631, Page 24, paragraph 3).

Response: The referenced sentence (first paragraph and sentence under Delta Smelt) will be reworded.

Change in text:
"In 1991, DFG should analyze existing data on environmental conditions, including reverse flows, affecting Delta smelt growth, survival, reproductive success and spatial distribution; ..."

Page 7-16, sec 7.4.3.2

Comment: USFWS states that biological models need to be addressed in this section as well (WQCP-USFWS-7, Page 7, paragraph 6).

Response: Text will be amended to include a section C. which will read as follows:

Change in text:
"C. Fishery Models
The following fishery models, in addition to any others that may be proposed, may be considered, as appropriate, in the impact analysis:

o Abundance and Survival of Delta Smolts in the Sacramento-San Joaquin Estuary by the USFWS.

The USFWS (since 1978) has annually conducted research on the survival and abundance of Chinook smolts and fry as they migrate down the Sacramento through the Estuary. The research has lead to the development of several different models, including: annual index of abundance of fall-run smolts; smolt survival based on adults returns 2 1/2 years later; and smolt survival index using flow, temperature, percent diverted at Walnut Grove, export rates and migration route variables. A San Joaquin River smolt survival index is being developed based on different release sites, various levels of inflow form the San Joaquin River, SWP and CVP export rates and ocean recoveries of adults.

o Chinook Salmon Population Model for the Sacramento River Basin by BioSystems Analysis, Inc.

This model estimates the abundance of fall-run Chinook salmon under a given set of flow and temperature conditions, mortality parameters, and assumptions about harvest in the ocean and river fisheries for the Sacramento River Basin. At present it serves as an indicator of the population trends as it has not yet been calibrated. Another version is presently being developed for winter-run Chinook salmon.

o Draft San Joaquin River System Chinook Salmon Population Model by EA Engineering, Science and Technology.

This is mechanistic simulation model representing the principle factors influencing the abundance and production of fall-run Chinook salmon in the San Joaquin River Basin."

Page 7-20, para. 1

Comment: DFG agrees with need to evaluate striped bass hatchery production, including rearing salvaged juvenile bass. Such an evaluation is presently underway. But it is premature to prejudge the merits of a 1,000,00 rearing goal, compared to other options, at this time. Request goal be deleted (WQCP-DFG-5,5).

Comment: (Page 1-18 also) - How was goal of 1,000,000 striped bass from growout facilities determined? May not be sufficient to restore the population (WQCP-USFWS-7,3).

Response: Agree.

Change in text:
The specific goal statement will be deleted.

Page 7-21

Comment: It should be made clear that the first paragraph refers to the Sacramento River Water Year Classification (WQCP-CVPWA-210,36-37).

Response: Agree.

Change in text:
Page 7-21, Section 7.5.3.1., para 1, and Page 1-15, Section 1.6, para 1, will be amended as follows: "The current <u>Sacramento River Basin Water Year Classification</u>..."

Page 7-21

Comment: The WQCP should state the acceptance of the sliding scale concept (WQCP-DWR-24,5).

Response: The Water Year Classification subworkgroup has unanimously accepted the concept of the sliding scale. To reflect this point, the statement in the WQCP, page 7-21, section 7.5.3.1; "DWR has proposed the addition of a sliding scale to the classification to smooth the transitions between categories.", will be changed.

Change in text:
"<u>The Water Year Classification subworkgroup has adopted, in concept</u>, the addition of a sliding scale to the classification to smooth the transitions between categories."

Page 7-22

Comment: Technical forum to discuss the Sacramento Four-Basin Index forecast process (WQCP-DWR-24,5).

Response: Page 7-22 of the WQCP states the need for this technical forum. Assumptions are a part of each years forecast. These assumptions may vary depending on the particular years hydrologic conditions. Each years assumptions should be explained in this forum. Also, the other part of the forecasting process that does not depend on assumptions should be explained and documented.

Change in text:
"DWR should convene a technical forum for interested parties for the purpose of providing the parties with the details of the methodology and assumptions used in the forecasting process. After this initial forum, additional meetings should be convened only when the methodology or the assumptions are changed."

SECTION II

Comments that Resulted in No Changes in Text of the Plan

General Comments

Flow

Comment: The State Board should have addressed flow and water project operations as well as water quality objectives in this Plan (WQCP-USMFS-1,1;WQCP-SCLDF-2,2).

Response: State Board review of the information submitted during Phase I and the Water Quality Phase of the proceedings indicated that specific salinity, temperature and dissolved oxygen levels could be determined which would provide protections to the beneficial uses addressed in the Plan. The appropriate place to provide this type of protection is a water quality control plan. However, water quantity issues, such as flow and project operations are more appropriately addressed in the portion of the proceedings leading to a water right decision. The State Board retains the option of setting flow objectives, if appropriate.

As previously stated the State Board will consider all information addressing flow and water project operations, and their relation to beneficial uses made of Bay-Delta waters during the Scoping and Water Right phases of the proceedings. In regard to water project operations the State Board will not be looking at the Central Valley Project (CVP) and State Water Project (SWP) solely. The State Board hopes to receive data which will allow it to address operations of all water projects including reservoirs larger than 100,000 acre-feet and direct water diversions of 100 cfs or greater. (The State Board will review smaller projects and their effects after completion of these proceedings, as data become available.)

The State Board believes that this Bay-Delta proceedings process should be a dynamic one. Thus, if, during the Scoping or Water Right phases of the proceedings, analysis of new information indicates that a water quality objective adopted during earlier phases of the proceedings may be inappropriate, the State Board can open a specific hearing to address that beneficial use. Similarly, a water right hearing can be opened if appropriate new data become available.

No change in text.

Negotiated Agreements

Comment: The State Board should not rely upon the use or the acceptability of negotiated agreements to protect beneficial uses adequately (WQCP-USNMFS-1,2;WQCP-USFWS-7,2).

Response: The State Board believes that beneficial use protections derived from negotiations must be considered by the State Board. The State Board will review the agreements thoroughly to make sure that the specific beneficial use(s) effected are protected and to determine that protection of beneficial uses potentially effected have not been compromised. The State Board does not intend to abrogate its responsibility.

No change in text.

Environmental Conditions

Comment: The Plan represents virtually no improvement in the environmental conditions of the Estuary over those in the 1978 Plan that the State Board admitted are inadequate (WQCP-SCLDF-1,2;EPA).

Response: Upon review of the data, the State Board found several aspects for which it could provide specific water quality protection including: expanding seasonal protection for striped bass, and temperature and dissolved oxygen protections for salmon in the Sacramento and San Joaquin rivers within the Delta area. Most of the information received by the State Board which indicated potential improvement in the protections to be afforded beneficial uses made of Bay-Delta waters addressed various flow conditions. As previously mentioned both flow and water project operations will be addressed during the Scoping and Water Right phases of the proceedings.

Comment: Issues were raised regarding Delta outflow in relation to entrapment zone location and phytoplankton blooms (WQCP-SCLDF-2,3).

Response: The Board has decided to take up these and other flow issues in the Scoping Phase of the proceedings. The State Board, however, does retain the option of setting flow objectives; if appropriate.

Comment: The State Board is recommended to direct staff to update and revise the technical portions of the Plan prior to commencement of the water rights phase of the proceedings (WQCP-WACOC-5,3).

Response: The State Board is always interested in using the most accurate and up-to-date information available. During the Scoping Phase, participants are encouraged to submit any information that they feel will be of use to the State Board in developing the environmental impact report (EIR) for the water right decision.

No change in text for all comments.

Operation Studies

Comment: The Prisoner's Point/Vernalis Striped Bass Spawning objective was only modeled when the standard was imposed at Vernalis (WQCP-DWR-24, on Chapter 6 of the Plan).

Response: Comment noted. See the response to WQCP-SWC-633 dealing with pages 6-2 and 6-14. [The reason for not modeling this objective and a qualitative analysis of the impact was deleted from earlier drafts.]

Comment: Suisun Marsh Wildlife standards are met only as per D-1485 interim standards in all operation studies. This needs to be made explicitly clear (WQCP-DWR-24, on Chapter 6 of the Plan).

Response: Comment noted. See the response to WQCP-SWC-633 dealing with pages 6-2 and 6-14. [This explanation was deleted from earlier drafts.]

Comment: Southern Delta agricultural objectives are modeled only at Vernalis, not at the proposed interior stations (WQCP-DWR-24).

Response: Comment noted. See the response to WQCP-SWC-633 dealing with pages 6-2 and 6-14. [This explanation was deleted from earlier drafts.]

No change in text.

Combined Effects

Comment: The plan does not analyze the impacts of its proposed actions on the estuary at the same time as evaluating the effect on water diversions. Consequently, the plan cannot inherently be considered to be a "balancing" of competing beneficial uses. The systematic analysis of the impact of any particular management program for the estuary requires examining the combined effect of all the overlapping flow and salinity requirements for the estuary on a particular component of the ecosystem (WQCP-SCLDF-2, on Chapter 6 of the Plan).

Response: The State Board has committed itself to an extensive evaluation of alternative management programs for the Estuary. Much analysis has been accomplished in the Plan and much more, the State Board recognizes, needs to be done in the Scoping and Water Right phases.

No change in text.

Striped Bass

Comment: The plan assumes, but does not require, maintenance of the 1978 Plan flow standards, which could lead to further ecosystem deterioration if these were modified in the future (WQCP-SCLDF-2,3).

Response: The D-1485 flow standards remain in effect until they are modified, if necessary, as part of a water right decision.

No change in text.

Comment: The Plan would not restore striped bass to historic levels, as accepted by the State Board in its restoration goal in 1978 (WQCP-SCLDF-2,3).

Response: We agree; however, in the limited scope of this plan, full restoration is not proposed. Even DFG has acknowledged that without flows and facilities, restoration to historic levels is impossible. The State Board will consider flow and facilities alternatives in the Scoping and Water Right phases. The State Board does retain the option of setting flow objectives, if appropriate.

No change in text.

Comment: The State Board rejected alternative sets of standards, including its own Alternative 5 originally recommended in 1988, which would restore striped bass and salmon to "historic" levels (WQCP-SCLDF-2,3).

Response: This alternative is beyond the scope of the present plan, because it includes flow requirements. This and other alternatives will be considered in the Scoping and Water Right phases.

No change in text.

Comment: The salinity standard proposed for striped bass spawning cannot be realistically evaluated, and is meaningless without accompanying flow and pumping standards to protect the young bass produced (WQCP-CWPC-1,10).

Response: We agree that because any salinity standard necessarily includes flow, the overall beneficial effects of salinity standards cannot be evaluated independent of possible related flow effects. However, the issue of spawning protection is separate from protection of eggs and young. The latter is a flow and diversions issue which will be dealt with in the Scoping and Water Right phases. The salinity objective for spawning is not meaningless, however. As proposed, protection would be provided for nearly all of the spawning period on the San Joaquin River independent of any umbrella protection, and slightly greater protection is provided in dry and critical years than is now the case under D-1485.

No change in text.

Comment: The present Plan is shifted toward protection of exports rather than protection of the Estuary, and continued imbalance can be expected in later phases of the hearings (CWPC - Fullerton Analysis, Page 6, para. 3).

Comment: The June 1990 Revised Draft Plan stated many strong commitments to protecting the aquatic environment. These have been in large part removed, and USFWS are concerned about the balancing process and criteria (WQCP-USFWS-7,1).

Response: The State Board revised the text to respond to concerns expressed by many participants that the previous draft was not appropriately balanced in its wording. All beneficial uses will be reasonably protected. It is inappropriate to prejudge at this time how the protection of beneficial uses will ultimately be balanced.

No change in text.

Comment: The use of the Sacramento River Basin Index may be appropriate, but if the system results in a shift towards a greater frequency of dry year occurrences, any adverse impacts on fish and wildlife must be identified and mitigated (WQCP-USFWS-7,1).

Response: The Sacramento River Basin Index more accurately reflects actual water conditions in the basin, which suggests that the pattern is slightly drier than previously believed. During the Scoping and Water Right phases, the State Board will consider deletion of two water year designations, the "subnormal snowmelt" and the "year following critical year", which presently reduce protection for fish and wildlife more than for other beneficial uses. If included in the final Sacramento River Basin Index, these changes will mitigate for the slightly higher incidence of dry years in the new Index.

No change in text.

Municipal and Industrial Water Quality Issues - Trihalomethanes

Comment: The water quality objectives for drinking water supplies proposed in the Plan may be adequate for the time being until the disinfection by-product and surface water treatment rules are effective. Water treatment technology is not the single answer to drinking water quality problems. Improvement of source water quality is essential (WQCP-SWC-632,3).

Comment: Implementation of objectives should not rely exclusively on water right modifications but should also include actions by other agencies, negotiated settlements, physical facilities and legislative action (WQCP-DWR-24,15-16).

Comment: Water at 250 mg/l chlorides does not provide adequate protection for M&I supplies. M&I water supplies cannot consistently meet current THM standards with a year round supply at 250 mg/l. The Scoping phase of the hearings should include careful examination of CCWD's proposal for a 50 mg/l chloride objective for portions of most years. The current Plan does not do this (WQCP-CCWD-21,2).

Comment: Agree that there is no cause to modify existing salinity (chloride) objectives for M&I. If drinking water standards are modified by EPA then it would be appropriate for the Board to consider new objectives as part of the triennial review process.

Strongly supports the Board's recommendation for a detailed study of agricultural discharges and development of best management practices to reduce impacts on Delta water quality and drinking supplies (WQCP,EPA).

Response To All Comments: Current text supports these comments.

No change in text.

Chinook-Temperature Objectives

Comment: DFG states that they recommend adoption of the proposed 68°F temperature objective although it is higher than optimum, because: 1) the existing temperature criterion in the Basin 5 Water Quality Control Plan; 2) the nature of the empirical evidence presented to the Board; and 3) many measures which could be implemented would lower temperatures in general rather than being targeted specifically for 68°F (WQCP-DFG-5; Page 2, paragraph 3).

Response: It would be extremely difficult, and probably not possible, to effectively or accurately control temperatures in the Delta, especially to within a range of a few degrees, given such a complex and dynamic system. A temperature value in a narrative objective provides slightly more guidance than would be available without that value. The intent of this value is to indicate a boundary by which to evaluate the relative health or quality of the Delta for fisheries habitat. (See discussion on reservoir releases to control Delta water temperatures.)

No change in text.

