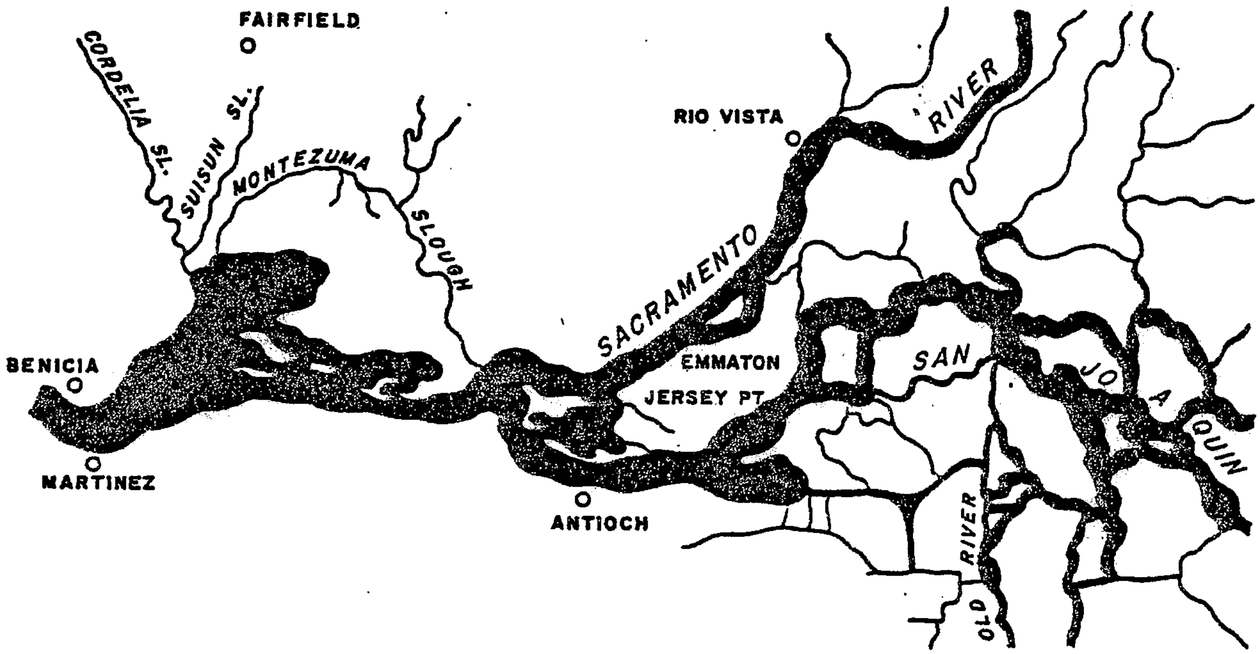
Water Quality Control Plan

Sacramento-San Joaquin Delta and Suisun Marsh



August 1978

STATE WATER RESOURCES CONTROL BOARD

STATE WATER RESOURCES CONTROL BOARD
RESOLUTION NO. 78-43

ADOPTION OF WATER QUALITY CONTROL PLAN FOR THE SACRAMENTO-SAN JOAQUIN DELTA AND SUISUN MARSH

WHEREAS:

1. A responsibility of the State Water Resources Control Board is the regulation of activities and factors which affect or may affect the quality of the waters of the State in order to attain the highest water quality which is reasonable, considering all demands being made and to be made on those waters, and the beneficial uses involved.

2. The State Board has undertaken a proceeding, under its full water right and water quality authority, to develop a single comprehensive set of water quality standards to protect beneficial uses of the waters of the Sacramento-San Joaquin Delta.

3. The State Board has conducted 32 days of evidentiary hearing initiated on November 15, 1976 and concluded on October 7, 1977 in accordance with the Federal Clean Water Act (P.L. 95-217) and the California Water Code, and has considered the evidence introduced at the hearing.

4. Based on the evidentiary record, a draft water quality control plan for the Sacramento-San Joaquin Delta and Suisun Marsh and a Draft Environmental Impact Report were formulated and submitted for public review on March 15, 1978.

5. The State Board conducted a public hearing on the draft water quality control plan and Draft Environmental Impact Report on May 30, 1978, after notice to all interested persons, in accordance with federal and State requirements and has considered the oral and written comments submitted.

6. The Water Quality Control Plan and Environmental Impact Report have been revised to incorporate appropriate comments received from the interested persons.

7. The water quality standards in the Water Quality Control Plan for the Sacramento-San Joaquin Delta and Suisun Marsh will be reviewed at least once every three years.

8. The State Board will reopen the Delta water right hearing not later than eight years from the adoption of this plan for the purpose of receiving further evidence relating to salinity control, protection of fish and wildlife in the Bay-Delta estuary, and coordination of terms and conditions of the permits for the Delta water supplies of the federal Central Valley Project and the State Water Project.

9. The Water Quality Control Plan for the Sacramento-San Joaquin Delta and Suisun Marsh does not mandate the construction of facilities or mandate activities outside of the State Board's jurisdiction.

10. By approval of the Water Quality Control Plan the Board does not intend to affect negotiations among various Delta water agencies and the Department of Water Resources and U.S. Bureau of Reclamation regarding agreements on water quality and water quantity in the Delta.

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

12. The State Board has certified the Environmental Impact Report on the Water Quality Control Plan (and corresponding Water Right Decision).

THEREFORE BE IT RESOLVED:

1. That the State Board adopts the Water Quality Control Plan for the Sacramento-San Joaquin Delta and Suisun Marsh (Delta Plan) in accordance with Section 13170 of the Water Code.

2. That the Delta Plan supersedes the Basin Plans to the extent of any conflict with specific water quality standards (salinity) and will be in effect until the end of calendar year 1988 unless modified earlier.

3. That adoption of the water quality standards (salinity) in the Delta Plan should not be construed as representing final action by the State Board on water quality standards for the Delta and Suisun Marsh and that water quality standards may be modified if necessary to protect beneficial uses of Delta water supplies.

4. That the Executive Director is directed to forward copies of the Water Quality Control Plan to the Environmental Protection Agency in accordance with requirements of the Federal Clean Water Act (as amended by P.L. 95-217).

CERTIFICATION

The State Water Resources Control Board has determined that there is no state mandate for a new program or increased level of service on any unit of local government as a result of the foregoing resolution because such resolution is not an executive regulation pursuant to the Revenue and Taxation Code, Section 2209.

The undersigned, Executive Director of the State Water Resources Control 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 August 16, 1978.

Dated: AUG 16 1978

Larry F. Walker

Executive Director
Larry F. Walker

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CHAPTER I

INTRODUCTION

The Sacramento-San Joaquin Delta and Suisun Marsh include about 120 square miles of surface water area where northern and central California's major river systems converge and flow westward, meeting the incoming seawater from San Francisco Bay and the Pacific Ocean. The Delta area is the largest, most important estuary for fish and waterfowl production on the Pacific Coast of the United States, and, at the same time, one of the state's most fertile and important agricultural regions and the location of a major water-related industrial corridor in the vicinity of Antioch.

The Delta is a vital link between the water surplus areas in the Sacramento Valley and the water deficient areas to the south and west of the Delta. Two major systems - one state and one federal - export surplus supplies from the Delta to areas of need. These systems are the State Water Project (SWP) operated by the Department of Water Resources (Department) and the Central Valley Project (CVP) operated by the U. S. Bureau of Reclamation (Bureau).

Competition for Delta water supplies between in-basin and export uses has increased substantially over the last few years and will become yet more intense in the future. This increased demand will test the ability of state and federal water officials over the next few years to ensure an adequate Delta water supply to meet all in-basin and export uses.

The Delta has been the subject of the most extensive and intensive water quality planning ever undertaken for any major area of the state. Notwithstanding this, much is unknown about this complex estuary. In addition there is uncertainty regarding what future water facilities may be constructed and affect the Delta and Suisun Marsh. A Delta transfer facility, overland facilities to western Delta islands and Suisun Marsh, internal water circulation facilities in the southern Delta, additional export pumps, the relocation of the Contra Costa Canal Intake, and the construction of additional storage facilities have all been proposed.

In 1967 the water quality control and water right functions of the state were merged in order that necessary inter-relationships between water quality and availability of unappropriated water could be considered together by a single state agency. The current proceeding is the first time that water quality control and water right functions of the Board have been fully combined in the development of a single set of water quality standards.

This water quality control plan for the Sacramento-San Joaquin Delta and Suisun Marsh (Delta Plan) represents the culmination of thirty-two days of evidentiary hearing initiated on November 15, 1976, and concluded on October 7, 1977. The evidentiary record also has been used in formulating a water right decision to implement applicable provisions of the plan through revisions of terms and conditions in permits of the Department and Bureau.

The applicable terms and conditions which have been incorporated into permits of the Department and Bureau are set forth in the plan.

Even though two documents have been adopted by the Board (a water quality control plan and a water right decision), they represent a unified effort by the Board to develop under its full authority a single comprehensive set of water quality standards to protect beneficial uses of Delta water supplies, recognizing the respective rights of all users to such supplies.

Since the two distinct approvals constitute the whole of a single project, a single environmental impact report (EIR) has been prepared and approved by the Board for both of these documents.

A. GEOGRAPHIC DESCRIPTION

The Sacramento-San Joaquin Delta as defined in Section 12220 of the California Water Code is a roughly triangular area of about 738,000 acres extending from Chipps Island near Pittsburg on the west to Sacramento on the north and to the Vernalis Gauging Station on the south (see Plate 1). The Delta generally is comprised of those waterways above the confluence of the Sacramento and San Joaquin Rivers which are influenced by tidal action, and about 510,000 acres of agricultural lands which derive their water supply from these waterways. The total surface area of these waterways is over 48,000 acres with an aggregate navigable length of 550 miles.

Suisun Marsh as defined by Section 29101 of the Public Resources Code is an intricate land-water area of marsh, ponds, sloughs and estuaries which furnish habitat for a variety of plants and animals. The Marsh includes the waterways north of Suisun and Honker Bays which are subject to tidal action and the adjacent lands whose management is dependent on tidal action in those waters (see Plate 1). The area contains approximately 50,000 acres of diked, managed wetlands, 5,500 acres of tidal marsh, and 30,000 acres of bays, sloughs and other waterways. These wetlands are a unique and highly productive interface between fresh and saltwater environments and play an important role in providing wintering habitat for waterfowl of the Pacific Flyway.

B. BOARD AUTHORITY

Water Quality Control

The Board is charged with responsibility under the California Water Code to regulate activities which affect or may affect the quality of waters of the state in order to attain the highest water quality which is reasonable, considering all demands being made and to be made on those waters and the beneficial uses involved. Section 13170 of the Water Code provides that the Board may adopt water quality control plans for surface waters.[1/]

1/ Such plans must be adopted in accordance with the provisions of Sections 13240 to 13247 of the Water Code.

A water quality control plan is a management document which identifies the municipal, industrial, agricultural, and instream environmental use of water within a specified area and sets forth an effective program to protect those uses. Such plans, when adopted, supersede any regional water quality control plan (basin plan) adopted by a Regional Board for the same waters to the extent of any conflict.

In addition, the Federal Water Pollution Control Act, as amended,[2/] requires the establishment of water quality standards[3/] for all surface waters of the state. Section 303(e) of the Act provides that each state is responsible for the establishment of such water quality standards through water quality control plans which must be submitted and approved by the Environmental Protection Agency.

Water Rights

The water right permits of the Department and Bureau which are the subject of this proceeding are set forth in the appendix to this plan (Appendix A).

2/ Referred to as the Clean Water Act of 1977 (PL 95-217)

3/ Under the California Water Code, "water quality objectives" mean enforceable numerical limits on water quality characteristics which are established to protect beneficial uses. However, the term "objectives" is commonly understood to mean goals or other non-binding guides. For this reason, "water quality standards" is used herein to convey the concept of enforceable numerical limits.

The Board's authority to review and amend these permits is derived from Section 1394 of the California Water Code, jurisdiction expressly reserved in the subject permits, Water Code Section 100 and the continuing authority of the Board, as stated in the terms of the permits, to prevent waste, unreasonable use, unreasonable method of use, or unreasonable method of diversion of water.

In exercising its reserved jurisdiction, the Board has two broad areas of concern based upon its statutory responsibilities. These are (1) protection of vested water rights, and (2) protection of the public interest.

Protection of Vested Water Rights

Prior vested water rights include those of riparian lands, pre-1914 appropriators and appropriators whose rights are based upon water right permits with priority earlier than those of the Department and the Bureau. In addition, the permits of both the Department and Bureau for use outside the Delta or the Sacramento River watershed are subject to use by appropriators within the Delta and watershed regardless of when such use was or is initiated (Water Code Section 11460 and Decisions D 990 and D 1275). The effect of this limitation is to make the rights of all legal users of water in the Delta and in the watershed senior to the rights of either the Department or the Bureau to store or divert water for use outside the Delta or the watershed.

The projects must be operated so as not to cause any material deterioration of water quality which would impair its usefulness for the reasonable beneficial uses which are made of water by senior right holders. The Department and Bureau can be relieved of this responsibility only if they provide an adequate substitute supply without additional expense to Delta water users (Water Code Section 12202). However, the rights of water users on riparian lands and appropriators in the Delta extend only to water quality and quantity which would have been available in the absence of the projects, taking into consideration upstream uses under vested rights. If Delta water users desire additional benefits in excess of their vested rights they can seek such benefits from project operators.

Although the Board in this proceeding is not adjudicating or determining the validity of individual vested water rights, it must nonetheless identify the extent to which such rights would have been satisfied in the absence of the projects to ensure that the operation of project facilities does not adversely encroach upon these uses.

Public Interest

"Public interest" is one of the primary statutory standards guiding the Board in acting upon applications to appropriate water (see Johnson Rancho County Water District v. State Water Rights Board, 235 Cal. App. 2d 863, 45 Cal. Rptr. 589 (1965); California Water Code Sections 1253-1258).

The Water Code provides in several sections that the Board should consider the broad public interest in making water right determinations. Section 1257 directs that the Board consider the relative benefit to be derived from all beneficial uses of the water concerned and further provides that the Board may subject appropriations to such terms and conditions as in its judgment will best develop, conserve and utilize in the public interest, the water sought to be appropriated. Similarly, Section 12581 provides that in studying water development projects, full consideration shall be given to all beneficial uses of the state's water resources, including irrigation, generation of electric energy, municipal and industrial consumption of water and power, repulsion of salt water, preservation and development of fish and wildlife resources, and recreational facilities, but not excluding other beneficial uses of water. Finally, with regard to the SWP, Section 11900 mandates that preservation of fish and wildlife should be provided for in connection with the construction of project facilities.

Another source of guidance in determining the public interest is the California Environmental Quality Act of 1970 (Public Resources Code, Div. 13) which provides that it is the state policy to:

> (a) Develop and maintain a high-quality environment now and in the future, and take all action necessary to protect, rehabilitate, and enhance the environmental quality of the state.

(b) Take all action necessary to provide the people of this state with clean air and water, enjoyment of aesthetic, natural, scenic, and historic environmental qualities, and freedom from excessive noise.

(c) Prevent the elimination of fish or wildlife species due to man's activities, insure that fish and wildlife populations do not drop below self-perpetuating levels, and preserve for future generations representations of all plant and animal communities and examples of the major periods of California history.

(d) Ensure that the long-term protection of the environment shall be the guiding criterion in public decisions.

(e) Create and maintain conditions under which man and nature can exist in productive harmony to fulfill the social and economic requirements of present and future generations.

(f) Require governmental agencies at all levels to develop standards and procedures necessary to protect environmental quality.

(g) Require governmental agencies at all levels to consider qualitative factors as well as economic and technical factors and long-term benefits and costs, in addition to short-term benefits and costs, and to consider alternatives to proposed actions affecting the environment.

A more specific mandate governing the Board in this decision is Part 4.5 of Division 6 of the Water Code, referred to as the Delta Protection Act. The Delta Protection Act accords first priority to satisfaction of vested rights and public interest needs for water in the Delta and relegates to lesser priority all exports of water from the Delta to other areas for any purpose. These statutory policies are subject to the overriding constitutional provision that all uses of water and diversions of water must be reasonable (Article 10, Section 2, California Constitution).

C. SCOPE OF BOARD ACTIONS

The jurisdiction reserved by the Board to revise or formulate additional terms and conditions in the water right permits issued to the Department and Bureau affecting Delta water supplies covers three general areas: (1) salinity control, (2) protection of fish and wildlife, and (3) coordination of terms and conditions of the respective permits for the SWP and CVP.

The principal focus of this plan is limited to current and near-term conditions in the Delta. The water quality standards are based on conditions expected to prevail over the next ten years. The Board, in limiting the effective period of the plan, recognizes the uncertainty associated with proposed project facilities to be constructed and the need for additional information on the Delta-Bay ecosystem. As new facilities are constructed and additional information gathered on the Delta, the Board will review water quality standards to ensure that beneficial uses of Delta supplies are protected.

This is consistent with Section 303(c)(1) of the Federal Water Pollution Control Act (PL 92-500) which requires review at least once every three years of water quality standards established in water quality control plans.

D. THE WATER QUALITY CONTROL PLAN

The Delta Plan consists of three elements: (1) designation of beneficial uses to be protected, (2) establishment of water quality standards for reasonable protection of the beneficial uses, and (3) establishment of a program of implementation needed for achieving these water quality standards (Water Code Section 13050(j). The implementation program set forth in Chapter VII of the plan provides both specific measures which must be taken to satisfy water quality standards during the effective period of this plan, and broad policy guidance to assist location, state and federal agencies in finalizing plans for additional project facilities.

Chapter II of this report discusses water quality conditions in the Delta and Suisun Marsh and Chapter IV describes the past proceedings undertaken by the Board and its predecessor agencies (the State Water Quality Control Board and the State Water Rights Board) to protect beneficial uses of Delta supplies.

The water quality standards are presented in Chapter VI. These standards reflect a closer fit to hydrologic conditions and available water supplies than current water quality objectives contained in the basin plans. Even though the standards require less freshwater outflow because of a more efficient use of Delta outflows and a better understanding of beneficial use needs in the Delta, the overall protection under the standards is greater than that provided by the current basin plan objectives (see Chapter IV of EIR). In addition, the water quality control plan requires mitigation of project impacts on Suisun Marsh by October 1, 1984.

The Delta Plan supersedes Figure IV-1 and the Delta salinity standards of Table IV-2 both contained in the Water Quality Control Plan for the Sacramento-San Joaquin Delta Basin (Basin 5B Plan). Also, the Delta Plan supersedes the Chipps Island and Suisun Marsh standards of the Water Quality Control Plan for the San Francisco Bay Basin (Basin 2 Plan), as modified by State Board Resolution 76-61.

The water quality control plan for the Delta and Suisun Marsh will be submitted to the Environmental Protection Agency for approval in accordance with requirements of PL 92-500 as amended. This water quality control plan, when considered as an adjunct to the comprehensive basin plans, satisfies all federal requirements.

CHAPTER II

WATER QUALITY CONDITIONS

Water quality conditions in the Delta and Suisun Marsh depend on water quantity. Delta waters are a mixture of seawater and freshwater including return flows of various salinity levels. The salinity of the mixture is extremely variable geographically, seasonally and from year to year. The extent of salinity intrusion into the Delta is determined by the relative magnitude of the opposing forces of tidal action and Delta outflow.

Upstream storage facilities, in-basin depletions and Delta exports have all reduced and seasonally altered the natural freshwater outflow from the Delta. This alteration of natural outflow has significantly affected the extent and duration of seawater intrusion into the Delta and Suisun Marsh.

Salinity is the major water quality factor affecting beneficial uses of Delta supplies and is directly influenced by operations of project facilities. Therefore, the discussion on water quality conditions in the Delta is restricted to salinity intrusion.

The major factors affecting Delta outflow are natural runoff, the regulatory effects of upstream developments which either reduce runoff or change its time of occurrence, and SWP and CVP operations which transport water through the Delta and pump water from it for export.

Storage facilities constructed by the state, federal government and other public and private agencies have reduced winter and spring flows but have increased summer and fall flows through storage releases. However, expected increases in export rates will lower the mid and late fall outflows below natural levels. Since riparian water rights in the Delta extend only to natural flows, measured flows must be adjusted to reflect these man-induced alterations to natural hydrology to assess impacts on vested water rights.

A hydrologic classification of year types has been developed for this plan. The water quality standards set forth in Table VI-1 provide for adjustments in the level of protection to beneficial uses according to the hydrologic year type.

A new year type classification system was proposed by the Department during the hearing process (Department Exhibit 1)1/. Figure II-1 shows the year classification system developed for the Delta Plan. It is the same as the Department's proposal except that the "Year Following Critical Year" designation does not apply to agricultural, municipal and industrial standards. This modification is necessary to provide those uses the full protection to which they are entitled under their vested water rights. The system is based on unimpaired runoff to the Sacramento Valley from the four principal tributaries to it: Sacramento River, Feather River, Yuba River and American River. Although there were some objectives, the only other substantial modification offered to the Department's classification system was one which included San Joaquin River flows. The evidence does not indicate that the addition of San Joaquin River inflows would improve the classification system.

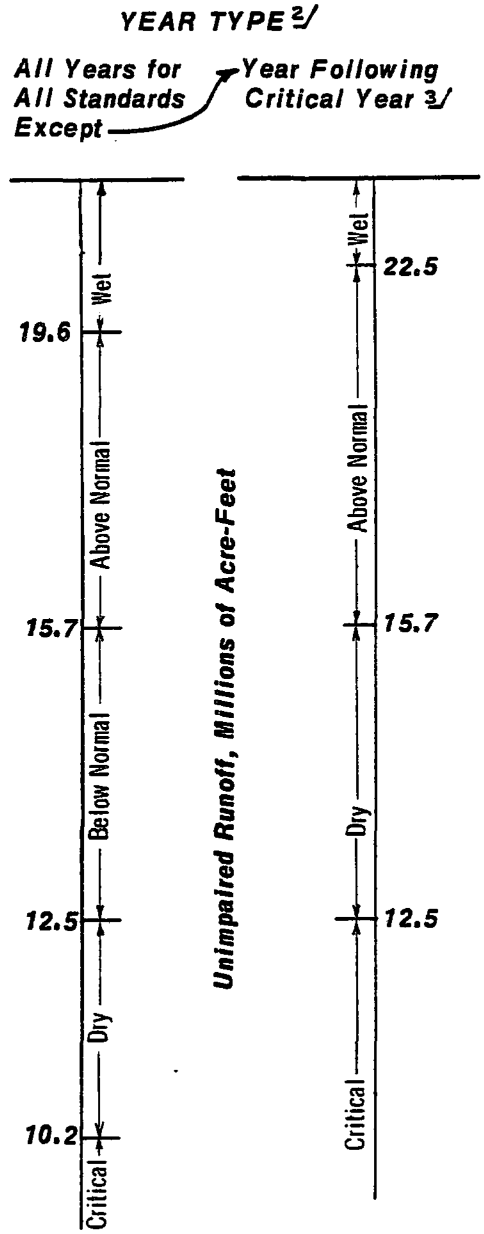
1/ References herein to the hearing record may be to either exhibits identified by party and exhibit number or testimony identified by reporter's transcript (RT) volume and page number.

FIGURE II-1

YEAR CLASSIFICATION

Year classification shall be determined by the forecast of 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 for 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.

YEAR TYPE	***RUNOFF, MILLIONS OF ACRE-FEET***
Wet 1/	equal to or greater than 19.6 (except equal to or greater than 22.5 in a year following a critical year). 3/
Above Normal 1/	greater than 15.7 and less than 19.6 (except greater than 15.7 and less than 22.5 in a year following a critical year). 3/
Below Normal 1/	equal to or less than 15.7 and greater than 12.5 (except in a year following a critical year). 3/
Dry	equal to or less than 12.5 and greater than 10.2 (except equal to or less than 15.7 and greater than 12.5 in a year following a critical year). 3/
Critical	equal to or less than 10.2 (except equal to or less than 12.5 in a year following a critical year). 3/



1/ *Any otherwise wet, above normal, or below normal year may be designated a subnormal snowmelt year whenever the forecast of April through July unimpaired runoff reported in the May issue of Bulletin 120 is less than 5.9 million acre-feet.*

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.*

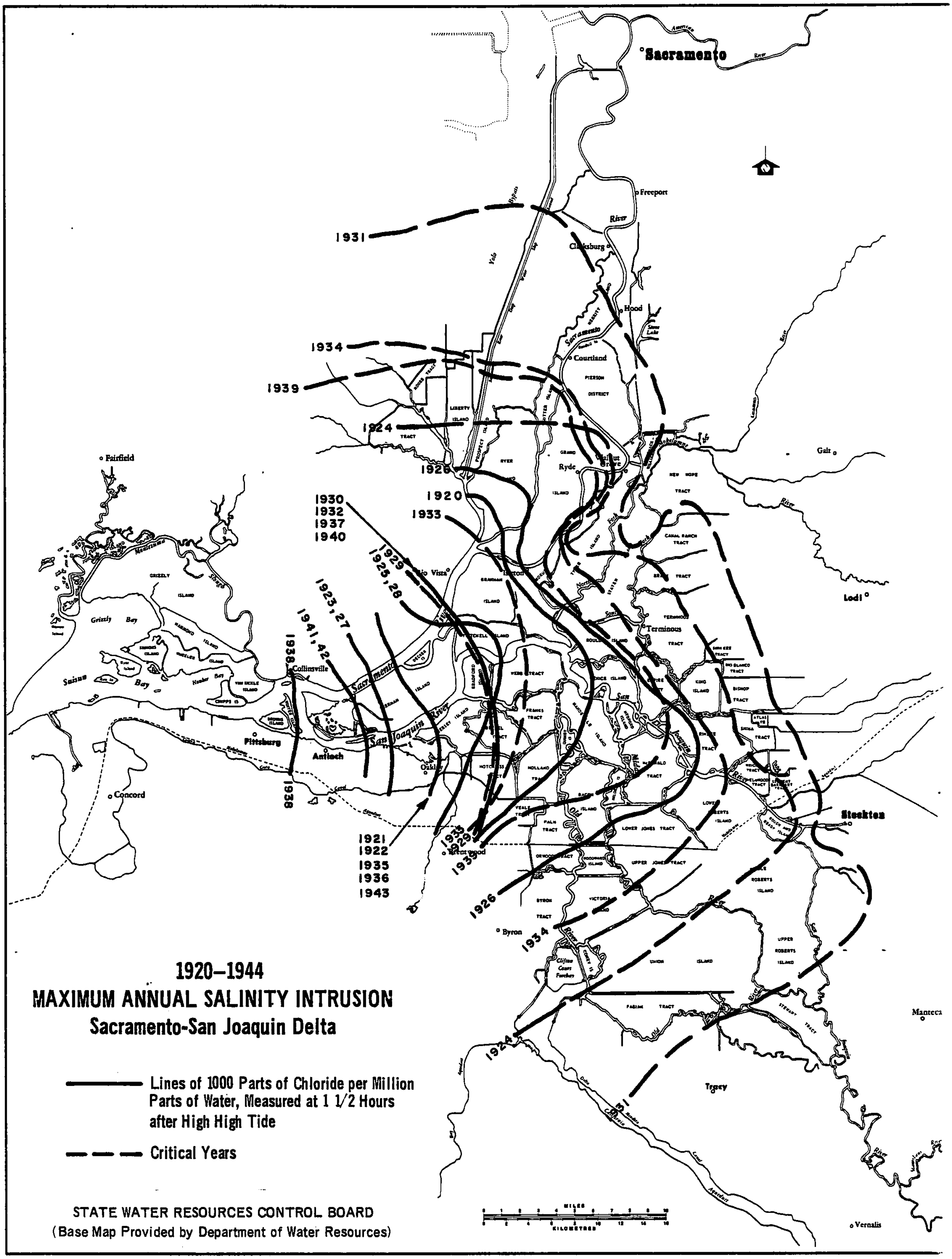
3/ *"Year following critical year" classification does not apply to Agricultural, Municipal and Industrial standards.*

The following discussion is divided into three parts: pre-project, post-project, and without project water quality conditions. Pre-project water quality reflects those conditions existing during the period 1920-1944. This is the most complete period of record for which salinity intrusion data on the Delta is available, prior to operation of SWP and CVP facilities. The post-project period 1945-1976, commencing with initial operation of Shasta Dam in 1945, encompassed an increasing number of regulatory facilities and stream depletions. The without project condition is a theoretical condition. It refers to the water quality that would occur in 1980 had the CVP and SWP facilities not been constructed. The without project condition reflects the effect of other non-project regulatory facilities and stream depletions.

A. PRE-PROJECT CONDITIONS

Under pre-project conditions (1920-1944), seawater moved upstream toward and into the Delta when freshwater inflows to the Delta decreased. Typically, this salinity intrusion began in late spring and continued through the summer, with maximum intrusion occurring sometime in August or September. Figure II-2 shows the maximum salinity intrusion each year for pre-project conditions, as reflected by the location of the 1000 ppm chloride line.[2/] The wide

2/ For purposes of this plan, salinity is expressed in terms of chloride ion concentration, total dissolved solids (TDS) or electrical conductivity (EC). Chloride ion concentration and TDS are expressed interchangeably as parts per million parts of water (ppm) or as milligrams per liter of water (mg/l). EC is expressed in terms of millimhos per centimeter at 25°C (mmhos). Seawater has an average chloride concentration of 18,000 ppm and predominantly freshwater river flows into the Delta have a chloride concentration of 10-20 ppm. The 1000 ppm chloride concentration, which is unusable for most beneficial uses in the Delta, has been used historically as a measure of salinity intrusion since the 1920's.


Sacramento
Freeport
Clarksburg
Hood
Courtland
Ryde
Walnut Grove
Rio Vista
Isleton
Terminous
Collinsville
Pittsburg
Antioch
Oakley
Brentwood
Byron
Concord
Fairfield
Stockton
Lodi
Galt
Tracy
Manteca
Vernalis
Grizzly Bay
Suisun Bay
1931
1934
1939
1924
1926
1920
1933
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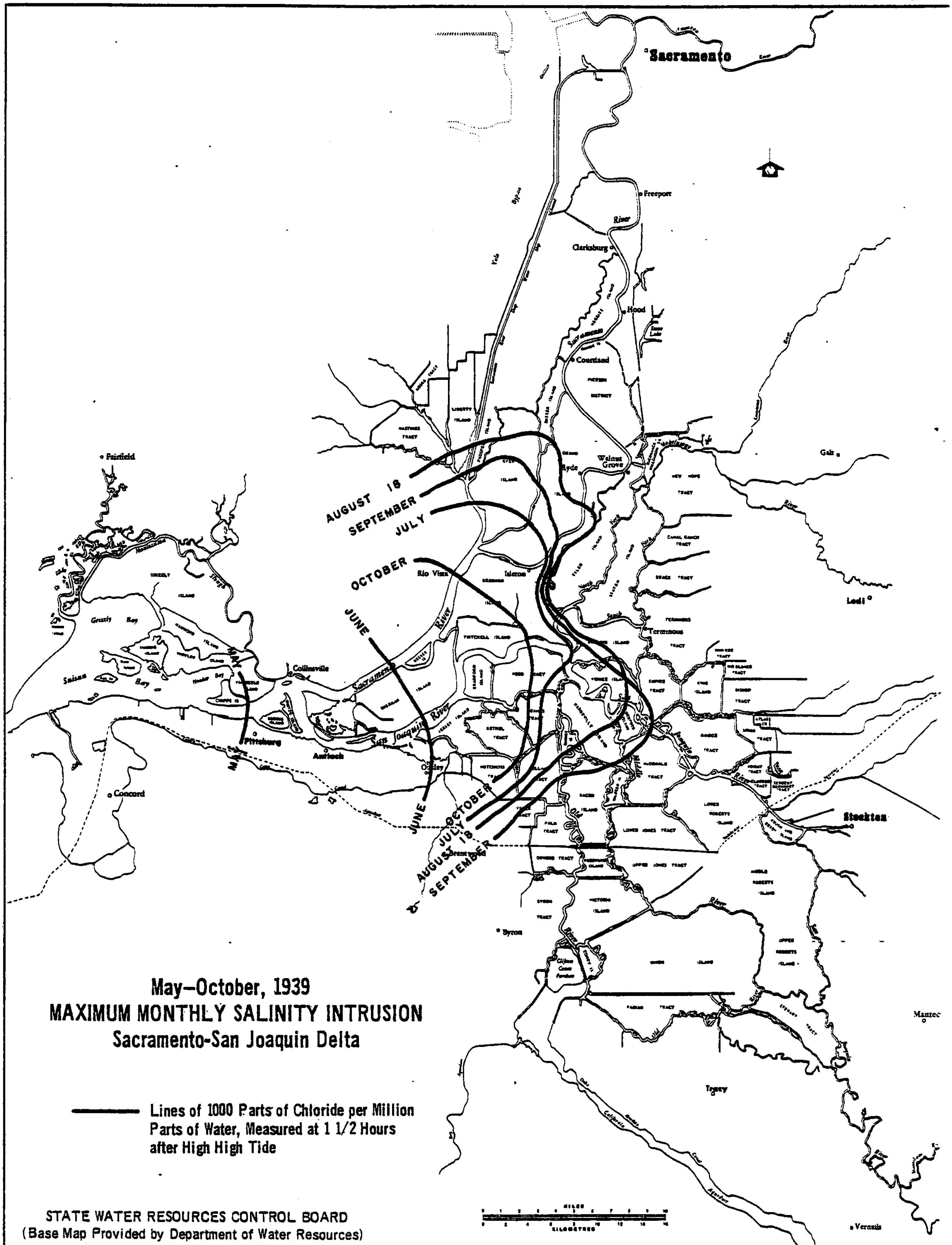
1940
1929
1925, 28
1923, 27
1941, 42
1938
1921
1922
1935
1936
1943
1920–1944
MAXIMUM ANNUAL SALINITY INTRUSION
Sacramento-San Joaquin Delta
Lines of 1000 Parts of Chloride per Million Parts of Water, Measured at 1 1/2 Hours after High High Tide
Critical Years
STATE WATER RESOURCES CONTROL BOARD
(Base Map Provided by Department of Water Resources)
MILES
KILOMETRES

fluctuation in the maximum salinity intrusion from year to year is due to the large-scale variations of freshwater Delta inflows from tributary streams experienced during the 1920-1944 period. These variations reflect differences not only in total annual inflows, but also in the seasonal distribution of those inflows. For instance, reduced freshwater inflows into the Delta during 1924 and 1931, both of which were critical water supply years, as defined by the runoff of the Sacramento Valley tributaries described in Figure II-1, resulted in extensive salinity intrusion. Conversely, high runoff in the Central Valley during 1938 held the maximum salinity intrusion to the western border of the Delta. Under pre-project conditions, the extent of salinity intrusion was not affected by CVP or SWP regulatory facilities or by upstream and export uses induced by those facilities.

Figure II-3 illustrates the progressive intrusion of seawater during a typical critical year, 1939. As shown in this figure, salinity intrusion into the western Delta commenced sometime in June, gradually pushing its way into the central portion of the Delta by August and September. The maximum salinity intrusion into the Sacramento River portion of the Delta occurred on August 18. After that date, freshwater inflows to the Delta increased sufficiently to repulse salinity. These increased inflows marked the close of the irrigation season for many crops in the Sacramento Valley resulting in a substantial accretion in return flows from upstream development. In the southern portion of the central Delta, along the San



May–October, 1939
MAXIMUM MONTHLY 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

STATE WATER RESOURCES CONTROL BOARD
(Base Map Provided by Department of Water Resources)

Joaquin River, the maximum salinity intrusion did not occur until September and salinity repulsion was much slower than in the Sacramento River portion of the Delta.

Pre-project conditions generally provided adequate protection of many Delta beneficial uses in most years. In dry and critical years, maximum salinity intrusion extended inland as indicated by the monthly intrusion pattern for 1939, shown on Figure II-3. Thus, even in dry and critical years there was suitable water quality for many uses during much of the summer. The occurrence and extent of seawater intrusion is important in assessing its impact on Delta beneficial uses. Figures II-4 and II-5 illustrate variations in these factors under the various hydrologic year types for Emmaton and Jersey Point in the western Delta and for Central Landing (on Andrus Island near the mouth of the Mokelumne River) and Webb Pump (on False River near Old River) in the interior Delta.

Figures II-4 and II-5 are based on the same historical water quality data as Figure II-2. The basic data represent water quality samples taken 1-1/2 hours after high high tide.[3/] These salinity values are somewhat greater than comparable mean tide values. These basic data have been adjusted to represent the

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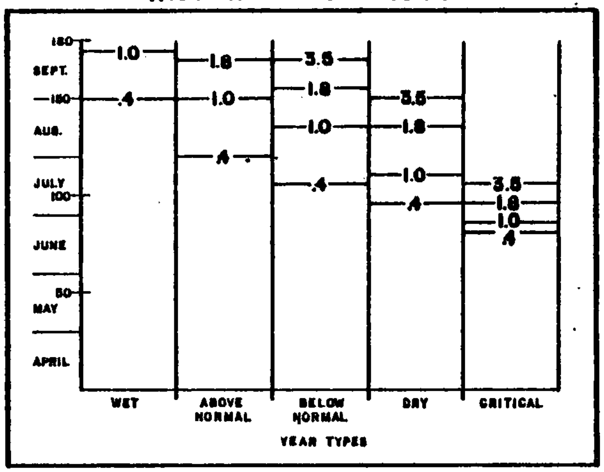
3/ The higher of the two high tides in each tidal cycle of about 25 hours.

WESTERN DELTA WATER QUALITY (electrical conductivity),

DURING APRIL THROUGH SEPTEMBER FOR EACH YEAR TYPE 1/

SACRAMENTO RIVER AT EMMATON

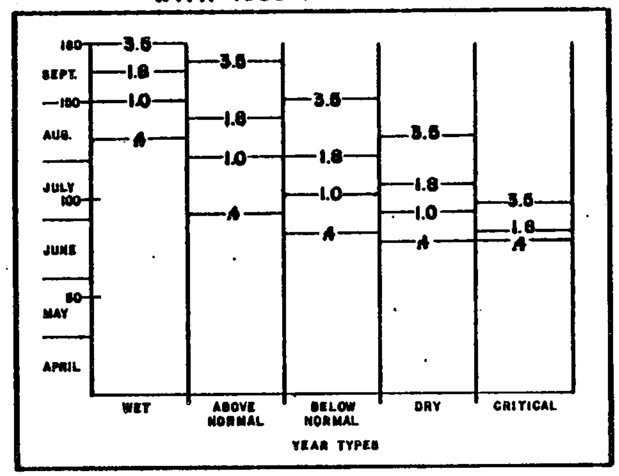
HISTORIC 1922-1944



APPROXIMATE CONVERSIONS

EC mm/cm	Cl⁻ mg/l	TDS mg/l
.4	73	258
1.0	252	611
1.8	536	1091
3.5	1000	2139

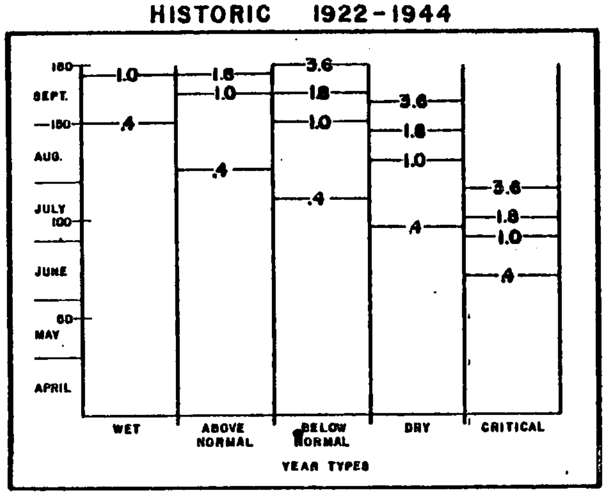
WITHOUT PROJECT (SWP/CVP) CONDITIONS WITH 1980 DEPLETIONS



II-70

SAN JOAQUIN RIVER AT JERSEY POINT

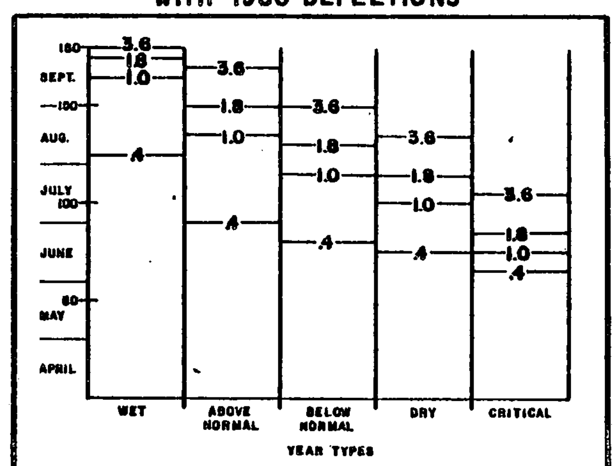
HISTORIC 1922-1944



APPROXIMATE CONVERSIONS

EC mm/cm	Cl⁻ mg/l	TDS mg/l
.4	62	244
1.0	241	580
1.8	476	1055
3.6	1000	2225

WITHOUT PROJECT (SWP/CVP) CONDITIONS WITH 1980 DEPLETIONS



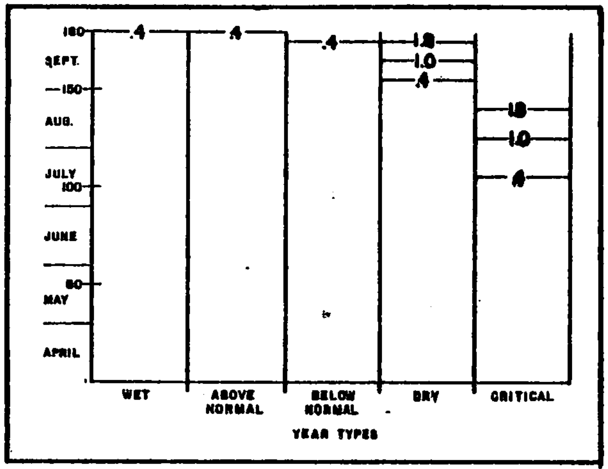
1/ Data corrected to represent mean tide conditions

FIGURE II-4

INTERIOR DELTA WATER QUALITY (electrical conductivity), DURING APRIL THROUGH SEPTEMBER FOR EACH YEAR TYPE 1/

MOKELUMNE RIVER AT CENTRAL LANDING

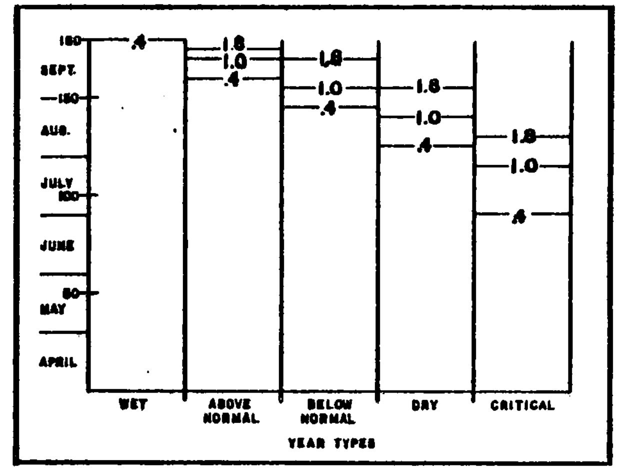
HISTORIC 1922-1944



APPROXIMATE CONVERSIONS

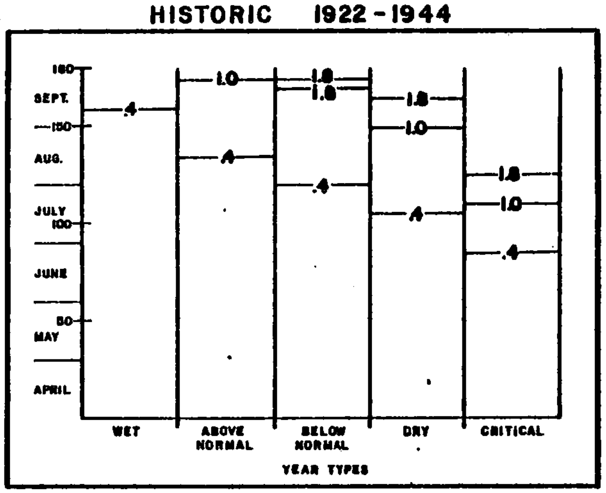
EC mm/cm	Cl- mg/l	TDS mg/l
.4	61	280
1.0	174	700
1.8	325	1260

WITHOUT PROJECT (SWP/CVP) CONDITIONS WITH 1980 DEPLETIONS



FALSE RIVER AT WEBB PUMP

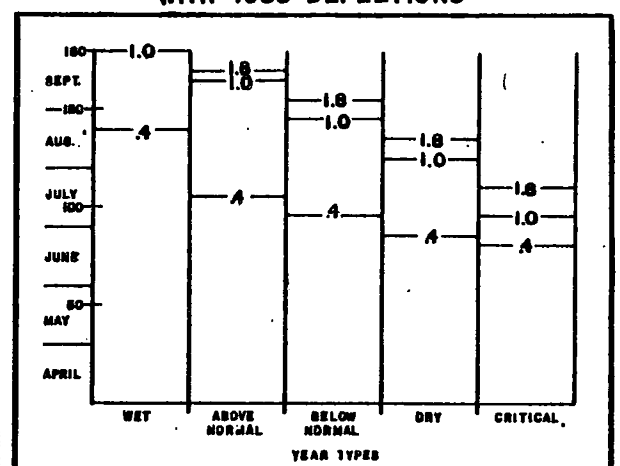
HISTORIC 1922-1944



APPROXIMATE CONVERSIONS

EC mm/cm	Cl- mg/l	TDS mg/l
.4	62	258
1.0	218	582
1.8	483	1014

WITHOUT PROJECT (SWP/CVP) CONDITIONS WITH 1980 DEPLETIONS



1/ Data corrected to represent mean tide conditions

FIGURE II-5

mean tide conditions shown in Figure II-2. (see RT Vol. XX, p. 39, et seq., and Staff Exhibits 4 and 5 for methodology on development of these figures).

The occurrence and duration of water quality equal to or better than salinity levels[4/] experienced during the irrigation season (April-September) of typical wet through critical hydrologic year types are shown in Figures II-4 and II-5. As reflected in these figures, there are significant differences in the occurrence and duration of these salinity levels between the western and interior Delta during the irrigation season. The western Delta experienced exceptionally good water quality during most of the irrigation season only in above-normal and wet years. Even though good water quality was experienced early in the season in dry years and in critical years, the quality deteriorated rapidly as low summer Delta inflows allowed extensive salinity intrusion. However, the water quality conditions at the two interior Delta stations, depicted in Figure II-5, were good except in critical years at the Webb Pump station. Water quality differences between the two interior Delta stations are due primarily to the respective influences of the major river systems. At Central Landing station the Sacramento River with substantial flows is the major influence whereas at Webb Pump station the low flowing and more saline San Joaquin River is the primary influence.

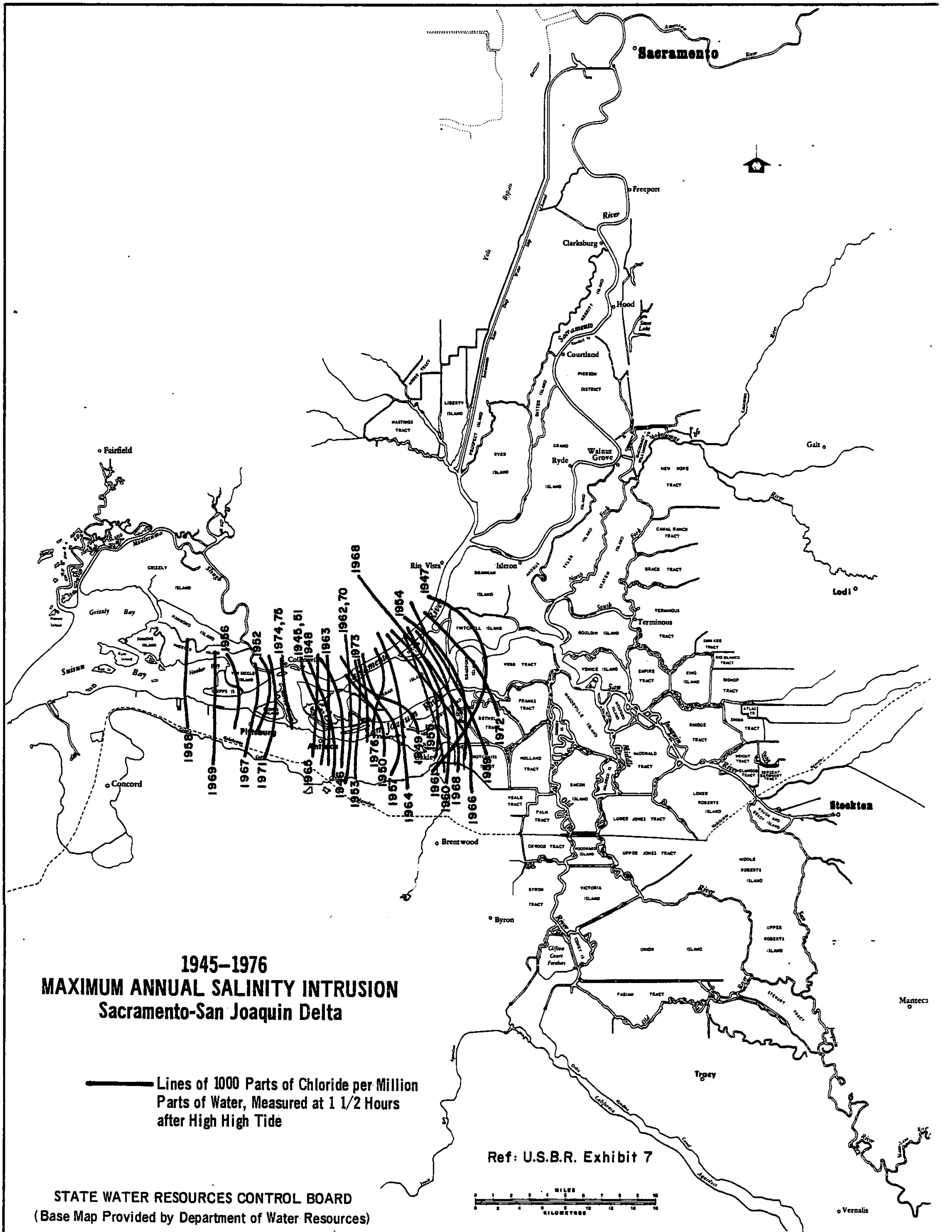
4/ The specified salinity levels have been selected to identify the extent that water quality conditions in the Delta would be suitable for agricultural uses.

B. POST-PROJECT CONDITIONS

Operations of the CVP and SWP and other water development projects have resulted in substantial regulation of stream flows tributary to the Delta. Major reservoirs in the watersheds tributary to the Delta have more than twenty million acre-feet of storage capacity. Figure II-6 shows the maximum annual salinity intrusion into the Delta for the post-project period 1945-1976. Project operations have reduced winter and spring outflows and increased summer and fall outflows. These operational outflow modifications generally have kept the maximum salinity intrusion into the Delta (the 1000 ppm chloride line) at a point further west than would otherwise have been the case. In most years since 1945, maximum salinity intrusion has not extended much beyond Emmaton and Jersey Point, because project reservoirs have stored the high spring flows and have released this water to increase summer and fall flows. Thus, salinity over the last 30 years through much of the summer generally has been somewhat less than would have occurred naturally, but the 1000 ppm chloride line reached Antioch earlier in the year during below normal, dry and critical runoff years of the post-project period than in similar year types prior to project operations (NDWA Exhibit D). However, it has not extended as far upstream as under pre-project conditions.

C. WITHOUT PROJECT CONDITIONS

Without project conditions have been established by adjusting pre-project salinities to reflect 1980 levels of upstream depletions attributable to sources other than the state and federal projects.


1945–1976
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
Ref: U.S.B.R. Exhibit 7
STATE WATER RESOURCES CONTROL BOARD
(Base Map Provided by Department of Water Resources)
Sacramento
Freeport
Clarksburg
Hood
Courtland
Walnut Grove
Ryde
Isleton
Rio Vista
Terminous
Stockton
Lodi
Galt
Fairfield
Concord
Brentwood
Byron
Tracy
Manteca
Vernalis
Grizzly Bay
Suisun Bay
1968
1947
1954
1962,70
1974,76
1945,51
1948
1963
1973
1952
1956
1958
1969
1967
1971
1955
1946
1953
1950
1976
1957
1964
1949
1959
1961
1960
1968
1966
1965
1972
MILES
KILOMETERS

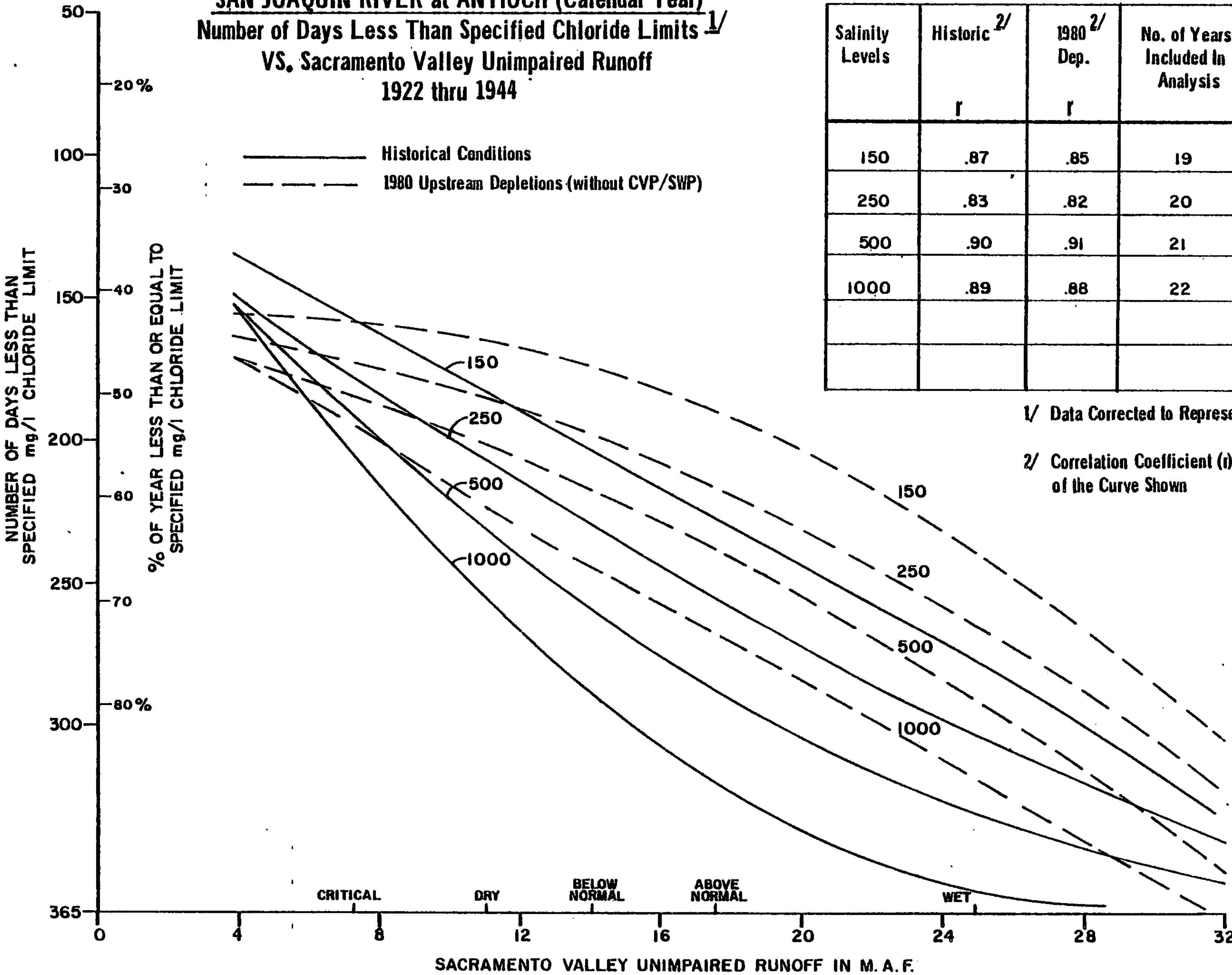
Data used in calculating these depletion adjustments is limited (Department Exhibit II-12). Consequently, these estimates may require refinement in future revisions of this water quality control plan. The results of this analysis are shown in Figures II-4, II-5 and II-7.[5/] The theoretical conditions shown in these figures should closely approximate those conditions which would exist in the absence of the CVP and SWP.

Upstream water development (including non-state/federal facilities) has continued to increase since 1945. This development includes storage facilities for irrigation and municipal supplies and for hydroelectric power generation, as well as substantial increases in upstream consumptive uses. The effect of these increased non-state/federal upstream depletions and regulations on Delta water quality has been masked to a substantial degree by CVP operation from 1945-1967, and since 1967 (when SWP operation began) by both CVP and SWP operations. The federal and state projects presently have more available yield than needed for their contractors. Consequently the projects have released large quantities of water that increased Delta outflows in the summer and fall. Over the last decade, the availability of these surplus project supplies has decreased as project export demands have increased. Continued decrease natural levels.

One of the primary concerns in preparing a water quality control plan for the Delta is the evaluation of CVP and SWP operations and

5/ See RT Vol. XX, p. 47, et seq. and Staff Exhibits 4 and 5 for methodology on the development of these figures.

SAN JOAQUIN RIVER at ANTIOCH (Calendar Year)
Number of Days Less Than Specified Chloride Limits 1/
VS. Sacramento Valley Unimpaired Runoff
1922 thru 1944



Salinity Levels	Historic 2/ r	1980 2/ Dep. r	No. of Years Included In Analysis	Years Not Included In Analysis Due to Lack of Data
150	.87	.85	19	22,23,24,33
250	.83	.82	20	22,24,33
500	.90	.91	21	22,33
1000	.89	.88	22	33

1/ Data Corrected to Represent Mean Tide Conditions

2/ Correlation Coefficient (r) Is Only for that Portion of the Curve Shown

FIGURE II-7

exports on Delta vested water rights. Without project conditions reflect that theoretical water quality which would occur in the absence of the CVP and SWP. If without project conditions in the Delta, as limited by reasonable beneficial use, are provided by this plan, vested water rights will be protected from infringement by project operations.

Delta salinity under without project conditions would have been worse in summer and fall months in wet and normal years than occurred under pre-project conditions. Delta salinity in critical years would be about the same under either set of conditions.

There are two primary factors contributing to the differences in effects between pre-project and without project conditions. Summer flow in the Sacramento and San Joaquin River systems essentially had been fully appropriated by the mid-1950's. In-basin use of water, unassociated with project development and in excess of the available natural supply has depended on the development of reservoir storage and the use of groundwater to meet these needs, resulting in less Delta inflow than would have otherwise occurred. However, many reservoirs are operated for hydroelectric power production. These hydroelectric projects generally store water during high flow periods and release the water during the low flow summer and fall months to meet their power demands. This regulation provides the Delta with some benefit from carryover of stored flows into dry and critical years.

D. DELTA FLOW PATTERNS/SALINITY DISTRIBUTION

Operations of the SWP and CVP have caused a significant shift in flow patterns and salinity distribution in the Delta and Suisun Marsh. Prior to development of upstream storage facilities and project export of significant quantities of water from the southern Delta, water entering the Delta from the Sacramento Valley flowed down the main channel of the Sacramento River, through Georgiana Slough connecting the river with the Mokelumne River, and through Three Mile Slough and lower Sherman Island channels connecting it with the San Joaquin River system. Of these channels only Georgiana Slough is far enough upstream so that it could effectively transfer fresh Sacramento River water to the San Joaquin River channels in times of salinity intrusion. From the south, San Joaquin River water flowed through the channels of the southern and central portions of the Delta (San Joaquin River, Old River, Middle River, and Paradise Cut) eventually mingling with Sacramento River water in the western portion of the Delta. Historically, inflow to the Delta from the San Joaquin River has been considerably less than that from the Sacramento River.

The hydraulic capacity of Georgiana Slough is insufficient to convey the necessary flows to satisfy project demands through interior channels of the Delta to export facilities during low flow periods.

Because of these flow limitations, the Bureau constructed the Delta Cross Channel in 1951 connecting the Sacramento and Mokelumne Rivers via Snodgrass Slough. The Delta Cross Channel provides the required additional capacity by controlled diversions into the Mokelumne River through a gated structure. The initial export pumping facilities for the Delta-Mendota Canal were also constructed by the Bureau in 1951, marking the commencement of CVP induced flow and salinity modifications in the Delta. These flow and salinity changes became more pronounced in 1967 when SWP exports commenced.

Under current operational practices of the SWP and CVP, flow reversals normally occur each year in Old and Middle Rivers, between the San Joaquin River in the south central portion of the Delta and the export pumps near Tracy. Flow reversals also occur in other channels with low San Joaquin River inflow, high Delta consumptive use, and high export rates. Flow reversal in the main channel of the San Joaquin River from Stockton south to the bifurcation with Old River near Mossdale occurs generally when the export rates are greater than five times the San Joaquin River inflow at Vernalis (RT Vol. IV, p. 163). Additionally, from the earliest days of CVP operation and more frequently in recent years, reverse flows have occurred around the lower end of Sherman Island from the Sacramento River to the San Joaquin River and up to the San Joaquin River to Old and Middle Rivers.

These flow reversals have caused changes in salinity distribution in the Delta. For example, areas receiving Sacramento River water (central Delta, Middle River) usually have low salinity concentrations, similar to Sacramento River water quality. Likewise, Old River in the central and western portions of the Delta and many of the western Delta channels contain a mixture of Sacramento River water and water drawn in from the San Joaquin River west of the Delta. Accordingly, high export rates under low Delta inflow conditions improve salinity conditions in the central Delta, worsen conditions in the southwestern Delta, and have mixed effects in the southern Delta.

CHAPTER III

BENEFICIAL USES

The establishment of beneficial uses is the initial step in development of a water quality control plan. The waters of the Delta and Suisun Marsh serve a wide variety of purposes and uses not only for Delta residents but also for the entire state. The beneficial uses in the Delta and Suisun Marsh have been classified historically under three broad categories: Fish and Wildlife, Agriculture, and Municipal and Industrial. These categories of use have been maintained in this plan.

Once the beneficial uses are identified, corresponding water quality standards and other water quality control policies are formulated for the reasonable protection of these uses. This chapter, in addition to identifying specific beneficial uses, presents the factors which were considered in selecting the level of protection for each beneficial use.

A. FISH AND WILDLIFE

It is unlikely that all of the information necessary to understand the complex interrelationships among the numerous estuarine organisms in Suisun Marsh and the Delta will ever be available. However, current knowledge is sufficient to make some sound judgments on the requirements for general protection of these organisms in the estuary.

Fishery

During the hearing, the Department of Fish and Game (Fish and Game) emphasized certain key fishery species, striped bass and salmon, (Fish and Game Exhibit 11[1], p. 6; RT Vol. XXIII pp. 15-16). These key species were selected primarily because of their overall importance in the Delta and Suisun Marsh and the current state of knowledge on these species relating environmental factors to expected fishery population levels. Striped bass and salmon also are particularly sensitive to operation of the water projects in the Delta and Suisun Marsh (Fish and Game Exhibit 3, Chapter I). A discussion of other important estuarine organisms including zooplankton, phytoplankton, zoobenthos, other anadromous fish and resident game and non-game fish is contained in the EIR prepared for this plan.

Striped Bass. Striped bass, one of the State's top ranking sport fish, was first introduced into California from the East Coast in 1879. It is a semi-anadromous, semi-resident fish highly adapted

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1/ Since 1970 Fish and Game, the Department, U.S. Fish and Wildlife Service (USFWS), and the Bureau have participated in coordinated ecological studies of the estuary. Currently, these parties are negotiating a memorandum of understanding which would provide for maintenance of fish and wildlife resources on the average at levels which have occurred in the recent past, as well as providing for realization of water projects' potential for enhancement of these resources. The April 1977 draft of this memorandum of understanding, or Four-Agency Agreement, was presented as an exhibit in the Delta hearing (Fish and Game Exhibit 11).

to estuarine life. The striped bass sports fishery accounts for two million angler days annually drawing fishermen from throughout the nation. Its net economic value for 1970 was estimated by Stanford Research Institute in 1965 dollars at about 7.5 million dollars per year (Fish and Game Exhibit 3, p. III-1). The striped bass life cycle in the Bay-Delta estuary, depicted in Figure III-1, is based on Fish and Game testimony during the Delta hearing (Fish and Game Exhibit 3).

Critical stages in the striped bass life cycle appear to be spawning and young survival. Certain flow and salinity conditions are necessary in each of these stages to maintain a successful fishery. Recommended water quality standards for these stages in the life cycle are enumerated in Fish and Game Exhibit 11 based on the information contained in their Exhibit 3. The key to survival of young bass, after the first few weeks of life, is *Neomysis mercedis*, a small shrimp found in the estuary. *Neomysis* is the principal food source for young striped bass and numerous other fishes in the Delta (Fish and Game Exhibit 3, p. III-2). Protection of the striped bass fishery requires protection of this principal food source.

An increasingly significant striped bass fishery has developed in SWP reservoirs and canals south of the Delta. This development is a result of physical removal of juvenile bass and bass eggs from

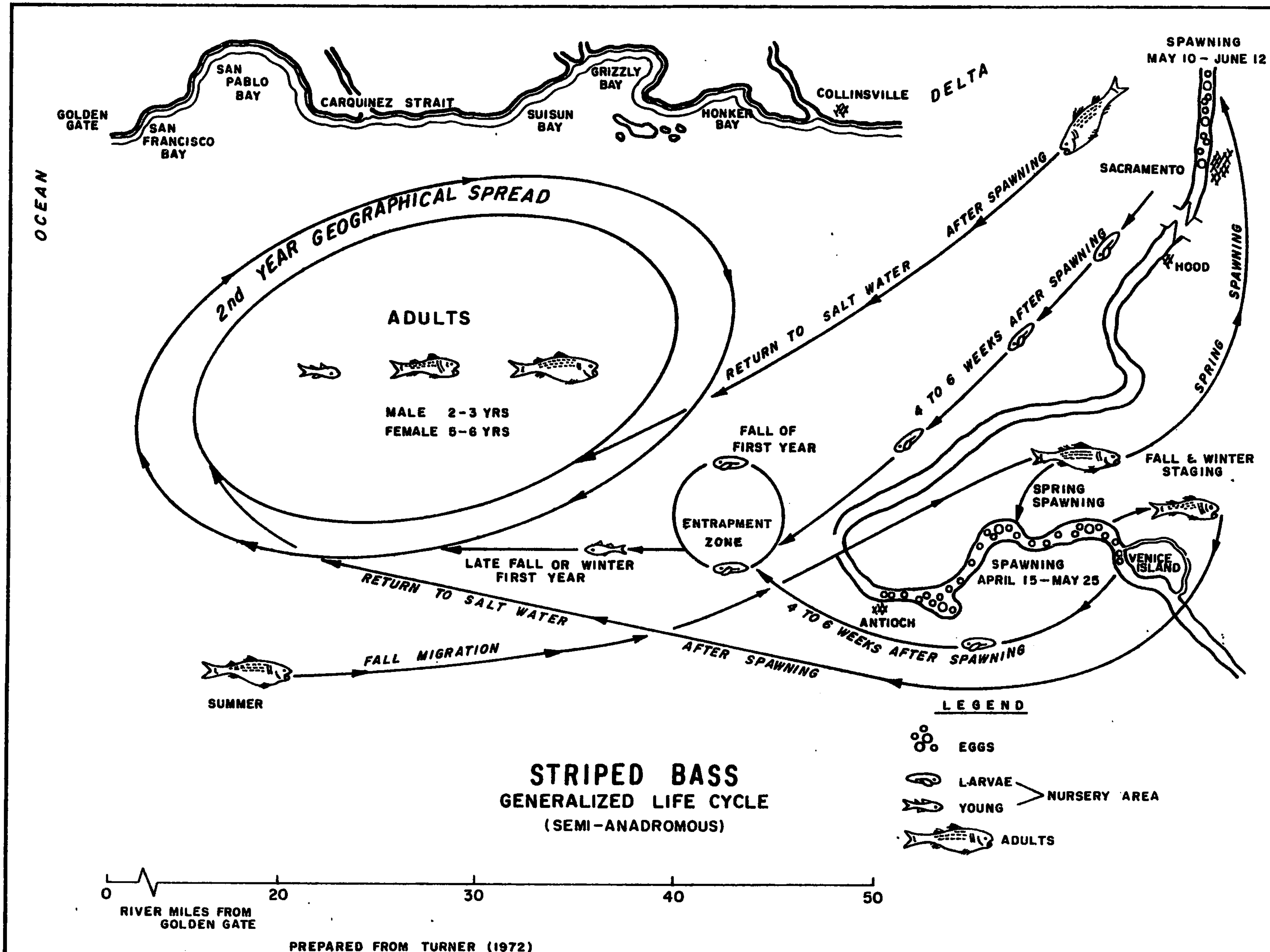

GOLDEN GATE
SAN FRANCISCO BAY
SAN PABLO BAY
CARQUINEZ STRAIT
SUISUN BAY
GRIZZLY BAY
HONKER BAY
COLLINSVILLE
DELTA
OCEAN
SPAWNING MAY 10 - JUNE 12
SACRAMENTO
HOOD
SPAWNING
SPRING
2nd YEAR GEOGRAPHICAL SPREAD
ADULTS
MALE 2-3 YRS
FEMALE 5-6 YRS
RETURN TO SALT WATER
AFTER SPAWNING
4 TO 6 WEEKS AFTER SPAWNING
FALL OF FIRST YEAR
ENTRAPMENT ZONE
FALL & WINTER STAGING
SPRING SPAWNING
SPAWNING APRIL 15 - MAY 25
VENICE ISLAND
ANTIOCH
LATE FALL OR WINTER FIRST YEAR
RETURN TO SALT WATER
AFTER SPAWNING
4 TO 6 WEEKS AFTER SPAWNING
FALL MIGRATION
SUMMER
LEGEND
EGGS
LARVAE
YOUNG
NURSERY AREA
ADULTS
STRIPED BASS
GENERALIZED LIFE CYCLE
(SEMI-ANADROMOUS)
0
20
30
40
50
RIVER MILES FROM GOLDEN GATE
PREPARED FROM TURNER (1972)

Figure III-1

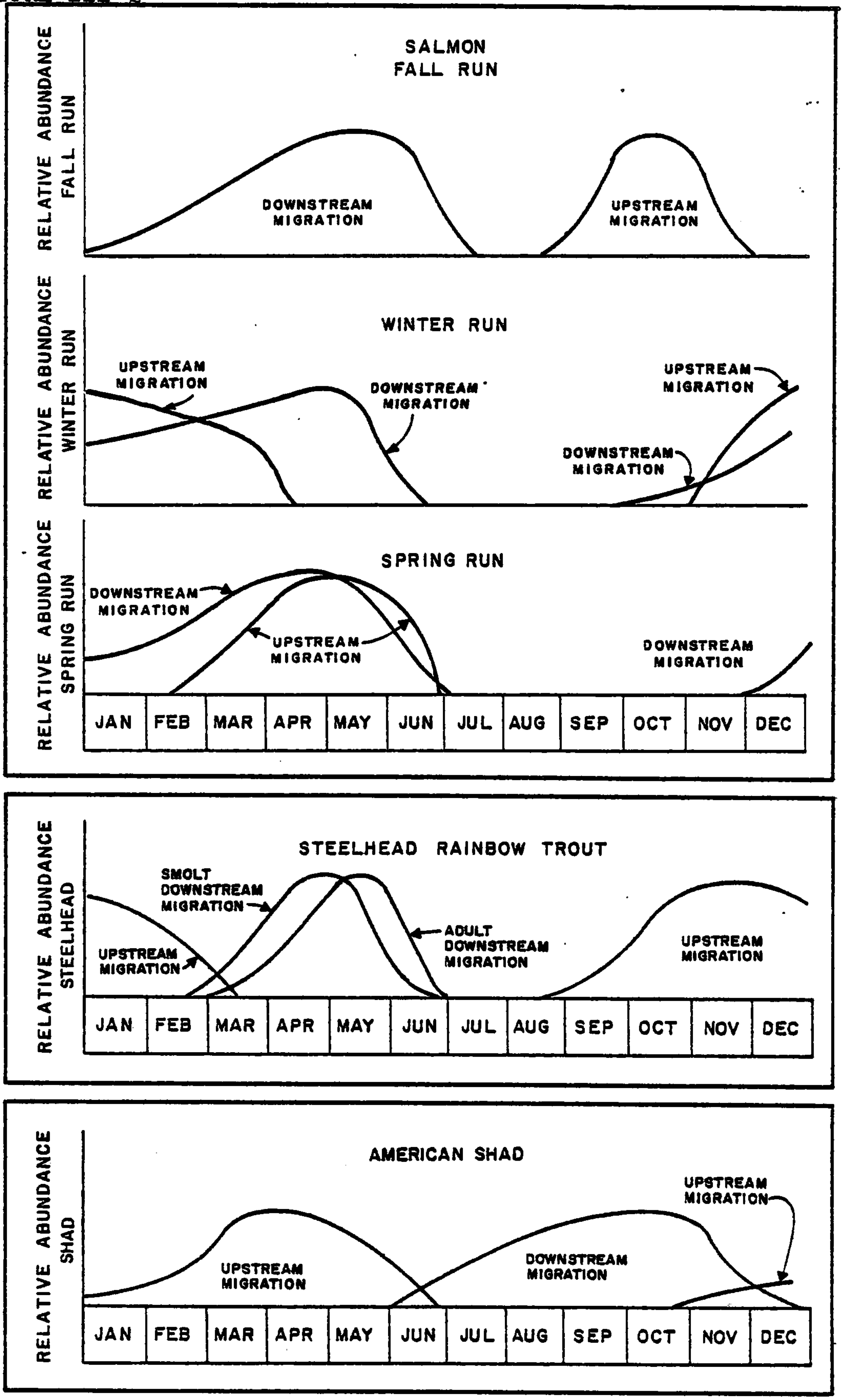
the Delta through the export pumps, and exists "...at the expense of the fishery in the estuary" (Fish and Game Exhibit 3, p. III-4).

The striped bass fishery in the southern Delta, south of the head of Old River, at one time was significant, but has declined substantially due to a combination of reduced inflow from the San Joaquin River and degraded water quality (RT Vol. XXIII, p. 58).

Salmon. King salmon also play an important role in the State's commercial and sport fisheries, contributing to both the inland and ocean fisheries. Salmon which utilize the Delta and Suisun Marsh account for about 75-80% of the State's commercial catch in ocean waters, and are valued in 1975 dollars at about 7.5 million dollars annually (Fish and Game Exhibit 3, p. II-1; RT Vol. XXIV, p. 38).

The king salmon migration patterns in the Bay-Delta estuary are illustrated in Figure III-2, based upon Fish and Game hearing testimony (Fish and Game Exhibit 3, Chapter II). The Delta is the gateway for adult king salmon to migrate to upstream freshwater spawning areas. Also, the Delta and Suisun Marsh provide young salmon with areas for feeding and gradual acclimation from fresh waters to ocean waters. The upper estuary is important as a nursery area for young salmon. Fish and Game Exhibit 11, reflecting these concerns, recommended specific Sacramento River flows to

FIGURE III-2



Graphical description of general times of occurance of salmon, steelhead rainbow trout and American shad in the Sacramento-San Joaquin estuary (based on DF&G Exhibit 3, Chapters II & IV).

facilitate upstream and downstream migrations throughout the year (Fish and Game Exhibit 11, p. 9). However, an additional concern is the possible adverse effect on the fishery from alterations of the normal Delta hydraulic regime by the projects' operations. These alterations often result in reverse flow in main channels in the southern and southwestern Delta which interfere with salmon migration. In addition, the projects' operations create high net velocities in many Delta channels which reduce food production and cause direct fishery losses at the export pumps.

Wildlife

Wildlife in the Delta and Suisun Marsh is an extremely valuable natural resource. Testimony presented by various parties at the Delta hearing concentrated on waterfowl in the Delta and Suisun Marsh, with major emphasis on Marsh waterfowl habitat.

Suisun Marsh provides habitat for some 36 species of mammals, over 200 species of birds, and 7 species of rare or endangered wildlife (Fish and Game Exhibit 3, p. VI-1). Fish and Game, discussing primarily waterfowl in the Marsh, testified during the hearing that management of waterfowl resources likely would protect other wildlife species (Fish and Game Exhibit 3, p. VI-1).

Waterfowl. Suisun Marsh is a major wintering area for waterfowl using the Pacific Flyway (RT Vol. XII, pp. 100, 101). The Flyway is the westernmost migratory route for waterfowl traveling from Alaska and Canada to wintering areas in the United States and Mexico. Survival of waterfowl using the Flyway depends upon protection and management of all wetlands, including Suisun Marsh.

The Marsh at times has provided habitat for almost 30% of California's waterfowl population. It represents almost 15% of the remaining natural wetlands in the State (USFWS Exhibit 4, p. 4; Fish and Game Exhibit 3, pp. VI-1 and VI-2). Total wetlands in California were once 5 million acres. Less than 10% of that now remains; thus, the use and importance of the Marsh has intensified (USFWS Exhibit 4, p. 4). Lack of sufficient wintering habitat is the critical factor affecting waterfowl in the Pacific Flyway (California Waterfowl Association (CWA) and Suisun Resource Conservation District (SRCD) Exhibit 1, p. 2). The importance of the Marsh is further reflected in international wildlife treaties between the United States, Canada, Mexico, and Japan (USFWS Exhibit 4, p. 4; RT Vol. XXIV, p. 59).

Waterfowl activity in the Marsh is seasonal, with peak populations experienced in the fall. Average monthly waterfowl populations during the fall generally vary between 100,000 and 500,000 birds, but occasionally exceed 1,000,000 (Fish and Game Exhibit 3, p. VI-2). Substantial waterfowl or wildlife activity also exists during the remainder of the year. A recent study issued by the Bay Conservation and Development Commission (BCDC) indicates that 1975 recreational use in Suisun Marsh was more than 115,000 person-days, with over half directly associated with Marsh waterfowl aspects (CWA and SRCD Exhibit 1, p. 3).