Comment: The Committee provides a summary of the changes in the temperature and dissolved oxygen objectives between the June 1990 and January 1991 draft Plans. It states that the 68°F objective is too high, that a more appropriate objective would have been a maximum of 63°F, and that the controllable factors language provides a huge "loophole". In addition, there is speculation that the SWRCB may intend to eliminate the salmon flow provisions of D-1485 in lieu of this temperature objective (WQCP-Committee for Water Policy Consensus, Page 5, paragraphs 1-3, concerning Pages 5-15, 5-20).

Response: Please see Specific Comments on pages 5-15 through 5-25 concerning Chinook-temperature objectives in response to comments in WQCP-EPA-1, Page 1; WQCP-SCLDF-1, Page 5; WQCP-CVPWA-210, page 23.

No change in text.

Municipal and Industrial Use

Comment: Objectives providing 150 mg/l Cl and better protection, including CCWD's proposed 50 mg/l objective for part of the year, should be addressed in the Scoping and Water Right phases (WQCP-CCWD-21,2).

Response: Comment noted.

No change in text.

Comment: Assessing water supply impacts should rely on both operation study results and an additional independent salinity analysis of the operations studies. The proposed Modeling development and Use group should resolve these issues (WQCP-CCWD-21,2).

Response: Comment noted.

No change in text.

Comment: The need for high water quality during times of uncontrolled flows should be addressed (WQCP-CCWD-21,2).

Response: With respect to chlorides, M&I supply is reasonably protected under all hydrologic conditions.

No change in text.

Water Quality Control Plan

Comment: The current 500 TDS Vernalis all-year standard should not be supplanted until all the downstream standards are fully implemented. The San Joaquin River Protection Act, at Water Code Sections 12230-12233 prohibits the Board from taking actions that would lead to further degradation of this reach of the San Joaquin River (WQCP-SWDA-36).

Response: Water Code Section 12232 provides that the Board shall do nothing, in connection with its responsibilities, to cause further significant degradation of the quality of water in the reach of the San Joaquin River between the Merced River and the Middle River. The 500 mg/l standard currently in force would be supplanted with the April through August 0.7 mmhos/cm EC standard and the September through March 1.0 mmhos/cm EC standard no later than 1994 when a new control station at Brandt Bridge, in addition to the Vernalis station, must meet this standard. By 1996 this standard must be met at all the control stations. This standard will provide better quality in the irrigation season and poorer quality in other parts of the year. This is the same long-term standard as in the 1978 Delta Plan. The Plan differs only in that it proposes to implement the standard regardless of whether there are circulation facilities. It is not a degradation.

No change in text.

Comment: The final water quality control plan represents virtually no improvement in the environmental conditions of the Estuary over the admittedly inadequate 1978 Plan (WQCP-SCLDF-1, Pages 2-3).

Response: The water quality control plan provides adequate protection against salinity, temperature and dissolved oxygen for the beneficial uses. The Plan provides at least as much protection for the beneficial uses with regard to salinity, temperature and dissolved oxygen as the 1978 Delta Plan. It does not change the flow standards; nor, contrary to the comment, does it allow any reduction in Delta outflow. Contrary to the comment, the Board has not found that the standards are unprotective. Any statements in unadopted drafts are not the Board's position unless they are adopted in this Plan. While the Board recognizes the importance of flows in protecting beneficial uses, it believes that the proper context in which to consider new flow objectives is in a water right proceeding. In the upcoming water right proceeding, the State Board retains the option of setting flow objectives to protect the beneficial uses.

No change in text.

Comment: The final water quality control plan violates the Porter-Cologne Act and the Clean Water Act, as follows: (a) it does not identify all beneficial uses which could recover through flow augmentation and pollution abatement; (b) the Plan fails to identify water quality objectives for all existing and potential beneficial uses; (c) the Plan fails to establish a program of implementation for beneficial uses; (d) the Plan fails to describe and regulate the flow of water; (e) the Plan generally fails to protect instream beneficial uses (WQCP-SCLDF-1, Pages 4-5).

Response: This response addresses the alleged individual violations in order.

(a) The Plan identifies all of the existing beneficial uses by listing the same uses which are listed in the water quality control plans for the San Francisco Bay Region and for the Central Valley Region. The Plan supplements protections in the plans for the two regions for all of these beneficial uses, to the extent that they require additional protection with regard to the parameters of salinity, dissolved oxygen, and temperature. The Plan does not violate the applicable requirements for identification of beneficial uses.

(b) This Plan is only one component of the water quality planning for the Estuary. Water quality objectives for all of the identified beneficial uses are not established in this Plan for two general reasons: first, the Plan protects only with regard to the three parameters, and leaves the balance of required protections to the Regional Board plans; second, the Board can provide protection only insofar as it knows what protection is needed.

The commenter misconstrues the deletion of the "antidegradation" standards since the previous draft. Rather than revising the Suisun Marsh standards and adding the old standards back as "antidegradation" standards, the Board will keep the standards that have been in effect until such time as it decides whether to replace them with different objectives in a future plan and water right decision.

The commenter also suggests that the Board should provide objectives for South San Francisco Bay, to reduce the concentration of toxic pollutants. The Board disagrees. Development of objectives for toxic pollutants remains assigned to the San Francisco Bay Regional Water Quality Control Board. This Plan is an adjunct to the Basin Plan for the San Francisco Bay Region; it does not supplant the Basin Plan. The Basin Plan contains objectives for toxic pollutants; such objectives are not within the scope of this Plan.

Further, the Board has no basis for requiring objectives to dilute pollutants in the South Bay. The Board's regulation at 14 CCR Section 780(b)(1) provides that the Board shall not modify a permit or license to meet water quality objectives in water quality control plans unless the Board finds that adequate waste discharge requirements have been prescribed and are in effect with respect to the discharges which have a substantial effect on the water quality, and that the water quality objectives cannot be achieved solely through the control of waste discharges. No such finding can be made. Further, EPA's regulation at 40 CFR 131.10(a) provides that waste assimilation shall not be a designated use of water.

The commenter also argues that subjecting the temperature objectives to controllable factors is inappropriate and should apply only to implementation. Water temperature is influenced by natural variations in ambient temperature and precipitation, as well as man's activities. On some hot days no amount of cold water nor any other measures could achieve temperature requirements in a reach. Further, to release large amounts of water to cool the Delta could under some circumstances be considered unreasonable. Without the "controllable factors" requirement to establish the times when the objective is in effect, the objective could not always be achieved; objectives should be achievable. See Water Code Section 13241(c). The Board will continue to subject the temperature objectives to "controllable factors."

(c) As the commenter notes, adequate implementation is required by the Clean Water Act, at 33 USCA Section 1313(e)(3)(F), for revised or new water quality standards. Only three standards are added or revised in the Plan, for Chinook salmon temperature, Chinook salmon dissolved oxygen, and export agriculture. Therefore, only three changes in implementation measures are required. The existing implementation measures in the 1978 Delta Plan remain in effect where they are not changed. Three new implementation measures are detailed in the Plan: one is added for implementation of the southern Delta agricultural standards even though the standards are unchanged; implementation is added for the Chinook salmon temperature standard, which will be met by controlling controllable factors that affect water temperature; implementation is added for the new export agriculture standard and for other beneficial uses as well, in the form of a salt load reduction policy to be prepared by the Central Valley Regional Board.

An additional implementation measure is added elsewhere in these responses, for the dissolved oxygen standard for Chinook salmon.

In addition, paragraph 7.2.2.3 is revised elsewhere in these responses, to provide additional explanation of the implementation measures that may be used to meet the temperature requirement for Chinook salmon.

(d) The Plan does not have to revise or add new objectives for flow. Because flow requirements directly affect the exercise of water rights, the final establishment of such requirements must be done in a water right proceeding. Flow plays two distinct roles in protection of the Estuary's water. It is important in this water quality control plan because it is a measure which may be used to implement the water quality objectives. It has in addition a separate role in protecting the Estuary's beneficial uses, because it represents the movement of a volume of water. This second role is not a subject of water quality objectives. While a water quality control plan is not precluded from discussing flows that would protect beneficial uses other than by implementing a level of water quality, such a discussion is not required in a water quality control plan.

The commenter is confusing these two roles of flow. As a result, the commenter thinks that the location of the entrapment zone is a quality issue. In fact, the quality of the entrapment zone would be about the same wherever it was located, so a specific flow is not needed to implement the quality of the entrapment zone. While the volume of moving water can determine its location in the Estuary, it does not affect the quality.

(e) The Board disagrees with the commenter's assertion that the Plan is based on protection of water rights and not protection of water quality. The Plan is developed to protect salinity, temperature, and dissolved oxygen parameters of water quality.

No change in text.

Comment: The final water quality plan violates the California Environmental Quality Act.(WQCP-SCLDF-1, Pages 7 to the top of page 9).

Response: This comment makes several assertions: (a) that the range of alternatives is not adequate; (b)that the Plan does not adopt mitigation measures to avoid adverse effects of water export; (c) that the Plan incorrectly states in the environmental checklist that the Plan will have no adverse environmental impacts. These are discussed individually below.

(a) The Board has listed seven alternatives, ranging from the base conditions in the current water quality control plan through an alternative that would provide much better protection than the preferred alternative. SCLDF's comments apparently contemplate a broader scope than the Plan has, and correspondingly request a broader environmental analysis. While one can always imagine more alternatives, the law does not require consideration of alternatives that are infeasible or impossible to achieve. The Plan considers all beneficial uses within the limited scope of the Plan, which is narrow. The Plan is an adjunct to other plans, not the whole of water quality planning for the Estuary. Flow issues and alternatives will be fully evaluated during the Scoping and Water Right phases of the proceedings.

(b) As explained below, the Board disagrees with Sierra Club's assertion that there are adverse impacts as a result of adoption of this Plan. Because there are no adverse effects, no mitigation measures are required. While future actions to adopt implementation measures suggested by this Plan may have adverse environmental effects, it is too speculative what those effects may be, and until the actual measures are up for consideration, it is premature to adopt mitigation measures for them.

(c) Sierra Club is incorrect that the Plan will have an adverse effect on the environment, for two reasons: first, the Plan sets objectives which provide for water quality and beneficial use protection which is equal to or better than the current conditions in the Estuary; second, even though one can speculate that some possible future actions might have an adverse effect, implementation of the Plan itself will not result in adverse effects compared with current conditions. CEQA does not consider an action to have an adverse effect unless, compared with <u>current</u> conditions, the effect is adverse. The commenter apparently wants the Board to <u>improve</u> water quality in the Estuary over current conditions. The "admissions" to which the Sierra Club refers do not refer to the matters decided in this Plan, but to other proposals and possible future actions. Because there are no adverse effects of <u>this</u> action, no mitigation measures are required.

Comment: The Plan violates California's antidegradation policy, because it doesn't propose flow standards (WQCP-SCLDF-1, page 9, point IV.).

Response: The absence of new flow objectives in the Plan is not a degradation, since the Board is leaving in place for now the flow standards in the 1978 Delta Plan.

No change in text.

Comment: The Board's plan approval process denied the public a fair hearing, because of ex parte contacts (WQCP-SCLDF-1, Page 9, point V).

Response: Copies of some preliminary drafts were circulated during the fall of 1990 to parties in all representative categories of interest for comment. The preliminary drafts were public documents when they were circulated. The Board is unaware of any bias, since it took into account all interests in preparing its next full draft. The next full draft, released in January 1991 was provided to all parties for comment, and the Board held a hearing on it, on March 11, 1991. Thus, the parties had a full opportunity to review the changes since the June 1990 draft and comment on them before Board action.

No change in text.

Comment: The Board failed to follow the rule-making procedures outlined in the Administrative Procedure Act (WQCP-SCLDF-1, Page 9, point VI).

Response: The adoption of a water quality control plan is not subject to the rulemaking procedures in the Administrative Procedures Act. Rather, it is subject to the procedural requirements of the Water Code.

No change in text.

Specific Comments

Chapter 1

Page 1-2, fifth paragraph

Comment: As a minimum, the water quality objectives for M&I relative to the DBP regulations will be reexamined at the triennial review, or before, if EPA proposes revised regulations (WQCP-SWC-632,1-7).

Response: Current Plan language is satisfactory. Recommended new language is too specific and is out of context with the rest of the section.

No change in text.

Page 1-4, "Fish vs. People"

Comment: There are laws and court decisions concerning the standing of fish and wildlife values in "balancing" beneficial use protections (WQCP-DFG-5,3; WQCP-NMFS-1,1).

Response: Comment noted.

No change in text.

Page 1-9; Page 3-10, Section 3.2.1.4; Page 6-9, Section 6.2.1B; and Appendix, Page 3.1-10

Comment: There is an inconsistency in the WQCP regarding the need for a subnormal snowmelt adjustment (WQCP-CVPWA-210,2).

Response: Though the current subnormal snowmelt adjustment is not recommended, it was kept in the Impact Analysis to artificially neutralize the impact of the new classification on the SWP of flow objectives. This was done because flow objectives, and the flow relaxations tied to the water year classification are issues that will be addressed in the Scoping and Water Right phases. As new information becomes available, the subnormal snowmelt adjustment will be reviewed as appropriate.

No change in text.

Page 1-10, second bullet from bottom of page

Comment: A comment concerning water conservation by Imperial Irrigation District (WQCP-SWC-633,3-4).

Response: Comment noted.

No change in text.

Page 1-11; second bullet; p.5-3; first bullet under 5.1:

Comment: The 250 mg/l chloride standard is for taste only and not for corrosion as indicated in the Plan (WQCP-SWC-632,7-14) .

Response: Comments noted.

No change in text.

Page 1-11; fourth bullet; p.5-4, last sentence

Comment: The language in these sections should be revised to state that current drinking water violations are occurring as a result of Delta-based supplies, and that as a result of the Surface Water Treatment Rule becoming effective in 1993, many more water suppliers will exceed the existing standard (WQCP-SWC-632,7-14).

Response: Violations of current drinking water standards occur infrequently, certainly not on a consistent basis. The net effect of the surface water treatment rule regarding production of Disinfection by-products (DBPs) is very dependent upon the operating procedures of individual systems. Therefore, it cannot be factually stated that the new rule <u>will</u> result in an increased production of DBPs. Therefore, the language should not be revised.

No change in text.

Page 1-12

Comment: The Tracy area in the south Delta is served by the CVP via the Bureau's Tracy export pumps. This location has a lower quality objective in the summer than the south Delta. Because of a lower rainfall in the Tracy area than in the rest of the south Delta, the CVP export pumps could arguably have a higher quality objective than the rest of the south Delta (WQCP-USBR-129B,1; WQCP-SDWA-36,1).