Approximately 89% of Suisun Marsh land area is artificially managed as a brackish water marsh. Proper management of wetlands is necessary to provide adequate habitat for waterfowl. Waterfowl need both large areas of water and sufficient food supplies. The preferred foods in Suisun Marsh in recent years for the vast majority of types and numbers of the waterfowl population are seeds produced from the plants alkali bulrush, brass buttons, and fat hen (Fish and Game Exhibit 3, pp. VI-4 to VI-8). Sustained seed production by these plants at their historical potentials requires primarily that the level of salinity in Marsh soils not exceed a certain maximum amount. The soil salinity levels are controlled through flooding of Marsh lands with water from adjacent waterways. Consequently, the salinity of this applied water determines the availability of the Marsh as a wintering area for migratory waterfowl.

Export Area Wildlife. A beneficial use of SWP water exported from the Delta is wildlife habitat in southern California (State Water Service Contractors (SWSC) Exhibit 29; RT Vol. XVIII, p. 96). These benefits occur primarily at storage reservoirs of both the SWP and its contractors south of the Delta (Department Exhibit 15A, pp. 65-68). Additional wildlife benefits are experienced in the Grasslands Water District in the San Joaquin Valley, a wildlife refuge managed by Fish and Game. Fifty thousand acre-feet of water are delivered annually through the Delta-Mendota Canal to this area under a long-term contract with the Bureau (Bureau Exhibit 64, p. 10).

B. AGRICULTURE

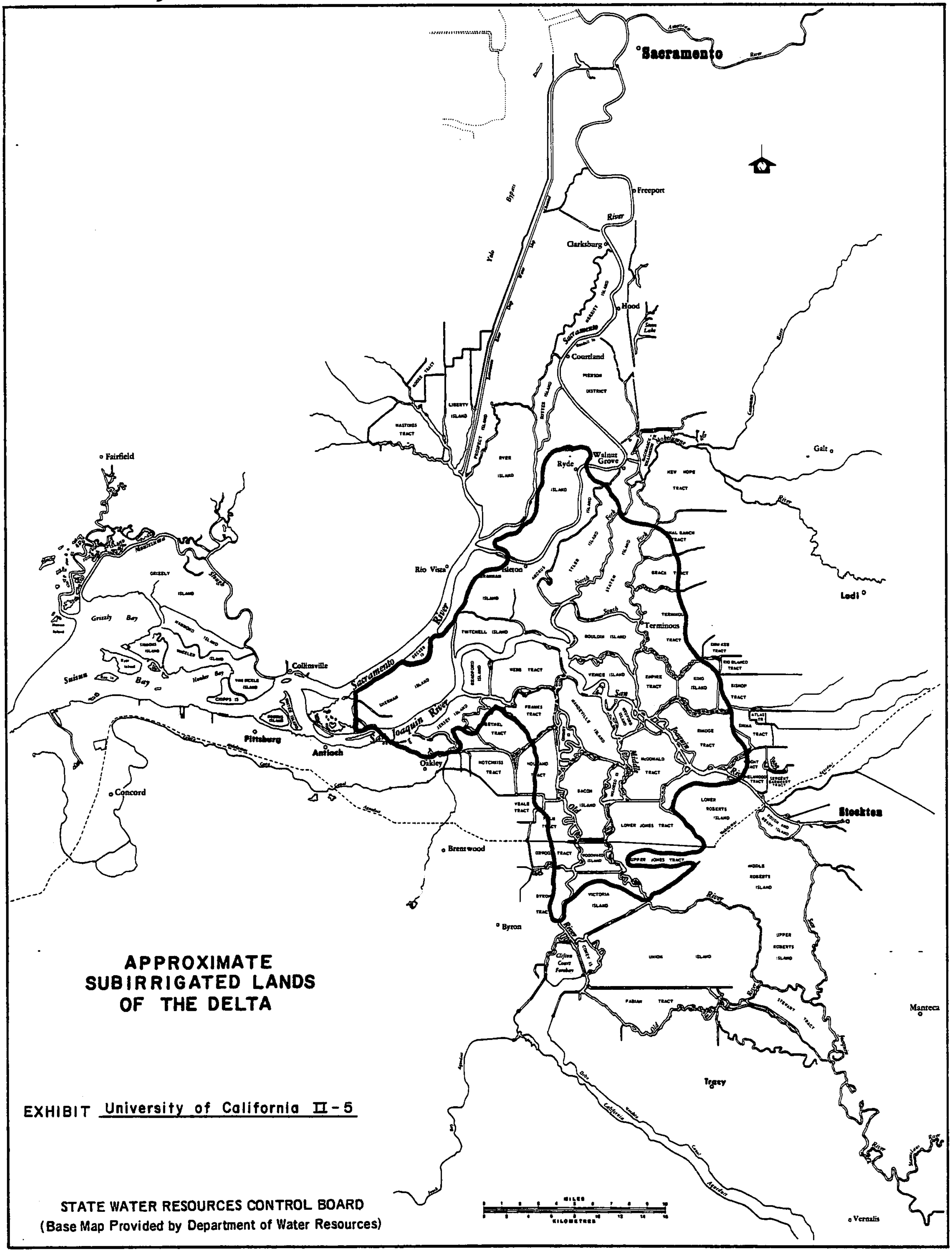
Delta Agriculture

About three-fourths of the Delta land area (500,000 acres) is farmed in some manner, producing a wide variety of crops with substantial yields (Department Exhibit II-18). Soils in the Delta fall generally into two distinct categories: organic and mineral soils. Organic soils are found generally in the Delta lowlands which consist of areas in the Delta below an elevation of +5 feet mean sea level. Mineral soils are found in both the Delta lowlands and uplands. The Delta uplands are those areas in the Delta above +5 feet mean sea level. Delta management and cropping practices for organic and mineral soils are different, and thus are presented separately below.

Organic Soils. Delta organic soils were formed through biological and chemical breakdown of marsh-type plants and grasses that existed prior to development of the present levee system. The amount of organic soils in the Delta is constantly being reduced due to continued decomposition and oxidation as a result of both natural processes and ongoing farming activities. In 1941 there were over 250,000 acres of organic soils in the Delta. By 1976 this acreage had been reduced by half (RT Vol. XIII, p. 23).

The high permeability of organic soils coupled with their low surface elevation with respect to surrounding waterways produce high groundwater table conditions. The high groundwater table along with problems associated with uneven decomposition and settlement of organic soils make subirrigation a desirable method of water application for crop production. Subirrigation is the delivery of water to plant roots by capillary action from the underlying saturated soil strata, and is the primary method of irrigation in the Delta organic soils (RT Vol. XX, pp. 112-115). As practiced in the Delta, subirrigation may be the most efficient irrigation process in California from the standpoint of net water consumption (RT Vol. XIII, pp. 107-108). However, because of soil and crop management constraints, this form of irrigation must be tied to a winter leaching program to remove salts accumulated in the root zone (RT Vol. XIII, p. 47). The general area of the Delta subirrigated soils is shown in Figure III-3.

Mineral Soils. Delta mineral soils were formed through deposition of soils and minerals eroded from the Sierra by various streams tributary to the Delta. These soils, which are much less permeable than organic soils, generally are found at higher elevations in the Delta, and are not affected as much by high groundwater conditions. Consequently, subirrigation generally is not necessary in the Delta mineral soils, and thus the more conventional irrigation methods are utilized. Water is applied to the surface of the soil, usually through furrows, flood irrigation, or sprinklers. Soil and crop management practices are much the same as in many other areas in California, with leaching of the soils required and with occasional changes in cropping patterns.



APPROXIMATE SUBIRRIGATED LANDS OF THE DELTA

EXHIBIT University of California II-5

STATE WATER RESOURCES CONTROL BOARD
(Base Map Provided by Department of Water Resources)

Delta Cropping Practices. The Department presented detailed information on 1976 levels of agricultural production in the Delta. In order to obtain cropping patterns for the organic and mineral soils in the Delta, the Department's island-by-island information was considered along with information presented by the University of California Cooperative Extension at the hearing. These cropping patterns are shown in Table III-1.

As indicated in the table, corn is the predominant crop in the organic soils, accounting for almost half of the total acreage of organic soils. Grain is grown on an additional one-fourth of the organic soils, with asparagus, alfalfa, and other crops accounting for the remainder.

In the mineral soils grain is grown on about 22% of the acreage, closely followed by corn on 17%. About 42% of the total acreage of mineral soils appears to be distributed fairly evenly among sugar beets, tomatoes, alfalfa, and mixed pasture. The remaining acreage is in miscellaneous crops such as fruits, nuts, beans and sorghum.

Agriculture Outside the Delta

The SWP and CVP export large quantities of water from the Delta to the San Joaquin Valley and southern California for agricultural uses. In total agricultural production, Fresno and Kern Counties consistently rank first and second, respectively, in the nation

TABLE III-1

PREDOMINANT DELTA CROPS, 1976

Organic Soils

Crop	Percent of Organic Soils Acreage
Corn	48
Grain	25
Asparagus	7
Alfalfa, Sugar Beets, Tomatoes, Sorghum, Miscellaneous	20

Mineral Soils

Crop	Percent of Mineral Soils Acreage
Grain	22
Corn	17
Sugar Beets	11
Tomatoes	11
Alfalfa	11
Mixed Pasture	9
Fruits, Nuts, Beans, Sorghum, Miscellaneous	19

(Compiled from Department Exhibit II-18 and U. C. Exhibit II-5) each year. This portion of the San Joaquin Valley is considered the most productive agricultural area in the world (RT Vol. XXXIV, p. 17). The San Joaquin Valley utilizes water from many sources for crop irrigation including imported Delta supplies, local surface supplies and groundwater. Accordingly, it is difficult to assign a particular acreage to the service areas of either project.

The following information was presented on the crop diversity in SWP service areas (SWSC Exhibit 106M):

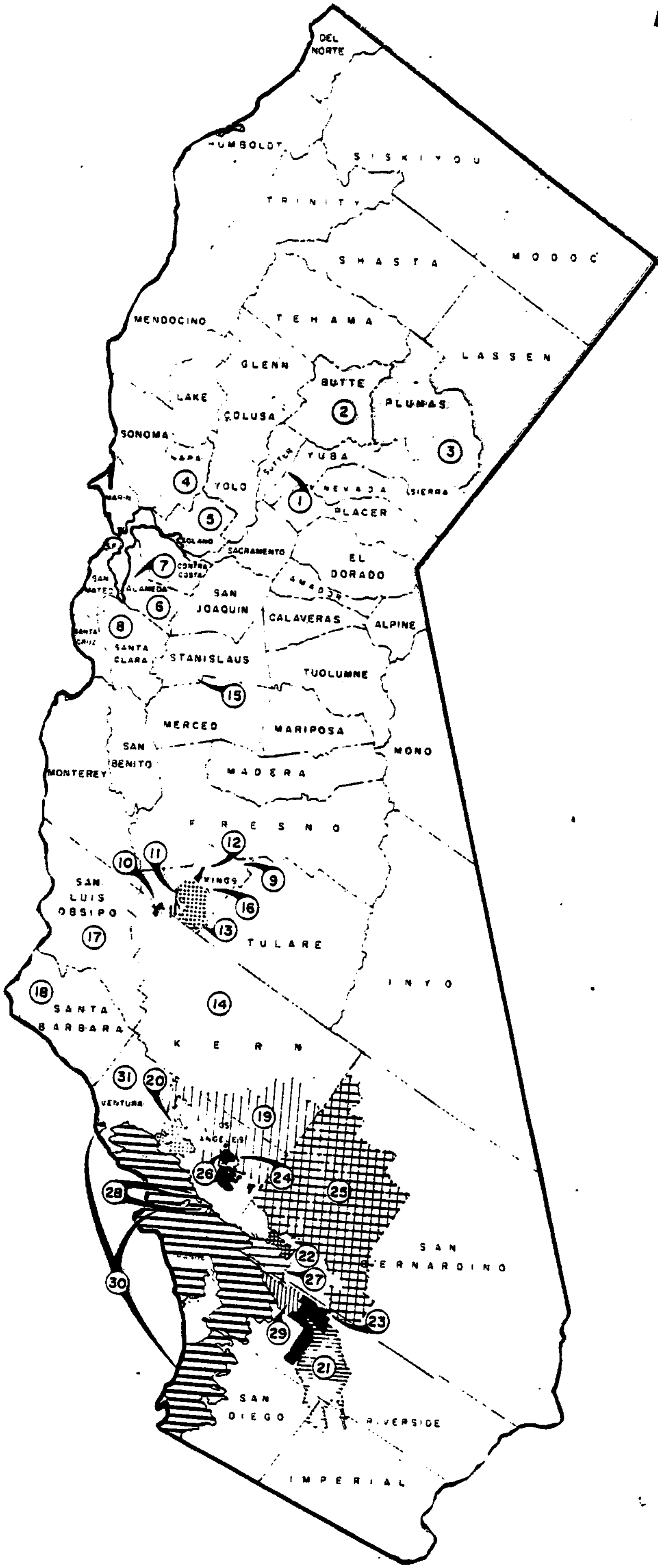
TABLE III-2

Crop v. Acreage Distribution
State Water Project

Crop	Percent of Acreage
Fruits, Vines, and Nuts	18
Cotton, Vegetable Crops, Field Crops, Except Grains	52
Alfalfa, Barley and Other Grains	30

The SWP agricultural service area is predominantly in the San Joaquin Valley, but includes portions of the South Bay area and southern California. Figure III-4 shows the SWP service area with the predominantly agricultural area noted. The maximum annual entitlements of SWP agricultural users in the San Joaquin Valley amount to 1,236,000 acre-feet, with 1977-level entitlements of 534,000 acre-feet (Department Exhibit 15A, p. 119; SWSC Exhibit 6).

FIGURE III-4



STATE WATER PROJECT
EXISTING AND PROJECTED SERVICE AREAS

Location No.	Contracting Agency
	UPPER FEATHER AREA
1	City of Yuba City
2	County of Butte
3	Plumas County Flood Control and Water Conservation District
	NORTH BAY AREA
4	Napa County Flood Control and Water Conservation District
5	Solano County Flood Control and Water Conservation District
	SOUTH BAY AREA
6	Alameda County Flood Control and Water Conservation District, Zone 7
7	Alameda County Water District
8	Santa Clara Valley Water District
	SAN JOAQUIN VALLEY AREA*
9	County of Kings
10	Devil's Den Water District
11	Dudley Ridge Water District
12	Empire West Side Irrigation District
13	Hacienda Water District
14	Kern County Water District
15	Oak Flat Water District
16	Tulare Lake Basin Water Storage District
	CENTRAL COASTAL AREA
17	San Luis Obispo County Flood Control and Water Conservation District
18	Santa Barbara County Flood Control and Water Conservation District
	SOUTHERN CALIFORNIA AREA
19	Antelope Valley–East Kern Water Agency
20	Castaic Lake Water Agency
21	Coachella Valley County Water Agency
22	Crestline-Lake Arrowhead Water Agency
23	Desert Water Agency
24	Littlerock Creek Irrigation District
25	Mojave Water Agency
26	Palmdale Water District
27	San Bernardino Valley Municipal Water District
28	San Gabriel Valley Municipal Water District
29	San Gorgonio Pass Water Agency
30	The Metropolitan Water District of Southern California
31	Ventura County Flood Control District

*predominantly agricultural

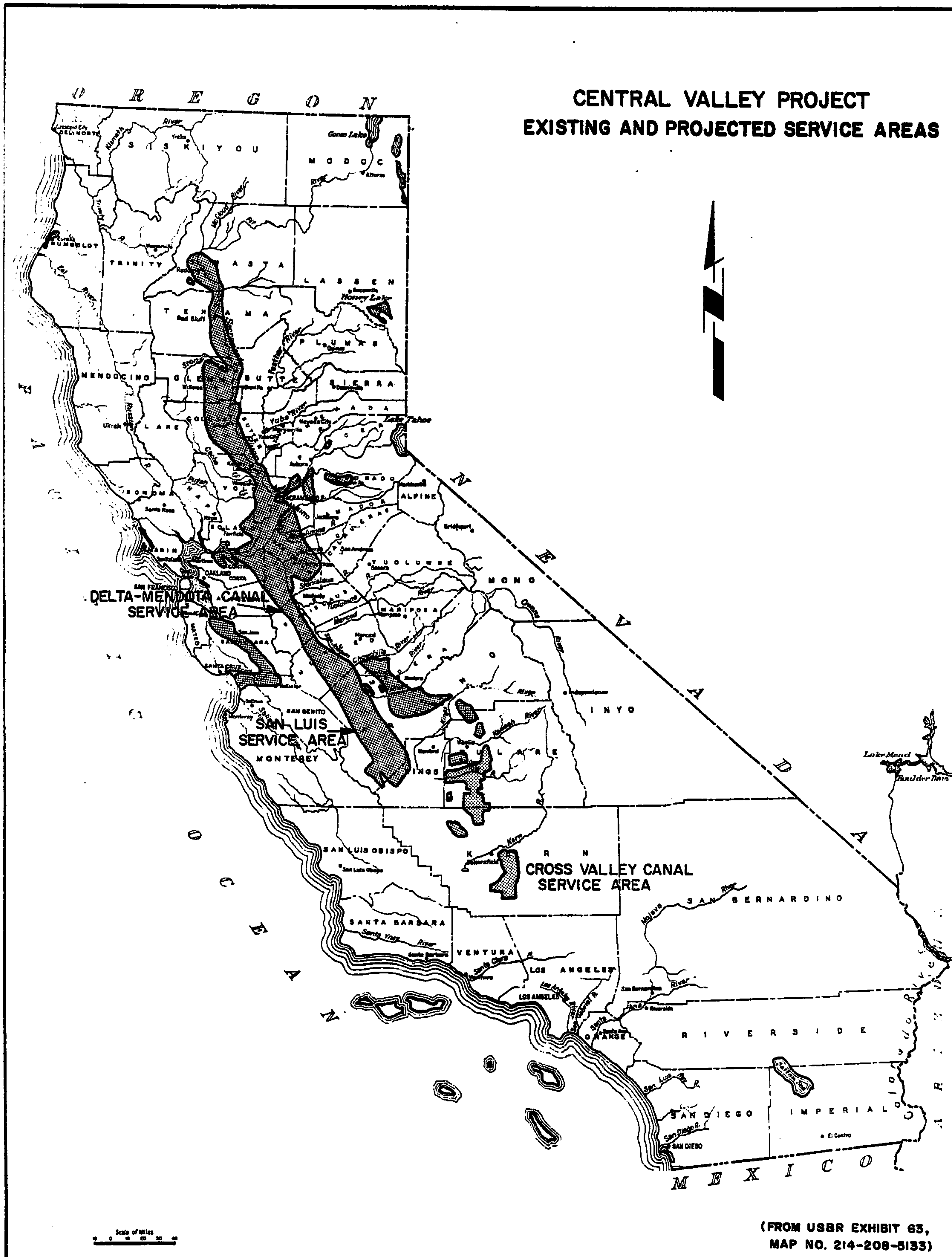
(From SWSC Exhibit 1, p. 2, and DWR Exhibit 15A)

Water exported from the Delta by CVP facilities is used in the Delta-Mendota Canal service area, the Cross-Valley Canal service area, and the San Luis Unit of the CVP. The San Luis Unit has an irrigable acreage of more than 550,000 acres along the west side of the San Joaquin Valley. It comprises land within the Westlands, San Luis, and Panoche Water Districts (RT Vol. XVII, pp. 156, 169). Westlands Water District accounts for most of the total San Luis Unit acreage (RT Vol. XVII, p. 156, and Westlands Water District Exhibit II-3). A wide variety of crops are grown in the District (RT Vol. XVII, pp. 174-175, and Westlands Water District Exhibits 5A, 5B, 5C, 5D, 5E, 5F, 6). The CVP service areas are shown on Figure III-5, and include both existing and projected service areas as well as areas served by local supplies. Under its existing long-term contracts, the CVP will export from the Delta to the San Joaquin Valley up to 2,750,000 acre-feet annually (Bureau Exhibit 59), which is predominantly for agricultural uses.

C. MUNICIPAL AND INDUSTRIAL

There are significant municipal and industrial uses of Delta waters both in the Delta and in areas outside of the Delta. The export areas from the Delta include portions of Alameda, Contra Costa, Solano and Santa Clara Counties, portions of the San Joaquin Valley, and major metropolitan areas in southern California (Department Exhibit 15A, pp. 128-131). Future proposed export service areas include San Luis Obispo, Santa Barbara and Napa Counties, and additional areas in Solano County.

FIGURE III-5


CENTRAL VALLEY PROJECT
EXISTING AND PROJECTED SERVICE AREAS
DELTA-MENDOTA CANAL SERVICE AREA
SAN LUIS SERVICE AREA
CROSS VALLEY CANAL SERVICE AREA
OREGON
NEVADA
MEXICO
OCEAN
SISKIYOU
MODOC
HUMBOLDT
TRINITY
SHASTA
LASSEN
TEHAMA
PLUMAS
MENDOCINO
GLENN
BUTTE
SIERRA
LAKE
SONOMA
MARIN
ALPINE
TUOLUMNE
MONO
MARIPOSA
INYO
SAN BENITO
MONTEREY
SAN LUIS OBISPO
SANTA BARBARA
VENTURA
LOS ANGELES
SAN BERNARDINO
RIVERSIDE
SAN DIEGO
IMPERIAL
OAKLAND
SAN FRANCISCO
LOS ANGELES
SAN DIEGO
Lake Tahoe
Lake Mead
Boulder Dam
Honey Lake
Goose Lake
(FROM USBR EXHIBIT 63, MAP NO. 214-208-5133)

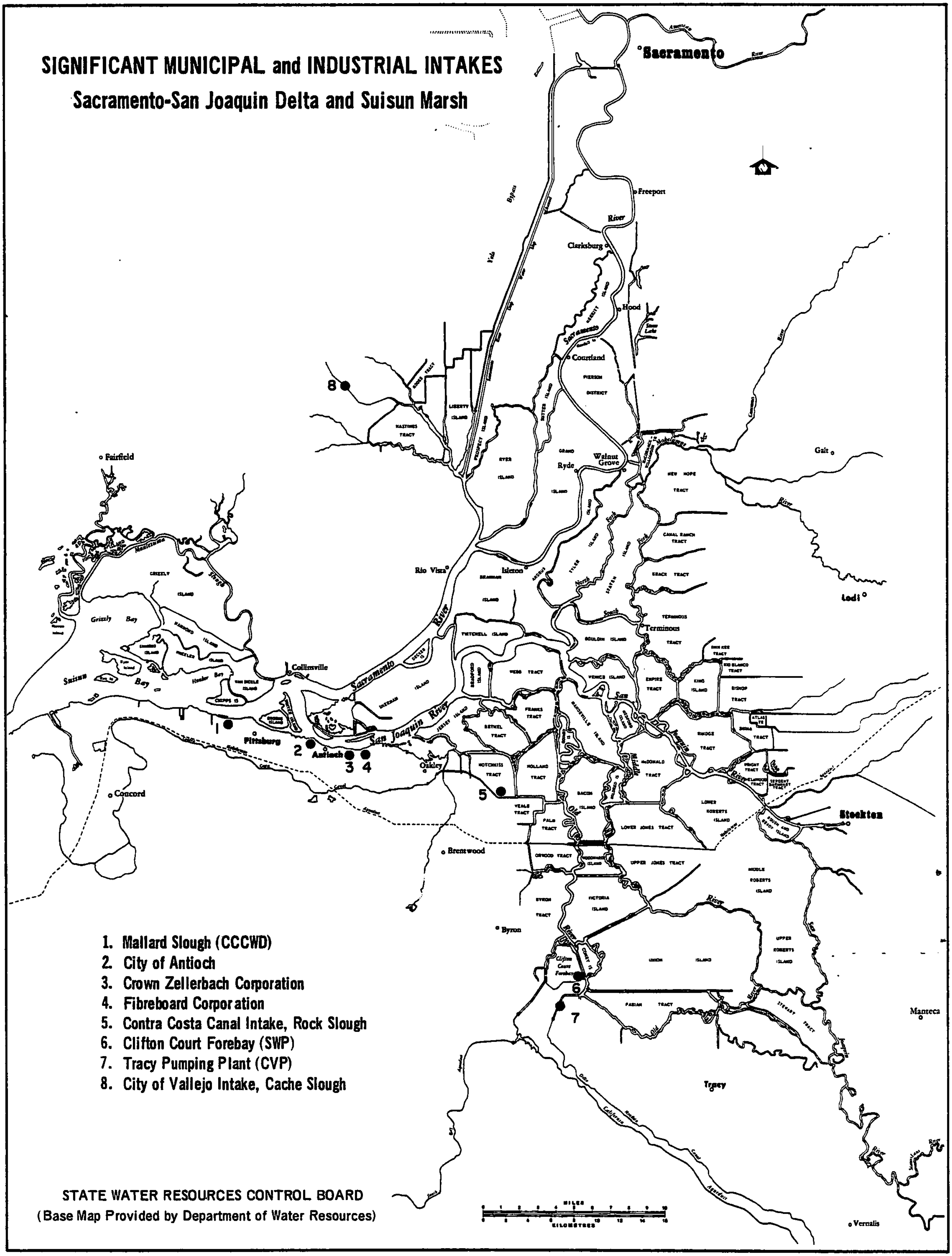
In addition, emergency supplies were furnished to many municipal and industrial users in the San Francisco Bay area during 1977 to augment local supplies depleted by the 1976-77 drought.

Figure III-6 shows the locations of significant water supply intakes for municipal and industrial uses in the Delta and Suisun Marsh. Each of these diversions is discussed below.

Contra Costa Canal Intakes: Rock Slough and Mallard Slough

The Contra Costa Canal provides water for about 240,000 people throughout eastern and central Contra Costa County, and also serves a large number of important industries throughout that area (RT Vol. XVI, pp. 161-163). The Canal is a unit of the federal CVP, but is operated by the Contra Costa County Water District (CCCWD). There is year-round demand for water from the Contra Costa Canal. Most of this water is diverted into the Canal at Rock Slough under a long-term contract for CVP water. Also, during periods of high freshwater Delta outflow when channel salinities are suitable for domestic and industrial consumption, water is withdrawn under a CCCWD appropriative water right from Mallard Slough generally when chloride concentrations are less than 100 ppm (RT Vol. XVI, p. 164). The area served by the Canal includes a portion of the legal Delta as well as areas outside the Delta to the west. Some of the industries served by the Canal also divert water directly from the San Joaquin River, but rely on Canal water whenever river salinities

FIGURE III-6


SIGNIFICANT MUNICIPAL and INDUSTRIAL INTAKES
Sacramento-San Joaquin Delta and Suisun Marsh
1. Mallard Slough (CCCWD)
2. City of Antioch
3. Crown Zellerbach Corporation
4. Fibreboard Corporation
5. Contra Costa Canal Intake, Rock Slough
6. Clifton Court Forebay (SWP)
7. Tracy Pumping Plant (CVP)
8. City of Vallejo Intake, Cache Slough
STATE WATER RESOURCES CONTROL BOARD
(Base Map Provided by Department of Water Resources)
Sacramento
Freeport
Clarksburg
Hood
Courtland
Walnut Grove
Ryde
Galt
Isleton
Rio Vista
Lodi
Terminous
Collinsville
Pittsburg
Antioch
Oakley
Concord
Fairfield
Brentwood
Byron
Stockton
Manteca
Tracy
Vernalis
Sacramento River
San Joaquin River
Suisun Bay
Grizzly Bay
Honker Bay
MILES
KILOMETERS

become too high (RT Vol. XVI, pp. 164, 165). The city of Antioch also utilizes a separate water supply intake when favorable salinity conditions prevail. Many other industries depend on the Contra Costa Canal as their sole water supply.

In order to sustain municipal and industrial beneficial uses within the Canal service area, salinity levels must be maintained below prescribed limits (CCCWD Exhibit 5, 6, 7). Of special concern is the adverse effect on industrial production as salinity increases in the water supply above specific critical levels (RT Vol. XVI, pp. 184-197). Also, the paramount uses of municipal and domestic drinking water supplies must be protected (RT Vol. XVI, pp. 197-203).

Paper Mills in Vicinity of Antioch

The Fibreboard and Crown Zellerbach Corporations both operate paper mills which are located about one mile east of the City of Antioch, abutting the San Joaquin River and within the Delta. While both mills are served by the Contra Costa Canal, each has separate facilities for direct diversion from the San Joaquin River (RT Vol. XVII, pp. 76-77, 136). Combined employment for both mills is about 1600 people (RT Vol. XVII, pp. 76, 135). The importance of these industries to the local economy is great, with a combined annual payroll of around $28,000,000 (RT Vol. XVII, pp. 76, 135). Additional economic effects are directly associated with gross production of the mills, and support services required from other local industries and services.

Much of the production at both mills consists of salt-sensitive paper grades. With normal manufacturing processes, this production requires a water supply with chloride concentration of 150 ppm or less (RT Vol. XVII, pp. 77, 137). Thus, low chlorinity water is essential for their processes (RT Vol. XVII, pp. 72-106, 131-147).

Clifton Court Forebay/California Aqueduct (SWP)

Clifton Court Forebay is the diversion point for the SWP California Aqueduct, which delivers water to municipal and industrial service areas in the San Francisco Bay Area, the San Joaquin Valley, and southern California (agricultural deliveries through such facilities are discussed in the preceding section). In the future, water also may be delivered to municipal and industrial users in the Central Coastal area, consisting of portions of San Luis Obispo and Santa Barbara Counties. The 1978-level water entitlements, maximum annual entitlements under long-term contracts, and 1975 population in the SWP service areas are listed in Table III-3 (SWSC Exhibit 6; SWSC Exhibit 1, p. 7; Department Exhibit 15A, pp. 118-121).

In addition to domestic, municipal and industrial uses, these supplies are used for related groundwater replenishment (SWSC Exhibit 29; RT Vol. XVIII, pp. 121, 122, 133; RT Vol. XXXIII, pp. 129, 130). Control of land subsidence and groundwater salinity intrusion is an additional related benefit in the SWP South Bay service area (RT Vol. XVIII, p. 143; RT Vol. XXXIII, pp. 134, 140, 141). Compliance

TABLE III-3

State Water Project

Municipal and Industrial Entitlements to Water and Service Area Populations

Service Area	1978-Level Long-Term Contracted Annual Entitlements, Ac-Ft/Yr	Maximum Long-Term Contracted Annual Entitlements, Ac-Ft/Yr	1975 Population of Service Area 1/
North Bay	0 2/	63,000	1,751,000
South Bay	131,000	188,000	
Central Coast	0	83,000	
San Joaquin Valley	64,000	119,000	780,000
Southern California	1,061,000 3/	2,438,000 3/	11,922,000
Total	1,256,000	2,891,000	14,453,000

1/ These estimates represent the total population in the respective service areas, and are not intended to reflect the actual population served by SWP supplies.

2/ Prior to 1980 non-project water will be delivered from outside of the Delta area pumped through an interim facility.

3/ Includes small amount of water used for agricultural purposes.

with water quality standards in the Water Quality Control Plan for the Santa Ana River Basin (Basin 8 Plan) depends on availability of good quality (low salinity) SWP water for municipal and industrial uses and for groundwater recharge (RT Vol. XXXI, pp. 1-3). Economic value of SWP water for municipal and industrial uses ranges from $500 to $800 per acre-foot (SWSC Exhibit 106K; RT Vol. XXXII, pp. 56-79).

Tracy Pumping Plant/Delta-Mendota Canal (CVP)

The Tracy Pumping Plant, located in the southern Delta near Clifton Court Forebay, is the diversion point for the federal CVP Delta-Mendota Canal. Municipal and industrial users served by this diversion through the San Luis Division of the California Aqueduct (joint federal-state facility) include those in the Cross-Valley Canal service area in the southern San Joaquin Valley as well as a few municipal and industrial users in the western portion of the Valley. Through the Cross-Valley Canal, up to 128,000 acre-feet of water per year will be delivered for a multitude of uses, including municipal and industrial supplies (Bureau Exhibit 64, p. 10; RT Vol. VIII, p. 166). The municipal and industrial users in the western San Joaquin Valley have a maximum contract entitlement of 27,500 acre-feet per year (Bureau Exhibit 64, p. 10). Water quality needs of these export uses are specified in the contracts for water delivered through the Tracy Pumping Plant.

Also, municipal and industrial deliveries of 216,000 acre-feet per year through the Delta-Mendota Canal are planned by the Bureau for the San Felipe Unit. In addition, a portion of the 650,000 acre-feet per year which would be delivered through the as-yet-unauthorized Mid-Valley Canal would be used for municipal and industrial purposes (Bureau Exhibit 64, p. 10; RT Vol. VIII, pp. 166, 167).

City of Vallejo and City of Antioch Intakes

No substantial testimony was presented regarding either of these two municipal water intakes. However, both intakes were included in the Board staff's trial objectives (Staff Exhibit 3, p. 18). Antioch has used its intake only when water quality has been adequate, generally in the winter and through the spring of most years (RT Vol. XVI, pp. 164, 165). The City of Vallejo Intake is located on Cache Slough in the northern portion of the Delta, and probably is influenced much more under the current configuration of the Delta by Sacramento River water quality and local agricultural drainage than by the effects of salinity intrusion. This intake provides a year-round supply of municipal and industrial water to the City of Vallejo.

CHAPTER IV

HISTORICAL WATER QUALITY STANDARDS

Water quality standards are limits or levels of water quality constituents which are established for the reasonable protection of specific beneficial uses of water. Even though beneficial uses of Delta supplies have been well established for some time, water quality standards for this important water body have been periodically reviewed and modified to reflect the current knowledge.

A. PAST PROCEEDINGS

The Board has previously established water quality standards through water quality control plans and water right decisions. A brief chronology of those actions is presented below. As previously noted, the current proceeding marks the first time for the Delta that the Board's water quality and water right authorities have been so closely integrated.

Decision D 1275 (Water Rights)

The development of comprehensive water quality standards for the Delta began with the so-called November 19, 1965 criteria. These criteria were developed by a group consisting of representatives of the Sacramento River and Delta Water Association, the San Joaquin Water Rights Committee, the Department and the Bureau. The criteria have had a continuing influence on subsequent development of water quality standards. The State Water Rights Board in

Decision D 1275, the principal water right decision on the SWP[1/] adopted May 31, 1967, ordered that the permits for the SWP be subject to the November 19, 1965 criteria (referred to in Decision D 1275 as SRDWA Exhibit 17) insofar as those criteria did not conflict with other terms included in the permits. The Board also included in Decision D 1275 a limitation on pumping from the Delta and on collecting water to storage in Oroville Reservoir under certain conditions of water quality. These pumping limitations, however, were modified by Decision D 1291 on November 30, 1967.

1967 Water Quality Control Policy (Water Quality)

The Federal Water Pollution Control Act as amended by the Water Quality Act of 1965 provided in Section 10(c)(1) that by June 30, 1967 each state was to establish water quality criteria applicable to interstate waters or portions thereof within the state. Consistent with the requirements of this legislation, the Board's predecessor agency, the State Water Quality Control Board, on June 23, 1967, transmitted to the Secretary of the Interior a statement of policy for the control of water quality in California's interstate waters including those of the Sacramento-San Joaquin Delta

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1/ The principal water right decision on the CVP, Decision D 990 adopted on February 9, 1961, does not include any water quality standards. However, the Water Rights Board in this decision (as in other decisions on the CVP and SWP) reserved jurisdiction to establish permit terms and conditions for salinity control in the Delta.

and Suisun Marsh. On July 19, 1968, the federal government expressed concern that the water quality control policy for the Delta did not adequately protect municipal, industrial, agricultural and fishery uses and proposed some supplemental water quality objectives for chloride and total dissolved solids concentrations. Following receipt of the federal comments and an additional hearing on the water control policy for the Delta on October 24, 1968, the Board adopted a supplemental water quality control policy for the Delta through its Resolution 68-17. By letter of January 9, 1969, the Secretary of the Interior notified the Board that he had approved the state water quality standards even though they failed to satisfy the recommendation of the federal government regarding the spawning of striped bass and the municipal, industrial and agricultural water uses of the western part of the Delta. The Secretary indicated that his approval was taken in reliance upon the commitment from the Board to conduct public hearings during 1969 and to consider before June 30, 1970 the matter of supplementing the salinity standards.

Decision 1379 (Water Rights)

In accordance with the commitment made in Resolution 68-17, a hearing was initiated on July 22, 1969, and continued with intermittent recesses until October 5, 1970. Based on that hearing record, the Board issued Decision 1379 on July 28, 1971. Minor modifications in this decision were made by the Board by supplementary orders dated September 16 and October 13, 1971. This decision established new water quality requirements for the Delta and Suisun Marsh and rescinded those in Decision D-1275. However, Decision 1379 has been stayed by the courts since October 1971 as a result of litigation originally instituted by the Central Valley East Side Project Association and the Kern County Water Agency to set aside the decision. In July 1974, the Federal District Court deferred any further action on these cases pending a final decision in California v. United States, a case in which the principal issue is the jurisdiction of the state to condition water rights of federal projects.2/ Due to the court order staying implementation of Decision 1379, the Decision D-1275 requirements remained in effect.

Interim Water Quality Control Plan (Water Quality)

In 1971, interim water quality control plans for the 16 planning basins comprising the state, including the Delta and Suisun Marsh, were adopted by the respective Regional Water Quality Control Boards and approved by the State Water Resources Control Board. The adoption of the interim plans marked the completion of the first phase of a comprehensive statewide planning effort which culminated in the adoption of the basin plans, discussed below.

Supplement to 1967 Water Quality Control Policy (Water Quality)

The Regional Administrator of the Environmental Protection Agency in a letter dated August 15, 1972, called the Board's attention to

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2/ On July 3, 1978, the United States Supreme Court, issued its decision in California v. United States upholding the position of the State that state imposed conditions on permits issued for federal reclamation projects are valid unless inconsistent with congressional directives respecting the projects.

the fact that there were considerations outstanding from the conditional approval previously received from the federal government. In response to that letter, the Board held a hearing on proposed supplemental water quality objectives for the Delta and on April 19, 1973, by Resolution No. 73-16 adopted "Water Quality Control Plan Supplementing State Water Quality Control Policies for Sacramento-San Joaquin Delta."

Basin Plans (Water Quality)

In line with the responsibility of the State and Regional Boards and in compliance with the provisions of Public Law 92-500, comprehensive water quality control plans have been developed for the 16 basins comprising the state. The Delta and Suisun Marsh are included in the water quality control plans for the Sacramento-San Joaquin Delta Basin (Basin 5B Plan) and the San Francisco Bay Basin (Basin 2 Plan), respectively. The Basin 2 Plan was approved by Board Resolution 75-28 on April 17, 1975, and amendments to it were approved by Board Resolution 76-61 on June 17, 1976. The Basin 5B Plan was approved by Board Resolution 75-80 on August 21, 1975. The long-term standards contained in these basin plans are summarized in Appendix B of this plan (the water quality standards in D-1275 were incorporated into the Basin 5B Plan, except for the operational constraint at Blind Point).

Drought Emergency Actions (Water Quality)

Because of the unprecedented drought during 1976-77, the Board found it necessary to take two separate emergency actions during 1977 to mitigate the impact of the drought on beneficial uses of Delta water throughout the state. By Resolution No. 77-6, on February 8, 1977, the Board adopted a 1977 (interim) Water Quality Control Plan for the Delta and Suisun Marsh. This plan was intended to remain in effect only until the end of calendar year 1977 and during that period was to supersede the basin plans to the extent of any conflicts with specific water quality standards.

However, prompted by the increased severity of the drought, the Board found it necessary to take further emergency measures to conserve water supplies upstream of the Delta and to provide continued protection of the Delta from deep seawater intrusion. Accordingly, on June 2, 1977, the Board adopted an emergency regulation, Section 764.20 of Title 23 of the California Administrative Code and extended it through calendar year 1978 on December 15, 1977. This emergency regulation was to be in effect no longer than necessary to protect the Delta. In view of substantial improvements in the water supply situation and Delta recovery from salinity intrusion, the Board repealed the emergency regulation February 2, 1978.

B. EVOLUTION OF DELTA OUTFLOW REQUIREMENT

As described in Chapter II, beneficial uses of Delta water supplies are dependent upon adequate outflow of freshwater to repel seawater intrusion and to provide suitable habitat for fish and wildlife. Delta water quality standards established to protect these uses have all recognized the need to maintain sufficient Delta outflow even under the most adverse water supply conditions.

However, net outflow from the Delta is not directly measured at present due to the complex effects of tidal fluctuation and flow patterns. In an effort to provide a common base for operation of SWP and CVP facilities, the Department and Bureau have jointly established a Delta Outflow Index.[3]

The Delta outflows thought necessary to ensure the maintenance of specific salinity levels throughout the Delta have changed over the last two decades. Experience in implementing specific salinity requirements and major improvements in mathematical models of the Delta have brought about better estimates of outflow needs to satisfy particular salinity levels in the Delta. This evolution is illustrated below by tracing the minimum Delta outflow which was thought

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3/ Delta Outflow Index is a calculated net Delta outflow which is equal to (1) Delta inflow through the major tributaries, minus (2) net Delta consumptive use, minus (3) SWP and CVP export pumping. The inflow and export values are measured, while the consumptive use figures are fixed in an April 9, 1969 federal-state agreement (Bureau Exhibit 576 in the proceeding leading to Decision 1379 and an October 10, 1969 Bureau memorandum to the Department).

to be needed to satisfy the water quality standard at Emmaton on the Sacramento River.

The Emmaton standard was initially presented in the November 19, 1965 criteria for the protection of western Delta channels from seawater intrusion. It requires a maximum 10-day mean (14-day mean in the Basin 5B Plan) daily chloride concentration of 1000 mg/l. Past studies by the Department and Bureau have generally used this standard in determining the minimum Delta outflow requirement.[4] Estimates of this outflow requirement have increased over time as understanding of flow salinity relationships in the Delta has expanded.

In 1964 the Interagency Delta Committee[5] concluded that an outflow of 1500 cfs would be required to satisfy this salinity level at Emmaton.[6] However, in 1966 the Department presented information at the hearing leading to Decision D 1275 which set the Delta

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4/ This was the case until August 1975 when the Board approved the Basin 5B Plan which contained the Chipps Islandstandard for protection of <u>Neomysis</u>. This objective provides a maximum 14-day running average chloride concentration of 4000 mg/l, which generally requires somewhat more outflow than that needed to meet the Emmaton objective.

5/ The Interagency Delta Committee was a committee composed of representatives from the U.S. Army Corps of Engineers, Bureau and Department with the task of evaluating various water development plans for the Delta.

6/ Draft of Task Force Report to the Interagency Delta Committee on a coordinated plan for the Sacramento-San Joaquin Delta, 1964, p. IV-3.

outflow necessary to meet this same salinity level at 1800 cfs (D 1275, Department Exhibit 81, p. 27).

Information presented by the Department during the current Delta proceeding in its Exhibit 5B indicates that 2500 cfs would be required as Delta outflow to meet the Emmaton standard (Department Exhibit 7B; RT Vol. VII, p. 171).7/

The water quality standards established to protect beneficial uses in the Delta are not the only factors affecting Delta outflow. When water is being exported, sufficient Delta outflow must be provided to prevent intrusion of saline water at the export pumps. This outflow required to meet export contractual water quality criteria is called "carriage water." Under controlled flow conditions, the carriage water requirement of the projects is governing much of the time.

When project exports are greater than about 4000 cfs and Delta inflow is low, Sacramento River water is drawn around the western end of the Delta and back up the San Joaquin River to the export pumps. The export water becomes more saline due to seawater intrusion as it approaches the western Delta. In order to meet export quality criteria under controlled flow conditions, the projects must increase the Delta

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7/ Recent studies by Department staff indicate that outflows in excess of 3000 cfs may be required to meet the same standard at Emmaton.

outflow to satisfy the carriage water requirements when exports exceed 4000 cfs. For instance, in order to satisfy the SWP quality requirements at its export pumps, a Delta outflow in excess of 6000 cfs might be required during the spring of dry years when the projects are exporting at their current full capacity.

Even though estimates of outflow necessary to satisfy the Emmaton standard have increased, the estimates of carriage water required to satisfy export water quality have increased proportionately. Thus, now as in the past, the carriage water needs of the projects are generally controlling Delta outflow (see Chapter III of the EIR for a discussion on carriage water requirements of export project facilities).

Contrary to a common belief, past increases in estimated Delta outflow requirements have not occurred solely as a result of more restrictive water quality standards, but also as a result of better understanding of outflow/salinity relationships in the Delta, including the great quantities of outflow necessary to protect the export operations.

C. PRESENT PROCEEDING

In approving the Basin 5B Plan, the Board indicated that it would convene hearings on the Delta no later than July 1, 1978 for the purpose of receiving further evidence relating to salinity control, protection of fish and wildlife in the Delta, and coordination of terms and conditions of the permits of the SWP and CVP.

CHAPTER V

ALTERNATIVES FOR PROTECTION OF BENEFICIAL USES

The most important phase in the formulation of water quality standards is the analysis of alternative approaches for the protection of beneficial uses. It is both a state and federal requirement that alternatives to a proposed action be investigated where such action has the potential to affect significantly the quality of the human environment (Section 21001 of California Environmental Act of 1969). An objective evaluation of alternative solutions or actions is required in order not to overlook or foreclose options which could protect beneficial uses while at the same time minimizing the impact on project operations. This analysis forms the basis for the selection and refinement of recommended actions.

This chapter presents a discussion of the various alternatives considered and the procedure used in the selection and refinement of the adopted water quality standards.

In accordance with the jurisdiction reserved in the permits of the SWP and CVP, the purpose of this water quality control plan is to provide water quality limits for salinity control and for protection of fish and wildlife, and to coordinate terms and conditions of the various SWP and CVP permits currently before the Board. The water quality standards established by the Board under this reserved jurisdiction are directed toward conditions expected to prevail over the next ten years. However, possible longer term solutions for all the major water quality problems in the Delta and Suisun Marsh have been kept in sight, and the Board's plan contains the necessary initial steps for their long-term resolution.

As previously discussed in Chapter III, beneficial uses in the Delta are classified into three categories: fish and wildlife, agriculture, and municipal and industrial. The plan establishes water quality standards for each of these categories to ensure that reasonable protection is provided to each of these uses in its own right. The standards are established for different year types, in accordance with the natural hydrologic regime of the Delta.

A. TRIAL SET OF WATER QUALITY OBJECTIVES

On March 15, 1977, a trial set of water quality objectives for the three categories of uses was transmitted by the Board staff to all interested parties to help focus the Phase II hearing. As explained in the staff transmittal, the trial objectives were developed from information gathered solely during Phase I of the hearing and did not reflect the consideration and trade off of factors presented during Phase II.

As in the current conceptual alternatives presented below, consumptive and non-consumptive uses were generally distinguished in the development of the trial set of objectives. The trial objectives for fish and wildlife (non-consumptive uses) were essentially those contained in the April 12, 1977 draft of the

Four-Agency Fish and Wildlife Agreement (Fish and Game Exhibit 11). This basic approach has been retained as one of the conceptual alternatives for fish and wildlife presented below.

The trial objectives for agriculture and municipal and industrial uses (consumptive uses) reflected the level of protection which would have been available under pre-project conditions (1922-1944). However, as many parties pointed out, water quality standards based on pre-project conditions would require the SWP and CVP to offset increased upstream depletions, unrelated to project operations, which have occurred since 1944 to the extent such upstream depletions infringe upon Delta riparian rights. The trial standards thus would require the projects to provide water quality levels significantly better than conditions which would prevail in the absence of the projects. Consequently, the staff trial objectives for consumptive uses have been replaced by conceptual alternatives to reflect without project conditions at 1980 level of depletions.

B. CONCEPTUAL ALTERNATIVES

Conceptual alternatives have been developed to reflect a broad range of possible levels of protection for each category of use. Generally, at least three basic alternatives have been considered for each of the three broad beneficial use categories:

o No Action. In accordance with Section 15143 of the CEQA Guidelines, the specific alternative of "no action" must be evaluated. If the Board took no action, the existing basin plans (Basins 5B and 2) and Decision D-1275, as amended by D-1291, would be controlling.

o Without Project Conditions/Preservation of Fish and Wildlife at Historical Levels. Under this basic approach, protection of consumptive uses in the Delta would provide only that water quality which would have existed in the absence of the SWP and CVP, as limited by the constitutional requirement of reasonable beneficial use. The comparable alternative for fish and wildlife would provide necessary protection to maintain the resource at historical levels which existed between 1922 and 1967. (see Section C of this chapter).

o Modified Without Project Conditions/Interim Protection of Fish and Wildlife. Under this basic approach, the entitlement of Delta water users would be satisfied by providing water quality conditions which would result in benefits better than or equivalent to without project conditions. Hydrologic conditions in the Delta have been substantially altered by both project operations and upstream development. This conceptual alternative takes into account both the beneficial and adverse aspects of project operations. Fishery resources, as represented principally by striped bass, would be maintained at levels approximating without project conditions. Wildlife resources in the Marsh would be provided increasing levels of interim protection until full protection is achieved in 1984.

The specific application of these basic approaches to each broad beneficial use category is presented below. Shown in Appendix C of this plan is a tabulation of these conceptual approaches.

C. FISH AND WILDLIFE

To date fish and wildlife uses have not been granted vested water rights under California water law. However, many statutes assure that these uses shall be protected for the public interest. For many years water right permits issued by the Board have included conditions to protect fish and wildlife. As previously stated, the basin plans recognize uses of water for fish and wildlife as beneficial uses. The Board's authority to protect fish and wildlife is expressly stated in various sections of the Water Code and policy statements previously cited.

The question is at what population level this resource should be protected. The position of Fish and Game is that the fish and wildlife resource should be preserved at "recent historical levels", herein called historical levels, on a long-term basis. These levels are defined by Fish and Game (Fish and Game Exhibit 11) as the average abundance of a fish or wildlife resource estimated to have existed between 1922 and 1967. Conditions upstream of the estuary may limit the abundance of some species. Fish and Game's policy deals only with those factors in the estuary that limit species abundance. However, Fish and Game recognizes that until additional project facilities are constructed, historical levels cannot be achieved (Fish and Game Exhibit 11, p. 4). Furthermore, fish and wildlife possess natural reproduction mechanisms which allow them to recover from drought and low flow conditions, much like other beneficial uses. The objective of Fish and Game is to share good as well as poor water supplies along with other beneficial uses.

No Action

If the Board took no action, the fish and wildlife standard of the basin plans (5B and 2) would be controlling. Unlike the standards for agricultural and municipal and industrial uses, the basin plan fish and wildlife standards do not include any provisions for relaxation during dry and critical years.

Preservation

Maintenance of historical levels of the fish and wildlife resource is essentially equivalent to preservation of the resource. With existing project facilities, protection of Suisun Marsh could be provided only through Delta outflow. In excess of 18,000 cubic feet per second (cfs) of Delta outflow, along with substantial curtailment of exports, would be required from May through July of normal years to protect striped bass at historical levels.

Four-Agency Fish and Wildlife Agreement (Fish and Game Exhibit 11)

Protection under this alternative is intended to maintain fish and wildlife resources on the average at historical levels (as in the preservation alternative), but recognizes that historical levels cannot realistically be maintained with existing project facilities and project demands. In view of this, this alternative provides interim water quality standards to maintain fish and wildlife on the average at less than historical levels until additional project facilities are constructed.

However, these interim standards will not be sufficient to protect the Marsh during dry and critical years. In order to fully protect the Marsh solely with outflow, in excess of 2 million acre-feet per year of Delta outflow (in terms of project yield) above that needed to satisfy the interim standards would be required (RT Vol. XXII, pp. 100-101). This would constitute about one-third of the combined CVP and SWP exportable yield. An additional 2 million acre-feet of Delta outflow in dry and critical years for this purpose is not consistent with the best interest of the State. The long-term protection for the Marsh in low runoff years can be guaranteed only through construction of physical facilities, proper management of the Marsh lands and a supplemental supply.

D. AGRICULTURE

The current Delta water quality standards for the protection of agricultural uses are essentially the November 19th criteria (see discussion on page IV-1). These standards are contained in Decision D 1275 and the Basin 5B Plan.

No Action

Under this alternative, the agricultural standards in Decision D 1275 and the Basin 5B Plan would remain in effect. These standards represent numbers that have not been changed substantially for over 12 years.

Evidence introduced during the course of this proceeding has raised considerable doubt as to the adequacy of these standards to protect agriculture in the Delta. Since the adoption of the Basin Plan, agricultural uses have been under an umbrella of protection provided by the fish and wildlife standards The relatively higher flows required to meet the fish and wildlife standards have kept salinity levels in the Delta generally far below the levels of the agricultural standards This incidental protection, however, would no longer be available under the approach suggested in the draft Four-Agency Fish Agreement.

<u>Without Project Conditions</u>

Under the without project alternative, the level of protection provided Delta agricultural uses would be that which would have been available to the Delta in the absence of the projects. Without project conditions have been determined in terms of the number of days that water of suitable quality would be available at various points of diversion throughout the Delta based on calculated conditions which would occur without the projects.

The water utilized by the plants is that in the root zone. The quality of this water is in effect a composite of the quality of all water applied during the irrigation season. In view of this, water quality standards under this alternative represent an average of without project water quality conditions over the major portion of the irrigation season (April 1 to August 15). This average reflects the number of days that certain water quality levels would be experienced.

The water quality standards for agriculture would be set at levels necessary to prevent any infringement on Delta vested water rights by the projects. Thus, the extent of Delta agricultural vested rights would be measured by reasonable beneficial use, not to exceed flows which would have reached the Delta had the SWP and federal CVP not been built, taking into account current upstream uses under vested rights.

It should be noted that upstream riparian uses have not changed appreciably since 1930. Also, for the critical July/August period, the Board has not issued any appropriative permits since 1955. Thus, even though Delta protection would be subject to non-project current upstream uses, these uses in the low flow season have not undergone much change over the last 20 years.

Modified Without Project Conditions

Under this alternative, the flow requirements to meet water quality standards imposed on the projects would be essentially equivalent to without project outflow requirements.

The basic difference between the modified without project alternative and the without project alternative is the manner in which protection is provided. As previously stated, the without project alternative is an average from April 1 through August 15 of water quality conditions which would have been available in the absence of the projects. The modified without project alternative would provide generally greater protection of agricultural uses early in the irrigation season, and less protection in the later portion of the irrigation season. The weighted average of these water quality conditions would be the same under both alternatives. It is anticipated that the impacts of both these alternatives will be nearly identical in terms of crop yield. However, the modified without project alternative which provides better water quality early in the irrigation season may provide better protection of seedlings and young plants and might provide better overall protection to Delta agriculture. Although this alternative is believed to be more beneficial to Delta agriculture, the possible benefits are not currently quantifiable in terms of crop yield.

Specific Areal Alternatives

The general conceptual alternatives presented above do not lend themselves to resolving water quality problems in certain areas of the Delta. This is especially true in the extreme western Delta and the southern Delta. In view of this, specific alternatives have been developed to resolve the special problems encountered in these areas.

Western Delta. The general conceptual approaches are designed to provide specific levels of protection to Delta agriculture. If the present agricultural uses on Sherman Island, Jersey Island, Hotchkiss Tract and other islands in the western Delta are to be continued, the water available to them must be suitable for irrigation. Under this alternative, project operators would have the option of satisfying in-channel quality requirements through substitute supplies, consistent with Section 12202 of the Delta Protection Act. If the project operators elect to provide a substitute supply in lieu of meeting particular water quality standards,[1] no added financial burden would be placed on Delta interests. If the project operators and Delta interests agree on water supply qualities better than their respective vested water rights, such agreement and compensation for benefits derived therefrom would be a matter to be resolved by the parties themselves and not by the Board so long as the capability of the projects to meet water quality standards is not jeopardized.

Southern Delta. An implementable solution for the southern Delta has eluded the best efforts of responsible public agencies for well over twenty years. Prior to 1944 water quality in the southern Delta was suitable for agricultural uses. Upstream depletions and water quality degradation of the San Joaquin River and its tributaries have greatly reduced the flows and quality available for protection of the southern Delta.

1/ See discussion on Page VII-20 of this plan regarding substitute supplies for the western Delta.

Riparians rights (taking into account upstream diversions by other riparians) would be generally sufficient to satisfy water quality needs of agricultural users in the southern Delta without regard to hydrologic year type. However, the permits of water development facilities in the San Joaquin River watershed, including those of the Bureau[2], which may be major contributors to southern Delta quality and quantity deterioration are not before the Board, nor has any jurisdiction been reserved in those permits to amend or supplement terms and conditions therein. Notwithstanding this, the permits do provide that such appropriations are subject to prior vested rights.

The direct effects of SWP and CVP diversions covered by permits currently before the Board do not result in major impact on water quality conditions in the southern Delta. It is questionable whether the Board could justify imposing terms and conditions in the permits before the Board to resolve all of the water quality problems in this area.

Thus, it would appear that the Board's vested water right authority through which terms and conditions are imposed in water right permits will not yield an implementable solution based on a consideration only of project facilities on the Sacramento River system and the Delta.

Under this specific areal alternative, water quality standards for the southern Delta would be established through the Board's water

2/ The SWP has no facilities on the San Joaquin River system. Also, in addition to the New Melones Project on the Stanislaus River, the CVP has the Friant Project on the San Joaquin River where that river accounts for less than 30 percent of the unimpaired Delta inflows from the San Joaquin River Basin.

quality control authority. The level of protection provided agricultural uses in the southern Delta would be set to satisfy riparian rights. Implementation of these standards could be achieved through the Board's broad enforcement authority. As previously indicated, all of the water right permits for the San Joaquin River Basin upstream of the Delta include a paramount provision that appropriations under these Board entitlements are subject to prior vested rights.

E. MUNICIPAL AND INDUSTRIAL

Water supply for human consumption has long been considered the highest use of water. Water quality standards developed for such uses must ensure that those supplies are potable and do not endanger human lives or health. Thus, the standards for municipal and domestic supplies developed for each of the alternatives presented below have been established at necessary levels to fully protect these uses.

No Action

The Basin 5B Plan standards for municipal and industrial uses would be controlling if the Board took no action. Municipal and industrial standards have been established at three locations in the Delta: Antioch, Rock Slough and City of Vallejo Intake at Cache Slough.

The Antioch standard includes a termination provision which would void the standard upon a determination by the Board that adequate substitute supplies are available to all existing municipal and industrial users in the Antioch and Pittsburg areas. During the hearing, the Department requested that the Board make such a determination on the basis that an adequate substitute supply is available to those users through the Contra Costa Canal.

The Rock Slough standard provides that the chloride concentration never exceed 250 mg/l and also that it stay below 100 mg/l at least 65 percent of the year. Basically, this standard reflects average water quality conditions that occurred at Rock Slough beginning with the operation of Shasta Reservoir in 1945 and continuing to 1966. On the basis of 1976 and 1977 conditions, it is unlikely that the 100 mg/l chloride limit could be met by the projects for the required period during dry and critical years.

The City of Vallejo Intake standard protects the export uses of the City of Vallejo. Seawater intrusion does not appear to have affected water quality significantly in the vicinity of Cache Slough, even during 1977 hydrological conditions.

Public Interest/Without Project Conditions

Under this alternative, protection of municipal and domestic uses would be provided under the Board's public interest authority. The principal basis of water quality standards for municipal water supply would be the protection of public health. The standards for drinking water contained in the proposed secondary drinking water standards of the Environmental Protection Agency developed under the "Safe Drinking Water Act" and the California State Department of Health criteria (Section 64473 of Title 22, California Administrative Code) would be followed. The question of compensation for benefits received by virtue of the operation of project facilities is left for resolution by the project operators and municipalities involved.

The level of protection for industries, on the other hand, would be based on the Board's vested water right authority. As in the case of agricultural supplies, industries would be provided at least that quality of water which they would have received in the absence of the projects.

Municipal uses are greatly enhanced in terms of taste and suitability for landscape watering by water quality levels better than the public health standards. The U. C. Guidelines for protection of chloride-sensitive vegetation and CCCWD Exhibit 17 indicate that taste suitability and landscape watering uses could be protected at the 150 mg/l chloride limit. It is proposed that municipal users be provided this higher level of protection to the extent that such quality would have been available to them in the absence of the projects.

Under this alternative, water quality standards for municipal and industrial uses in the vicinity of Antioch would be established to ensure the necessary water quality offshore of Antioch.

Substitute Supplies

As previously stated, municipal and industrial users in the vicinity of Antioch have adequate substitute supplies available through the Contra Costa Canal. Under this alternative, offshore water quality in the vicinity of Antioch would not be protected. The level of protection provided municipal supplies at Rock Slough under the Board's public interest authority would be identical to that of the previous alternative. The industrial standards would be based on providing a substitute water supply through the Contra Costa Canal equivalent to that which would have been available offshore at Antioch.

Modified Without Project Conditions

Under this alternative, the number of days that the 150 mg/1 chloride level is provided at Rock Slough would be permitted to vary with hydrologic conditions experienced. However, the chloride level would never be allowed to go above that required for public health. This alternative may provide long-term protection for industrial uses comparable to that of the substitute supply approach presented above.

F. SELECTION PROCESS

The individual conceptual alternatives outlined above have been sorted into alternative plans which include a complete set of standards covering all beneficial uses in the Delta and Suisun Marsh.

Each alternative strategy reflects the same general level of protection to beneficial uses.

See Chapter IV of the EIR for a full discussion of the impacts of these strategies on project operations and the environment. Based on the analysis contained in the EIR, the degree of protection provided by each alternative strategy and its impact on project operations can be compared. The water quality standards set forth in Chapter VI of this plan were selected from such comparative analysis of resulting benefits and detriments.

CHAPTER VI

WATER QUALITY STANDARDS

The water quality standards set forth in this chapter are the result of a full examination of agricultural, municipal and industrial, and fish and wildlife uses in the Delta; the beneficial uses of water exported from the Delta; and available Delta supplies, regulated and otherwise. After analysis of the major alternatives outlined above and the impacts of each outlined in the EIR, the following water quality standards are adopted.

A. FISH AND WILDLIFE

The fish and wildlife standards contained herein are those recommended to the Board by Fish and Game (Fish and Game Exhibit 11)1/ with minor modifications explained below. The Department in its closing brief endorsed the Fish and Game recommendations. The standards were developed through extensive negotiations among the Department, Bureau, Fish and Game and U. S. Fish and Wildlife Service. However, these agencies have not yet executed an agreement.

The Fish and Game recommendations are based on maintenance of fish and wildlife resources on the average at recent historical levels (1922-1967)2/ but recognize that these levels cannot be

1/ April 12, 1977 draft of the so-called Four-Agency Fish Agreement.

2/ Conditions upstream of the estuary may limit the abundance of some species. This recommendation deals only with those factors in the Delta estuary that limit species abundance.

achieved with existing project facilities and current export levels (Fish and Game Exhibit 11, p. 4). Until additional project facilities are constructed and operational, the recommendations provide, except as to Suisun Marsh (discussed below), for the maintenance of the fishery (as represented principally by striped bass) in the Delta estuary at levels which would approach those that would have existed in the absence of the SWP and CVP.

The recent historical fishery levels in the Delta have exceeded what would have occurred in the absence of the SWP and CVP. The Board believes that the fishery in the Delta should be maintained at these historical levels. Higher levels of protection involving greater Delta outflows are not realistic. Any future Delta transfer facility should be operated to ensure the maintenance of these recent historical levels. In the absence of such a facility, the fishery resource should be maintained as close as practicable to those levels which would have existed in the absence of the SWP and CVP (without project conditions).

As discussed in Chapter V and in more detail in the EIR, other alternatives in addition to the Fish and Game recommendations were evaluated. Based on this evaluation, the Fish and Game recommendations, with modification of the striped bass spawning and survival relaxation provisions, and interim Suisun Marsh standards, are the most appropriate water quality standards for the reasonable protection of fish and wildlife resources. These standards are shown in Table VI-1.

Presented below is a brief discussion on the rationale and technical basis for the fish and wildlife standards. More detailed information is contained in the EIR as well as in the extensive testimony and exhibits introduced by Fish and Game during the Delta hearing.

Striped Bass Spawning

As indicated in Chapter III, striped bass have been selected as a key species for establishing Delta fish and wildlife criteria. The striped bass spawning locations on the Sacramento and San Joaquin River systems are shown in Figure III-1. Salinity affects striped bass spawning on the lower San Joaquin River (Fish and Game Exhibit 3, p. III-8). Spawning in this reach of the river typically occurs in the main channel and connecting sloughs between Antioch and Prisoners Point on Venice Island. Salinity limits of 1.5 mmhos EC (1000 mg/l TDS) and 0.55 mmhos EC (350 mg/l TDS) at Antioch and Prisoners Point, respectively, have been established as maximum allowable levels for striped bass spawning on a long-term basis (see Appendix B). However, it may be possible to exceed these values for brief periods with little adverse effect on spawning (Fish and Game Exhibit 3, p. III-8). Information gathered during 1977, currently being evaluated by Fish and Game, should help clarify this concern.

Substantial spawning on the San Joaquin River generally commences in mid to late April and continues for about 5 weeks (Fish and Game Exhibit 12A). The Antioch spawning standard requires sufficient outflow to achieve minimum acceptable salinity levels by the time substantial spawning starts, and the maintenance of suitable salinity during the first several weeks of spawning. Under steady state conditions, a 6700 cfs outflow should result in approximately 1.5 mmhos EC at Antioch (Department Exhibit II-9 Attachment No. 3). During the latter part of the spawning period, salinities are influenced by the striped bass survival standard.

The previous Antioch spawning standard in the Basin 5B Plan was triggered when water temperatures reached a specific level (see Appendix B). This presented two problems. First, the required spawning salinity was often provided prior to any significant spawning. Second, the triggering date was difficult to establish due to fluctuation of stream temperatures near this limit (RT Vol. XXII, p. 157).

Relaxation Provision

Both Fish and Game and the Department recommended relaxation of the striped bass spawning standard during periods of extreme water shortage. Relaxation would be commensurate with the deficiencies imposed on firm supplies to SWP and CVP water users. During periods of extreme water shortage these agencies recommended that the Antioch spawning standard, plus the 6,700 cfs outflow provision for the first 15 days of the spawning standard period, be replaced by minimum total flows of 470,000 acre-feet during the 35-day period (470,000 acre-feet is equal to about 6,700 cfs for 35 days), less an amount equal to 10 percent of the annual deficiencies in deliveries of firm supplies by the projects, excluding any deficiencies in the Friant Division of the CVP.

This outflow-related relaxation criteria has serious flaws. The parameter of concern in striped bass spawning is salinity, not outflow. Also, the Delta Outflow Index during the beginning of the irrigation season (around April) may not be representative of true outflow in some years (EIR, Chapter III), and the assumption that 6,700 cfs can maintain 1.5 mmhos EC at Antioch is based on water quality models that do not account for the effects of exports on the salinity-flow relationships in this area of the Delta. The occurrence of such effects during the early portion of the irrigation season may require larger outflows at higher export rates in order to maintain the target salinity condition at Antioch.

In view of these deficiencies, the recommended striped bass spawning relaxation standard has been modified to maintain salinity levels at Antioch rather than outflow while retaining the original intent of the recommended relaxation provision. This approach was used in the trial set of objectives and was not challenged by any of the hearing participants.

Striped Bass Survival and *Neomysis* Protection

The goals of this standard are twofold. The first is to maintain striped bass populations on the average at levels which approach without project conditions prior to construction and operation of a Delta transfer facility. The second is to maintain populations on the average at recent historical levels after the operation of such a facility. The standard also benefits opposum shrimp, *Neomysis*, the critical food source for young striped bass.

The Striped Bass Index, a measure of young bass survival through their first summer, is the parameter of concern for striped bass survival. The Striped Bass Index is a measurement of relative abundance rather than an estimate of the actual number of striped bass present. However, the use of the Striped Bass Index as a water quality control parameter poses some technical problems. Therefore, the Striped Bass Index has been translated to the environmental conditions most directly related to it. The most direct mechanism to monitor these environmental conditions is through the use of the Delta Outflow Index. The technical basis for this approach is set forth in the hearing record (Fish and Game Exhibit 3, pp. III-13 to III-34 and RT Vol. XXII, pp. 168-175).

The recommended standard is based on statistical relationships between striped bass abundance, Delta outflow and water diversions from Delta channels for both local and export uses (Fish and Game Exhibit 3, Figures III-13 and III-6, and Fish and Game Exhibit 11, Appendix C, p. 5). Using known or estimated recent historical outflow and diversions, the average abundance of striped bass for the period 1922-1967 was found to be 106 Striped Bass Index units. In order to derive a standard that would achieve the long-term goal for fishery preservation, mean May, June and July flows for the six hydrologic year types (see Figure II-1) were selected which produce a mean Striped Bass Index of 106, assuming the historical occurrence of year types coupled with export curtailments sufficient to eliminate detriments due to exports (Fish and Game Exhibit 11, Appendix C, pp. 5 and 6, and RT Vol. XXII, pp. 166-175).

Analysis of the striped bass survival standard indicates that striped bass, on the average, can be maintained at levels that approach without project levels under the expected export conditions during the effective period of this plan (see EIR, Chapters IV and V).

The without project level of striped bass, based on June and July flows, is about 71 Striped Bass Index units. However, other factors may also affect striped bass survival. For instance, conditions prior to and after the June/July period affect striped bass abundance. The magnitude of this impact cannot be quantified at this time. The nature of this impact suggests that something higher than 71 index units would be required to maintain striped bass abundance at without project levels (see EIR, Chapter V, Section B). How much higher is unknown.

The average Striped Bass Index under this plan is about 79 index units. Even though without project levels would be somewhat higher than 71, it is believed that the striped bass levels (79) under this plan would approximate without project levels if the effects of all factors at all times of year could be properly evaluated. This striped bass survival standard will in any event provide substantially better protection to striped bass than the previous basin plan objectives (63 index units), while having a lesser impact on project exports (EIR, Chapter V).

Even though the current method used to assess without project levels of striped bass lacks the precision necessary to identify fully project mitigation responsibilities, it is sufficient to indicate a project responsibility to provide immediate protection to the fishery resource. While this level of protection falls short of full mitigation of all project impacts on the fishery, it is nonetheless a reasonable level of protection.

The method used to assess without project levels of striped bass is at best only a rough approximation of project impacts on striped bass abundance. Prior to any attempt to fix project responsibilities for mitigating impacts on the fishery, the analytical tools for assessing project impacts must be refined. As with the Draft Four-Agency standards, the Department, Bureau, Fish and Game, and U. S. Fish and Wildlife Service should work together to develop a mutually acceptable approach to identify project impacts on the fishery.

The striped bass standards are expected to benefit species other than striped bass, as previously discussed. The spring and early summer flows provided in the above standards coincide with the spawning and migration period of many species which presumably are adapted to the natural high flows occurring during this period (see Figure III-2). While the Delta Plan approaches without project levels of protection for striped bass, there are many other species, such as catfish, shad and salmon, which would not be protected to this level. In order to provide full mitigation of project impacts on all fishery species now would require the virtual shutting down of the project export pumps. Such extreme action would not be in the best public interest.

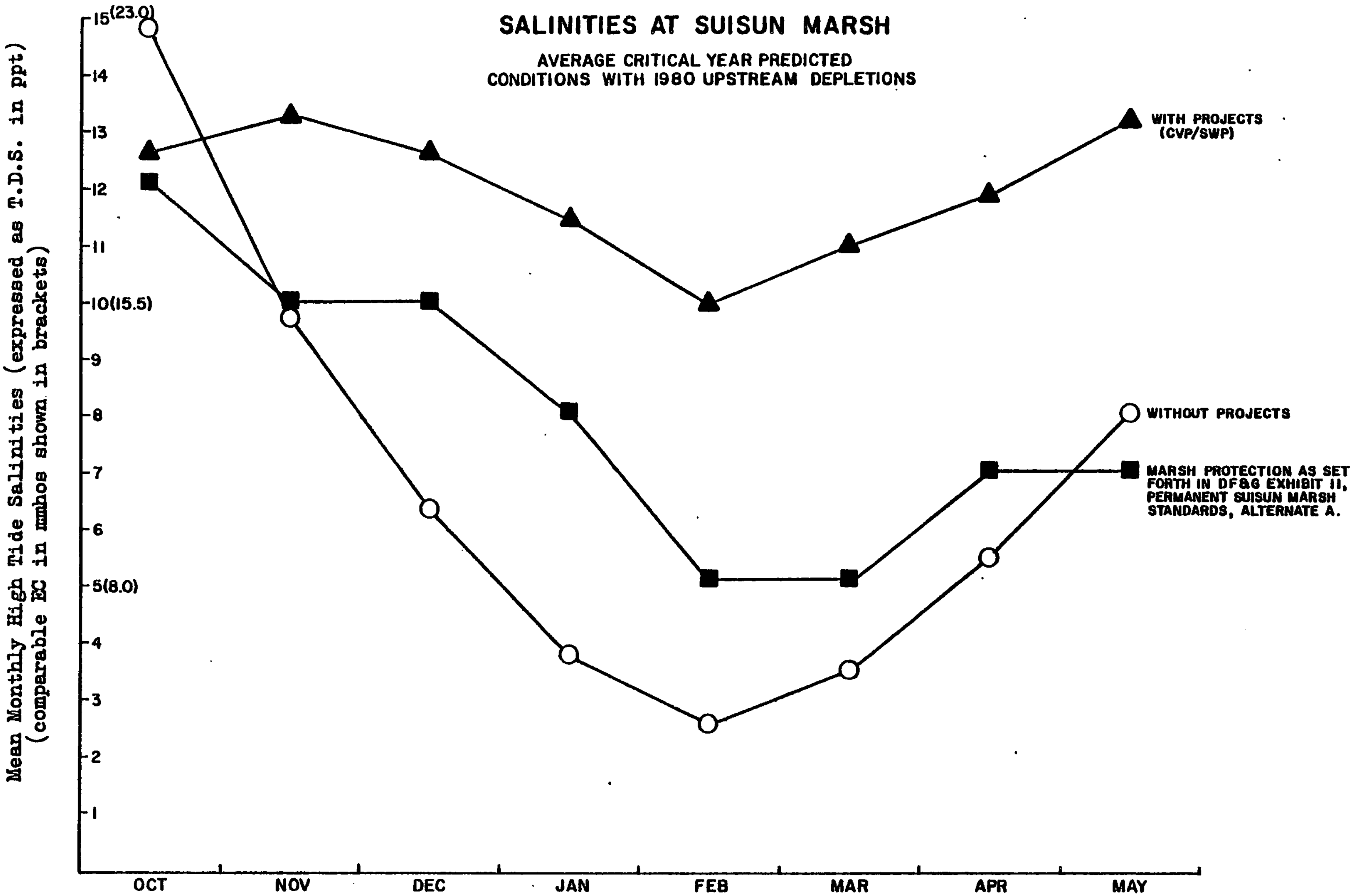
Salmon Migration

The salmon standard reflects the minimum flows which Fish and Game believes would be suitable for salmon migration. Fish and Game's recommendation is based largely on information from the San Joaquin River which relates river flows to abundance of returning adult salmon (Fish and Game Exhibit 3, Chapter II). However, the information necessary to refine this standard is not currently available (Fish and Game Exhibit 11, p. 6). Notwithstanding this, the standard is an appropriate base from which more definitive standards can be established in the future.

Suisun Marsh

Full protection of Suisun Marsh at present poses an extremely difficult problem. As shown in Figure VI-1, the interim standards set forth in Fish and Game Exhibit 11 plus anticipated uncontrolled flows will not fully protect Suisun Marsh in typical critical years.

FIGURE VI-1



Predicted salinities are shown for the mouth of Suisun Slough which was estimated at 0.75 times the Port Chicago salinities (from DF&G Exhibit 24, DWR Exhibit II-13-B).

This figure also shows that under 1980 without project conditions, the Marsh would have been protected in average critical years. Thus, the interim standards do not fully mitigate the adverse effects of the projects on the Marsh.

State and federal legislation require the SWP and CVP to mitigate the adverse environmental effects of project operations.[3] Standards providing such mitigation measures to the Marsh are evaluated in the EIR. Full protection of the Marsh solely with outflow could require in excess of 2 million acre-feet (in terms of project yield) in addition to that outflow required to meet the interim Marsh standards (RT Vol. XXII, p. 101). This would result in a one-third reduction in combined SWP and CVP exportable yield from existing facilities. The Bureau, the Department, Fish and Game and the U. S. Fish and Wildlife Service are working to develop supplemental water supplies for the Marsh. Such supplemental supplies are a more desirable method for protecting the Marsh and mitigating the adverse impacts of the CVP and SWP on this extremely valuable resource.

Recognizing the effort currently underway by this Four-Agency group, a time schedule has been developed for the completion of the necessary measures to mitigate the projects' impacts on Suisun Marsh. Initial phases of this program should be completed by January 1, 1980, with full mitigation required by October 1, 1984. A more detailed discussion of this program is set forth in the program of implementation, Chapter VII.

3/ Section 11900 of California Water Code; The California Environmental Quality Act (Public Resources Code Section 21000, et seq.); Fish and Wildlife Coordination Act [16 U.S.C. Section 661, et seq. (1970)]; and National Environmental Policy Act of 1969 [42 U.S.C. Section 4321 et seq. (1970)].

The interim standards do not provide complete protection to Suisun Marsh. The interim standards require some modification of project operations to benefit the Marsh, but rely primarily on the occurrence of uncontrolled outflows to protect the Marsh until 1984.

Fish and Game recommended relaxation of the interim Marsh standards whenever the projects impose deficiencies in firm scheduled water deliveries. This recommendation was based on attaining full protection for the Marsh by January 1, 1982. However, during the public hearing on the draft plan, the Department indicated that full Marsh protection could not be achieved until the fall of 1984. In view of this, the control date by which full Marsh protection would be required was extended to October 1, 1984. In order to ensure sufficient protection over this extended interim period, relaxation of interim Marsh standards will not be allowed in the critical months of January through May.

The Board supports the long-term goal of Fish and Game that all managed wetlands of Suisun Marsh (except those on Ryer, Roe, Snag and Freeman Islands) should be provided with sufficient quantities of adequate quality water to attain a soil water electrical conductivity of 14 mmhos EC (9 parts per thousand TDS) in the first foot of soil during May, using best practical water management practices (Fish and Game Exhibit 11, p. 13). Best available information indicates that water quality conditions to achieve this goal would have been available even in most critical years had the projects not been constructed. Therefore, provision of water quality conditions to achieve this goal is a project responsibility. These conditions are included as standards to be achieved at specific locations in the Marsh by October 1, 1984. The program of implementation in Chapter VII of the plan sets forth the specific actions that must be taken by the project operators to mitigate their impacts on the Marsh in the interim period prior to October 1, 1984.

Operational Constraints

In addition to the interim fish and wildlife standards, Fish and Game has recommended that CVP and SWP facilities be required to operate in a manner which would minimize their impact on the Delta fishery. Even though such operating criteria are not a usual element of a water quality control plan, they are proper considerations for a water right decision. In view of the dual nature of this proceeding, these operating criteria are included in Table VI-1.

The most important operational requirement is a curtailment of exports to protect striped bass. The export curtailment, in combination with the spring and summer flows for striped bass survival, is an important factor in approaching the without project level of this resource. In order to ensure the attainment of this goal, the operational constraints recommended by Fish and Game have been modified so that SWP export curtailment would be required regardless of Delta outflow conditions.

Other constraints include restrictions on the operation of the Delta Cross-Channel and requirements on the operation of the fish protective facilities at the SWP and CVP export locations.

B. AGRICULTURE

Water quality standards to protect Delta agricultural uses have been developed for three general geographic areas: the western, interior and southern Delta. The particular needs of each area are determined by its location in the Delta, its soil types and irrigation practices. While the general approach for all three areas is substantially the same, the agricultural water quality standards have been tailored to the particular characteristics of each area.

The approach used in developing the agricultural standards involves an initial determination of the water quality needs (criteria) of significant crops, predominant soil types, and irrigation practices in each area. The extent to which these water quality needs would be satisfied in various portions of the Delta under without project conditions was then determined. The agricultural standards are based on this determination and ensure that project operations do not encroach upon Delta vested rights. The level of protection provided agricultural uses under these standards will extend no further than without project conditions, as limited by reasonable beneficial use. However, additional needs could be met through contracts with the Department and Bureau under the statutory preference accorded Delta beneficial uses.

Water Quality Criteria

Subirrigated Organic Soils. As indicated above, a substantial portion of the western and interior Delta organic soils are subirrigated (see Figure III-4). This method of irrigation is very energy efficient. However, since subirrigation wets the soil from below the surface, effective leaching is reduced. This reduced leaching makes it necessary to irrigate with high quality (low salinity) water. Subirrigation has been practiced historically with good success in the Delta. The widespread use of this method of irrigation is due largely to the fact that organic soils cannot be successfully irrigated by furrow or border check methods (RT Vol. XIII, p. 29). The water quality criteria developed for organic soils is based on the high water quality required when subirrigation is practiced.

However, there are other acceptable methods for irrigating organic soils which could reduce the need for this high quality water. One such method is sprinkler irrigation which was discussed during the hearing as a possible alternative to subirrigation. Sprinkler irrigation of Delta organic soil would require a substantial additional capital and operating cost (RT Vol. XIII, p. 46-47). In view of the considerable expense involved, such alternative means of irrigation have been treated in the same manner as the substitute supplies provision of the Delta Protection Act. Under the Delta Protection Act, Delta water users would not incur additional expense if a substitute supply is provided by the project operators (see discussion in Chapter I).

In order to determine the water quality needs of the Delta organic soils, the crop of major significance to this area's economy was identified. As indicated in Chapter III, corn is the principal crop grown on subirrigated soils. In accordance with the Delta Protection Act provision to maintain and expand Delta agriculture, water quality requirements have been established to provide 100% crop yields for corn.

The University of California (UC) Guidelines and Irrigation and Drainage Paper 29 of the Food and Agriculture Organization of the United Nations (FAO) (UC Exhibits 1 and 2) provide a methodology for determining the maximum salinity of the applied water which allows a 100% yield of specific crops. However, the equations used in this determination must be modified for subirrigated organic soils (UC Exhibit 8). The FAO report assumes a soil water salinity concentration of three times that of the applied water. However, Exhibit 8 indicates that the applied water salinity is actually concentrated from five to ten times in the organic soils of the Delta where subirrigation is practiced. If a concentration factor of 7.5 is substituted into the FAO equations, the applied water salinity requirement for corn on subirrigated organic soils would be 0.45 mmhos EC.

Throughout the extensive testimony of the U. C. Cooperative Extension electrical conductivity is used as the best measure of salinity impacts on Delta agriculture. While total dissolved solids and chloride ion concentration have been employed traditionally as measures of Delta water quality, electrical conductivity is more closely related to osmotic pressure (which the plant is responding to) than any other measure of salinity. Figures II-4 and II-5 list the conversion factors from electrical conductivity to chloride ion concentration and total dissolved solids for representative stations in the Delta.

The 0.45 mmhos EC water quality requirement will be imposed only during the irrigation season, April 1 to August 15. It was not possible to establish the water quality needs of this area during other periods of the year because of the lack of information in the hearing record.[4/]

However, the water which the plant uses may not be solely that which is directly applied in the field (RT Vol. XX, p. 181). The mechanics of this water movement through the soil has not been well defined, but preliminary research by the U. C. Cooperative Extension indicates that water applied in spud ditches may be adding additional upward force to the underlying groundwater and that the plant might actually be using the groundwater for consumptive use. If these preliminary indications prove to be valid, the quality of the groundwater could be the most important factor in the consideration of water quality needs in subirrigated organic soils. The complexity of factors affecting groundwater quality and water movement are not fully understood at this point. Future research may clarify these relationships.

Mineral Soils. As more fully described in Chapter III, mineral soils are found predominantly in the northern and southern portions of the Delta. Unlike the organic soils which are predominately subirrigated, mineral soils permit surface irrigation. Some leaching

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4/ The interim agreement between the Department, North Delta Water Agency and Reclamation District 341 executed on June 21, 1977, due to the drought does make provisions for supplying specific quality levels to areas in the western Delta for a two-week period in December 1977 for preirrigation.

of the mineral soils is accomplished by surface irrigation during the growing season. The water quality needs of mineral soils are not as high as those for subirrigated soils for the same crop yields. Therefore, the water quality standards developed for the protection of the subirrigated organic soils in the western and interior Delta will provide suitable water quality for the mineral soils in the northern portion of the Delta.

Water quality and quantity needs in the southern Delta are a different matter. A major portion of the southern Delta has a considerable amount of clay intermixed in the soil profile. These soils tend to have low permeability, and drainage and water movement is often restricted.

The drainage and high water table problems in portions of the southern Delta limit the type of crops which can be grown. For instance, beans were grown on about 20,000 acres in the southern Delta during the early 1930's. Field beans are now grown on only about 2,400 acres in the southern Delta. A reason advanced for this decline is the poorer water quality presently available to the southern Delta. Most of the beans now grown in this area are black-eyed beans, because they are more salt tolerant. Even these salt tolerant beans are grown generally in areas receiving Delta-Mendota Canal water due to its better quality (RT Vol. XIII, p. 157).

Beans are an important crop to the southern Delta due to market demand and suitability to climate and soil. Also, beans are well suited to crop rotation in this area. The U. C. Guidelines recommend an applied water quality of 0.7 mmhos EC during the irrigation season, April through August, to maintain beans at a 100% yield (UC Exhibit 1). Other important crops in the southern Delta are alfalfa, pasture and sugar beets. These crops use water throughout the year. Also, during a major portion of the year, one area or another of the southern Delta is in the seedling stage of growth (RT Vol. XIV, p. 86). In view of the year-round demand for irrigation water, the water quality needs of this area for months other than April through August must be considered.

The U. C. Guidelines indicate that alfalfa requires an applied water of 1.3 mmhos EC for a 100% yield. Because of permeability problems, associated winter leaching factors and the water quality requirements of crops in the seedling stage, an applied water quality of 1.3 mmhos EC would not fully avoid crop decrement. In order to provide sufficient protection to crops in the southern Delta outside of the April through August irrigation season, the quality of applied water has been set at 1.0 mmhos EC during the period September 1 to March 31. The ongoing research by the U. C. Cooperative Extension in the southern Delta may produce information which will show a need for future revision of these water quality criteria.

Water Quality Standards.

Western Delta. In order to establish water quality standards for the western Delta organic soils, water quality data at representative locations were analyzed to determine without project water quality conditions (i.e., conditions which would exist in the absence of CVP and SWP). Figure II-4 shows this level of water quality for Emmaton and Jersey Point.

Under without project conditions, the high quality water needed for full crop yields in the western Delta would not be available throughout the entire irrigation season in most years. In most years, water with extremely good quality would be available during the early portion of the irrigation season, but the quality would deteriorate rapidly during the later portion of the season. The start of the deterioration would depend upon the year type. Standards designed solely to reproduce such conditions would require large quantities of water for little benefit. In order to provide the extremely good quality water early in the irrigation season, Delta outflows in excess of 10,000 cfs would be required. In most years, uncontrolled flows provide much of the needed outflow. However, since without project conditions would allow rapid and extensive salinity intrusion during the latter part of the irrigation season, the benefits to agriculture provided by reproducing such conditions would appear to be offset by the detriments. Thus, the direct application of without project conditions without some modification would result in unreasonable standards. Equivalent without project conditions have been developed by providing the western Delta the same weighted average salinities over the period April 1 through August 15 as those shown on Figure II-4. Such modification will benefit both agricultural users in the western Delta and project operators.

The agricultural standards for the western Delta shown in Table VI-1 are based on these equivalent without project conditions. Under these standards, a water quality of 0.45 mmhos EC would be assured for that portion of the irrigation season during which it would have occurred in the absence of the projects, in all years except critical years. The water quality provided for the remaining portion of the irrigation season would reflect a salinity which when weighted with the 0.45 mmhos EC value would be equivalent to the without project weighted average over the entire irrigation season. In some years, particularly wet and above normal years, the combined effect of both of these factors result in a requirement of 0.45 mmhos EC for the entire period April 1 through August 15. In such cases the 0.45 mmhos EC requirement is shown for the entire period in the first column of the agricultural standards in Table IV-1.

Provision of the 0.45 mmhos EC early in the irrigation season would be unreasonable during critical years, because of the relatively large outflows required. In view of this, the water quality standards for the western Delta during critical years are based on the time-weighted average water quality conditions over the entire period April 1 through August 15. These time-weighted averages are the same as the without project average conditions for such years.

Interior Delta. The agricultural water quality needs of the interior Delta are essentially the same as those of the western Delta subirrigated organic soils, 0.45 mmhos EC during the irrigation season. The without project water quality conditions for representative locations in the interior Delta are shown in Figure II-5. Central Landing on the Mokelumne River is representative of water quality in the portions of the interior Delta influenced directly by the Sacramento and Mokelumne Rivers. Webb Pump on False River represents water quality of the interior Delta affected by the San Joaquin River. As shown in Figures II-4 and II-5, water quality in the interior Delta under without project conditions would be considerably better than in the western Delta during the irrigation season. Also, water quality in that portion of the interior Delta influenced by the Sacramento and Mokelumne Rivers is better than that of areas influenced by the San Joaquin River.

The water quality standards developed for the interior Delta are based on the same general principles as those for the western Delta. These standards are shown in Table IV-1. In the absence of a cross-Delta water transfer facility, salinity protection of the interior Delta south of the San Joaquin River is afforded by the Jersey Point standards. The Board intends to adopt standards for specific locations in the interior Delta south of the San Joaquin River if such a facility is constructed.

Southern Delta. In Chapter V, the problems associated with development of implementable water quality standards for the southern Delta are discussed. In recognition of the concerns expressed therein, a phased approach has been developed to resolve the long standing water quality problems in the southern Delta. The current Vernalis objective contained in the Basin 5B Plan is used as an interim level of protection for the southern Delta. However, achievement of this interim level of protection cannot be ensured until New Melones Reservoir is operational.

The most practical solution for long-term protection of southern Delta agriculture is construction of physical facilities to provide adequate circulation and substitute supplies. If necessary physical facilities are constructed, the circulation flows needed may be only a moderate increase above those committed from New Melones Reservoir.[5/] Negotiations concerning such facilities are currently underway between the project operators and the South Delta Water Agency.

C. MUNICIPAL AND INDUSTRIAL

The principal concerns in development of water quality standards for municipal and industrial uses in the Delta are public health protection and the needs of established salt sensitive industries. The development of suitable standards is complicated by the effect of established water supplies from both historical water right diversions and substitute sources.

5/ See Memorandum Agreement for the Protection and Enhancement of the Water Quality of the Stanislaus and San Joaquin Rivers as Affected by the New Melones Project under Water Right Application 19304 of the United States of America and by Municipal and Industrial Wastes, between the Bureau and Central Valley Regional Water Quality Control Board dated July 2, 1969.

Contra Costa Canal Intake

Historically, diversions for municipal and industrial uses have been made not only from the Delta in the Antioch/Pittsburg area, but also downstream from the Delta as far as Crockett in the Carquinez Strait area (Department of Public Works Bulletin 27, Plate IV).

As stated in Chapter V, water quality standards for public drinking supplies have been developed at levels necessary to provide full protection regardless of a particular entity's vested rights. In accordance with Section 64473 of Title 22 of the California Administrative Code, the standard for drinking water has been established at 250 mg/l chloride.

The level of protection provided industrial uses and municipal supplies (other than drinking supplies) extends to at least that quality of water which would have existed in the absence of the projects. These without project water quality conditions offshore at Antioch are shown in Figure II-7, and their development is discussed in Chapter II. As indicated in Chapters II and V, the production of salt-sensitive paper, drinking water taste enhancements and irrigation of salt-sensitive plants require a chloride concentration of 150 mg/l or less (RT Vol. XVII, p. 137; CCCWD Exhibit 17, p. 11; UC Exhibit 1, p. 1).

The maintenance of without project conditions offshore at Antioch would require additional Delta outflow of 22 to 44 acre-feet to protect each acre-foot of use (RT Vol. XXIV, p. 151). Even though previous water quality standards provided limited protection offshore at Antioch during portions of the year, these standards were intended to be in effect only until a substitute supply was available to areas in the vicinity of Antioch.

All principal water users in the vicinity of Antioch now have an alternate source of supply from the Contra Costa Canal, which has its intake at Rock Slough (RT Vol. II, pp. 56 and 57, and Vol. XVII, p. 72). The Department has offered to pay any increased cost incurred by these principal water users in taking water from the Contra Costa Canal as a result of reduced availability of suitable offshore supplies due to SWP operations (RT Vol. II, p. 57). The Department has already contracted with CCCWD (Mallard Slough Intake) and the City of Antioch to make such compensation (RT Vol. XXIV, p. 148). Based on recent negotiations, it appears that the remaining issues with the other principal users can be resolved. In view of this and the large Delta outflow required to protect offshore uses in the vicinity of Antioch, a specific offshore Antioch standard has not been included in this plan.

However, in accordance with the Delta Protection Act, such substitute supply should provide Delta users at least that water quality which would have been available to them in the absence of the projects. The standard for municipal and industrial uses in the vicinity of Antioch is based on providing a substitute supply through the Contra Costa Canal equivalent to that available offshore at Antioch. Thus, this standard provides a chloride limit of 150 mg/l at Rock Slough for periods equal to those during which water of that quality would occur offshore at Antioch. Users in the vicinity of Antioch have no vested water right at Rock Slough. Therefore, the intent of this standard is to protect this substitute supply. The station selected for monitoring compliance with this standard is the CCCWD Pumping Plant No. 1. The quality at this station will closely reflect the delivered water quality. Substantial differences in water quality can occur between Rock Slough and CCCWD Pumping Plant No. 1. These differences are due to agricultural return flows (RT Vol. IV, pp. 175-177; Department Exhibits 10a, 10b, 10c) (See page VII-3 for discussion of action concerning the agricultural return flow problem). There is no requirement that the quality of this substitute supply be maintained consecutively for the entire period shown in Table VI-1, but it must be provided in intervals of at least two weeks duration. Whenever users in the vicinity of Antioch elect to satisfy their vested water rights through offshore supplies, compliance will be measured at either Pumping Plant No. 1 or Antioch, provided that the durational requirement is satisfied.

The Department has proposed a Contra Costa Canal Intake (Rock Slough at Old River) standard which would allow greater variation in the period when the 150 mg/l chloride level is provided, especially during drier years (Department's Closing Brief, p. 31). Under this proposal, the 150 mg/l chloride level would be provided more than 65% of the time on an annual overall average assuming the historical occurrence of year types. The annual overall average for the proposed Rock Slough standard shown in Table VI-1 is 53%. Even though the Department's proposal provides for a greater average annual occurrence of high quality water at Rock Slough and takes better account of low water supply conditions, this proposal was not selected as a standard since it would not provide a substitute supply equivalent to that available offshore at Antioch during dry and critical years. The Board has concluded that Rock Slough water quality levels should not go below this minimum.

City of Vallejo Intake (Cache Slough)

The City of Vallejo has an appropriative right to divert water at Cache Slough for use outside the Delta. Riparian uses and earlier priority appropriations elsewhere in the Sacramento Basin limit the availability of water for exercise of this right in critically dry years. The previous water quality standards for Cache Slough provided a maximum total dissolved solids limit of 250 mg/l (100 mg/l chloride). However, data from 1972 to 1976 shows that this standard has been met only half of the time and that it is often exceeded during periods of high Delta inflow and outflow. This suggests that local return drainage affects this area's water quality more directly than project operations. Also, saltwater intrusion during 1977 did not appear to influence significantly water quality in the vicinity of Cache Slough. The 250 mg/l chloride limit proposed in this plan will protect this supply for municipal uses in accordance with Section 64473 of Title 22, California Administrative Code.

Although current operations of the projects do not seem to significantly affect water quality at the City of Vallejo Intake, future activities of the projects might adversely affect this quality. Therefore, the City of Vallejo Intake standard will be included in the water right permits of the Department and Bureau.

<u>Clifton Court and Tracy Pumping Plant</u>

Diversions from Delta channels for municipal and industrial uses outside the Delta occur at Clifton Court and Tracy Pumping Plant. Consistent with the chloride limits for drinking water discussed previously, a maximum of 250 mg/l chloride is included as the water quality standard at these locations. However, water supply contracts of the SWP and CVP presently require better water quality. Thus, water quality at the project export facilities will be significantly better than that provided by the water quality standards established in this plan as a result of project operations.

Table VI-1
WATER QUALITY STANDARDS
FOR THE SACRAMENTO-SAN JOAQUIN DELTA AND SUISUN MARSH[1/]

BENEFICIAL USE PROTECTED and LOCATION	PARAMETER	DESCRIPTION	YEAR TYPE[2/]	VALUES	
MUNICIPAL and INDUSTRIAL					
Contra Costa Canal Intake at Pumping Plant No. 1	Chloride	Maximum Mean Daily Cl^- in mg/l	All	250	
Contra Costa Canal Intake at Pumping Plant No. 1 or Antioch Water Works Intake on San Joaquin River	Chloride	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 Year shown in parenthesis)		Number of Days Each Calendar Year Less than 150 mg/l Chloride	
			Wet	240 (66%)	
			Ab. Normal	190 (52%)	
			Bl. Normal	175 (48%)	
			Dry	165 (45%)	
			Critical	155 (42%)	
City of Vallejo Intake at Cache Slough	Chloride	Maximum Mean Daily Cl^- in mg/l	All	250	
Clifton Court Forebay Intake at West Canal	Chloride	Maximum Mean Daily Cl^- in mg/l	All	250	
Delta Mendota Canal at Tracy Pumping Plant	Chloride	Maximum Mean Daily Cl^- in mg/l	All	250	
AGRICULTURE				0.45 EC April 1 to Date Shown	EC from Date Shown[3/] to Aug. 15
WESTERN DELTA					
Emmaton on the Sacramento River	Electrical Conductivity	Maximum 14-day Running Average of Mean Daily EC in mmhos	Wet	Aug. 15	—
			Ab. Normal	July 1	0.63
			Bl. Normal	June 20	1.14
			Dry	June 15	1.67
			Critical	—	2.78
Jersey Point on the San Joaquin River	Electrical Conductivity	Maximum 14-day Running Average of Mean Daily EC in mmhos	Wet	Aug. 15	—
			Ab. Normal	Aug. 15	—
			Bl. Normal	June 20	0.74
			Dry	June 15	1.35
			Critical	—	2.20
INTERIOR DELTA					
Terminous on the Mokelumne River	Electrical Conductivity	Maximum 14-day Running Average of Mean Daily EC in mmhos	Wet	Aug. 15	—
			Ab. Normal	Aug. 15	—
			Bl. Normal	Aug. 15	—
			Dry	Aug. 15	—
			Critical	—	0.54
San Andreas Landing on the San Joaquin River	Electrical Conductivity	Maximum 14-day Running Average of Mean Daily EC in mmhos	Wet	Aug. 15	—
			Ab. Normal	Aug. 15	—
			Bl. Normal	Aug. 15	—
			Dry	June 25	0.58
			Critical	—	0.87
SOUTHERN DELTA					
Vernalis on the San Joaquin River	Total Dissolved Solids	Maximum 30-day Running Average of Mean Daily TDS in mg/l	All (after New Melones Reservoir becomes operational and until the standards below become effective)	500	
				Apr. 1 to Aug. 31	Sept. 1 to March 31
Tracy Road Bridge on Old River Old River near Middle River Brandt Bridge on San Joaquin River Vernalis on San Joaquin River	Electrical Conductivity	Maximum 30-day Running Average of Mean Daily EC in mmhos	All (to become effective only upon the completion of suitable circulation and water supply facilities)[4/]	0.7	1.0

Table VI-1
WATER QUALITY STANDARDS
FOR THE SACRAMENTO-SAN JOAQUIN DELTA AND SUISUN MARSH 1/

BENEFICIAL USE PROTECTED and LOCATION	PARAMETER	DESCRIPTION	YEAR TYPE 2/	VALUES
FISH AND WILDLIFE				
• *STRIPED BASS SPAWNING*				
Prisoners Point on the San Joaquin River	Electrical Conductivity	Average of mean daily EC for the period not to exceed	All	April 1 to May 5 0.550 mmhos
Chipps Island	Delta Outflow Index in cfs	Average of the daily Delta outflow index for the period, not less than	All	April 1 to April 14 6700 cfs
Antioch Waterworks Intake on the San Joaquin River	Electrical Conductivity	Average of mean daily EC for the period, not more than	All	April 15 to May 5 1.5 mmhos
Antioch Waterworks Intake	Electrical Conductivity (Relaxation Provision – replaces the above Antioch and Chipps Island Standard whenever the projects impose deficiencies in firm supplies 5/	Average of mean daily EC for the period, not more than the values corresponding to the deficiencies taken (linear interpolation to be used to determine values between those shown)	All – whenever the projects impose deficiencies in firm supplies 5/	See below

Total Annual Imposed Deficiency MAF	April 1 to May 5 EC in mmhos
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

• *STRIPED BASS SURVIVAL*

Chipps Island — Delta Outflow Index in cfs — Average of the daily Delta outflow index for each period shown not less than

Year Type	May 6–31	June	July
Wet	14,000	14,000	10,000
Ab. Normal	14,000	10,700	7,700
Bl. Normal	11,400	9,500	6,500
Subnormal Snowmelt	6,500	5,400	3,600
Dry 6/	4,300	3,600	3,200
Dry 7/ or Critical	3,300	3,100	2,900

• *SALMON MIGRATIONS*

Rio Vista on the Sacramento River — Computed net stream flow in cfs — Minimum 30-day running average of mean daily net flow

Year Type	Jan.	Feb. 1–Mar. 15	Mar.16–June 30
Wet	2,500	3,000	5,000
Ab. Normal	2,500	2,000	3,000
Bl. Normal	2,500	2,000	3,000
Dry or Critical	1,500	1,000	2,000

Year Type	July	Aug.	Sept. 1–Dec. 31
Wet	3,000	1,000	5,000
Ab. Normal	2,000	1,000	2,500
Bl. Normal	2,000	1,000	2,500
Dry or Critical	1,000	1,000	1,500

• *SUISUN MARSH*

Chipps Island at O&A Ferry Landing — Electrical Conductivity — Maximum 28-day running average of mean daily EC

Year Type	Jan.–May	Oct.–Dec.
Wet	12.5 mmhos	12.5 mmhos
Ab. Normal	12.5 mmhos	12.5 mmhos
Bl. Normal	12.5 mmhos	12.5 mmhos
Dry or Critical	12.5 mmhos	15.6 mmhos

(The 15.6 mmhos EC Standard applies only when project water users are taking deficiencies in scheduled water supplies 8/ otherwise the 12.5 mmhos EC remains in effect.)

BENEFICIAL USE PROTECTED and LOCATION	PARAMETER	DESCRIPTION	YEAR TYPE	VALUES
Chipps Island	Delta Outflow Index in cfs	Average of the daily Delta outflow index for each month, not less than values shown	Wet	February–May 10,000 cfs
			Subnormal Snowmelt	February–April 10,000 cfs
		Minimum daily Delta outflow index for 60 consecutive days in the period	Ab. Norm. and Bl. Norm.	January–April 12,000 cfs

Table VI-1

WATER QUALITY STANDARDS

FOR THE SACRAMENTO-SAN JOAQUIN DELTA AND SUISUN MARSH [1/]

BENEFICIAL USE PROTECTED and LOCATION	PARAMETER	DESCRIPTION	YEAR TYPE [2/]	VALUES
FISH AND WILDLIFE				
• *SUISUN MARSH*				
Chipps Island (continued)	*Delta Outflow Index in cfs*	*Average of the daily Delta outflow index for each month, not less than values shown*	*All (if greater flow not required by above standard)—whenever storage is at or above the minimum level in the flood control reservation envelope at two out of three of the following: Shasta Reservoir, Oroville Reservoir, and CVP storage on the American River*	*Jan.–May* *6,600 cfs*
Collinsville on Sacramento River (C–2) *Miens Landing on Montezuma Slough (S–64)* *Montezuma Slough at Cutoff Slough (S–48)* *Montezuma Slough near mouth* *Suisun Slough near Volanti Slough (S–42)* *Suisun Slough near mouth (S–31)* *Goodyear Slough south of Pierce Harbor (S–35)* *Cordelia Slough above S. P. R.R. (S–32)*	*Electrical Conductivity*	*The monthly average of both daily high tide values not to exceed the values shown (or demonstrate that equivalent or better protection will be provided at the location)*	*All – To become effective Oct. 1, 1984*	*Month* — *EC in mmhos* *Oct.* 19.0 *Nov.* 15.5 *Dec.* 15.5 *Jan.* 12.5 *Feb.* 8.0 *Mar.* 8.0 *Apr.* 11.0 *May* 11.0
• *OPERATIONAL CONSTRAINTS*				
Minimize diversion of young striped bass from the Delta	*Diversions in cfs*	*The mean monthly diversions from the Delta by the State Water Project (Department) not to exceed the values shown.*	*All*	*May June July* *3,000 3,000 4,600*
		The mean monthly diversions from the Delta by the Central Valley Project (Bureau), not to exceed the values shown	*All*	*May June* *3,000 3,000*
Minimize diversion of young striped bass into Central Delta		*Closure of Delta cross channel gates for up to 20 days but no more than two out of four consecutive days at the discretion of the Department of Fish and Game upon 12 hours notice*	*All – whenever the daily Delta outflow index is greater than 12,000 cfs*	*April 16–May 31*
Minimize cross Delta movement of Salmon		*Closure of Delta Cross Channel gates (whenever the daily Delta outflow index is greater than 12,000 cfs)*	*All*	*Jan. 1–April 15*

Table VI-1
WATER QUALITY STANDARDS FOR THE SACRAMENTO-SAN JOAQUIN DELTA AND SUISUN MARSH 1/

FISH PROTECTIVE FACILITIES

Maintain appropriate records of the numbers, sizes, kinds of fish salvaged and of water export rates and fish facility operations.

STATE FISH PROTECTIVE FACILITY

The facility is to be operated to meet the following standards to the extent that they are compatible with water export rates:

(a) King Salmon — from November through May 14, standards shall be as follows:
- (1) Approach Velocity — 3.0 to 3.5 feet per second
- (2) Bypass Ratio — maintain 1.2:1.0 to 1.6:1.0 ratios in both primary and secondary channels
- (3) Primary Bay — not critical but use Bay B as first choice
- (4) Screened Water System — the velocity of water exiting from the screened water system is not to exceed the secondary channel approach velocity. The system may be turned off at the discretion of the operators.

(b) Striped Bass and White Catfish — from May 15 through October, standards shall be as follows:
- (1) Approach Velocity — in both the primary and secondary channels, maintain a velocity as close to 1.0 feet per second as is possible
- (2) Bypass Ratio
  - (i) When only Bay A (with center wall) is in operation maintain a 1.2:1.0 ratio
  - (ii) When both primary bays are in operation and the approach velocity is less than 2.5 feet per second, the bypass ratio should be 1.5:1.0
  - (iii) When only Bay B is operating the bypass ratio should be 1.2:1.0
  - (iv) Secondary channel bypass ratio should be 1.2:1.0 for all approach velocities.
- (3) Primary Channel — use Bay A (with center wall) in preference to Bay B
- (4) Screened Water Ratio — if the use of screened water is necessary, the velocity of water exiting the screened water system is not to exceed the secondary channel approach velocity
- (5) Clifton Court Forebay Water Level — maintain at the highest practical level.

TRACY FISH PROTECTIVE FACILITY

The secondary system is to be operated to meet the following standards, to the extent that they are compatible with water export rates:

(a) The secondary velocity should be maintained at 3.0 to 3.5 feet per second whenever possible from February through May while salmon are present

(b) To the extent possible, the secondary velocity should not exceed 2.5 feet per second and preferably 1.5 feet per second between June 1 and August 31, to increase the efficiency for striped bass, catfish, shad, and other fish. Secondary velocities should be reduced even at the expense of bypass ratios in the primary, but the ratio should not be reduced below 1:1.0

(c) The screened water discharge should be kept at the lowest possible level consistent with its purpose of minimizing debris in the holding tanks

(d) The bypass ratio in the secondary should be operated to prevent excessive velocities in the holding tanks, but in no case should the bypass velocity be less than the secondary approach velocity.

FOOTNOTES

1/ Except for flow, all values are for surface zone measurements. Except for flow, all mean daily values are based on at least hourly measurements. All dates are inclusive.

2/ The year type shall be determined as described in FIGURE II-1. The type determined for any year shall remain in effect until the February forecast for Bulletin 120 or until an earlier estimate becomes available.

3/ When no date is shown in the adjacent column, EC limit in this column begins on April 1.

4/ If contracts to ensure such facilities and water supplies are not executed by January 1, 1980, the Board will take appropriate enforcement actions to prevent encroachment on riparian rights in the southern Delta.

5/ For the purpose of this provision firm supplies of the Bureau shall be any water the Bureau is legally obligated to deliver under any CVP contract of 10 years or more duration, excluding the Friant Division of the CVP, subject only to dry and critical year deficiencies. Firm supplies of the Department shall be any water the Department would have delivered under Table A entitlements of water supply contracts and under prior right settlements had deficiencies not been imposed in that dry or critical year.

6/ Dry year following a wet, above normal or below normal year.

7/ Dry year following a dry or critical year.

8/ Scheduled water supplies shall be firm supplies for USBR and DWR plus additional water ordered from DWR by a contractor the previous September, and which does not exceed the ultimate annual entitlement for said contractor.

NOTE: EC values are mmhos/cm at 25°C.

CHAPTER VII

PROGRAM OF IMPLEMENTATION

Although the implementation program contained herein has been developed primarily for the next 10 years, the Board recognizes that the state and federal agencies responsible for water development are considering additional project facilities and operating agreements to satisfy the water demands of the state beyond the effective period of this plan.

The program contains not only the control actions necessary for implementation of the plan, but also offers policy assistance to the project operators for use in their long-range planning activities.[1/]

In addition, a monitoring program to assess the effectiveness of the plan in protecting beneficial uses is included.

A. CONTROL ACTIONS

State Water Resources Control Board

At the time it adopts the final water quality control plan, the Board will adopt a corresponding water right decision amending

1/ The Board has determined that there would be no state mandate for a new program or increased level of service on any unit of local government as a result of the Board's adoption of this plan because it is not an executive regulation pursuant to Section 2209 of the Revenue and Taxation Code.

terms and conditions for permits issued for SWP and CVP. Such terms and conditions will supplement the relevant provisions of this plan. However, a series of other actions by the Board will be required in order to implement the plan more fully and resolve all the concerns which cannot now be fully addressed for various reasons.

Adoption of Water Right Decision. The water right decision to accompany final plan adoption will require the maintenance of the salinity and other standards of this plan through amendments in the form of terms and conditions in SWP and CVP water right permits identified in Chapter I. These terms and conditions are in accordance with the jurisdiction reserved by the Board in the subject permits to formulate terms and conditions relative to salinity control, protection of fish and wildlife, and coordination of terms and conditions of the respective permits for the SWP and CVP. In view of the near-term focus of this decision, the Board will continue the reserved jurisdiction contained in these permits.

Water Quality Action. Existing and potential salinity problems associated with drainage from irrigated agriculture in the San Joaquin Valley are under study in the Interagency Drainage Program, in which the Board is participating with the Department and

Bureau. Achievement of the program's goals will require successful solution to the problem of disposal of increasing volumes of high-salinity drainage.

Under Section 208 of the Federal Water Pollution Control Act Amendments of 1972 (PL 92-500), the Board is evaluating the effects of irrigation return flow on water quality, and is working to develop best management practices where appropriate to reduce detrimental effects. Two specific areas previously mentioned in this plan that are affected by such drainage are the Cache Slough and Rock Slough areas. Both are sources of municipal and industrial supplies. The Board in conjunction with the California Regional Water Quality Control Board, Central Valley Region, will pursue the determination of appropriate management practices and take prompt action designed to reduce the detrimental effects on water quality of these return flows.

Ongoing Review. To the extent of its authority, the Board will monitor and review contract negotiations among the Bureau, Department and Delta water interests. The Board will annually review and modify, if necessary, the monitoring program set forth in this chapter to ensure that the program is achieving its intended purpose. The Board will ensure the coordination of the various efforts of state, federal and local agencies to minimize duplication.

Department of Water Resources and U. S. Bureau of Reclamation
To the full extent of their operational capabilities, the Department and Bureau are responsible for meeting the water quality standards of this plan.[2/] As stated above, these water quality standards will be incorporated in their respective water right permits.

Suisun Marsh Facilities. As stated in Chapter VI, additional facilities are needed in Suisun Marsh to mitigate current impacts attributable directly to the operation of the CVP and SWP. These mitigation facilities have the capability to fully protect the Marsh as set forth in Fish and Game Exhibit 11, page 13, in all but extremely critical years. In view of this and the extremely large Delta outflows that would be required to fully protect the Marsh solely with outflow (as would be the case until such facilities are constructed), interim standards are adopted which guarantee only partial protection of the Marsh in years of low runoff and prior to construction and operation of the physical facilities.

2/ As provided by Section 13247 of the Water Code, the Department is required to comply with water quality control plans adopted by the Board. Also, it is the State's position that the Federal Water Pollution Control Act (PL 92-500 as amended in 1977 by PL 95-217) requires the Bureau to comply with such water quality control plans. In addition, the Department and Bureau must comply with terms and conditions in their water right permits.

Protection of the Marsh is a mitigation responsibility of both the SWP and CVP. For this reason, the Department and Bureau shall:

1. Develop a plan for Suisun Marsh by July 1, 1979, in cooperation with other agencies which will ensure that the standards in Table VI-1 for full protection of the Marsh are met. Such plan must be satisfactory to the Board and shall include appropriate EIR/EIS documentation, a monitoring network, physical facilities, operating and management procedures, and assurances to restore and maintain Suisun Marsh primarily as a brackish water marsh capable of producing high-quality feed and habitat conditions for waterfowl and other marsh-related wildlife using best practical management practices.

2. Implement fully such Suisun Marsh plan by October 1, 1984. Under this plan water quality standards for full protection of Suisun Marsh shall be met no later than October 1, 1984.

3. Implement initial components of the Suisun Marsh plan, on which there is general agreement by affected parties, to achieve the following goals by January 1, 1980:

- o Conveyance and delivery of water from Montezuma Slough to wetland areas on Grizzly, Simmons, Wheeler, Dutton, Van Sickle, and Hammond Islands which are presently flooded with water from Honker, Suisun and Grizzly Bays.
- o Conveyance and delivery of water from Goodyear Slough to certain adjacent wetland areas and provision of outflow from Goodyear Slough into either Grizzly or Suisun Bays.

4. Report to the Board on January 15 of each year on progress toward implementation of mitigation facilities.

Southern Delta. The current negotiations between the project operators and the South Delta Water Agency concerning the construction of physical facilities to provide adequate circulation in the southern Delta are discussed in Chapter VI. These negotiations appear to be directed toward the most practical solution for long-term protection of southern Delta agriculture and should be concluded as soon as practicable, at least by January 1980. In view of its importance, the Department and Bureau should report to the Board on the status and progress of negotiations every six months beginning January 1, 1979. If the agreement is not executed by January 1, 1980, the Board will examine in detail southern Delta water rights, determine the causes and sources of any encroachment, and take appropriate action to the extent of the Board's authority.

Improvements in Delta Outflow Determination. Recent experience has shown that as a result of the complexity of the Delta hydrologic system continuing and variable operating problems arise in sustaining Delta water quality standards. Part of the difficulty relates to the mix of estimates and measurements. In order to assure compliance with standards, the Department and Bureau must improve the accuracy of Delta outflow determinations, either through improved measurement techniques or a refinement of the inputs that are used to compute the Delta Outflow Index. Also, to ensure compliance with the Rio Vista flow requirement a method of measuring or estimating that flow must be developed. The Bureau and Department should report to the Board by January 1, 1979 on the methods to be used in determining flows past Rio Vista and improving accuracy of Delta outflow estimates or on studies to be commenced by that date to determine such procedures. Concurrently, the Department and Bureau shall report annually on methods for making precise projections of salinity distribution in the Delta under varying inflow, outflow and export conditions. These salinity distribution projections are necessary predictive tools for analysis of alternate operational schemes, including possible near-term provision of supplies to some agricultural areas in the Delta for water conservation purposes. Reports on the progress of these activities should be made available to the Board annually.

Coordinated Project Operations. An early long-term operations agreement between the Department and the Bureau is essential for proper management of Delta water resources for water quality control and project operation. The parties should work diligently to finalize such an agreement as soon as possible.

Hydrologic Studies. The hydrologic experience of the dry cycle beginning in 1976 will be evaluated by the Department and Bureau to determine if yield estimates of the SWP and CVP have been affected. It may not be appropriate to continue to estimate delivery capabilities of the projects on the basis of the 1928-1934 dry cycle.

B. MONITORING PROGRAM

A carefully designed monitoring program is necessary to determine compliance with a water quality control plan. The following program provides for collection of the data necessary to measure compliance with the water quality standards. Also, this program outlines the special studies or monitoring surveys that are needed to help address the major concerns that cannot confidently be resolved due to lack of data. The monitoring program set forth below is needed primarily to ensure that current and proposed project operations of the CVP and SWP maintain the water quality standards in this plan. The program is based upon the Department's recommendations, but the program will have to be implemented cooperatively by both the Department and Bureau (Department Exhibit II-22). The Department and Bureau will be required to do so through conditions in their respective water right permits currently before the Board in this proceeding.

The Board will assist in seeing that these program activities are coordinated with the activities of other agencies to minimize duplication and to enhance the usefulness of the data collected and study results. The data and study results should be made available to the Board and interested parties upon request.

Design of a monitoring program that maintains its effectiveness through time is difficult. A monitoring program must be sufficiently flexible to respond to advances in knowledge of the system being studied. Consequently the monitoring program places special emphasis on the general goals to be accomplished. The compliance monitoring and special studies are designed to accomplish these goals. If it becomes apparent that the general goals are not being achieved through the monitoring program or if some of the data proves to be of minor value, the Department and the Bureau should propose appropriate modifications for the concurrence of the Board. Progress reports summarizing the previous year's findings and detailing future study plans should be made to the Board each year.

The goals and the monitoring program to accomplish them can be divided into two general areas: compliance monitoring and special studies.

Compliance Monitoring Goals

- Ensure compliance with existing water quality standards contained in this plan,
- Identify meaningful changes in any significant water quality parameters potentially related to project operations, and
- Reveal trends in ecological changes potentially related to project operations.

Monitoring Activities. Activities to accomplish these goals:

1. Operate and maintain continuous electrical conductivity recorders at the stations indicated in Table VII-1 and Figure VII-1 to report mean daily water quality conditions representative of each location.

2. Conduct the discrete sampling program shown in Figure VII-1 and Table VII-1 bound at the end of this chapter. The sampling frequency may vary as appropriate. When the monthly Delta Outflow Index is projected to average greater than 10,000 cfs, the program operators may reduce the sampling frequency of the base parameters to once each month. When the outflow is below 10,000 cfs the sampling frequency of base parameters should be increased to at least twice a month, if necessary, to achieve the monitoring goals.

3. Conduct water quality profiles in the main navigation channels between Carquinez Strait 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 *in vivo* chlorophyll.

4. Establish continuous recorders at representative stations in the Delta and Suisun Bay to collect information on air and water temperature, wind velocity and direction, pH, dissolved

oxygen, turbidity, and where feasible, in vivo chlorophyll. These data should be evaluated and correlated with conditions as they exist in the adjacent main channels.

5. Conduct ongoing and future monitoring surveys recommended by Fish and Game and concurred in by the Board concerning food chain relationships and fisheries impacts as they are affected by CVP and SWP operations in the Delta and Suisun Marsh.

Special Studies Goal

Develop a better understanding of the hydrodynamics, water quality, productivity and significant ecological interactions of the Delta and Suisun Marsh so that more accurate predictions of enviromental impacts related to project operations can be made.

Activities. To accomplish this goal:

1. Conduct special studies to meet specific needs and to take advantage of particular circumstances where the data obtained are of significant value. Such studies would include but should not be limited to fish population and zooplankton measurements, waterfowl food plant production measurements, intensive phytoplankton studies, tissue analysis of selected biota, photosynthesis rates, sediment profile and composition, and water velocity.

2. Develop and improve water quality and biological predictive tools for the following areas of the estuary:

a. Western Delta and Suisun Bay area, including Suisun Marsh
b. San Francisco Bay to Golden Gate Bridge
c. Interior Delta

Emphasis should be placed on improving the understanding of flow/salinity/phytoplankton relationships in the western Delta, and on improving hydraulic characteristics in existing models to represent more closely true channel characteristics.

3. Participate in research studies described in Section C of this chapter.

Reporting

Provide to the Board and other interested agencies upon request results of the above monitoring as soon as practicable following the month during which the monitoring was accomplished. Annual reports summarizing the previous calendar year's findings and detailing future study plans shall be submitted to the Board by January 15 of each year. Detailed reports containing the previous year's monitoring results shall be submitted by August 1 of each year.

C. CHANGING CONDITIONS

The Delta's ecology and man's activities relating to it undergo change. This section identified areas of probable changes and seeks to provide guidance for the longer term, beyond the effective period of this plan.

The changing conditions have been subdivided into two basic categories: those having a potential significant impact on future project facilities and those which could have an impact on current project operations.

Impact on Future Facilities

Water development agencies in the state are currently planning substantial new water facilities. As part of this planning process, these agencies must make sound determinations of the firm yield expected from such proposed facilities. These determinations are based on the operations of potential future SWP and CVP facilities over a period of historical hydrology. Theoretical operation of these future facilities is usually superimposed over the 1922-71 hydrologic period with emphasis on the seven year dry cycle (1928-34). The yield of future facilities in the Sacramento River Basin will depend largely on the amount of unregulated flow available for appropriation from this source.

The factors listed under this section may greatly affect the amount of unregulated flow available for future appropriation. In this section the Board provides general guidance on these factors in order to assist the Department and the Bureau in planning their activities for conditions substantially beyond the effective period of the plan.

San Francisco Bay. Concerns were expressed by some hearing participants regarding the possible adverse impacts on San Francisco Bay and the estuary in general which might occur unless sufficient unregulated Delta outflows are reserved for its protection (RT Vol. XXIII, p. 10; Vol. XXXIV, pp. 126-27, 140). The Board has a statutory responsibility to protect all beneficial uses of water, including uses of the Bay. In determining the amount of water available for appropriation, the Board must take into account the amount of unregulated water needed to remain in the source for the protection of all beneficial uses (Water Code Section 1243.5). Future project facilities and increasing export rates under existing water right permits could substantially reduce the quantity and frequency of flushing and other unregulated flows available to San Francisco Bay. In making allocations of the remaining unregulated flows, consideration must be given to the outflow needs in San Francisco Bay.

Unregulated outflows, particularly short bursts of moderate flows, have been found to have a substantial effect on hydraulic and salinity conditions in the Bay (RT Vol. XXXIV, pp. 116-127). This was determined through examination of outflow and salinity conditions from 1939 to the present (period for which adequate outflow information is available). In order to bring about significant salinity changes in the central and south-central portions of the Bay, an increase in outflow of about 10,000 cfs (or greater) occurring within five to ten days is necessary. However, the Association of Bay Area Governments (ABAG) and others who presented testimony on this subject indicated that current knowledge allows only qualitative identification of the likely beneficial effects of such flows.

The ecological benefits of unregulated outflows and the salinity gradients established by them have been suggested to include the following: (1) alteration of the distribution and migrations of free-swimming organisms, (2) creation of counter-currents moving upstream along the bottom of the Bay which are hypothesized to be necessary for the brackish water migration of certain crabs and shrimps, and (3) transportation of young anadromous fish and maintenance of adequate food supplies (RT Vol. XXXIV, pp. 122-123). Until the necessary information quantifying the beneficial effects of such unregulated outflows is developed, the adoption of specific outflow standards by the Board for San Francisco Bay would be premature.

In view of the fact that no additional project facilities are expected to be completed for at least ten years, current levels of unregulated Delta outflow should not be appreciably reduced during the effective period of this plan. Full consideration will be given to the unregulated outflow needs of San Francisco Bay in the Board's periodic review of the water quality standards in this plan. It is imperative that the necessary studies to determine the effects of these flows be initiated as soon as possible. In view of the pressing need for such studies, and in accordance with Water Code Sections 13165 and 13163(b), the Department shall iniate by October 1, 1979, the necessary studies to provide more complete and reliable information regarding the outflow needs of San Francisco Bay. The Board will work closely with the Department and other agencies to develop a comprehensive program identifying the scope of such studies by June 1, 1979. Participation of interested agencies and consultants in the design, implementation and interpretation of these studies is essential. To ensure that an effective and meaningful program is carried out, the Board will coordinate the activities of agencies related to Bay/Delta studies.

The Board will ensure that the costs of such studies bear a reasonable relationship to the need for them.

In the meantime, the following policy guidance is offered to assist water development agencies in evaluating possible future water development facilities:

1. Operation studies for planning purposes should allow for surges in Delta outflow of at least 10,000 cfs within a five to ten day interval on an average of four times per year for the historical hydrologic period from 1939 to 1976. This means that either additions to upstream storage facilities or increased exports of unregulated Delta inflows should not interfere with these short-term bursts of increased Delta outflow. The need for such outflow is based on the average historical occurrence of incremental increases in Delta outflow of this magnitude and duration from 1939 to 1976. The frequency of such incremental increases has ranged from two per year to nine per year, except in water year 1976 (one per year) and water year 1977 (no occurrences) (RT Vol. XXXIV, pp. 123-126).

2. Incremental increases in Delta outflow of at least 10,000 cfs should occur within a five to ten day interval at least once each year over the yield-determining seven year dry cycle (1928-1934).

Upper Estuary Productivity. Fish and Game has developed many relationships relating late spring and summer Delta outflows to Neomysis and young striped bass abundances. These relationships are based on conditions experienced during years when winter flows were sufficiently high so that they probably were not limiting estuary productivity (RT Vol. XI, p. 81). Fish and Game has expressed concern regarding the low estuary production in 1976 when controlled low flow conditions existed during the winter (RT Vol. XI, pp. 78-89 and Vol. XXIII, pp. 127-128).

There is a need for caution in establishing long-term fishery standards based on these historical flow-abundance relationships, particularly with the future prospects of extended periods of low-flow conditions in the Delta (RT Vol. XI, p. 129). While 1976 production in the estuary was low, relationships between spring and summer Delta outflow and Neomysis and young striped bass abundances generally predicted the actual indexes measured that year.[3/]

In view of this, the following policy guidance for long-term water development planning has been established until this concern is more fully understood:

3/ In a prepared statement given at a special meeting of the Board on October 27, 1977 concerning the substantial impacts on the Delta ecosystem during 1977, Mr. Harold K. Chadwick, representing Fish and Game, stated that flows in 1977 prior to June were likely insufficient to (1) support adequate production at lower levels of the food chain, (2) stimulate upstream migration of adult striped bass, (3) provide suitable salinities for striped bass spawning in the San Joaquin River, and (4) distribute young bass over the entire nursery area.

In closing he stated: "We recognize that the observations during 1977 raise various questions about the adequacy of some of the proposed standards in the April draft (Fish and Game Exhibit 11). We believe that any adjustments (of these recommendations) should await a thorough evaluation of all evidence."

The 14-day mean electrical conductivity values at Pittsburg during January, February and March should not exceed those experienced for the same period in 1976, throughout the 50-year hydrologic planning period (1922-1971).

Studies to determine the cause of the dramatic 1977 reductions in estuary production are currently underway by Fish and Game and the Bureau. Additional studies to determine the need for winter flows for long-term protection of striped bass and other aquatic organisms in the Delta shall be conducted by the Department.

Maintenance of Fishery Resources at Historical Levels.

Based on existing conditions the Board has determined that fishery resources in the Bay-Delta estuary should be maintained at levels that at least approach those levels that would have existed had the CVP and SWP not been built. Higher levels of fishery resources are desirable, but cannot be attained in the public interest with current project facilities. However, any future Delta transfer facility or upstream project facilities should:

(1) ensure the maintenance of fishery resources in the estuary on the average at historical levels (1922-1967). (Conditions upstream of the estuary may limit the abundance of some species. This policy deals only with those factors in the Bay-Delta estuary that limit species abundance), and

(2) include a fish screen system capable of salvaging 95 percent of the fish more than 1-1/4 inches long.

Net Downstream Flows in Delta Channels. Project caused net flow reversals in Delta channels are detrimental to the fishery that live in or pass through the Delta. Any future Delta water transfer facilities should:

(1) restore net downstream flows at all times in all Delta channels, and

(2) provide water in the San Joaquin River upstream of the Mokelumne River, in Old River and in Middle River to be primarily of San Joaquin River origin from September 1 through November 30.

Impact on Current Project Operations

There are also other factors which could have an impact (both favorable and adverse) on current project operations. These factors can be addressed now only in a general way because of a lack of information and the uncertainty of future actions by other agencies. They are presented below:

Mechanism by which Salinity Changes in Surrounding Waterways Affect Plant Growth in the Subirrigated Areas in the Delta. As stated in Chapter VI, the U. C. Cooperative Extension expressed the possibility that crops in Delta subirrigated soils may be drawing water from groundwater, rather than from surface water applied in spud ditches (RT Vol. XX, p. 181). A determination of the predominant source of water for these crops is important in future review of agricultural water quality standards The U. C. Cooperative Extension researched this area during the 1977 irrigation season. However, an expanded research program will be required to yield a full understanding. The Board and other state and local agencies will be participating with the U. C. Cooperative Extension.

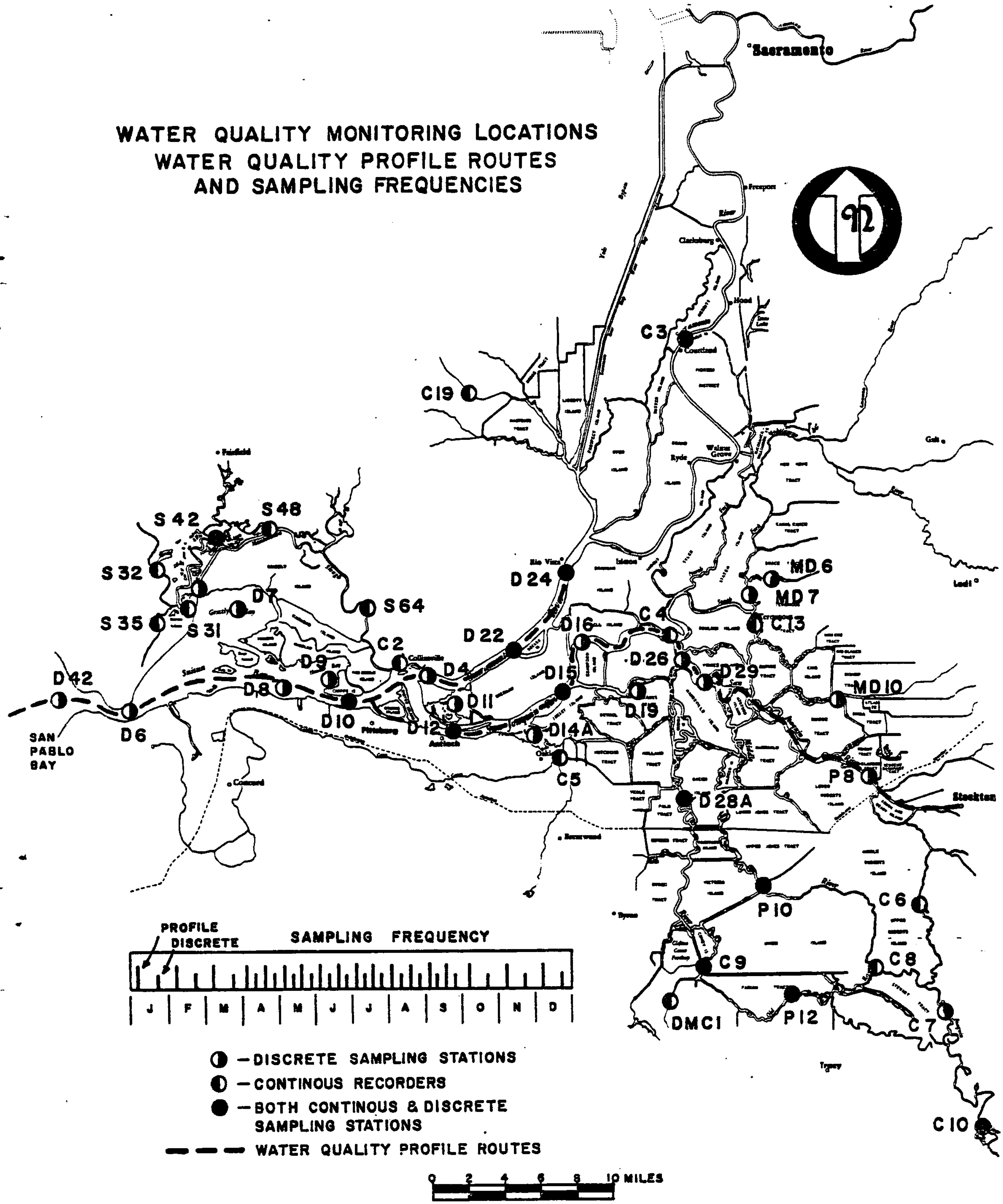
<u>Additional Data Needs to be Developed for the Subirrigated Organic Soils in the Delta.</u> A better understanding of the water quality needs of agriculture in the organic soils is necessary. The Board will take an active role in coordinating this research with other interested agencies including the U. C. Cooperative Extension and the U. S. Salinity Laboratory, and other hearing participants. Some of the areas where additional research is necessary include the correlation of electrical conductivity of the applied irrigation water (EC_w) to electrical conductivity of the soil saturation extract (EC_e), the relationship between the yield of corn and EC_w and EC_e and the determination of the threshold tolerance of corn. The quality of water which is necessary outside of the irrigation season (April 1 to August 15) also needs to be investigated. This investigation could include an evaluation of leaching practices and related necessary water quality and also a determination of water quality needed for crops which are irrigated during the period outside of the normal irrigation season.

Overland Supplies to Western Delta. Overland supplies to the western Delta are currently being considered by the project operators and Delta interests as a possible method to conserve water and fully protect western Delta agriculture. If successful, the Emmaton and Jersey Point water quality standards, for agriculture could be reduced.

It is important to keep in mind that the Emmaton and Jersey Point standards afford benefits to the entire western Delta, not just protection for agriculture on Sherman and Jersey Islands.

Also, as discussed above, there are significant questions related to the mechanism by which water makes its way to the root zone in subirrigated soils. If groundwater quality plays an important role, the water quality of the surrounding channels may continue to be of great importance. This would suggest some caution in finalizing plans for converting permanently to overland delivery systems.

Finally, changes in irrigation practices could be incorporated in plans to change the points of diversion to sources further upstream. Such modifications could include the installation of sprinkler irrigation systems. Chapter VI discusses this alternative briefly. Changes in irrigation practices should be handled in the manner prescribed by the Delta Protection Act. The conversion of large areas of the western Delta to sprinkler irrigation could have significant impacts on cropping patterns, energy costs, Delta consumptive use of water and farm operating costs.



(BASE MAP PROVIDED BY DEPT. OF WATER RESOURCES)

TABLE VII-1

DELTA ESTUARY WATER QUALITY MONITORING PROGRAM

Station Location	Electrical Conductivity	Base Parameters 1/	Phytoplankton 2/	Phosphorus 3/ TDS and Cl⁻	Heavy Metals, Pesticides 4/	Benthos 5/
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					
C6 San Joaquin River at Brandt Bridge	C G.H.					
C7 San Joaquin River @ Mossdale		SM/M	SM/M	M	SA	SA
C8 Old River near Middle River	C					
C9 West Canal @ mouth/intake to Clifton Ct. Forebay	C	SM/M	SM/M	M		
C10 San Joaquin River @ Vernalis	C Flow	SM/M		M		
C13 Mokelumne River @ Terminous	C					
C19 Cache Slough @ City of Vallejo Intake	C					
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	SM/M		M		
D11 Sherman Lake near Antioch		SM/M		M	SA	SA
D12 San Joaquin River @ Antioch Ship Channel		SM/M	SM/M	M	SA	
D12* San Joaquin River @ Antioch Water Works	C					
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 Is.		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	C Flow	SM/M	SM/M	M		
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	W					
D42 San Pablo Bay near Rodeo		SM/M	SM/M	M		
DMC1 Delta Mendota Canal	C					

(Continued on next page)

TABLE VII-1

DELTA ESTUARY WATER QUALITY MONITORING PROGRAM

Station Location		Electrical Conductivity	Base Parameters 1/	Phytoplankton 2/	Phosphorus, 3/ TDS and Cl⁻	Heavy Metals, Pesticides 4/	Benthos 5/
MD6	Sycamore Slough near Mouth		SM/M		M		SA
MD7	South Fork Mokelumne River below Sycamore Slough		SM/M	SM/M	M		SA
MD10	Disappointment Slough @ Bishop Cut		SM/M	SM/M	M		
P8	San Joaquin River at Buckley Cove		SM/M	SM/M	M	SA	SA
P10	Middle River @ Borden Highway	C G.H.	SM/M		M		
P12	Old River @ Tracy Road Bridge	C G.H.	SM/M		M		
S31	Suisun Slough near mouth	C					
S32	Cordelia Slough above S.P.R.R.	C					
S35	Goodyear Slough so. of Pierce Harbor	C					
S42	Suisun Slough near Volanti Slough	C	SM/M	SM/M	M		
S48	Montezuma Slough at Cutoff Slough	C					
S64	Miens Landing on Montezuma Slough	C					
D7*	Montezume Slough near mouth	P					

* Location close to the station shown
C - Continuous
W - Weekly (April 1 - May 5)
SM - Semi-monthly (twice a month)
M - Monthly
SA - Semi-annually (spring and fall)
G.H. - Gage Height
P - Periodic, to obtain adequate correlation with other stations

1/ 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, extracted chlorophyll a, silica.

2/ Enumeration and identification to the species level where possible.

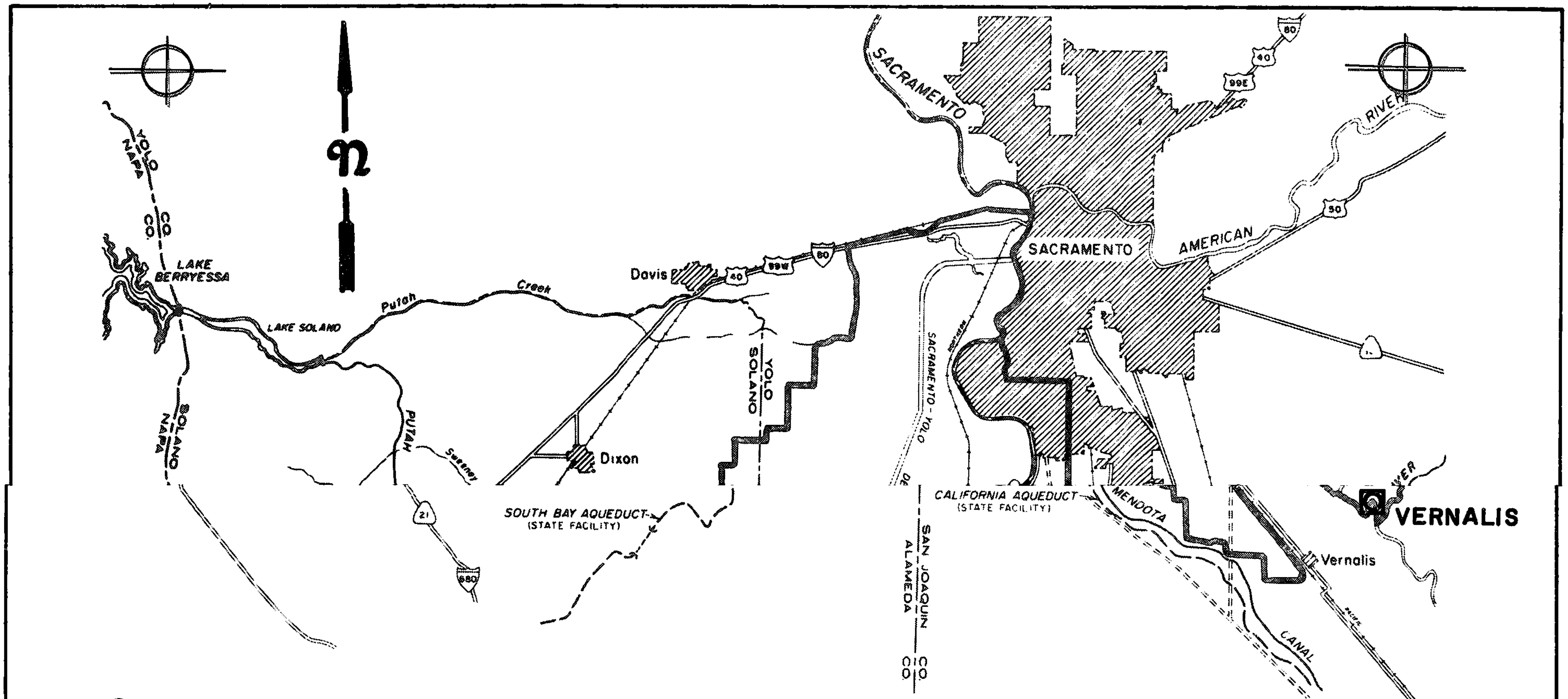
3/ Orthophosphate and total phosphorus.

4/ Heavy metals - arsenic, cadmium, chromium (all valences), copper, iron, lead, manganese, mercury, zinc.

Pesticides - chlorinated hydrocarbons to include: Aldrin, Altrazine, BHC, Chlordane, 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.

5/ 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.



● HISTORICAL & CURRENT WATER QUALITY CONTROL STATION

○ HISTORICAL WATER QUALITY CONTROL STATION

■ NEW WATER QUALITY CONTROL STATION

□ POSSIBLE FUTURE WATER QUALITY CONTROL STATION

●●●● SUISUN MARSH BOUNDARY

LEGAL DELTA BOUNDARY

STATE OF CALIFORNIA

STATE WATER RESOURCES CONTROL BOARD

SACRAMENTO-SAN JOAQUIN DELTA

NOTE:
BASE MAP BY THE BUREAU OF RECLAMATION

PLATE I

APPENDIX A

TABLE A-1 PERMITS FOR DELTA WATER SUPPLY OF FEDERAL CENTRAL VALLEY PROJECT AND STATE WATER PROJECT

TABLE A-1

PERMITS FOR DELTA WATER SUPPLY
of
FEDERAL CENTRAL VALLEY PROJECT AND STATE WATER PROJECT

Application No.	Permit No.	Source	Direct Diversion		Storage		Purpose
			Quantity (cfs)	Season	Quantity (AF)	Season	
5625	12720	Sacramento River	11,000	Jan.1 to Dec. 31	3,190,000	Oct. 1 to June 30	Power
5626	12721	Sacramento River	8,000	Jan.1 to Dec. 31	3,190,000	Oct. 1 to June 30	Irrigation, domestic, stockwatering navigation and recreation
5627	11966	Trinity River	1,100	Jan.1 to Dec. 31	1,540,000	Jan. 1 to Dec. 31	Power
5628	11967	Trinity River	2,500	Jan.1 to Dec. 31	1,540,000	Jan. 1 to Dec. 31	Irrigation, domestic, navigation, salinity control and flood control
5629	16477	Feather River	7,600	Jan.1 to Dec. 31	380,000	Oct. 1 to July 1	Power, recreation, fish and wildlife enhancement
5630	16478	Feather River	1,400	Oct.1 to July 1	380,000	Oct. 1 to July 1	Irrigation, domestic, municipal, industrial, salinity control, recreation, fish and wildlife enhancement
9363	12722	Sacramento River	1,000	Jan.1 to Dec. 31	310,000	Oct. 1 to June 30	Municipal and industrial

TABLE A-1 (Continued)

PERMITS FOR DELTA WATER SUPPLY
of
FEDERAL CENTRAL VALLEY PROJECT AND STATE WATER PROJECT

Application No.	Permit No.	Source	Direct Diversion		Storage		Purpose
			Quantity (cfs)	Season	Quantity (AF)	Season	
9364	12723	Sacramento River	9,000	Jan. 1 to Dec. 31	1,303,000	Oct. 1 to June 30	Irrigation, flood control, domestic, stockwatering, navigation & recreation
9365	12724	Sacramento River	2,275	Jan. 1 to Dec. 31	1,303,000	Oct. 1 to June 30	Power
9366	12725	Rock Slough	200	Jan. 1 to Dec. 31	--	--	Irrigation and domestic
9367	12726	Rock Slough	250	Jan. 1 to Dec. 31	--	--	Municipal and industrial
9368	12727	Old River	4,000	Jan. 1 to Dec. 31	--	--	Irrigation and domestic
13370	11315	American River	8,000	Nov. 1 to Aug. 1	1,000,000	Nov. 1 to July 1	Irrigation, salinity control and flood control
13371	11316	American River	700	Nov. 1 to Aug. 1	300,000	Nov. 1 to July 1	Municipal, industrial, domestic and recreational
13372	11317	American River	8,000	Jan. 1 to Dec. 31	1,000,000	Oct. 1 to July 1	Power

TABLE A-1 (Continued)

PERMITS FOR DELTA WATER SUPPLY
of
FEDERAL CENTRAL VALLEY PROJECT AND STATE WATER PROJECT

Application No.	Permit No.	Source	Direct Diversion Quantity (cfs)	Direct Diversion Season	Storage Quantity (AF)	Storage Season	Purpose
14443	16479	Feather River,	1,360	Jan. 1 to Dec. 31	3,500,000	Sept. 1 to July 31	Irrigation, domestic, municipal, industrial, salinity control, recreational, fish and wildlife enhancement
		Sacramento-San Joaquin Delta Channels	6,185	Jan. 1 to Dec. 31	42,100	Jan. 1 to Dec. 31	
14444	16480	Feather River	11,000	Jan. 1 to Dec. 31	3,500,000	Oct. 1 to July 1	Power, recreational and fish and wildlife enhancement
14445A	16481	Italian Slough	2,115	Oct. 1 to July 1	44,000	Oct. 1 to July 1	Irrigation, domestic, municipal, industrial, salinity control, recreational and fish and wildlife enhancement
14662	11318	American River	--	--	300,000	Oct. 1 to July 1	Power
14858	16597	Stanislaus River	--	--	980,000	Nov. 1 to June 30	Recreational, water quality control and preservation and enhancement of fish and wildlife

TABLE A-1 (Continued)

PERMITS FOR DELTA WATER SUPPLY
of
FEDERAL CENTRAL VALLEY PROJECT AND STATE WATER PROJECT

Application No.	Permit No.	Source	Direct Diversion Quantity (cfs)	Direct Diversion Season	Storage Quantity (AF)	Storage Season	Purpose
14859	16598	Stanislaus River	6,000	Jan. 1 to Dec. 31	980,000	Nov. 1 to June 30	Power
15374	11968	Trinity River	300	Jan. 1 to Dec. 31	200,000	Jan. 1 to Dec. 31	Municipal and industrial
15375	11969	Trinity River	1,700	Jan. 1 to Dec. 31	1,800,000	Jan. 1 to Dec. 31	Irrigation, domestic, fish & wildlife propagation, navigation, water quality control and recreation
15376	11970	Trinity River	3,525	Jan. 1 to Dec. 31	1,800,000	Jan. 1 to Dec. 31	Power
15764	12860	Old River	--	--	1,000,000	Oct. 1 to April 30	Irrigation, domestic, stockwatering municipal, industrial and recreation
16767	11971	Trinity River	--	--	700,000	Jan. 1 to Dec. 31	Irrigation, domestic and water quality control
16768	11972	Trinity River	175	Jan. 1 to Dec. 31	700,000	Jan. 1 to Dec. 31	Power

TABLE A-1 (Continued)
PERMITS FOR DELTA WATER SUPPLY
of
FEDERAL CENTRAL VALLEY PROJECT AND STATE WATER PROJECT

Application No.	Permit No.	Source	Direct Diversion		Storage		Purpose
			Quantity (cfs)	Season	Quantity (AF)	Season	
17374	11973	Trinity River	1,500	Jan. 1 to Dec. 31	--	--	Irrigation, domestic, municipal, industrial, salinity control, recreation, fish and wildlife enhancement
17375	12365	Clear Creek	1,900	Jan. 1 to Dec. 31	250,000	Nov. 1 to April 1	Power
17376	12364	Clear Creek	3,600	Nov. 1 to April 1	250,000	Nov. 1 to April 1	Irrigation, domestic and recreational
17512	16482	Italian Slough and San Luis Creek	--	--	1,100,000	Oct. 1 to July 1	Irrigation, domestic, municipal, industrial, salinity control, recreation, fish and wildlife enhancement
17514A	16483	Lindsey Slough	135	Oct. 1 to July 1	--	--	Municipal and industrial
18115	13776	Stony Creek	--	--	160,000	Nov. 1 to April 30	Irrigation, domestic, municipal and industrial

TABLE A-1 (Continued)

PERMITS FOR DELTA WATER SUPPLY
of
FEDERAL CENTRAL VALLEY PROJECT AND STATE WATER PROJECT

Application No.	Permit No.	Source	Direct Diversion		Storage		Purpose
			Quantity (cfs)	Season	Quantity (AF)	Season	
18721	16209	North Fork American River and Knickerbocker Creek	100	Nov. 1 to Aug. 1	1,700,000	Nov. 1 to July 1	Irrigation, recreation, incidental domestic and water quality control
18723	16210	North Fork American River and Knickerbocker Creek	6,300	Jan. 1 to Dec. 31	1,700,000	Nov. 1 to July 1	Power, incidental recreation and domestic
19303	16599	Stanislaus River	--	--	1,420,000	Nov. 1 to June 30	Power
19304	16600	Stanislaus River	--	--	1,420,000	Nov. 1 to June 30	Recreational, water quality control and preservation and enhancement of fish and wildlife
21542	15149	Old River	--	--	1,000,000	Nov. 1 to April 30	Power
21636	16211	North Fork American River and Knickerbocker Creek	600	Jan. 1 to Dec. 31	800,000	Nov. 1 to July 1	Power

TABLE A-1 (Continued)

PERMITS FOR DELTA WATER SUPPLY
of
FEDERAL CENTRAL VALLEY PROJECT AND STATE WATER PROJECT

Application No.	Permit No.	Source	Direct Diversion		Storage		Purpose
			Quantity(cfs)	Season	Quantity(AF)	Season	
21637	16212	North Fork American River and Knickerbocker Creek	900	Nov. 1 to July 1	800,000	Nov. 1 to July 1	Irrigation, municipal, industrial, domestic, recreation, fish and wildlife enhancement and water quality control
22316	15735	Rock Slough	--	--	5,400	Oct. 1 to June 30	Irrigation, domestic, municipal, industrial, water quality control and recreation

APPENDIX B

TABLE B-1-HISTORICAL WATER QUALITY OBJECTIVES FOR THE SACRAMENTO-SAN JOAQUIN DELTA AND SUISUN MARSH

TABLE B-1

HISTORICAL WATER QUALITY OBJECTIVES
FOR THE SACRAMENTO-SAN JOAQUIN DELTA AND SUISUN MARSH

Beneficial Use Protected and Location	Parameter	Description	Shasta Inflow Water Yr. Type	Value	Rationale	Source
Municipal and Industrial						
Antioch on San Joaquin River (These objectives shall not apply when the State Bd. determines that adequate substitute supplies are available to all M&I users in the Antioch and Pittsburg areas.)	TDS	Maximum 14-day running average of the mean daily TDS for:			Interim protection of municipal and industrial water supplies taken from the San Joaquin River.	Basin 5 Plan (1967 policy and supplements - Res. 73-16, Fed. B. 5) 3/
		150 days	Normal and below normal	450 mg/l		
		120 days	Dry	450 mg/l		
		100 days	Critical	450 mg/l		
Contra Costa Canal Intake at Rock Slough	TDS	Maximum mean tidal cycle	All	750 mg/l	Acceptable short-term maximum TDS value	Basin 5 Plan (1967 policy ar supplements - 1971 Interim Plan)
	TDS	Maximum mean tidal cycle, 65% of the year	All	380 mg/l	Based on average historical water quality (1945-1966)	
	Chloride	Maximum mean tidal cycle	All	250 mg/l	Cal.Admin.Code maximum desirable chloride content of drinking water from taste standpoint	
	Chloride	Maximum mean tidal cycle, 65% of the year	All	100 mg/l	Based on average historical water quality (1945-1966)	

TABLE B-1

HISTORICAL WATER QUALITY OBJECTIVES
FOR THE SACRAMENTO-SAN JOAQUIN DELTA AND SUISUN MARSH

Beneficial Use Protected and Location	Parameter	Description	Shasta Inflow Water Yr. Type	Value		Rationale	Source
Municipal and Industrial							
City of Vallejo Intake at Cache Slough	Chloride	Maximum (instantaneous)	All	100 mg/l			Basin 5 Plan (1967 policy a supplements - 1971 Interim Plan)
	TDS	Maximum (instantaneous)	All	250 mg/l			
Agriculture				AMJJ	ASOND[1]		
Blind Point on the San Joaquin River	EC	Maximum 14-day running average of mean daily EC in mmhos	Non-crit.	2.2	3.1	Protection of Delta agriculture without an overland supply to western Delta. Blind Point is below lowest agricultural intake on San Joaquin River. Water quality should not degrade to poor during the irrigation season except during critical years	Basin 5 Plan
			Critical	3.6	3.6		
Blind Point on - San Joaquin River	Permit Condition Limiting Storage and Direct Diversion	The SWP shall make no direct diversions and shall not collect water to storage during the period from April 1 through June 30 at any time the maximum surface zone chloride ion content exceeds 250 parts per million					D 1275 as modified by D 1291

TABLE B-1

HISTORICAL WATER QUALITY OBJECTIVES

FOR THE SACRAMENTO-SAN JOAQUIN DELTA AND SUISUN MARSH

Beneficial Use Protected and Location	Parameter	Description	Shasta Inflow Water Yr. Type	Value	Rationale	Source
Agriculture						
Jersey Point on the San Joaquin River and Emmaton on the Sacramento River	Chloride	Maximum 14-day[2] running average of mean daily chloride	Non-critical	1000 mg/l	Based on Nov. 19th criteria for the protection of western Delta channels from ocean salinity intrusion. This objective is predicated on an overland supply to some 12 to 15 thousand acres in the extreme western Delta	Basin 5 Plan (D-1275) (1967 Policy and Supplement - Res. 68-17)
			Critical	Jan/July 1000 mg/l Aug/Dec 1400 mg/l		
	Chloride	Average mean daily concentration for a period of at least 10 consecutive days	Non-dry or critical	Sometime between April 1 to May 31, 200 mg/l	Based on Nov. 19th criteria. To provide suitable water quality for seed germination at the beginning of the irrigation season and limited salt flushing flows	Basin 5 Plan (D-1275) (1967 Policy and Supplement - Res. 68-17)

TABLE B-1

HISTORICAL WATER QUALITY OBJECTIVES
FOR THE SACRAMENTO-SAN JOAQUIN DELTA AND SUISUN MARSH

Beneficial Use Protected and Location	Parameter	Description	Shasta Inflow Water Yr. Type	Value JFM	Value AMJJ	Value ASOND[1]	Rationale	Source
Agriculture Terminous, Rio Vista, San Andreas Landing, Clifton Court Ferry and, with the peripheral canal, Bifurcation of Old and Middle River	TDS	Maximum 14-day[2] running average of mean daily TDS in mg/l	Normal or above	700	700	700	Based on Nov. 19th criteria for protection of interior Delta channels to provide water of suitable quality for agricultural uses	Basin 5 Plan (D-1275) (1967 Policy and Supplemen - Res. 68-17)
			Below Norm.	700	700	800*		
			Dry or Crit.	700	800*	800*		
		Average of mean daily TDS in mg/l for any calendar month not to exceed	Normal or above	500	500	500		
			Below Norm.	500	500	600*		
			Dry or Crit.	500	600*	600*		
		Average of mean daily TDS in mg/l for any calendar year not to exceed	Normal or above		450			
			Below Norm.		450			
			Dry or Crit.		500			
Green's Landing on the Sacramento River	TDS	Whenever maximum 14-day[2] running average or mean monthly water quality at this station exceeds 150 mg/l TDS the objectives at the above (interior Delta) stations are changed by adding to those values the product of 1½ times the amount by which the recorded TDS at Green's Landing exceeds 150 mg/l	All		150 mg/l		Modifier of interior Delta agricultural objectives which provides for instances or extreme salt water intrusion on the Sacramento River	Basin 5 Pla (D-1275) (1967 Polic and Supplement - Res. 68-1

* The TDS value at any of these five stations may reach but not exceed the asterisked values, provided the average of the TDS value at all five stations does not exceed the adjacent non-asterisked value.