Response: The effect of rainfall will be addressed in the proposed South Delta Agriculture Study. Proposed interior stations are intended to protect all of the south Delta including the Bureau's Tracy export pumps. South Delta and export agriculture protections overlap at the Tracy export pumps.

No change in text.

Page 1-12; Page 5-12, Sections 5.3.2.1 and 2

Comment: Board staff analysis indicates that 1.5 mmhos/cm EC requires only one additional period of leaching during a 57-year period. Based on this analysis 1.5 mmhos/cm EC is reasonable and should be set for the protection of western and interior Delta agriculture prior to receiving an economic analysis of the costs of leaching (WQCP-DWR-24,8; WQCP-SWC-630,2; WQCP-SWC-633,4 & 7; WQCP-CVPWA-210,2-3).

Comment: 1.5 mmhos/cm EC is not reasonable protection for western and interior Delta agriculture as it is based on receiving "umbrella" protection (CDWA -Testimony).

Response: The Board staff analysis indicated one to two additional periods of leaching during a similar hydrologic period that occurred between 1922 and 1978, with a current level of development, current facilities, and the balance of D-1485 standards. The hydrology, development, facilities, and standards all provide a certain level of "umbrella protection", additional protection not provided by the objective. If any of these change, the "umbrella protection" and therefore the leaching frequency will change. The Board cannot base protection of a beneficial use on an unsubstantial "umbrella protection", but must provide protection that will be sufficient irregardless of other circumstances.

No change in text.

Page 1-13, 5-15

Comment: CVPWA agrees with the exclusion of reservoir releases from controllable factors; and CVPWA and SWC state that it is unclear what the time period is for measuring the temperature objective (WQCP-CVPWA-210, Page 4, paragraph 1, WQCP-CVPWA-210, Page 11, last paragraph-Page 12, 3rd paragraph; WQCP-SWC-631, Page 4, last two paragraphs).

Response: Please see response to USBR comments in GENERAL COMMENTS, Chinook-Temperature Objectives which includes changes in the text.

The time period for measuring the temperature objective is one day as it is the mean of multiple measurements within each day during the months specified. Remainder of comment considered.

No change in text.

Page 1-13

Comment: DWR notes that the clause excluding reservoir releases from controllable factors should be included in the footnotes in the two referenced tables (Table 1-1; Table 6-3;) (WQCP-DWR-25, Page 4, 3rd paragraph; WQCP-USBR-129B, Page 1, paragraph 3).

Response: Please see response to USBR comments in GENERAL COMMENTS, Chinook-Temperature Objectives which includes changes in the text.

Change in text.

Page 1-13

Comment: SWC agrees with the exclusion of reservoir releases as a means to control temperatures however the text implies that reservoir releases would be a "controllable factor" if not specifically excluded. Suggested revision of wording is provided (WQCP-SWC-631, Page 2, first paragraph).

Response: At present it appears unreasonable to meet the temperature objectives with reservoir releases. Studies do need to be conducted and additional evidence presented on the feasibility of using reservoir releases to achieve decreases in temperatures in the Estuary especially in the spring and fall months. The State Board welcomes any input regarding the appropriateness of using reservoir releases and any other controllable factors during certain times of the year during certain water years to improve conditions for salmon in the Delta.

We don't understand the statement that EPA interprets a statement to mean that all measures available to control pollutants and protect designated uses should be considered in the state's implementation plans for these standards.

No change in the text.

Page 1-16 fourth bullet; p.7-16, Section 7.4.3.2 Modelling Needs:

Comment: A model to be developed should investigate the formation of THM and other DBP precursors in the Delta (WQCP;SWC-632,7-14).

Response: Comment noted.

No change in text.

Page 1-18

Comment: Support concept of additional water project operation tests. Question of how substantial tests will be; could they include spring-time export curtailments? (WQCP-USFWS-7, Page 3, para. 10).

Response: The details of particular test criteria should be developed through the IESP. Spring curtailment experiments are certainly important to consider.

No change in text.

Chapter 2

Page 2-2, Section 2.2 Scope and Purpose of the Plan, second bullet

Comment: Questions were raised about the Board's use of a substitute document for an environmental impact report (WQCP-WACOC-5,2).

Response: The water quality planning process is a certified program under the California Environmental Quality Act (CEQA) Guidelines Section 15251(g).

No change in text.

Page 2-2; Fourth paragraph:

Comment: The sentence needs to be strengthened to reflect the need to review the Plan so as to incorporate changes in the Disinfection By-Product Regulations. Language is provided for the recommended change (WQCP-SWC-632,1-7).

Response: It is already stated that the Plan shall undergo a triennial review or sooner if needed. Additional specific revision is not necessary.

No change in text.

Chapter 3

Page 3-7, Section 3.2.1.1

Comment: Expand the explanation of the regression analysis (WQCP-CVPWA-210,7).

Response: An expanded explanation is contained in Appendix 3.1.

No change in text.

Page 3-8

Comment: The preliminary nature of the San Joaquin River Basin Classification Index should be emphasized in the WQCP (WQCP-CVPWA-210,7).

Response: There is no proposal for a San Joaquin River Basin Classification Index, just an example of a possible alternative.

No change in text.

Page 3-8, Section 3.2.1.2

Comment: The San Joaquin River Basin Water Year Classification must account for the out-of-basin diversions of water by the Hetch Hetchy and Friant-Kern Projects (WQCP-MID/TID-9,3-4).

Response: Comment noted. This issues will be addressed in the San Joaquin Water Year Classification subworkgroup.

No change in text.

Page 3-10, Section 3.2.1.5

Comment: Table 3-2 is not included in the WQCP (WQCP-CVPWA-210,8).

Response: Comment noted.

Table will be included in the final Plan.

Chapter 4

Page 5-1, last paragraph (concerning page 4-1 in the Plan.)

Comment: The comment states, "[w]e agree with the Plan that 'estuarine habitat' should not be designated as a beneficial use" (see WQCP-SWC-633, p.6).

Response: The Plan does not make that statement. "Estuarine Habitat" is a designated beneficial use of the Bay-Delta Estuary (WQCP, p.4-1).

No change in text.

Chapter 5

General Comment: Questions were raised about the relative lengths of the discussions of the various beneficial uses, with the implication that length of section equated with importance of beneficial use (WQCP-WACOC-5,3).

Response: The length of discussion for each beneficial use or component thereof is related to the complexity of the particular issue and to the volume of evidence submitted. Increasing the length of a technical discussion without need is a waste of resources. The Scoping Phase is specifically intended to provide a forum for discussion of specific implementation measures. As such, an isolated facility will be looked at as one possible way to obtain better quality water for municipal and industrial supplies. The water quality control plan is not the State Board's dedicated arena for a detailed analysis of any physical facilities.

No change in text.

Page 5-1

Comment: Statement is misleading in talking about various influences on beneficial uses, including commercial and sports fishing, while not mentioning export pumping, because focuses on the least of the concerns. Entire paragraph is inappropriate for discussion on water quality objectives. (WQCP-USFWS-7,4).

Response: Comment noted. Issues such as the importance of export pumping are discussed elsewhere in the Plan.

No change in text.

Page 5-1, last paragraph

Comment: The comment states, "[w]e agree with the Plan that 'estuarine habitat' should not be designated as a beneficial use" (WQCP-SWC-633, p.6).

Response: The Plan does not make that statement. "Estuarine Habitat" is a designated beneficial use of the Bay-Delta Estuary (See the Plan, p. 4-1).

No change in text.

Page 5-2, Section 5.0.3

Comment: The use of the D-1485 water quality standards as the "no project" alternative was questioned (WQCP-DFG-5,; WQCP-NMFS-1,1-2). Both agencies want the Board to use the "historical without-project conditions for the CVP and the SWP and any other projects included in the water rights decision" (WQCP-NMFS-1).

Response: The Board has decided that the D-1485 standards, as amended, form an adequate base condition for this Plan. Furthermore, the Board, having heard all the evidence, believes that flow conditions are the primary factors needed for protection of the fish and wildlife beneficial use; these conditions will be considered in the upcoming phases of the proceedings. The State Board retains the option of setting flow objectives, if appropriate.

No change in text.

Municipal and Industrial

Page 5-3, Section 5.1

Comment: 250 mg/l Cl does/does not provide adequate protection for M&I supplies, while 150 mg/l Cl for industry is/is not reasonable (WQCP-CCWD-21,2 (against 250 mg/l Cl, for 150 mg/l Cl); WQCP-MID/TID-9,1; WQCP-USBR-129A,1; WQCP-SWC-633,6; WQCP-CVPWA-210,8 (for 250 mg/l Cl, against 150 mg/l Cl).

Response: The WQCP states that a level of 250 mg/l Cl sufficiently protects municipal use for aesthetics and corrosion as set by the Department of Health Services. Consumer acceptance is accounted for in the consideration of aesthetics and corrosion. Industry is protected in the WQCP at a level of 150 mg/l Cl, not 250 mg/l Cl. The extent of the industrial beneficial use is two paper industries within the Bay-Delta Estuary boundaries. Testimony was presented on these industries requirements. Evidence submitted by DWR and CCWD conflict as to the significance of the amount of water required to meet this objective. Public health concerns are discussed in the section on Trihalomethanes.

No change in text.

Page 5-3, Section 5.1

Comment: Relocation of the CCWD's Rock Slough Intake will also result in a need to reevaluate the appropriateness of this objective (WQCP-CVPWA-210,8).

Response: Comment noted.

No change in text.

Page 5-3 second bullet last sentence

Comment: The paragraph should be changed to reflect future conditions. Also, adverse human health effects cannot be substantiated. Proposed language is provided (WQCP-SWC-632,1-7).

Response: Agree with the proposed wording to revise the sentence concerning adverse human health effects. However, disagree with the remainder of the proposed wording. It is not certain that should DBP regulations be changed, they will be more strict. EPA and DHS have confirmed this.

No change in text.

Page 5-4, Section 5.1.3

Comment: Additional M&I control points are needed in Old River and in Cache Slough to help allocate responsibility for meeting M&I objectives (WQCP-DWR-24,6).

Response: Allocation of responsibility for meeting water quality objectives will be addressed in the Scoping and Water Right phases of the proceedings. Additionally, the subject area to address this issue is more appropriately, agricultural drainage reduction, not M&I beneficial uses.

No change in text.

Page 5-5, Section 5.2.1

Comment: Revise language to state that Total Organic Carbon (TOC) is a consistent predictor of THMFP in Delta waters (WQCP-SWC-632,7-14).

Response: According to Hutton, when referencing Jung, DOC (Dissolved Organic Carbon), a component of TOC, is not a consistent predictor of THMFP in Delta waters (Hutton, P. "Trihalomethane Formation Potential in the Sacramento-San Joaquin Delta: A Mathematical Model, California Department of Water Resources Draft Report, Jan. 1991, p.5: Jung, M. "Delta Island Drainage Investigation Report" California Department of Water Resources Final Report, June 1990, p.93).

No change in text.

Page 5-5; Last paragraph; Page 5-6, following the third paragraph:

Comment: Revise language to indicate that the latest data suggests that bromodichloromethane may be the THM of highest toxicological concern and if individual THM's are regulated, users of Delta water could be significantly impacted by sea water intrusion (WQCP-SWC-632,7-14).

Response: Such language is speculative. According to EPA, not much toxicological data exists for brominated compounds. Therefore, it is likely that the first set of rules will not key in on brominated compounds (Contact Report dated March 15, 1991 re. conversation between Leo Winternitz, SWRCB; Bruce Macler, EPA; and Alexis Milea, DHS).

No change in text.

Page 5-6; first paragraph:

Comment: Revise first sentence to state that D-1485 did not include any water quality objectives for THM's because the THM standard was not adopted until 1979, one year after adoption of D-1485 (WQCP-SWC-632,7-14).

Response: Agreed

D-1485 did not include any water quality objective for THM's because the trihalomethane standard was not adopted until 1979, one year after the adoption of D-1485. It was concluded, during the 1984 Trienniel Review, that, for public health reasons, protection from THMs in water from the Delta is more properly addressed through the use of alternate water treatment techniques or relocation of problem intakes rather than through the setting of more stringent salinity or TOC objectives.

No change in text.

Agriculture

Page 5-8

Comment: Protection for western and interior Delta agriculture should be based only on corn (WQCP-DWR-24,8).

Response: The WQCP states that the western and interior Delta "...water quality objectives were developed using corn as the representative crop". Central Delta Water Agency has requested protection for crops other than corn outside of the corn growing season. This is a reasonable request that will be addressed in the Scoping and Water Right phases.

No change in text.

Pages 5-9 and 1-12

Comment: In lieu of the proposed interior South Delta objectives the Board should adopt the Framework Agreement between the SDWA, DWR, and USBR (WQCP-CVPWA-210,3; WQCP-SWC-630,3-4).

Comment: The Board should insert into the WQCP a statement that if the agreement is not fully approved and executed by the end of the Water Right phase of these proceedings, the Board will reopen the WQCP to consider adoption of additional objectives (WQCP-SWC-630,3-4).

Comment: The Board should wait for the completion of agreements between the parties before adopting objectives for southern Delta agriculture (WQCP-USBR-129A,2).

Response: This would not expedite the negotiations. Also, it would not sufficiently guarantee protection of south Delta agriculture given the history of delays in setting objectives. If new information becomes available, page 7-10, section 7.4.2.2, "Southern Delta Agriculture", of the WQCP, indicates that the south Delta objectives could be reviewed and if warranted changed in the next Triennial Review.

No change in text.

Page 5-9, Section 5.3

Comment: More information needs to be developed concerning crop sensitivity to salinity during early stages of growth, potential leaching fractions, effectiveness of rainfall and timing of objectives for crops other than alfalfa. If such information warrants, then the objectives should be modified (WQCP-USBR-129B,1).

Response: It is agreed that this information is needed. This information is described on page 7-10, section 7.4.2.2.

No change in text.

Pages 5-10, and 5-12, and Table 5-5

Comment: Threemile Slough should be established as an alternative control point to Emmaton, to become effective when the Contract between DWR and the North Delta Water Agency has been fully implemented (WQCP-DWR-24,10).

Response: Western and interior agriculture objectives have not been changed in the WQCP. Location of objective stations will be addressed along with leaching and economic information at a later date.

No change in text.

Page 5-12

Comment: The WQCP's agricultural objectives for the interior south Delta conflicts with the statement that care should be given "so as not to undermine negotiations but to bring the negotiations to a timely and fruitful conclusion", and is contrary to the intent of the negotiated contract. With the contract in place, the water quality objectives should only apply to the station at Vernalis (WQCP-DWR-24,7; WQCP-SWC-630,3).

Response: Page 5-12, Section 5.3.2.3, and Page 5-13, Section 5.3.3.2, "Southern Delta", sufficiently address the relationship between the negotiations and the WQCP. Page 5-13, of the WQCP states "...(any) agreement affecting south Delta water quality will be fully reviewed by the State Board prior to implementation of the final stage. The objectives and locations at that time may be revised as the State Board deems appropriate." This statement allows the Board the needed flexibility to protect south Delta agriculture should the negotiations fail, while additionally not giving advantage to any negotiating party. Further details of the negotiations are unnecessary to the WQCP.

No change in text.

Page 5-13 (Table 5-5)

Comment: South Delta agriculture objectives should be maintained on a 14-day running average instead of a 30-day monthly average. More stations need to be monitored in the south Delta (WQCP-SDWA-36,1).

Response: Protection for south Delta agriculture is accomplished by phasing in the 1978 WQCP objectives, while giving regard to the South Delta negotiations. Variations to the 1978 WQCP objectives will be addressed when either or both the negotiations or the South Delta Agriculture Study have been finished.

No change in text.

Fish and Wildlife

Page 5-14,Section 5.4, Para. 1

Comment: The USFWS points out that the referenced Conclusion states that there is insufficient information in the record to set specific salinity and temperature objectives for the protection of Delta smelt. USFWS states there is information on the range of temperature and salinity tolerances for Delta smelt, the general habitat type inhabited by Delta smelt in the Estuary, and the strong association of Delta smelt abundance with high phytoplankton and zooplankton productivity when the entrapment zone was situated in the Suisun Bay. In addition, in 1990, the USFWS was petitioned to list the Delta smelt as endangered (WQCP-USFWS-7,4 & 5).

Response: For the most part, all of this information is included in the sections of the Plan (Pages 5-38 through 5-42) and the Technical Appendix (Pages 4-27, 4-28) addressing Delta smelt. This information is general, and without additional information, it would be difficult to state that the Delta smelt would be protected by establishing any particular EC objective at a specific station during a specific portion of the year. The location of the entrapment zone in the vicinity of Suisun Bay does appear to be associated with subsequent relative abundance of Delta smelt. The issue of the entrapment zone will be addressed in subsequent proceedings.

No change in text.

Page 5-15

Comment: Other comments from the same exhibits are on details of the discussion (WQCP-SWC-631,3-4; WQCP-CVPWA-210,11).

Response: Since the Board has decided that "...the location of the entrapment zone in Suisun Bay is related primarily to the freshwater outflow," they "...will defer consideration of this issue to the Scoping and Water Right Phases of the proceedings" (page 5-15). The State Board does, however, retain the option of setting objectives, if appropriate. Participants are encouraged to submit data on this and related subjects during the upcoming phases.

No change in text.

Page 5-15

Comment: SWC comments that the role of salmon fry rearing in the Delta has not been documented. The survival rate and contribution of fry rearing (compared to smolt rearing) in the Delta to adult stock should be examined and documented as part of the ongoing fishery investigation program (WQCP-SWC-631, Page 4, Chinook salmon section).

Response: We agree that the contribution of fry rearing in the Delta to the adult stock is not well documented; however, it is documented by USFWS that considerable numbers of fry are present in the Delta, especially during the years of high inflow (USFWS, 31,82-92). The relative contribution of those fry to the adult stock may well reflect the quality of the

Page 5-16, para. 6

Comment: SWC suggests removing the references to the San Joaquin River when stating that the natural population of Chinook salmon is declining and refers to the reference USFWS,31,58 (WQCP-SWC-361,6).

Response: The reference to (USFWS,31,58) will be changed to (DFG,15,Appendix 1) in the first sentence of the 4th paragraph on Page 5-16. This references a table which contains the data demonstrating that San Joaquin River tributary Chinook salmon stocks as well as Sacramento River stocks have declined since the beginning of the period of record in 1953.

No change in text.

Page 5-16 to 5-19, para. 6

Comment: CVPWA suggests revision to referenced paragraph based on the assumption that the paragraph is intended to conclude that salinity is not a factor affecting Chinook salmon during their migration through the Delta (WQCP-CVPWA-210,14).

Response: The assumption that this paragraph is intended to make or support this conclusion is incorrect. In fact it was to provide an indication of the information that is known regarding smolt survival during their emigration through San Francisco Bay.

No change in text.

Page 5-17,para. 6

Comment: SWC suggests deleting the reference to the naturally produced fish in the sentence referring to the increased survival rates of those hatchery fish trucked around the Delta (WQCP-SWC-361,6).

Response: Survival rates of juvenile wild fish migrating downstream and through the Delta is assumed to be somewhat the same as that of hatchery fish because they are exposed to the same environmental conditions, travel the same migratory pathways and are exposed to the same diversions as the hatchery fish. The publication, USFWS (1990), Abundance and Survival of Juvenile Chinook Salmon in the Sacramento-San Joaquin Estuary, states that the survival rates of "wild" fish are correlated with temperatures at Freeport as are the survival rates of the hatchery fish.

No change in text.

fishery habitat in the Delta. Fry rearing in the Delta may well warrant further investigation, however that does not warrant the removal of the reference to fry rearing from the text.

No change in text.

Page 5-15

Comment: SWC suggests additional wording supporting the conclusion that upstream reservoirs can not reasonably control water temperatures in the Delta; CVPWA agrees (WQCP-SWC-631,5,11,12; WQCP-CVPWA-210,4,11).

Response: Please see response to USBR comments in GENERAL COMMENTS, Chinook-Temperature Objectives which includes changes in the text (pages, I-6 and I-7).

No change in text.

Page 5-16, para. 5

Comment: CVPWA comment includes: 1) suggested revisions to the sentence regarding San Joaquin River flow at Vernalis and salmon escapement two and one half years later; and 2) suggested modification of portion discussing trucking of fish (WQCP-CVPWA-210,13).

Response: 1) Referenced sentence will read as follows: San Joaquin River flow at Vernalis during April through June has been identified as a major factor affecting smolt survival; and mean flows during these months is correlated to subsequent adult escapement of hatchery and naturally produced Chinook salmon two and one-half years later (T,XXXVI,139:17-22).

Comment considered.

No change in text.

Page 5-16, para. 6

Comment: SWC suggests that the correlation between adult escapement and flow may be the result of an autocorrelation between hydrologic conditions and other environmental variables such as water temperature which may be influencing salmon smolt survival and SWC provides a suggested revision (WQCP-SWC-361,6).

Response: Comment noted; however, the sentence came from testimony during a hearing and therefore cannot be changed.

No change in text.

Page 5-17

Comment: The comment states that Figure 5-1 should be clearly labeled to indicate 2 1/2 years lag time (WQCP-SWC-361,6).

Response: The figure is adequately labeled, however it will be updated as time permits.

No change to Figure 5-1.

Page 5-18

Comment: SWC suggests relabeling and updating Figure 5-2 (WQCP-SWC-361,6).

Response: This figure will be updated as time permits.

No change to Figure 5-2 at present.

Page 5-19, para. 1

Comment: CVPWA suggests revision to paragraph addressing factors that influence water temperatures (WQCP-CVPWA-210,14).

Response: The suggestions do not clarify the intent or meaning of the text.

No change in text.

Page 5-19 para. 2

Comment: SWC provides a suggested revision of a sentence addressing the Upper Sacramento River Fisheries and Riparian Habitat Management Plan (WQCP-SWC-361,7).

Response: The revised wording does not clarify the meaning of the sentence and the list of issues was not meant to be inclusive.

No change in text.

Page 5-19, para 3

Comment: SWC suggests deleting the reference to the Delta in the sentence discussing water temperatures because "concerns have focused primarily on areas such as Freeport on the Sacramento River..." (WQCP-SWC-361,7).

Response: Freeport and Vernalis are within the legal boundary of the Delta and therefore the reference to the Delta is appropriate.

No change in text.

Page 5-19

Comment: SWC states that lethal water temperatures in the Delta have not been substantiated for juvenile salmon in the Delta and therefore the word lethal should be deleted and replaced with the word stressful (WQCP-SWC-361,7).

Response: WQCP-SWC-605, Page 3, states that the upper lethal temperature for juvenile chinook salmon was determined by Brett to be above 77°F (25°C) for acclimation at or above 59 °F. In some years, temperatures above 25°C occur at Freeport and Vernalis, within the Delta (USGS temperature monitoring data), during the times of the year when juvenile salmon may be present.

No change in text.

Page 5-19, para 3

Comment: SWC comments refer to the sentence regarding "pulse flows" (WQCP-SWC-361,7).

Response: The statement that increased flows could have an affect on water temperatures is consistent with the evidence presented by several parties.

No change in text.

Page 5-19

Comment: CVPWA states that there are no winter-run Chinook in the San Joaquin River (WQCP-CVPWA-210,16).

Response: USFWS notes that winter-run have been observed in the Calaveras River (WQCP-USFWS-7,7).

No change in text.

Page 5-20

Comment: SWC suggest revision of the wording regarding cool river temperatures as benefitting the fall and winter runs (WQCP-SWC-361,8).

Response: The proposed wording confuses the timing and presence of the two runs during the spring and early summer.

No change in text.

Page 5-20, last para.

Comment: SWC comments are in regard to water temperature conditions in the Delta as opposed to Freeport (WQCP-SWC-361,8).

Response: Please see above comments regarding legal boundary of the Delta and the USGS temperature monitoring data.

No change in text.

Page 5-20

Comment: SWC comments on Figure 5-3 and the use of the USFWS survival index as opposed to survival rates (WQCP-SWC-361,8).

Response: This sentence refers to Figure 4-4 (USFWS,31,43) as stated, which shows Delta smolt survival based on recoveries of adult marked salmon correlated with mean water temperatures. It does not refer to Figure 5-3, which is only one component of an annual survival index as it represents only one reach. The older references use survival interchangeably with survival index.

No change in text.

Page 5-20

Comment: CVPWA discusses the smolt survival index relative to temperatures (WQCP-CVP-210,18).

Response: Comments noted.

No change in text.

Page 5-20

Comment: CVPWA in this comment discusses the relative importance of dissolved oxygen and temperature on the upstream migration of salmon in the San Joaquin River (WQCP-CVP-210,19).

Response: Comments considered.

No change in text.

Page 5-20, last para.

Comment: SWC comments that 1) the section discussing the blockage of migrating adult salmon in the San Joaquin River due to high temperatures and low dissolved oxygen levels in the fall is difficult to interpret; 2) the statement should be based on cited scientific references supported by quantitative data; and 3) tagging studies conducted in the San Joaquin River were difficult to interpret (WQCP-SWC-361,9).

Response: 1) The section discussing the blockage of migrating adult salmon in the San Joaquin River is based on Hallock et al (1970), as cited in the text; 2) it is the only study conducted in the Delta of a phenomenon specific to this particular area which is of concern due to the timing of its occurrence and the simultaneous presence of migrating salmon and; 3) the results of the referenced study are difficult to interpret because it is difficult if not impossible to distinguish whether the fish are reacting to the low dissolved oxygen levels or to the high temperatures or to a combination of the two variables. Please see above comments on the Dissolved Oxygen objective.

No change in text.

Page 5-22 and 5-24

Comment: SWC suggests 1) deleting a reference to the fact that the fall-run Chinook salmon population has been supported by hatchery production in the Sacramento and San Joaquin Rivers; 2) deleting the phrase: "based on the hearing record and the testimony presented at the hearing"; and 3) deleting a statement that was taken from the stated reference, WQCP-USFWS 2, 3 and 5 (WQCP-SWC-361,10).

Response: Comments considered, however the sentences state facts.

No change in text.

Page 5-23

Comment: CVPWA proposes changes in wording in the section addressing "pulse flows" (WQCP-CVPWA-210,21).

Response: Comments noted.

No change in text.

Page 5-24, para. 2

Comment: CVPWA discusses the USBR temperature model and suggests rewording of the paragraph addressing this model (WQCP-CVPWA-210,21).

Response: Comments considered

No change in text.

Page 5-24

Comment: SWC suggests changing the wording to include the statement that temperature models need to be developed (WQCP-SWC-361,10).

Response: The comment was considered but it was not sufficiently clear what these temperature models might accomplish. Sometimes models are less useful than investigative research. The USBR temperature model will no doubt evolve as future needs are identified. Please see above section on Evaluation of Water Quality Alternatives.

No change in text.

Page 5-24

Comment: SWC suggests deleting the phrase, "achieve the coldest temperature possible", because cold water temperatures may interfere with other fish species (WQCP-SWC-361,11).

Response: During the forthcoming proceedings, the possibility of and degree to which the water can be cooled to benefit juvenile salmon will be further investigated.

No change in text.

Page 5-25, para. 3

Comment: SWC suggests: 1) consideration of controllable factors does not include areas of the "the Delta", and 2) the statement regarding the potential benefits of maintaining water temperatures is an extremely weak statement (WQCP-SWC-361,11).

Response: Freeport and Vernalis are within the legal boundary of the Delta. The statement was meant to be of a general nature because it is expected that additional information will be presented on this topic.

No change in text.

Page 5-25

Comment: CVPWA suggests emphasizing that stored water cannot reasonably control temperatures.

Comment summarizes the substance of the temperature objectives and states there is little scientific justification for the temperature objectives in the plan. EPA cannot approve objectives that are not supported by available scientific evidence (WQCP-CVPWA-210,22; WQCP-EPA-1,1; WQCP-SCLDF-1,5; WQCP-CVPWA-210,23).

Response: Board staff reviewed a plethora of scientific data on laboratory experiments and field studies dealing with the effect of water temperature on juvenile Chinook salmon. Laboratory experiments indicate that there is a considerable range of temperatures at which salmon can thrive or merely survive. Laboratory data are not directly applicable to the environmental conditions in the Delta. The USFWS field experiments, do not and cannot document the conditions through which the salmon smolts migrate. They do indicate that mortality increases with increasing temperatures, however, temperature is not the only factor causing mortality in the Delta. Smolt survival rates vary with time of outmigration, flow, temperature, export rates, migration paths, etc.. Our knowledge of the interplay of these factors and how they affect smolts survival in the Delta is imprecise. The very nature of field experiments, especially those in the Delta, is that they often provide ambiguous results, subject to interpretation. This situation is not likely to change, much less improve in the short-term, even with additional study.