TABLE B-1

HISTORICAL WATER QUALITY OBJECTIVES
FOR THE SACRAMENTO-SAN JOAQUIN DELTA AND SUISUN MARSH

Beneficial Use Protected and Location	Parameter	Description	Shasta Inflow Water Yr. Type	Value	Rationale	Source
Agriculture						
San Joaquin River at Vernalis	TDS	Maximum 30-day average	All	500 mg/l	Protection of Southern Delta agriculture	Basin 5 Plan (D-1275 with New Melones) (1967 Policy and Supplements-1971 Interim Plan)
Eastern Delta Channels	TDS	Maximum mean monthly	All	700 mg/l		Basin 5 Plan (1967 Policy and Supplements-1971 Interim Plan)
Fish and Wildlife						
Bays and Intertidal Sloughs of Suisun Marsh	TDS	Water quality to produce average TDS in first 12 inches of soil of Suisun Marsh	All	April 15 to June 1 9,000 mg/l	Optimal seed production of alkali bulrush, an important food for waterfowl	Basin 2 Plan
	TDS	Maximum mean monthly	All	18,000 mg/l	Protection of permanent stands of alkali bulrush	Basin 2 Plan
Chipps Island at O & A Ferry	Chloride	Maximum 14-day running average of mean daily chloride	All	4,000 mg/l	Protection of Neomysis and striped bass	Basin 2 Plan
Antioch Water Works Intake on the San Joaquin River	EC	Maximum 14-day running average of mean daily EC when water temperature has increased to 60°F and for 5 weeks thereafter	All	1,500 umhos	Protection of striped bass spawning areas on the San Joaquin River. This objective can be modified for experimental purposes	Basin 5 Plan (1967 Policy and Supplements - Res. 73-16 Fed. B.2) 3/

TABLE B-1

HISTORICAL WATER QUALITY OBJECTIVES

FOR THE SACRAMENTO-SAN JOAQUIN DELTA AND SUISUN MARSH

Beneficial Use Protected and Location	Parameter	Description	Shasta Inflow Water Yr. Type	Value	Rationale	Source
Fish and Wildlife						
Prisoners Point on the San Joaquin River	EC	Maximum 14-day running average of mean daily EC when water temperature has increased to 60°F and for 5 weeks thereafter	All	550 umhos	Antioch and Prisoners Point are the historical striped bass spawning area limits. Spawning generally occurs as temperature is increasing from 60°F with salinities between 1500 umhos and 550 umhos EC (approx. 1000 mg/l and 350 mg/l TDS)	Basin 5 Plan (1967 Policy a[illegible] Supplements - Res. 73-16, Fed. B.2) 3/

1/ October-December based on Shasta Inflow water year type for previous water year.

2/ 10-day running average in D-1275

3/ Recommended by Department of Interior Task Force established to consider salinity standards in the Delta. Also recited in letter dated January 9, 1969, from Secretary of the Interior Stewart L. Udall to Governor Reagan (D 1379 Exhibit USBR 524).

APPENDIX C

CONCEPTUAL ALTERNATIVES

Conceptual Alternatives

MUNICIPAL AND INDUSTRIAL LOCATION	A. NO ACTION (Basin Plan) DESCRIPTION / YEAR TYPE / VALUE	B. NEED LIMITED BY "WITHOUT PROJECT" CONDITIONS and WATER RIGHTS DESCRIPTION / YEAR TYPE / VALUE	C. OPTION B with RECOGNITION OF CURRENT WATER SUPPLY ALTERNATIVES DESCRIPTION / YEAR TYPE / VALUE	D. OPTION C with REASONABLENESS CONSIDERATION (DEPARTMENT PROPOSAL) DESCRIPTION / YEAR TYPE / VALUE
1. Antioch on San Joaquin River	Max 14 day TDS (mg/l) for: 150 days — Below Normal (BN) & Normal (N) — 450 120 days — Dry (D) — 450 100 days — Critical (C) — 450	Max mean daily Cl (mg/l) for No. of days shown (% of years in parens) Value: 150 / 250 Wet (W) — 240 (66) / 265 (73) Above normal (AN) — 190 (52) / 220 (60) BN — 175 (48) / 195 (53) D — 165 (45) / 185 (51) C — 155 (42) / 170 (47)	Objective for this location should be dropped, provided quality of an alternative supply to these riparians is at least that shown in Option B.	SAME AS OPTION C
2. Rock Slough at Contra Costa Canal Intake	Value: TDS / Cl⁻ Max mean tidal cycle (MTC) (mg/l) — All — 750 / 250 Max MTC 65% of year (mg/l) — All — 380 / 100	Water supply is a contract right--therefore water qualities to be provided are determined by those contracts. Public Interest Needs Max mean daily Cl⁻ (mg/l) — All — 250	Max mean daily Cl⁻ of 150 mg/l for No. of days shown (% of years in parens) W — 240 (66) AN — 190 (52) BN — 175 (48) D — 165 (45) C — 155 (42) (weighted average 53 %) Public Interest Needs Max mean daily Cl⁻ (mg/l) — All — 250	Max mean daily Cl⁻ of 150 mg/l for % of year determined by linear interpolation between values shown YEAR AFTER / Sacto Valley Unimpaired Runoff Runoff in MAF: < 5, 8, 10, > 15.7 W or AN — 30, 45, 60, 90 BN — 15, 30, 50, 80 D or C — 0, 15, 35, 65 (weighted average > 65%) Public Interest Needs Max mean daily Cl⁻ (mg/l) — All — 250
3. Cache Slough	Value: TDS / CL Max (instantaneous) (mg/l) — All — 250 / 100	Public Interest Needs Max mean daily Cl⁻ (mg/l) — All — 250	Public Interest Needs Max. mean daily Cl⁻ (mg/l) — All — 250	Public Interest Needs Max. mean daily Cl⁻ (mg/l) — All — 250
4. Intake to Clifton Court Forebay at West Canal		Max mean daily Cl⁻ (mg/l) — All — 250	Max mean daily Cl⁻ (mg/l) — All — 250	
5. Delta Mendota Canal at Tracy Pumping Plant		Max mean daily Cl⁻ (mg/l) — All — 250	Max mean daily Cl⁻ (mg/l) — All — 250	

Table C-1

Conceptual Alternatives (continued)

AGRICULTURE

A. NO ACTION (Basin Plan)

B. NEED LIMITED BY AVERAGE "WITHOUT PROJECT" CONDITIONS

C. SAME AS ALTERNATIVE B EXCEPT RECOGNIZES THAT GOOD WATER QUALITY CONDITIONS EXISTED EARLY IN THE SEASON

LOCATION	A. DESCRIPTION	A. YEAR TYPE	A. VALUE	B. DESCRIPTION	B. YEAR TYPE	B. VALUE	C. DESCRIPTION	C. YEAR TYPE	C. VALUE
1. WESTERN DELTA Emmaton on Sacramento River	Max 14-day Cl (mg/l) 10 day avg Cl (mg/l) some time from Apr. 1–May 30	All but C C All except D or C	1000 Jan.-July 1000 Aug.-Dec. 1400 700	Max 14 day EC (mmhos)	 W AN BN D C	Apr. 1-Aug. 15 0.45 0.51 0.73 0.99 2.78	Max 14-day EC (mmhos)	 W AN BN D C	0.45 EC Until / EC to Aug. 15 Aug. 15 July 1 0.63 June 20 1.14 June 15 1.67 June 15 5.69
Jersey Point on San Joaquin River	(SAME AS EMMATON)			Max 14-day EC (mmhos)	 W AN BN D C	Apr. 1-Aug. 15 0.45 0.45 0.57 0.85 2.20		 W AN BN D C	0.45 EC Until / EC to Aug. 15 Aug. 15 Aug. 15 July 20 0.74 June 15 1.37 June 5 3.82
Blind Point on San Joaquin River	Max 14-day EC (mmhos)	All except C C	AMJJ / ASOND 2.2 / 3.1 3.6 / 3.6	(NOT INCLUDED)			(NOT INCLUDED)		
2. CENTRAL DELTA Terminous, Rio Vista San Andreas Landing Clifton Court Ferry	Max 14-day TDS (ppm) Max monthly TDS (ppm) Max yearly TDS (ppm)	N or above BN D or C N or above BN D or C N or above BN D or C	JFM / AMJJ / ASOND 700 / 700 / 700 700 / 700 / 800* 700 / 800* / 800* 500 / 500 / 500 500 / 500 / 600* 500 / 600* / 600* 450 500* 500 * Provided avg at all 5 stations for balance of yr does not exceed adjacent lower value						
Greens Landing	When 14-Day or mean monthly max TDS exceeds 150 mg/l		Add to Central Delta TDS levels 1 1/2 times the amount by which TDS at Greens Landing exceeds 150 mg/l						
Terminous (Based on Central Landing)				Max 14 day EC (mmhos)	 W AN BN D C	Apr. 1-Aug. 15 0.45 0.45 0.45 0.45 0.54	Max 14 day EC (mmhos)	 W AN BN D C	0.45 EC until / EC to Aug. 15 Aug. 15 Aug. 15 Aug. 15 - Aug. 15 July 1 0.72
San Andreas Landing (Based on Webb Pump)				Max 14-day EC (mmhos)	W AN BN D C	0.45 0.45 0.45 0.50 0.87	Max 14-day EC (mmhos)	W AN BN D C	Aug. 15 Aug. 15 Aug. 15 June 25 0.55 June 20 1.48
3. SOUTHERN DELTA Vernalis on San Joaquin River	Max 30-day avg TDS (mg/l)	All	500	Max 30 day avg TDS (mg/l)	All (After New Melones Res. becomes operational and until the objective below becomes effective)	500	Max 30-day avg TDS (mg/l)	All (After New Melones Res. becomes operational and until the objective below becomes effective)	500
Eastern Delta Channels	Max mean monthly TDS (mg/l)	All	700						
Tracy Road Bridge on Old River Old River near Middle River Brandt Bridge on San Joaquin River Vernalis on San Joaquin River				Max 30 day EC (mmhos)	All (To become effective only upon the completion of suitable circulation and water supply facilities)	Apr. 1-Aug. 31 / Sept. 1-Mar. 31 0.7 / 1.0	Max 30 day EC (mmhos)	All (To become effective only upon the completion of suitable circulation and water supply facilities)	Apr. 1-Aug. 31 / Sept. 1-Mar. 31 0.7 / 1.0

Table C-1

Conceptual Alternatives (continued)

FISH AND WILDLIFE

A. NO ACTION (Basin Plan)

B. PRESERVATION AT HISTORICAL LEVELS*

C. INTERIM PROTECTION TO THE FISHERY AND SUISUN MARSH (4-Agency Fish Agreement, Fish and Game Exhibit 11)

LOCATION	A. DESCRIPTION	A. YEAR TYPE	A. VALUE	B. DESCRIPTION	B. YEAR TYPE	B. VALUE	C. DESCRIPTION	C. YEAR TYPE	C. VALUE
1. STRIPED BASS SPAWNING Prisoners Point on San Joaquin River	Max 14-day average EC for 5 weeks when water temperature reaches 60°	All	0.550 mmhos	Max 14-day average EC for 5 weeks when water temperature reaches 60°	All	0.550 mmhos	Average EC not to exceed	All	Apr. 1–May 5 0.550 mmhos
							Average Delta outflow not less	All	Apr. 1–Apr. 15 6,700 cfs
Antioch on the San Joaquin River	Max 14-day average EC for 5 weeks when water temperature reaches 68°	All	1.500 mmhos	Max 14-day average EC for 5 weeks when water temperature reaches 60°	All	1.500 mmhos	Average EC not to exceed	All	Apr. 15–May 5 1.5 mmhos
							Relaxation provision (replaces the above outflow and Antioch objective) when SWP and CVP apply deficiencies to firm supplies (determined by linear interpolation between values shown)	All	Total Am.Def. (MAF) / Apr. 1–May 5 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
2. STRIPED BASS SURVIVAL Chipps Island at O&A Ferry	Max 14-day average Cl⁻ (Neomysis and striped bass)	All	4,000 mg/l	Average outflow index (thousands of cfs) for the period not less than:	W AN BN D C	May / June / July: 33.6 / 32.0 / 24.0 27.6 / 23.0 / 17.0 16.8 / 16.0 / 12.0 13.5 / 10.0 / 8.0 6.0 / 4.5 / 3.5	Average outflow index (thousands of cfs) for the period not less than 1/ Subnormal Snowmelt 2/ Dry after wet, above normal or below normal 3/ Dry after dry or critical	W AN BN SnSn 1/ D 2/ D&C 3/	May 6–31 / June / July: 14.0 / 14.0 / 10.0 14.0 / 10.7 / 7.7 11.4 / 9.5 / 6.5 6.5 / 5.4 / 3.6 4.3 / 3.6 / 3.2 3.3 / 3.1 / 2.9
Minimize Diversion of Young Striped Bass into the Central Delta				Closure of Delta Cross Channel Gates up to 20, but no more than 2 of 4 consecutive days on 12 hrs notice by DFG	All	April 16–May 31 when outflow index > 12,000 cfs	Closure of Delta Cross Channel Gates up to 20 but no more than 2 of 4 consecutive days on 12 hrs notice by DFG	All	Apr. 16–May 31 whenever outflow index > 12,000 cfs
Minimize Diversion of Young Striped Bass from the Delta				When daily outflow index < 10,000 cfs, mean monthly export rates from Delta will not exceed (cfs): SWP CVP	All	May–July 2,000 2,000	Mean monthly export rates from Delta will not exceed (cfs): SWP CVP	All	May–June / July 3,000 / 4,600 3,000
3. SALMON MIGRATIONS	Flow direction	All	Positive net downstream flow in all main Delta channels	(SAME AS ALT. C)			Min. 30-day average of computed net mean daily flow at Rio Vista (thousands of cfs)	W AN BN D&C	Jan. / Feb.1–Mar.15 / Mar.16–June 30 / July / Aug. / Sept.1–Dec.31: 2.5 / 3.0 / 5.0 / 3.0 / 1.0 / 5.0 2.5 / 2.0 / 3.0 / 2.0 / 1.0 / 2.5 2.5 / 2.0 / 3.0 / 2.0 / 1.0 / 2.5 1.5 / 1.0 / 2.0 / 1.0 / 1.0 / 1.5
Minimize Cross Delta Movement of Salmon				Closure of Delta Cross Channel gates	All	Jan. 1–April 15 when Delta outflow index > 12,000 cfs	Closure of Delta Cross Channel gates	All	Jan. 1–April 15 When Delta outflow index > 12,000 cfs
4. SUISUN MARSH Bays and Intertidal Sloughs of Suisun Marsh	Sufficient water quality so as not to exceed specified soil salinity (TDS in top 12" of soil)	All	April 15–June 1 9,000 mg/l	Suisun Marsh channel water EC (mmhos) (The monthly average of both daily high tide values not to exceed)	All	Oct. 19.0 Nov. 15.5 Dec. 15.5 Jan. 12.5 Feb. 8.0 Mar. 8.0 Apr. 11.0 May 11.0	Average Delta outflow index for the month not less than	W	February–May 10,000 cfs
	Max mean monthly TDS (mg/l)	All	18,000 mg/l				Min. daily outflow index for 60 consecutive days	SnSn	February–April 10,000 cfs
								AN	January–April 12,000 cfs
								BN	12,000 cfs
							Avg outflow index for each month not less than (if greater flow not required by above objective)	All	January–May 6,600 cfs Whenever storage at or above min. flood control res. envelops level at any two of Shasta, Oroville, and CVP storage on American River
Chipps Island at O&A Ferry							Max. 28 day EC (mmhos) When no deficiencies in project scheduled water supplies	All	Oct.–May 1/ 12.5
							In months when project water users take deficiencies in scheduled supplies		15.6
							1/ From Jan. 1 to Feb. 15 objective is the same as in previous December		

* In order to approach historical levels for the fishery, positive net downstream flow in all Delta Channels is required

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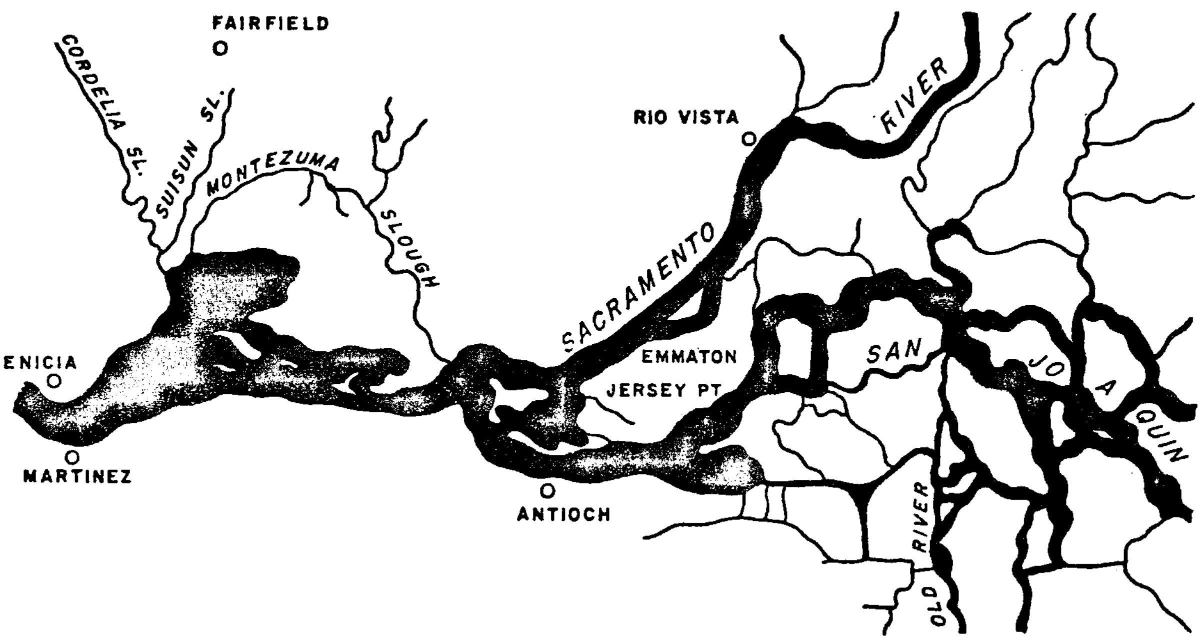
FINAL
environmental impact report
for the
Water Quality Control Plan and Water Right Decision Sacramento-San Joaquin Delta and Suisun Marsh



August 1978
STATE WATER RESOURCES CONTROL BOARD

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CHAPTER I

SUMMARY

The final environmental impact report (EIR) contained herein is on the proposed State Water Resources Control Board action to adopt a water quality control plan for the Sacramento-San Joaquin Delta and Suisun Marsh, and to amend corresponding conditions in water right permits of the Department of Water Resources and U. S. Bureau of Reclamation.

Chapter III of the EIR contains a detailed description of the environmental setting in the Delta and Suisun Marsh. Chapter IV discusses the development of the various alternatives considered, and Chapter V presents an analysis of the environmental impacts of the alternatives. A brief description of the proposed Board action is presented in Chapter VI. This report concludes with Chapter VII, which is an environmental assessment of the proposed Board action. Public comments received on the Draft EIR and the Board's response to them are contained in a special appendix to this report which has been bound separately.

The Delta and Suisun Marsh support unique and vital fish and wildlife resources, important local agricultural activities, and local industries. Suisun Marsh provides habitat for a wide variety of wildlife, and is a major wintering area for waterfowl using the Pacific Flyway. The Delta also is a vital link between the water surplus areas in the Sacramento Valley and the water deficient areas to the south and west of the Delta. Two major systems -

the State Water Project (SWP), operated by the Department of Water Resources, and the Central Valley Project (CVP), operated by the United States Bureau of Reclamation - withdraw water from the Delta. These systems support an extremely valuable agricultural economy in the San Joaquin Valley and serve municipal and industrial uses in northern and southern California.

Seven alternative plans (sets of water quality standards) have been considered in the development of a recommended plan. These alternatives are combinations of various levels of protection for fish and wildlife, municipal, industrial and agricultural uses of water. The EIR evaluates the potential impacts of each alternative on Delta and Suisun Marsh beneficial uses and on water project deliveries to areas outside the Delta. The potential impacts of each alternative are summarized in Table V-1. The recommended plan would provide the same level of protection to agricultural, municipal and industrial uses that would have been available to these uses in the absence of the SWP and CVP.

Striped bass is a key species used in the development of standards for the protection of the fishery in the Delta and Suisun Marsh. The Striped Bass Index is used as an indicator of striped bass abundance in the Delta and Marsh. Under the recommended plan, the survival of young striped bass would approach without project levels and project operators would be required to mitigate impacts of the projects on Suisun Marsh by October 1, 1984.

A major innovation of the recommended plan is that the water quality standards are adjusted according to type of year: wet, above normal, below normal, dry or critical. Existing water quality standards are more uniform and do not vary as much with variations in actual water supply. The result of this new approach is that the water quality regime in the Delta will correspond more closely to the hydrologic and ecologic conditions which would exist in the absence of the SWP and CVP. This regime is more naturally suited to fish and wildlife uses in the Delta and Suisun Marsh. At the same time, the water project deliveries will be less adversely impacted by this approach than by existing standards.

If the Board took no action, the existing Basin Plans (San Francisco Bay Basin (2) and Sacramento-San Joaquin Delta Basin (5B)) and water right Decision D 1275, as amended by D 1291, would be controlling. The existing salinity and outflow conditions together with the Basin Plans and water right decisions comprise the theoretical "no action" alternative against which environmental effects of the recommended plan have been assessed.

The overall protection under the recommended plan, while requiring less freshwater outflow in water short years, would be greater than would result if the Board took no action. This reduction in Delta outflow is made possible by a more efficient use of Delta water supplies and a better understanding of beneficial use needs in the Delta. However, the recommended plan does have some potential adverse impacts.

Under the recommended plan, drinking water supply intakes in the Delta would be protected to meet public health salinity drinking standards. In addition, salt sensitive industries presently taking water offshore at Antioch in the western Delta would be ensured water quality above that required for drinking purposes.

Extremely large amounts of freshwater would be required to maintain adequate water quality immediately offshore at Antioch to protect these industrial uses. However, all principal water users in the Antioch area, including the industrial users, are able to obtain suitable substitute supplies from the Contra Costa Canal, a Central Valley Project facility which withdraws water from the Delta east of Antioch. In accordance with Water Code Section 12202, the recommended plan would require that the quality of the substitute supply meet the industrial needs to the same extent that such needs would have been satisfied at Antioch without the projects.

Municipal and industrial users of Delta waters would not be adversely affected by the recommended plan, except possibly users in the Contra Costa Canal service area. Under the recommended plan, water users served by the Contra Costa Canal would receive fewer days of good quality water (150 mg/l chloride or better) in all years except wet years, than that provided by the "no action" alternative. The economic impact of this reduction in availability of good quality water for salt-sensitive industries and municipal users cannot be quantified, but is a potentially significant impact of the recommended plan.

Under the recommended plan, the level of protection provided to Delta agriculture would be that which would have been available to the Delta in the absence of the projects. The patterns of Delta outflow and salinity under the recommended plan would most of the time be better than that of the "no action" alternative. No significant environmental impacts to Delta agriculture are expected other than under limited circumstances in the western Delta. Even in the western Delta, the recommended plan would provide better water quality conditions in dry, below normal, above normal and wet years than those of the "no action" alternative.

The recommended plan uses striped bass as the key species in the Delta and Suisun Marsh. This species has been used to develop fishery standards because of its importance and because information available on this species is the most extensive. In view of this, the impacts of the recommended plan on the fishery are assessed in terms of its effect on striped bass. However, a qualitative statement on the impacts of the plan on other species is also presented in this report.

Water quality levels and the resulting freshwater outflow from the Delta required to protect striped bass will benefit other fish species. The recommended plan would require maintenance of striped bass populations on the average at levels that approach those that would have existed if the projects had not been constructed. This protection is provided by specific requirements for suitable water quality for spawning and survival of young bass during their first year. Fish populations would vary with the type of year, as they would have varied under conditions without the projects. The recommended plan envisions that any future facilities should be designed to improve the level of protection to fishery resources.

The impacts of the recommended plan on the fishery have been broken down into various environmental components. The recommended plan would require maintenance of suitable conditions for striped bass spawning. However, during water short years when deficiencies are imposed by the SWP and CVP on the firm supplies of project water users, increases in Delta salinity are allowed which could reduce striped bass spawning areas in the lower San Joaquin River. The impact on striped bass abundance of this short term reduction in spawning areas cannot be determined with available information. However, the potential impact to striped bass spawning is considered insignificant.

In addition, the recommended plan on the average would maintain striped bass survival at levels higher than those under the "no action" alternative. The Striped Bass Index under the recommended plan would be 79 as compared to an index of 63 under the "no action" alternative. This assessment is based on certain relationships between Delta outflow and abundance of striped bass. Recent information suggests outflows fall below those of the may not be valid when Delta outflow fall below those of the 1976 winter. Algal productivity may be insufficient under these conditions to support the expected populations of striped bass.

In view of this, the recommended plan provides for re-examination of the relationships between Delta outflow and striped bass. Since modifications of these relationships could indicate need for revisions of the fishery standards, the Board would review the results of this analysis by the Department of Fish and Game and consider whether further action is necessary. Nonetheless, when compared against the "no action" alternative, the recommended plan would have no potential for a significant adverse impact since the standards controlling during the winter would be the same under both the recommended plan and the "no action" alternative.

Suisun Marsh provides habitat for a wide variety of wildlife. The Department of Fish and Game testified that measures to protect waterfowl would also protect other wildlife. Most of Suisun Marsh would have been fully protected in all but the most critical years under conditions without the SWP and CVP. However, protection of the Marsh at present poses an extremely difficult problem.

Protection from adverse salinity conditions caused by operations of these projects would require a cutback of about one-third in water currently withdrawn from the Delta for use in other parts of California. Additionally, protection for the Marsh in any one year could severely limit the ability of the projects to meet Delta water quality standards later in the same year, due to reductions in upstream reservoir storage. Such commitment of limited upstream supplies could also adversely impact the ability of the projects to provide needed protection to Suisun Marsh in subsequent years, particularly if extended dry periods occur.

For these reasons, the recommended plan does not require immediate full Marsh protection. Rather, the plan requires an intermediate level of protection and actions to ensure that adverse impacts sustained by the Marsh prior to 1984 are at least partially mitigated. From a practical standpoint, the recommended plan offers essentially the same protection to Suisun Marsh prior to 1984 as does the "no action" alternative. Both rely on uncontrolled flows for Marsh protection. The recommended plan requires that the project operators work with other agencies to develop a long-term protection plan for the Marsh by mid-1979, and implement this plan by October 1, 1984.

The mitigation measures include the requirement that interim and permanent substitute water supplies be provided for Suisun Marsh to mitigate the CVP and SWP impact on this valuable resource. Mitigation of these project induced impacts should fully protect most of the Marsh.

The Delta Plan deals with a limited resource and involves essentially the allocation of water shortages. The overall protection to all uses of Delta supplies under the recommended plan would be greater than that provided by the "no action" alternative, while requiring less freshwater outflow during critical years.

CHAPTER II

INTRODUCTION

The purpose of an environmental impact report (EIR) is to identify the significant environmental effects of a project and to indicate the manner in which such impacts can be mitigated. The project considered in this Final EIR is the adoption of a water quality control plan for the Sacramento-San Joaquin Delta and Suisun Marsh and of a water right decision to amend water right permits of the Department of Water Resources (Department) and U. S. Bureau of Reclamation (Bureau).

A. BOARD ACTION

The water quality control plan would establish salinity controls for the protection of beneficial uses of Delta water supplies and of Suisun Marsh. The same salinity controls would be adopted in a water right decision amending permits for the federal Central Valley Project (CVP) and the State Water Project (SWP) to ensure that the operations of these facilities do not adversely affect beneficial uses.

Even though two documents will be considered for adoption by the Board, the plan and water right decision represent an effort by the Board to develop under its full authority a single comprehensive set of water quality standards to protect beneficial uses of Delta water supplies. A single environmental impact report (EIR) has been prepared to cover both the plan and water right decision.

The water quality control plan for the Sacramento-San Joaquin Delta is designed for conditions over the next ten years. However, the plan also provides policy guidance to the operators of the SWP and CVP for use in their long-range planning activities.

Delta water supplies are used for municipal, industrial and agricultural purposes. In addition, the Delta and Suisun Marsh sustain major inland fisheries and wildlife populations. These uses are dependent on the maintenance of suitable salinities.

Two major systems - the CVP and SWP - export surplus supplies from the Delta to serve a wide range of uses which are also dependent upon salinities.

Salinity is the primary water quality factor affecting beneficial uses of Delta water supplies and is directly influenced by operation of project facilities. Past water right decisions regarding project diversions from the Delta have dealt almost exclusively with salinity control in establishing water quality standards for the protection of beneficial uses of Delta water supplies.

The existing salinity controls for the Delta and Suisun Marsh are contained in the water quality control plans for the Sacramento-San Joaquin Delta Basin (Basin 5B) and the San Francisco Bay Basin (Basin 2) and in Decision D 1275, as amended by Decision D 1291.

The Basin 5B and 2 plans contain comprehensive water quality standards which include the following water quality characteristics: physical (temperature, dissolved oxygen, turbidity, suspended solids, color and odor), inorganic (including salinity) and organic constituents, biological properties and radioactivity. Under the current proceeding, only the salinity control aspects of the basin plans will be modified as necessary to reflect the most current information and changes in conditions. In all other respects, the basin plans will continue to be the guiding policy for water quality control in the affected basins.

Experience in implementing the salinity standards in the basin plans and Board water right decisions and information developed during the extensive evidentiary hearing on the Delta and Suisun Marsh have made it apparent that the salinity standards must be revised in order to ensure protection of each use in its own right and to identify the responsibility of the projects for salinity control in the Delta and Suisun Marsh.

The proposed Board action would establish salinity standards to ensure the protection of beneficial uses of Delta water supplies and would affect the operations of the SWP and CVP. The Delta and Suisun Marsh standards also would have an effect on environmental conditions downstream as far as San Francisco Bay.

The consequences of the proposed action would be felt generally throughout California. As explained in Chapter V, the net effect of the proposed action would be to provide greater overall protection to beneficial uses while reducing the amount of freshwater outflows required than would be the case under the existing salinity controls of the basin plans and D 1275.

The SWP is at a stage where the project yield must be increased in the near future to meet contractual commitments.

The water quality standards established in the plan will be incorporated into water right permits of the Department and Bureau through a water right decision. The water quality control plan, when adopted, supersedes the Basin 2 and 5B Plans for the same waters to the extent of any conflict.

Upon its adoption, the water quality control plan will be submitted to the Environmental Protection Agency (EPA) for approval in accordance with the requirements of the Federal Water Pollution Control Act (as amended by PL 95-217). This plan, when considered as an adjunct to the comprehensive basin plans, will satisfy all federal requirements.

A more detailed description of the proposed action is set forth in Chapter V of this report.

B. RELATIONSHIP OF EIR AND WATER QUALITY CONTROL PLAN

The selection process through which the recommended water quality standards of the plan were developed included an analysis of the potential environmental impacts of several alternative actions. The development of the water quality control plan and EIR has been an integrated process.

The plan contains generally a more detailed discussion of legal issues and plan implementation, whereas the EIR is more complete in its discussion of the technical and environmental factors involved in the analysis of water quality criteria for various beneficial uses. In order to minimize the amount of duplication in the two documents, a brief discussion in one document may be referenced to a more thorough discussion in the other document.

C. THE HEARING PROCESS AND THE EIR

On September 28, 1976, a notice was published to inform the public of the Board's intent to review the water right permits of the Department and Bureau and to hold a public hearing for the purpose of developing an evidentiary record upon which to base the proposed Board action. The notice indicated that the hearing would be conducted as a dual hearing under the water quality and water right authority of the Board and that specific procedures would be followed. In view of the fact that the water right hearing procedures are more restrictive, they were followed. While all interested individuals were given an opportunity to present relevant information during the course of the hearing, these procedures provide that individuals or agencies which have a special interest and intend to present a formal case can be qualified as "adversary parties". In accordance with these procedures, copies of all exhibits and written material offered in evidence must be furnished to all adversary parties prior to presentation. Also, all testimony must be presented under oath with an opportunity provided for cross-examination of witnesses, and presentation of rebuttal evidence. In view of the dual nature of the proceeding, the Board has confined itself to the hearing record in developing the water quality control plan.

The EIR has been prepared to identify systematically the potentially significant impacts of the recommended water quality standards, alternatives to the proposed action, and the manner in which significant impacts can be avoided or mitigated. Although the analysis of environmental impacts relies upon the testimony and exhibits presented to the Board in the hearing, it was also necessary to review other material referenced by witnesses in their testimony or exhibits.

The hearing process is assumed to fulfill the normal procedures required by Section 15066 of the State EIR Guidelines[1/] for consulting with persons or agencies having expertise, authority or concern in the area of impact during preparation of the Draft EIR. The Board's intent was widely publicized and the official published notices of hearing requested interested parties to submit information on potential impacts of the Board's decision.

The Draft EIR was circulated widely to allow all interested persons or agencies to comment on the scope of the information considered by the Board and the analysis of this information. All areawide clearinghouses in California and the State Clearinghouse (SCH 77111538) were notified on November 4, 1977, of the Board's intent to circulate a Draft EIR and draft water quality control plan. The draft plan and Draft EIR were released for public review on March 15, 1978.

1/ Chapter 3, Division 6 of Title 14, California Administrative Code.

The Board held a public hearing on May 30, 1978, to receive comments on the draft Plan and the Draft EIR. The hearing record was left open until June 15, 1978, in order to accommodate written comments on both documents.

The respective concerns and the Board's responses to them are contained in the special appendix to this report. These comments have been incorporated into the Delta Plan and Final EIR as appropriate.

This Final EIR contains the information on environmental impacts which the Board must consider prior to adopting a water quality control plan for the Sacramento-San Joaquin Delta and Suisun Marsh and corresponding water right decision.

CHAPTER III

ENVIRONMENTAL SETTING

A. PHYSICAL CHARACTERISTICS

Geographic Description

The Sacramento and San Joaquin Rivers which drain the Central Valley of California join in a large lowland area before entering San Francisco Bay. Much of this area, interwoven with natural channels, is at or below sea level. This natural lowland area, the Sacramento-San Joaquin Delta, is roughly triangular in shape and is bounded generally by a line extending from Sacramento on the north to Vernalis in the south, then to Pittsburg in the west, and back to Sacramento.

The Delta is distinguished physically from the Central Valley by its unique soils (Nuttonson, 1963)[1/], tidal influence on surrounding stream channels and low elevation of the land. Through the years an elaborate system of man-made levees has been developed to protect the Delta lowlands from flooding by tidal action and high river flows. Most of the agricultural areas are surrounded year-round by water which has necessitated special irrigation practices, and a historical dependence on waterborne transportation.

1/ References other than to the hearing record are listed following the report. References herein to the hearing record may be to either exhibits identified by party and exhibit number or testimony identified by reporter's transcript (RT) volume and page number.

The legal boundaries of the Delta were established by the Legislature in 1959. The Delta, as defined in Section 12220 of the California Water Code (see Plate 1), generally is comprised of those waterways above the confluence of the Sacramento and San Joaquin Rivers which are influenced by tidal action and about 510,000 acres of agricultural lands which derive their water supply from those waterways. It contains about 738,000 acres with a water surface area of over 48,000 acres. There are about 700 miles of waterways with an aggregate navigable length in excess of 550 miles, with some of the channels as deep as 50 to 60 feet. All references to the Delta in this report will mean the area as defined in Water Code Section 12220 unless otherwise stated.

Suisun Marsh is a natural marsh area located north of Suisun Bay, immediately west of the Delta. At one time, some of the land in the Marsh was reclaimed for agriculture, but now most of the area is managed primarily for waterfowl and hunting purposes by private individuals and public agencies. The boundaries of the Marsh have also been established by the Legislature as defined in Section 29101 of the Public Resources Code (see Plate 1). References to Suisun Marsh in this report will be to the area so defined unless otherwise noted.

Even though the proposed Board action is limited to the establishment of salinity controls in the Delta and Suisun Marsh, the waters of San Francisco Bay, generally considered to include Suisun, San

Pablo and San Francisco Bays, will be affected. The plan points out the need, in planning further water development projects, to investigate, quantify and take into account unregulated flows to protect the Bay and entire estuary. Such protection will be a factor to be considered in connection with requests for new appropriations of water from presently unregulated flows. The entire waterway from the Golden Gate through the Delta is a continuous estuarine system where water quality and life forms are interrelated. Therefore, this chapter also contains a description of physical and biological relationships in San Francisco Bay.

Relationships Among Important Delta Features

Under natural conditions the Sacramento and San Joaquin Rivers flowed unimpaired through the network of channels forming a common Delta until they joined near Pittsburg and discharged into Suisun, San Pablo, and San Francisco Bays. Much of this natural Delta area was permanent tule marsh covered with various types of aquatic vegetation, trees and grasses. Silt brought in by the rivers interlaid and accumulated on top of vegetation and peat, forming low islands which were partially or entirely covered with water at times (Department 1967).

Large areas of the natural Delta were affected by tidal action. Ordinarily, saltwater was present below Suisun Bay and freshwater was present in the Delta. For short intervals in late summer of years of low Central Valley runoff, salinity incursion from San Francisco Bay extended into the lower river and Delta region. In seasons of high runoff upper San Francisco Bay was fresh, part of the time, through the Golden Gate.

This variation in quality of water was not of sufficient duration to affect substantially the characteristic vegetative growth of the regions above or below Carquinez Strait, nor to modify the designation of Suisun Bay as ordinarily a freshwater body and San Francisco Bay as ordinarily saline (Means, 1928, p. 1).

In the 1860's reclamation began in the natural Delta on lands which now lie at elevations between 5 feet above and 20 or more feet below sea level, the Delta "lowlands". These lands totalled about 415,000 acres. Cooperative levee construction by local landowners was undertaken to allow the lands to be formed, and by the 1920's the area was completely reclaimed and in agricultural production (Baldwin, 1968, p. 210).

Reclamation of land in the Delta caused considerable alteration of natural channels. Some of the smaller channels were closed, but many new artificial channels were created by dredge cuts made to obtain material for levee construction. Most of the main natural channels were widened by the excavation of levee material (Department 1967, p. 5).

Prior to extensive reclamation, saltwater incursion into the Delta was a rare occurrence. Records of 1775, 1841, and the 1870's indicate that brackish water extended only a short distance above the confluence of the Sacramento and San Joaquin Rivers even in dry years. Prior to 1920, the invasion of saline tidal waters above Antioch happened at such rare intervals that their occurrence was news (Baldwin, 1969, p. 211). Increased upstream irrigation diversions, reclamation and flood control efforts combined to increase the saltwater incursion into the Delta after 1920 (Baldwin, 1969, p. 211).

The waters of the western Delta were used for agricultural, municipal and industrial purposes. These uses are dependent on freshwater, and the presence of seawater caused problems. In the 20 years between 1900 and 1920, the area irrigated from the Sacramento River system tripled, while in the San Joaquin River system the increase was nearly fourfold. The total area irrigated from both river systems was 1,159,000 acres in 1920 (Department Bulletin 27, which is Department Exhibit 8 in proceedings leading to Decision D 1275, p. 126). Just prior to 1918, levees were built to protect some of the largest reclamation districts in the valley. This work reduced the natural offstream retention of high flows and reduced the flow passing through the Delta in late summer (Means, 1928, p. 14). The combined effects of these and other projects, coupled with the dry years in the period from 1917 to 1926, accentuated the problems associated with salinity incursion (Means, 1928, p. 1; Baldwin, 1969, p. 211).

In 1940 the Contra Costa Canal was constructed with its intake at Rock Slough in the western Delta. The canal provides a dependable supply of water to portions of Contra Costa County, including the municipalities and industries which were partially dependent on diversion of water from the Sacramento and San Joaquin Rivers in the zone of salinity incursion.

High levels of salinity incursion continued sporadically until 1944, when the construction and operation of Shasta Dam increased the summer outflow through the Delta and thereby decreased the maximum extent of the incursions (Baldwin, 1969, p. 211). In 1951, the Bureau constructed a pumping plant near Tracy in the southern Delta to export water for delivery to lands in the San Joaquin Valley. The diversion of water near Tracy could cause a southerly flow of water in the natural channels of the central Delta, resulting in transfer of Sacramento River water to the pumps. Releases of water from Shasta Reservoir augmented the natural flow of the Sacramento River in the summer and fall and increased the amount of water available for export during this period. In the same year the Delta Cross Channel with control gates was constructed near Walnut Grove (see Plate 1) to allow a more efficient transfer of water to the Tracy pumps. This transfer of water across the Delta is discussed in more detail later. The Bureau has since added major CVP storage facilities on the American River and the Trinity River.

In 1967 the State Water Project, consisting of Oroville Dam on the Feather River and the SWP Delta Pumping Plant west of Tracy (see Plate 1), began operation. The combined operation of the two major pumping plants in the southern Delta increased the amount of water transferred across the Delta and diverted from it.

Delta Hydrology and Hydraulics

Variations in Delta Inflow. California experiences changing weather patterns each year. In some years, rain is frequent and runoff is abundant. In other years, like 1976 and 1977, rain is infrequent and runoff is scarce. Unimpaired inflow to the Delta, the inflow that would occur in the absence of upstream reservoirs and developments, has ranged from 47,500,000 acre-feet in 1907 to 6,300,000 acre-feet in 1977, with a 1906-1977 median of about 22,800,000 acre-feet.[2/] As hydrologic data indicates, we rarely have an "average" year, with most years having higher or lower flows. In addition to variations in runoff from year to year, there are seasonal variations. In the Central Valley there is a typical "wet" season in the winter and spring, followed by a "dry" season in summer and fall, with transition periods between.

Freshwater inflow to the Delta is primarily from the Sacramento and San Joaquin Rivers, although additional amounts are contributed by lesser tributaries including the Mokelumne and Cosumnes Rivers. In the period (1922-1944) prior to construction and operation of the SWP and CVP, the Sacramento River provided about 80 percent of the total inflow, the San Joaquin River about 15 percent, while the remainder came from the minor tributaries. In the post-project period (1945-1971), the Sacramento River provided about 75 percent, the San Joaquin River about 10 percent, with the remainder from other tributaries.

Classification of Year Types. Rainfall and runoff patterns each year in the Central Valley result in wide variations in total unimpaired runoff. Currently the Department and Bureau are using

2/ Data from records of DWR Cooperative Snow Surveys, determined for major flow stations.

the hydrologic year classification system described in Figure III-1 (Staff Exhibit 1, p. I-4-13) to define below normal, dry and critical years.

These definitions first came about as a result of Bureau water supply contracts negotiated in the early 1950's, when Shasta Dam was the only CVP storage facility in operation. This is the reason the classification system now used is based on inflow to Shasta Reservoir. The classification system was established because of the great importance of the available water supply insofar as it affected Delta outflow conditions, contractual deliveries by the Bureau, and water quality conditions in the Delta and Suisun Marsh.

Problems with the present classification system include: (1) There is no classification covering above normal or wet years; (2) Shasta Reservoir hydrology differs in many years from hydrology of the rest of Sacramento Valley, all of which affects the Delta; and (3) there is no recognition of water-short conditions in years following a critical year. Accordingly, the Department has suggested a revised hydrologic year type classification in their Exhibit 1. Figure III-2 shows the new classification system, which is the same as the Department's recommendation except that the "year following critical year" designation does not apply to agricultural, municipal, and industrial standards. This modification is necessary to ensure that the year classification system is consistent with vested rights.

Tidal Action. Tides represent the combined effect of motion of the earth and gravitational influences of the moon and the sun. The tides go through one complete cycle in about 25 hours. One

FIGURE III-1

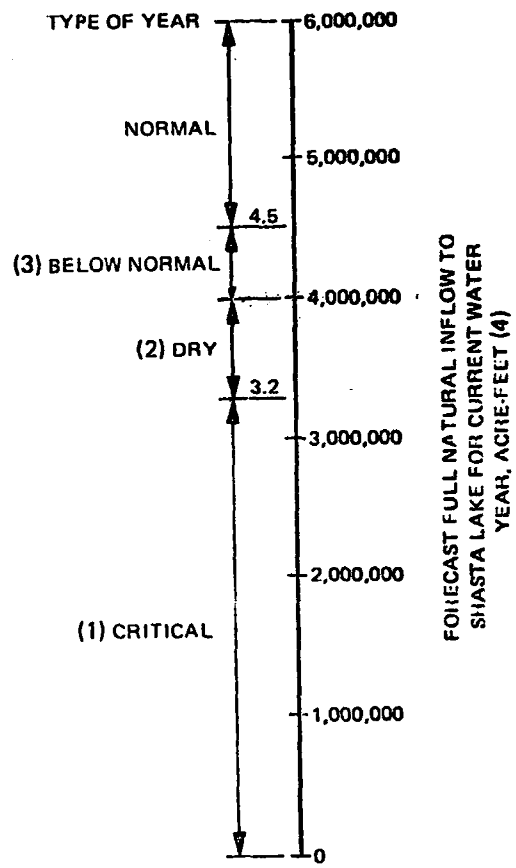
PREVIOUS DEFINITIONS OF TYPES OF WATER YEARS

1. "Critical year" shall mean any year in which either of the following eventualities exists:
   a. The forecasted full natural inflow to Shasta Lake for the current water year (1 October of the preceding calendar year through 30 September of the current calendar year) is equal to or less than 3,200,000 acre-feet; or
   b. The total accumulated actual deficiencies below 4,000,000 acre-feet in the immediately prior water year or series of successive prior water years each of which had inflows of less than 4,000,000 acre-feet together with the forecasted deficiency for the current water year, exceed 800,000 acre-feet.

2. "Dry year" shall mean any year other than a critical year in which the forecasted full natural inflow to Shasta Lake for the current water year is equal to or less than 4,000,000 acre-feet.

3. "Below normal year" shall mean any year in which the forecasted full natural inflow to Shasta Lake for the current water year is equal to or less than 4,500,000 acre-feet but more than 4,000,000 acre-feet.

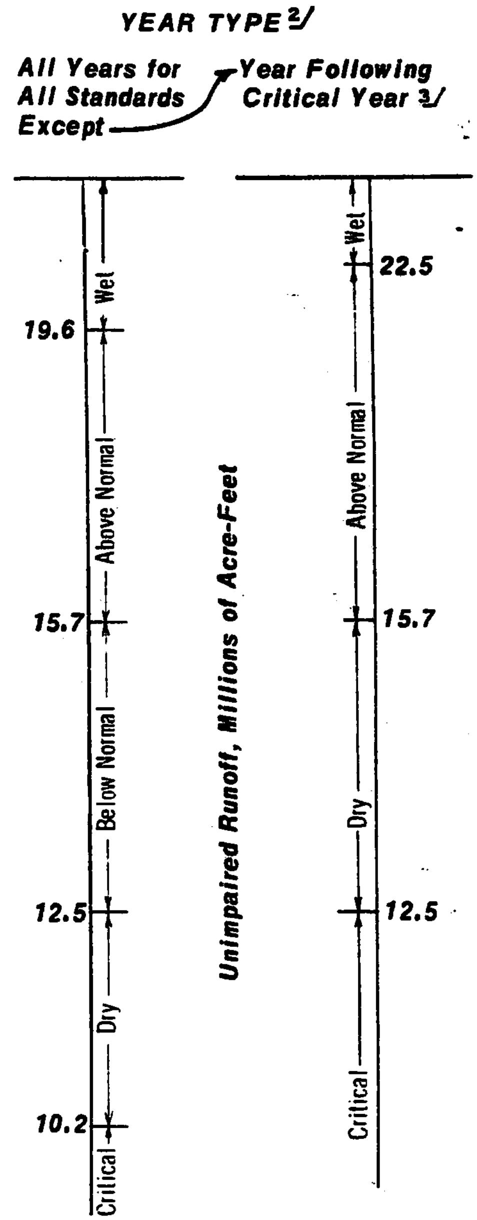
4. "Full natural inflow to Shasta Lake" shall mean the computed inflow to Shasta Lake under present water development above Shasta Lake. In the event that a major water project is completed above Shasta Lake after 1 September 1963 which materially alters the present regimen of the stream systems contributing to Shasta Lake, the computed inflow to Shasta Lake will be adjusted to eliminate the effect of such water project. After consultation with the State, the Weather Bureau, and other recognized forecasting agencies, the United States Bureau of Reclamation will select the forecast to be used and will make the details of it available to the Delta water users. The same forecasts used by the United States for the operation of the Central Valley Project shall be used to make the forecasts under this agreement. Such forecasts shall be made by February 15 of each year and may be revised as frequently thereafter as conditions and information warrant.



YEAR CLASSIFICATION

Year classification shall be determined by the forecast of 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 for 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.

YEAR TYPE	***RUNOFF, MILLIONS OF ACRE-FEET***
Wet 1/	equal to or greater than 19.6 (except equal to or greater than 22.5 in a year following a critical year). 3/
Above Normal 1/	greater than 15.7 and less than 19.6 (except greater than 15.7 and less than 22.5 in a year following a critical year). 3/
Below Normal 1/	equal to or less than 15.7 and greater than 12.5 (except in a year following a critical year). 3/
Dry	equal to or less than 12.5 and greater than 10.2 (except equal to or less than 15.7 and greater than 12.5 in a year following a critical year). 3/
Critical	equal to or less than 10.2 (except equal to or less than 12.5 in a year following a critical year). 3/



1/ *Any otherwise wet, above normal, or below normal year may be designated a subnormal snowmelt year whenever the forecast of April through July unimpaired runoff reported in the May issue of Bulletin 120 is less than 5.9 million acre-feet.*

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.*

3/ *"Year following critical year" classification does not apply to Agricultural, Municipal and Industrial standards.*

complete cycle includes two high tides and two low tides, each having a different tidal elevation. Therefore, each tidal cycle has a low-low tide, high-low tide, low-high tide, and high-high tide. The high-high tide has special significance since its occurrence coincides generally with the time of daily maximum salinity intrusion into the Delta. The back-and-forth movement of the tides provides the predominant flushing action in the Delta, except during periods of very high Delta outflow.

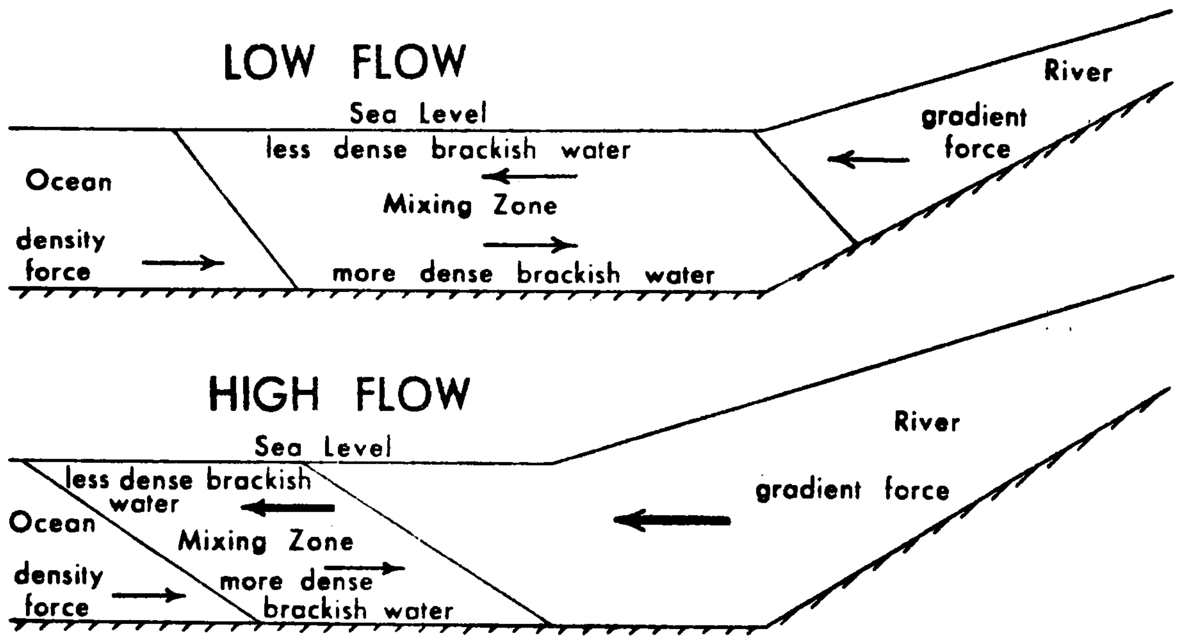
Counteracting the force of the tides from San Francisco Bay and the Pacific Ocean are freshwater inflows from the Sacramento and San Joaquin Rivers. Flows at any time in Delta channels are the resultant of these opposing forces. Many times when inflow is low, upstream flow in Delta channels occurs with an incoming tide. Such tidal-caused flow reversals occur over most of the Delta during low flow periods although it is often masked in parts of the Delta by influence of the export pumps. Tidal action generally results in water moving back and forth. However, the net flow over the tidal cycle is usually downstream. At high export rates the net flow of water can reverse and move toward the export pumps.

Mixing. The Delta outflow regime responds to the competing forces of the tides and inflow, and Delta salinity responds to the differences in salinity of these two water sources. The less dense freshwater tends to flow seaward above the more dense saline water. Although tidal currents cause vertical mixing of the fresher water downward and the more saline water upward, there still are two layers resulting from the density differences. The seaward flow and tidal action result in the establishment of opposing net flow patterns, an upper seaward flowing layer of fresher water and an underlying landward flowing layer of more saline water. There is no marked interface between the oppositely flowing waters, although salinity increases from top to bottom.

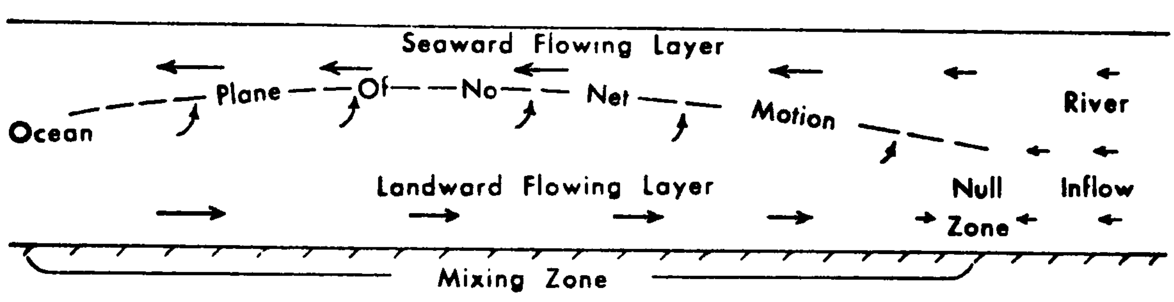
The forces influencing the mixing of freshwater and saltwater are suggested by Figure III-3 (Bureau Exhibit 39). The greater the freshwater flow, the greater the hydraulic head and the greater the seaward driving force. Higher Delta outflows tend to shift the saline water/freshwater mixing zone seaward, increasing the salinity stratification and compressing the mixing zone. At some location in the upper part of the San Francisco Bay-Delta estuary, the landward force in the lower layer is equalled by the seaward force of the freshwater flow. In this region the opposing forces are nullified and an area of no net flow, or "null zone" is created. The flow pattern and general location of the null zone with respect to the mixing zone are also shown in Figure III-3. The "entrapment zone", an associated phenomenon caused by the same hydraulics that create the null zone, is generally downstream from and adjacent to the null zone and acts to "trap" sediments and nutrients. Herein lies the importance of these zones to the fishery, since accumulated nutrients play an important part in the aquatic food chain. These nutrients are important in growth of phytoplankton, which controls zooplankton growth and eventual fish survival.

The location of the null zone changes with variations in Delta freshwater outflow. High Delta outflows force the null zone

FORCES INFLUENCING TWO LAYER FLOW AND VERTICAL MIXING IN ESTUARIES



The primary driving forces responsible for two-layer flow in estuaries.

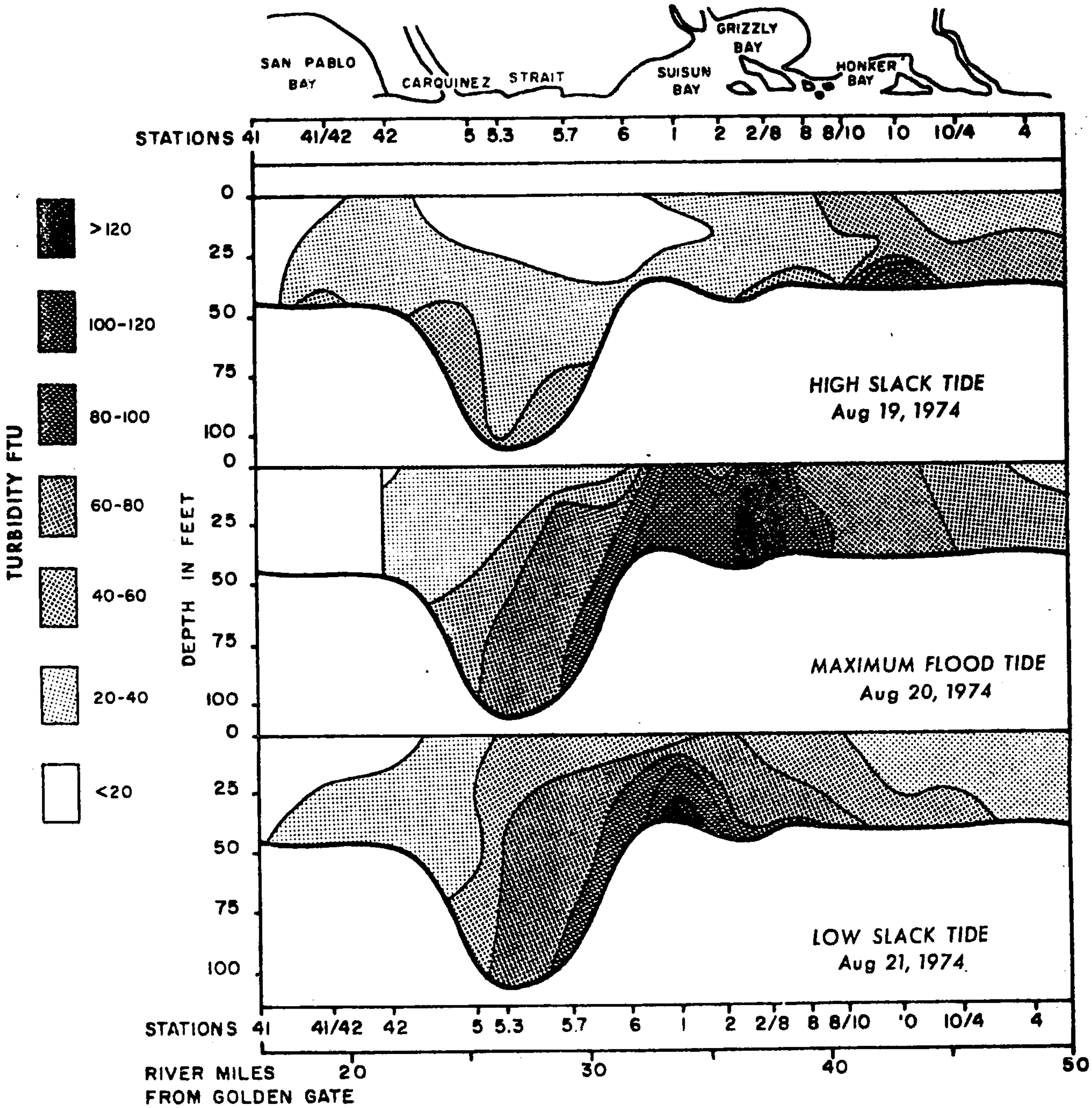


Net flow pattern in a two-layer flow with vertical mixing estuary.

SOURCE: U.S. Bureau of Reclamation, Exhibit 39 toward San Francisco Bay, while low Delta outflows cause the null zone to recede upstream towards the Delta. Since tidal forces vary throughout the tidal cycle, the location of the null zone would be expected to be further upstream on high slack tide and further downstream on low slack tide, as Figure III-4 (Bureau Exhibit 45) shows. At the time of maximum flow of water during the flood tide, the entrapment zone is generally larger and located between its positions during high and low slack tides.

Salinity conditions in the Delta and down through Suisun Marsh depend on the magnitude of freshwater outflow. As with the null zone, the larger the freshwater outflow, the further downstream is the interface between freshwater and seawater. There is no abrupt boundary between seawater and freshwater, and a gradient or gradual change in salinity with distance exists. The length and magnitude of this gradient varies with Delta outflow. The Department presented information in the hearing which predicts the salinity gradient west of the Delta and up the Sacramento River for varying Delta outflows (Department Exhibit 7B). The key to salinity control in the Delta lies in such inverse flow-salinity relationships.

<u>Delta Outflow.</u> Net outflow of freshwater from the Delta is not now susceptible to direct measurement since, at times, the estimated net Delta outflow may be less than 5 percent of the flows due to tidal fluctuations. However, the net Delta outflow is important for purposes of water quality control and water resource management.



Isoturbidity contours demonstrating the change in location of the entrapment zone and turbidity concentrations with different tidal phases. Delta outflow index – 11,600 to 12,900 ft^3 s.

SOURCE: U.S. Bureau of Reclamation, Exhibit 45.

To provide a common base for operation of their project facilities, the Department and the Bureau have jointly established a Delta Outflow Index. One of the critical factors in determining the Outflow Index is the net Delta consumptive use. This factor was fixed in the Federal-State Memorandum of Agreement dated April 9, 1969 (hearing preceding Decision 1379, Bureau Exhibit 576). The consumptive use values were based on a 1955 Delta land use survey, estimates of consumptive use by identified crops, changes in soil moisture, and estimates of leaching requirements. A subsequent amendment to the Memorandum of Agreement dated October 10, 1969, established a Delta Outflow Index in which net Delta outflow is equal to: (1) Delta inflow from the major tributaries, minus (2) net Delta consumptive use, minus (3) SWP and CVP export pumping. The inflow and export values are measured, while the consumptive use figures are those fixed in the April 9, 1969 agreement. Therefore, the Index is an accurate representation of true net Delta outflow only when consumptive uses match the values used in the Index. During portions of very dry or very wet years, the Index cannot be expected to be representative of true net outflow. This was the case in 1976 and 1977, when Delta consumptive uses were much higher than normal during the early part of the year. These high early season consumptive uses were due primarily to extensive pre-irrigation necessitated by depleted soil moisture caused by lack of sufficient rainfall.

<u>Pre-Project Conditions.</u> Under pre-project conditions (1920-1944), seawater moved upstream toward and into the Delta when freshwater inflows to the Delta decreased. Typically, maximum salinity

intrusion occurred sometime in August or September. Figure III-5 shows the maximum salinity intrusion each year for pre-project conditions, as reflected by the location of the 1000 ppm chloride line.[3/] The wide fluctuation in the maximum salinity intrusion from year to year is due to the large-scale variations of freshwater Delta inflows from tributary streams experienced during the 1920-1944 period. These variations reflect differences not only in total annual inflows, but also in the seasonal distribution of those inflows. For instance, extensive salinity intrusion resulted from reduced freshwater inflows into the Delta during 1924 and 1931, both of which were critical water supply years as defined in Figure III-1. Conversely, high runoff in the Central Valley during 1938 held the maximum salinity intrusion to the western border of the Delta.

Figure III-6 illustrates the progressive intrusion of seawater during a typical critical year, 1939. As shown in this figure, salinity intrusion into the western Delta commenced sometime in June, gradually pushing its way into the central portion of the Delta by August and September. The maximum salinity intrusion into the Sacramento River portion of the Delta occurred on August 18. After that date, inflows to the Delta increased sufficiently to repulse salinity. These increased inflows marked the close of the irrigation season for many crops in the Sacramento Valley, resulting in substantial reductions in upstream withdrawals from

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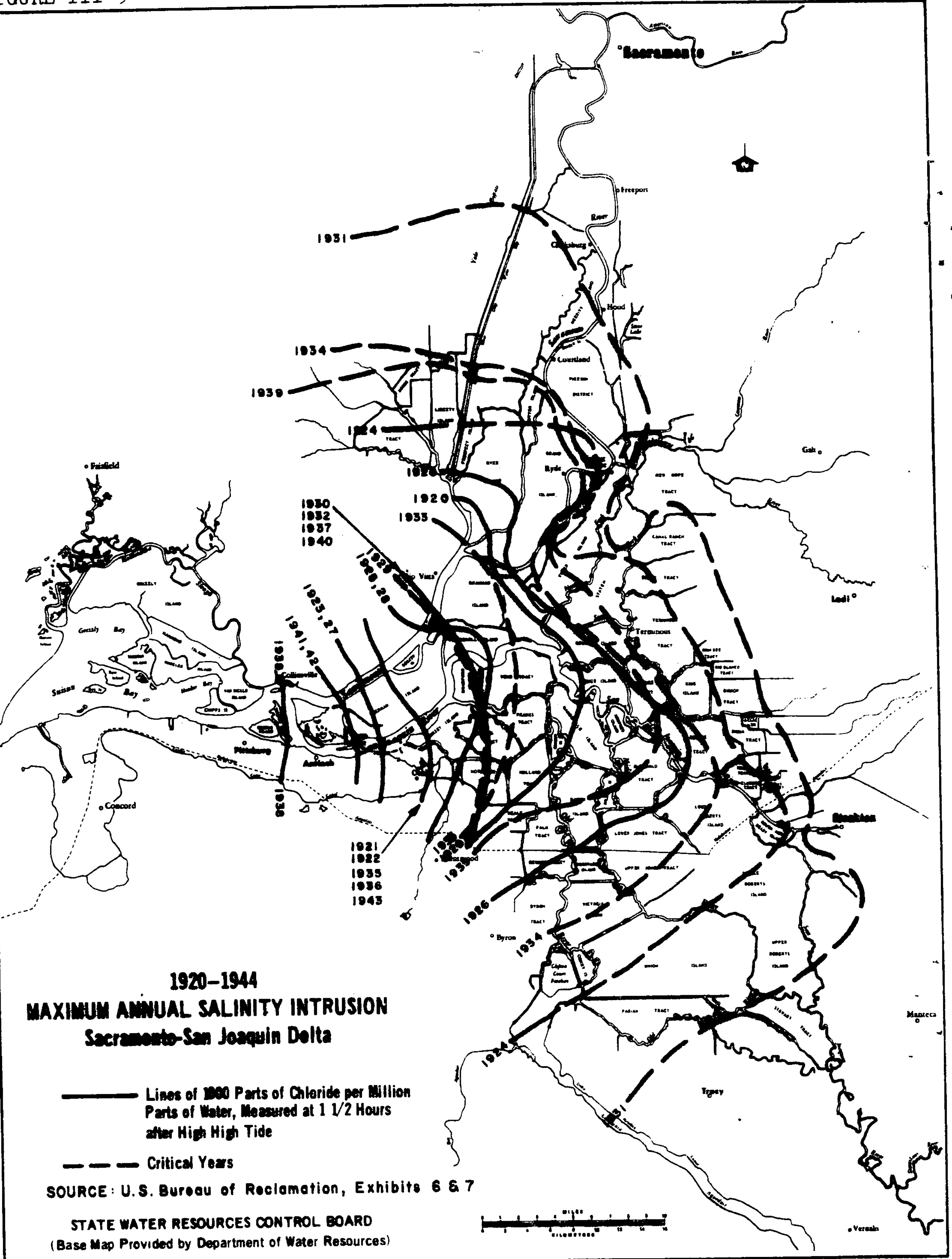
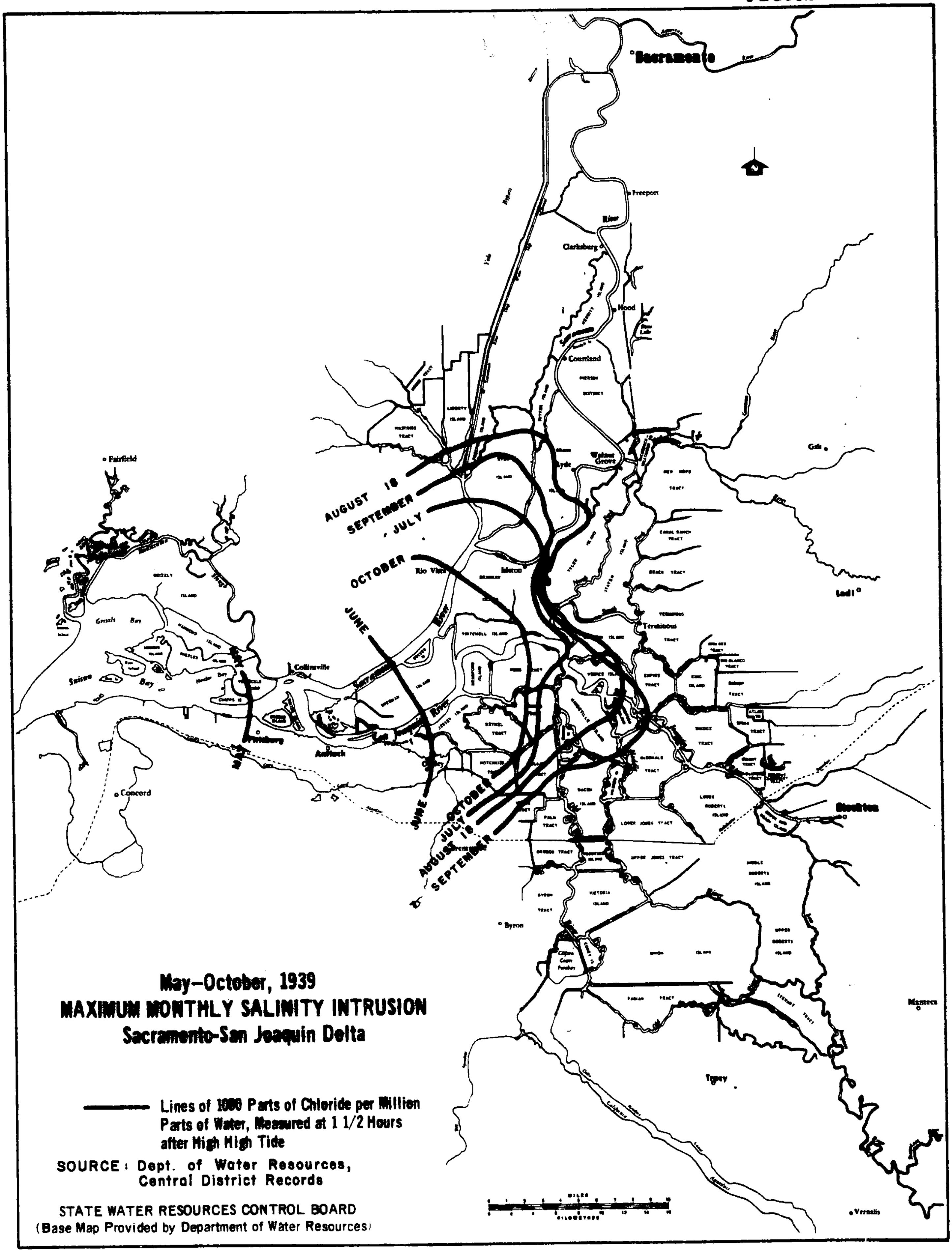
3/ The 1000 ppm chloride concentration, which is unusable for most beneficial uses in the Delta, has been used historically as a measure of salinity intrusion since the 1920's.

FIGURE III-5


1920–1944
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
Critical Years
SOURCE: U.S. Bureau of Reclamation, Exhibits 6 & 7
STATE WATER RESOURCES CONTROL BOARD
(Base Map Provided by Department of Water Resources)
Sacramento
Freeport
Hood
Courtland
Rio Vista
Collinsville
Pittsburg
Antioch
Concord
Fairfield
Suisun Bay
Grizzly Bay
Terminous
Stockton
Lodi
Galt
Byron
Tracy
Manteca
Vernalis
1931
1934
1939
1924
1920
1935
1930
1932
1937
1940
1941, 42
1936
1921
1922
1935
1936
1943
1926
1934
1924


Sacramento
Freeport
River
Clarksburg
Hood
Courtland
Walnut Grove
Ryde
Fairfield
Rio Vista
Collinsville
Pittsburg
Antioch
Concord
Terminous
Lodi
Stockton
Byron
Tracy
Manteca
Vernalis
AUGUST 18
SEPTEMBER
JULY
OCTOBER
JUNE
Suisun Bay
May--October, 1939
MAXIMUM MONTHLY 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
SOURCE: Dept. of Water Resources, Central District Records
STATE WATER RESOURCES CONTROL BOARD
(Base Map Provided by Department of Water Resources)

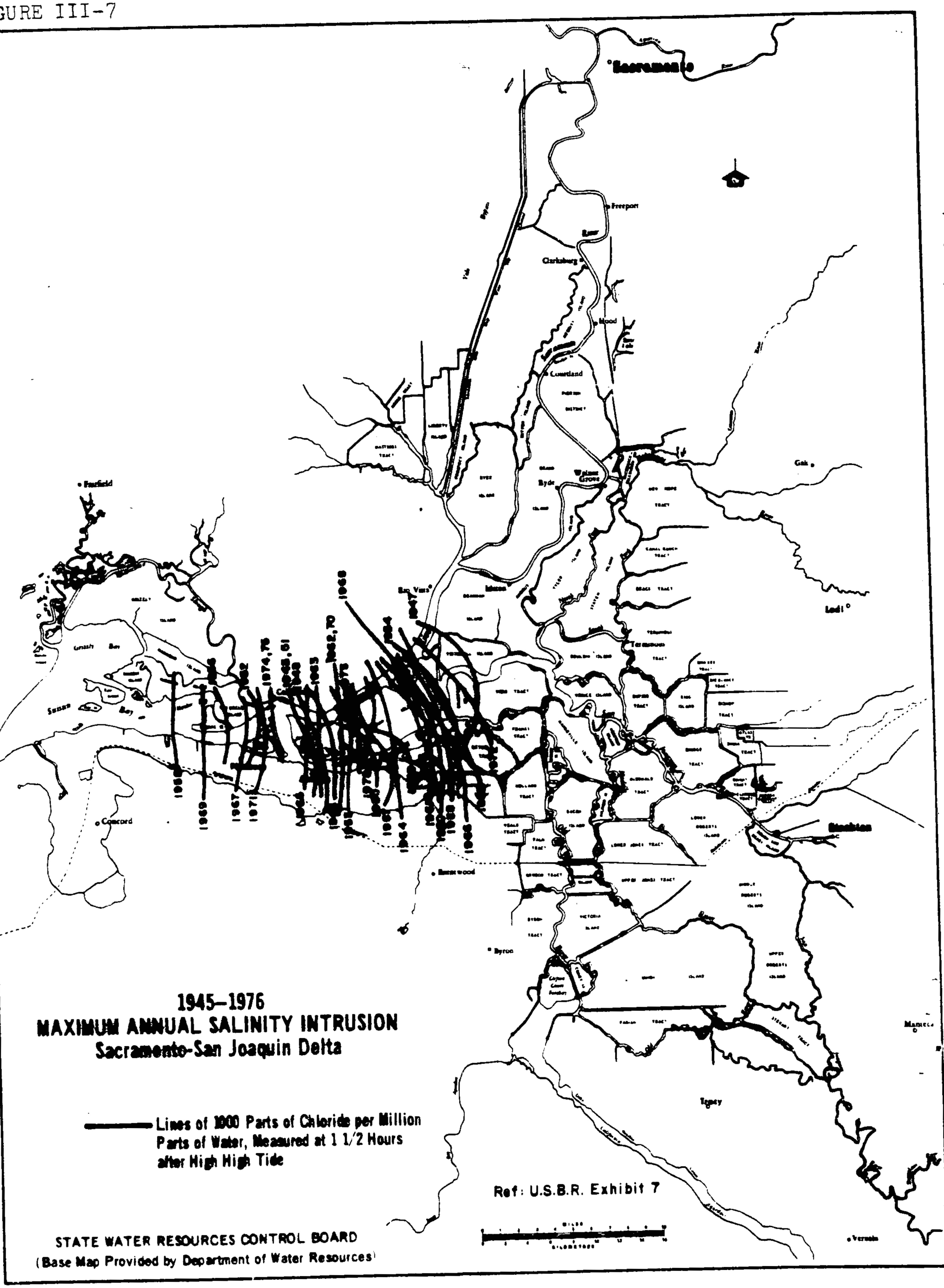
the Sacramento River and accretions by return flows from upstream development. In the southern portion of the Delta along the San Joaquin River, the maximum salinity intrusion did not occur until September. Salinity repulsion in the San Joaquin River was much slower than in the Sacramento River portion of the Delta.

Pre-project conditions generally provided adequate protection of many Delta beneficial uses in most years. In dry and critical years, maximum salinity intrusion extended inland as indicated by the monthly intrusion pattern for 1939, shown on Figure III-6. Thus, even in dry and critical years there was suitable water quality for many uses during much of the summer. The duration and extent of seawater intrusion are important in assessing its impact on Delta beneficial uses.

As inflow to the Delta decreased through the summer, the effects of the tides overcame the downstream forces of inflow and salinity intrusion occurred. During the fall, inflows increased sufficiently to overcome tidal forces and repulse the salinity intrusion.