The temperature objectives specify that the 66 and 68°F values are to be maximum values because that is the range above which it is found that the salmon become "stressed" or their overall condition deteriorates. Also, of all of the USFWS smolt survival studies, these temperatures were associated with the mid-range of the survival rates.

There are limited data available regarding the effects of temperatures on adult Chinook salmon either from laboratory experiments or from field studies. The field study in the San Joaquin River which provided the data on temperatures during the upstream migration of fall-run Chinook also provided information on dissolved oxygen. The two environmental factors are related and quite possibly have a synergistic effect on the salmon migration behavior. Even with limited and imprecise information, it is possible to conclude that: 1) an upper temperature limit for adult Chinook salmon migration is desirable; 2) temperatures are generally above desirable levels for migrating salmon in the Delta in the fall months; and 3) 68°F is at the upper end of desirable temperatures to provide passage to adult salmon through the Delta.

No change in text.

Page 5-25

Comment: EPA also questions whether different temperature objectives should be set for different salmon runs. The plan notes that DFG believes that temperature tolerances for winter run are similar to those of other runs. A fully protective objective is appropriate to ensure that all runs are protected (WQCP-EPA-1,1; WQCP-SCLDF-3,2).

Response: There is no precise method for determining what temperatures in the Delta provide adequate protection for Chinook salmon. A range of 66 to 68°F was identified as the boundary between providing appropriate protection and unacceptable conditions.

In the Delta during the spring and early summer months, it would be unreasonable to set temperature objectives within a conservative range of temperatures, say 55 to 60°F. Because the winter run is a federal and state listed species, the lower end of the range was determined to be appropriate for this run as its survival is more tenuous.

No change in text.

Page 5-25, Table 6-3

Comment: MID/TID states that: 1) the temperature objective on the San Joaquin River is probably not achievable, 2) the definitions of controllable factors should all be consistent, and 3) the dates of the San Joaquin River temperature objective should be changed to exclude the months of June and September because the smolt outmigration may end in the first week in June and ambient air temperature is the major factor controlling water temperature in most Septembers (WQCP-MID/TID-9,2; WQCP-DFG-5,2).

Response: 1) Comment considered; 2) appropriate changes have been made in the text (for example see page 1-13); and 3) timing of outmigration is often highly variable between years and in the San Joaquin River, a portion of the smolts do outmigrate in June in some years. The purpose of including June is to consider these smolts. Adult salmon are present in the lower San Joaquin River in September. We agree that ambient air temperature is not a controllable factor and that it may be difficult to control temperatures in September. The State Board welcomes information on those factors that are controllable for the improvement of fisheries habitat in the lower Sacramento and San Joaquin Rivers.

Please see response to USBR comments in GENERAL COMMENTS, Chinook-Temperature Objectives which includes changes in the text (pages, I-6 and I-7).

No change in text.

Page 5-26

Comment: EPA agrees that the dissolved oxygen objective is necessary but questions the scientific basis for deciding that the objective should only be in effect for three months and why different potions of the Delta should be subject to different objectives for dissolved oxygen (WQCP-EPA-1,2; WQCP-SCLDF-1, 6).

Response: Prior to this Plan, there were no water quality objectives for dissolved oxygen objectives for the interior Delta except the Basin 5 Water Quality Control Plan which allowed a 5 mg/l dissolved oxygen objective in areas "from which fish have been excluded or where the fishery is not important as a beneficial use" and provided a 7.0 mg/l objective in the Sacramento River (below I Street Bridge) and in all Delta water west of the Antioch Bidge. Through DWR monitoring data and DFG research, a particular area during a particular time of year was identified where the local dissolved oxygen levels inhibited the movement of migrating salmon through the lower San Joaquin River. If, in the future, it is found that the low levels of dissolved oxygen occur during other times of the year in other areas in the Delta, within fisheries habitat, the Plan can incorporate those modifications during the triennial review process.

No change in text.

Comment: Page 5-29 Suggest removing the words "minimal, but" from a discussion of the adequacy of the D-1485 salinity objectives (WQCP-SWC-631,13).

Response: We disagree. As noted farther down in Section 5.6.2.1, DFG described the spawning habitat protections under D-1485 as minimal. We accept their evaluation.

No change in text.

Comment: Page 5-30 - Reference to the estimated size of the spawning area available (9.5 miles) when Antioch EC is 25.2 mmhos/cm (extreme relaxation condition) should be removed because no technical basis exists for making this statement. The length of the spawning area is in fact "relatively constant" (between ten and twenty miles in length) in high and low flows though it may move up and down the river (WQCP-SWC-631,13).

Response: We disagree. This section is intended to provide the historical context in which the present standard was developed and presented in the 1978 Delta Plan and Final EIR. As we indicate in Section I of this document, we also find the technical basis to be inadequate, but this finding does not change the historical facts and references. We also disagree that a change in spawning area from twenty miles width to only ten (a 50% reduction) constitutes a "relatively constant" size.

No change in text.

Relationship of Striped Bass Spawning Protection Relaxation Provisions to Water Supply

Pages 5-32 through 5-37

Comment: Page 5-32 - DFG disagress with using total Basin water supply rather than deficiencies as the basis for relaxation of the striped bass spawning objectives, because fish and wildlife frequently take deficiencies in protection under the present standards while water deliveries are not cut. They advocate closer linkage between fish and wildlife deficiencies and water delivery deficiencies (WQCP-DFG-5,2).

Comment: Page 5-35 to 5-37 - Commends Board for rethinking approach to relaxation provisions. Use of CVP and SWP may not be appropriate, since may be triggered by management decisions. If relaxation provisions included, recommend approach of Alternative 2-E (Section 5.6.3.2) (WQCP-EPA-1,5).

Comment: Page 5-35 to 5-37 - The current and proposed relaxation provisions may not be adequate to protect striped bass for extended dry periods, and cannot accept without scientific evidence to support (WQCP-EPA-1,6).

Comment: Page 5-35 to 5-37 - The proposed relaxation standards do not identify the scientific basis for the Board's conclusion that these provisions will protect striped bass spawning during extended drought conditions (WQCP-SCLDF-1,6).

Response: The procedure addressed in Section I of this document would tie reduction in spawning habitat directly and proportionally to shortages in project deliveries, which is more appropriate that the method used at present. DFG and EPA have concerns that other approaches may be more appropriate, particularly by relating fish and wildlife deficiencies to other deficiencies. The use of the Sacramento River Basin Index could, if the State Board elects to do so, after completion of the Scoping and Water Right phases, delete two criteria (year following critical year, and subnormal snowmelt) which at present reduce protection for fish and wildlife while not changing protection for other beneficial uses. In addition, the Board will consider other approaches, such as the tying of export levels to water availability, and requiring certain minimum amounts of carryover storage in project reservoirs, in the scoping and water rights phases.

No change in text.

Data Needs, Gaps and Tests

Pages 5-33 through 5-37

Comment: Plan should use all available models for Plan analysis, including fishery models, such as Dr. Botsford's [UC Davis] (WQCP-NMFS-1,2).

Comment: Page 5-33 - Need to conduct investigations of the relationship between EC and spawning in the San Joaquin River, as well as the relationship between egg and larval survival and EC (WQCP-SWC-631,14-15).

Comment: Pages 5-33 to 5-34 - Conflicting information on survival of striped bass eggs in various salinities; statement about poor survival in upper San Joaquin River as possibly related to high salinity should be deleted (WQCP-CVPWA-210,25-26).

Comment: Page 5-33 to 5-34 - Statement on poor egg survival as possibly related to high salinity in the San Joaquin River above the Delta (Turner, 1976) should be removed in absence of better understanding of salinity/hatching success relationship. Need detailed field work and better analysis of existing DFG data sets (WQCP-SWC-631,14-15).

Comment: Page 5-34 - Statement on temperature effects on striped bass eggs and young needs scientific references. Need analyses of temperature effects on striped bass spawning success, especially where temperature needs may conflict with salmon requirements (WQCP-SWC-631,15).

Comment: Page 5-36 - Analysis of DFG data needed to determine relationship of salinity and spawning location in the San Joaquin River (WQCP-SWC-631,16).

Comment: Page 5-37 - Reiteration of concern about temperature and striped bass egg and larval survival (WQCP-SWC-631,16).

Comment: Page 5-55 - Some bibliographic references missing (WQCP-SWC-631,19).

Comment: Page 6-13 - Need better data analysis so that can demonstrate an actual rather than a "theoretical" improvement in spawning protection at Prisoners Point (WQCP-SWC-631,21).

Comment: Page 6-20 - Agree that should use models to analyze different alternatives for striped bass, but should use the best available models in subsequent phases to provide quantified impact assessments (WQCP-USFWS-7,6).

Response: The State Board agrees that additional information is required in nearly every area of discussion related to the setting of water quality objectives and other requirements. We urge participants to avail themselves of any models and data available, and to share these data and analyses as much and as early as possible. It is possible to quibble with nearly any statement in the Plan; the San Joaquin River salinity statement is one example. The statement should be viewed as an area of concern for the Board, and as a call for further investigation, both in terms of salinity effects on egg survival <u>and</u> in terms of additional investigations of upstream spawning success when conditions in the San Joaquin River are sufficient to allow upstream migration. The word "theoretical" in relation to Prisoners Point was intended only to indicate that the proposed objective of 0.44 mmhos/cm EC was already achieved at that location under most conditions, not that the benefit of 0.44 mmhos/cm was theoretical.

No change in text.

Comment: Page 5-33 - Suggest removing the word "substantial" from the sentence "This undoubtedly results in substantial losses of eggs and young.", with regard to striped bass spawning in channels which move water to the export pumps (WQCP-SWC-631,14).

Response: We disagree. Losses due to reverse flows, entrainment, and translocation are implicated as the biggest factor in the striped bass decline.

No change in text.

Comment: Page 5-33 - Suggest removing the word "substantial" from the sentence, "as late as 1963, substantial spawning in the San Joaquin River occurred in the reach between Stockton and Mossdale (Farley, 1966)." (USFWS-SWC-631,14).

Response: We disagree. The data from Farley (1966) show that this area was one of the two most productive spawning areas on the river that year.

No change in text.

Period of Spawning Protection

Pages 5-34 through 5-37

Comment: Page 5-34 - Suggest the wording on the period of striped bass spawning be revised to read "the period April 1 to May 31, or such earlier date when biological sampling has demonstrated that spawning has ended." (SWC-WQCP-631,15).

Comment: Pages 5-34 to 5-37 - EPA cannot support the provision until the Board demonstrates how such a determination can be made accurately given normal fluctuations in water levels and spawning activity (WQCP-EPA-1,5).

Comment: Pages 5-34 to 5-37 - The standard which includes "or until spawning ends" defies implementation, because the termination of spawning activity is difficult to predict and identify from one year to the next (WQCP-SCLDF-1,6).

Comment: Pages 5-34 to 5-37 - The extension of the spawning period protection from May 10 [sic] to May 31 may cost the projects 10,000 acre-feet of yield, but the inclusion of the phrase "or until spawning has ended', will largely eliminate this impact. Dr. Hansen's [sic] work shows that in dry and critical years spawning ends earlier (WQCP-SWC-630,8-9).

Comment: Pages 5-34 to 5-37 - Exhibit DWR-WQCP-11 showed that 99% of spawning occurs before May 21, therefore the benefit of extending the period to May 31 is speculative, at best (WQCP-DWR-24,12-13).

Response: The State Board added the phrase "or until spawning ends" to provide reasonable protection, and yet also recognize the variability in biological systems. The Board has specifically not stipulated what measurement should be used to determine when spawning ends so that a wide variety of approaches to provide this information may be explored. We therefore are not making the wording change suggested in SWC-WQCP-631. We disagree that 99% of spawning is completed by May 31, as DWR suggests; only 2 of the 15 years of data summarized in Table 5-2 in Section 5.6.2.1 show that even 95% of spawning activity was completed by May 21. To suggest that the benefits of this extension are "speculative" is to deny the data on the actual period of spawning in the San Joaquin River. Nor do we find that this protection, and its effect on yield, to be unreasonable, given that only about 30-40% of spawning activity is protected at the present time in dry and critical years.

We disagree that spawning necessarily ends earlier in dry and critical years; for example, 1977, the driest year on record, showed a late spawning period. We also disagree that this phrase will serve as a ready means to shorten the period of protection, as SWC suggests. The State Board will place the burden of proof on those who wish to shorten the period of protection. For the present time, we will require that requests for early curtailment of this objective be supported by proof based on real-time data for that particular year, not on general statistical relationships. Thus, we also disagree that the objective is not implementable in its present form, as EPA and SCLDF suggest. The proposed objective provides substantially increased protection for striped bass spawning independent of umbrella protections, and yet provides appropriate flexibility to reflect actual conditions.

No change in text.

Page 5-38, last para.

Comment: SWC suggests adding the phrase, "whose taxonomy has been characterized as 'confusing' (DFG 1990)", to the second sentence (WQCP-SWC-361,16).

Response: Comment considered.

No change in text.

Page 5-39

Comment: CVPWA comments address the variability of the annual Delta smelt abundance and the reasons for that variability; and suggest changes to the section on Delta smelt (WQCP-CVPWA-210,26).

Response: Comments noted.

No change in text.

Page 5-39, para. 4

Comment: SWC suggests, in part, inclusion of a phrase stating that DFG concluded that there is "no evidence" that Delta outflow has had major effects on Delta smelt abundance (DFG, 1990) (WQCP-SWC-361,17).

Response: It would be more appropriate to say that although there may be no correlation directly between outflow and abundance of Delta smelt there does appear to be an indirect relationship. Flow affects the location of the entrapment zone and the location of the entrapment zone has an effect on Delta smelt production. Other comments considered.

No change in text.

Page 5-42, para. 2

Comment: SWC suggests adding a reference to the peripheral canal as a method for reducing impacts to the Delta smelt by reducing entrainment into the CVP and SWP (WQCP-SWC-361,18).

Response: Methods of reducing impacts to Delta smelt, as well as other fish species, from entrainment by diversion by the CVP and SWP will be discussed in the forthcoming phases.

No change in text.

Page 5-42, para.3

Comment: SWC suggests deleting the section addressing the entrapment zone (WQCP-SWC-361,18).

Response: Comment considered.

No change in text.