Post-Project Conditions. Operations of the CVP and SWP and other water development projects have resulted in substantial regulation of stream flows tributary to the Delta. More than 20 million acre-feet of storage capacity exists in major reservoirs in the watersheds tributary to the Delta. The maximum annual salinity intrusion into the Delta for the post-project period 1945-1976 is shown in Figure III-7. Project operations have reduced winter and spring outflows and increased summer and fall outflows. These operational outflow modifications generally have kept the maximum salinity intrusion into the Delta (the 1000 ppm chloride line) at a point further west than would otherwise have been the case. In most years since 1945, maximum salinity intrusion has not extended much beyond Emmaton and Jersey Point. Generally salinity over the last 30 years through much of the summer has been somewhat less than would have occurred without the effects of reservoir regulation, depletion and export. However, the 1000 ppm chloride line reached Antioch earlier in the year during below normal, dry and critical runoff years of the post-project period than in similar year types prior to project operations (NDWA Exhibit D). Information furnished during the hearing shows that under post-project conditions the 1000 ppm chloride line has intruded into the Delta earlier in the year, but has not extended as far upstream as under pre-project conditions.

Post-project flow patterns in the Delta have also been greatly influenced by operation of the projects. The Bureau took action to increase the efficiency of water transport across the Delta


Sacramento
Freeport
Clarksburg
Hood
Courtland
Walnut Grove
Ryde
Isleton
Rio Vista
Fairfield
Grizzly Bay
Suisun Bay
Concord
Brentwood
Byron
Terminous
Stockton
Lodi
Manteca
Tracy
Vernalis
1945–1976
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
Ref: U.S.B.R. Exhibit 7
STATE WATER RESOURCES CONTROL BOARD
(Base Map Provided by Department of Water Resources)

through construction of the Delta Cross Channel in 1951, concurrent with the completion and operation of CVP export facilities in the southern Delta. The hydraulic capacity of Georgiana Slough is insufficient to convey the necessary flows through interior channels of the Delta to these export facilities during low flow periods. The Cross Channel, which connects the Sacramento and Mokelumne Rivers via Snodgrass Slough, provides additional capacity by controlled diversions into the Mokelumne River through a gated structure.

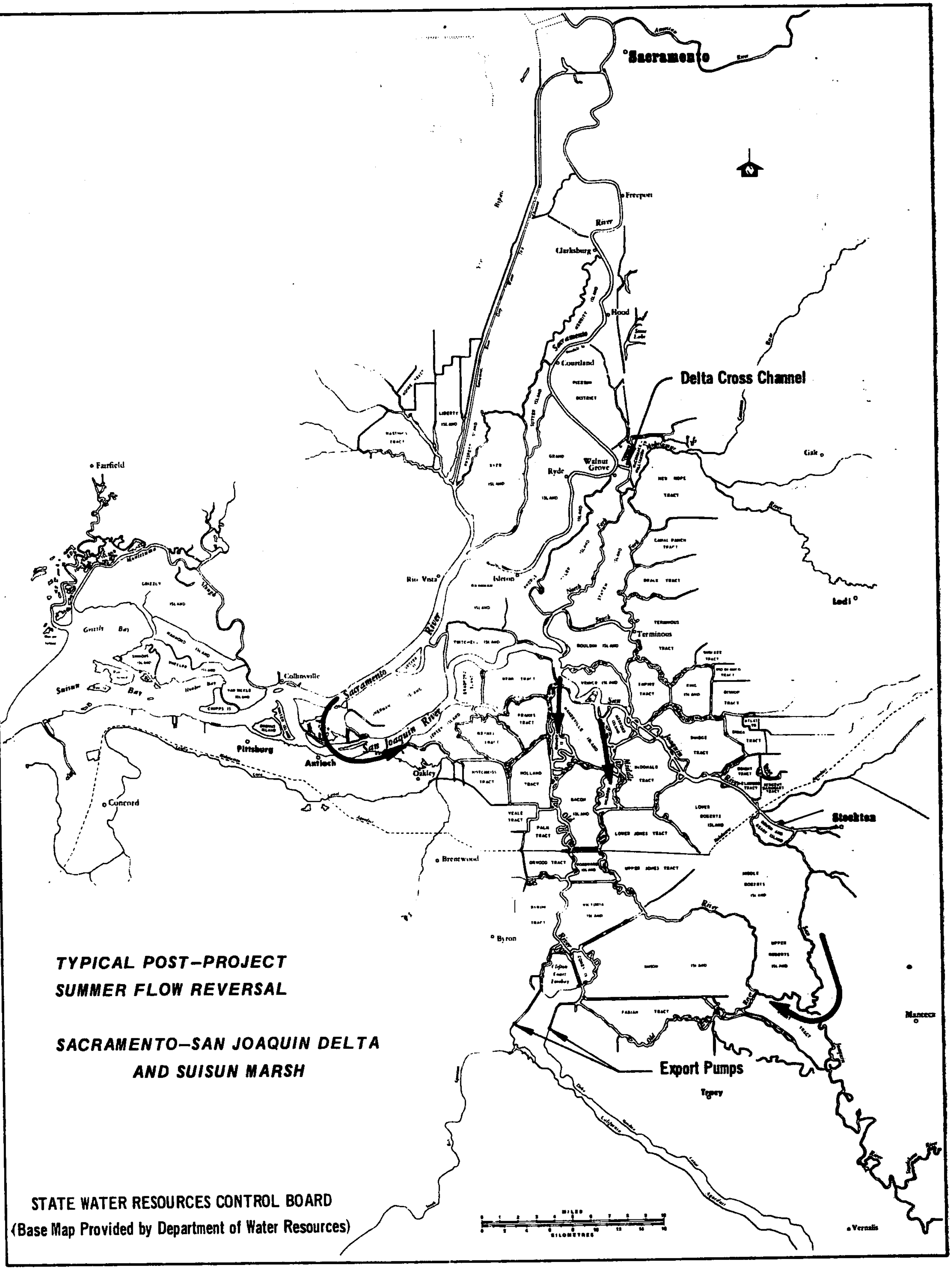
Exports have increased since 1951, and particularly since 1967 when SWP export facilities began pumping. With such large exports and with current operational practices of the SWP and CVP, flow reversals normally occur each year in Old and Middle Rivers, between the San Joaquin River in the central portion of the Delta and the export pumps near Tracy.

Transport of Sacramento River water into central portion of the Delta via the Cross Channel does not always satisfy all of the export needs. During periods of high Delta inflow, there is enough water from the San Joaquin River, eastern Delta tributaries and water transported from the Sacramento River to meet much of the export demands. Under high exports, low San Joaquin River inflow, and high Delta consumptive uses, however, water must reach the pumps along additional paths. Under these conditions, reverse flows around the lower end of Sherman Island from the Sacramento River to the San Joaquin River have occurred from the earliest days of CVP operation and more frequently in recent years. Reverse flows also can occur with high Sacramento River flows, high exports and low

San Joaquin River flows, as in January 1978. Additionally, flow reversal in the main channel of the San Joaquin River from Stockton south to the bifurcation with Old River near Mossdale occurs generally when the export rates are greater than five times the San Joaquin River inflow at Vernalis (RT Vol. IV, p. 163). The various flow reversals are pictured in Figure III-8.

Without Project Conditions. One of the primary concerns in preparing a water quality control plan for the Delta is evaluation of the effects of CVP and SWP operations and exports on Delta vested water rights. Without project conditions reflect that theoretical water quality which would currently exist in the absence of the CVP and SWP.

Upstream water development (including non-state/federal facilities) continued to increase after 1945. This development includes storage facilities for irrigation and municipal supplies and for hydroelectric power generation, and has been accompanied by substantial increases in upstream consumptive uses. The effect of increased non-state/federal upstream depletions and regulation on Delta water quality has been masked to a substantial degree by CVP operations from 1945-1967, and since 1967 (when SWP operation began) by both CVP and SWP operations. The federal and state projects until 1976 had more available yield than needed for their contractors. Consequently, the projects released large quantities of water that increased Delta outflows in the summer and fall. Over the last decade, the availability of these surplus project supplies has decreased as project export demands have increased.


Sacramento
Freeport
River
Clarksburg
Hood
Courtland
Delta Cross Channel
Walnut Grove
Ryde
Fairfield
Rio Vista
Isleton
Lodi
Terminous
Collinsville
Sacramento
River
San Joaquin River
Pittsburg
Antioch
Oakley
Concord
Stockton
Brentwood
Byron
Manteca
Export Pumps
Tracy
Vernalis
TYPICAL POST-PROJECT
SUMMER FLOW REVERSAL
SACRAMENTO-SAN JOAQUIN DELTA
AND SUISUN MARSH
STATE WATER RESOURCES CONTROL BOARD
(Base Map Provided by Department of Water Resources)

In developing without project conditions, the pre-project salinities were increased by an incremental amount equivalent to that resulting from the Delta outflow reduction attributed to the increased 1980 level non-project depletions. Data used in calculating these depletion adjustments are limited (Department Exhibit II-12). Consequently, these estimates may require some refinement in future revisions of the proposed water quality control plan. The results of this analysis are shown in Figures III-9, III-10, and III-11[4]. The theoretical conditions shown in these figures should closely approximate those conditions which would exist in the absence of the CVP and SWP.

Delta salinity under without project conditions would have been worse in wet and normal years than occurred under pre-project conditions. Delta salinity in critical years would be about the same under either set of conditions, due in part to the regulation of spring and summer flows by non-project reservoirs for both irrigation and hydroelectric power generation, and the fact that summer flow in the Sacramento and San Joaquin River systems essentially had been fully appropriated by the mid-1950's.

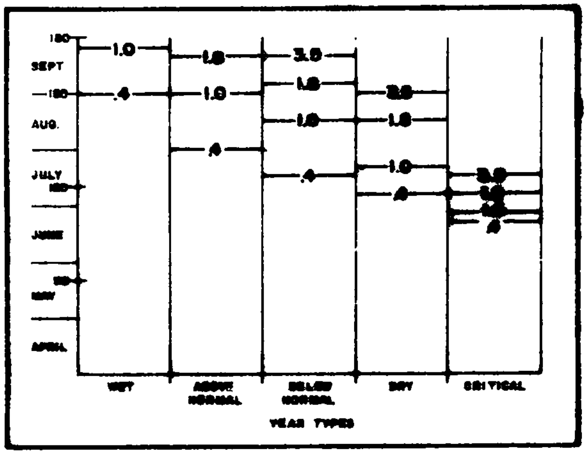
In-basin use of water in excess of the available supply has depended on the development of reservoir storage and the use of groundwater to meet these needs. Many reservoirs are operated for hydroelectric power production. These projects generally store water during high

4/ See RT Vol. XX, p. 47 et seq. and Staff Exhibits 4 and 5 for methodology on the development of these figures.

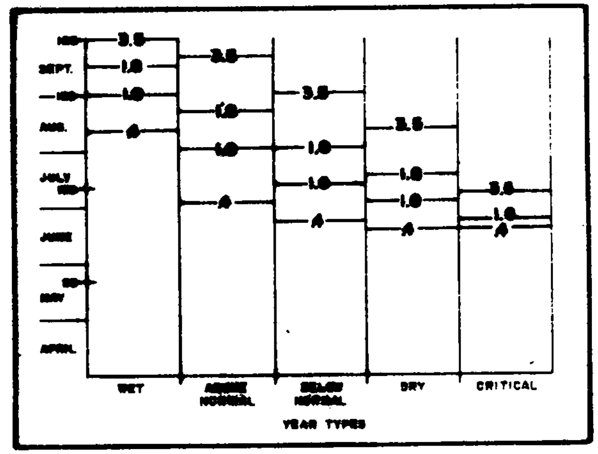
WESTERN DELTA WATER QUALITY (electrical conductivity), DURING APRIL THROUGH SEPTEMBER FOR EACH YEAR TYPE 1/

SACRAMENTO RIVER AT EMMATON

HISTORIC 1922-1944



WITHOUT PROJECT (SWP/CVP) CONDITIONS WITH 1990 DEPLETIONS

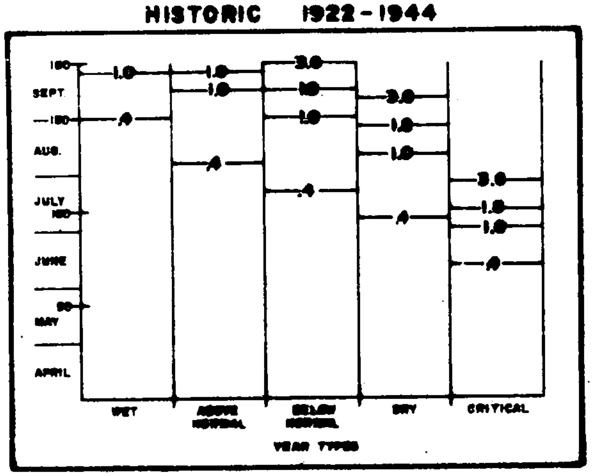


APPROXIMATE CONVERSIONS

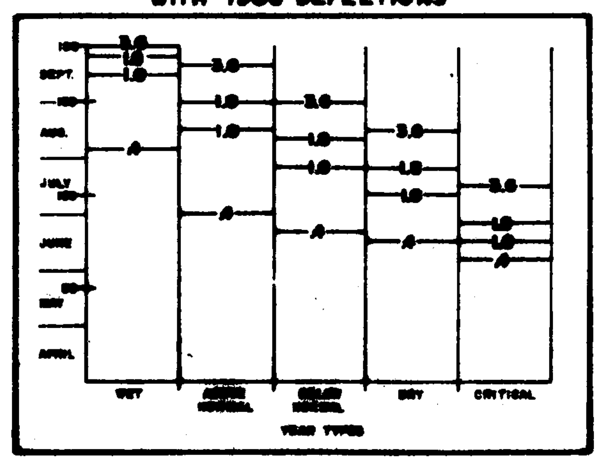
EC mm/cm	Cl- mg/l	TDS mg/l
.4	73	258
1.0	252	611
1.8	536	1091
3.5	1000	2139

SAN JOAQUIN RIVER AT JERSEY POINT

HISTORIC 1922-1944



WITHOUT PROJECT (SWP/CVP) CONDITIONS WITH 1990 DEPLETIONS



APPROXIMATE CONVERSIONS

EC mm/cm	Cl- mg/l	TDS mg/l
.4	62	244
1.0	241	580
1.8	476	1055
3.6	1000	2225

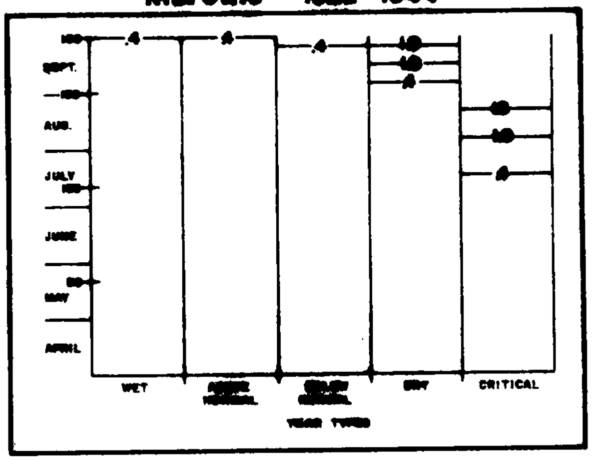
1/ Data corrected to represent mean tide conditions

FIGURE III-9

INTERIOR DELTA WATER QUALITY (electrical conductivity), DURING APRIL THROUGH SEPTEMBER FOR EACH YEAR TYPE 1/

MOKELUMNE RIVER AT CENTRAL LANDING

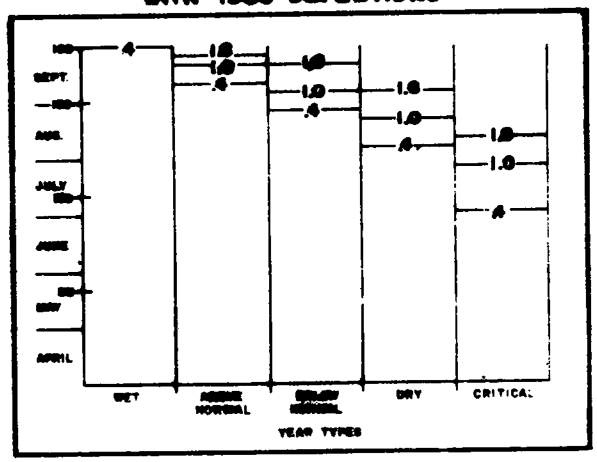
HISTORIC 1922 - 1944



APPROXIMATE CONVERSIONS

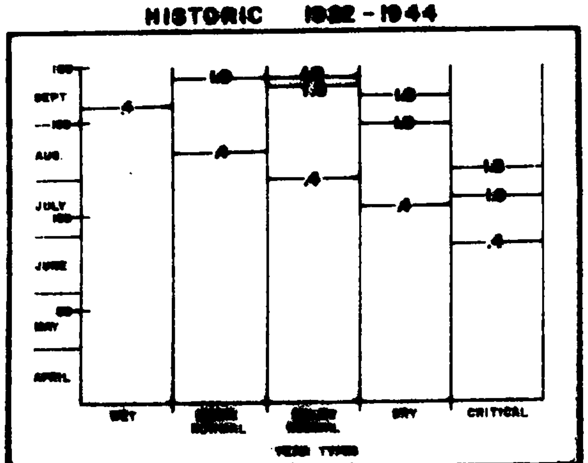
EC mm/cm	Cl- mg/l	TDS mg/l
.4	61	280
1.0	174	700
1.8	325	1260

WITHOUT PROJECT (SWP/CVP) CONDITIONS WITH 1980 DEPLETIONS



FALSE RIVER AT WEBB PUMP

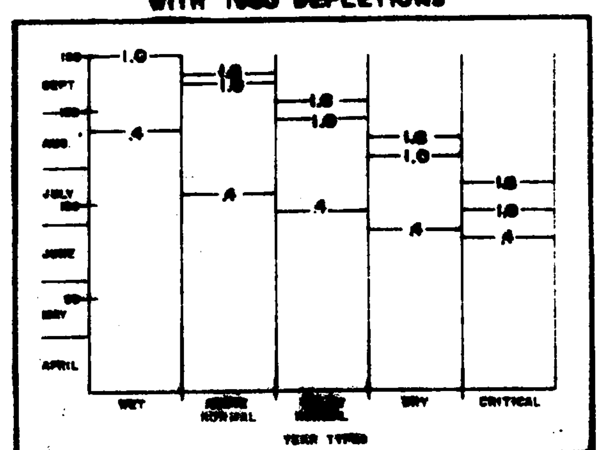
HISTORIC 1922 - 1944



APPROXIMATE CONVERSIONS

EC mm/cm	Cl- mg/l	TDS mg/l
.4	62	258
1.0	218	582
1.8	483	1014

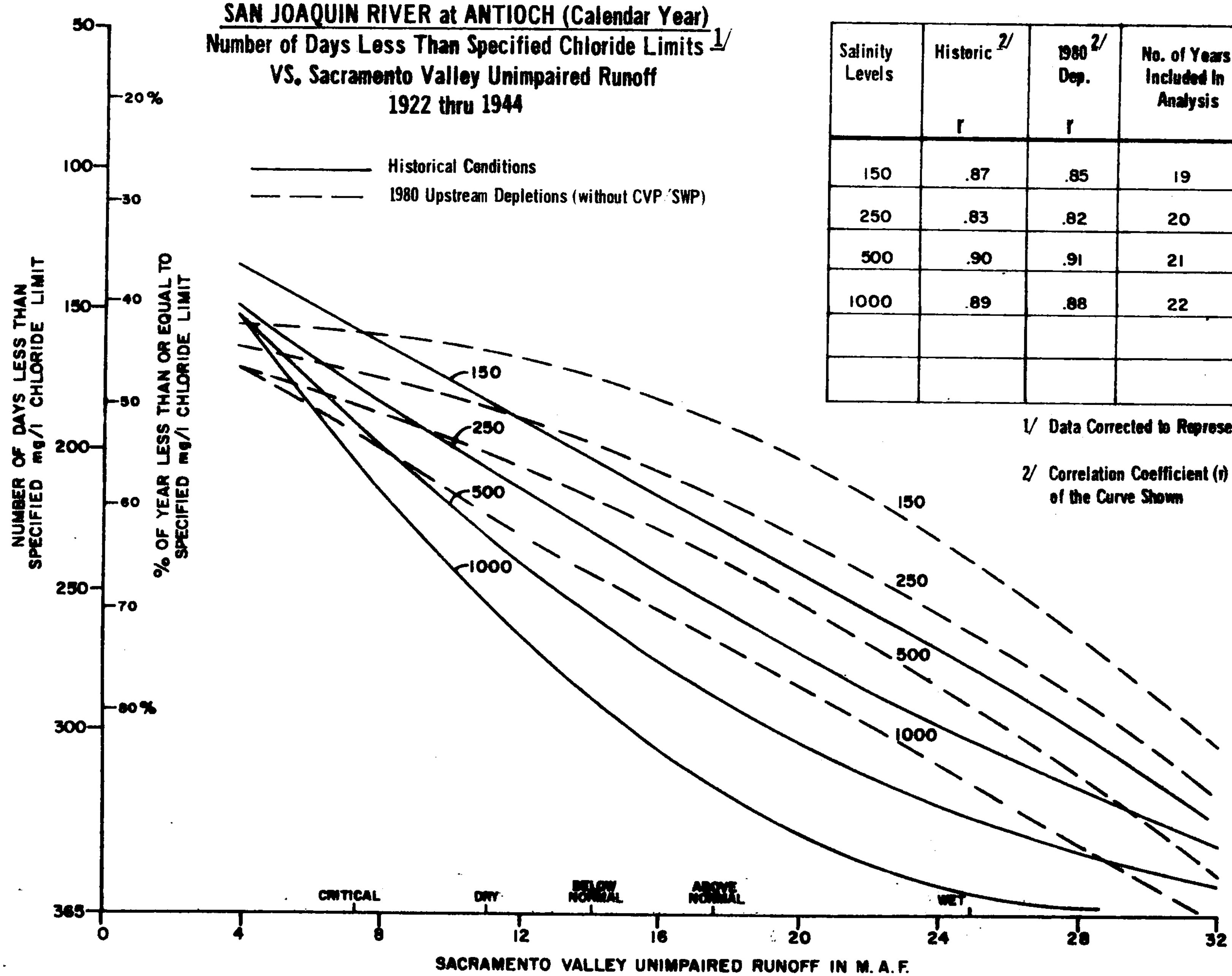
WITHOUT PROJECT (SWP/CVP) CONDITIONS WITH 1980 DEPLETIONS



1/ Data corrected to represent mean tide conditions

SAN JOAQUIN RIVER at ANTIOCH (Calendar Year)

Number of Days Less Than Specified Chloride Limits 1/
VS. Sacramento Valley Unimpaired Runoff
1922 thru 1944



Salinity Levels	Historic 2/ r	1980 2/ Dep. r	No. of Years Included In Analysis	Years Not Included In Analysis Due to Lack of Data
150	.87	.85	19	22,23,24,33
250	.83	.82	20	22,24,33
500	.90	.91	21	22,33
1000	.89	.88	22	33

1/ Data Corrected to Represent Mean Tide Conditions

2/ Correlation Coefficient (r) is Only for that Portion of the Curve Shown

FIGURE III-11

flow periods and release the water during the low flow summer and fall months to meet their respective needs. This also provides the Delta with some benefit from carryover of these stored flows into dry and critical years.

Suisun Bay and Suisun Marsh Hydrology

The Suisun Marsh area around the northern periphery of Suisun Bay was a natural brackish water marsh prior to widespread reclamation for agricultural purposes. However, the agricultural developments were largely unsuccessful because of poor drainage and accumulation of salts in the soil. The reclaimed marsh lands were gradually converted to private duck clubs and State wildlife management areas. The entire area consists of 84,190 acres, of which about 26,880 acres are bays and sloughs. The remaining 57,310 acres are diked, managed wetlands. Approximately 45,710 acres of managed wetlands are privately owned and used primarily for duck hunting. Of the remaining managed area, 10,490 acres are owned and operated 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. Since eventual ownership by the state of a major portion of the managed area in the Suisun Marsh is unlikely, it is vital for the maintenance of waterfowl populations in California that conditions in the privately owned and managed marsh area remain suitable for waterfowl.

Waterfowl are attracted to Suisun Marsh primarily by the presence of large areas of water and the abundance of food. The most important food plants are alkali bulrush, brass buttons, and fat hen, whose seeds provide the bulk of the winter food supply. The abundance and distribution of food plants within the Marsh is controlled by a number of factors including length of time of submergence and salinity in the first foot of soil, which is the salinity to which the roots of the plants are subject.

The duck clubs flood the lands about the first week in October to attract waterfowl in the area prior to opening of the waterfowl hunting season in Mid-October. Flooding is controlled by opening tide gates in the levees to admit water from the sloughs and channels surrounding the managed areas. The water level in the ponds is generally reduced, or the ponds drained, after the hunting season is over in January. Depending on the management practices of the clubs, the lands may be permanently ponded or alternately flooded and drained, to provide suitable salinity conditions for the desired food plants.

Seed productivity of the desirable food plants decreases as salinity increases within the normal range of Suisun Bay salinity. The natural high salinity content of the soil underlying the Marsh and the use of brackish water for flooding and leaching makes salinity management a necessity for continued maintenance of the Marsh in its present form.

The salinity of water within Suisun Bay is a function of the fresh water outflow from the Delta. Thus, the salinity of water along the northern boundary of the Bay varies seasonally. Salinities of the water in Montezuma Slough are lower than in Suisun Bay for a longer period of time each year because the Slough receives inflow from the Sacramento River further upstream than Suisun Bay. Montezuma Slough and other major sloughs also receive seasonal freshwater inflow from numerous tributary channels to the north from local precipitation and runoff. A comparison of salinity in the water at several locations within the Suisun Marsh area and its tributaries and channels is shown in Table III-1. As noted on Table III-1 some of this data was taken at random tides. Because tidal influences can have a dramatic effect on salinity,usefulness of this data is limited. While salinities in portions of Suisun Marsh channels are generally representative of Suisun Bay salinities, there is a salinity lag in the Marsh both in the summer when salinities are increasing and in the fall when salinities are decreasing. The lag phenomenon results in low salinity water being maintained in the Marsh later in the spring and in early summer, but also results in higher salinity later in the fall before the Marsh channels are flushed by increased Delta outflows (Jones and Stokes et al, 1975, p. 283). More recent data exists for most of the areas shown in Table III-1. However, this table adequately shows relationships stated above.

The local watershed tributary to Suisun Marsh is an important factor in terms of water supply and water quality. The drainage area upland from the Suisun Marsh and above the 5-foot elevation contour is about 250 square miles (see Figure III-12). Measurements of the flow of streams tributary to the Marsh are not available, but the Soil Conservation Service estimates that the upland tributary areas contribute an average of about 65,000 acre-feet of water per year to the Marsh, while precipitation on the Marsh itself contributes about 55,000 acre-feet per year (Jones and Stokes et al, 1975, p. 267). In California, most of the rainfall

COMPARISON OF PRESENT SALINITY VARIATIONS AT SELECTED LOCATIONS IN AND ADJACENT TO THE SUISUN MARSH
(Total Dissolved Solids in Parts per Million)

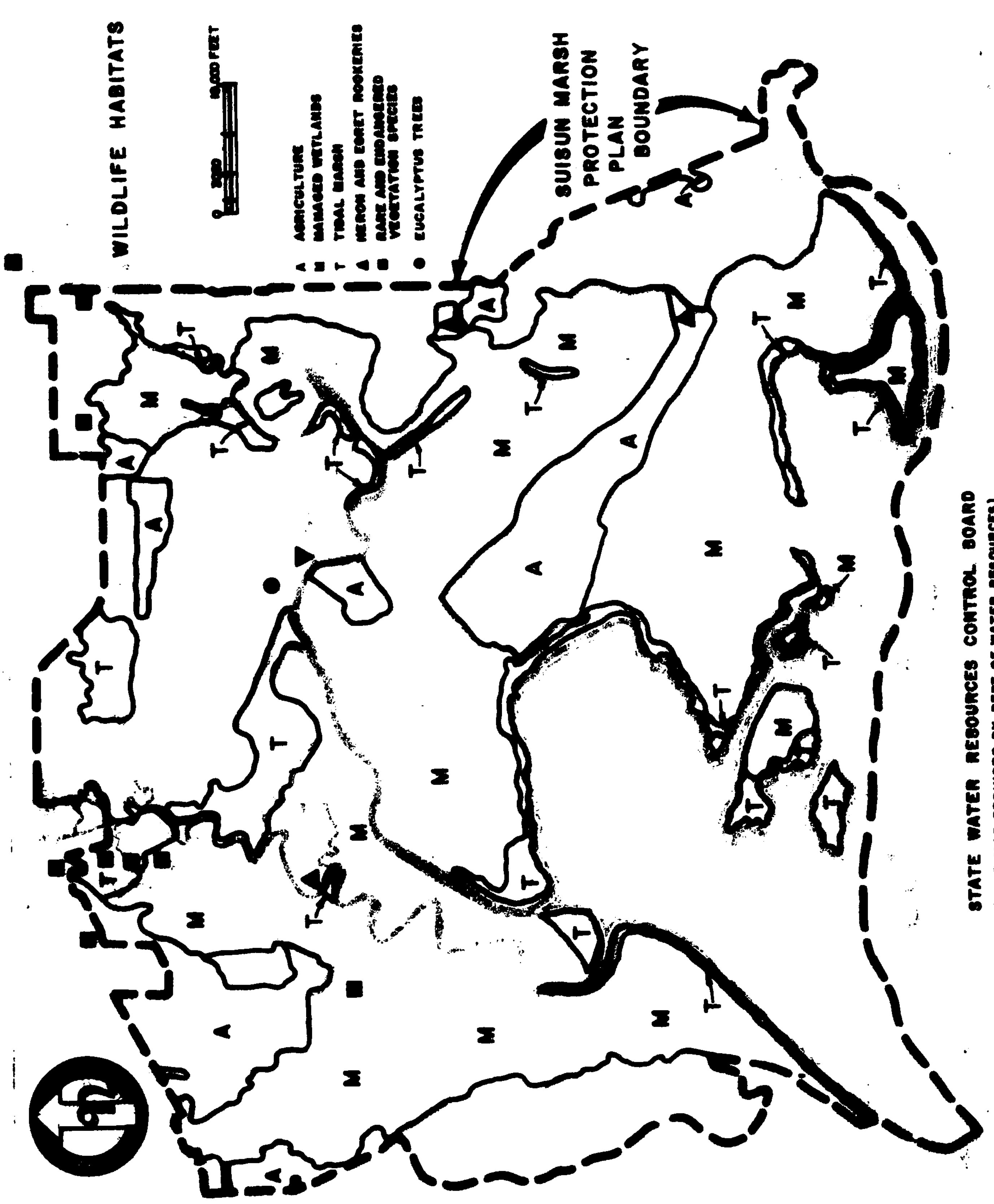
	ESTUARY & BAY (High-Tide) a/			MARSH CHANNELS (Random Tides) b/					
MONTH	D-6 BENICIA	D-8 PORT CHICAGO	COLLINS-VILLE	S-4 HILL SLOUGH	S-16 CORDELIA SLOUGH (UPPER END)	S-22 CHAD-BOURNE SLOUGH	S-33 CORDELIA SLOUGH (AT CYGNUS)	S-42 SUISUN SLOUGH	S-49 MONTE-ZUMA SLOUGH
JAN	6,000	3,000	100	1,500	–	1,500	1,500	1,500	1,500
FEB	4,000	1,000	100	1,500	–	1,000	1,000	1,500	1,000
MAR	5,500	1,500	100	2,000	1,000	1,000	1,000	1,000	1,000
APR	8,000	4,000	300	2,000	1,000	1,500	1,500	1,500	1,000
MAY	10,500	6,000	1,000	2,500	1,000	3,000	4,000	2,500	2,500
JUN	12,000	7,500	2,000	2,500	1,000	3,500	5,000	3,500	3,500
JUL	14,500	9,000	3,000	4,500	1,500	4,000	6,500	7,000	6,500
AUG	15,000	9,500	2,500	4,500	1,000	4,500	6,000	5,500	5,500
SEP	12,000	7,000	1,000	5,500	1,000	5,500	5,000	5,500	5,500
OCT	13,000	8,000	1,000	4,000	1,000	5,500	4,500	4,000	4,500
NOV	12,000	7,500	500	1,500	1,000	3,000	4,000	4,500	4,000
DEC	8,500	5,000	200	3,000	–	3,500	3,500	3,500	4,000
SEASONAL AVERAGES									
JAN–MAY	6,800	3,100	300	1,900	1,000	1,600	1,800	1,600	1,400
JUN–SEP	13,400	8,300	2,100	4,300	1,100	4,400	5,600	5,400	5,300
OCT–DEC	11,200	6,800	600	2,800	1,000	4,000	4,000	4,000	4,200

a/ Mean values for 7 years, 1967 – 1973.

b/ Random field observations, 1963 – 1973.

Source: Draft Environmental Impact Report, Peripheral Canal Project, Department of Water Resources, August 1974

FIGURE III -12



and resulting runoff from low elevation watersheds occurs from October to March. This local watershed runoff freshens and flushes out the slough areas of the Marsh.

Water Quality Characteristics Other Than Salinity

Beneficial uses of water in the Delta and Suisun Marsh are dependent on or affected by water quality characteristics other than salinity. Although the proposed action by the Board is intended to regulate only flow and salinity, operations of the CVP and SWP to conform to the proposed action could affect other water quality factors which are related to Delta inflow, export of water from the Delta and Delta outflow. However, no significant changes beyond those discussed in Chapter V are expected in these factors as a result of the proposed Board action. The Board action is intended to apply at existing levels of development of the CVP and SWP so that the ability of these projects to control Delta inflow and circulation will be limited to conditions within the ranges that have occurred in the recent past. If additional facilities are constructed which can cause significant changes in Delta water quality, the Board will consider further appropriate action. Therefore, information on water quality parameters other than salinity is not presented in this report.

Climate

The Delta climate is characterized as Mediterranean with hot, rainless summers and cool, moist winters. Maritime air enters the Delta through the Golden Gate-Carquinez Strait openings in the Coast Range, moderating both temperature and humidity. Recorded temperatures range from $13^{\circ}F$ to $114^{\circ}F$. The January temperatures average near $45^{\circ}F$ and the July temperatures near $75^{\circ}F$. Because of the cooling influence of maritime air the Delta climate is cooler than other locations to the north or south.

Rainfall in the Delta-Suisun Marsh area varies, with annual averages increasing in a north and northeasterly pattern. An average of about 10 inches of rain falls each year in the lee of the Mt. Diablo Range, while Stockton receives an average rainfall of about 14 inches and Sacramento about 16 inches. About 82 percent of the precipitation falls during the period November through March (Delta Advisory Planning Council, 1975, p. 3-375).

Prevailing winds enter the Delta through Carquinez Strait and follow a fanning pattern: northwesterly in the southern Delta and southwesterly in the northern Delta. In the summer the pressure differential between the hot air over the interior valley and the cool heavier air over the ocean causes a strong, gusty wind pattern to occur most generally in early mornings and late afternoons, with the speed of the winds varying according to pressure differential. Summer winds are characterized by a cycle of three to five windy days followed by three to five calmer days, dependent on the cooling effect of the maritime winds. As the winds cool the interior valley, the pressure differential is lessened and the winds decrease until the cooling effect is lost. Conversely as the interior air is heated it expands, and heavier cool air rushes in from the ocean. Winter winds are much decreased in velocity and are more constant because there is less temperature differential between the ocean and the Central Valley. Winter weather alternates between wet, stormy frontal systems and fair periods with little wind. The highest frequency of stagnant air occurs in the fall after the summer winds have subsided and before the winter storms have begun.

The Delta area is subject to prolonged periods of fog during the fall and winter as a result of thermal inversions and moist soil conditions. In the fall when nights begin to lengthen and winds are decreased, the earth loses heat by radiation during the night and cools a thin layer of air near the surface. High atmospheric humidity and a temperature below the dew point cause fog to form. The fog remains until the sun warms the lower layer of air sufficiently to evaporate the moisture and produce mixing. Under certain conditions, the fog is not dispelled daily and may persist for many days or weeks.

B. BIOLOGICAL FACTORS

Phytoplankton

Phytoplankton are comprised of small drifting plants collectively called algae which form the base of most food webs for marine, estuarine and freshwater ecosystems. It is the major aquatic component of the food web capable of converting significant amounts of inorganic chemicals into organic compounds that can be utilized as food by higher life forms. Phytoplankton, along with other microscopic organisms and detritus, are utilized by animal life from zooplankton to fish. In some situations phytoplankton can also cause significant esthetic problems when dense populations die and create an unsightly, malodorous and decaying mass. Phytoplankton populations also contribute to the oxygen balance in the water through endogenous respiration, decay after death, and through production of oxygen as a by-product of photosynthesis. Consequently, a change in phytoplankton populations can have a significant effect on aquatic organisms living in the estuary (Chadwick, 1972).

Abundance and Distribution. The phytoplankton populations in the Delta and Suisun Bay are found in four broad groups of algae: diatoms, green algae, cryptomonads (a group of flagellated, motile algae) and blue-green algae. Diatoms are the most abundant algae during the spring and fall, followed in abundance by green algae. Cryptomonads are dominant in some areas during the winter months. Blue-green algae, which are commonly responsible for most of the severe adverse oxygen and esthetic conditions caused by high phytoplankton concentrations, are found in low concentrations in some backwater areas, principally in the sloughs of the eastern Delta (Bureau, 1977: Chadwick, 1972).

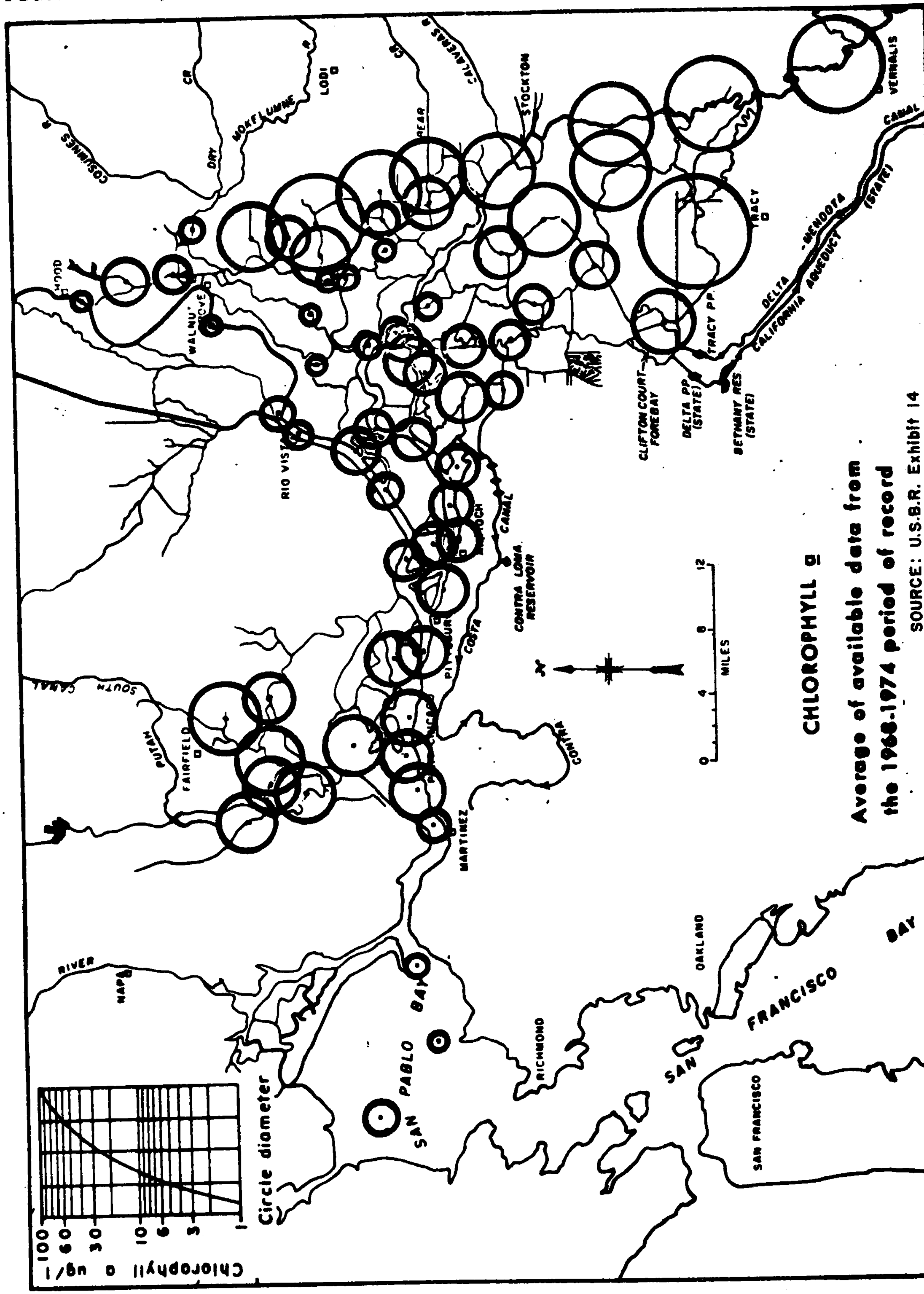
Concentration of chlorophyll pigments, particularly chlorophyll a, has been used in this estuary to estimate the gross abundance of phytoplankton. Such measurements indicate instantaneous standing crop of algae and may not be directly related to the productivity per unit time and volume of water. However, these measurements are used to compare phytoplankton abundance at different locations.

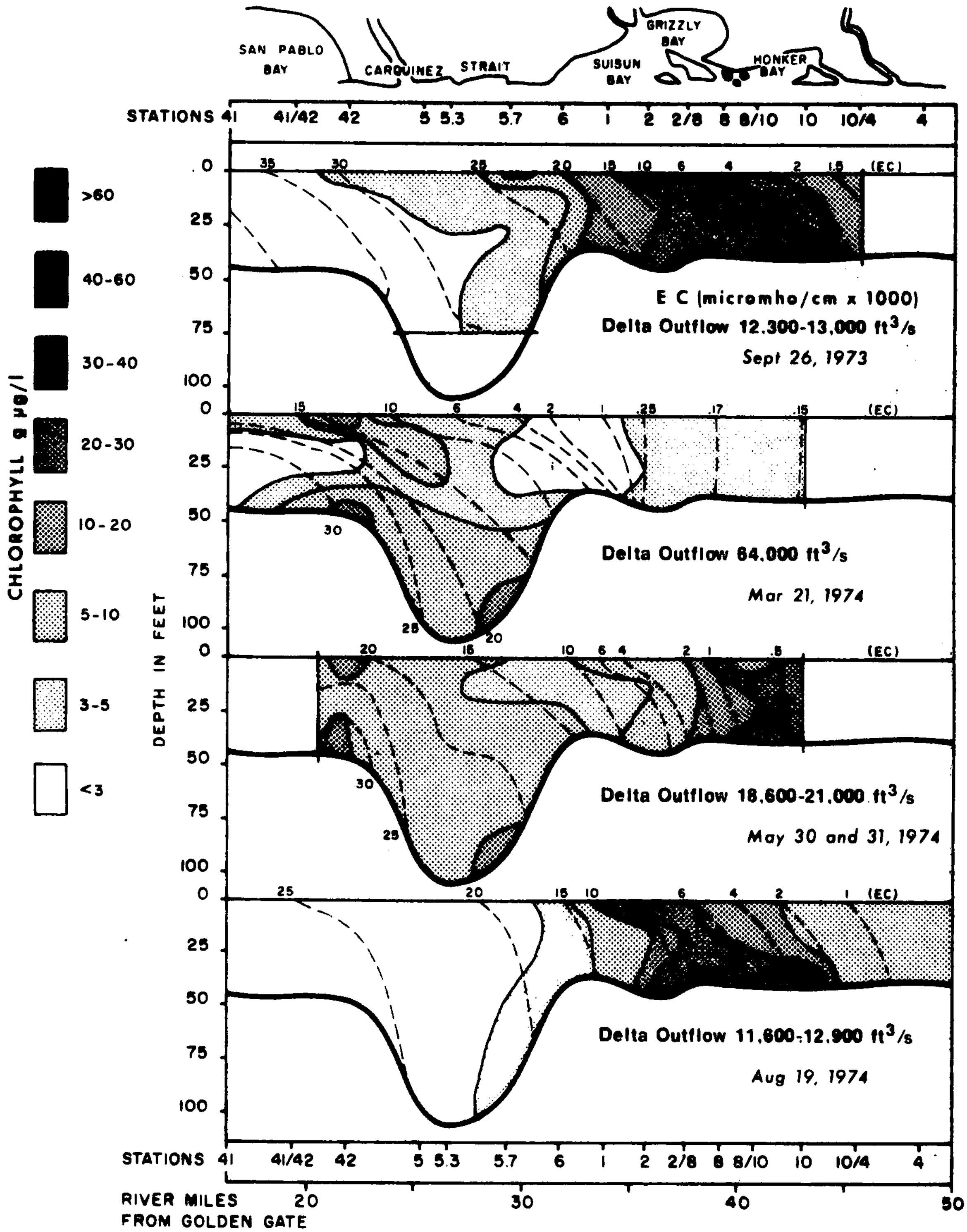
Figure III-13 illustrates the average concentration of algae in the middle and upper reaches of the Delta estuary from 1968 to 1974 (Bureau Exhibit 14). The data for this figure is biased towards the summer and fall periods of the year (RT Vol. IX, p. 35). Average concentrations of algae are highest in the slow moving waters of the eastern and southern portions of the Delta. In the northern and interior channels, where water velocities are high, average phytoplankton concentrations are low. These high water velocities are due in part to natural conditions, and flow conditions induced by export pumping in the southern Delta. Average concentrations are moderate in the western Delta and Suisun Bay areas but drop off markedly in San Pablo Bay.

The area of highest biological activity is in the western Delta and Suisun Bay where river inflow initially meets ocean water, creating the entrapment and null zones which were discussed earlier. The entrapment zone is typified by high concentrations of suspended solids, phytoplankton, Neomysis, young striped bass and other estuarine organisms.

Figure III-14 (Bureau Exhibit 47) shows generally where this entrapment zone is located and the extent to which it accumulates algae at varying outflow conditions (also Bureau, 1977, p. 42; Peterson et al, 1975). The production of phytoplankton in the estuary is greatest when the entrapment zone is located in the upstream end of Suisun Bay (RT Vol. IX, p. 77; Bureau, 1977, p. 72; Peterson et al, 1975, p. 8).

FIGURE III-13





Relationship between the distribution of chlorophyll a (shaded area) and salinity (dashed EC contour lines) during high slack tide for each sampling run

SOURCE: U.S.B.R. Ex.47

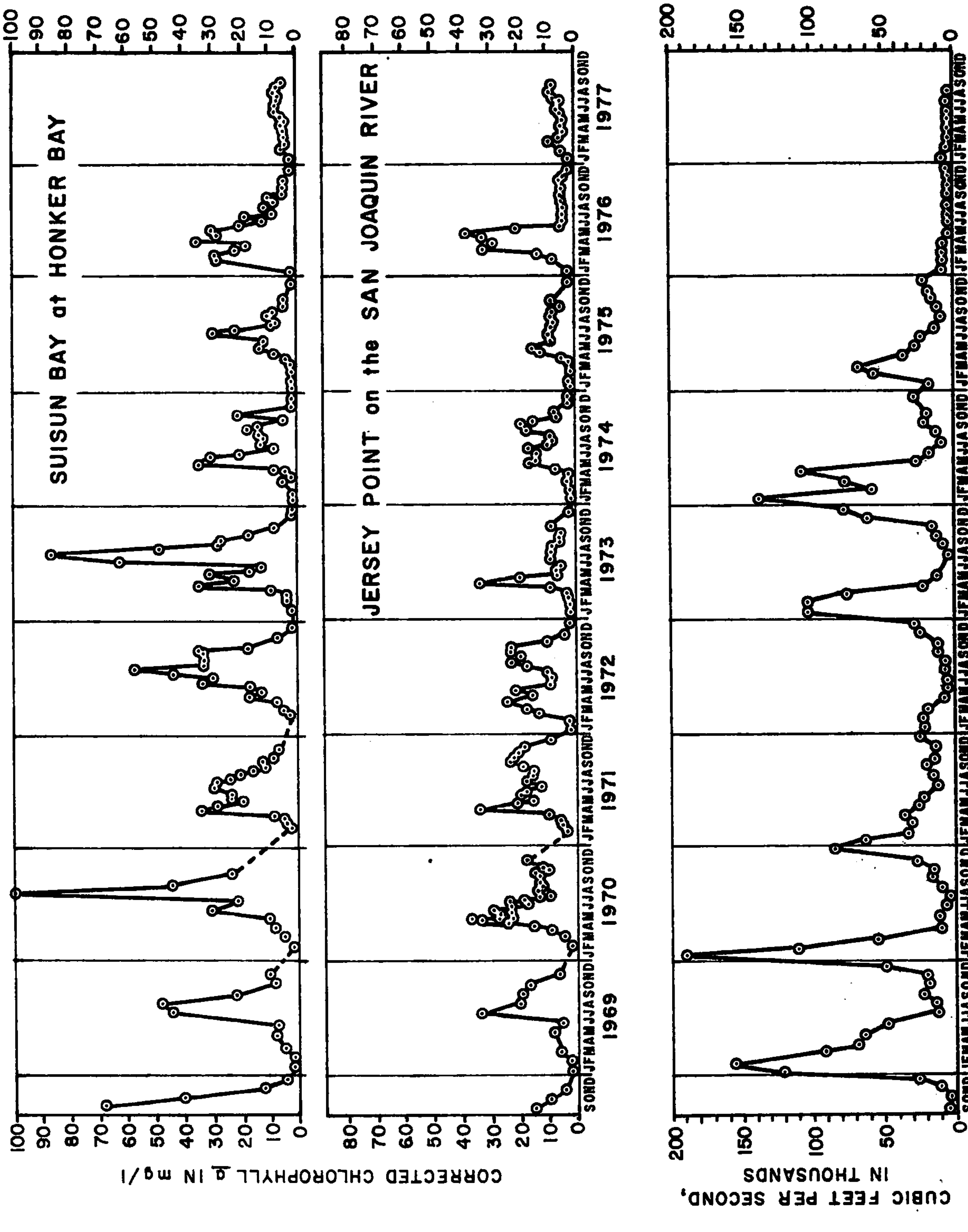
Figure III-15 shows the seasonal variations of phytoplankton and computed Delta outflow in two representative areas of the western Delta for the period 1969-1977. Populations are lowest in the winter, with peak abundance usually occurring in spring and early summer. In areas dominated by sloughs with slow moving water or shallow areas such as the eastern Delta or Suisun Marsh, secondary population peaks may also occur in the fall (Chadwick, 1972).

Environmental Requirements. Factors which can affect phytoplankton abundance and distribution include light, temperature, salinity, sediment, nutrients, toxicants, hydraulic conditions, foraging by zooplankton, and algal parasites (RT Vol. VII, p. 3; Bureau, 1977, p. 16; Chadwick, 1972, p. 21). Operation of the CVP and SWP can affect most of these factors to some degree and thus influence the abundance of phytoplankton. Therefore, identification and definition of the factors that may be controlling phytoplankton levels at different times is important so that the environmental consequences of changes in project operations can be addressed adequately.

Early studies indicated that inorganic nitrogen was limiting phytoplankton productivity in the western Delta-Suisun Bay area during July, August and September. When nitrogen was not limiting algal growth, light penetration appeared to be the most limiting factor (Bureau, 1972).

FIGURE III-15

MONTHLY CHLOROPHYLL a and DELTA OUTFLOW 1969 to 1977

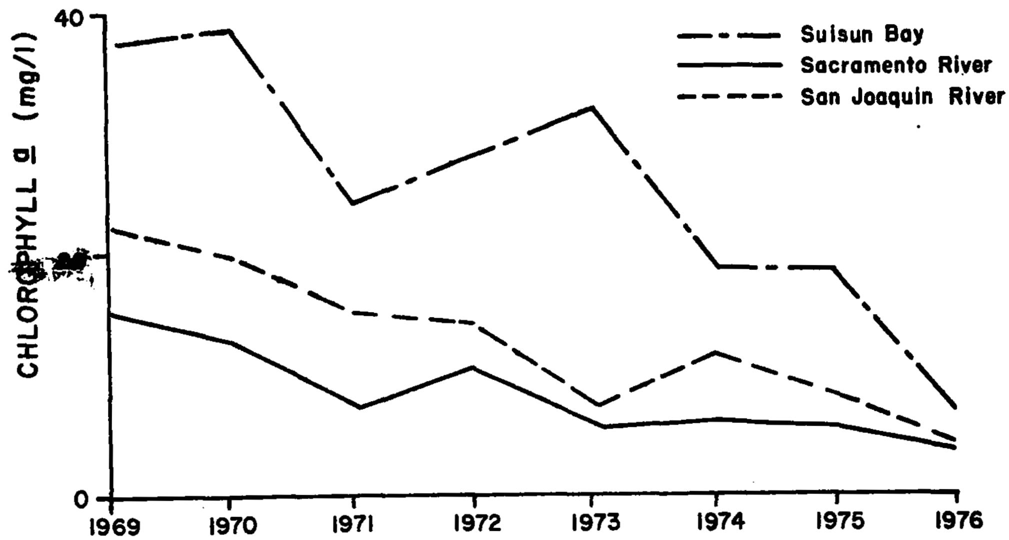


*INCLUDES FLOWS FROM THE YOLO BYPASS AND "AVERAGE" DELTA CONSUMPTIVE USE.

SOURCE: U.S.B.R. Exhibits 22 & 25 and Subsequent Data..

At low levels of Delta outflow, such as were experienced in 1976 and 1977, other factors appear to influence phytoplankton production. It was previously believed that low Delta outflow would cause a reduction of turbidity and that this would cause significantly greater, even undesirable, levels of phytoplankton abundance. However, observations during 1976 have established that reduced Delta outflow does not lead to excessive phytoplankton abundance (RT Vol. VII, p. 43, 46; Vol. XXII, p. 123). Phytoplankton abundance was particularly low in 1976 as indicated in Figure III-16 (RT Vol. IX, p. 52; Vol. XI, p. 77).

FIGURE III-16



Chlorophyll a levels in Suisun Bay, and the Sacramento and San Joaquin Rivers. These are the June to September means for each year.

SOURCE: Dept. of Fish & Game Exhibit 3 Fig. V-22

Fish and Game has developed many relationships between late spring and summer Delta outflows and abundance of Neomysis and young striped bass. These relationships are based on conditions during years when winter flows were sufficiently high so that they probably did not limit estuary productivity (RT Vol. XI, p. 81). Fish and Game has expressed concern regarding the low estuary production in 1976 when controlled low flow conditions existed during the winter (RT Vol. XI, pp. 78-79 and Vol. XXIII, pp. 127-128). While 1976 production in the estuary was low, relationships between spring and summer Delta outflow and Neomysis and young striped bass abundance generally predicted the actual indexes measured that year (Fish and Game Exhibits 3 and 4, Figures III-6 and III-13).

Even lower phytoplankton abundance occurred in 1977 than in 1976, giving rise to a belief by Fish and Game representatives that some unexplained hydrodynamic effect was responsible for the low production.[5/] In addition, the established spring-summer Delta outflow relationships for young striped bass predicted much higher population levels than actually occurred.

Until more is known about the mechanisms that control algal production it would appear that winter Delta outflows less than those during the winter of 1976 may pose the potential for lower than

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5/ At a special meeting of the Board on October 27, 1977, Mr. Harold K. Chadwick reported on the effect of the drought on fish and wildlife, in part, that "Laboratory studies of phytoplankton growth have shown that neither toxicants or a scarcity of nutrients is responsible for the poor production in the estuary (during 1977). The water in the estuary has been substantially clearer than in previous years, so more light is potentially available for phytoplankton growth. While phytoplankton growth in the open waters of the estuary has been poor, we have observed substantial populations in isolated areas such as marinas. These facts indicate some hydrodynamic effect associated with the Delta outflows on the order of 2000 to 3000 cfs is probably responsible for the poor production, but I am not aware of any convincing evidence as to what the effect is. . .flows earlier than June 1977 were likely insufficient to (1) stimulate upstream migration of adult striped bass, (2) provide suitable salinities for striped bass spawning in the San Joaquin River, (3) distribute young bass over the entire nursery area, and/or (4) support adequate production at lower levels of the food chain."

acceptable algal populations. These mechanisms must be studied in considerably more detail before adequate water quality objectives can be established to ensure that neither excessive nor insufficient levels of phytoplankton exist in the estuary.

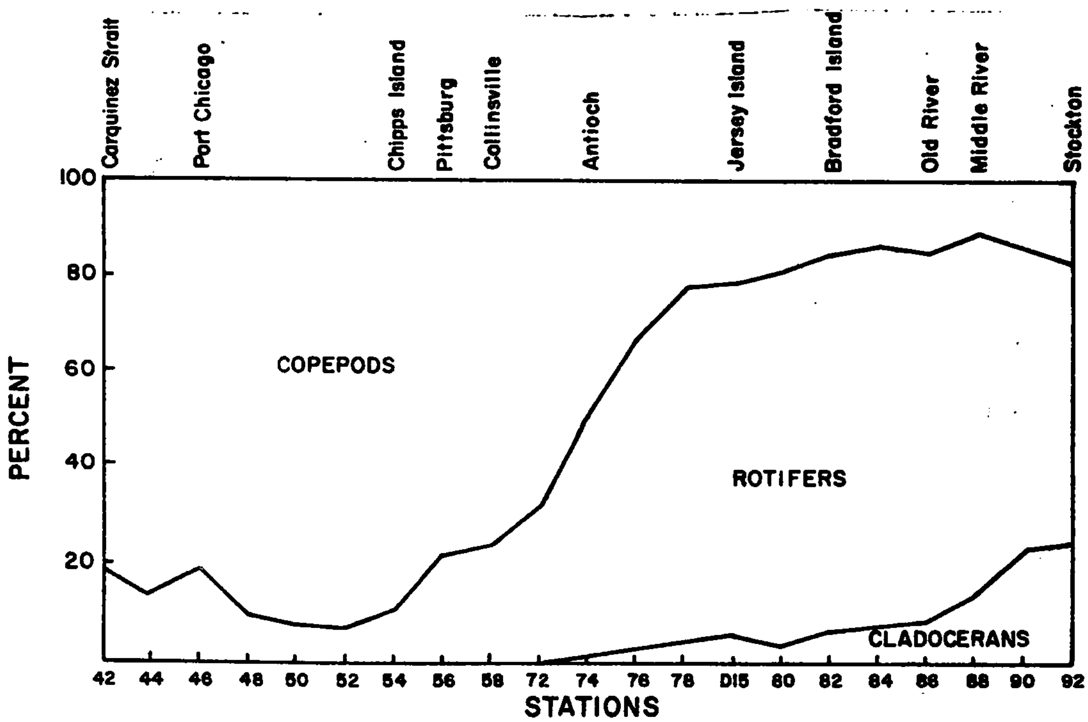
Zooplankton

Zooplankton is a collective term used to describe aquatic animals having very limited swimming capabilities. Although many are able to alter their position in the water column in order to remain in a favorable environment, their limited mobility makes them highly dependent upon water current and tides. Zooplankton consist of a wide diversity of animals such as protozoans, rotifers, and crustaceans (copepods, cladocerans, mysid shrimp). Zooplankton in the Delta and adjacent waters range in size from microscopic for protozoans to about 18 millimeters (3/4-inch) for *Neomysis*.

Zooplankton perform a very important function in estuaries and in freshwater and marine ecosystems by consuming phytoplankton, detritus and smaller zooplankton. They are also a food source usable by larger organisms. In Suisun Bay and the Delta, juvenile salmon, shad, striped bass, sturgeon, black bass, crappie, blue gill, catfish, and other fishes depend heavily on various species of zooplankton for survival. Species belonging to the genera *Neomysis* (mysid shrimp), *Daphnia* (a cladoceran), and *Eurytemora* (a copepod) are among those known to be major food items. Of these, *Neomysis* is perhaps the most important to all of the fishes listed and will be discussed in a separate section. *Eurytemora* is particularly important as a food to young-of-the-year striped bass before they begin to feed on Neomysis (Fish and Game Exhibit 3, p. V-2).

Abundance and Distribution. Zooplankton populations and geographic distribution vary considerably with the season. In general, zooplankton biomass peaks in the spring coincident with the spring phytoplankton bloom, and then declines sharply. The populations then increase again in the summer and fall following increases in phytoplankton. The geographical distribution of various groups of zooplankton is generally related to salinity and location in the estuary (Figure III-17). The abundance of particular species has also been found to be associated with the changes in location of the null zone with tidal action (Figure III-18).

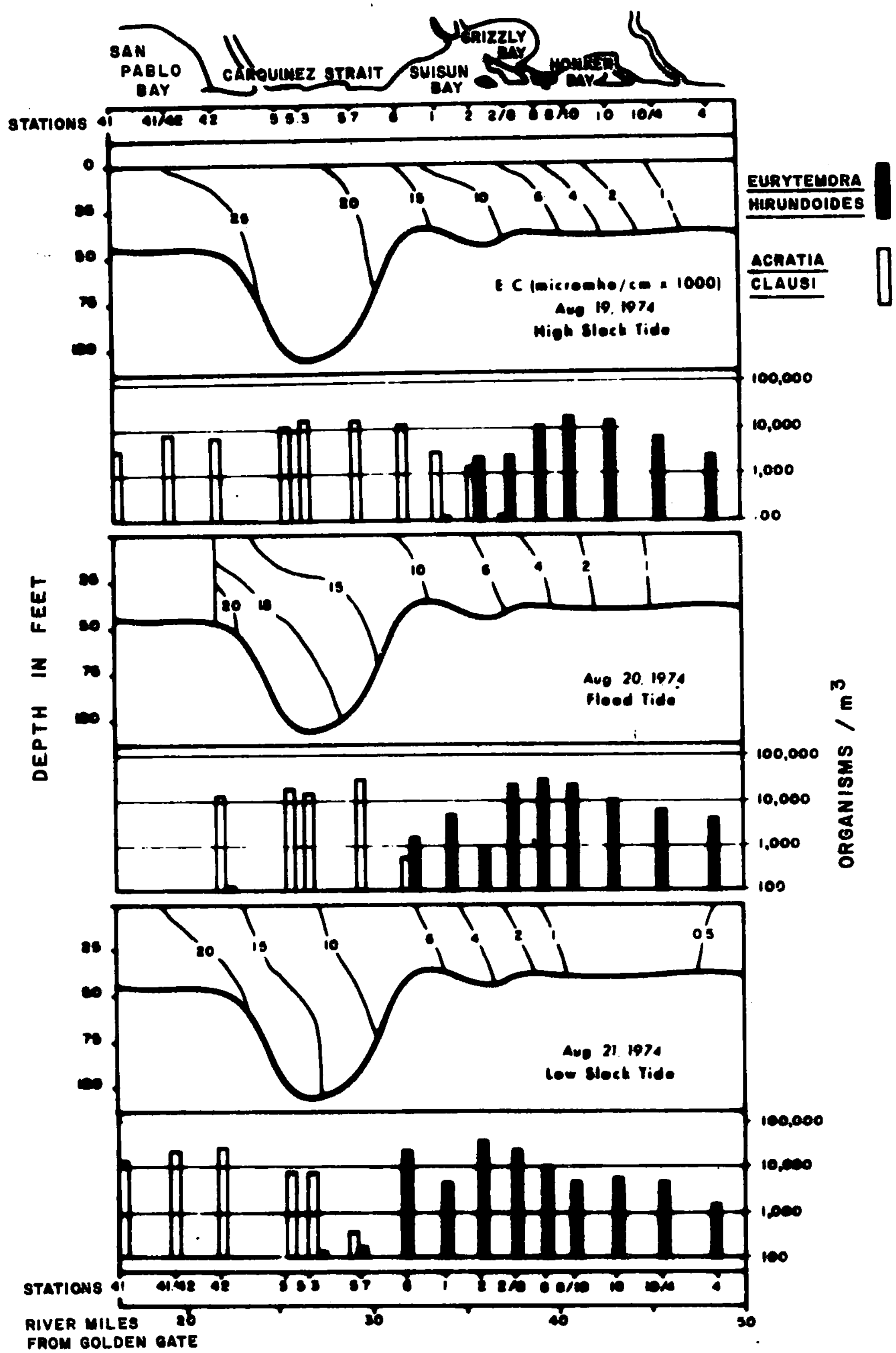
FIGURE III-17



Percent of total ATP biomass in each major zooplankton group, Suisun Bay and the San Joaquin River, April to October means at each station in 1973.

SOURCE: Dept. of Fish & Game et. al. 1975 Fig. V-14

FIGURE III-18



ABUNDANCE OF THE TWO DOMINANT COPEPOD SPECIES RELATIVE TO SALINITY AT DIFFERENT TIDAL STAGES.

SOURCE: U. S. Bureau of Reclamation, Exhibit 52

Environmental Requirements. Copepods and cladocera are affected by channel velocity and are most abundant in channels having the lowest net flow velocities (Fish and Game Exhibit 3, p. V-2). In the freshwater portion of the Delta the abundance of both rotifers and crustaceans (cladocerans and copepods) is highly correlated with chlorophyll a. Presumably the zooplankton are feeding on the phytoplankton so the correlation shows the effect of variations of food availability on zooplankton production (Fish and Game et al, 1975, p. 65). The relationship between zooplankton abundance and chlorophyll has led to the belief that the relationship between zooplankton abundance and velocity is possibly a reflection of the inverse relationship between net velocity and chlorophyll. Monitoring stations in the Delta with high velocities tend to have low chlorophyll concentrations. At stations along the San Joaquin River and Suisun Bay which show similar net velocities, zooplankton populations are highest at the stations rich in chlorophyll (Fish and Game et al, 1975, p. 70).

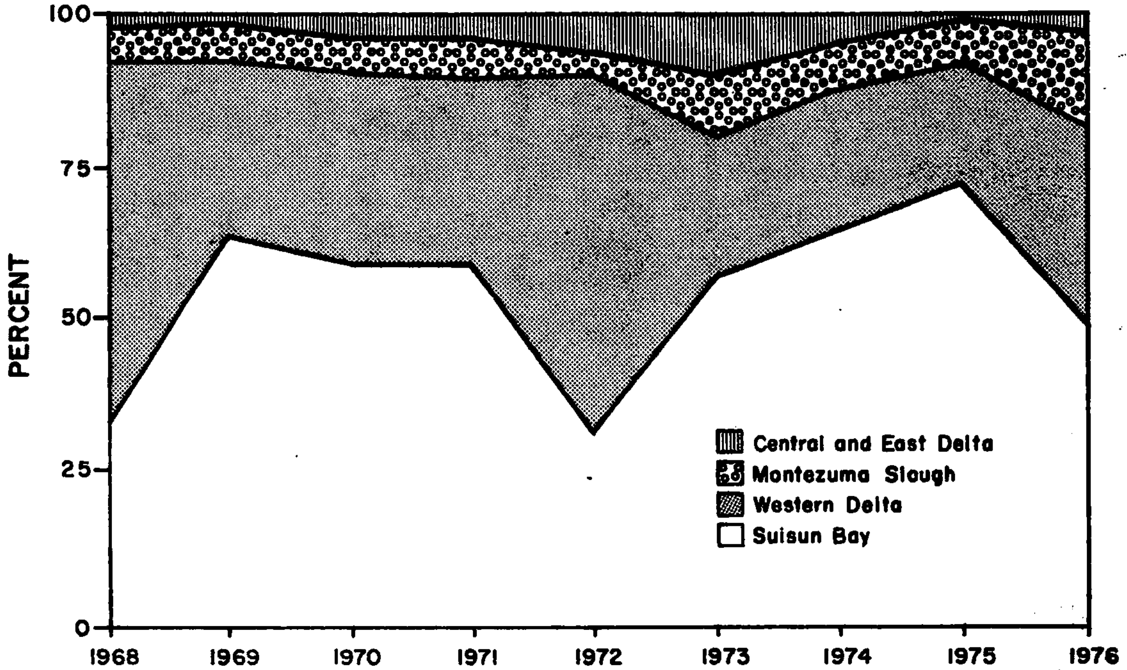
The location of some zooplankton organisms in the entrapment zone, although related to salinity tolerance, may also be related to the abundance of phytoplankton in the entrapment zone. These zooplankton organisms are apparently able to maintain an optimum position in relation to the entrapment zone because their location relative to it shifts with the tidal shifts of the entrapment zone (Bureau Exhibits 52 and 53).

Neomysis mercedis

The opposum shrimp Neomysis mercedis, formerly referred to as Neomysis awatschensis or Neomysis intermedia in literature of the Sacramento-San Joaquin Delta Estuary system (Simmons et al, 1974(a) and 1974(b)), is an important food item for young striped bass (Fish and Game Exhibit 3, p. V-8) and numerous other fishes in the Delta (Skinner, 1972). Neomysis, a crustacean, is a relatively large zooplankter with individuals reaching a size of 18 millimeters (3/4-inch). Its common name, opposum shrimp, is derived from the fact that the female carries the young in a small abdominal pouch called a marsupium, and gives live birth to 10 to 70 young at a time.

Abundance and Distribution. Neomysis populations are distributed in brackish or freshwater along the West Coast from the northern Pacific to San Francisco Bay (Banner, 1954). However, recent studies have shown that Neomysis is also found in Southern California estuaries (Orsi, Fast, Knutson, unpublished manuscript). Within the San Francisco Bay system, Neomysis is usually most abundant from Suisun Bay upstream. Highest concentrations of Neomysis are generally found near the upstream portion of the entrapment zone. Except in drier years like 1968, 1972 and 1976, 60 percent or more of the mean June to October Neomysis population is in Suisun Bay. The second most populated area is the western Delta from Chipps Island up the Sacramento River to near Rio Vista, and up the San Joaquin River to the mouth of the Mokelumne River. Suisun Bay and the western Delta together contain at least 80 to 90 percent of the total population in all but the driest years (Figure III-19).

FIGURE III-19



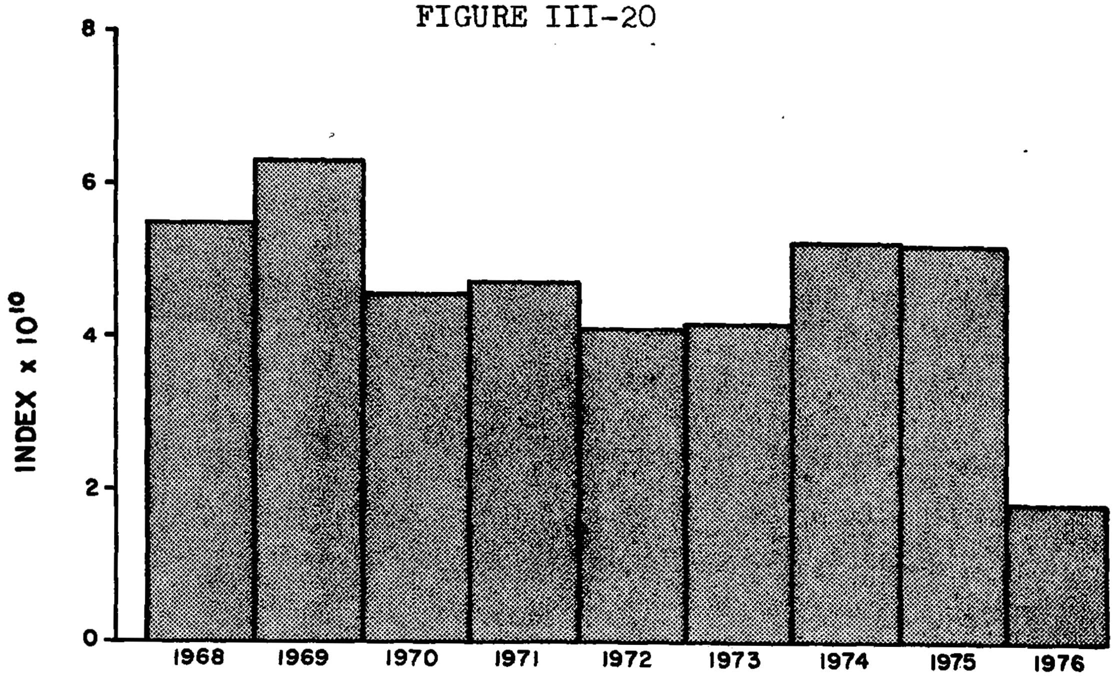
Percent of total Neomysis population in various areas of Suisun Bay and the Delta from June to October, 1968 to 1976.

Usually more than eight percent of the Neomysis population in the estuary upstream of Carquinez Strait is found in Montezuma Slough (Fish and Game Exhibit 3, p. V-8).

Neomysis populations generally increase in the spring to reach peak abundance in late spring or summer. In the fall of years when Delta outflow is low, reproduction and survival exceed mortality and a second population peak occurs. In years of high outflow this second peak does not occur (Fish and Game Exhibit 3, p. V-8). Populations decrease in November and the individuals surviving through the winter reproduce in the spring of the following year.

As shown in Figure III-20 Neomysis populations vary from year to year. Fish and Game samples population abundance each year and has developed a population index used to estimate the relative Neomysis abundance in the Delta, Suisun Bay and San Pablo Bay (RT Vol. XI, p. 63; Fish and Game et al, 1975, p. 28). The following section discusses some of the environmental factors that are believed to affect Neomysis abundance.

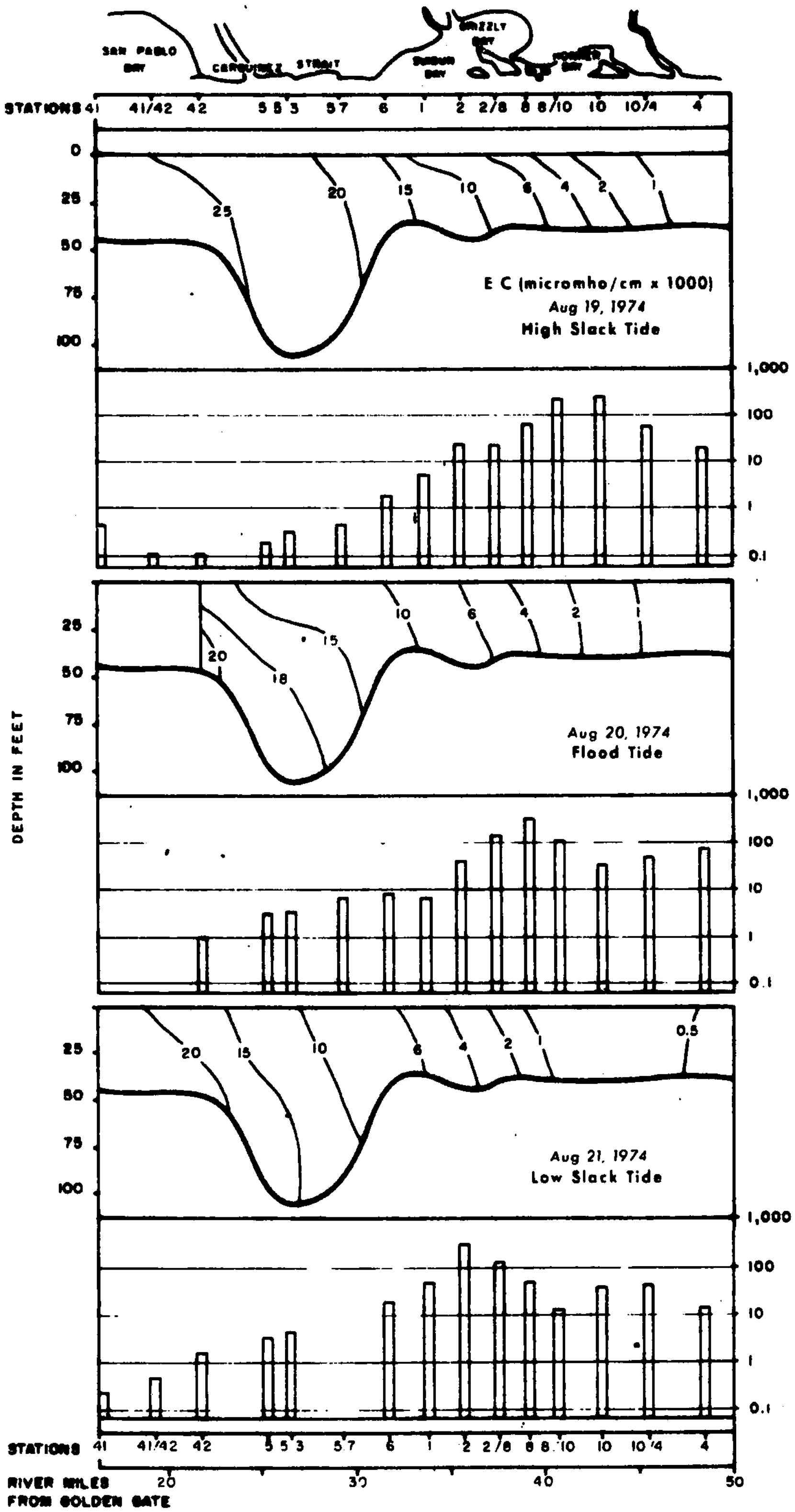
FIGURE III-20



Neomysis Population Index for Suisun Bay and Western Delta combined, 1968 to 1976. The index is the mean June to October standing crop of Neomysis $\geq$ 4 mm in length.

SOURCE: Fish & Game Exhibit 3 Fig. V4, V7

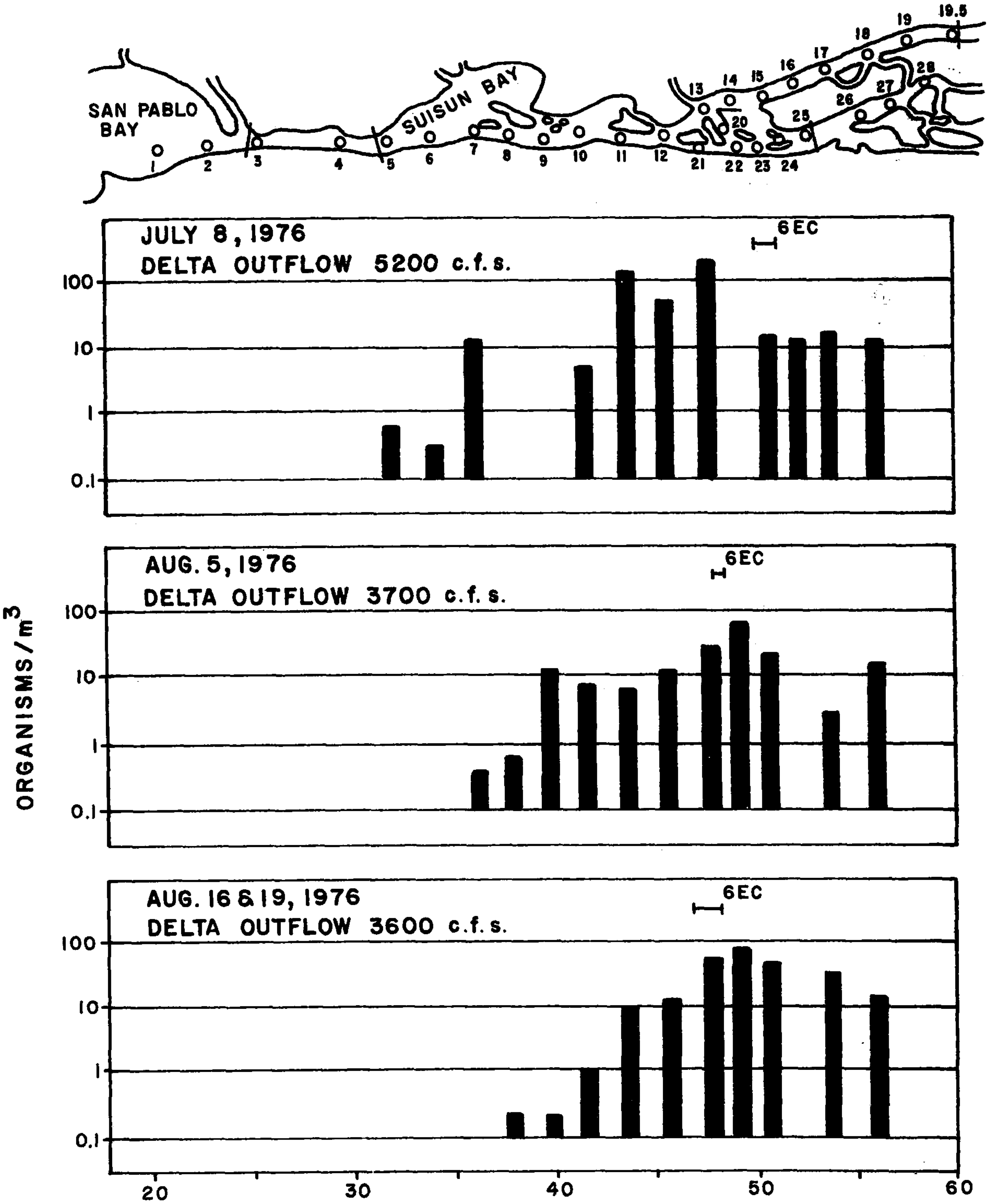
Neomysis are found in greatest abundance in the entrapment zone (Figure III-21 and Figure III-22). Surface conductivities where the entrapment is located and where Neomysis are abundant range from 2000 to 6000 micromhos/cm (Fish and Game et al, 1975, p. 37). Although Neomysis has limited swimming capabilities, it is known



Relationship of the population distribution of Neomysis sp. to salinity (*EC contours*) during different tidal phases on three consecutive days. Delta outflow index – 11,600 to 12,900 ft^3/s.

SOURCE: U.S.B.R. Ex. 56

FIGURE III-22



Population Distribution of Neomysis sp., High Slack Tide, Sacramento River.

SOURCE – U.S.B.R. Exhibit.. 55

to be negatively phototrophic[6/] and to migrate vertically with tidal stage. Apparently these vertical migrations allow Neomysis to maintain its location in the estuary during normal mild downstream flows by taking advantage of flow differentials in the vicinity of the entrapment zone.

These behavioral responses may also be the reason why Neomysis are most easily found in areas where channel depths exceed 10 feet, why it is more randomly distributed near shore and shallower channels at night, and why it is not found in areas where light penetrates to the bottom regardless of upstream tidal flow (Skinner, 1972).

Neomysis is able to feed upon a wide variety of foods of suitable size (Kost and Knight, 1975). While detritus and diatoms make up the major food items for Neomysis, diatoms increase in relative importance during the summer and detritus increases in importance during the winter. Pieces of crustaceans and rotifers have also been found in the stomach of Neomysis.

Phytoplankton is of major importance in the food supply for Neomysis when it is alive and distributed in the water column, and when it is senescent or dead and has become part of the detritus. Therefore, chlorophyll a concentrations have been used in the estuary as an index of the food supply available to Neomysis (RT Vol. XXII, p. 122).

6/ Negative phototropism describes a behaviorial response of an organism away from light.

Environmental Requirements. Field studies by Fish and Game conducted prior to 1970 indicated that during the period of peak *Neomysis* population, the greatest concentrations were found in areas of less than 4000 mg/l chloride, in spite of the fact that *Neomysis* were distributed over a wider range of chloride concentration during the spring. Based on this finding and the known ability of *Neomysis* to maintain its position in the estuary, salinity was generally accepted as the principal factor affecting *Neomysis* distribution. Consequently, previous water quality objectives were established to maintain chloride concentrations below 4000 mg/l (an EC of approximately 12,500 micromhos/cm) at Chipps Island (California Regional Water Quality Control Board, 1975, p. I-4-17). However, recent laboratory work indicates that stress on *Neomysis*, as measured by increased respiration, generally decreases as salinity increases from 200 to 13,000 mg/l chloride and that the organism is stressed more directly by temperature than salinity at temperatures greater than 65°F (Simmons and Knight, 1975).

As stated previously, *Neomysis* are found in greatest abundance in the area of the entrapment zone with electrical conductivity ranges from 2000 to 6000 micromhos/cm (approximately 600 to 2000 mg/l chloride). Therefore, they are found in areas with salinities lower than would be expected from the experimental data. Some overriding beneficial factors such as food availability, type of habitat, or temperature, possibly result from the hydraulic conditions which create the entrapment zone where the *Neomysis* are found.

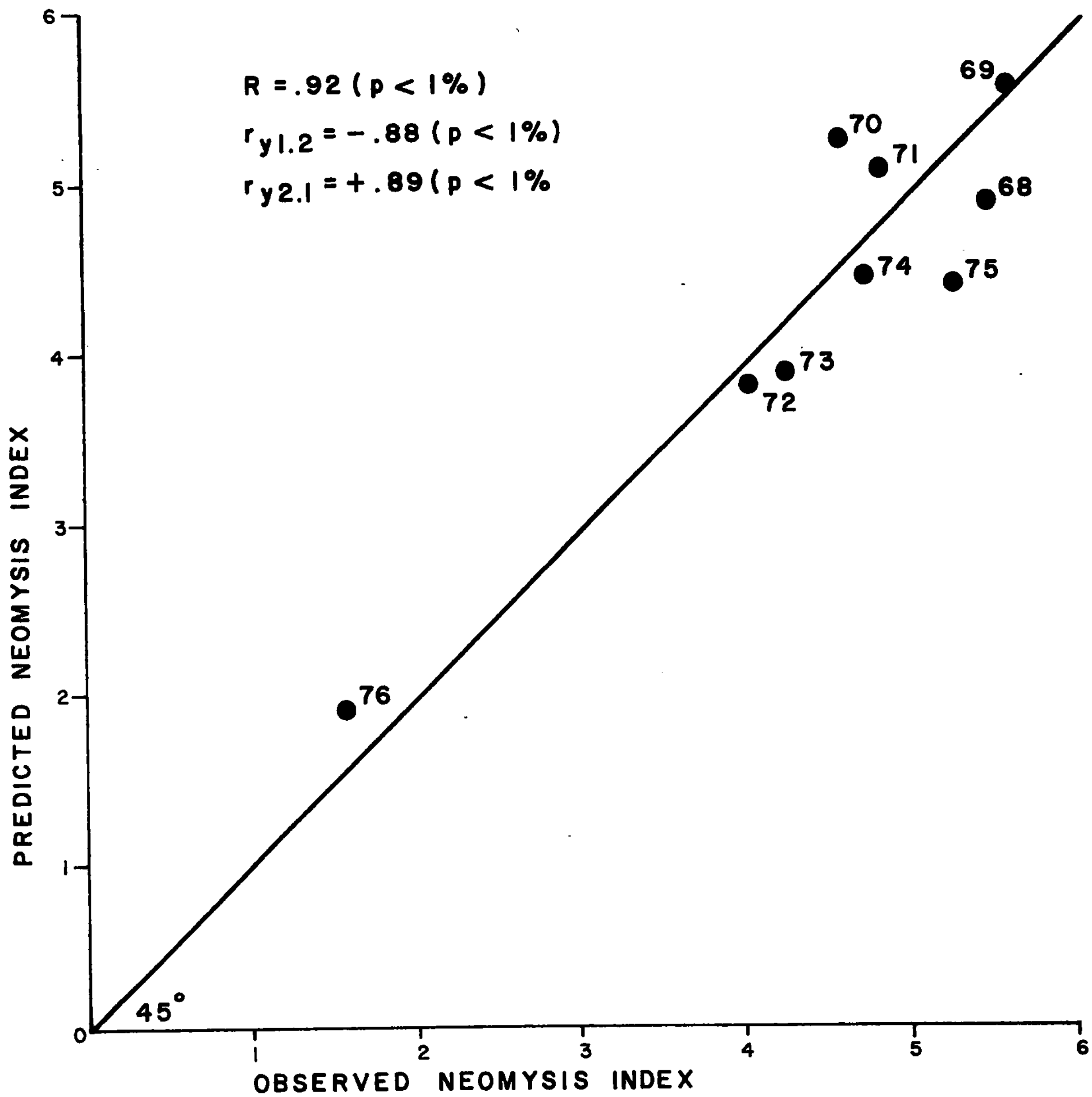
The following discussion relates expected *Neomysis* abundance to environmental conditions including salinity. The actual mechanism affecting the *Neomysis* population is probably not salinity per se but some factor related to salinity and Delta outflow.

The observed *Neomysis* abundance in Suisun Bay and the western Delta from June to October has been related to electrical conductivity and chlorophyll *a* concentrations during that period. This relationship is shown in Figure III-23. It shows that as electrical conductivity at Chipps Island increases (decreases in Delta outflow) and chlorophyll *a* decreases, the *Neomysis* index is expected to decrease. This relationship indicates that *Neomysis* populations are affected not only by summer Delta outflow but also by the levels of phytoplankton produced in the estuary. Chapter IV discusses the recommendations that have been made to protect both *Neomysis* and striped bass. These recommendations are primarily based on the assumption that the summer outflows required to protect striped bass will also benefit *Neomysis*. Figure III-23 illustrates that such benefits to *Neomysis* will occur provided there are adequate populations of phytoplankton.

The previous discussion on phytoplankton pointed to the concern that phytoplankton populations in low flow years may depend on environmental conditions that exist prior to the spring and summer. Because of the direct relationship shown between phytoplankton (chlorophyll *a*) and *Neomysis* levels, there is an additional concern that adequate phytoplankton populations be maintained in the

FIGURE III-23

RELATIONSHIP BETWEEN THE ABUNDANCE OF NEOMYSIS IN SUISUN BAY AND THE WESTERN DELTA, SALINITY AT CHIPPS ISLAND, AND PHYTOPLANKTON ABUNDANCE



Observed and predicted population indices for Neomysis ≥ 4 mm in length from Suisun Bay and western Delta combined. All values are June to October means from 1968 to 1976. The predicted Neomysis index (y) = $3.63 - .00029x_1 + .098x_2$, where x_1 is EC at Chipps Island and x_2 is chlorophyll a.

SOURCE – DEPT. OF FISH & GAME Exhibit.. 4

estuary so that appropriate Neomysis levels can be achieved. This concern is particularly significant during the winter months of low flow years. Recommendations based on this concern are discussed in the phytoplankton section and Chapter VII of the draft water quality control plan.

Zoobenthos

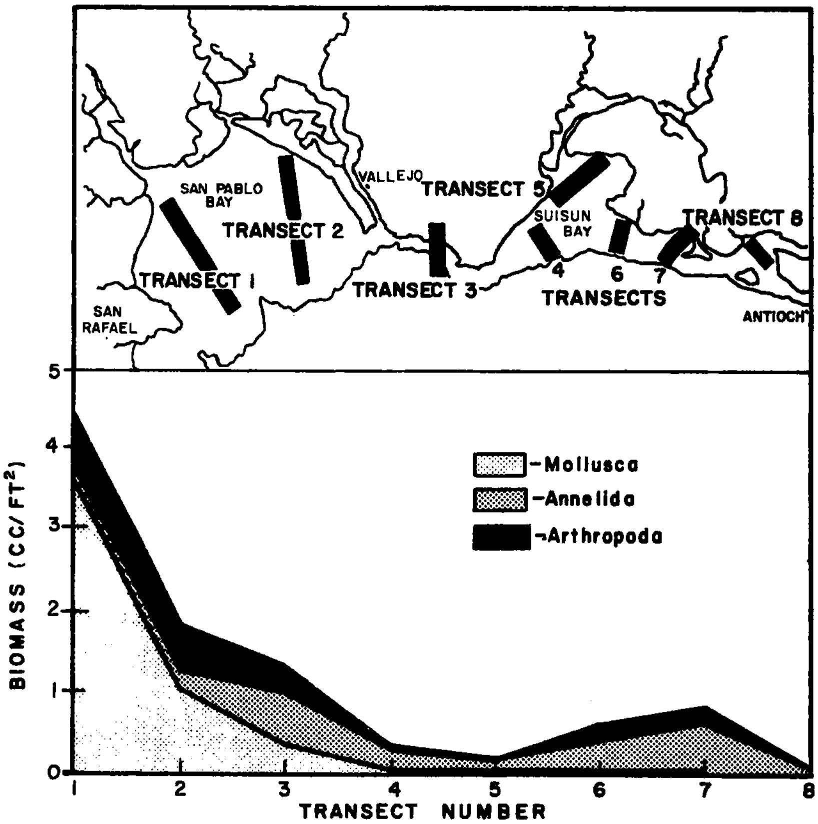
Invertebrate animals living in or on the bottom substrate of aquatic habitats are called zoobenthos. The zoobenthos in this estuary include many species of clams, worms, aquatic insects, and crustaceans. These benthic organisms are important as food for waterfowl and fish. *Gemma gemma* (a clam), *Macoma inconspicua* (bentnosed clam), *Synidotea laticauda* (an isopod), *Nassarius obsoletus* (a snail) and *Tapes semidecussata* (Japanese littleneck clam) are important food sources for diving ducks in San Pablo and Suisun Bays. *Macoma inconspicua*, *Photis californica* (an amphipod), and *Synidotea laticauda* are important as fish food in the estuary. Species of *Corophium* and *Nereis* (*Neanthes*) (a polychaete worm) are part of the young-of-the-year striped bass diet (Painter, 1966). Species of *Corophium* have also been found in large numbers in stomachs of catfish and sunfish (Daniel, 1972) as well as other fish.

Abundance and Distribution. The kinds of zoobenthos found in the Bay-Delta estuary differ greatly moving upstream from San Pablo Bay. Salinity appears to be the primary factor controlling the distribution and abundance of zoobenthic organisms. Within areas of suitable salinity, these organisms are distributed in accordance with other habitat requirements such as substrate type and net velocities.

In terms of biomass, the zoobenthos concentrations found in San Pablo Bay are two to four times greater than those found in Suisun Bay (Figure III-24). Mollusks (clams) which constitute a valuable food source for fish are shown to contribute the bulk of the biomass found in San Pablo Bay but are almost absent from Suisun Bay. This marked change in speciation and abundance is referred to as a "faunal break". The change occurs in the eastern Carquinez Strait area and is caused by salinity. Marine species generally stay downstream of the "breaking point" and freshwater type species remain upstream of it. However, the rather impoverished condition of the benthic fauna in Suisun Bay may be caused not only by the lower salinities there, but also by the great seasonal variations in salinity coupled with the inability of the immobile benthic animals to move to areas of more suitable salinity (Fish and Game Exhibit 3, p. V-7).

Figure III-24 shows that in Suisun Bay, annelid worms comprise the bulk of the biomass with anthropods (crustaceans) of secondary importance and mollusks rating a distant third.

AVERAGE MONTHLY BIOMASS OF FISH AND WILDLIFE FOOD ORGANISMS FROM EIGHT TRANSECTS IN SAN PABLO AND SUISUN BAYS



SOURCE: Dept. of Fish & Game, Fish Bulletin No. 133 page 46 (1966)

Zoobenthos found in the Delta are essentially freshwater organisms, not found in great abundance seaward of Honker Bay. Two amphipods (crustaceans) make up most of the Delta's zoobenthic population. These amphipods, *Corophium stimpsoni* and *Corophium spinicorne*, are principal food items for white and green sturgeon, white and channel catfish, tule perch and small black crappie. They are also the most important food item of young striped bass, next to *Neomysis*. Other benthic organisms abundant in the Delta include the Asiatic clam, tendipedid larvae, oligochaete worms and the crayfishes. All of these organisms are eaten by Delta fishes but none are as important as *Corophium* as a fish food (Fish and Game Exhibit 3, p. V-7).

Environmental Requirements. Little information exists regarding the environmental requirements of zoobenthos found in this estuary. As stated earlier, the large mollusk populations found in San Pablo Bay are prevented from penetrating very far into Suisun Bay because of the low salinities that prevail in Suisun Bay during at least part of the year. These clams develop high populations only where the yearly mean salinities are above 6,000 ppm chloride.

The Delta species of *Corophium* are freshwater species. Their distribution in the Delta is directly affected by environmental conditions other than salinity. Hazel and Kelley (1966) reported that high net flow velocities and associated shifting sand bottoms are detrimental to Delta zoobenthos, especially *Corophium stimpsoni*.

Striped Bass

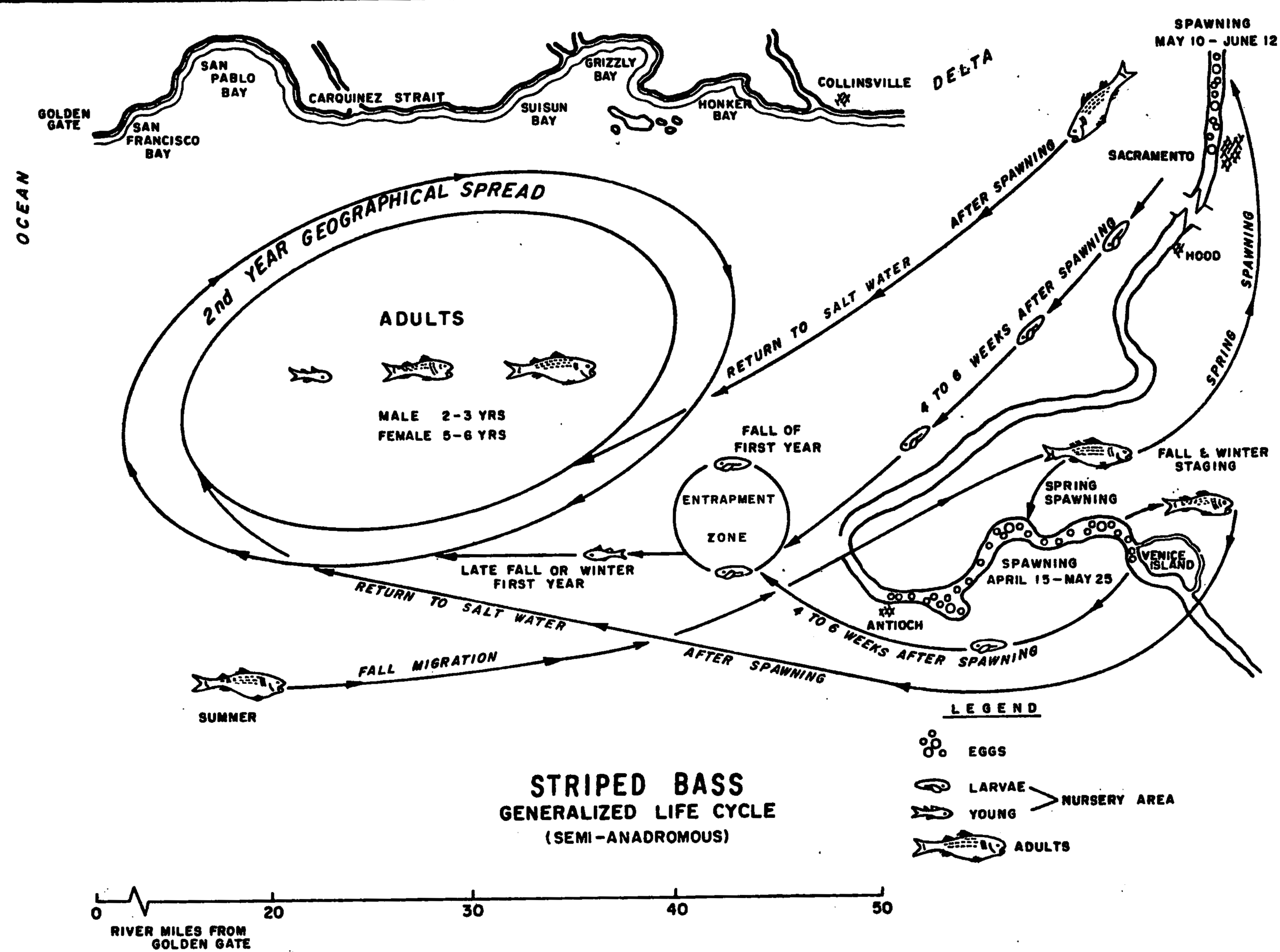
Striped bass (Morone saxatilis)were introduced to the West Coast of the United States in 1879 from their native waters in the East Coast. Their numbers increased rapidly and they were soon the object of both sport and commercial fishing in the Delta and San Francisco Bay. In 1935 all commercial fishing for striped bass was halted to protect the sport fishery.

Striped bass is one of California's most important sport fish species. Fish and Game estimates that 2 million angler days are supported annually by this resource (Fish and Game Exhibit 3, p. III-1). The adult striped bass population (fish 16 inches and over) is estimated to be in the order of 1.4 million fish, but records indicate a larger population in the past probably up to 3 million fish. Stanford Research Institute in 1966 projected the 1970 net economic value of this sport fishery to be about \$7.5 million (1965 dollars).

Life History. Small adult striped bass generally stay in San Francisco, San Pablo and Suisun Bays. Larger adult bass are known to leave the confines of the San Francisco Bay area. Striped bass are taken by surf fisherman along the coast from Monterey to the Russian River, with a few reports of further spread.

A generalized life cycle for striped bass is shown on Figure III-25. Male bass mature when they are two or three years old, while females

FIGURE III-25



STRIPED BASS
GENERALIZED LIFE CYCLE
(SEMI-ANADROMOUS)

PREPARED FROM TURNER (1972)

mature at an age of four or five years. When the striped bass mature they become migratory for spawning purposes. During the fall months there is a general migration of adult striped bass into the freshwaters of the Delta where some of the population stays during the winter. During the spring the adults migrate to the spawning locations. The two major spawning areas for striped bass are the Sacramento River from Sacramento upstream to Colusa, and the San Joaquin River and adjacent sloughs from Antioch upstream to Venice Island. About one-third of the bass spawn in the San Joaquin River and about two-thirds spawn in the Sacramento River.

The average female lays about 800,000 eggs. Immediately after spawning the adult fish return to saltwater. Bass eggs are semi-buoyant and drift with the water currents until they hatch in two or three days. Four to six weeks after the eggs are spawned, the young bass are found in greatest abundance in the entrapment zone (Fish and Game Exhibit 3, p. III-2).

The young bass initially depend upon small zooplankton such as Eurytemora, a brackish water copepod for food. Within a few weeks Neomysis become their principal food. The young bass stay near the mixing zone through the fall. In early winter they migrate downstream toward San Pablo Bay. During their second year young bass spread out geographically. Large numbers move into the rivers upstream from the Delta and throughout San Pablo Bay. They generally change from a diet of aquatic invertebrates to fish, although Neomysis is still important during their second summer.

<u>Environmental Requirements for Spawning.</u> Striped bass are believed to react to salinity while spawning in the San Joaquin River system. This spawning largely occurs upstream of Antioch. Once in this area of the Delta the striped bass generally do not migrate further upstream in the San Joaquin River system than where salinity due to agricultural drainage exceeds 0.55 mmhos/cm EC (about 350 mg/l TDS). However, more than 80 percent of all striped bass eggs collected during Fish and Game studies in recent years were from areas between Venice Island, where salinities are less than 0.13 mmhos/cm EC (about 200 mg/l TDS), and Antioch. Field observations and laboratory studies have indicated that egg survival is not adversely affected by salinities up to 1.5 mmhos/cm EC (about 1000 mg/l TDS) (Fish and Game Exhibit 3, p. III-8).

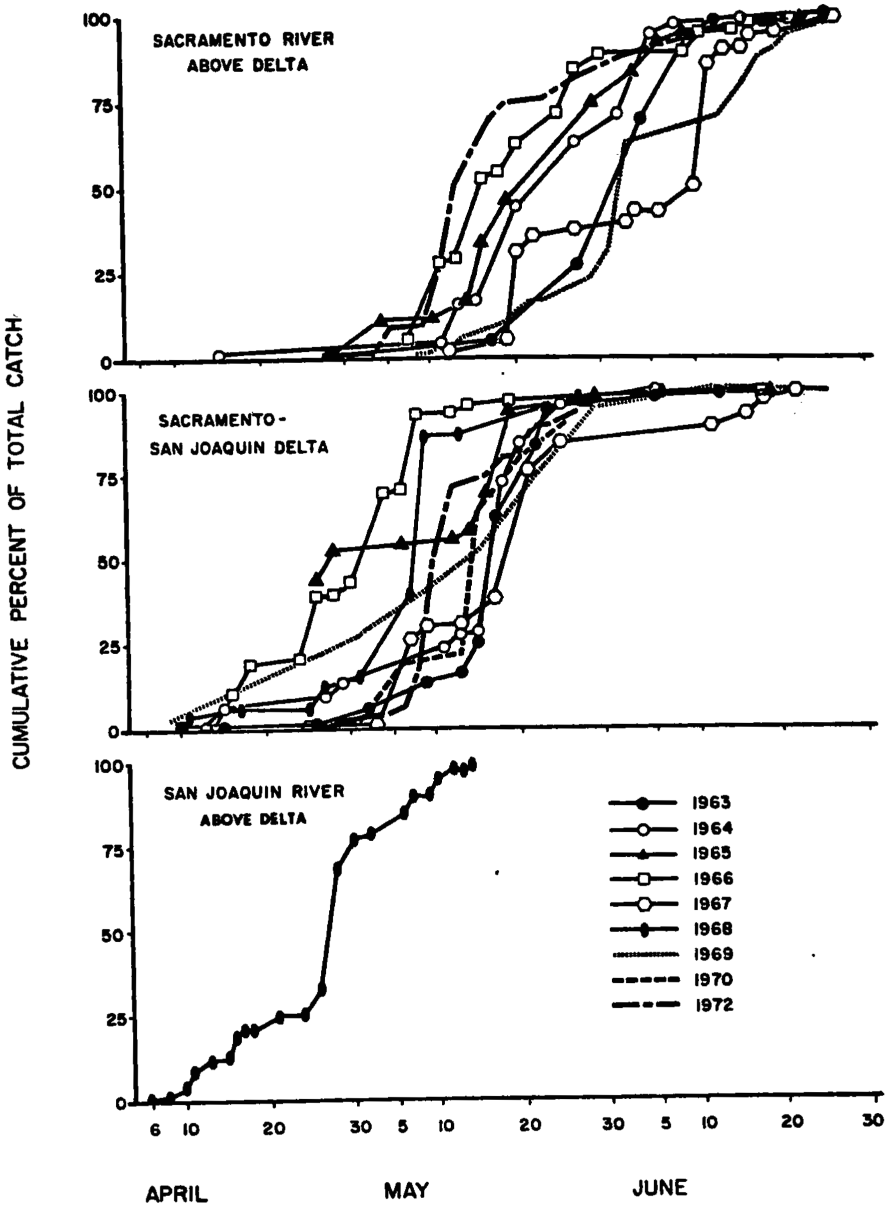
The onset of spawning has been observed historically to be coincident with river temperatures at Antioch increasing to exceed 60°F. Spawning then generally continues for a little over a month.

Because of these factors, previous water quality objectives have been developed to provide salinity limits of 1000 mg/l TDS and 350 mg/l TDS at Antioch and Prisoners Point on Venice Island, respectively. These objectives were to be in force when temperatures at Antioch increased to 60°F and for 5 weeks thereafter (Staff Exhibit 1). These objectives were considered to be the maximum suitable levels for striped bass spawning on a long-term basis. Fish and Game has reported that it is difficult in practice to define when the river temperature actually reaches and is going to stay above 60°F because of water temperature fluctuations in spring around the Antioch area (RT Vol. XXII, p. 157). In addition water temperatures of 60°F tend to occur in late March or early April and, as shown in Figure III-26, most of the bass are not ready to spawn until mid-April. Therefore, Fish and Game no longer recommends temperature as the trigger for a striped bass spawning standard. Instead they recommend that a specific date, April 1, be established to trigger the spawning standard which would be effective during the period of time generally coinciding with the bulk of the spawning on the San Joaquin River (see Figure III-26).

Fish and Game believes that protection of striped bass spawning necessitates achievement of minimum acceptable salinity levels at Antioch by the time substantial spawning starts, and maintenance of suitable salinity for spawning and egg survival during the first few weeks of the normal spawning period (see Figure III-26). This can be accomplished by (1) the maintenance of a minimum mean Delta Outflow Index of 6,700 cfs for the period April 1 through April 14, and (2) the maintenance of no more than 1.5 mmhos/cm EC from April 15 through May 5. Reference to Department Exhibit II-9, Attachment No. 3, shows that under steady state conditions a Delta outflow of 6,700 cfs will result in approximately 1.5 mmhos/cm EC at Antioch.

Environmental Requirements for Young Survival. Since the early 1960's there has been a general decline in angler success for striped bass, which is attributed to decreases in the adult bass population (Fish and Game Exhibit 3, p. III-1). Research to determine the

FIGURE III-26



Cumulative percentage of striped bass spawning over time in various areas. Daily percentages for the Delta from 1966–1972 and for the Sacramento River in 1972 were estimated by dividing total weighted catches each day by the seasonal total weighted catch. Percentages for the other surveys were estimated by dividing the daily catch per unit effort by the sum of those statistics for the season. The cumulative percentage is a running sum of the daily percentages.

SOURCE: Dept. of Fish & Game Exhibit 12 A factors responsible for this decline in striped bass abundance has focused on young bass because annual variations in adult abundance are believed to depend on environmental conditions affecting survival of young several years earlier.

In order to help quantify the effects of environmental conditions Fish and Game has developed a monitoring program that each year measures young bass abundance in terms of the Striped Bass Index. The Striped Bass Index is 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 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 standard sampling methods allows statistical treatment of data to estimate abundance of young striped bass and to correlate changes in the number caught with changes in environmental factors.

Studies in the estuary have shown the abundance of young striped bass found in Suisun Bay to be highly correlated with the logarithm of mean June-July outflow (Fish and Game Exhibit 3, Figure III-8). The abundance increases with outflow up to about 14,000 cfs. The effect of flows higher than 14,000 cfs may be to move young striped bass downstream where they are not sampled intensively (Fish and Game Exhibit 3, p. III-24). Delta outflow is believed to increase the capacity of the estuary to support bass (Fish and Game Exhibit 3, p. III-34).

An important consideration of possible influences of the projects is the function of Delta outflow in moving the young bass and their food organisms downstream away from the influence of the CVP and SWP export pumps (RT Vol. X, p. 183). Relationships established for young striped bass found in the Delta show a distinct decrease in abundance with increased export and decreased outflow during June and July (Fish and Game Exhibit 3, Figure III-6) although young bass are diverted during the entire period of May through August. The eggs and young striped bass drawn toward the pumps may be prevented or delayed from reaching suitable habitat, diverted out of the Delta, or lost at the pump screens. The screens save no eggs and are only about 20 percent efficient for fish one month old (15 mm length) and about 70 percent efficient for fish six weeks old (25 mm length) (Fish and Game Exhibit 3, p. II-4). In addition, increased net channel velocities are detrimental to the maintenance of large phytoplankton and zooplankton populations. Export pumping at high rates increases net velocities in the interior Delta channels which decreases the availability of food for young striped bass. Recent work by Fish and Game found that May exports have been increased to the extent that a May-June relationship for survival vs. flow and export more closely explains the interaction of these parameters than the June-July relationship.

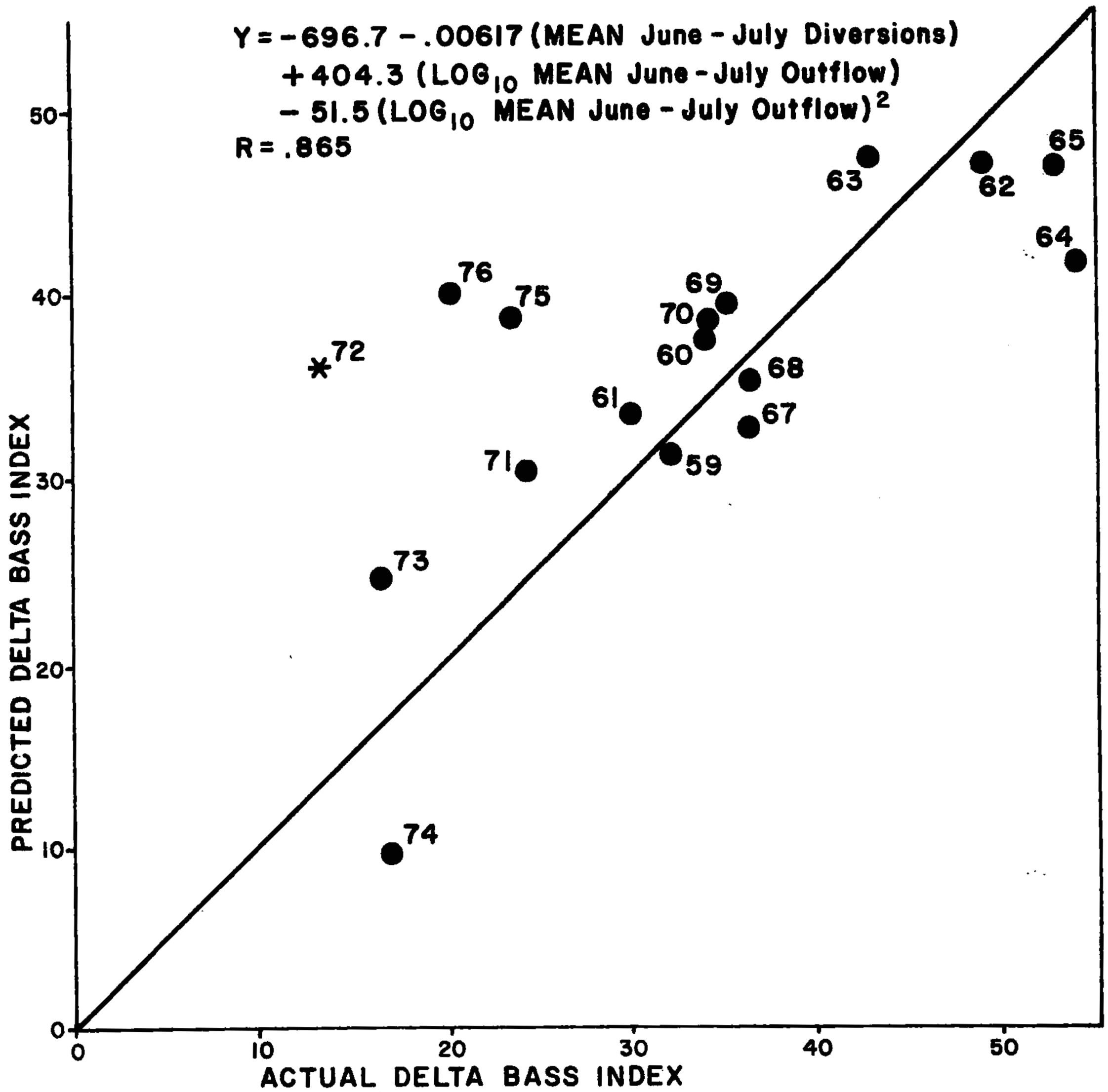
In summary, there are two basic relationships that have been developed to measure striped bass abundance depending on the location in the estuary. Young bass populations found in the Delta are related to both mean June-July diversion rates and mean June-

July Delta outflow whenever May conditions reflect those conditions that existed in the Delta prior to 1970 (Fish and Game Exhibit 3, Tables III-7 and III-8). This relationship is shown on Figure III-27 which is taken from Fish and Game Exhibit 3, Figure III-6.

The number of striped bass found in Suisun Bay has been related directly to Delta outflow during June and July. This relationship is shown by equation Y_2 on Figure III-28. As discussed earlier, this line begins to curve substantially starting at about 14,000 cfs. Recruitment of young bass into the adult population has been found to be related to mean June-July Delta outflow three years earlier (Fish and Game Exhibit 3, Figure III-12). From this relationship Fish and Game has concluded that the Striped Bass Index is related to the logarithm of the outflow in a linear fashion up to about 14,000 cfs. Sampling for the Striped Bass Index does not include the San Pablo and San Francisco Bay areas. Bass transported to these areas due to high June and July Delta outflows are assumed to survive to be recruited into the adult populations. This linear relationship between the logarithm of June-July outflows and striped bass survival expected in Suisun Bay and downstream is shown in Figure III-28 as equation Y_1.

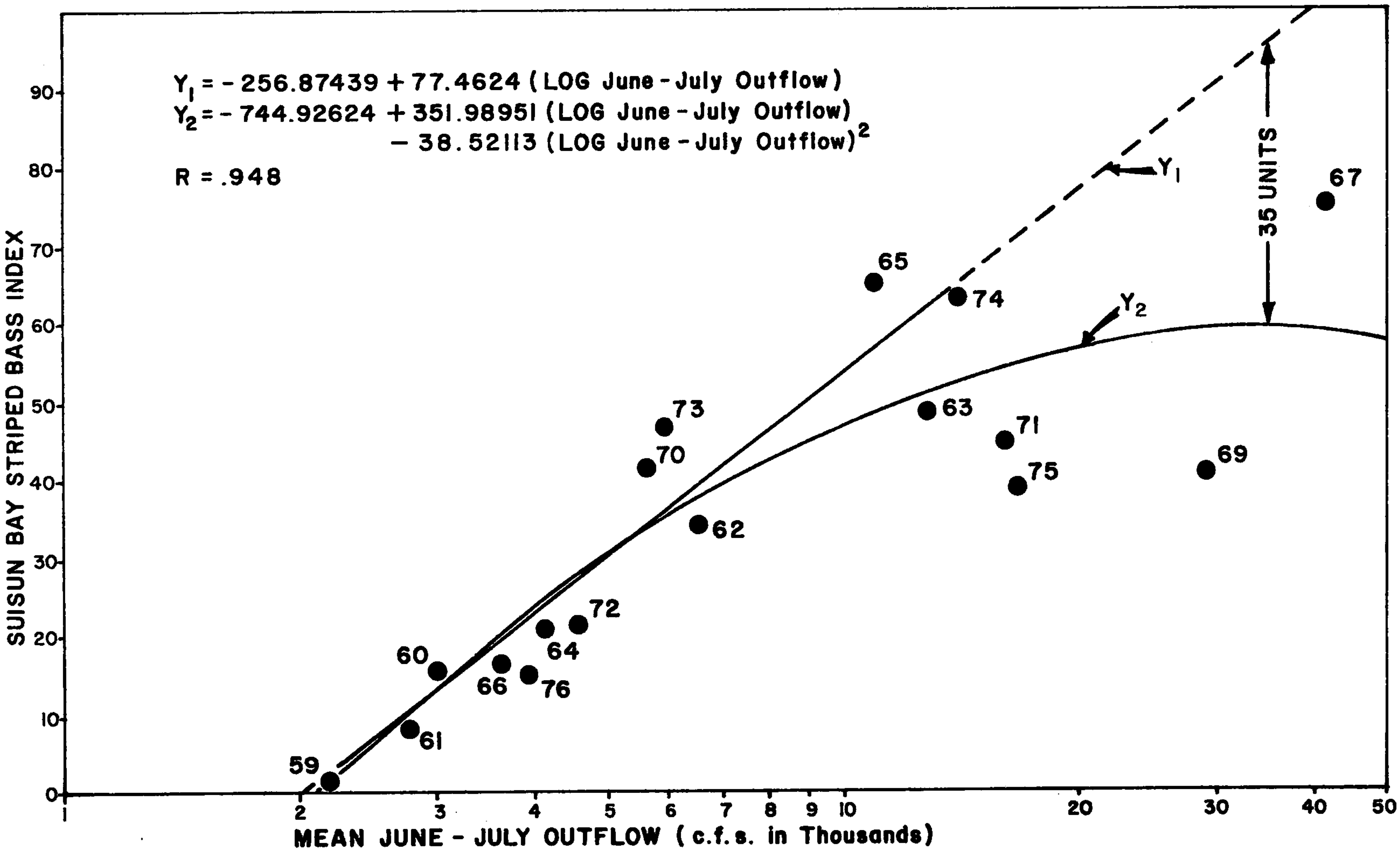
Provided adequate environmental conditions exist in May and earlier in the year, the total Striped Bass Index expected to occur in the estuary can be calculated from environmental conditions in June and July by summing the results of the equations found in Figures III-27 and III-28.

FIGURE III-27



Relationship between actual Delta bass abundance and bass abundance predicted from mean June-July diversions (export + local), and mean June-July Delta outflow. Predicted values are based on equation for years 1959-74. The point for 1972 was not included in the prediction equation because the Andrus Island levee break affected survival that year.

SOURCE: Department of Fish and Game Exhibit 3, Figure III-6



Comparison between average indices derived from a curve fit to Suisun Bay index v. Delta outflow and a straight line fit to the index v. outflow up to 14,000 cfs. The distance between the straight line and the curve is an estimate of bass survival west of Suisun Bay. For example at 35,000 cfs, 35 index units survive in San Pablo and San Francisco Bays.

SOURCE: Department of Fish and Game, Exhibit 3, Figure III-13.

FIGURE III-28

Environmental Requirements for Adult Survival. Fish and Game reports that one study estimated that about 85 percent of the variation in recruitment to the adult population was controlled by conditions that affect young striped bass (RT Vol. X, p. 182). In addition, Fish and Game has established that over the past 40 years the number of adult bass entering the sport fishery has consistently been greatest when Delta outflows were high when the bass were young (Fish and Game Exhibit 3, p. III-24). Therefore, the environmental conditions that affect young striped bass have been emphasized in this report.

Bass Exported from the Delta. The striped bass eggs and young which are pumped into the California Aqueduct and the Delta-Mendota Canal with the export water have formed a substantial striped bass fishery in San Luis Reservoir and O'Neill Forebay where some of the export water is stored. In the period November 1975 to October 1976, Fish and Game estimated about 160,000 striped bass were caught by anglers in the two reservoirs. The estimated average annual catch in the Delta is 250,000-300,000 striped bass.

Striped bass diverted from the Delta also provide fishing in the California Aqueduct, the Delta-Mendota Canal, and in some of the SWP reservoirs in southern California. These fisheries generally are not considered self-sustaining because of the lack of suitable spawning areas in the reservoirs. However, there are indications that some striped bass may spawn in the California Aqueduct (RT Vol. X, p. 192).

Salmon and Steelhead

King salmon (Oncorhynchus tshawytscha) and steelhead rainbow trout (Salmo gairdneri) are the principal salmonids which utilize the Sacramento-San Joaquin Estuary. King salmon are sought by commercial and sport fishermen in the ocean and by freshwater anglers in the Sacramento River system. On a price-per-pound basis, the king salmon is the most valuable of the Pacific salmon. The average annual California commercial catch of salmon, over half a million fish, is worth about $7.5 million (1975 dollars). The ocean sport catch of over 100,000 fish annually and the inland catch of another 25,000 fish has been valued at a projected $1.3 million (1965 dollars) in 1970 (Fish and Game Exhibit 3, p. II-1).

On the Pacific coast, only the Columbia River system produces more salmon than California's Central Valley rivers. These California rivers supply an estimated 75 percent of California's commercial ocean salmon catch and contribute to the ocean and inland sport fishery as well (Fish and Game Exhibit 3, p. II-1).

Over 90 percent of the Central Valley's king salmon are produced in the Sacramento River system. Runs in the San Joaquin system have declined to less than one-fifth of their abundance of 40 years ago, as a direct result of water resource development projects in the basin (Fish and Game Exhibit 3, p. II-1).

Not only has the general abundance of salmon declined due to water development projects, but the timing of salmon migration patterns has also been modified by these facilities. Historically the

Sacramento River system supported three distinct spawning runs of king salmon. The range of these populations extended into the uppermost tributaries of the Sacramento River drainage basin, including the McCloud and Pit Rivers. The large spring run that existed historically has been replaced by the winter run in overall abundance. Lower summer temperatures due to reservoir releases have made more of the mainstream Sacramento River available as nursery habitat than under natural conditions. In addition, the construction of reservoirs has eliminated large areas of the upstream spawning grounds for the spring run salmon (Fish and Game Exhibit 3, p. II-4).

Steelhead utilize both the Sacramento River system and the Mokelumne River. Prior to the operation of Coleman, Feather River, and Nimbus hatcheries, the total adult steelhead population was estimated at 20,000 fish. Recently, the total run has increased to about 50,000 fish (Fish and Game Exhibit 3, p. II-1, II-4 and II-5).

Both salmon and steelhead fish populations, therefore, represent resources that have been affected dramatically by past upstream water project developments. Fish repopulation measures have attempted to mitigate the impacts of these projects. In any event, past projects have so altered these populations that it seems academic to address the estuarine environmental needs of the historic populations. Environmental needs of salmonids in the Delta must address the needs of the present "partially mitigated" populations of salmonids.

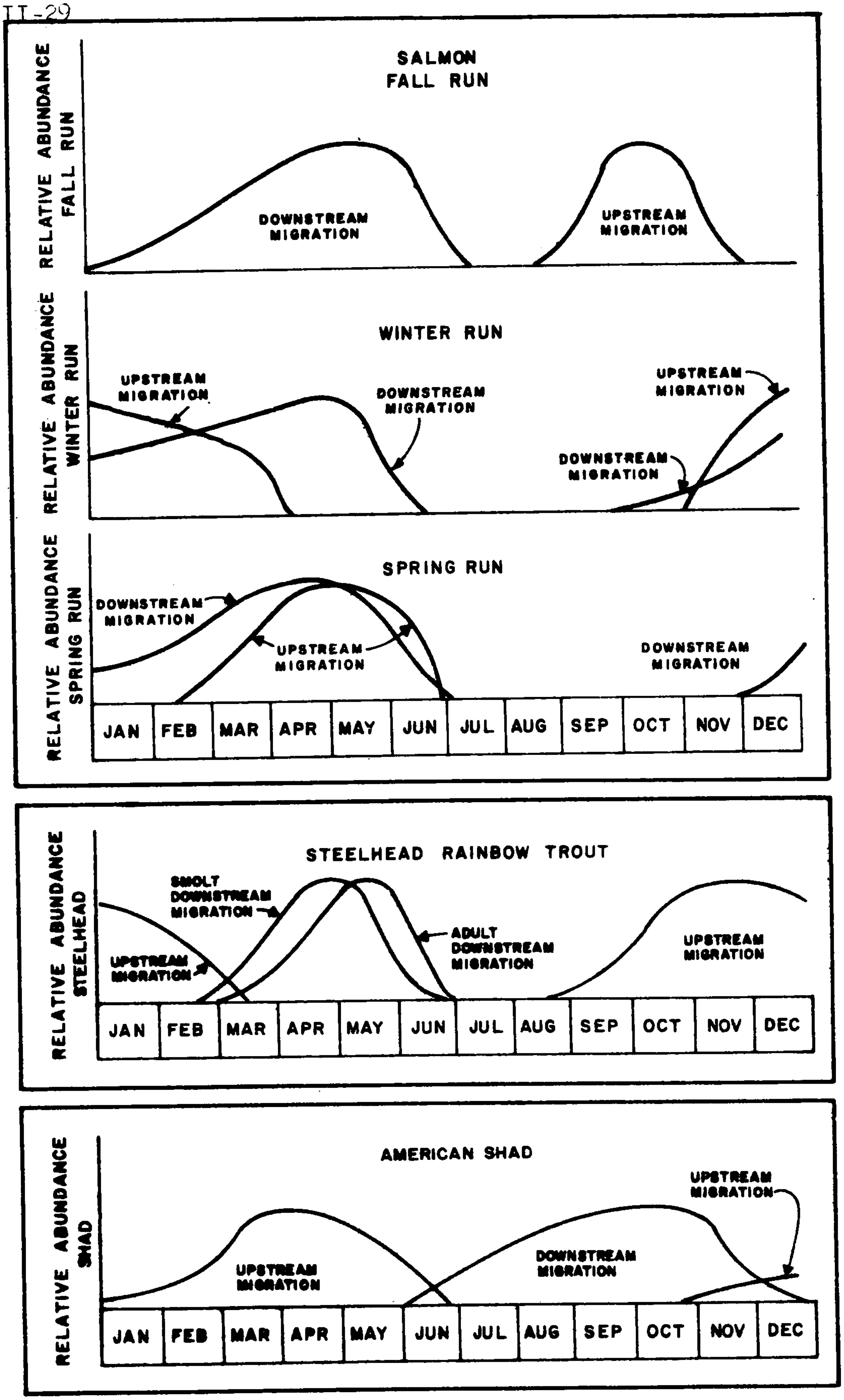
The life history and environmental requirements of these fish will therefore specifically address characteristics of the present salmonid populations.

Life History. King salmon pass through the Delta twice during their lifetime: once as young when they migrate to sea and once as mature adults when they return to spawn in their home stream after spending up to four years in the ocean. The adults die after spawning.

Presently there are three spawning runs of king salmon in the Sacramento River system. The names of the runs are derived from the season in which migration to the upstream spawning grounds takes place. They consist of the fall run (late August through November), ranging from 150,000 to 300,000 fish; the winter run (November through March), ranging from 20,000 to 60,000 fish; and the spring run (mid-February through mid-June), ranging from 5,000 to 30,000 fish (Fish and Game Exhibit 3, p. II-4). The San Joaquin River system supports a fall run which averages less than 20,000 fish and does not reach above the Merced River, though runs do exist in the Merced, Mokelumne, Stanislaus and Tuolumne Rivers (Fish and Game Exhibit 3, p. II-2). Also a small winter run of king salmon exists in the Calaveras River.

Figure III-29 shows the general migration patterns of the various salmon runs. Fall run spawning takes place in fall and early winter. Young salmon move into the lower river and some move into upper estuary

FIGURE III-29



Graphical description of general times of occurance of salmon, steelhead rainbow trout and American shad in the Sacramento-San Joaquin estuary (based on DF&G Exhibit 3, Chapters II & IV).

as fry[7] from January to March. After transforming into smolt[8] these fish migrate rapidly to the sea (Jensen, 1972). The peak of this migration occurs in May and June. Spawning by winter run salmon occurs in late May and June (Fry, 1973, p. 78). From October through December fry move out of the upper river with the bulk of the smolt downstream migration occurring in April and May. Spring run spawning occurs in early fall. Smolt migrate downstream through the Delta from January through June. A smaller, but readily identifiable, downstream migration of large yearling king salmon has been identified at both Chipps Island and the state and federal fish protective facilities during October and November. Thus, king salmon outmigrants (smolts and some yearlings) can be found in the Delta almost year-round, though the bulk of the movement is in the spring (Fish and Game Exhibit 3, p. II-4).

Adult steelhead begin to migrate upstream through the estuary in August, and the movement lasts through the winter months. Unlike salmon, many adults survive spawning and return to the ocean during the spring (Fish and Game Exhibit 3, p. II-2 and II-5). Steelhead juveniles spend one or two years in the upper rivers before migrating to the ocean in the winter and early spring. Hatchery releases of young steelhead usually take place between January and March (Fish and Game Exhibit 3, p. II-2).

7/ Fry are young fish not mature enough to migrate to the sea.

8/ Smolt refers to young fish mature enough to migrate to the sea. Salmon larger than three inches generally fall into this category.

Environmental Requirements for Upstream Migration. Because adult salmonids are capable of making a fairly rapid transition from salt to freshwater, any natural salinity gradient is acceptable for upstream migration (Fish and Game Exhibit 3, p. II-5; Jensen, 1972).

Because homing salmonids are directed primarily by olfactory perception of home stream water, a "homing" or "parent" stream odor gradient is necessary. Any water diversions which destroy or mislocate these gradients can cause straying, and an accompanying delay, of upstream migrant king salmon. The minimum amount of "home stream" water necessary in either the Sacramento or San Joaquin River system is unknown (Fish and Game Exhibit 3, p. II-5 and II-6). Salmon have migrated successfully past Stockton in the San Joaquin River at net downstream flows of 500 cfs (Hallock, Elwell & Fry, 1970). Higher flows may be necessary for optimum conditions, and it is likely that higher flows are desirable in the larger channel of the Sacramento River.

Physical barriers are another problem faced by upstream migrant salmonids. Temporary rock dams have been placed in the Delta in recent years in order to resist salinity intrusions or to control direction of flow in the San Joaquin River. This type of barrier, if misplaced or not constructed to provide a fishway, can pose a significant problem for upstream migrant salmonids.

Salmon fry remain in the gravel after hatching until the yolk sac is absorbed. After emergence they establish territories but, since the nursery area is limited, the earlier emerging fry force later emerging fry to look elsewhere for suitable territories.

This density-dependent movement often results in king salmon fry moving slowly into the upper portions of the Delta. The fall run in the Sacramento River, and to a lesser extent in the San Joaquin River, produce a sufficient number of fry to cause the above-mentioned downstream movement (Fish and Game Exhibit 3, p. II-9). The fry remain in their "residences" until they reach a size and stage of development which allows them to migrate. Maturation of the fry into smolt, the migratory stage of the young salmon, takes place when the fry are about 3 inches long. The occurrence of young outmigrating salmon peaks almost simultaneously at sampling stations throughout the entire estuary. This indicates a rapid movement through the estuary and out to sea.

Flow rates sometimes directly influence young survival. Tagging experiments conducted from 1969 to 1971 showed that mortality of young salmon released in the spring at Sacramento was substantially higher than mortality of those released at Rio Vista, and the difference in the mortality rates of fish released at these locations was directly related to the flow rate when the fish were released (Fish and Game Exhibit 3, p. II-12).

Food supply is another important factor affecting survival. Juvenile salmon (smolt and fry) feed throughout their outmigration. In the estuary various insects, <u>Neomysis</u> and <u>Corophium</u> sp. are significant items in their diet (Fish and Game Exhibit 3, p. II-12).

Finally, the survival of young salmon is influenced by losses and handling at the CVP and SWP export fish screens. The number salvaged annually has ranged from 58,000 to 512,000 during the last decade. The overall efficiency of the screens for salmon is on the order of 65 to 90 percent (depending upon the size class of the salmon), so the numbers salvaged indicate a loss of several tens of thousands of young salmon. In addition, an unknown fraction of those salvaged are lost in handling. The number salvaged probably represents less than 5 percent of the total outmigration, but a much larger fraction is drawn out of their normal migration paths. Studies are underway to determine whether such deviation from normal migration routes increases mortality, but its effects on the adult return rate will not be known for some time (Fish and Game Exhibit 3, pp. II-12 and II-14).

<u>Summary of Environmental Requirements.</u> Under the scope of the water quality control plan environmental requirements in the Delta for salmonids relate primarily to (1) the maintenance of adequate food supplies for young outmigrating salmon, (2) the

protection of salmonids from both direct losses in water diversions and indirect losses due to delays by water diversion-caused deviations from normal migration routes, and (3) the probable streamflow requirements to facilitate both upstream and downstream migration.

Previous sections of this report have addressed the environmental requirements of the zooplankton food sources utilized by salmonids. Fish and Game in their Exhibit 11, page 9, has made estimates as to the minimum satisfactory flows in the Sacramento River to protect salmonid migration. Higher flows provide benefits beyond this minimum. In addition, recommendations are made as to project export curtailments, operational criteria to minimize the diversion of young salmonids into the interior Delta, and methods of operations at the diversion locations to minimize the diversion of salmonids from the Delta. The recommended flows past Rio Vista are the best available information reflecting the minimum flow needs of salmonids in the Delta. The specific flows will be described in Chapter IV. In addition, net downstream flow in Delta channels is believed necessary for efficient migrations.

American Shad

The American shad (Alosa sapidissima) is a popular sportfish in the rivers above the Delta. Shad are anadromous, spawning in freshwater and maturing in the ocean. Figure III-29 shows that the bulk of the spawning run passes through the Delta from February to May. Adults migrating through the Delta feed principally on Neomysis, but they also eat small zooplankton. A few shad spawn in the southern Delta and small numbers use the San Joaquin River, but most are bound for the Sacramento River system (Fish and Game Exhibit 3, p. IV-1).

Spawning occurs from April to July, with peak spawning in late May and early June. Water temperatures are usually from 58°F to 70°F. Some spawning takes place in the Delta in locations where there is fast current and freshwater, but most spawning is further upstream. Many shad die after spawning (Fish and Game Exhibit 3, p. IV-1).

Fertilized eggs drift with the current near the bottom and hatch in 4 to 6 days. The primary nursery area for young shad is upstream of the Delta where they grow to a length of 2 to 3 inches before they migrate. Outmigration occurs over a long period. Throughout the river system larvae are most abundant in May and June, peaking in June. Larger fry and young-of-the-year are most abundant in July.

Outmigrants are most numerous in the Delta from July through November (Figure III-29). The length of the outmigrants increases as the season progresses. Limited information indicates that the young shad in the Delta eat zooplankton (copepods and cladocerans) primarily (Fish and Game Exhibit 3, p. IV-1).

Two relationships have been described that relate annual production of young shad to river flow during the spawning season. The first relationship, based on young shad outmigrants captured during trawl surveys, shows that the catch increases as the April through June Delta inflow increases (Fish and Game Exhibit 3, Figure IV-2). The second relationship shows that the catch of shad migrants at the

CVP and SWP fish screens during August and September increases as water exports and April-June flow to the Delta increase (Fish and Game Exhibit 3, Figure IV-1).

The most plausible hypothesis for the mechanism controlling these relationships is that (1) Delta inflow likely reflects the amount of suitable spawning and nursery habitat upstream of the Delta, (2) habitat availability likely determines productivity by controlling density-dependent mortality, and (3) exports draw large populations of young shad away from their typical migration routes on their way to sea.

Many shad migrate downstream through the forks of the Mokelumne River, which are major cross-Delta water transport channels. This increases the susceptibility of shad populations to project exports. Shad "salvaged" at the CVP and SWP screens totaled about 3 and 4 million in 1974 and 1975, respectively. "Salvage" of shad is a somewhat misleading description since mortality at the fish screens is probably high as shad are notoriously difficult to handle and transport. Preliminary data indicates a 28 percent mortality just from placement of the shad in holding tanks at the SWP facility for 1 to 4 hours.

The cross-Delta flows direct shad into the interior Delta where they are more susceptible to predation than they are when they migrate in the Sacramento River. Once in the interior Delta some shad may become disoriented by project induced reverse flow conditions and never reach the ocean (Fish and Game Exhibit 3, p. IV-2).

Suitable flows are essential in the spawning tributaries to maintain the shad resource. The young and adult outmigrants need to be protected against losses due to Delta water exports. Both young and adult shad feed while migrating through the Delta, so their food supply, consisting of copepods, cladocerans, and Neomysis, also requires protection (Fish and Game Exhibit 3, p. IV-2).

Sturgeon

Two species of sturgeon, white (*Acipenser transmontanus*) and green (*A. medirostris*), live in the estuary. The white sturgeon is the more abundant of the two. In 1967 the population of white sturgeon was estimated to be about 115,000. Sturgeon often live far more than 30 years and grow to several hundred pounds (Fish and Game Exhibit 3, p. IV-5).

The party-boat fishery for sturgeon has grown tremendously since 1964. In that year it was found that sturgeon could be taken by using shrimp as bait. The yearly party-boat catches jumped from three sturgeon in 1963 to 1,825 in 1967 (Fish and Game 1968, p. 264).

White sturgeon are found most often in Suisun and San Pablo Bays during the summer, fall, and winter. In late winter and spring a portion of the population migrates up the Sacramento River to the area between Knights Landing and Hamilton City for spawning. After spawning the adults move back downstream to the Delta, Suisun Bay and San Francisco Bay. Green sturgeon often migrate along the coast as far north as the State of Washington (Fish and Game Exhibit 3, p. IV-5). They also spawn in the Sacramento River, but the exact distribution is not known; it is probably similar to that of the white sturgeon. The spawning period is inferred to be from mid-February to late May from collections of sturgeon larvae found in the Sacramento-San Joaquin River systems (Kohlhorst, 1976).

Sturgeon eggs are adhesive after being fertilized and stick to vegetation and rocks. Incurbation is generally 5 to 10 days. The nursery area for the young is apparently formed both by the river near and below the spawning area and by the Delta and bays downstream. The abundance of young in the Delta and Suisun Bay is related to river flows. Many newly hatched larvae are transported downstream to the Delta and Suisun Bay in years with high runoff, but they are scarce there in years with low runoff. Neomysis and Corophium make up most of the food of juveniles in the Delta. Larger sturgeon feed primarily on small crabs, bay shrimp, clams, and small fishes (Fish and Game Exhibit 3, p. IV-5).

Sturgeon are quite variable in growth rate and age at sexual maturity. In the Sacramento-San Joaquin system ripe females ranged from 12 to 20 years old and were 45 to 69 inches in length. The interval between spawnings for female white sturgeons in California is probably 5 years or so. No similar data is available for males (Miller, 1972).

There is little knowledge of factors controlling abundance of sturgeon either in the Bay-Delta area or in the other West Coast river systems. The principal feature of the important feeding areas in San Pablo and San Francisco Bays appears to be the broad mud flats supporting large invertebrate populations. Environmental factors such as photoperiod, temperature, and the usual copious winter and spring flows could be important spawning stimuli. Since yolk sac larvae have negligible swimming capabilities, they are probably very susceptible to removal by water diversions. Early transport to the Delta where important food organisms are abundant depends on river flows, but the importance of this early transport to the overall production of young is unknown. Conditions which are optimum for Neomysis and Corophium, will likely enhance survival and growth of both young-of-the-year and juveniles (Fish and Game Exhibit 3, p. IV-5; RT Vol. XI, p. 50).

Resident Game Fishes

The major resident game fishes in the Delta are catfish and various sunfish (centrarchids). The catfish species are the white and the channel catfish and the black and the brown bullhead. The most important sunfish are the black crappie, largemouth bass, and bluegill. The largest resident sport fishery in the Delta is for catfish, mostly white catfish. The black crappie, largemouth bass, and bluegill fisheries are important, but less extensive than the catfish fishery (Fish and Game Exhibit 3, p. IV-6).

The white catfish, Ictalurus catus, was first introduced into California in 1874 from its native coastal streams in the southern and mid-eastern United States (Fish and Game 1968, p. 233).

White catfish have not been observed spawning in the Delta. Young-of-the-year white catfish are found throughout the Delta, but a survey in 1963 and 1964 showed them to be more abundant in the southern Delta channels. Adult white catfish are found throughout the Delta and seem to prefer the quiet waters of main channels and dead-end sloughs. White catfish have been collected as far downstream as Suisun Bay although in very small numbers (Fish and Game 1968, p. 233). Channel catfish are found mostly in the swifter waters in principal channels upstream from the central Delta.

Because of the wide distribution of white catfish, many young-of-the-year are drawn to the export pumps at Tracy. Screening efficiency at the SWP screens is only 4 to 68 percent for various size groups between 10 and 100 mm. Therefore, most of the young drawn to the pumps are carried into the export channels (Fish and Game Exhibit 3, p. IV-7).

While exact salinity tolerances of white catfish are not known, a few have been taken in Suisun Bay at salinities up to 5800 mg/l TDS and in small sloughs in Suisun Marsh at salinities up to about 10,000 mg/l TDS. However, catfish are most abundant at salinities below 1000 mg/l TDS.

Largemouth bass (Micropterus salmoides), bluegill (Lepomis macrochirus) and black crappie (Pomois nigronmaculatus) are the major species in the sunfish sport fisheries (Fish and Game Exhibit 3, p. IV-6).

While sunfish have not been observed spawning in the Delta it is suspected that they do. Young sunfish are found primarily in the quiet sloughs off the main Delta channels. These fish seem to be less tolerant to high TDS than the white catfish. Black crappie have been taken in some of the Suisun Marsh sloughs at salinities of 9000 to 10,000 mg/l, but they were not abundant. In early October 1976, crappies were abundant at TDS levels of about 8100 to 8600 mg/l in Denverton Slough. In general, however, the greatest populations of sunfish are found in waters of less than 1000 mg/l TDS (Fish and Game Exhibit 3, pp. IV-6, IV-7).

Catfish and young sunfish feed primarily on Neomysis and Corophium. Young sunfish, however, consume quantities of copepods and cladocerons (crustacean zooplankton) while adult crappie and largemouth bass commonly prey on small fish.

The environmental requirements of resident game fish are generally less demanding than those of the anadromous fish, chiefly due to their relatively nonmigratory nature. In addition, because most resident game fish prefer quiet water and nest on the bottom, they are relatively immune to losses due to water diversions from the Delta. As mentioned previously, however, the losses of young-of-the-year while catfish are an exception.

One influence of water export which resident fish have in common with the anadromous fishes is the reduction of food organisms, e.g., Neomysis and Corophium, due to cross-Delta water transport. The other effect is the reduction in freshwater habitat due to salinity intrusions into the western Delta. The extent of the effect would depend upon the extent and frequency of intrusions (Fish and Game Exhibit 3, pp. IV-5, IV-6 and IV-7).

Resident Non-Game Fishes

In addition to the fishes taken by anglers and commercial fishermen, a variety of other fishes are found in the Delta. Some are food for game fish, while others either feed on game fish or compete with them in various ways. A few have some potential value as food for humans, but their direct value for sport or commercial fisheries are limited (Fish and Game Exhibit 3, p. IV-7).

Cyprinids. Members of the cyprinid (minnow) family in the Delta include the native Sacramento blackfish, Orthodon microlepidotus, Sacramento hitch, Lavinia exilicauda, splittail, Pogonichthys macrolepidotus, Sacramento squawfish, Ptychocheilus grandis, the introduced carp, Cyprinus carpio, goldfish, Carassius auratus, and golden shiner, Notemigonus crysoleucas. Cyprinids are basically freshwater fishes, but the salinity tolerances vary among species. The splittail has a reasonably high salt tolerance and is found throughout the Delta and even in the bays (Fish and Game Exhibit 3, p. IV-8). The Sacramento squawfish, in contrast, is found primarily upstream of the Delta (Fish and Game Exhibit 3, p. IV-7) and seems to be limited to completely freshwater areas (Turner, 1966(a).

Cyprinids, except for the Sacramento squawfish, tend to be most abundant in areas with low flow velocities. Few are found west of Antioch. Increased flow velocities in cross-Delta transport channels would likely restrict and degrade their habitat (Fish and Game Exhibit 3, p. IV-7).

The splittail is found in few places outside the Delta. The Department of Fish and Game is concerned that unless areas inhabited by splittail are maintained in their present condition, it may not survive. Little information is available regarding habitat requirements of this species but splittail are known to spawn in quiet waters along the eastern periphery of the Delta (Fish and Game Exhibit 3, p. IV-8).

Threadfin Shad. Threadfin shad, Dorosoma petenense, are important forage fish for the striped bass and other predatory fish, such as black crappie and largemouth bass. They are most abundant in slow moving waters along the eastern periphery of the Delta but are also found downstream in the Bay. Increased cross-Delta flows probably would have a small negative impact on the species (Fish and Game Exhibit 3, p. IV-8).

Smelts. Two species of smelt (Osmerids) are found in the Delta. These are the longfin smelt, Spirinchus thaleichthys, and Delta smelt, Hypomesus transpacificus. The Delta smelt seems to be restricted to the low end of the salinity gradient. The longfin smelt tolerate greater salinities and are found in the Delta and bays (Fish and Game Exhibit 3, p. IV-8).

Like most osmerids the longfin smelt is anadromous. As with striped bass and American shad, annual production of the longfin smelt is highly correlated with spring (April-May) outflow (Fish and Game Exhibit 3, Figure IV-4, p. IV-9). Smelt lay eggs that sink and adhere to pebbles or sand grains, but the newly hatched young behave much like young striped bass and drift with the current. Hence, the production of longfin smelt may be controlled by the same factors that control young striped bass survival (Fish and Game Exhibit 3, p. IV-8).

Tule Perch. Tule perch are primarily benthic feeders. Corophium is the most important food source for these fish. Tendipedia larvae are also important, especially for young-of-the-year tule perch (Turner, 1966(b)). These benthic habits, plus the fact that the young are born fully formed and capable of swimming, should make this species relatively immune to the direct effects of water export increases. Indirect effects by restriction of Corophium could possibly pose a problem.

Starry Flounder. The starry flounder, Platichthys stellatus, is a euryhaline flatfish which is common in San Pablo and Suisun Bays below the Delta. It is probable that this species ranges into the Delta from the bay area. Its role in the Delta ecosystem appears to be a minor one. Some spawning may occur there and the young flounders provide some striped bass forage (Radke, 1966). It is unlikely that either moderate salinity intrusion or an increase in water exports would directly impact this species.

Sculpins. At least two species of sculpins have been taken in the Delta. These are the Pacific staghorn sculpin, *Leptocottus armatus*, and the prickly sculpin, *Cottus asper*. The staghorn sculpin is primarily marine but ranges into brackish and freshwater. The prickly sculpin is found in the freshwater of coastal streams and is known to breed in the Delta (Turner, 1966(b)).

Sculpins, as bottom-dwelling fish, are unlikely to be directly impacted by water transport in the Delta. Moderate salinity intrusions would probably not reduce the abundance of the two sculpins, but might restrict the range of the prickly sculpin (Fish and Game Exhibit 3, p. IV-8).

Rare and Endangered Fish Species. Only one species of fish in the Delta or Suisun Marsh is currently listed by the Department of Fish and Game as rare or endangered. This fish, the thicktail chub, *Gila crassicauda*, has not been collected since 1957 and is thought to be extinct in the Delta and Suisun Marsh areas (Jones and Stokes et al, 1975).

Suisun Marsh

Hydrology and salinity relationships in the channels of the Suisun Marsh area have been described previously in this chapter. This section discusses the environmental factors which have been considered in establishing salinity control objectives for continued maintenance of the Marsh.

Suisun Marsh is a remnant of the more extensive brackish water marsh areas which formerly bordered San Francisco Bay. The diversity and extent of habitat available in Suisun Marsh is a critical factor in the maintenance of certain species of fish and wildlife.

Over 200 species of birds have been identified in Suisun Marsh. In addition to ducks and geese, there are herons, egrets, shore birds, rails, coots, grebes, terns, hawks, eagles, doves, pheasants and many other birds that depend on the marsh for their survival. Many are permanent residents; still more are either summer or winter visitants.

In addition to birds, the Marsh also supports many mammals reptiles, amphibians, fishes and invertebrates. Among mammals that inhabit the Marsh are muskrat, beaver, river otter, mink and the Suisun shrew. There are two subspecies of salt marsh harvest mouse in the San Francisco Bay area and in the marshes around Suisun Bay. Suisun Marsh supports 45 species of mammals and 15 species of reptiles and amphibians (RT Vol. XII, p. 10).

As might be expected of a dwindling habitat, a number of species of animals found in the Marsh are rare and/or endangered. These include one of the subspecies of the salt marsh harvest mouse just mentioned, the giant garter snake, California black rail, American peregrine falcon, bald eagle, yellow-billed cuckoo, and the tule goose. Of these species, the mouse, snake and rail are dependent on marsh habitat (RT Vol. XII, pp. 10-11, p. 83).

The Marsh provides not only food but also essential habitat for many species of animals. Trees and bushes in Suisun Marsh provide nesting sites for many birds that otherwise could not live there. Tules and cattails provide food for beaver and muskrat and valuable cover for many non-game species of wildlife (rail, blackbird, etc.).

To maintain the diversity of animal species, the Marsh must be heterogeneous. A single uniform habitat could not maintain the present wide variety of animals. Beaver and muskrat eat foods from plant species found in freshwater portions of the Marsh. On the other hand, the Suisun shrew and salt marsh harvest mouse live among plant species (Salicornia) that predominate only in saltier parts of the Marsh. It is not known whether or not their life cycles require low salinity water at some time (Schaub, 1971).

One of the major factors controlling the vertical stratification of vegetation is the extent of tidal inundation of the plants. The resulting plant distribution in natural marsh areas produces definite patterns or vertical zones of vegetation. The vertical patterns in the managed portion of the Marsh are more diffuse than in natural tidal marsh areas because the land manager can and does alter the duration and depth of submergence (Fish and Game Exhibit 3, p. VI-8).

Some plant species, such as fat hen (Atriplex patula) and brass buttons (Catula coronapifolia), grow best on disturbed soil (Fish and Game Exhibit 3, p. VI-13). Alkali bulrush (Scirpus robustus), of great importance as waterfowl food, is a perennial that survives well under stable conditions. Only as a result of low salinity conditions for seed germination are new stands of alkali bulrush produced. These newly established stands in turn produce more seed than other stands (Miller et al, 1975). Thus, changes in conditions through time, temporal heterogeneity, are beneficial for the Marsh. Therefore, both spatial and temporal heterogeneity are important to maintenance of marshes as complex and productive ecosystems. Continuing this heterogeneity may be as difficult as meeting the need for low salinity water.

Salinity Requirements of the Managed Wetlands. As described earlier, about 57,000 acres of the Suisun Marsh area are diked, managed wetlands which provide habitat for waterfowl during their winter stay in California. The managed areas are more important for most waterfowl than the surrounding natural tidal marshes because management of these lands allows more food per acre can be produced and the water surface area and depth to be controlled to provide more desirable waterfowl habitat.

Studies by Fish and Game have shown that the five most abundant duck species primarily utilize only 6 of the 177 plant species identified in the Marsh (Fish and Game Exhibit 3, p. VI-2). Of these six plant species, alkali bulrush was the major food of an estimated 88 percent of the wintering waterfowl even though it represented only 6.3 percent of the marsh vegetation in 1960 and 12.7 percent in 1973. Brass buttons was second in overall use even though it constituted only 2.1 percent of the marsh vegetation in 1960. No use data was provided for 1973. Fat hen was third in importance in 1960 and second in 1971 (Fish and Game Exhibit 3, p. VI-4).

Soil salinity in the Marsh during spring is a major factor affecting these important plants. It not only affects their distribution in the Marsh but also affects the amount of waterfowl food that they produce. Soil salinity reflects composite of the water available to the land over the year.

The tidally influenced areas of the Marsh are periodically inundated by water from the contiguous bays and sloughs. Maximum flooding of these lands occurs at high tide. Therefore, channel water at high tide is the major source of water for these areas, as it is for the managed areas of the Marsh. The managed areas, diked and physically separated from the tidal marshes, obtain their water supply from the surrounding bays and sloughs principally from October through May. Flap gates allow water at high tide to flow into the managed areas to fill the interior ponds. At low tide the flap gates are used to prevent flow of water from the ponds, except when they are being actively drained. Because of the small gradient between the pond level and the maximum or minimum tidal stages, filling or draining the pond takes many tidal cycles to complete.

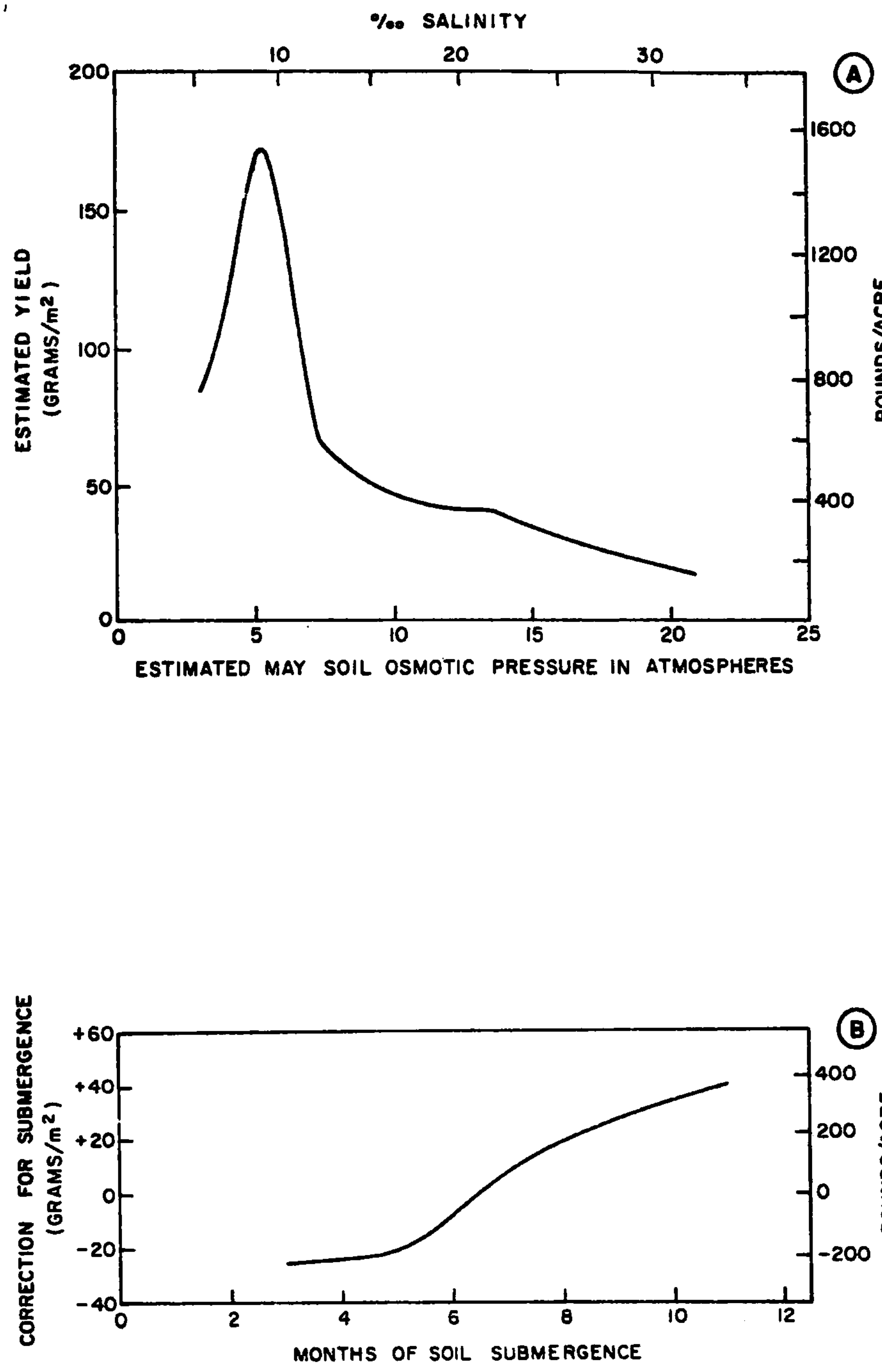
Pond water and the salt it contains, along with management of the water applied to obtain effective leaching of salts from the soils, determine the soil salinity. As Delta outflow decreases, channel water salinity at high tide increases causing higher pond water salinities which result in higher soil salinities.