Pages 5-43 and 5-44, Section 5.10 Suisun Marsh

Comment: The choice of monitoring stations was questioned, especially in regard to the Board's rationale for the differences between the 1978 Delta Plan and the amendments to D-1485 which were made in 1985 (WQCP-EPA-1; WQCP-SCLDF-1,7; WQCP-SCLDF-2,2-3; WQCP-CWPC-1,6-7). In addition, "...the 10,000 plus acres of tidal marshes are not being addressed directly or indirectly in the Final Draft Plan" is a concern (WQCP-USFWS-7,5). More is needed in the biological assessment than simply an endangered species review; "[t]he studies should include 1) wetlands outside the legally-defined Suisun Marsh; 2) other alternatives in addition to the SMPA standards; and 3) the full range of species that depend upon marsh resources, in addition to endangered species" (WQCP-EPA-1). USFWS opinion is that "...the waterfowl resources using the 10,000 plus acres of tidal marshes in Suisun Marsh need to have their water quality needs addressed as well" (WQCP-USFWS-7,5).

Some participants advocate that the Board adopt the SMPA water quality standards for the Suisun Marsh, "...pending the completion of an endangered species review for the entire Bay-Delta plan" (WQCP-DWR-25,5; WQCP-USBR-129A,3; WQCP-SWC-633,11-12). SWC recommends "...that the Board adopt the {interim} objectives contained in Decision 1485, before it was amended, until the biological assessment is completed" (WQCP-SWC-630,10-11; "interim" added during testimony on March 11, 1991).

Response: After reviewing the information presented to date, the State Board has concluded that "...the 'Normal Standards' ... in the SMPA may adequately protect the managed wetland habitat of the Suisun Marsh" and that there is a need for "...additional information on the water quality requirements of the rare, threatened, and endangered species and their habitat in the marshes around Suisun Bay ... before it can consider modifying the current water quality objectives" (WQCP, p.5-44).

No change in text.

Comment: Only a part of the money available for "...improved duck club management schemes..." (WQCP, p.5-43) has been spent and that "...the Lower Joice Island fill/drain facility has not been constructed" (WQCP-DWR-24,10).

Response: The duck club management schemes referred to are the fill-circulate-drain cycle options designed for the operation of each club. The word "schemes", as used here, does not include any facility construction as such.

No change in text.

Page 5-44, last paragraph

Comment: The Board needs to be careful to fully satisfy both the federal and state endangered species acts (WQCP-NMFS-1,2; WQCP-USFWS-7,7).

Response: This is the Board's intent; the assistance of NMFS, USFWS, and DFG will be appreciated.

No change in text.

Comment: There was a comment on the "rare" classification (WQCP-SWC-633,12,17).

Response: Many of the designated "rare" plants are also federal candidate species and as such must be considered in the assessment, even though there is no direct protection given to them.

No change in text.

Page 5-48

Comment: Section should include data from D-1485 monitoring program, should include discussion of review of benthic monitoring program, and changes resulting from Potamocorbula clam introduction (WQCP-SWP-631,18-19).

Response: Much of the data presented in this section is from the D-1485 monitoring program, as summarized by Markmann (1986). The data on Potamocorbula are not as thoroughly analyzed as earlier data. The entire compliance monitoring is under review by a committee of the IESP. The Board has chosen not to recommend any major revisions to the current program pending completion of this review and its evaluation by the Board.

No change in text.

Page 5-51, Delta [Recreation]

Comment: There was disagreement with the discussion of the limited information available to the Board (WQCP-SWC-633,12-13).

Response: Unless additional (and up-to-date) information becomes available, the Board sees no reason to change the discussion in the Plan.

No change in text.

Page 5-53, Export Agriculture

Comment: The 1.0 mmhos/cm EC objective is too high (WQCP-SDWA-36,1).

Response: The 1.0 mmhos/cm EC objective for export agriculture is based upon reasonable protection of the beneficial use. The export pumps will receive umbrella protection from South Delta objectives. Thus, this 1.0 EC objective will not cause a degradation of export water quality.

The 5% leaching fraction mentioned on page 7-4 is the average minimum leaching fraction for the export area. With a 73% irrigation efficiency the actual average leaching fraction will probably be more like 10 to 15% due to incidental deep percolation losses. Thus, the 1.0 mmhos/cm EC objective appears to provide reasonable protection of export agriculture. Also, higher leaching fractions in the San Joaquin Valley would just exacerbate the problem of agricultural drainage in the San Joaquin River.

No change in text.

Chapter 6

Pages 6-4 to 6-13, 6-13, paras. 1 and 2

Comment: The USFWS comments relate to the impacts on salmon smolt survival from the analysis of the water supply impacts of the various water quality alternatives (WQCP-USFWS-7,6; WQCP-CVPWA-210,30-31).

Response: The assessments of the impacts to salmon smolt survival based on the water supply impacts, resulting from the various water quality alternatives, is very preliminary and of a general nature. The results of the water supply impacts analysis are provided only in terms of acre-feet in only two year types, average and critical, based on the 57 years of record. Assessment of impacts to salmon smolts will depend on how much, when and where the flows occurs. This analysis will be done during the scoping phase of the Proceedings (See Chinook-Upstream effects of Delta flow requirements).

No change in text.

Page 6-4, Paragraph 2

Comment: The plan does not provide a complete definition of water supply impacts in that it does not include impacts on upstream reservoir storage and the timing of the flows (WQCP-DWR-24,4; WQCP-DWR-15,4).

Response: Comment noted. Table A6.3-1 from Appendix 6 presents the "Project Deliveries" water supply impacts, which includes CVP and SWP reservoir storages. [Project Deliveries was deleted from earlier drafts.]

No change in text.

Page 6-5, TABLE 6-2, Water Supply Impacts...

Comment: A question was raised about the interpretation of the "-9" figure describing "Total Delta Exports" in the results of the operations studies for Alternative 3 (WQCP-WACOC-5,4).

Response: The "-9" figure represents a decrease of 9,000 acre-feet per year in total Delta exports when compared to the base of 6,295,000 acre-feet allowed under D-1485. This small reduction is not significantly different from zero. The State Board has concluded that there will be no significant adverse environmental impacts due to the adoption of this Plan (Plan,6-29).

No change in text.

Page 6-5, 6-7, 6-8

Comment: Studies should not be analyzed by comparing Delta outflow. Decreases in Delta outflow could be due to additional upstream reservoir storage and not necessarily due to Delta objectives (WQCP-DWR-24,6-5,6-7,6-8,6.3-3 and 6.3-4).

Response: Numerous studies have been performed using Delta outflow as an indicator of water supply impacts. Delta flows and exports as well as reservoir storages will be considered in the final draft.

No change in text.

Page 6-10

Comment: The discussion of the paper industries needs, salinity treatments capability, and negotiations should be expanded in the WQCP (WQCP-DWR-24,6).

Response: Section 5.1.2 of the WQCP sufficiently discusses the paper industries needs, and the relationship between the negotiations and the WQCP. Discussion of the paper industries salinity treatment capability would not add necessary information to the WQCP.

No change in text.

Page 6-13 para. 2

Comment: SWC suggests substituting June for July in the period of April through July in the discussion of the impact assessment of the water quality Alternatives (WQCP-SWC-631,20).

Response: The reason the period April through July is used here is because the operation studies identify this period separately because the fish and wildlife objectives are introduced in April and are not removed until July. This analysis of the alternatives was very preliminary and will be more thoroughly analyzed in the forthcoming proceedings.

No change in text.

Page 6-13 para. 2

Comment: SWC suggests: 1) stating that it is a fact that there is no data available to evaluate the relationship between water temperature and smolt survival on the San Joaquin River, and 2) deleting wording stating that spring outflow in the San Joaquin River is correlated with adult salmon returns two and one half years later because it is a flow-based consideration and should be addressed later (WQCP-SWC-631,20).

Response: 1) It is not a fact that there are no data available to evaluate the relationship between water temperature and smolt survival in the San Joaquin River, and 2) in this section of the Plan, we are making a preliminary attempt to analyze the water supply impacts of the alternatives and the resulting impacts to the salmon. In subsequent Proceedings, these issues will be more thoroughly addressed.

No change in text.

Comment: NMFS urges the Board to broaden its consideration of computer models to include the Chinook population model (CPOP) for the Sacramento River Basin (WQCP-NMFS-1,2).

Response: There are several models such as CPOP that can be used as tools to assess the impacts of various operation alternatives on the salmon resources upstream and in the Delta. In the preparation of the Draft Environmental Impact Report, all available and appropriate tools will be utilized to assess the impacts of the project alternatives to be considered (See Chinook-Program of Implementation; also see 'Response to WQCP-USFWS-7, para. 6, regarding 7-16, Section 7.4.3.2 of the Plan.)

No change in text.

Comment: NMFS points out that the Board may also need to consider the Delta flow effects of Shasta reservoir carry-over storage regimes, that may be required for successful maintenance of suitable salmonid spawning and incubation temperatures in the upper Sacramento River (WQCP-NMFS-1,2).

Response: The State Board will consider the upstream effects, including the effects on fisheries, of the alternative flow requirements in the Delta during the Scoping Phase and later in the Water Right Phase. The State Board is very aware of the upper Sacramento River temperature issues and their effects on salmonid production. This issue will need to be further addressed in the context of implementation of the proposed temperature objectives for protection of Chinook salmon at Freeport during the spring months.

No change in text.

Page 6-17

Comment: CVPWA suggests revisions to the wording, discussing the evaluation of alternative water quality objectives (Alternative 6) and the potential impacts on Chinook salmon (WQCP-CVPWA-210,32).

Response: A thorough analysis of the impacts of the various water quality objectives on salmon resources will be done during the Scoping Phase of the proceedings.

No change in text.

Page 6-17

Comment: SWC suggests removal of wording in which there is speculation as to the relative benefits of the water quality alternatives to the juvenile Chinook salmon (WQCP-SWC-631,21).

Response: The wording is speculative and the relative cost and benefits of the water quality alternatives will be analyzed during the forthcoming proceedings.

No change in text.

Page 6-18

Comment: Alternative 6 does not provide full protection against entrainment of striped bass eggs and larvae in the San Joaquin River (WQCP-SWC-631,22).

Response: We agree, but as the text indicates, this refers to salinity protection for adult spawning, not to protection for the products of that spawning. There was no intention to suggest that eggs and larvae are not subject to entrainment losses under this alternative.

No change in text.

Page 6-19

Comment: DWR disagrees with the statement "Further, the '1990 level of development' used in the model does not reflect actual diversions at this time (WQCP-DWR-24,4).

Response: Reviewing the past ten years of DWR Bulletin 132 publications, 5-year entitlement delivery projections consistently overestimate actual entitlement deliveries. On an average basis this analysis indicates this overestimation is significant. In 1989, a critical year where local supplies in export areas were deficient and the SWP requirement increased, the actual entitlement delivery was 2.85 MAF. Deliveries under normal hydrologic conditions would likely be less. Bulletin 132-90 projects 1990 entitlement deliveries will be 3.3 MAF, for a normal hydrologic condition, a increase of 450 TAF in one year. The Board staff is currently investigating this issue with MWD and DWR staff.

No change in text.

Page 6-19

Comment: CVPWA suggests that the section entitled Cumulative Impacts of Flow Alternatives should be deleted because it does not address water quality issues and the improvement in the entrapment zone through flow objectives may not necessarily provide the benefits to salmon and striped bass contemplated in this section (WQCP-CVPWA-210,32; WQCP-SWC-631,22).

Response: Comments considered. This issue will be considered further in the subsequent proceedings.

No change in text.

Expansion of Striped Bass Spawning Habitat Upstream to Vernalis

Page 6-20

Comment: At this time there is little use in expanding striped bass spawning habitat in the San Joaquin River. Evidence indicates that striped bass are not spawning habitat limited under present conditions. Until problems of rearing habitat downstream and dislocation are corrected, little likely benefit to striped bass (WQCP-USBR-129A,2).

Comment: DWR's comments regarding lack of evidence supporting expansion of the spawning objectives were not reflected in the Final Draft (WQCP-DWR-25,5).

Comment: EPA disagress with the decision not to extend spawning habitat to Vernalis. While it agrees that pumping is the biggest factor affecting striped bass, this should not be used as basis for excluding other objectives that would help restore and maintain striped bass. Given the continued decline, it is difficult to understand rationale for rejecting objectives to improve habitat. This problem underscores the need to develop an integrated set of standards to improve spawning and migration conditions for striped bass (WQCP-EPA-1,5).

Comment: The decision to not expand spawning habitat is nonsensical in view of the continuing decline of striped bass population. The State Board should make every effort to improve habitat. It is unconscionable to reject habitat objectives because it has failed to address the entrainment losses problem. The State Board must address both problems to assure restoration of the striped bass fishery (WQCP-SCLDF-1,6).

Comment: The only major improvement in standards compared to the 1978 Plan was "blackballed" by the State Board. The reasons were the potential water costs and the doubtful benefit the objective would produce, because the Board was also not addressing the required flow and export restrictions at this time. When and if pumping restrictions are set, the Board will once again consider the issue (Section 5.6) (WQCP-CWPC-1,8).

Comment: (Page 1-14, para. 1, also) USFWS cannot understand why the State Board cannot set a Vernalis spawning objective now, and implement it later, if indeed it is a desirable action. Objectives should be set realizing that it may take time and varied actions to achieve implementation (WQCP-USFWS-7,3).

Comment: (Page 6-20, Section 6.3.3, para. 3) USFWS's opinion is that the Final Draft text and their testimony support the extension of the spawning objective to Vernalis, with qualifications as to its implementation (WQCP-USFWS-7,6).

Response: The State Board remains unconvinced that extension of the striped bass spawning habitat upstream to Vernalis would produce any significant beneficial effects, given the present configuration and water project operations in the Delta. The Board remains open to further consideration of this issue in subsequent phases and in the Triennial Review.

No change in text.

Page 6-22, Section 6.5, Environmental Effects, paragraph 3

Comment: Two questions were asked: 1) if the Plan is essentially identical to the 1978 Delta plan, as inferred by the first bullet in Section 6.4, page 6-20; and 2) if the Environmental Checklist refers "...only to the adoption of the objectives or to their ultimate implementation?" (WQCP-USFWS-7,6).

Response: In answer to 1), other than the striped bass spawning objectives, the proposed Plan is essentially identical to the 1978 Delta Plan. In answer to 2), the Board has limited the discussion to the adoption of the objectives since the actual implementation methods will be determined in the upcoming phases of these proceedings and will be subjected to an environmental analysis at that time.

No change in text.