The requirements of alkali bulrush have been studied because of the importance of its seed to waterfowl. Seed yield is a function of soil salt concentrations in the month of May. The most suitable salt concentration during May was found to be about 8 parts per thousand (ppt) TDS (RT Vol. XII, p. 25). The relationship between seed yield and May soil salinity is shown in Figure III-30. The apparent decline in yield with concentrations less than 8 ppt TDS is due to interspecific competition and not the effects of lowered salinity (Fish and Game Exhibit 3, p. VI-11).

Germination of alkali bulrush seeds is also affected by soil and water salinity. As water salinity increases in the spring, the rate of seed germination declines and the time required for germination increases. In Fish and Game studies, only 3-8 percent of the seeds immersed in water with a salinity of 10 ppt TDS

FIGURE III-30

RELATION OF ALKALI BULRUSH SEED YIELD TO MAY SOIL SALINITY AND LENGTH OF SOIL SUBMERGENCE.



SOURCE: Dept. of Fish & Game Exhibit 3 Figures VI 2 germinated during a two-month test. In distilled water 91 percent of the seeds germinated within 3 weeks. Virtually no germination occurred in water of 15 ppt TDS.

Management practices also influence seed production of alkali bulrush. Long soil submergence provides an added benefit by increasing seed yield. Less than eight months submergence reduces yield, and longer submergence increases yield. This relationship is shown in Figure III-30(b). Although not indicated by the figure, May salt concentrations at or above 25 ppt TDS are assumed to be completely limiting to seed production regardless of the length of soil submergence (Fish and Game Exhibit 3, p. VI-13).

In addition, manipulation of flooding practices affects the soil salinity concentrations. Salts are present at all times in the soil underlying Suisun Marsh. When the soil is flooded with freshwater, salts in the upper zone are leached out. The extent of reduction in soil salinity during flooding depends on (1) salinity of the applied water, (2) permability of the soils, (3) efficiency of drainage systems, (4) the number of leaching cycles, and (5) to a lesser extent the duration of soil submergence. The management of land in Suisun Marsh is based on these effects. Individual facilities for moving water on and off the managed portions of the Marsh, water management programs and, of course, available water quality are used by land managers to selectively encourage desirable food plants while discouraging other less desirable species.

Before one can determine the water quality necessary to provide the best possible conditions for any particular species of plant, assumptions must be made as to the adequacy of the management facilities and the type of water management programs that will be employed.

Fish and Game in their Exhibit 3, pages VI-17 and VI-18, presented a water management schedule that has been formulated as a guide to duck club owners and operators to maximize waterfowl food production. This water management schedule was the product of many years of research and field experience. "Properly executed it favors the production of the three major waterfowl food plants, alkali bulrush, fat hen, and brass buttons, and does not result in the complete eradication of any other plant species" (Fish and Game Exhibit 3, p. VI-18).

Assuming that adequate management facilities would be available on each duck club, Fish and Game proposed a water quality schedule for the months October through May (Fish and Game Exhibit 3, p. VI-20). If this water quality were made available to each club, Fish and Game believes that 90 percent of maximum alkali bulrush production could be achieved provided adequate management facilities are utilized and the proposed water management schedule is followed. The specifics of this water quality schedule are discussed under project mitigation in Chapter IV and are shown in Table IV-1, Column B.

Suisun Marsh Protection Plan. Recent legislation has authorized the development of a plan for protection of Suisun Marsh. The Suisun Marsh Preservation Act of 1977 (AB 1717) authorized the San Francisco Bay Conservation and Development Commission (BCDC) to administer the Suisun Marsh Protection Plan which was submitted by BCDC to the Legislature on December 17, 1976. Section 29205 of the Act establishes the Marsh as part of BCDC's segment of the California coastal zone for purposes of planning and management pursuant to the Coastal Zone Management Act of 1972 (PL 92-583; 16 U.S.C. 1451 et seq.). The Act provides that the County of Solano shall prepare a local protection program for the Marsh which is consistent with the policies of the Protection Plan prepared by BCDC (Section 29400). The local protection program is to regulate development in and adjacent to Suisun Marsh. The Suisun Resource Conservation District is designated as the agency to prepare and administer a management program designed to preserve, protect and enhance the plant and wildlife communities within the primary management area of the Marsh. These plans are to be approved by Fish and Game and submitted to BCDC for certification not later than January 1, 1979.

The Act recognizes the dependency of the Marsh on the maintenance of adequate water quality which is a function of the freshwater outflow from the Delta, and that future upstream storage on tributaries to the Delta could have adverse impacts on the Marsh unless adequate mitigation measures are taken (Section 29010(a). The Act does not authorize BCDC to take action relating to maintenance of adequate salinity in the Marsh. However, it states that the

Legislature expects the resolution by other agencies of the problems relating to upstream development and the development of alternative water supplies to the Marsh to protect it from the adverse impacts of salinity intrusion and from any other significant adverse impacts (Section 29010(b)).

The Act imposes a judically enforceable responsibility on all state agencies to comply with the policies of the protection plan (Section 29302(a)) but specifically exempts any local, state or federal agency from being required by such policies to establish or meet a specific water quality standard in the Marsh, or to maintain a specific level of Delta outflow (Section 29302(c)). These policies were used in the development of the recommended plan discussed in Chapter V of this document. The policies contained in the Suisun Marsh Protection Plan have been reviewed and the following appear to be relevant to the proposed action by this Board. The headings and numbers are as they appear in the Suisun Marsh Protection Plan.

<u>Environmental Policies</u>:

1. The diversity of habitats in the Suisun Marsh and surrounding upland areas should be preserved and enhanced wherever possible to maintain the unique wildlife resource.
2. The Marsh waterways, managed wetlands, tidal marshes, seasonal marshes, and lowland grasslands are critical habitats for marsh-related wildlife and are essential to the integrity of the Suisun Marsh. Therefore, these habitats deserve special protection.

3. Existing uses should continue in the upland grasslands and cultivated areas surrounding the critical habitats of the Suisun Marsh in order to protect the Marsh and preserve valuable marsh-related wildlife habitats. Where feasible, the value of the upland grasslands and cultivated lands as habitat for marsh-related wildlife should be enhanced.
4. The eucalyptus groves in and around the Marsh, particularly those on Joice and Grizzly Islands, should not be disturbed.

Water Supply and Quality Policies:

1. There should be no increase in diversions by state or federal governments that would cause violations of existing Delta Decision or Basin Plan standards.
2. Basin Plan water quality standards should be reviewed as better data becomes available, and revised as necessary to protect the Marsh.
3. Water quality standards in the Marsh should be met by maintaining adequate inflows from the Delta. Freshwater from projects designed to import or redistribute freshwater in the Marsh, and, therefore, to compensate for reduced inflow from the Delta, should not be used unless it is established that the importation or redistribution of water will not have a significant adverse impact on the Marsh.

The (proposed action by the Board) would not be in conflict with the above policies. The Act authorizes BCDC to submit to any state agency recommendations designed to carry out its functions in a manner consistent with the policies of the protection plan (Section 29304(a)). Any state agency receiving such recommendations must consider them and, in the event the recommendations are not implemented, report to BCDC or the Governor and the Legislature its action and the reasons therefor (Section 29304(b)).

Recommendations were submitted by BCDC to the Board during the hearing (RT Vol. XV. p. 9 et seq., December 11, 1976. The recommendations which relate to the control of salinity and Delta outflow, or the mitigation of adverse impacts resulting from these factors, are summarized below.

Adoption by the Board of the following specific objectives was recommended by BCDC for any water quality control program for the Suisun Marsh:

> "That diversity [of] habitats in the Suisun Marsh and surrounding upland areas should be preserved and enhanced wherever possible to maintain the unique wildlife resource and the marsh waterways, managed wetlands, tidal marshes, seasonal marshes, and lowland grasslands should receive special protection since they are critical habitats for marsh-related wildlife, and are essential to the integrity of the Suisun Marsh."

"The Board should set long-term easily monitored salinity standards for water in the Marsh ensuring that, one, a mean annual soil salinity between 8 and 18 parts per thousand TDS in the first 12 inches of soil on the managed wetlands anywhere in the marsh, and, two, soil salinity during the month of May not exceeding nine [parts per thousand] TDS in the first 12 inches of soil."

"We would encourage you to change the existing definition of the Suisun Marsh to include the Primary Management area defined in the Suisun Marsh Protection Plan. In addition, the westward limit of the boundary should be extended to the Carquinez Straits."

"In order to reduce or eliminate the possible effects of increased salinity, a number of freshwater importation projects are under study; however, the extent of possible feasibility of freshwater import projects is unproven. In light of the uncertainty surrounding the impacts of the marsh from freshwater import projects, [BCDC] believes that water quality standards in the marsh should be met through the maintenance of adequate inflow from the Delta. The Board, therefore, [should] preclude projects designed to import or redistribute freshwater in the marsh unless it is established that such projects will have no significant adverse impacts on the marsh."

"The Central Valley Project and California Water Project should be required to finance (1) the construction, operation, and maintenance of any facilities required to provide a replacement freshwater supply of suitable quality to the marsh; (2) the distribution of such water within the marsh, and (3) the increased cost of improved water management methods necessary to efficiently use it on the managed wetlands."

"Continued monitoring and research. Monitoring should continue indefinitely to accurately record impacts on the flushing of San Francisco Bay, turbidity, sediment distribution, and soil salinity. The cost of monitoring should be borne by those who use diverted water."

Salinity Requirements of the Unmanaged Wetlands. The recommendations of Fish and Game, California Waterfowl Association and the Suisun Resource Conservation District primarily relate to protection of the managed areas of Suisun Marsh. The concerns expressed by the U. S. Fish and Wildlife Service for protection of fish and wildlife habitat in the unmanaged areas of the Marsh (U. S. Fish and Wildlife Service Exhibits 4 and II-1), and the policies of the Suisun Marsh Protection Plan have required consideration of additional information. Several recent reports are available as sources of such information (Jones and Stokes et al, 1975; CH^2M Hill, 1976; BCDC Staff, 1976; Department, 1974(b); Miller et al, 1975).

As previously described Suisun Marsh has been defined by the Legislature to include Suisun, Grizzly and Honker Bays and the islands within these bays. The managed marshlands comprise approximately 88 percent of the total land area. Some of the remaining 12 percent, or about 6880 acres, could be affected as wildlife habitat by increases in salinity. However, a substantial amount of this area, including the Potrero Hills and the eastern boundary of the Marsh near the Montezuma Hills and Kirby Hill, are at sufficient elevation above sea level that the vegetative cover would not be affected by changes in Marsh salinity. The remaining possibility would be that the vegetation on or adjacent to levees might be affected and change its value as habitat for wildlife.

The riparian vegetation along the channel side of the levees in tidal sloughs is limited by the depth and frequency of flooding to species such as narrowleaf cattail (*Typha angustifolia*), olney bulrush (*Scirpus olneyi*), and tules (*Scirpus acutus or S. californicus*). Figure III-12 on page III-34 graphically shows the locations of the managed marsh, tidally influenced areas and various other habitats in the Marsh. Olney bulrush and tules can tolerate higher salinities than narrowleaf cattail. These plants provide protective cover for waterfowl, small mammals and game birds, fish, and amphibians. They also provide nesting sites for some species and serve as food for muskrats. The abundance of this type of vegetation is limited in many areas due to channelization and dredging for levee fill. Progressing upstream in the various channels which receive fresh water inflow, the levees may support willows (*Salix sp*), blackberry (*Rubus ursinus*), California rose (*Rosa californica*), and occasional trees such as eucalyptus (*Eucalyptus sp*) or alder (*Alnus rhombi olia*) (Jones and Stokes et al, 1975).

Although such riparian vegetation may be limited to narrow strips and may be subjected to occasional control efforts, it is more important as resident wildlife habitat on an acre-for-acre comparison than many areas of the Marsh which are seasonally flooded. The riparian vegetation supports many small animals such as birds, rodents and amphibians which are prey for predators such as the mink (Mustela vison), otter (Lutra canadensis), raccoon (Procyon lotor), owls, hawks, falcons and eagles. For a more comprehensive list of species and information on their occurrence with various types of vegetation, the reader is referred to the Fish and Wildlife Element of the Suisun Marsh Protection Plan (Jones and Stokes et al, 1975).

The effect of increasing salinity in the tidal channels probably would be to alter gradually existing riparian vegetation to more salt tolerant species. In a given area this could mean that cattails would be replaced by tules, tules would be replaced by cord grass, and that willows, blackberries, California Rose and trees which require less saline water would gradually die and disappear. The most significant loss in such a change probably would be the disappearance of trees which serve as nesting sites and roosting cover for various birds. The extent of tidal areas and the location of eucalyptus trees are shown on Figure III-12. Insufficient information is available to allow a quantitative estimate of the effects of habitat changes on wildlife populations in the Marsh. In addition, the significance of any such change may be overshadowed by other changes in the management or development of adjacent lands. If changes in vegetation and wildlife habitat occur, it is important to consider potential effects on rare and endangered species.

Lists of plants and animals in the Suisun Marsh area which have been classified as rare and endangered are included in Tables III-2 and III-3, respectively. Locations of the rare and endangered plant species are shown in Figure III-12.

If the proposed Board action results in an increase in the salinity in the tidal channels, the only species on the lists in Tables III-2 and III-3 which might conceivably be adversely affected would be the California yellow-billed cuckoo and the thicktail chub. The remaining species either have a high salinity tolerance or inhabit the managed areas of the Marsh and would not be adversely affected by the proposed action.

The California yellow-billed cuckoo may no longer exist in Suisun Marsh. Recent statewide surveys have established to Fish and Game's satisfaction that the species does not exist in the Suisun Marsh area (Leach, 1978). Thus, no further consideration of this species is warranted.

The thicktail chub may be already extinct since the last known specimen was collected in 1957 from Steamboat Slough. The thicktail chub has not been found since then in the extensive fish collections by Fish and Game from their netting operations conducted in the Delta and Suisun Marsh, or from the fish collection facilities at the CVP and SWP Delta pumping plants. The Board believes that sufficient netting has been done by Fish and Game in the Suisun Marsh area to be reasonably sure that this species no longer exists in the Marsh.

TABLE III - 2

RARE AND ENDANGERED PLANTS LOCATED IN THE SUISUN MARSH AREA

	Species	CNPS 1/ R-E-V-D Code	Habitat Type
1.	Bolander water hemlock (Cicuto bolanderi)	2-2-2-3	Salt marshes
2.	Suisun thistle (Cirsium hydrophilum var. hydrophilum)	3-3-3-3	Brackish marshes around Suisun Bay
3.	Hispid bird's beak (Cordylanthus mollis hispidus)	2-2-2-3	Alkaline places, valley grasslands
4.	Soft bird's beak (Cordylanthus mollis mollis)	P.E.--3	Salt marshes
5.	Contra Costa baeria (Lasthenia conjugens)	3-2-2-3	Low, sunny flats, drying borders of vernal pools
6.	Lilaeopsis masonii (no common name)	P.E.--3	No information

1/ California Native Plant Society Rarity - Endangerment Code

Rarity (R)

1. Rare, of limited distribution, but distributed widely enough that potential for extinction or extirpation is apparently low at present.
2. Occurrence confined to several populations or one extended population.
3. Occurs in such small numbers that it is seldom reported; or occurs in one or very few highly restricted populations.

P.E. Possibly extinct or extirpated.

Endangerment (E)

1. Not endangered.
2. Endangered in part.
3. Totally endangered.

Vigor (V)

1. Stable or increasing.
2. Declining.
3. Approaching extinction or extirpation.

General Distribution (D)

1. Not rare outside California.
2. Rare outside California.
3. Endemic to California.

[Information from California Native Plant Society, Spec. Pub. No. 1, "Inventory of Rare and Endangered Vascular Plants of California," 1974]

TABLE III-3

RARE, ENDANGERED AND UNIQUE VERTEBRATE SPECIES WHOSE DISTRIBUTION INCLUDES THE SUISUN MARSH AND SACRAMENTO-SAN JOAQUIN DELTA

		Present Status				
		State		Federal		
Common Name	Scientific Name	Cal	Pro	FR	T	
MAMMALS						
*Salt-marsh harvest mouse	Reithrodontomys raviventris halicoetes	E	x	x		
BIRDS						
+Aleutian Canada goose	Branta canadensis leucopareia			x		
+Tule white-fronted goose	Anser albifrons gambelli				x	
*Red-shouldered hawk	Buteo lineatus elegans				x	
Ferruginous hawk	Buteo regalis				x	
Southern bald eagle	Haliaeetus leucocephalus leucocephalus	E	x	x		
American osprey	Pandion haliaetus carolinensis				x	
Prairie falcon	Falco mexicanus		x		x	
American peregrine falcon	Falco peregrinus anatum	E	x	x		
+California black rail	Laterallus jamaicensis coturniculus	R	x		x	
*Alaskan short-billed dowitcher	Limnodromus griseus caurinus				x	
Northern long-billed curlew	Numenius americanus parvus				x	
+California yellow- 1/ billed cuckoo	Coccyzus americanus occidentalis	R				S
*Suisun song sparrow	Melospiza melodia maxillaris				x	
*Western burrowing owl	Speotyto cunicularia hypugaea				x	
*White-tailed kite	Elanus leucurus		x			
FISH						
+Thicktail chub 1/	Gila crassicauda	E	x			S
*Sacramento perch	Archaplites interruptus				x	
REPTILES						
*Alameda striped racer	Masticophis lateralis euryxanthus	R				
*Giant garter snake	Thamnophis couchi gigas	R			x	

State of California

Cal California Department of Fish and Game, 1976. At the Crossroads - A Report on California's endangered and rare fish and wildlife.

R Rare species

E Endangered species

Pro Fully protected species by state law, California Fish and Game Code.

(continued on next page)

TABLE III-3
(continued)

Federal Government

FR On official federal endangered species list, Federal Register, July 14, 1977.

T Those species identified by the U. S. Fish and Wildlife Service as being possible candidates for official endangered species list, but at the present time have no legal status. U. S. Fish and Wildlife Service, 1973. Threatened Wildlife of the United States.

S May be adversely influenced by changes in salinity in tidal channels.

+ Occurrence of this species on the study area is uncertain.

* Known or likely to breed in the study area.

1/ No longer believed to exist within the study area.

Sources: Jones & Stokes, 1975
Fish and Game, 1976

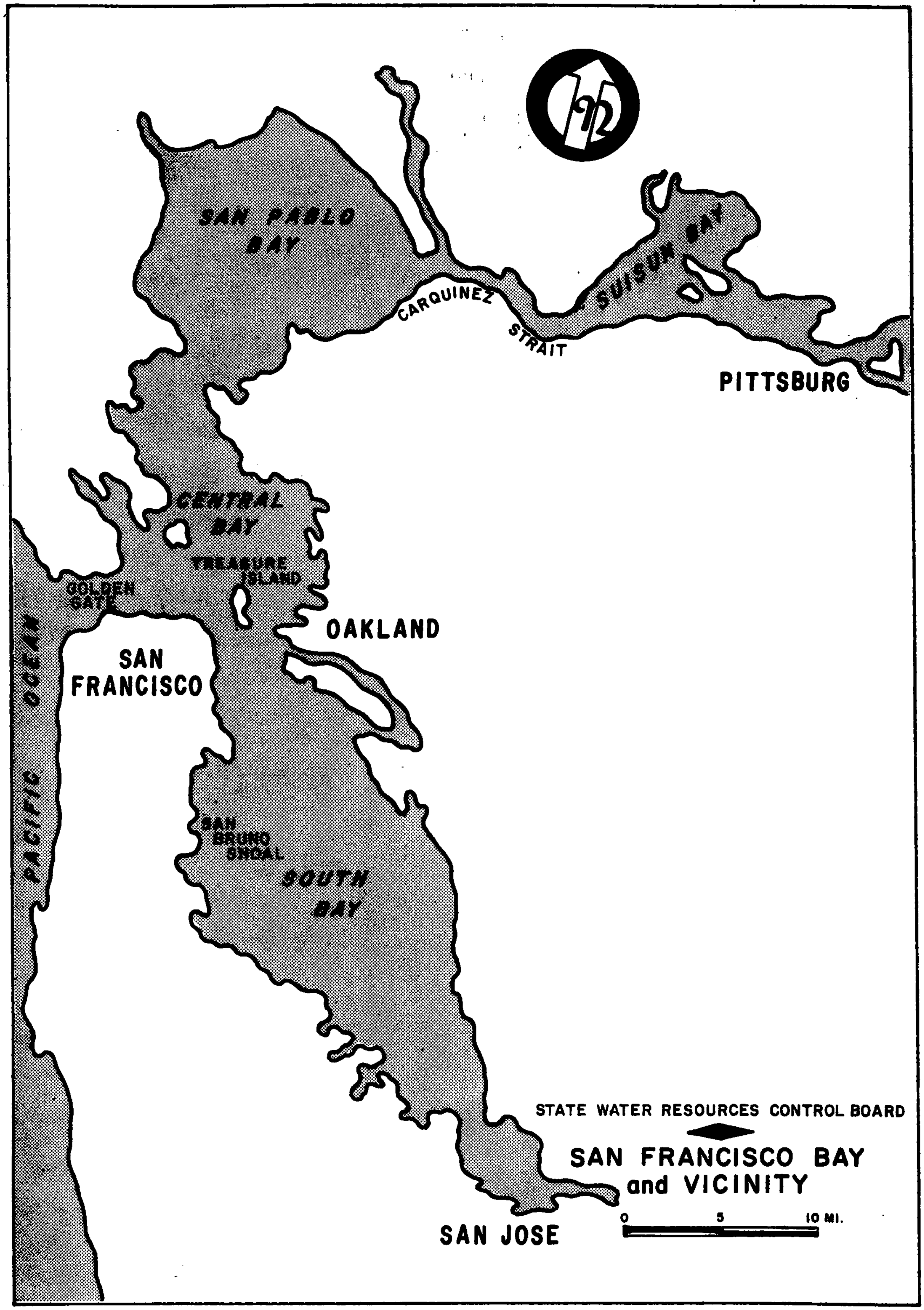
San Francisco Bay

General Characteristics. The San Francisco Bay Basin (Figure III-31) is oriented in a general northwest/southeast direction encompassing San Francisco (central and south), San Pablo, Suisun, Grizzly and Honker Bays, and including all or major portions of Alameda, Contra Costa, Santa Clara, San Mateo, San Francisco, Marin, Sonoma, Napa and Solano Counties.

Tidal marshlands border a considerable portion of southern San Francisco Bay (South Bay), the northern edge of San Pablo Bay, and much of Suisun Bay. Headlands project into the water along the western shore of the Bay in the vicinity of the Golden Gate. The eastern shore is bordered by marshlands and a low, gently sloping piedmont plain. The Bay provides the only sea-level break in the coast ranges.

It has been estimated that in 1850 there were about 700 square miles of water surface in the San Francisco Bay area, extending upstream to the western border of the Delta. Of this, about 300 square miles were marshlands, 250 square miles were shallow tidelands, and about 150 square miles were deep channels. Since that time a great deal of this area has been reclaimed through filling or isolation (e.g., salt evaporation ponds). Most of this reclamation has been on marshlands. Now there are only about 75 square miles of remaining marshlands, with about half of this in Suisun Marsh. There remains less than 400 square miles of water surface in the Bay system (Smith, 1966, p. 29).

FIGURE III-31



Drainage into the San Francisco Bay area is classified into two groups: (1) Sacramento-San Joaquin Delta; and (2) local tributary streams. The Delta is the terminal point for most of the 60,000 square-mile Central Valley drainage, roughly 40 percent of the total area of California. This drainage input to the Bay results from combined effects of precipitation, upstream regulation and use, and Delta export. Local drainage into the Bay encompasses some 3500 square miles, and responds primarily to local rainfall.

Climate. The climate of the Bay area is relatively mild, with year-round moderate temperatures. Meteorologic variations in the Bay area (as with most of the west coast) are affected by the Pacific High, a high-pressure air mass generally varying in location from Alaska to British Columbia. Its specific location determines storm patterns on the west coast. Precipitation in the Bay area, generally limited to winter and early spring months, averages about 32 inches annually, with local wide variations from area to area. The annual precipitation also varies substantially from year to year.

Wind patterns vary locally, and respond to local topography and proximity to the Pacific Ocean. Higher winds and lower air temperatures occur inland where breaks in the coast ranges facilitate the inland flow of sea breezes. Winds are generally from the west and northwest. Winter storms bring the highest velocity winds, while strongest average winds occur in the summer.

Temperatures in the Bay area have a mean annual range of 54^{o} to 62^{o}F, with temperatures as low as freezing and as high as about 100^{o}F. Summer temperatures are somewhat higher than winter temperatures.

Hydrodynamics. San Francisco Bay is really three large connecting bays: San Pablo Bay, the northern and central portion of the Bay, and the south Bay. Without a freshwater input other than local drainage, San Francisco Bay would be like a small extension of the Pacific Ocean, subject to daily tidal fluctuations with salinity concentrations much like those in the ocean.

However, San Francisco Bay is more than just an extension of the ocean. Drainage from the Central Valley flows through the Bay into the ocean, and is a large and significant freshwater input to the Bay. This freshwater input, or Delta outflow, has a salinity and density much less than that of seawater. Salinity gradients, both longitudinal and vertical, exist in the estuary as a result of the gradual mixing of freshwater with ocean water. The magnitude and geographical extent of these gradients depend on the magnitude of Delta outflow.

As previously discussed, tides play an important part in the hydraulics of the Delta and Bay. Salinity stratification throughout the estuary depends on a resultant of the competing forces of Delta outflow and tides. Under conditions of very high outflow, the influence of freshwater is seen much further toward the ocean than under low-flow conditions. This large force of freshwater causes two distinct salinity bands to form: an incoming "salt wedge" on the bottom of the channel, and an overlying and outflowing freshwater layer. Under high outflow conditions, and through the combination of incoming streamflow and tidal mixing, the salinity in the main portion of San Francisco Bay is somewhat reduced.

The South Bay responds much of the year like a bay connected directly to the ocean without significant freshwater input except in years of high runoff in the Sacramento River basin. This is due to the fact that (1) local drainage into the South Bay is minimal most of the time; and (2) freshwater Delta outflow does not influence areas close to the South Bay for most of the year. Therefore, the South Bay is characterized by fairly uniform salinity concentrations and uniform hydraulic mixing caused by tidal fluctuations and wind action. Of course, salinity gradients exist in the immediate area of local freshwater inputs, including wastewater treatment plant outfalls. While the South Bay does not exhibit two-layer estuarine circulation, it does have seasonally reversing near-bottom and surface currents (Conomos and Peterson, 1977).

Sediments brought into the South Bay by tributary streams tend to settle in areas of low velocity. These sediments are resuspended by tidal currents and wind-caused wave action. If the salinity gradient is pronounced, it can result in density-induced circulation which tends to recirculate sediments. These sediments are a large source of nutrients for aquatic life. The South Bay tends to collect sediments in winter, and discharge them in summer. Over the last several decades, the South Bay has been gradually losing sediment to the rest of San Francisco Bay. Seasonal erosion of mud flats has been observed, with up to nine centimeters eroded away in one summer month (Conomos and Peterson, 1977, p. 93).

Other factors that might influence bay producitivity are discussed in the preceding sections on phytoplankton and zooplankton.

Delta Outflow Considerations. Testimony presented by the Association of Bay Area Governments (ABAG) emphasized the likely importance of Delta outflows to the hydraulic and salinity regimes of the San Francisco Bay system.

Research recently completed indicates that Delta outflows significantly affect the salinity of San Francisco Bay and this effect can be seen in the extreme reaches of the South Bay. This research also indicates the magnitude of outflows required to cause salinity changes over certain areas and how long these conditions remain. There are two primary factors that lead to the conclusion that Bay salinity and flow distribution may be affected by high Delta outflows. First, an aerial photograph published in 1974 "...clearly showed a tongue of silty Sacramento River water flowing past Treasure Island into the South Bay" (Imberger et al, 1977, p. 1). Second, high Delta outflow causes a reduction in salinity of the central portion of San Francisco Bay, which is the source of water for South Bay tidal exchange. During the winter period, large-volume short-duration Delta outflows can cause freshwater to penetrate well into the Central Bay, where it is brought into the

South Bay by tidal exchange. Such events cause salinity stratification in much of the South Bay. The salinity stratification can persist for several weeks or months following the initial freshwater appearance (Imberger et al, 1977, pp. i, ii).

The importance of this lies in the magnitude of Delta outflow required to make significant changes in San Francisco Bay circulation and salinity distribution, and in the ecological significance of such changes. An increase in outflow of about 10,000 cfs or greater for at least five to ten days apparently is necessary to bring about significant salinity changes in San Francisco Bay as far south as the San Bruno Shoal (RT Vol. XXXIV, p. 125). Such a surge in Delta outflow is expected to cause a drop in salinity of one or two parts per thousand in this area (RT Vol. XXXIV, pp. 119 and 120). Higher outflows cause larger drops in salinity. A similar surge of 40,000 cubic feet per second will cause this freshwater to overflow into the extreme south end of the Bay.

The normal rate at which salinity subsequently returns to the Bay is two parts per thousand per month. Recovery in a typical wet year will proceed throughout the entire summer. It generally takes until fall for the South Bay to fully recover from the effects of the previous winter.

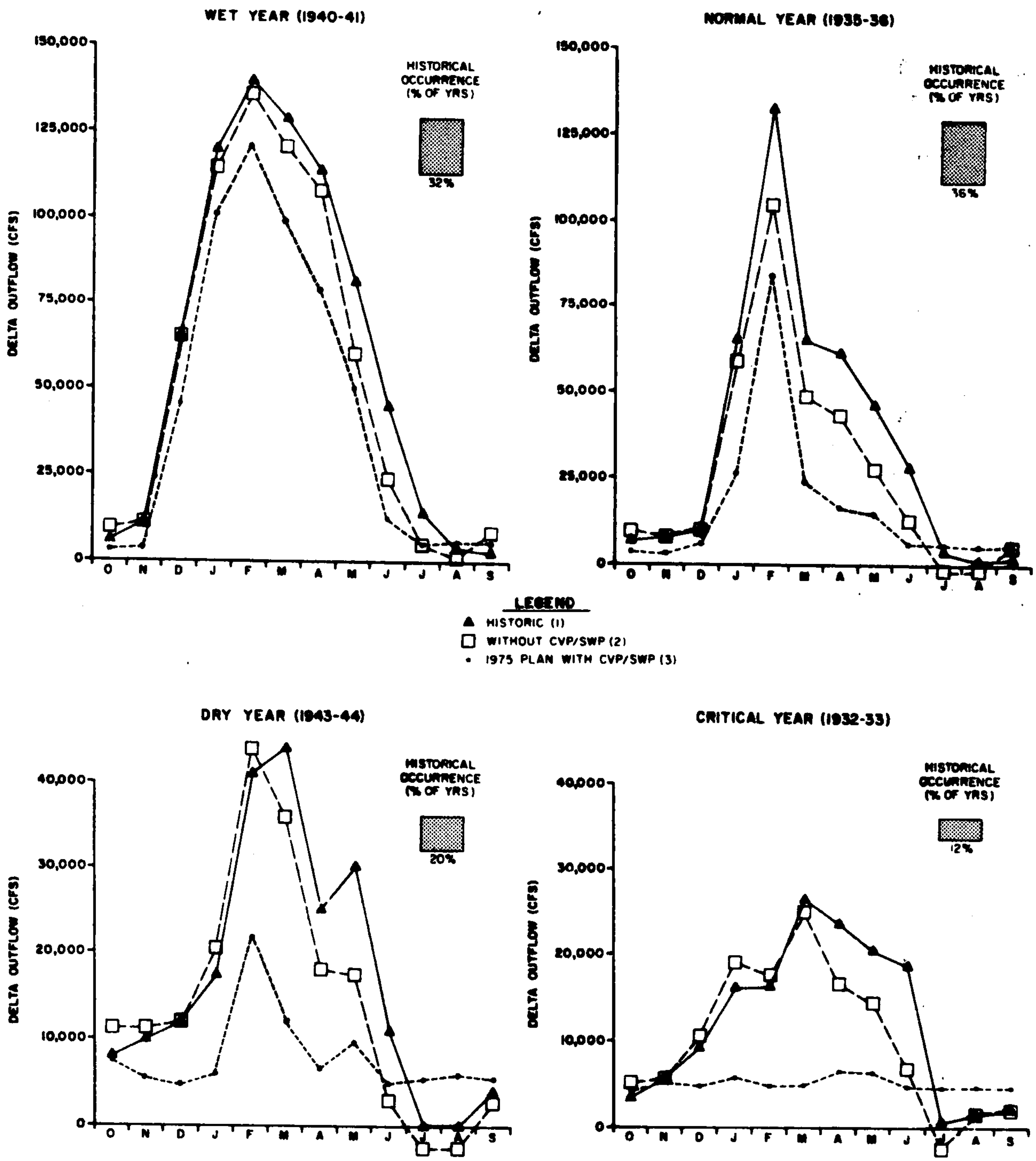
The Bay appears to be extremely sensitive to the amount of increase in Delta outflow (the amount of rise to a peak) and not to the duration of such peak flow. In addition, effects of Delta outflow on the

Bay depend a great deal on what happened previously. Increases in Delta outflow have a more marked effect on the salinity of the Bay when these increases are preceded by a prolonged dry period than when they are preceded by high outflow conditions (RT Vol. XXXIV, pp. 119 to 121).

The ecological benefits of unregulated outflows and the salinity gradients established by them have been suggested to include the following: (1) altering the distribution and migrations of free-swimming organisms, (2) creating counter-currents moving upstream along the bottom of the Bay which are hypothesized to be necessary for the brackish water migration of certain crabs and shrimps, and (3) affecting the transportation of young anadromous fish and maintaining adequate food supplies (RT Vol. XXXIV, pp. 122-123). There is currently not enough information to quantitatively identify these benefits or in some cases even to verify that such benefits do in fact exist. The effects of unregulated flows on the San Francisco Bay system cannot, however, be ignored simply because sufficient knowledge to specify their benefits is not available. Further study is needed to identify more closely the effects Delta outflow has on the biology of San Francisco Bay.

Delta outflows to the Bay, specifically high uncontrolled flows, have changed from historical levels. Figure III-32 shows Delta outflow for four year types (wet, normal, dry and critical) under different conditions. The flows depicted are mean monthly flows; peak daily flows during the month could, of course, be much

DELTA OUTFLOW UNDER DIFFERENT CONDITIONS



DELTA OUTFLOW to San Francisco Bay (1) as it actually occurred during four years prior to the construction of the CVP and SWP (pre-project), (2) how it would have been if present levels of non-CVP and -SWP related upstream development had occurred in those years and the CVP and SWP had not been constructed (without project), (3) how it would have been if present levels of upstream use and Delta export occurred in those years and assuming that the CVP and SWP operated to the 1975 basin plans (1975 basin plan).

higher than those shown. The conditions represented on the figure are (1) historical (pre-CVP and -SWP) conditions, (2) projected conditions that would exist today (1980 level) if the CVP and SWP had not been constructed, (3) expected conditions that would exist today (1980 level) with the CVP and SWP operating to the 1975 basin plan (Alternative I-B) and (4) expected conditions that would exist today (1980 level) with the CVP and SWP operating to the recommended plan (Alternative IV). This discussion is limited to the differences in the first three conditions. Chapter V compares the differences between conditions under the 1975 plan and conditions under the recommended plan.

For the graphs shown in Figure III-32 specific hydrologic years were selected which represent typical conditions likely to exist in each year type. The specific years chosen to represent each year type are those used by Kelly and Tippets (1977) in their report on San Francisco Bay except for the critical year. Kelly and Tippets selected the 1930-31 water year which is in the drier end of the critical year range but, more importantly, is followed by a below normal year. Figure V-4 of this report shows the outflow and export rates for operation to 1975 plan "no action" Alternative I-B versus the recommended plan during a calendar year, rather than a water year. Therefore, to make the information of Figure III-32 more comparable to that of Figure V-4, water year 1932-33, which is followed by a critical year, was used to represent a critical year.

Figure III-32 is based on (1) estimated outflow conditions that occurred historically in specific years shown prior to the operation of the CVP and SWP, (2) estimated Delta outflow had the CVP and SWP not been built, from Department Exhibit II-12, (3) an operation study using the 1975 basin plan (Alternative I-B) as the controlling standards in the Delta, from Department Exhibit II-10, and (4) the May 16, 1978 operation study of the Department using the March 1978 draft plan standards as the controlling standards. These studies are the best available information regarding actual or hypothetical conditions that would exist in the Delta. While the assumptions contained in these studies can and should be refined, especially those used in preparing Department Exhibit II-12, useful information can be drawn from these studies.

Figure III-32 shows that very high Delta outflows existed historically in wet and normal years and that average monthly flows in excess of 20,000 cfs were not uncommon in dry years and even in some critical years. With no CVP and SWP development in the Sacramento River and San Joaquin River basins, outflows would have been reduced below the historical levels in most months. Exceptions occur in the fall of most years and the early winter of drier years when outflows actually would have been higher than historical. Decreases below historical outflows may be attributed to non-project reservoir storage and non-project related in-basin increases in use, primarily by agriculture. Increases above historical outflow result from non-project reservoir storage releases, primarily for hydroelectric power production.

Adding the effects of the CVP and SWP developments dramatically alters historical conditions, particularly in critical years. The projects' storage and export of water greatly reduce the magnitude of high flows. Current facilities can control virtually all of the Delta inflow in most months in critical years so that only water needed to meet standards and other operational commitments flows to the Bay. The environmental impact of such drastic reductions in uncontrolled flows to the Bay due to past water development decisions is not known. Future water development in California must recognize and be able to determine what incremental effect those developments will have on the remaining unregulated flows and what the environmental consequences will be on the Bay.

C. SOCIOECONOMIC FACTORS

Delta Agriculture

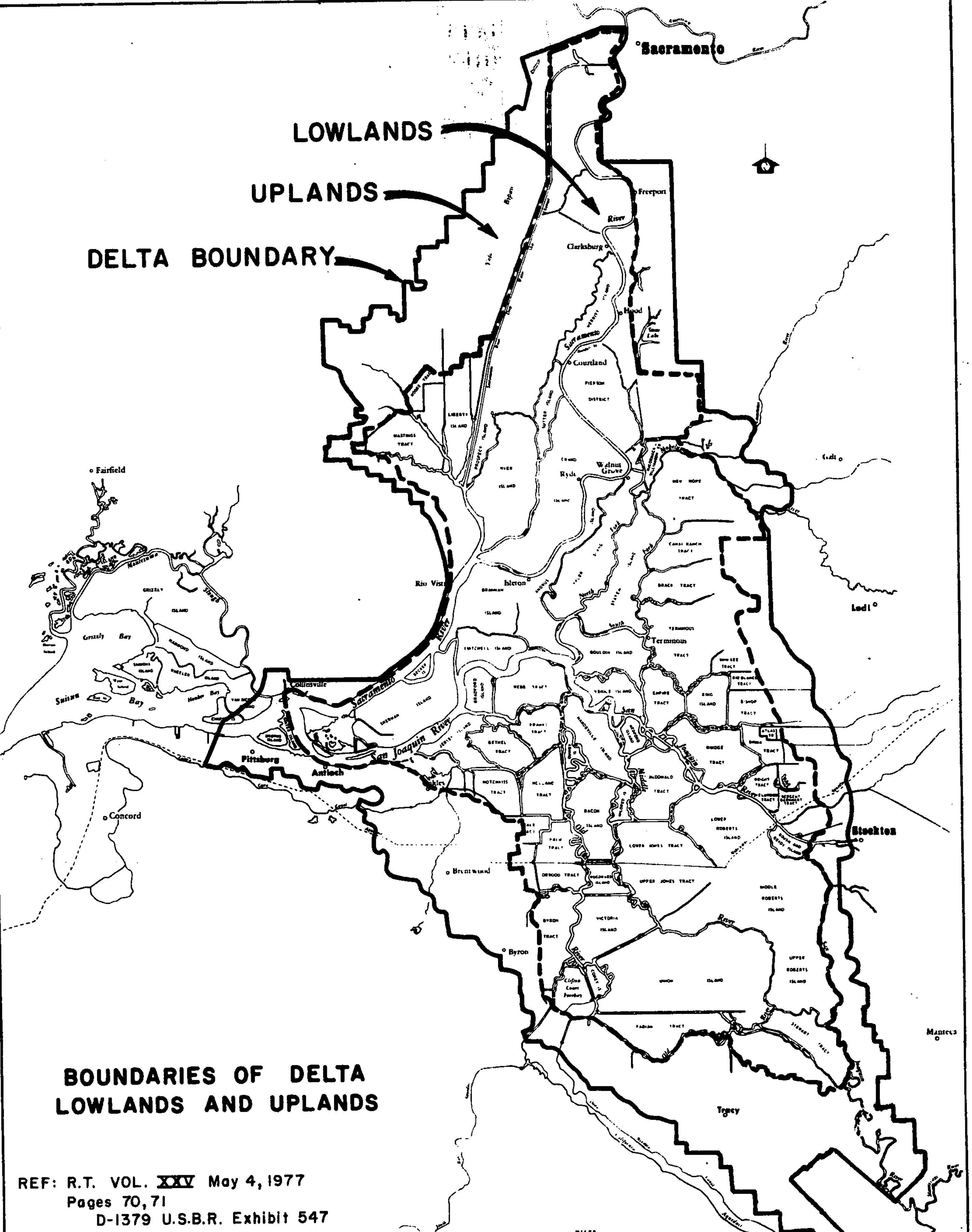
Environmental Setting. The Delta covers an area of more than 738,000 acres. About 510,000 acres of this land is utilized by agriculture. Because of its unusual physical situation the Delta area produces a diversity of crops under a unique set of management practices. An understanding of soil types and land elevations in relation to water levels is necessary to understand these management practices.

The Delta can be divided into the Delta lowlands and the Delta uplands. The uplands are those areas above the five-foot mean sea level contour while the lowlands are those areas below this contour. Approximately one-third of the Delta area is in the uplands while almost two-thirds is in the lowlands. Figure III-33 shows the boundaries of the lowlands and uplands.

The soils in the Delta lowlands are of three general types: the organic or peat soils, the intermediate organic soils and the mineral soils. Figure III-34 shows the distribution of these soil types in the Delta lowlands. Although the uplands contain some organic and intermediate organic soils, most of the soils are mineral soils. The organic soils, which generally include 20 percent or more organic matter, are mainly in the central and western Delta and cover about 125,000 acres (RT Vol. XIII, p. 23).

These peat and peaty muck (organic) soils contain partly the remains of hydrophytes, such as reeds and tules, which have decomposed and accumulated for at least the last 10,000 years. This deposit of organic soils in the Delta is wedge shaped as to depth, with the deep end, up to 60 feet deep, in the west and the shallow end in the east (RT Vol. XIII, pp. 25-26).

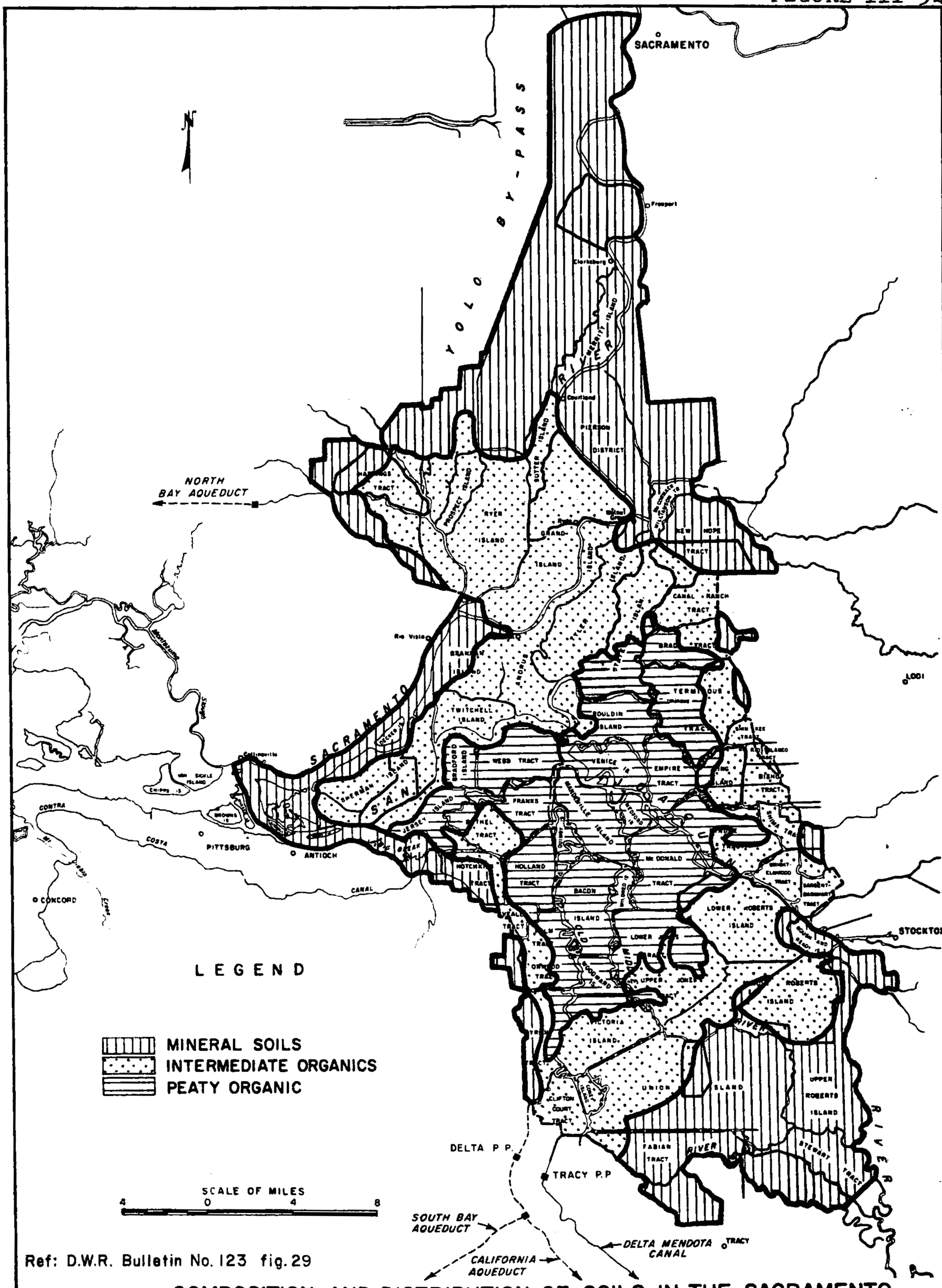
FIGURE III-33



BOUNDARIES OF DELTA LOWLANDS AND UPLANDS

REF: R.T. VOL. XXV May 4, 1977
Pages 70, 71
D-1379 U.S.B.R. Exhibit 547

STATE WATER RESOURCES CONTROL BOARD
(Base Map Provided by Department of Water Resources)



Ref: D.W.R. Bulletin No. 123 fig. 29

COMPOSITION AND DISTRIBUTION OF SOILS IN THE SACRAMENTO SAN JOAQUIN DELTA LOWLANDS

The peat soils undergo subsidence as a result of natural processes hastened by agricultural activities. Subsidence mechanisms include biological oxidation, compaction, wind erosion and in the past included burning of the peat soils. The rate of subsidence in the Delta peat soils tapers off as the organic matter disappears but is still as much as one or two inches per year in some places (RT Vol. XIII, pp. 27-29).

As a result of subsidence, primarily oxidation, the total area of organic soils has been decreasing. In the early 1940's a soil survey by the Department of Agriculture showed more than 250,000 acres of organic soils. Now only about half that acreage remains (RT Vol. XIII, p. 31).

The intermediate organic soils in the Delta are a blend of the organic and mineral soils. These generally have less than 20 percent organic matter. Some of them, such as those on Sherman Island, have a thin surface layer of mineral soil underlaid by organic soils.

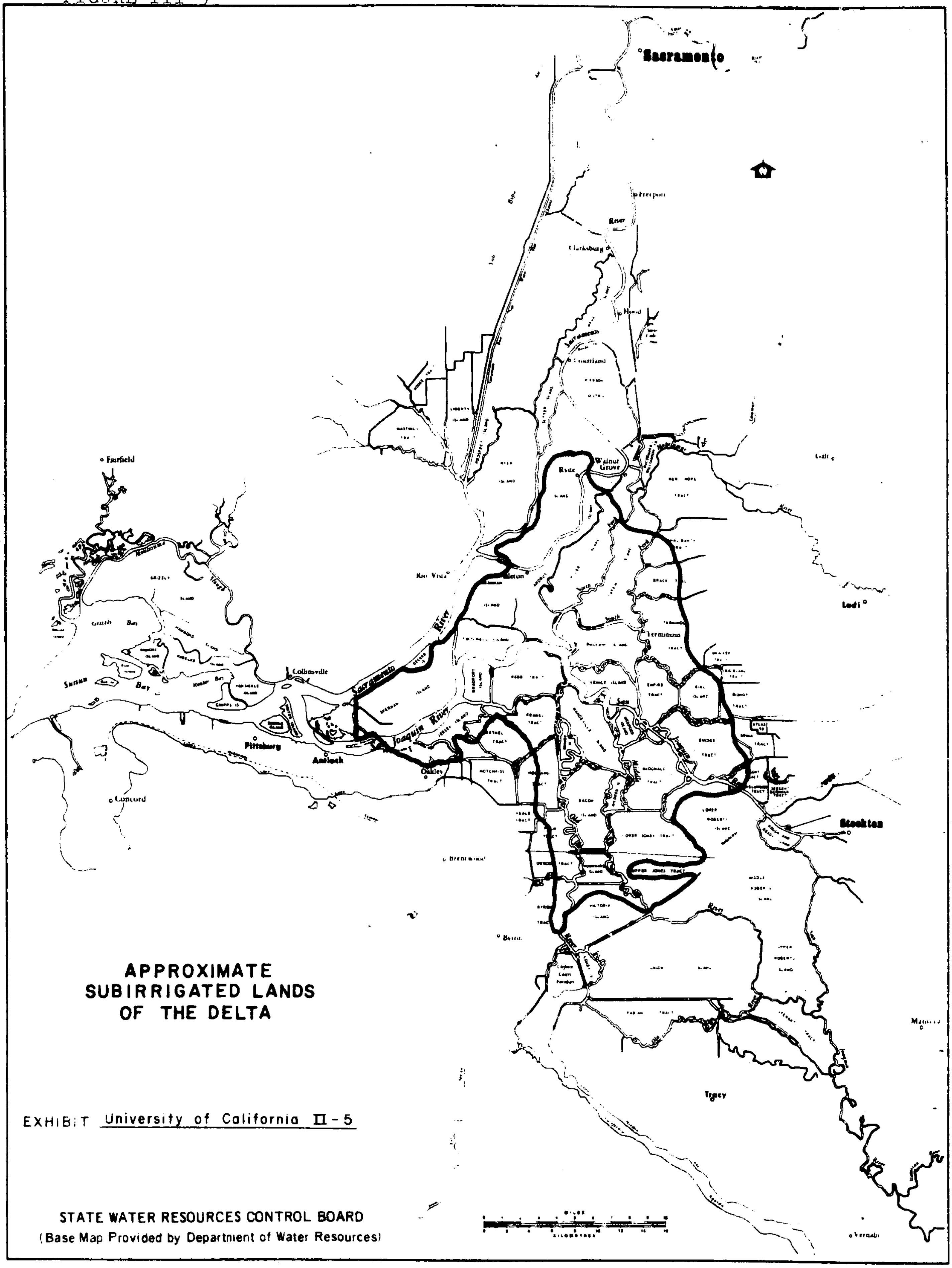
The mineral soils in the Delta are mainly alluvial soils with highly variable characteristics. In texture these mineral soils range from permeable sands to slowly permeable clays. Some of the clay soils are restrictive to water movement. Maintenance of adequate leaching and drainage are often problems in these clayey mineral soils.

Most of the organic soils are at a lower elevation than the water in the surrounding Delta channels. Because of this these lowlands must be continually drained. The drainage water is pumped back into the surrounding channels.

Without regular pumping of the drainage water these islands would be flooded. Often the water table is maintained only two or three feet below the soil surface. At the end of a cropping season it may be five feet below the surface.

One problem resulting from the high water table is the difficulty it presents to leaching practices. Leaching, the process of flushing salts from the soil column, is used to control the salts which accumulate in the soil. This accumulation of salts is a result of both water removal by the crop which leaves the salt behind in the soil and evaporation of water from the soil which brings salts to the surface where they remain after the water evaporates.

Subirrigation is the predominate method of irrigation used in the organic soils in the Delta. In subirrigation water is applied from beneath the soil surface rather than on the top. The area of subirrigated lands is shown in Figure III-35. There are several reasons for the use of subirrigation rather than a more conventional surface irrigation method. First, subirrigation is relatively simple and inexpensive. Second, the subsidence which occurs in the organic soils is not uniform, resulting in uneven surfaces



APPROXIMATE
SUBIRRIGATED LANDS
OF THE DELTA

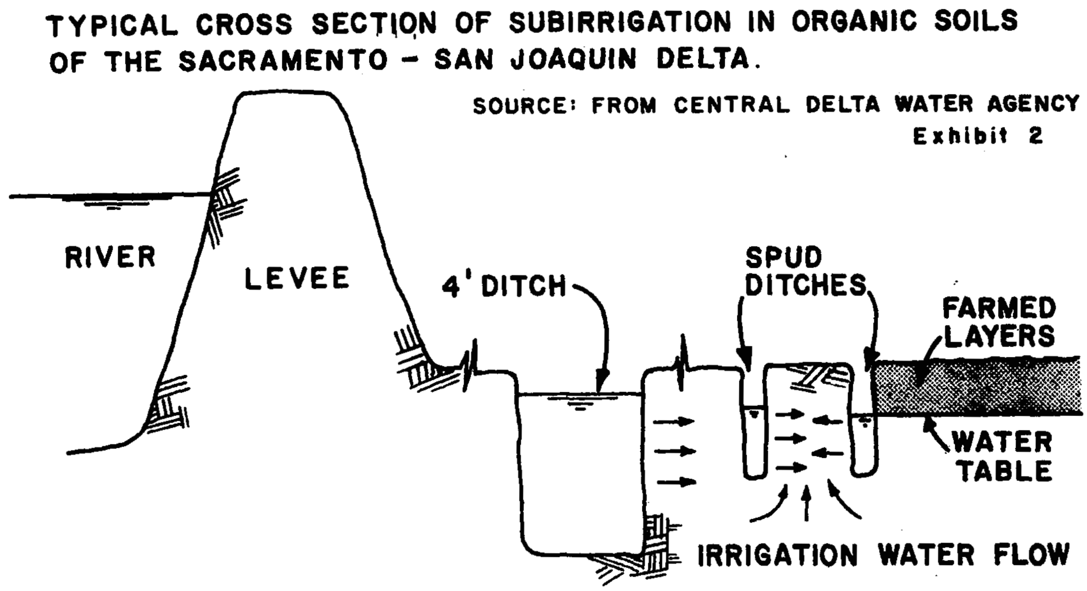
EXHIBIT University of California II-5

STATE WATER RESOURCES CONTROL BOARD
(Base Map Provided by Department of Water Resources)

which in turn cause problems with most surface irrigation methods. Third, the very high permeability of the organic soils makes movement of water across the surface of the soils difficult because of the soils' high infiltration rates. Sprinkler irrigation, used in the organic soils by a few operators, avoids this problem. However, use of sprinklers still requires controlled maintenance of the underlying water table by drainage pumps. Also the operation of sprinklers has high energy costs and capital outlay (RT Vol. XIII, p. 47). Subirrigation along with winter leaching has long been used on the organic soils and is well adapted to the area.

Subirrigation in the Delta involves siphoning water from the Delta channels into a "surface" ditch or canal, "4-foot ditch", which then distributes the water to shallow "spud" ditches. These spud ditches run laterally through the field to be irrigated. They are about eight inches wide, from 25 to 100 feet apart, and as much as two feet deep. They vary in length up to 600 feet and greater (RT Vol. XIII, p. 30; RT Vol. XIV, p. 190). Figure III-36 shows a typical cross-section for subirrigation as practiced in organic soils in the Delta.

FIGURE III-36



In applying irrigation water by subirrigation, the spud ditches normally are held nearly full until sufficient water has infiltrated or "subbed" across the area to raise the water table to the desired level between the spud ditches. The term "subbed" refers to the water which slowly moves laterally and downward to raise the water table and irrigate the crop from below (subirrigate)(RT Vol. XIII, p. 30). When potatoes are grown, the water in the spud ditches and water table in the field are held at a fairly constant level throughout the growing season. With other crops, like corn, the spud ditches are filled to raise the water table and wet the crop root zone. After the water table has been raised to the desired level, irrigation ceases and the drainage system takes over to cause the water table to recede to the level determined by the drainage pump setting. This irrigation procedure is repeated several times to rewet the crop root zone as necessary during the growing season. By irrigation through the spud ditches and adjustments of the drainage pumps, a grower can closely control the depth of the water table in his field. This control is a major factor in the successful use of subirrigation in the Delta.

The 1976 Delta crop survey submitted by the Department shows that the major crops in the organic soils are corn (45%), grains (wheat and barley)(25%), and asparagus (7%). The leading crops in the mineral soils are grains (22%), corn (17%), sugar beets (11%), tomatoes (11%), and alfalfa (11%). Other crops include pasture, beans, sorghum and various types of orchards (Department Exhibit II-18; UC Exhibit II-5).

Water Quality Needs. Water quality is one of the crucial factors for a viable agricultural economy in the Delta. Some of the problems that can result from use of poor quality water in an agricultural environment are problems related to salinity, soil permeability, and toxicity effects. Other factors such as excessive concentrations of trace elements may affect specific crops. The most critical water quality factor in the Delta is salinity.

The salinity of the applied irrigation water has a direct relationship to the quality of the water in the soil solution. The University of California has attempted to verify and quantify this relationship in some field experiments (RT Vol. XIII, p. 17). Most of the dissolved salts in the applied irrigation water remain in the root zone after the water is consumptively used by the crop. A balance is desirable between the salts which enter into the soil root zone via the applied irrigation water and those which leave through the drainage water. If salts accumulate, the excess salts must be leached or flushed out of the root zone to maintain this salt balance.

Water Quality Needs in Delta Organic Soils. With normal surface irrigation, root zone salinity is controlled by leaching which results from deep percolation of a portion of the applied irrigation water. In the Delta organic soils control of salinity in the root zone is complicated by the subirrigation method of applying water and by the high water table. The normal agricultural practice in these soils includes winter leaching every one to three years depending on the crop grown, and, to some extent, on the quality of water used for irrigation.

The University of California (UC) Guidelines for Interpretation of Water Quality for Agriculture and the Irrigation and Drainage Paper 29 of the Food and Agriculture Organization of the United Nations (FAO) (UC Exhibits 1 and 2) and testimony presented by the U. C. Cooperative Extension provides a method for determing the crop yields expected with a given applied water salinity. Total dissolved solids and chloride concentration usually have been used to evaluate salinity in the Delta, but electrical conductivity[9] is more closely related to the osmotic effects which more directly relate to the rate of uptake of soil water by the plant. Electrical conductivity was used by the U. C. Cooperative Extension during its testimony as the most practical indicator of salinity impacts on agriculture.

The guidelines state that for mineral soils and surface irrigation the salinity of the applied irrigation water becomes concentrated about three times in becoming the soil water which the plant actually uses. This can be written as:

$$EC_w \times 3 = EC_{sw} \qquad \text{(equation 1)}$$

where EC_w is the electrical conductivity of the applied irrigation water and EC_{sw} is the electrical conductivity of the soil water.

The guidelines also show that the salinity of the soil saturation extract is about one-half the salinity of the soil water:

$$EC_{sw} \times \frac{1}{2} = EC_e \qquad \text{(equation 2)}$$

where EC_e is the electrical conductivity of the saturation extract of the soil.

The guidelines are based on the assumption that a 15 percent leaching fraction occurs during irrigation. The leaching fraction is the fraction of the water entering the soil which then passes beyond the root zone. However, this leaching fraction does not occur with subirrigation in the Delta organic soils. On the basis of field investigations of subirrigated organic soils in the Delta, the salinity concentration of the irrigation water is apparently

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9/ Electrical conductivity (EC) is expressed in terms of millimhos per centimeter at $25^{\circ}C$ (mmhos/cm).

increased from 5 to 10 times rather than the three-fold concentration shown in equation 1 for surface irrigation (UC Exhibit 8). The average value of 7.5 is used as representative of the 5 to 10 range and for subirrigation. Equations 1 and 2 can then be rewritten and combined:

$$EC_w \times \frac{7.5}{2} = EC_e \qquad \text{(equation 3)}$$

On page 24 of the FAO publication an equation is given for the relationship between crop yield (y) and the salinity of the soil saturation (EC_e) extract:

$$Y = 100 - b\,(EC_e - a) \qquad \text{(equation 4)}$$

where Y = relative crop yield in percent

EC_e = salinity of soil saturatio n extract

a = salinity threshold value for the crop, representing the maximum EC_e at which a 100 percent yield can be obtained

b = yield decrement per unit of salinity, or percent yield loss per unit increase in salinity (EC_e) between the threshold value (a) and the EC_e value representing the 100 percent yield decrement.

The values for "a" and "b" were determined from interpretation of testimony and exhibits presented by U. C. Cooperative Extension. For corn, the salinity threshold or "a" value used is 1.7, and the "b" value is 12.05.

EC_e from equation 3 can be substituted for EC_e in equation 4 which then becomes

$$Y = 100 - b\left[\left(EC_w \times \frac{7.5}{2}\right) - a\right] \qquad \text{(equation 5)}$$

Using this equation, estimates of the effect of various qualities of water on crop yields can be made for various crops grown under subirrigation on the organic soils in the Delta. Thus, the equation indicates that an applied water quality of 0.45 mmhos EC_w is needed in order to obtain a 100 percent yield of corn on the subirrigated organic soils in the Delta. Corn is the predominant crop in the organic Delta soils. Therefore, it is reasonable to consider water quality of 0.45 mmhos EC as that which is necessary to prevent yield decrements on the organic soils.

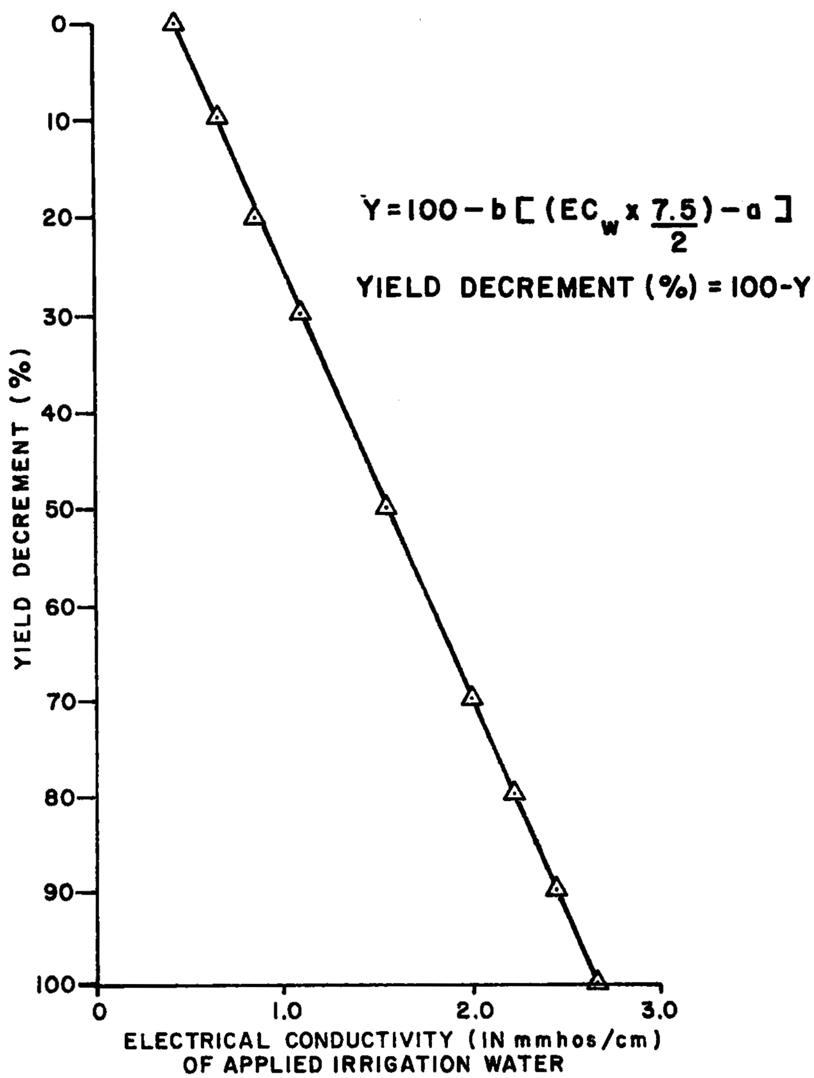
Water quality of 0.45 mmhos EC represents an average value of the applied irrigation water over the entire irrigation season. Historically, water of this quality or better was available in the interior Delta during most of the irrigation season, as was discussed earlier in this chapter.

The expected yield reductions for corn can be determined by using equation 5 with average values for applied water quality (EC_w). The relationship of theoretical yield decrement and average applied water quality for corn grown in the organic soils in the Delta is shown in Figure III-37.

The salt sensitivity of most crops is not constant throughout the growing season but varies with stages of growth. Corn appears to be more salinity sensitive during the emergence and early seedling periods than it is during the later stages of growth (U.C. Exhibit II-1, p.8; U.C. Exhibit II-3). In the Delta organic soils, crops can be germinated by the soil water moisture which is the result of winter and spring rainfall. Thus, during the germination period and the emergence period the crop would have available to it soil water very low in salinity.

FIGURE III- 37

RELATIONSHIP BETWEEN YIELD DECREMENTS FOR CORN (*Zea mays*) GROWN ON SUBIRRIGATED LANDS AND SALINITY OF APPLIED IRRIGATION WATER.



The subirrigated organic soils in the Delta are virtually impossible to compare to surface irrigated mineral soils found elsewhere. There has been a limited amount of research done on these organic soils. This limited information has allowed certain logical assumptions to be made regarding water quality needs in Delta organic soils. However, other questions concerning the movement of groundwater in the Delta subirrigated soils (RT Vol. XX, p. 181) and water quality requirements for leaching and preirrigation still need to be answered. Because of these questions and the uniqueness of these organic soils in the Delta additional research is warranted.

Water Quality Needs in Delta Mineral Soils. Mineral soils are located in the northern and southern portions of the Delta. Because some leaching during irrigation usually occurs in these soils, use of the published U. C. Guidelines as a criteria for agricultural water quality needed in these areas is reasonable. These guidelines state that water of less than 1.1 mmhos EC is needed in these mineral soils for a crop like corn. However, beans have been grown historically in the southern Delta mineral soils. The U. C. Guidelines recommend an applied water quality of $EC_w = 0.7$ for this crop. The typical irrigation season for beans is April through August. Other important crops in the southern Delta are alfalfa, pasture and sugar beets. These crops usually require water throughout the year. Also, during a major portion of the year, one area or another of the southern Delta is in the seedling stage of growth (RT Vol. XIV, p. 86). In view of the year-round demand for irrigation water, the water quality needs of the southern Delta for months other than April through August must be considered.

Soil types in the southern Delta range from sandy loam to silty clay loam. Because of low permeability and associated high water table problems, some of these mineral soils can be leached only during the winter, between crops or during crop dormant periods. The frequency of leaching depends on both the water management and the quality of the water applied during the irrigation season.

Crops in the southern Delta which require irrigation water from September to April include alfalfa and some other crops still in the seedling stage. The U. C. Guidelines indicate that alfalfa requires an applied water of 1.3 mmhos EC for a 100 percent yield. Because of permeability problems in the southern Delta, water quality of better than 1.3 mmhos EC might be required. Also because some crops are in the seedling stage during this period outside of the normal irrigation season a water quality of 1.0 mmhos EC would be reasonable. The ongoing research by the U. C. Cooperative Extension in the southern Delta may produce information which will show a need for future revision of these water quality criteria.

Municipal and Industrial Uses of Water in the Delta

The only cities in the Delta relying directly on Delta surface waters for municipal supplies are Antioch, Pittsburg, and Oakley. Pittsburg and Oakley obtain raw water supplies from Rock Slough via the Contra Costa Canal. Antioch diverts part of its water supply directly from the San Joaquin River offshore from the city, and obtains part from the Contra Costa Canal. Sacramento maintains a standby diversion facility on the Sacramento River in the upper Delta, but normally diverts from two other facilities on the American River and Sacramento River upstream from the Delta. The cities of Stockton, Tracy[10/], Rio Vista, and other Delta communities rely on groundwater for municipal water supplies.

Delta industries are located principally in the urban areas of Antioch, Pittsburg, Sacramento, Stockton, and Tracy. All major water-suing Delta industries dependent on Delta surface water supplies are in the Antioch-Pittsburg area except for American Crystal Sugar Company located near Clarksburg. Other industries utilize local groundwater or water supplies from municipalities which do not obtain raw water from Delta channels. American Crystal Sugar Company's diversion is located on the Sacramento River, upstream from the Delta Cross-Channel diversion at Walnut Grove. Therefore, it is not expected to be significantly affected by salinity intrusion or operations of the SWP and CVP export facilities. American Crystal Sugar Company did not participate in the Delta hearing.

Only those Delta cities and industries located in eastern Contra Costa County are dependent on Delta surface water supplies which would likely be affected by salinity intrusion and SWP and CVP operations. The sources of Delta water for these cities and

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10/ Tracy is currently constructing a water treatment plant which is expected to receive raw water supplies from the Delta via the CVP's Delta-Mendota Canal, beginning in late 1978.

industies are limited to Rock Slough, New York Slough, and the San Joaquin River offshore from Antioch. The extensive use of exported Delta waters by cities and industries located outside of the Delta is described in this chapter in a later section entitled Export and Water Transfer.

Municipal Diversions. The cities of Antioch, Oakley, and Pittsburg as entities were not represented in the Delta hearing. However, Contra Costa County Water District (CCCWD), which supplies raw water diverted at Rock Slough to each of these cities through the Contra Costa Canal, participated in the hearing and presented testimony and exhibits regarding municipal water use and quality requirements (CCCWD Exhibit 17; RT Vols. XVI, XVII and XXX). Only part of the CCCWD service area is located within the Delta. Service by the District to areas outside the Delta includes raw water supplies to Pleasant Hill and Martinez and treated water supplies to Concord, Clayton, and parts of Walnut Creek, Pleasant Hill and Martinez. The Contra Costa Canal customers in 1974, and their canal and river diversions, are listed in Table III-4.

Contra Costa Canal is the sole source of municipal water for the Oakley County Water District, the City of Pittsburg, and the Bay Water Company (West Pittsburg service area), and is an alternate supply for the City of Antioch when the quality of the San Joaquin River offshore supply is inadequate.

TABLE III-4

CONTRA COSTA CANAL CUSTOMERS

1974

Customer	River Diversion by Customer (AF/YR)	Canal Diversion (AF/YR)	Total Diversion (AF/YR)
Oakley County Water District	0	2,600	2,600
City of Antioch	4,900	1,800	6,700
City of Pittsburg	0	5,000	5,000
Bay Water Company	0	1,300	1,300
Treated Water Division	16,900	15,800	32,700
Gregory Gardens County Water District	0	1,000	1,000
City of Martinez	0	4,400	4,400
Other Municipal Users	-	4,800	4,800
Industrial Users (3)	18,900	32,900	51,800
Agriculture	-	4,400	4,400
TOTAL	40,700	74,000	114,700

Source: Salinity Study Suisun Bay/Delta by CH_2M Hill, November 1976 p. VI-6

Quality standards for domestic water supplies have been established or proposed by the State of California in Title 22, California Administrative Code. Guidelines for drinking water quality are set forth in EPA Drinking Water Regulations pursuant to Public Law 93-523. Although higher values are allowable, the recommended maximum concentrations for total dissolved solids and chlorides are 500 mg/l and 250 mg/l, respectively. Concentrations exceeding these recommended limits may be objectionable but would not be considered hazardous to health. Consumer acceptance limits have not been established. However, constituent concentrations lower than the recommended limits are recognized as desirable for a higher degree of consumer acceptance.

The 1976-77 drought brought about additional public health concerns at the Contra Costa Canal Intake. These concerns center on the formation through the water treatment process of small organic compounds called trihalomethanes, especially bromoform, as salinity at this intake increases. These compounds are suspected cancer causing substances.

The Environmental Protection Agency (EPA) has proposed regulations related to treatment processes to ensure that the proposed standard of 100 parts per billion trihalomethanes is not exceeded in public drinking supplies. Studies, principally by the Contra Costa County Water District, during the recent drought showed that as chloride concentrations at the District treatment plant increased above about 100 parts per million, the trihalomethanes produced as a result of their chlorination process approached or exceeded this standard. As seawater intrusion increased, the formation of these suspected carcinogens also increased. It is believed that bromide, a compound in seawater, and chloride ions are made reactive during the chlorination process. These reactive compounds attack the naturally occurring organic materials found in Delta waters to produce trihalomethanes.

EPA proposed regulations are basically a treatment technique requirement. They initially require community water systems with populations greater than 75,000 people to use granular activated carbon in their drinking water treatment systems by a certain date. EPA believes this treatment is the best broad spectrum technology presently available for control of organic chemicals in drinking water. Water systems demonstrating that this treatment is not necessary to protect the health of the people they serve may be granted a variance. Unless a water system is granted a variance, it will be required to design, construct, and operate a granular activated carbon system or an approved alternative system to reduce the level of synthetic organic compounds to the maximum extent feasible. All affected water systems will have two and one-half years to comply with these regulations.

In that the organic precursors to the formation of trihalomethanes are naturally present in the Delta, concern has focused on ocean derived salinity. The existing basin plan does not provide for water at the Contra Costa Canal Intake of sufficiently low salinity for over one-third of the year to meet EPA's proposed standard. Therefore under the existing basin plans Contra Costa County Water District would be required to implement the necessary treatment. The District is currently evaluating the extent of the trihalomethane problem in the Delta, various alternative treatment processes, and other means to meet EPA's proposed regulation. Preliminary information suggests that if the trihalomethane standard is revised downward (as some expect) the high organic content of Delta waters will require extensive treatment for organic compounds regardless of salinity. The EPA regulation will require extensive treatment except in those areas that can demonstrate that they do not face problems related to organic compounds in their delivered water. The Board does not believe that requiring excellent salinity at all municipal intakes is sufficient to remove the concern regarding organic chemicals in Delta drinking supplies. The Board will work closely with all agencies concerned with this problem to assist them in identifying the extent of this natural water quality related problem.

Industrial Diversions. A number of industries have located along the south shore of the San Joaquin River at least in part because of the availability of water for industrial use and wastewater disposal. Water use in 1975 of eleven major industries each of which used at least 50,000 gallons per day is summarized in Table III-5.

TABLE III-5

INDUSTRIAL WATER USE SUMMARY
1975
(acre-feet per year)

Industrial Water User	Product	Water Use	Water Source: Offshore Diversions	Ground Water	Contra Costa Canal	Treated Municipal Supply	Total
Crown	Pulp and	Boiler	(230)*		(90)	(40)	360
Zellerbach	Paper	Cooling	(620)				620
Antioch	Products	Process	(11,000)				11,000
		Total	11,850	0	90	40	11,980
E.I.DuPont	Pigments	Boiler				420	420
Oakley	Petrochemicals	Cooling				240	240
	Fluorocarbons	Process				1,420	1,420
		Total	0	0	0	2,080	2,080
Fibreboard	Pulp and	Boiler		(780)	(230)		1,010
Antioch	Paper	Cooling	(1,770)				1,770
	Products	Process	(14,020)		(320)		14,340
		Total	15,790	780	550	0	17,120
Hickmott	Tomato	Boiler					
Canning	Products	Cooling				560	560
Antioch		Process				560	560
		Total	0	0	0	1,120	1,120
Kaiser	Wall	Boiler					
Gypsum	Board	Cooling				(75)	75
Antioch		Process				(75)	75
		Total	0	0	0	150	150
PG&E	Electric	Boiler					
Antioch	Power	Cooling	1,106,000				1,106,000
		Process					
		Total	1,106,000	0	0	0	1,106,000
Collier	Ammonium	Boiler					
Carbon and	Phosphate	Cooling	25		25		50
Chemical	Fertilizers	Process			60		60
Pittsburg		Total	25	0	85	0	110
Dow	Commercial	Boiler			(1,300)		1,300
Chemical	Chemicals	Cooling	(1,310)				1,310
Pittsburg		Process	(1,110)		(200)		1,310
		Total	2,420	0	1,500	0	3,920
Johns-	Roofing	Boiler				40	40
Manville	Paper	Cooling	190				190
Pittsburg		Process	150			100	250
		Total	340	0	0	140	480
PG&E	Electric	Boiler					
Pittsburg	Power	Cooling	708,000				708,000
		Process					
		Total	708,000	0	0	0	708,000
U.S.Steel	Steel	Boiler					
Pittsburg	Products	Cooling			(10,000)		10,000
		Process				(1,500)	1,500
		Total	0	0	10,000	1,500	11,500

*NOTE: Parantheses indicate assumed breakdown of water use where industry could not furnish these data.