Pages 6-24 to 6-29, TABLE 6-5, Environmental Checklist

Comment: Questions were raised about some of the items in the checklist based upon the misunderstanding of the "-9" figure in Table 6-2 (WQCP-WACOC-54-6).

Response: See response to Page 6-5.

Pages 6-24 to 6-29, Environmental Checklist

Comment: There was disagreement with the "No" response for the following checklist items (WQCP-SWC-631,22):

3a. Changes in currents, or the course or direction of water movements, in either marine or fresh waters?
3h. Substantial reduction in the amount of water otherwise available for public water supplies?

5a. Change in the diversity of species, or numbers of any species of animals ... ?

Response: The Board's "No" responses were based on the conclusion that there would be no adverse impacts due to the adoption of the water quality objectives. Beneficial impacts need not be discussed "...because the State Board has set the water quality objectives at levels designed to adequately protect the designated beneficial uses of the Sacramento-San Joaquin Delta and San Francisco Bay waters" (WQCP, p.6-29).

No change in text.

Page 6-31, last paragraph

Comment: The Board's conclusion that "[t]he availability of water for export uses is not significantly affected by this Plan" was questioned. The comment stated that "[t]he amount of water required to meet the objectives in the south Delta interior stations and the revised Antioch relaxation provision or the water required to meet any revised Suisun Marsh objectives is unknown, but could be significant" (WQCP-SWC-633,16).

Response: Based on the available information that there is a "...lack of specificity in the ability to accurately model water supply impacts associated with various water quality objectives..." (WQCP-SWC-631,22), the State Board sees no reason to change the statement in the Plan. There has been testimony that are various ways to implement the water quality objectives. The effects of proposed implementation measures will be analyzed in the upcoming phases of the proceedings.

No change in text.

Chapter 7

Page 7-3, Section 7.2.2.2, "Western and Interior Delta"

Comment: The Board should establish procedures by which an individual objective can be modified independently of the entire WQCP when additional information becomes available, for instance when the leaching study is completed (WQCP-USBR-129A,2).

Response: As stated on page 1-2 of the Plan, the State Board intends to review information as it becomes available and to update objectives as warranted.

No change in text.

Page 7-3

Comment: This section should recognize that these objectives will be changed if the results of the leaching study called for in Section 7.4.2.2 show that requiring Delta farmers to practice Best Management Practices such as leaching is reasonable (WQCP-SWC-633,17; WQCP-CVPWA-210,34).

Response: Section 7.2.2.2 addresses implementation of proposed objectives. Proposed objectives are the same as those that are currently implemented, therefore further implementation measures are not necessary. Also, page 1-2, paragraph 4 of the WQCP explains when new information will be incorporated into the WQCP as follows: "The product of the current Water Quality Phase of the planning process will be updated to reflect findings and conclusions at the end of the Water Right Phase and periodically, thereafter, whenever sufficient new information is received."

No change in text.

Page 7-3, Section 7.2.2.2, "South Delta"

Comment: This section on southern Delta Agriculture, should be expanded to address South Delta negotiations and the impossibility of meeting the proposed objectives (WQCP-DWR-24,15).

Response: These issues are sufficiently addressed in previous chapters of the WQCP. See other comments on south Delta agriculture.

No change in text.

Page 7-4, Agriculture

Comment: The Salt-Load Reduction Goal may be too difficult to meet (WQCP-MTD/TID-92; WQCP-CVPWA-210,34; WQCP-SDWA-36,2).

Response: Based on the reasoning on page 7-4 we believe that a 10% salt load reduction is a reasonable goal and see no reason to change this goal. This evaluation is supported by the results of the State Board's Technical Committee and the San Joaquin Valley Drainage Program.

No change in text.

Pages 7-5 and 7-6

Comment: It is premature to specify compliance monitoring requirements. This subject area should be open to discussion and even developed by a workgroup (WQCP-USBR-120,3; WQCP-DWR-24,14).

Response: The State Board believes that there should be no hiatus in compliance monitoring. The Interagency Ecological Studies Program (IESP) is in the process of reviewing the data developed from the D-1485 compliance monitoring program. The State Board would appreciate receiving the analysis and recommended changes of the IESP as soon as they become available. Upon review the State Board will make appropriate changes. Until that time the compliance monitoring program addressed in the Plan should continue.

There is an aspect of this monitoring program that the State Board would like discussed during the Scoping Phase which is, cost sharing to fund this program. Currently this program is funded solely by CVP and SWP contractors. There are many projects affecting either the water quality or flow into the Bay-Delta and therefore possibly the beneficial uses made of Bay-Delta waters. Funding considerations and mechanisms should start with reservoirs greater than 100,000 acre-feet and direct diverters of 100 cfs or more.

No change in text.

Page 7-5, Section 7.2.2.6 Suisun Marsh

Comment: A petition to change the compliance schedule for the Suisun Marsh objectives from that approved in the 1985 amendment to D-1485 to the schedule set forth in the SMPA (calculated from the operational date of the Montezuma Slough Control Structure) has been submitted (WQCP-DWR-24,10).

Response: The State Board has received that petition and it is being reviewed.

No change in text.

Page 7-6, Table 7-1, Bay-Delta Estuary Water Quality Monitoring Program

Comment: There is no discussion in the draft report of a State Board critique and statistical analysis of the database collected as part of the existing D-1485 monitoring program (WQCP-SWC-633,23).

Response: The State Board agrees that such an analysis is a good idea. Furthermore, the State Board believes that all the monitoring being performed in the Estuary needs to be evaluated. We would support the allocation of sufficient funds to the Interagency Ecological Study Program to perform the necessary work.

No change in text.

Comment: The following corrections should be made to Table 7-1 (WQCP-DWR-24,11):

1. There are two stations numbered "D12"; and
2. Gauge height records should be added to any Marsh compliance stations that do not have them listed.

Response: Comment noted.

No change in text.

Page 7-8, Section 7.3.2.1

Comment: What is the reason for requesting additional monitoring requirements for the North Bay Aqueduct Intake at Barker Slough (WQCP-DWR-24,7).

Response: No monitoring station had been created at Barker Slough at the time of the request.

No change in text.

Page 7-9

Comment: The SCLDF states that the State Board did not analyze the impacts of the alternative sets of objectives on esturarine resources and that if it had, it would have determined that salmon populations would be managed at substantially lower levels, with more frequent population crashes than occurred in DFG's historic baseline period of 1922-1967 (WQCP-SCLDF-2, 3,).

Page 7-9, Page 7-19

Comment: CVPWA suggests revisions and states that the SWRCB should work with interested parties to focus attention on improving the ability to define quantitative relationships between biological processes and hydrological conditions within the Bay-Delta system. The impact of harvest of salmon populations needs to be assessed as well as the losses to unscreened or improperly screened diversions (WQCP-CVPWA-210,36).

Response: The analysis of the impacts of the various water quality objectives on salmon resources will be done during the scoping phase of the Proceedings (See Chinook-Upstream effects of Delta flow requirements). It would be appropriate to analyse losses to all screened and unscreened diversions, including diversions by the projects, in the Delta at that time as well.

No change in text.

Pages 7-9 to 7-27, Sections 7.4 and 7.5

Comment: Additional special studies should be undertaken before commencement of the Water Right Phase (WQCP-WACOC-56,7).

Response: The State Board intends that the studies outlined in these sections be at least started during the upcoming Scoping Phase of the proceedings. Not all of them will be completed before the Water Right Phase commences. As information from these studies becomes available, the State Board will take new data into account under either its water quality or water right authority and make changes as appropriate.

No change in text.

Pages 7-11 and 7-12

Comment: SWC suggest revisions to the wording of the proposed studies (WQCP-SWC-631,24).

Response: These are listed directly from Kjelson et al., 1990 and it would be inappropriate to change the wording. It is stated in the text that these studies are to be considered by the Five Agency Salmon Committee for implementation.

No change in text.

Page 7-11

Comment: CVPWA states that an additional study objective should be added to this section to determine the component of smolt mortality due to causes other than temperature that have been incorporated into the smolt survival index (WQCP-CVPWA-210,35-36).

Response: The list of studies is not exclusive (see above response to WQCP-USFWS-7, Page 7). It is doubtful whether it would be possible to attribute components of smolt mortality with predation,associated with temperature, as it is not possible to attribute smolt mortality to temperature alone.

No change in text.

Page 7-16

Comment: The proposed Interagency Modeling Development and Use Committee (IMDUC) is not needed since the Department-sponsored Operation Studies Workgroup is appropriately addressing the pertinent issues. A new committee would be redundant (WQCP-DWR-24,7-16).

Response: The function of the Operation Studies Workgroup is to analyze the water supply impacts of the proceedings' water quality, flow, and implementation alternatives. The purpose of the proposed IMDUC is to enhance the modeling efforts of all modeling studies, not just those related to the proceedings. Consequently, the IMDUC is needed unless the Operation Studies Workgroup is willing to expand its role to perform, on an ongoing basis, the tasks listed on page 7-16.

No change in text.

Page 7-16

Comment: The recommended Modeling Development and Use Committee should be structured to investigate independent salinity analysis of operation studies (WQCP-CCWD-21,7).

Response: Comment noted.

No change in text.

Page 7-16

Comment: It is critical that the modelling studies be prioritized to achieve the most useful results for the Board's future decisions. Completion of the Bureau of Reclamation-funded San Joaquin River Operation Model is needed as soon as possible (WQCP-USFWS-7,7).

Response: Comment noted.

No change in text.

Page 7-19, Section 7.5.2.2

Comment: The Board should provide protection for western and interior Delta agriculture during all periods of the year where water is used by agriculture (CDWA-Testimony)

Response: The WQCP states that the western and interior Delta "...water quality objectives were developed using corn as the representative crop". Central Delta Water Agency has requested that protection for crops other than corn outside of the corn growing season. This is a reasonable request that will be addressed in the Scoping and Water Right phases.

No change in text.

Page 7-20, Section 7.5.2.5

Comment: Detailed information on upstream and export area recreation and fishery habitat is requested here for consideration in the Scoping and Water Right phases, but little concern about this issue is expressed in Section 5.16 (USFWS-WQCP-7,7).

Response: The objectives proposed in this Plan do not, of themselves, have any significant effects in terms of project operations, flows, and water storage. In the Scoping and Water Right phases, protection for other beneficial uses not covered in this Plan may require some degree of modification of project operations, flows, and reservoir storage levels. These may have significant effects on reservoir and instream recreation, instream habitat, reservoir fish habitat, and wildlife habitat. The Board needs information on these potential impacts to use in its balancing process.

No change in text.

Page 7-21

Comment: It is not necessary that the San Joaquin River Basin Water Year Classification be similar to the Sacramento (WQCP-CVPWA-210,36-37).

Response: Comment noted.

No change in text.

Pages 7-23 to 7-27, Section 7.5.3.4 Physical Facilities

Comment: It was requested that the Western Suisun Marsh Salinity Control Project be added to the list (WQCP-DWR-24,11).

Response: Since the list was not intended to be exclusive, the State Board sees no compelling reason to expand the list at this time.

No change in text.

Pages 7-23 to 7-27

Comment: NRDC claims that 1) the constraints listed on page 7-27 are "... unduly restrictive and technically misguided, and result in a process which greatly underestimates the potential for water savings..."; and 2) "... although the Board has treated the potential for new physical facilities extensively (pages 7-23 through 7-27), it has provided no description of opportunities for agricultural water conservation."

NRDC also comments on the adequacy (or lack thereof) of the work done to date by the Agricultural Water Conservation Workgroup (WQCP-NRDC-0).

Response: The State Board believes these issues are flow-related and belong in the Scoping and Water Right phases, where they will receive appropriate analysis.

No change in text.

SECTION III

Technical Appendices
Comments and Responses

APPENDIX 3.1

Page 3.1-1

Comment: The Sacramento Basin Index equation is incorrect (WQCP-USBR-129B,4; WQCP-CVPWA-210,38).

Response: Agree.

Change in text:
The Sacramento Basin Index equation will be amended as follows: "Index = C1*X + C2*Y + C3*Z"

Page 3.1-2, bullet - Determination of Water Year Classification Breakpoints, paragraph 1, sentence 3,

Comment: The term "flows" is incorrectly used (WQCP-CVPWA-210,38).

Response: Agree.

Change in text (underlined):
"In other words, there is an equal chance that the Sacramento Basin Index will..."

Page 3.1-4 bullet - Verification Process, paragraph 1, sentence 6

Comment: Figure A3-1.1 is incorrectly referenced as Figure A3-1 (WQCP-CVPWA-210,38).

Response: Agree.

Change in text (underlined):
Reference figure correctly as Figure A3-1.1.

Page 3.1-4, "Verification Process"

Comment: The derivation of water availability should be addressed. Appendix, Pages 3.1-6 through 3.1-9, The available water supply is not defined or calculated in the appendix or elsewhere (WQCP-CVPWA-210,38,39).

Response: A discussion of water availability (available water supply) was not included for the purpose of brevity.

No change in text.

Page 3.1-5

Comment: The San Joaquin Basin Index is still under development and no derivation or description of this relationship is found. Therefore, reference to the San Joaquin Basin Index should be removed (WQCP-CVPWA-210,38-39).

Response: Comment noted. A description of a possible San Joaquin Basin Index can be found in the WQCP.

No change in text.

Page 3.1-10

Comment: The subnormal snowmelt adjustment should not be eliminated from consideration (WQCP-DWR-24,5-6).

Response: The WQCP does not eliminate the subnormal snowmelt adjustment from consideration. On page 3.1-10 the WQCP states that if a subnormal snowmelt adjustment increased the accuracy of the index, then it would be beneficial. To clarify this point, the last sentence in the last paragraph of the section titled "Adjustments to Water Year Classification" is changed.

Change in text:
"However, the <u>current</u> subnormal snowmelt modification..."

<u>APPENDIX 4.0</u>

Page 4.0-5, Section 4.0.4.1, "Delta Organic Soils", paragraph 2

Comment: The definition of subirrigation is incorrect (WQCP-USBR-129B,2).

Response: Agree.

Change in text:
"...(subirrigation is an irrigation technique by which water is delivered to the crop root zone by horizontal flow through the soil from the spud ditches)."

Page 4.0-5, Section 4.0.4.1, "Delta Mineral Soils"

Comment: Most leaching in mineral soils is probably accomplished during the first few irrigations during the season and not after harvest (WQCP-USBR-129B,2).

Response: Comment noted. The WQCP will be modified to reflect the contribution of irrigation to salt leaching.

Change in text:
"Excess salts are removed <u>during irrigation and</u> after harvest..."

Page 4.0-5, Section 4.0.4.1. "Delta Organic Soils", paragraph 3

Comment: Information is insufficient to conclude that "(u)nder present conditions in the Delta, leaching measures are not currently necessary on a regular basis (WQCP-DWR-24; WQCP-USBR-129B,2)."

Response: Agree.

Change in text:
The Appendix to the WQCP will be amended by deleting the first sentence, third paragraph, Page 4-5, in the section titled "Delta Organic Soils".

Comment: There was a lengthy discussion of their concept of beneficial uses and "balancing" (WQCP-USBR-129B,2-4).

Response: The Board has designated the beneficial uses of the Bay-Delta Estuary waters, based on the general statements in the California Water Code Section 14050(f) and the requirements of the federal regulations (40 CFR 131.10) promulgated under the Clean Water Act by EPA. This designation is reconfirmed in Chapter 4 of this Plan. The State Board sees no compelling reason to change the beneficial use descriptions in response to this comment.

No change in text.

Comment: Revision of Section 4.0.5.1 Delta Habitat (page A4-11) "...to provide a stronger emphasis on the relationship between water quality parameters and habitat conditions for the various fish, invertebrates and algae inhabiting the Bay-Delta system" was requested (WQCP-SWC-631,25).

Response: Until the State Board has received sufficient evidence to allow a better discussion of such relationships, there is no compelling reason to change the description in this section.

No change in text.

Comment: The question on WQCP-CVPWA-210,39 is answered in our response to the earlier comment on page 5-14.

Page 4.0-17

Comment: SWC comments that the fact that the Columbia River does not provide habitat for four races of Chinook salmon should be verified (WQCP-SWC-631,25).

Response: The availability of fisheries habitat in the Columbia River is beyond the scope of this document; however, there are three runs of Chinook salmon in the Columbia River, spring, summer and fall.

No change in text.

Page 4.0-17

Comment: SWC comments that Table 1.4-5, Chinook Salmon Environmental Requirements and Life History Stages, should be updated to include more recent information (WQCP-SWC-631,25).

Response: A new table may be prepared for subsequent documents.

No change in text.

Chinook-Inland Catch Rates as Relates to Value of the Fishery

Comment: USBR references publication (USFWS 1984) and recently compiled information for the period of October 1, 1989-October 1 1990 and states that the use of the 0.02 catch value may underestimate the number of fish caught per outing thereby affecting the valuation of fish related recreation (WQCP-USBR-129B,4).

Response: Comment considered, information will be reviewed. The following may be added (Page 4-19, paragraph 2, in front of last two sentences on the page).

Change in text:
"Catch rates are highly variable. Fishing success rates may vary from an average of 0.01 fish per hour effort from Carquinez Strait to Sacramento, to an average of 0.09 fish per hour from Red Bluff to Keswick Dam. The success rates range from 0.08 to 0.72 fish per assumed 8-hour outing with the majority of the Sacramento River fish being caught on the upper portions of the river."

APPENDIX 5.0

Page 5.0-14, para. 2

Comment: Page 5.0-14, para. 2 - USBR believes the discussion of the position of the water development community, DFG and USFWS concerning increasing spawning habitat is misleading. Present Delta configuration will not help but it may be worthwhile to increase spawning habit later (WQCP-USBR-129B,1).

Response: Comment noted.

No change in text.

APPENDIX 5.2

Page 5.2-1

Comment: The time interval for compliance of the objective should be average soil salinity over the growing season, not maximum daily salinity (WQCP-DWR-24,9).

Response: This issue was discussed in the Western and Interior Delta Agriculture subworkgroup. Terry Prichard, the subworkgroups agricultural expert in the western and interior Delta, recommends an interval of compliance of 14 days (Letter to S. Humpert, June 12, 1990). Based on Mr. Prichard's recommendation, the statement in WQCP Appendix 5.2, page 5.2-1 in the section titled "Salinity Requirements for Corn", which states, "State Board Exhibit 24 indicates that, in the short-term, to maintain maximum corn yield, the maximum daily salinity of applied water should be no more than 1.5 mmhos/cm EC from April 1 through July 31 (SWRCB,24,1).", will be deleted and a clarifying statement will be added.

Change in text:
"Evidence indicates that in order to maintain maximum corn yield, in the short-term, the maximum 14-day running average of daily average salinities of applied water should be no more than 1.5 mmhos/cm EC from April 1 through July 31."

APPENDIX 5.3

Page 5.3-1, para 2

Comment: USFWS states that the reference USFWS exhibits and testimony was misrepresented by referring to Chinook salmon spawning and egg incubation temperature requirements being less than 60°F. (Page 5.3-3, Table 5.3-1) Reference should be WQCP-USFWS-1 (WQCP-USFWS-7,8).

Response: This was not meant to mislead but was a shorthand method of describing the early life history temperature requirements as being less than 60°F. Referenced text will be amended.

Change in text to Table 5.3-1:
"According to one publication, temperature requirements for the early life stages of Chinook salmon are as follows: Spawning and egg incubation: 49-56°F; Fry and juvenile rearing: 45-58°F (Bell, 1973)."

Page 5.3-1, third bullet

Comment: CVPWA states that the reference in the text to the testimony, "upstream and estuarine food supplies may be poor" is taken out of context (WQCP-CVPWA-210,39).

Response: Comments considered

No change in text.

Page 5.3-1, third bullet

Comment: SWC comment addresses elevated temperatures and food supply of juvenile salmon (WQCP-SWC-631,26).

Response: The referenced sentence is correct and is not inconsistent with the testimony. We are familiar with the different publications authored by Brett. This appendix cannot describe or contain all of the information on this topic. This section is an attempt to give a range of parameters and issues concerning Chinook salmon and temperature. Comments noted.

No change in text.

Page 5.3-2

Comment: CVPWA states that the text ignore a variety of sources of impact to upstream habitat and survival and suggests other to be included (WQCP-CVPWA-210,40).

Response: The text gives dams and diversions as an example of an impact to upstream habitat. A complete list would be too cumbersome. The additional impacts suggested, loss by entrainment, loss of gravel, additional predator habitat, etc., are impacts associated with dams and diversions.

No change in text.

Page 5.3-2, second to last paragraph, first sentence

Comment: CVPWA states that the numbers in Appendix Table 5.3-1 should be described as predicted (WQCP-CVPWA-210,40).

Response: Comment noted.

Change in text:
"The following table is a summary of predicted smolt survival indices....etc. The title of Appendix Table 5.3-1 will be changed to include the word "predicted."

Page 5.3-3, Table 5.3-1

Comment: Similar comment to that of CVPWA (WQCP-SWC-361,26).

Response: Comment noted.

Change in text:
The word <u>predicted</u> will be included in the text and in the Table title.

<u>APPENDIX 5.4</u>

Page 5.4-10

Comment: Low San Joaquin River flow may be associated with salinity, but no evidence that bass are spawning habitat limited. Releases from New Melones have improved south Delta water quality (WQCP-USBR-129B,2).

Response: The general discussion on spawning habitat and its limitations is presented in Section I of this document. Concerning the improved south Delta water quality, improvement there does little good if striped bass are prevented from taking advantage of the improved water quality because of salinity barriers farther downstream, or because the water quality is still not sufficient to provide adequate habitat.

No change in text.

Page 5.4-11

Comment: Recent evidence suggest that the summer dieoff may be due to toxic organic pollutants (WQCP-USBR-129B,2).

Response: Comment noted and the text will be modified.

Change in text:
"The cause is unknown, but may be related to liver dysfunction, possibly caused by toxic organic pollutants."

Pages 5.4-14ff

Comment: Extensive discussion of various technical issues related to striped bass, also discussed in comments on Plan text (SWC-WQCP-631,26-28).

Response: Comment noted. These issues have been responded to already in above responses.

No change in text.

SECTION IV

Addendum to the
"Responses to Comments"
on
The Water Quality Control for Salinity

The following comments were received after the State Board's special Board meeting on April 2, 1991.

Department of Fish and Game (DFG) Comment

Comment: DFG submitted a comment memo dated April 19, 1991, on the Compiled Revisions (April, 1991) to the Draft Water Quality Control Plan. They stated that the description of the Suisun Marsh Mitigation Agreement was incorrect on pages 1-2 and 7-31, and Tables 1-1 and 6-3 of the Final Draft of the Plan (January, 1991). The Suisun Marsh Preservation Agreement (SMPA), not the Mitigation Agreement, includes the descriptions of physical facilities.

Response: Agree. The text will be corrected in the appropriate places.

Sierra Club Legal Defense Fund (SCLDF) Comments

A. Chinook Salmon Temperature Objectives

Comment: In a letter dated April 15, 1991, SCLDF states that the State Board contends that the use of reservoir releases to control water temperature is not "reasonable, due to the distance of the Delta downstream of reservoirs and controllable factors such ambient air temperature, etc...". SCLDF believes that the State Board's position is mistaken, that regulating reservoir releases is indeed a controllable factor and in fact is the principle means available by which man can affect water temperature, etc. The Plan describes the USBR temperature model that will help evaluate Sacramento River flows required to achieve various temperature alternatives. There is no identification of any other feasible "controllable factors" that may influence temperatures. It is not clear why reservoir releases were excluded from consideration, even though they are the only logical "controllable factor" that could possibly affect water temperature.

Response: It is not that reservoir releases cannot affect temperatures, rather that amount required to do so is so great, because of the distance from major reservoirs to the Delta. For this reason, releasing water for the purpose of temperature control is considered unreasonable and a waste of water. The State Board will require a test of reasonableness before consideration of reservoir releases for such a purpose.

In regard to other possible controllable factors, Section 5.5 of the Plan includes waste discharge controls, increases in riparian canopy, and bypassing of warming areas (e.g., Thermalito Afterbay). As specified in the "Responses to Comments," the Plan will be changed in several sections:

Footnote 11 in Tables 1-1, 5-5 and 6-3; and Section 1.5, Page 1-13, and Section 5.5, Page 5-15.

B. The Specific Objectives for Salmon are Inadequate

Comment: In the April 15, 1991 letter, SCLDF also states that: 1) the State Board does not provide a logical or adequate explanation for the bifurcation of the temperature objective (66°F for the winter-run and 68°F temperature for all other races); 2) the "Responses to Comments" jumps from discussing a protection level of 66°F to a level of 60°F, without addressing the range in between (60 to 65°F) which evidence has demonstrated is the range needed to adequately protect salmon; 3) the "Response" does not address SCLDF's concern that protection for winter-run should also apply to all other runs; and 4) it is erroneous to claim that there is no precise method for determining what temperatures in the Delta adequately protect Chinook salmon despite evidence that salmon require temperatures below 65°F.

Response: As stated in the April 1991 "Responses to Comments" (under Page 5-22 heading), the State Board considers the winter-run salmon temperature objective as a cap. The temperature objectives for the winter and other runs are based on the entirety of the exhibits submitted by all parties at the hearings and workshops to date, as well as other pertinent publications, all of which are summarized in the Technical Appendix of the Plan. This information was not duplicated in the Responses to Comments. The objective is a narrative objective not a numerical objective, and as such serves as a guide to water managers regarding salmonid habitat in the Delta.

C. EC Standards

Comment: On page 3 of the April 15, 1991 letter, SCLDF states that the Plan should adopt the DFG recommendation on EC now, rather than retain "an admittedly inadequate standard".

Response: As noted on page I-20 of the "Responses to Comments," retaining the 1.5 mmhos/cm EC at Antioch retains an EC value of approximately 0.44 mmhos/cm at Jersey Point. So retaining the present Antioch standard does what DFG wanted to accomplish in D-1485, which was to provide spawning habitat upstream of Antioch. A water quality objective at Antioch of 1.5 mmhos/cm EC for striped bass spawning protection has been recognized since 1967.

Comment: On page 4 of the same letter, SCLDF states that, given the claimed lack of critical scientific EC data, the need for additional studies, and the precipitous decline in the striped bass population, the State Board should be conservative and set a standard of 0.3 mmhos/cm EC from Antioch to Vernalis, in conjunction with pumping restrictions.

Response: The State Board must set standards based on appropriate scientific data, and must be able to justify those standards. The State Board feels that it does not have adequate data to support such a standard at this time. If inadequate spawning habitat protection is not the major cause of the decline, as most participants acknowledge, then changing the standard will have little effect in and of itself, though the resultant flows might increase survival of eggs and young. In addition, pumping restrictions are not part of this phase, and will do nothing to protect adult spawning habitat. Pumping restrictions might also benefit survival of eggs and young, but again that is a separate issue unrelated to adult spawning protection. That issue will be discussed in the Scoping and Water Right phases.

D. Beneficial Uses

Comment: The State Board admits that all beneficial uses are not fully protected by the Plan, yet states that the water quality objectives are set at levels designed to adequately protect the designated beneficial uses of the Estuary (WQCP-SCLDF-3,7).

Response: These two statements are not incompatible. The Plan addresses the water quality aspects of salinity, temperature and oxygen concentrations which were identified with protecting beneficial uses. The State Board believes that the water quality objectives set forth in the Plan provide adequate protection of the designated beneficial uses. The State Board has determined that providing any more protection for the Estuary's beneficial uses from the effects of the parameters would require an unreasonable amount of water. However, there are non-water quality aspects such as entrainment and flow which the State Board will address in the forthcoming Water Right Phase. The State Board routinely holds focused actions on specific policies on water quality parameters contained in its Basin Plans, Ocean Plan and other planning documents. The Water Quality Control Plan for the Bay-Delta is similarly focused and must be viewed in conjunction with the Regional Board Basin Plans, the Inland Surface Waters and Bays and Estuaries plans, and the State Board's water right decisions that affect this water body.

E. Flow Standards

Comment: In the April, 1991 letter, SCLDF states in several places that the State Board was remiss in not including flow standards in the Plan (WQCP-SCLDF-3,5,6).

Response: While the Board does state that flow is necessary to protect beneficial uses, this statement does not indicate that the physical aspect of water is a water quality parameter. As SCLDF recognizes, the State Board identifies flow requirements when they can be tied to water quality effects on a beneficial use. However, even though flow in its own right may provide protection of a beneficial use, these protections are to be addressed in water right decisions rather than in the Water Quality Control Plan for these proceedings. The State Board believes that all the submitted data regarding protection levels for the beneficial uses of Bay-Delta waters were analyzed and appropriate water quality objectives developed.