REFERENCE: Salinity Study Suisun Bay (Delta) Prepared for U. S. Army Corps of Engineers, San Francisco District, by CH_2M Hill, November 1976.

The industries located in the Antioch-Pittsburg area depend almost exclusively on Delta surface waters for their water supplies. These industries have three possible Delta water sources:

1. Water diverted directly from the San Joaquin River or New York Slough, utilizing the industries' own pumping facilities.

2. Raw water purchased from CCCWD conveyed from Rock Slough via the Contra Costa Canal, or in the Pittsburg area, pumped from Mallard Slough at the District's pumping plant.

3. Treated water purchased from municipal purveyors who obtain their raw water from the Contra Costa Canal, or in the case of Antioch, from either Contra Costa Canal or a San Joaquin River diversion.

In 1975 all industries except PG&E used some water from the Contra Costa Canal either directly or after treatment by municipal water systems. Collier Carbon and Chemical in Pittsburg used water from New York Slough for part of their cooling purposes and relied on Contra Costa Canal water for process water and the remaining cooling use. Dow Chemical, Johns-Manville, Crown Zellerbach, and Fibreboard were the only industries using offshore supplies for process uses.

The PG&E powerplants at both Antioch and Pittsburg use large quantities of water for once-through cooling. Since these uses are not affected substantially by salinity changes, they will not be discussed further. PG&E did not participate in the Delta hearing.

The three general categories of industrial water use are boiler feed water for steam production, cooling water, and process water. Salinity water quality criteria for boiler feed water and cooling water are given in Table III-6. As indicated in the table, the criteria vary with boiler operating pressure and cooling system design. Details concerning these elements of the installations at each of the eastern Contra Costa County industries is not generally available.

Criteria for industrial process water cannot be generalized because requirements vary for different types of industries and different processes within each industry. Process waters can be used for incorporation into the product, washing, fluming, rinsing, quenching, or retorting. Many industries, recognizing the varying water quality requirements for different processes, conserve water by successive uses of spent water from one process in another process with less restrictive quality requirements. A general idea of the nature of industry's concerns for process water quality may be obtained from surveys of western Delta industries conducted by CCCWD and the Department (CCCWD Exhibit 17). The salinity criteria from these surveys are shown in Table III-7.

The Crown Zellerbach and Fibreboard paper mills near Antioch were the only Delta industries which supplied specific information on their water requirements during the Delta hearing. Two other Delta industries, U. S. Steel and Johns-Manville, participated in the hearing preceding Decision 1379 but did not participate in the current hearing. The following discussions for these industries have been abstracted from information in the respective hearing transcripts and exhibits.

TABLE III-6

SALINITY WATER QUALITY CRITERIA

Requirements for Boiler Feedwater

Values in mg/l

Constituent	Industrial: Low Pressure 0 to 150 psig	Industrial: Intermediate Pressure 150 to 700 psig	Industrial: High Pressure 700 to 1500 psig	Electric Utilities*: 1500 to 5000 psig
Dissolved solids	700	500	200	0.5
Chloride (Cl)	(1)	(1)	(1)	(2)

* Quality of water prior to the addition of substances used for internal conditioning.

(1) Accepted as received (if meeting total solids or other limiting values); has never been a problem at concentrations encountered.

(2) Controlled by treatment for other constituents.

Requirements for Cooling Water

Values in mg/l

Constituent	Once-Through: Fresh	Once-Through: Brackish (1)	Recirculation Make-up: Fresh	Recirculation Make-up: Brackish (1)
Dissolved solids	1,000	35,000	500	35,000
Chloride (Cl)	600	19,000	500	19,000

(1) Water with TDS 1,000 mg/l

Source: Taken from CCCWD Exhibit 17 and CH_2M Hill Salinity Study 1976

TABLE III-7

WATER QUALITY CRITERIA AT POINT OF USE FOR PRODUCT AND PROCESS

(Results of Surveys)

Values in mg/l

Constituent	Food (Canning)	Paper (Bleached Kraft)		Primary Metals		Chemical	
	CCCWD D* T*	DWR	CCCWD D* T*	DWR	CCCWD D* T*	DWR	CCCWD D* T*
Total Dissolved solids		300	--- 250			200 to 700	--- 500
Chloride (Cl)	100 250	200	50 150	175	50 150	50 to 250	100 100

*Data shown as: desired level (D) and tolerance level (T)

Source: CCCWD Exhibit 17

Crown Zellerbach Corporation operates a paper mill on the south shore of the San Joaquin River in Contra Costa County east of Antioch. The mill was constructed in 1956 and has operated continuously since. The primary source of fiber is recycled wastepaper. The mill uses about 150,000 tons of it annually. However, some pulp is brought in also from other paper mills which have pulping capabilities. The several paper grades produced are converted into corrugated boxes, towels, tissue, and napkins. Approximately 12.5 million gallons per day (MGD) of water are required for processing and cooling in the manufacture of several grades of paper.

About 60 percent of the mill's production is linerboard from which corrugated boxes are fabricated. These boxes can be used for packaging and storing canned goods. However, corrosion rates of canned goods which have been in contact with linerboard containing more than 500 ppm sodium chloride are unacceptable. Therefore, customers who purchase this linerboard require that the sodium chloride content in the paper not exceed 500 ppm. Corrosion tests conducted by Crown Zellerbach under simulated storage conditions have verified the reasonableness of the customers' sodium chloride requirement. Operating experience has shown that the sodium chloride limit in the finished product will be exceeded when the chloride concentration of the process water is greater than 150 mg/l. The salt-sensitive linerboard is produced on the largest of the mill's four paper machines and requires about 4 to 5 MGD as process water. Three smaller machines produce paper which is not considered salt-sensitive.

The Crown Zellerbach mill has two sources of water supply. One source is the San Joaquin River from which water is pumped just offshore from the mill property. An alternate supply is water purchased from CCCWD and delivered via the Contra Costa Canal. Because Contra Costa Canal water costs more than water pumped directly from the river, the mill uses the river supply for all cooling water needs and, when water quality permits, for process waters. Under normal operations, the process water supply is switched over to the Contra Costa Canal when the chloride concentration of the river water exceeds 150 mg/l. Crown Zellerbach has a limited ability to blend the two water supplies to maintain suitable process water quality when the chlorinity of the Contra Costa Canal water is significantly below 150 ppm and the river chlorinity is not greatly in excess of 150 ppm. If salt-sensitive grades of paper are not produced, the mill can continue on the river supply.

During significant portions of 1976 and 1977 the chlorinity of both the San Joaquin River and Contra Costa Canal water supplies exceeded 150 mg/l. In order to continue full production during these periods, Crown Zellerbach implemented several changes in normal operations:

- Capital expenditures of about $100,000 allowed a reduction in water usage from 8000 gallons per ton of product in November 1976 to 4500 gallons per ton by June 1977.

- By using demineralized water to reduce the salt content of the paper as it was being formed on the machine, acceptable quality salt-sensitive paper was manufactured even though chloride concentration of the process water was as high as 250 mg/l.
- If sodium chloride content of salt-sensitive paper was greater than 500 ppm the paper was either rejected or, if possible, diverted into use for a non-salt-sensitive grade.

(RT Vol. XXX, pp. 91-92).

Crown Zellerbach emphasized that these procedures could not be maintained on a continuous ongoing basis. The existing demineralization unit, for boiler feed water supply, has a design capacity of about 200 gallons per minute. The modified procedures required that the unit be operated at 250 gallons per minute and continuously maintained in the best possible condition.

The Fibreboard San Joaquin Division is a large kraft paper mill located on the south shore of the San Joaquin River approximately five miles east of Antioch. The mill began operation in 1949 and has operated continuously since. Between 16 and 20 MGD of water is used in the production of approximately 150,000 tons of linerboard, 90,000 tons of corrugating medium, and 60,000 tons of food board annually (RT Vol. XVII, p. 135). Unlike the nearby Crown Zellerbach mill, Fibreboard's predominant raw material is pulp produced from wood chips.

Linerboard produced at the Fibreboard mill is also a salt-sensitive product because of possible corrosion when it is used in corrugated boxes for canned goods storage. Fibreboard also requires process water with not more than 150 mg/l chloride for the production of the salt-sensitive linerboard.

Fibreboard has two main sources of water. One source is the San Joaquin River from which water is pumped directly just offshore from the mill property. An alternate supply is water purchased from CCCWD which conveys water from Rock Slough via the Contra Costa Canal. A third source, relatively minor in volume, is groundwater which is used only for domestic purposes and a particular process requiring cold water. Total groundwater use from two wells is between 500,000 and 800,000 gallons per day.

Water is reused several times in various processes involved in paper manufacturing. Incoming water is used for cooling before being used as process water. Normally, water from the San Joaquin River offshore supply is used for process water until the chloride ion concentration of the river water exceeds 125 mg/l. At that concentration clarifiers No. 2 and 3, which deliver approximately 5.5 MGD of process water for salt-sensitive paper production, are switched over to the Contra Costa Canal water supply. However, clarifier No. 1, which has a rated capacity of 10.5 MGD, continues to use only the offshore supply until the chlorinity reaches 250 mg/l. Fibreboard then blends canal water with river water to maintain a maximum chloride concentration of 250 mg/l as an operating limit for process water.

When the chloride concentration of the Contra Costa Canal water exceeds 150 mg/l, demineralized water from the boiler feed water supply is blended with the process water to maintain the chlorinity of process water for salt-sensitive paper production at no greater than 150 mg/l. The demineralizer capacity is about 1500 gallons per minute. As the chloride level of the supply water increases, the quantity and quality of demineralizer output decreases and deterioration of the ion beds increases.

Because of limitations on the demineralizer's capability at high chloride levels, sufficient boiler feed water (less than 250 mg/l chloride) cannot be provided to maintain the required steam rate for the mill (RT Vol. XVII , pp. 152-153). Fibreboard believes that chlorinities between 200-250 mg/l are the upper limit for continued production of sufficient demineralized water for blending to produce salt-sensitive paper. Fibreboard has limited capability within its own converting operations for use of high chloride linerboard on only the outside surface of the corrugated box. This capability probably is limited to use of several days' production.

<u>Dow Chemical Company</u> did not present information on current water requirements during the hearing, but did introduce testimony and exhibits from the Decision 1379 hearing. The Dow Chemical plant, located on New York Slough between the cities of Antioch and Pittsburg, diverted approximately 35,000 acre-feet (22,000 gallons per minute) on a continuous basis from New York Slough for cooling and process waters (hearing preceding Decision 1379, RT

Vol. XXXI, pp. 3292-3371; Dow Exhibit 502). An alternate water supply from the Contra Costa Canal was available for "critical water use" when the offshore supply exceeded a chloride concentration of 160 mg/l. The supply from the Contra Costa Canal was limited to only 2000-2500 gallons per minute by existing diversion facilities and by contract with CCCWD. The "critical water use" requirement of 160 mg/l chloride concentration was the level above which production of chemically pure water for various processes within the plant was not economical. The maximum use of this chemically pure water, as indicated, was approximately 1800 gallons per minute during 1968 (hearing preceding Decision 1379, Dow Exhibit 502). When chlorinity exceeded 1000 mg/l, other plant operations also became uneconomical and on a long-term basis equipment would be damaged. A water supply with 3500 mg/l chloride concentration was considered to be a maximum for use of water as brine makeup. Chloride itself actually is not presently a problem in the brine makeup but is used to measure other contaminating constituents such as magnesium and calcium which are present in proportion to chlorides. A comparison of the information presented by Dow in 1970 with the summary of 1975 water use in Table III-5 indicates a significant change in the use of water at the Dow facility. Total water use was reduced from 35,000 to about 4,000 acre-feet per year and a greater relative dependence on the Contra Costa Canal supply was evident as it represented over 38 percent of the total supply in 1975. Information is not available to identify the reason for these changes.

U. S. Steel presented testimony in 1970 regarding water use at its steel processing facilities located on the south shore of New York Slough between Pittsburg and Antioch. Water was diverted from New York Slough for cooling uses, and seasonally, for process water in the Wire Mill. New York Slough diversions were approximately 14,000 acre-feet in 1969. Contra Costa Canal water was used for process water in the Sheet and Tin Mill, the Morgan Rod Mill, the Pipe Mill, and for boiler feet water supply (hearing preceding Decision 1379, RT Vol. XXX, pp. 3175-3246).

If process water with a chloride concentration exceeding 250 mg/l is used in the Rod and Wire Mills, a stress type corrosion known as hot-short cracking develops on the surface of the steel. Therefore, when the water in New York Slough reaches the 250 mg/l chloride concentration, Contra Costa Canal water is used for all process water supplies and New York Slough water is then used only for cooling purposes. Table III-5 shows that U. S. Steel did not divert from New York Slough in 1975, but used 11,500 acre-feet of water from the Contra Costa Canal and city supplies.

Johns-Manville Products Corporation presented testimony in 1970 concerning water use at its plant located on New York Slough in the City of Pittsburg (hearing preceding Decision 1379, RT Vol. 28, pp. 3098-3140). Products manufactured at the Johns-Manville Pittsburg plant in 1970 included asbestos roofing papers, asphalt roofing, asbestos cement sheets, shingles and other miscellaneous products. The estimated water use for 1970 was 800 acre-feet of which approximately 270 acre-feet was used for cooling and process water in the paper mill and 88 acre-feet was used for boiler feed water supply. Maximum chlorinity levels determined for the boiler supply and the paper mill supply were 200 mg/l and 600 mg/l, respectively. New York Slough was the source for the entire water supply until the chlorinity limits were reached. An alternate supply purchased from the City of Pittsburg was then used for the boiler feed water and paper mill. Facilities were not available to obtain water directly from the Contra Costa Canal. Table III-5 indicates 1975 water use of 340 acre-feet from New York Slough and 140 acre-feet from the city supplies.

Export and Water Transfer

Physical Facilities in the Delta. Water is diverted from the Delta for export at Contra Costa Canal Intake of the CVP on Rock Slough, Tracy Pumping Plant of CVP, the Delta Pumping Plant of SWP, and the City of Vallejo Pumping Plant on Cache Slough. Export water is diverted by the CVP and SWP from uncontrolled flows reaching the Delta and winter runoff which has been stored in various reservoirs for subsequent release and later diversion from the Delta when natural runoff is low. The stored water from the Sacramento River basin is transferred predominantly across the Delta in natural channels. To facilitate this transfer, the Delta Cross Channel was constructed near Walnut Grove to connect the Sacramento River and Snodgrass Slough, a tributary of the Mokelumne River. The channel is designed to convey approximately 3500-4000 cfs, although higher or lower flows can occur depending on the driving force of Sacramento River flows. Water from the Sacramento River is also transferred through Georgiana Slough immediately downstream from Walnut Grove.

Department studies indicate that flows in Georgiana Slough and the North Fork Mokelumne River merge and flow both eastward toward Terminous and southward down Old River to the export pumps. At Terminous, this flow is joined by the smaller downstream flow in the South Fork Mokelumne River. The combined flow then moves southward in Little Potato Slough and continues toward the San Joaquin River via the channels of Little Potato and White Sloughs, using Little Connection Slough, Honker Cut, and Disappointment Slough. Water arriving at the San Joaquin River via these channels begins a slow net eastward movement toward and into Turner Cut (Department, 1967, p. 60; Department Exhibit II-2, p. 5).

Some of the water flowing down the San Joaquin River from the vicinity of Stockton joins the Sacramento River water flowing in Turner Cut. The southwesterly flow in Turner Cut travels through Empire Cut and into Middle River, thence southward to Old River via the three canals on the north and south sides of Woodward and Victoria Islands. About one-third of the flow moves through each canal. Based on dye studies under the conditions of flow and diversion at that time (1963), travel time for the 50 miles between Walnut Grove and the Tracy Pumping Plant was about 19 days.

The CVP Tracy Pumping Plant lifts water 197 feet in elevation for conveyance to the San Joaquin Valley via the Delta-Mendota Canal. It has fish screens and salvage facilities which were designed to reduce the number of fish diverted into the canal and to return salvaged fish to the waters of the Delta. The six pumps at the Tracy Pumping Plant have a combined capacity of about 4600 cfs (Bureau Exhibit 63).

The SWP Clifton Court Forebay is formed by dikes which enclose an area of about 2000 acres. The Forebay has a capacity of 28,653 acre-feet and serves as part of the intake to the SWP Delta Pumping Plant. The pumping plant lifts water about 244 feet to supply the California Aqueduct. The Forebay provides storage capacity which allows for withdrawal of water from the Delta during favorable tide conditions only, even though pumping from the forebay continues at a fairly uniform rate. An unlined canal conveys water from the forebay to the Delta Pumping Plant (Department, 1974(a). Fish screens and salvage facilities at the pumping plant are designed to reduce the loss of fish by diversion out of the Delta or by mechanical injury. The combined capacity of the seven pumps in the pumping plant is 6,035 cfs (Department, 1974(a)).

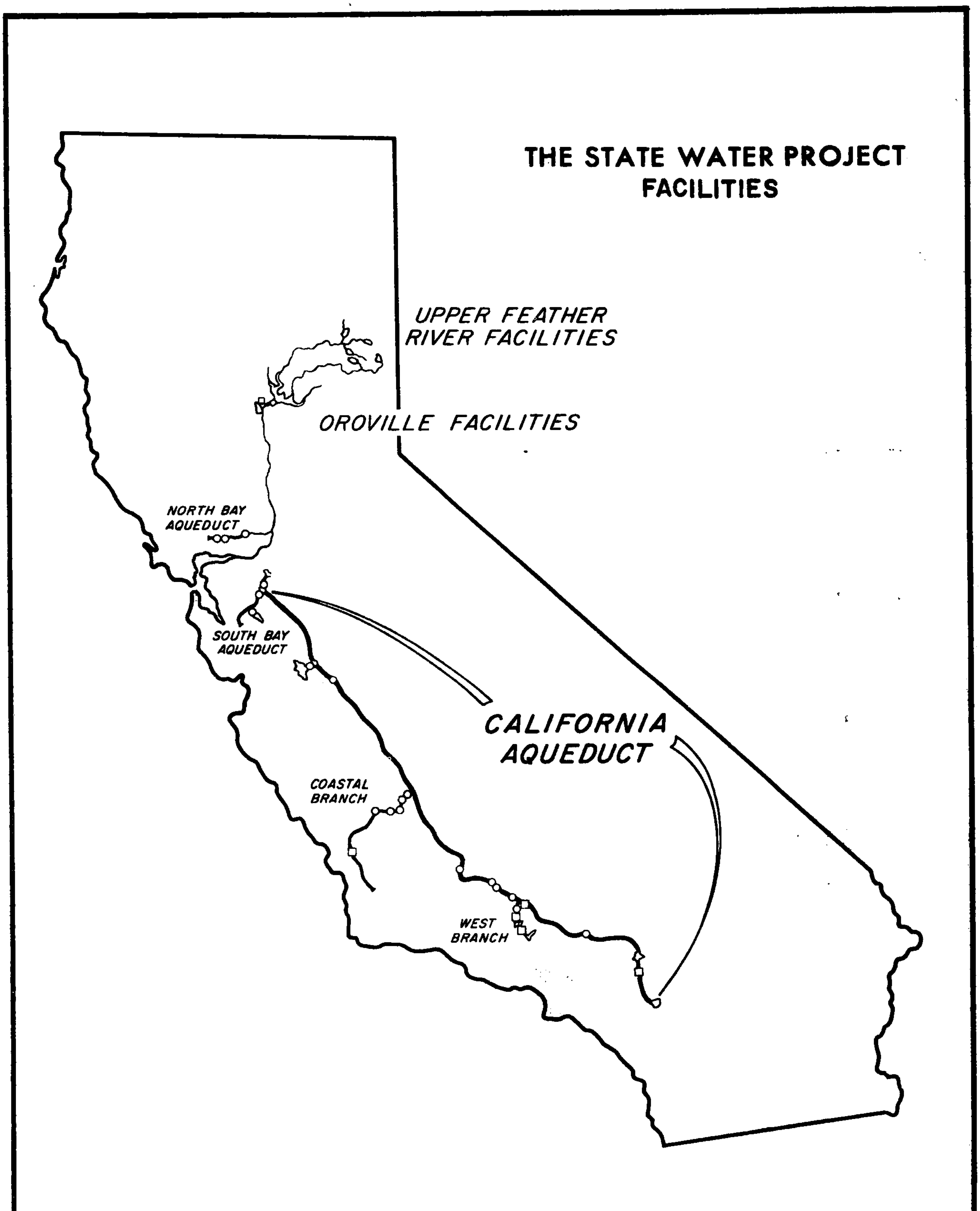
From the SWP Delta Pumping Plant, water is conveyed to the San Joaquin Valley, the San Francisco Bay area and Southern California. The California Aqueduct delivers water to the San Joaquin Valley and Southern California. The South Bay Aqueduct, branching from the California Aqueduct, delivers water as far west as San Jose (Department, 1974(b), p. II-11).

Water is also exported by the City of Vallejo at Cache Slough in eastern Solano County. The City of Vallejo pumping plant has three pumps with a total capacity of 21 million gallons per day (about 32 cfs). The City's appropriative right is for diversion of about 32 cfs year-round. The quantity of water diverted under this right in the last several years has been 15,000 acre-feet (an average of approximately 21 cfs) or less annually.

The water diverted at Rock Slough into Contra Costa Canal, a CVP facility operated by the Contra Costa County Water District, is used partly within the Delta and partly in portions of Contra Costa County that are outside the Delta. This diversion is discussed under Delta municipal and industrial uses.

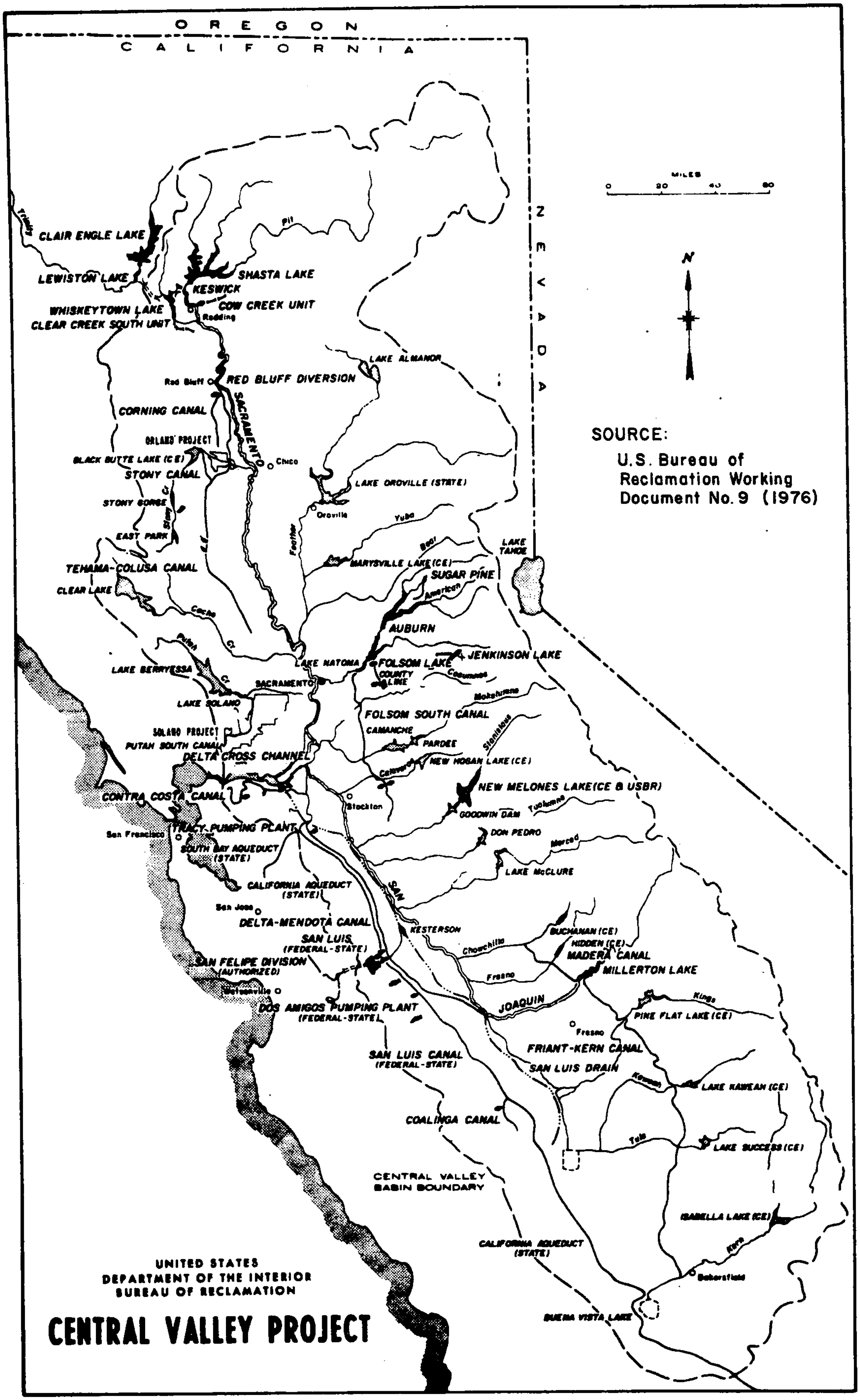
Physical Facilities Outside the Delta. The export of water from the Delta and the transfer of water across the Delta necessitates the coordinated operation of the CVP and SWP. The SWP has facilities which extend from Plumas County in the north to Riverside County in the south (see Figure III-38). The main storage facility of the SWP is Lake Oroville in Butte County. Water released from the Oroville complex flows down the Feather River into the Sacramento River and then into the network of channels in the Delta. A more complete description of SWP facilities is available in Department Exhibit 15A, and in various other Department publications.

The CVP includes a large number of storage, conveyance and power facilities as shown in Figure III-39. Storage facilities at Shasta Reservoir on the Sacramento River and Clair Engle Reservoir



SOURCE: Dept. of Water Resources Bulletin 200 (1974)

FIGURE III-39



SOURCE:
U.S. Bureau of Reclamation Working Document No. 9 (1976)

on the Trinity River from which water is imported to the Sacramento River through Whiskeytown Reservoir, provide the major control of the Sacramento River above the Feather River. Folsom Dam on the American River is also part of the CVP. Water released from these reservoirs is conveyed in the Sacramento River to the channels of the Delta. The CVP exports water diverted at Rock Slough through the Contra Costa Canal and at the Tracy Pumping Plant through the Delta-Mendota Canal, previously described. The San Luis Reservoir and related facilities on the west side of the San Joaquin Valley provide offstream storage and power generation for both the CVP and the SWP. A more complete description of the CVP facilities is available in Bureau Exhibits 63 and 64, and in various Bureau publications.

Water Rights and Project Operations. The CVP and SWP operate under water right permits subject to the continuing authority of the Board. The permits of the Bureau and Department which contribute to the CVP and SWP Delta water supply and details of the permits are listed in Appendix A of the draft water quality control plan.

The permits show the maximum quantities of water which may be stored or maximum rates of diversion of water from the sources shown. However, the information in the permits gives no indication of the extent to which water is available within those limits or the project water yield that will result from diversions in accordance with the permit conditions. Neither does it indicate the complexity of the operation of the two projects necessary to obtain that yield. The operations of the projects are governed by the priorities of various project water rights,[11] conditions in the permits, contractual obligations, cooperative agreements, requirements of project authorizations, amount and pattern of runoff, the storage available in the projects' reservoirs, physical operating restrictions, and prior water rights. The water quality objectives established by the Board are an operating requirement to protect beneficial uses in the Delta, to honor vested rights and to conform to statutory provisions that authorized the CVP and SWP.

The permits of the Bureau contain no requirements concerning Delta salinity other than the reservation of jurisdiction by the Board to establish such requirements. However, the permits for the SWP , in addition to the same reservation of jurisdiction, include two terms with specific Delta salinity limits which can affect project operations. One of these terms subjects the SWP to the water quality limits of the November 19 criteria. The other is the so-called "Blind Point" condition. This condition prohibits diversion to storage or direct diversion, other than for hydroelectric power generation at Oroville Reservoir, by the SWP at any time from April 1 to June 30 when the maximum surface zone chloride ion content of the San Joaquin River at Blind Point exceeds 250 ppm.

11/ Determinations of yield to each project which would result if diversions were made in accordance with the priorities of each of the many permits involved have thus far been unnecessary due to cooperative agreements for sharing the available supply.

Export Demands. Water exported from the Delta serves a wide variety of uses as indicated by the information summarized in Appendix A of the draft water quality control plan. The quantities of water which have been exported in the recent past are characterized by the data in Table III-8.

TABLE III-8

DELTA EXPORTS

Acre-feet

Central Valley Project

Long-Term Contracts	Anticipated Demand
2,900,000	4,300,000

Source: Bureau Exhibit 2A

State Water Project

1978 Level Entitlement	Maximum Annual Entitlements
1,800,000	4,200,000

Source: Department Exhibit 15A, p. 121

City of Vallejo

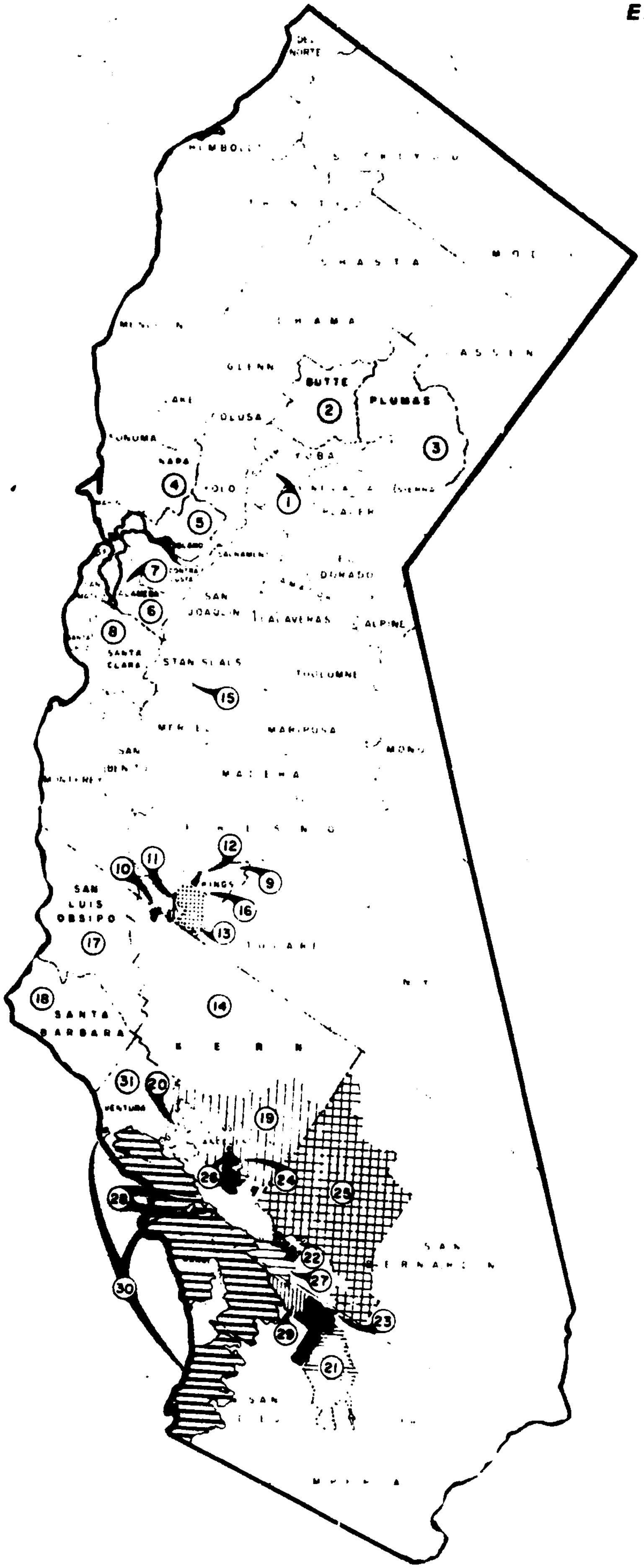
License Entitlement

About 22,500

Source: SWRCB, Division of Water Rights Records

As shown by this data, most of the water is exported each year by the CVP and SWP, and the two projects expect to export larger quantities of water in the future. Areas served by the SWP and CVP from the Sacramento Valley supply are shown in Figures III-40

FIGURE III-40

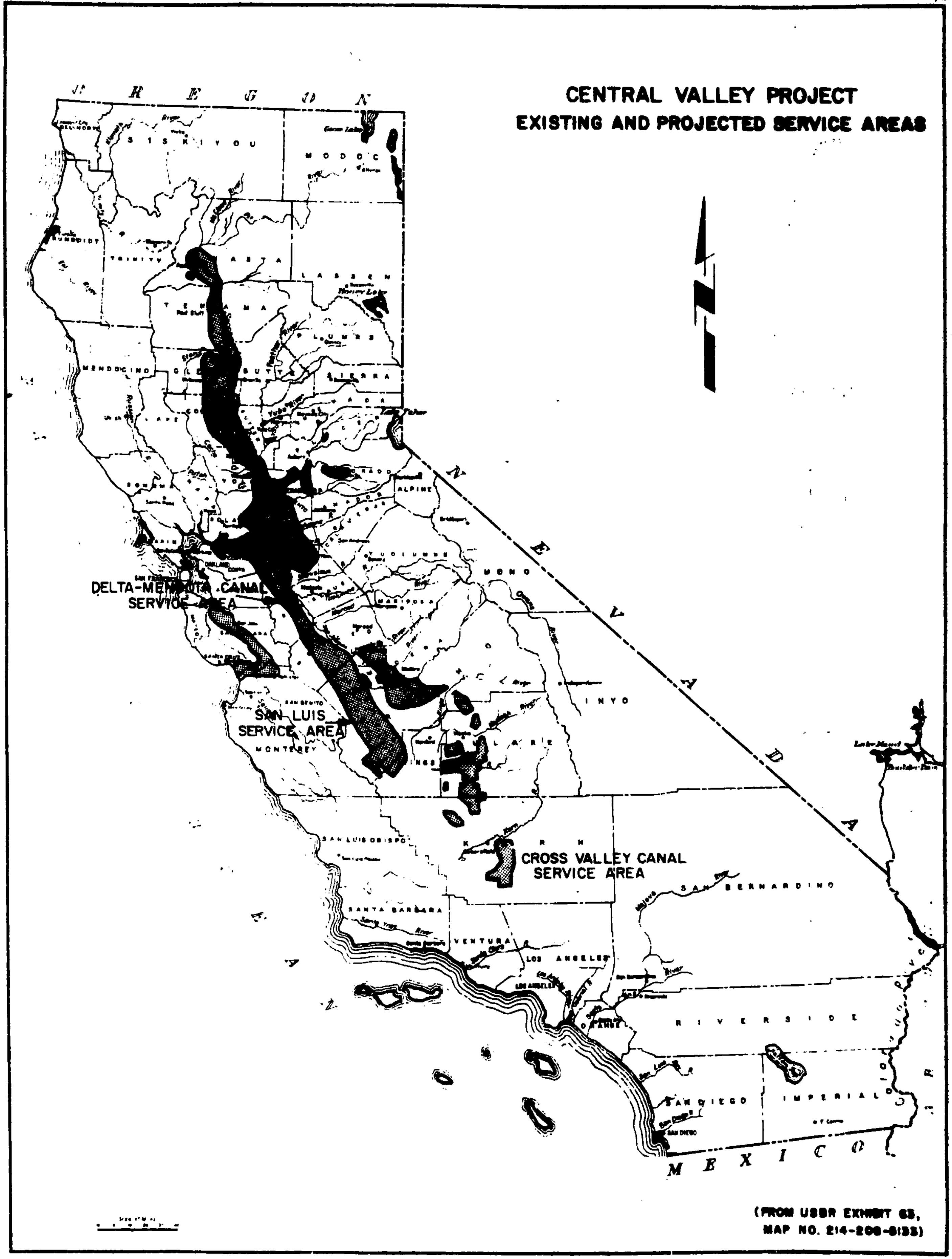


STATE WATER PROJECT
EXISTING AND PROJECTED SERVICE AREAS

Location No.	Contracting Agency
	UPPER FEATHER AREA
1	City of Yuba City
2	County of Butte
3	Plumas County Flood Control and Water Conservation District
	NORTH BAY AREA
4	Napa County Flood Control and Water Conservation District
5	Solano County Flood Control and Water. Conservation District
	SOUTH BAY AREA
6	Alameda County Flood Control and Water Conservation District, Zone 7
7	Alameda County Water District
8	Santa Clara Valley Water District
	SAN JOAQUIN VALLEY AREA*
9	County of Kings
10	Devil's Den Water District
11	Dudley Ridge Water District
12	Empire West Side Irrigation District
13	Hacienda Water District
14	Kern County Water District
15	Oak Flat Water District
16	Tulare Lake Basin Water Storage District
	CENTRAL COASTAL AREA
17	San Luis Obispo County Flood Control and Water Conservation District
18	Santa Barbara County Flood Control and Water Conservation District
	SOUTHERN CALIFORNIA AREA
19	Antelope Valley–East Kern Water Agency
20	Castaic Lake Water Agency
21	Coachella Valley County Water Agency
22	Crestline-Lake Arrowhead Water Agency
23	Desert Water Agency
24	Littlerock Creek Irrigation District
25	Mojave Water Agency
26	Palmdale Water District
27	San Bernardino Valley Municipal Water District
28	San Gabriel Valley Municipal Water District
29	San Gorgonio Pass Water Agency
30	The Metropolitan Water District of Southern California
31	Ventura County Flood Control District

* predominantly agricultural

(From SWSC Exhibit 1, p. 2, and DWR Exhibit 15A)


CENTRAL VALLEY PROJECT
EXISTING AND PROJECTED SERVICE AREAS
DELTA-MENDOTA CANAL SERVICE AREA
SAN LUIS SERVICE AREA
CROSS VALLEY CANAL SERVICE AREA
OREGON
NEVADA
MEXICO
SISKIYOU
MODOC
TRINITY
LASSEN
TEHAMA
PLUMAS
MENDOCINO
SIERRA
ALPINE
MONO
INYO
MONTEREY
SAN LUIS OBISPO
KERN
SANTA BARBARA
VENTURA
LOS ANGELES
SAN BERNARDINO
RIVERSIDE
SAN DIEGO
IMPERIAL
(FROM USBR EXHIBIT 63, MAP NO. 214-208-8133)

and III-41, respectively. These service areas include portions of the Sacramento Valley as well as export service areas in the Bay area, the San Joaquin Valley, and Southern California.

The Department has contracted at the outset for delivery of the planned maximum yield of the SWP. Facilities are to be constructed in phases to meet the gradually increasing need for water. Water supply contracts include a schedule of increasing firm deliveries or entitlements of water. This allows the Department to schedule construction of facilities to meet demands. In any year in which more water is available than needed to meet that year's entitlement, contractors may purchase such surplus water. As use under annual entitlements increases, availability of surplus water will decrease and be confined to more water-abundant years. Should yield not be increased, deficiencies in entitlements would be necessary in some years.

The Department conducts many studies to determine future operation of the SWP, and the availability of water supplies for its contractors. Perhaps the most important determination made in these studies is that of the "yield" of the project, which is a measure of a long-term minimum average amount of water available for delivery on demand. The yield is calculated as the average annual delivery capability of the SWP through the period 1928-1934, which represents the most severe long-term drought period of recent record. The Bureau uses the same determination of yield for the Central Valley Project.

The Department presented various exhibits which were outputs of complex yield-determining operations studies (Department Exhibits II-7, II-8, II-10, II-11, II-12). The major elements in these studies are listed below:

1. Hydrologic base: either 1922-1971 or 1922-1954; in either case, the 1928-1934 yield-determining hydrologic period is evaluated.
2. Delta consumptive uses
3. Controlling Delta water quality objectives: these vary in each study, and can have a significant impact on yield.
4. Project exports: actual exports of water from the Delta by the SWP and CVP, with consideration given to carriage water requirements.
5. Level of development: the extent of upstream water development and use (studies use 1970, 1980, 1988, and 1990).
6. Other assumptions: annual carryover storage, power operations, downstream fish releases, etc. for project and nonproject facilities.

Considerations 3 and 5 vary in each study. Each operations study assumes that SWP and CVP reservoirs are essentially at maximum operating levels in 1928, decreasing to a minimal carryover storage at the end of 1934. The deliveries through the entire period are summed, and divided by the number of years in the period to arrive at the yield figures. With any one set of Delta water quality objectives, the operations studies show that yield will decrease with time as nonproject upstream water development and water use increases (Department Exhibits II-7, II-10, II-11). The yield of the projects can be characterized as either firm project yield or firm exportable yield. Exportable yield, discussed in more detail in Chapter V, is a measure of the capability of the projects to meet export demands south and west of the Delta. In the case of the SWP, most of the project demands are in export areas, so SWP firm project yield is about equal to SWP firm exportable yield. However, for the CVP some large service areas are upstream of the Delta, so CVP firm project yield is substantially greater than CVP firm exportable yield. The discussion in this chapter deals with firm project yield, while the discussion in Chapter V is concerned with the effects of the standards on combined firm exportable yield.

A SWP dependable annual yield of 4,230,000 acre-feet is necessary to satisfy full contractual entitlements. The dependable yield determined from the above studies (assuming existing basin plan water quality objectives) with present facilities is about 2,300,000 acre-feet, which the Department estimates will meet contract entitlements through the early to mid-1980's. A comparison of present estimated supply to present and future demands is shown in Table III-9. The table also indicates that SWP contractors have voluntarily postponed some of their firm entitlements through reduced delivery schedules which result in significant decreases in demand through about the year 2010. Even so, the SWP will need to take some actions much earlier than 2010 in order to meet future demands under dry and critical year conditions.

TABLE III-9

SWP SUPPLY AND DEMAND

Quantities in Thousands of Acre-Feet

Year	Supply a/	Demand b/	Maximum Entitlement c/
1975	2,300	1,231	1,387
1980	2,300	2,010	2,231
1985	2,300 d/	2,539	3,214
1990	2,300 d/	3,479	4,192
2000	2,300 d/	3,859	4,229
2010	2,300 d/	4,131	4,229
2020	2,300 d/	4,226	4,230

a/ Assumed approximate firm supply available to meet contractual needs.

b/ This represents a voluntary reduction by contractors in the schedule of deliveries of firm contract entitlement (from Table B-5B, The California State Water Project - 1976 Activities and Future Management Plans, Bulletin No. 132-77, Department).

c/ This represents maximum firm contract entitlement (from Table B-4, ibid.)

d/ Future supply may be increased through conservation and reclamation programs, construction of new facilities, development of new groundwater storage, etc. It may also be decreased by non-project upstream water development and use.

The CVP firm yield has been determined by operation simulation studies conducted by the Bureau. These studies are based on historical runoff, the capabilities of each unit of the CVP and the coordination of the individual reservoir operations with all of the CVP supply and operational commitments. Since the CVP relies on the availability of return flows from upstream uses of project water as part of the supply for downstream project needs, the expected project yield increases as upstream use of project water increases.

The Bureau takes a different approach than the State in matching water supply contracts and a developed supply. The Bureau determines the eventual need for a water supply, and then constructs storage and conveyance works to provide immediate benefits, including flood control and power generation, even though water supply contracts for full use of the project yield have not been executed. Consequently, the CVP now has a firm yield exceeding that needed to meet present water supply contracts, although the Bureau considers this water obligated to predetermined areas of need. However, as shown by Table III-10 the future demand is expected to exceed the yield with presently existing facilities.

TABLE III-10

CVP SUPPLY, DEMAND, AND INTERIM SUPPLY AVAILABLE

Quantities in thousands of acre-feet

Year	Supply[a/]	Demand	Interim Supply Available Inbasin
1975	10,689	7,429	3,260
1980	10,689	8,245	2,444
1985	11,407	9,484	1,923
1990	11,407	9,952	1,455
2000	11,407	10,699	708
2010	11,407	11,165	242
2020	11,407	11,320	87

a/ Based on 2,500 cubic feet per second allowance for Delta outflow and construction of additional facilities after 1980.

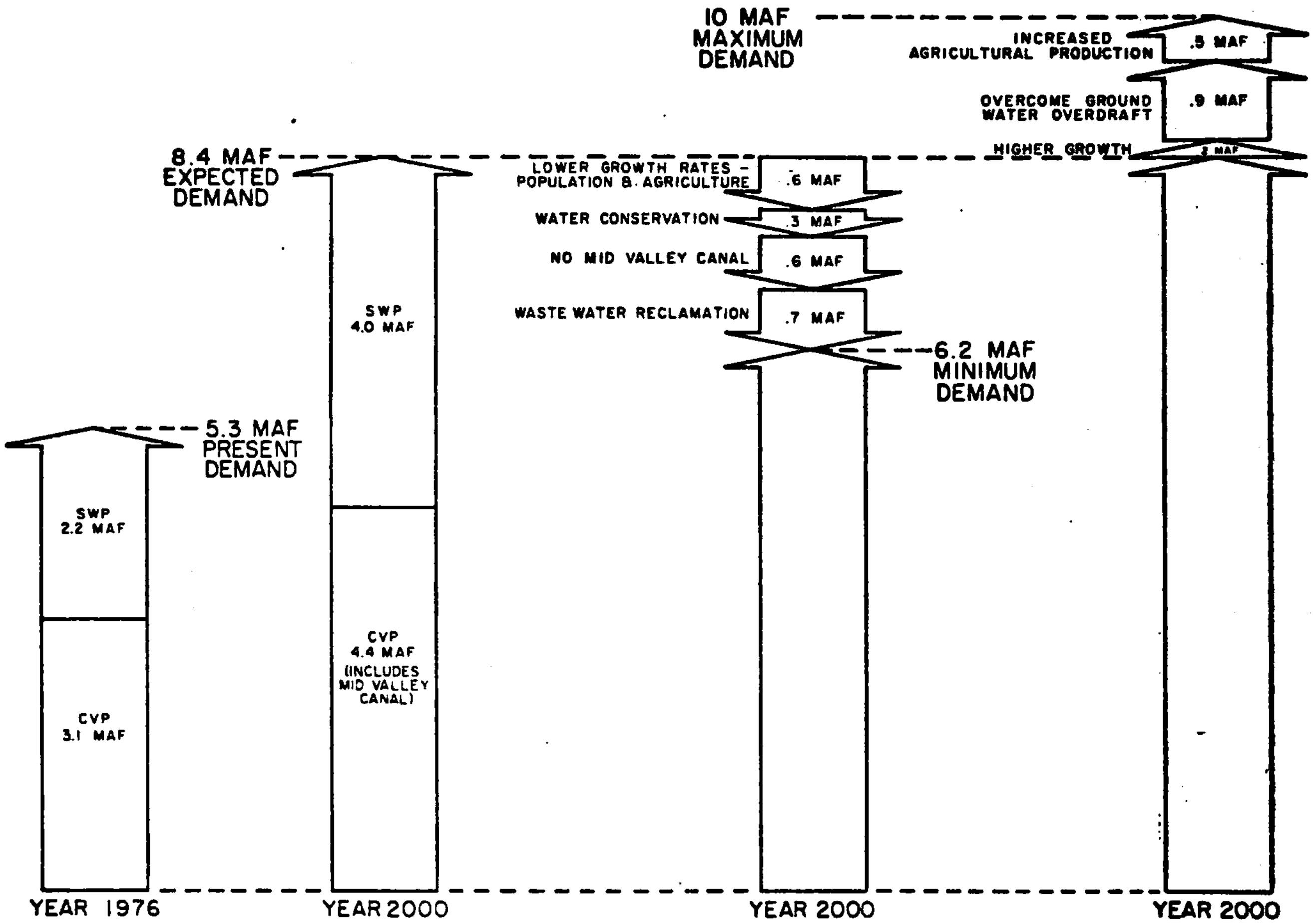
Source: Bureau Exhibit 64, p. 20

Another difference is that CVP water contracts do not provide for a gradual increase of entitlements, so that every long-term contractor is entitled to the maximum contractual amount of water in any year, subject to specific curtailments during dry years.

The Bureau also sells surplus water in years in which the supply available exceeds that necessary to meet the long-term contractual commitments. The general operational objectives of the CVP are fixed, but the detailed operational plans change throughout the year due to changing project demands, hydrologic conditions and other factors.

The availability of water with suitable salinity for export by the CVP and SWP will be affected by the salinity standards adopted by the Board, agreements executed by the CVP and SWP, and by hydrologic and growth factors.

The estimated future demands for water are based upon population projections, trends in irrigated agriculture, assumptions regarding success of water conservation measures and other factors. As an example of the relative effect of these factors, Figure III-42 shows three estimates of possible Delta export demand for the year 2000 (Department Exhibit II-2, p. 7). These estimates range from 6.2 million acre-feet to 10.0 million acre-feet annually. The second arrow from the left in the figure shows the estimate which the Department currently uses for planning purposes. The estimated lowest possible demand from the Delta for the year 2000, shown by the third arrow, assumes:



Present and future Delta export demands.

SOURCE: Dept. of Water Resources Exhibit II-2 Fig. 3

1. A minimum population growth rate (assuming a zero net migration and a fertility rate of 2.1 children per woman) and a minimum growth in agriculture (assuming low rates of national population growth and foreign trade demands);
2. A 10 percent increase in efficiency of water management practices in the municipal and industrial service areas to effect water conservation;
3. The Mid-Valley Canal will not be constructed; and
4. A tenfold increase in new water supplies from reclamation and use of wastewater.

The maximum possible demand from the Delta shown by the fourth arrow assumes an increase in population through higher birth rates and immigration, elimination of groundwater overdraft in the San Joaquin Valley, and additional water development to support increased agricultural production for domestic use and foreign trade.

In order to meet the expected Delta export demands the CVP and SWP have a number of options. Basically, these involve increasing storage capacity, changing operating criteria, implementing water conservation and reclamation programs, amending export contracts, providing alternative supplies to Delta users, improving the efficiency of cross-Delta transfer of water, or some combination of those options. The users of water in the service areas also have a number of options which could reduce the expected demand. If these options raised the price of water, demand would decrease correspondingly. They can develop local supplies of surface water, increase their use of available groundwater so long as permanent overdrafts do not occur, implement water conservation measures, reclaim wastewater or curtail new uses of water (Department Exhibit II-1, p. 8). The decisions by project operators and water users will be influenced by many factors, including the Board's decision.

Water Quality Needs and Contractual Obligations. The water exported from the Delta by the SWP and CVP is used in the respective project service areas for a wide range of beneficial uses, encompassing irrigation, domestic, municipal, industrial and groundwater recharge including related control of land subsidence and groundwater salinity intrusion. The water supply contracts of the SWP and CVP for water diverted at Clifton Court and the Tracy Pumping Plant, respectively, appear to provide water of adequate quality for the most restrictive of the beneficial uses of water diverted at those locations.

The SWP contracts include provisions that the State shall take all reasonable measures to make available, at the structures for delivery of project water to the contractors, water of quality not to exceed specified limits on both a monthly average and ten-year average basis for some 15 specific constituents. The goal is to deliver SWP contractors water with chlorides not exceeding 110 ppm on a monthly average basis. The SWP considers 100 ppm chloride at Clifton Court necessary to meet the 110 ppm requirement in water delivered.

In making deliveries from the Delta-Mendota Canal and Mendota Pool, under exchange contracts, the Bureau is obligated to provide water of a quality that does not exceed the following mean total dissolved solids concentrations:

Period	Maximum TDS Limits (ppm)
Daily	800
Monthly	600
Annual	480
Five-year	400

Under Bureau contracts with irrigation districts, the districts are not obligated to accept and pay for any water which contains in excess of 300 parts per million chloride (about 1100 ppm TDS). However, if the water is used, it is paid for at prevailing contract rates.

The revised contract with the Contra Costa County Water District for water supplied to the Contra Costa Canal intake calls for the best water quality possible within the operations capability of the CVP.

The ability of SWP and CVP to meet these quality commitments depends on water quality in the Delta channels, which in turn is determined by export rates and use of Delta inflow for both Delta outflow and Delta consumptive uses. Enough flow into the Delta must be provided to assure adequate transfer of water to the export pumps. This Delta inflow also must provide enough Delta outflow to assure adequate export water quality. The outflow required to meet export water quality objectives is called "carriage water". The carriage water serves the dual purpose of meeting the water quality objectives for export water and partially meeting the water quality objectives to protect the beneficial uses of the Delta and Suisun Marsh.

D. WATER QUALITY CONTROL

Water quality control in the Delta and Suisun Marsh has been accomplished through water quality control plans and water right decisions adopted by the Board. A brief description of those actions which are currently controlling is presented below. (See Chapter IV of the draft water quality control plan for a more detailed discussion on water quality control development in the Delta.)

The development of comprehensive water quality objectives for the Delta began with the so-called November 19, 1965 criteria.[12] These criteria were incorporated into Decision D 1275, the principal water right decision on the SWP adopted May 31, 1967, by the State Water Rights Board. Also, this decision included an operational limitation on pumping from the Delta and on collecting water to storage in Oroville Reservoir under certain water quality conditions. This pumping limitation was modified by Decision D 1291 on November 30, 1967.

12/ These criteria were developed by a group consisting of representatives of the Sacramento River and Delta Water Association, San Joaquin Water Rights Committee, Department, and Bureau.

The November 19 criteria provide specific water quality requirements at designated locations throughout the Delta. These criteria were negotiated between Delta agricultural interests and project operators based upon the best information available in 1965 and were intended primarily for the protection of agricultural uses in the Delta. The November 19 water quality criteria are essentially equal to salinity levels in the Delta necessary to satisfy water quality requirements at the intakes to the Delta Mendota and Contra Costa Canals. (Department Exhibit 502, p. 67; Decision 1379 Hearing) The criteria provide for relaxation in critical years. However, this relaxation would not be tied to required deficiencies by water service contractors in such years.

The principal water right decision on the CVP, Decision D 990 adopted on February 9, 1961, does not include any water quality objectives. In 1971 the Board adopted Decision 1379 which established new water quality requirements for the Delta and rescinded those in D 1275. It was not until this decision that specific water quality objectives for the protection of fish and wildlife were established. This decision made no provisions for relaxation of these objectives during dry and critical years.

Due to a court order staying implementation of Decision 1379, the D 1275 water quality requirements are currently operative. Notwithstanding the stay on Decision 1379, water quality requirements of that decision must generally be met, since they have been incorporated into later water quality control plans.

The currently controlling long-term salinity objectives are those contained in the water quality control plans for the San Francisco Basin (Basin 2 Plan) and the Sacramento-San Joaquin Delta Basin (Basin 5B Plan). The Basin 2 Plan includes Suisun Marsh and was approved by the State Water Resources Control Board Resolution 75-28 on April 17, 1975; the Basin 5B Plan includes the Delta and was approved by Board Resolution 75-80 on August 21, 1975. Amendments to salinity objectives in the Basin 2 Plan were approved by Board Resolution 76-61 on June 17, 1976. The salinity objectives of these plans are summarized in Appendix B of the water quality control plan for the Delta and Suisun Marsh. The water quality standards in D 1275 have been incorporated into the Basin 5B Plan, except for the operational constraint at Blind Point.

The "Blind Point" condition under the "no action" alternative, with the implementation of Decision 1379 stayed, would continue to be a limitation on operation of the SWP.

CHAPTER IV

DEVELOPMENT OF ALTERNATIVE PLANS

The most important phase in the development of a water quality control plan is the analysis of alternative approaches for the protection of beneficial uses. The step-by-step approach used to develop these alternatives is presented below. The process involves essentially five steps: (1) development of conceptual alternatives for each beneficial use category, (2) preliminary evaluation of the conceptual alternatives, (3) development of alternative plans (complete sets of water quality standards covering all beneficial uses) by combining certain conceptual alternatives prepared for each beneficial use, (4) evaluation of the relative impacts of the alternative plans, and (5) selection of the recommended plan. The first three steps of this process are discussed in this chapter and the last two are presented in Chapter V.

A. CONCEPTUAL ALTERNATIVES

Conceptual alternatives, reflecting a broad range of possible levels of protection, have been developed for each beneficial use: Municipal and Industrial, Agriculture, and Fish and Wildlife. The specific alternatives developed for each major use are discussed below and listed in Table IV-1 (at the end of this chapter).

Municipal and Industrial

Water supply for human consumption has long been considered the highest use of water. Water quality standards developed for such uses must ensure that those supplies are potable and do not endanger human lives or health. Thus, all of the municipal and industrial alternatives presented below would provide protection for municipal and domestic water supplies.

No Action. The Basin 5B Plan objectives for municipal and industrial uses would be controlling if the Board took no action. Municipal and industrial objectives have been established at three locations in the Delta: Antioch, Rock Slough (Contra Costa Canal Intake) and Cache Slough (City of Vallejo Intake). These objectives are shown in Column A of Table IV-1.

Public Interest/Without Project Conditions. Under this alternative, protection of municipal and domestic uses would be provided under the Board's public interest authority. The principal basis of municipal water supply quality would be the protection of public health. The municipal standard for drinking water is based on EPA regulations adopted pursuant to the "Safe Drinking Water Act" (PL 93-523) and the California State Department of Health criteria set forth in Section 64473 of Title 22 of the California Administrative Code.

The level of protection for industries, on the other hand, would be based on the Board's vested water right authority. Industries would be provided water of a quality suitable for the most salt-sensitive industrial processes for the length of time that they would have received it in the absence of the projects.

Municipal uses are greatly enhanced in terms of suitability for landscape watering and taste by water quality levels better than the public health standards. Thus, water quality criteria for municipal and industrial uses should recognize this need. The U. C. Guidelines for protection of chloride-sensitive vegetation and CCCWD Exhibit 17 indicate that such municipal uses could be protected at the 150 mg/l chloride limit. This alternative also would provide municipal users the 150 mg/l chloride level of protection to the extent that such quality would have been available to them in the absence of the projects. This industrial and municipal standard would be provided offshore at Antioch.

The development of without project salinity conditions at Antioch is described in Chapter III. Briefly, an analysis was made to estimate salinities at Antioch which could be expected to occur at the 1980 level of upstream depletions unrelated to CVP and SWP development. The results of this analysis are shown in Column B of Table IV-1.

Substitute Supplies. Municipal and industrial users in the vicinity of Antioch have adequate substitute supplies available through the Contra Costa Canal. Under this alternative, offshore water quality in the vicinity of Antioch would not be protected.

The level of protection provided to municipal drinking supplies at the Contra Costa Canal Intake would be identical to that of the previous alternative. The industrial standard would be based on providing a substitute water supply through the Contra Costa Canal equivalent to that which would have been available offshore at Antioch. However, to the extent that vested water right holders elect to satisfy their needs offshore at Antioch, the substitute supply would be proportionately reduced. The standards under this alternative are shown in Column C of Table IV-1.

Modified Without Project Conditions. Under this alternative, the number of days of 150 mg/l chloride or less at Rock Slough would be permitted to vary with hydrologic conditions. This concept may provide long-term protection for industrial uses comparable to that of the substitute supply approach presented above. The modified without project standards are shown in Column D of Table IV-1.

Agricultural

No Action. Under this alternative, the current Delta agricultural standards contained in the Basin 5B Plan and also in the Board's water right Decision D 1275 would remain in effect. These standards are shown in Column A of Table IV-1. Decision D 1275 also contains specific operational constraints on the SWP if certain water quality conditions are not met at Blind Point on the San Joaquin River.

Without Project Conditions. In Chapter III the salinity requirement to protect Delta agriculture on subirrigated soils is discussed and established at 0.45 mmhos EC during the irrigation season. Without project water quality conditions are developed in Chapter III. Figures III-9 and III-10 depict without project conditions in the western and interior Delta, respectively, for the various year types. As shown in Figure III-9, without project conditions would not provide the western Delta with 0.45 mmhos EC water quality throughout the major portion of the irrigation season, except in wet years.

In order to establish the salinity levels that each geographical area of the Delta is entitled to, Figure III-9 and Figure III-10 were used to develop weighted average water quality during the major portion of the irrigation season (April 1 to August 15). The weighted average salinities for various locations in the Delta are shown in Column B of Table IV-1. The average salinity for Central Landing is listed under "Terminous", and that for False River at Webb Pump under "San Andreas Landing". Even though the substituted stations are not the locations for which the data were gathered, the data adequately represent water quality at these stations.

During those water year types in which the weighted average salinity is less than or equal to 0.45 mmhos EC, a salinity requirement of 0.45 mmhos EC would be met. As discussed in Chapter III, water quality better than 0.45 mmhos EC most likely would not provide any additional benefit to subirrigated agriculture. Thus, the salinity requirements listed in Column B of

Table IV-1 provide Delta agriculture with the average water quality which would have been experienced in the absence of the CVP and SWP as limited by their water quality needs.

Modified Without Project Conditions. A modification of the previous alternative is shown in Column C of Table IV-1. This conceptual alternative recognizes that good water quality (low salinity) would have been available at all times early in the irrigation season under without project conditions, but that the quality would degrade rapidly later in the irrigation season. This "modified" alternative would provide 0.45 mmhos EC for a period during the beginning of the irrigation season, and then would allow higher salinity to occur during the latter portion of the irrigation season. The weighted average salinity under this "modified" alternative is the same as that for the without project alternative. The benefits and drawbacks of these two approaches are discussed in more detail in Chapter V.

Fish and Wildlife

No Action (Basin Plans). If the Board took no action, the fish and wildlife objectives of Basin Plans 5B and 2 would be controlling. The Basin Plan objectives are shown in Column A of Table IV-1.

Project Mitigation/Interim Protection(Fish & Game Exhibit 11). The Board believes that conditions in the Delta and Suisun Marsh for fish and wildlife resources should be such that these resources are maintained at or at least approach those levels which would have existed had the SWP and CVP not been built. Conditions upstream of the estuary may limit the abundance of some species. This alternative deals only with those factors in the Delta and Marsh that limit species abundance.

During the hearing, Fish and Game emphasized certain key fish and wildlife-related species (RT Vol. XXII, pp. 142-144). Striped bass, salmon and alkali bulrush are presently considered key species by Fish and Game. These key species have been selected primarily because of their overall importance and the current state of knowledge relating environmental factors to expected fish and wildlife population levels. In measuring the attainment of the mitigation goal in the Delta and Suisun Marsh this alternative has been assessed in terms of these key species. The water quality standards that strive to attain this level of protection are shown in Column C of Table IV-1.

- <u>Striped Bass.</u> Information relating Delta outflow and diversion rates to young striped bass survival (in terms of the Striped Bass Index) is presented in Chapter III. Based on these flow/bass relationships and Department Exhibit II-12[1/], the average Striped Bass Index expected under without project conditions has been estimated.

  The June-July relationships of outflow, diversion rates and young striped bass survival were considered to be the most appropriate for the determination of the without project Striped Bass Index. The Index was

1/ Department Exhibit II-12 identifies environmental conditions in the Delta and Suisun Marsh which would have occurred in the absence of SWP and CVP under 1980 level of development.

found to vary from 108 index units in an average wet year to 18 index units in an average critical year, with the overall average (based on the frequency of occurrence of hydrologic year types during the period 1922-1971) being 71 index units. This is likely an underestimate of without project conditions. The basis of this conclusion is discussed in more detail in Chapter V.

Fish and Game's recommendations, set forth in their Exhibit 11, were then analyzed to determine if these recommendations would provide the without project level of protection to striped bass. The results of this analysis are discussed in detail in Chapter V. These results show that the Fish and Game recommendations approached mitigation of project-induced impacts on striped bass under conditions expected to exist for the next few years. The Fish and Game recommendations are therefore included under this alternative and shown in Column C of Table IV-1.

- Salmon. Mitigation levels for salmon have not been developed. As previously indicated in Chapter III, salmon populations in the Sacramento and San Joaquin watersheds are believed to be affected more by project developments upstream of the Delta where they spawn than by environmental conditions in the Delta. In addition, project development upstream of the Delta over the last 40 years has changed the predominant runs of salmon from spring to winter, and thus has changed the timing of environmental needs of salmon in the Delta. The environmental needs in the Delta of the present salmon runs are not well understood. However, Fish and Game has recommended minimum flows in the Delta which it believes would be suitable for salmon migration (Fish and Game Exhibit 11, p. 9). These recommendations have been included under this conceptual alternative for the protection of salmon, and are shown in Column C of Table IV-1.

c <u>Suisun Marsh.</u> The mean monthly channel salinities in Suisun Marsh required to produce optimal seed production of alkali bulrush with best management practices are discussed in Chapter III. The critical period is from October through May during which tidal flooding of the managed area takes place. The salinities needed to protect the Marsh are shown by the solid line with squares in Figure IV-1. Also, shown on Figure IV-1 are the conditions expected in the Marsh both with and without the SWP and CVP during average critical years.2/ Figure IV-1 shows that

2/ The curve labeled "with projects" was taken from Fish and Game Exhibit 24 and represents conditions expected to occur over the next few years with the projects operating to the interim Marsh objectives contained in Fish and Game Exhibit 11. The curve labeled "without projects" was developed from Department Exhibits II-12 and II-13B in the same manner that Fish and Game Exhibit 24 was developed.

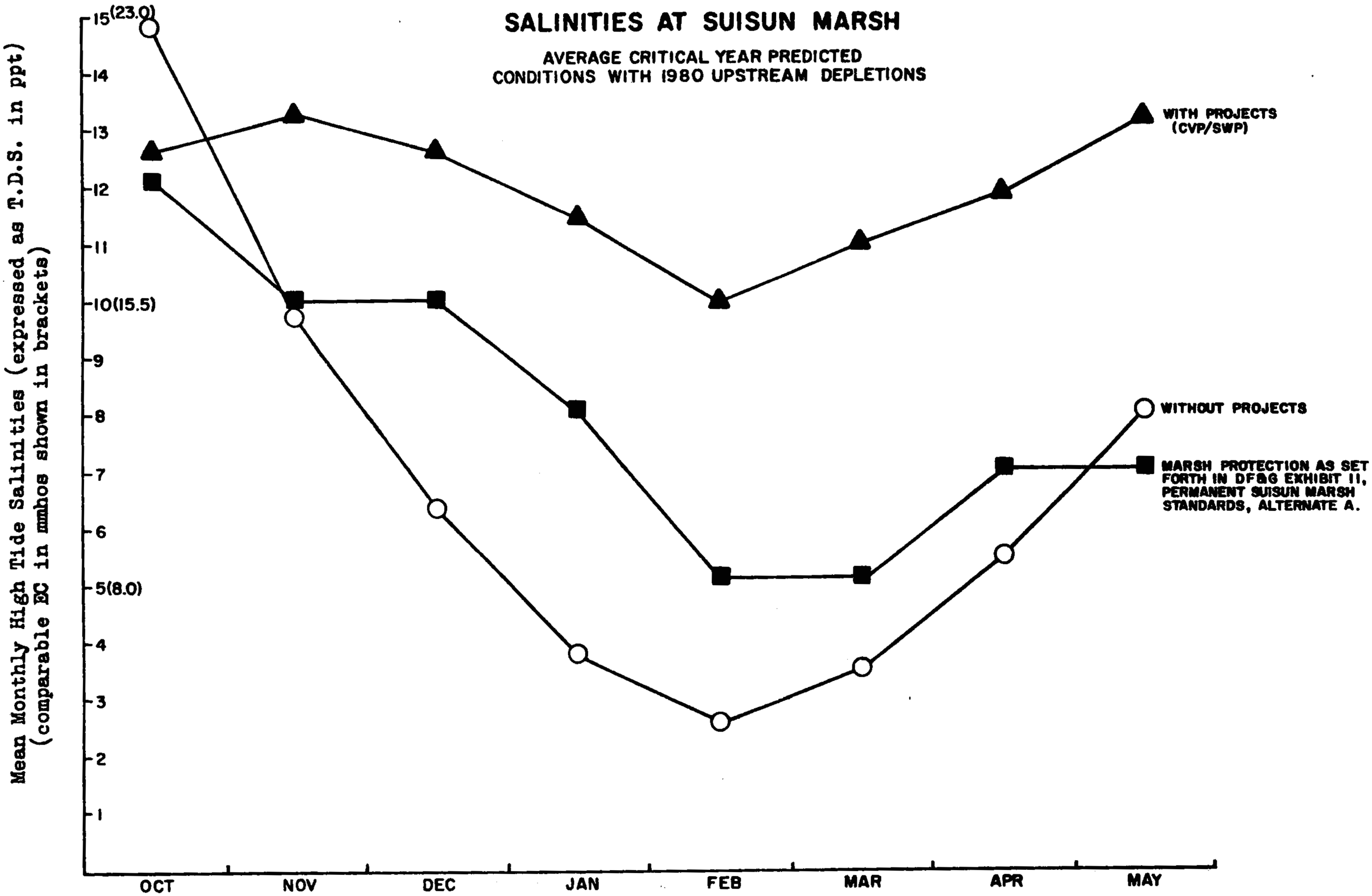


Figure IV-1

Predicted salinities are shown for the mouth of Suisun Slough which was estimated at 0.75 times the Port Chicago salinities (from DF&G Exhibit 24, DWR Exhibit II-13-B).

salinity levels would be substantially lower under without project conditions than with the projects. These lower salinity levels would provide full protection to a major portion of the Marsh, even in critical years.

In addition, Figure IV-1 indicates that the interim recommendations contained in Fish and Game Exhibit 11 would not provide full protection to the Marsh during critical years in the immediate future under with project conditions. Thus, Fish and Game's interim recommendations do not provide for immediate full mitigation of project-induced impacts on Suisun Marsh. Full mitigation of project impacts could require in excess of 2 million acre-feet of Delta outflow in a critical year above that required for the with project condition depicted in Figure IV-1 (RT Vol. XXII, p. 101). The estimated monthly Delta outflows required to mitigate fully project impacts on the Marsh and thus protect the Marsh are listed below:

Month	Average Delta Outflow cfs	Month	Average Delta Outflow cfs
October	5,900	February	14,500
November	6,700	March	14,500
December	6,700	April	11,000
January	9,700	May	11,000

(Based on attaining at Suisun Slough the salinities shown on Table IV-1 under Fish and Wildlife, Suisun Marsh, Column B.)

Presently, protection of the Marsh can be accomplished only with Delta outflow. The Delta outflow required for full Marsh protection would reduce the combined exportable yield of the projects by about one-third.

Recognizing the severe impacts which would be imposed on the projects if full Marsh protection were required now, Fish and Game recommended essentially two levels of protection for the Marsh. Full protection of the Marsh would be achieved on a permanent basis as soon as necessary facilities are constructed to provide alternative supplies to the Marsh. Under the time schedule established by the Board in the water quality control plan, these mitigation facilities must be completed by October 1, 1984. In the interim over the next six years, Fish and Game recommended that something less than full protection be provided to the Marsh recognizing the probable occurrence of large uncontrolled flows in most years which would provide the Marsh needed protection. Based on historical occurrences, Marsh protection under this approach would occur about two-thirds of the time. Fish and Game's recommendation for Suisun Marsh satisfies the intent of this mitigation conceptual alternative, although such mitigation does not take place immediately. The water quality standards for this approach are shown in Column C of Table IV-1. Full protection to the Marsh is evaluated in detail below under the preservation conceptual alternative.

Preservation of Fish and Wildlife at Historical Levels. Fish and Game has adopted a general policy that fish and wildlife resources in the Bay-Delta estuary should be maintained at recent historical levels (RT Vol. XXII, pp. 140-141). However, conditions upstream of the estuary may limit the abundance of some species. Fish and Game's policy deals only with those factors in the estuary that limit species abundance. The recent historical levels are the average abundance of fish and wildlife resources over the 1922-1967 period. The 1922-1967 period was derived through negotiations between the Department, Bureau, Fish and Game, and U. S. Fish and Wildlife Service. The year 1922 represents the beginning of reliable hydrologic data on the Bay-Delta estuary. In view of this, 1922 has been traditionally used as the starting point for operation studies of the Bureau and Department. The year 1967 marks the point at which substantial increases in export occurred as a result of the start-up of the SWP and San Luis Division of the CVP (RT Vol. XXII, pp. 141-142).

Fish and Game has not attempted to define the levels of recent historical abundance for all the fish and wildlife species in the Delta and Suisun Marsh. Fish and Game has indicated that these levels will be "...estimated only for key species when the need arises" (RT Vol. XXII, p. 142). The recent historical levels have been developed for striped bass and, in a general way, for Suisun Marsh. The determination for Suisun Marsh is not based on actual historical levels of specific plants or waterfowl that occurred during 1922 to 1967. Instead, recent historical levels for the Marsh reflect the potential resource that could have existed in this area under the water quality available during the 1922 to 1967 period and best management practices.

This conceptual alternative may provide some enhancement beyond that provided in the previous alternative, project mitigation/interim protection. Compensation for any enhancement would be subject to the provisions of the authorizing legislation of the SWP and CVP. The development of water quality standards for this conceptual alternative is discussed below. Although these standards are based on the best available information, it is uncertain whether historical levels could be achieved even if these requirements were met.

o <u>Striped Bass</u>. Actual measurements of striped bass abundance are available only for the period beginning with 1959. Thus, the method for determining the without project levels (explained above) has been used to calculate the historical level of striped bass abundance. However, in place of the theoretical without project conditions, the actual environmental conditions that occurred during the 1922-1967 period have been used along with the outflow-diversion-striped bass relationships in estimating the historical level. Fish and Game Exhibit 14 shows that the estimated average Striped Bass Index during the 1922-1967 period is 106 index units (also see RT Vol. XXII, pp. 167-168).

Water quality standards were then developed to achieve an average Striped Bass Index of 106 with existing project facilities using the outflow/bass relationships. June and July outflows and diversions for the various year types have been developed to best fit the needs of both striped bass and the projects, and to result in an overall average of 106 Striped Bass Index units. The frequency of occurrence of each year type is consistent with the historical occurrence over the past 50 years. There are, of course, an infinite number of possible outflow and export combinations that could have been selected. Table IV-2 illustrates how limitations on export rates affect the Delta outflow required to obtain a weighted Striped Bass Index of 106.

The Striped Bass Index values shown in Table IV-2 for current export rates (7550 cfs) depend on extrapolation of the outflow-Striped Bass Index relationship far beyond actual measurements. For this reason, an export level of 4000 cfs was used to develop the flows needed to protect striped bass at historical levels. The 4000 cfs export level is a required limitation on project operations. Based on the outflow/bass relationships this export limitation is necessary to achieve the historical level of protection to striped bass with existing project facilities and the outflows listed in Table IV-2. Whether these conditions would actually result in historical level of striped bass is uncertain.

- Suisun Marsh. Fish and Game Exhibit 19 indicates that during average critical years of the historical period (1922-1967), Suisun Marsh received water quality better than that needed for optimal seed production of alkali bulrush. Water quality conditions during wetter years of the historical period were considerably better than those during critical years. Therefore, full protection of Suisun Marsh was afforded in all year types during the period 1922-1967. In order to protect the Marsh solely with Delta outflow, water qualities in the channels of the Marsh would have to be as good or better than those listed in Column B of Table IV-1. The outflows required to achieve these water qualities in the Marsh are shown in the project mitigation/interim protection section. These water quality conditions would be required as minimum standards each year to protect fully the Marsh.

TABLE IV-2

RELATIONSHIP BETWEEN JUNE-JULY DELTA OUTFLOW AND STRIPED BASS INDEX (SBI)

	Export Level 4,000 cfs 2/		Export Level 7,550 cfs 2/	
Year Type (Frequency) 1/	June-July Delta Outflow (cfs) 3/	SBI	June-July Delta Outflow (cfs)	SBI
Wet (32%)	28,000	120.9	100,000	130.4
Above Normal (18%)	20,000	116.4	60,000	113.2
Below Normal (18%)	14,000	109.2	24,000	92.7
Dry (20%)	9,000	96.8	14,000	87.3
Critical (12%)	4,000	64.1	8,000	70.9
Weighted Average SBI		106.3		105.6

1/ From Department Exhibit 1.

2/ The export levels represent export rates expected during June and July under normal operations of the projects (7,550 cfs) and export rates that existed prior to SWP (4,000 cfs). Delta channel depletions have been estimated at 4,000 cfs during June and July.

3/ The June and July flows shown in Column B of Table IV-1 were averaged to achieve the flows listed. The May flows were set at 1.2 to 1.5 times the June-July flows (RT Vol. XXII, p. 170).

- Other Fish and Wildlife Concerns. The recommendations made in Fish and Game Exhibit 11 relative to physical operations of the present Delta facilities of the CVP and SWP and the flows required for salmon have been incorporated as water quality standards under this conceptual alternative. In addition, positive net downstream flows in all Delta channels would also be required to achieve the historical level of protection. These requirements are listed in Column B of Table IV-1.

B. INITIAL ASSESSMENT OF CONCEPTUAL ALTERNATIVES

Individual conceptual alternatives for each use were developed at the outset in order to clarify as precisely as possible the various options available to the Board and to allow an initial assessment of possible alternatives. Upon the completion of this initial assessment, the leading conceptual alternatives for each use were combined into complete alternative plans. A brief description of this initial screening process is presented below.

Municipal and Industrial

The without project conceptual alternative depicted in Column B of Table IV-1 would require large amounts of Delta outflow. The estimated mean daily outflow required to maintain 150 mg/l Cl^- at Antioch is about 10,000 cfs (RT Vol. XXIV, p. 149). Depending upon the carriage water releases to maintain export water quality, the 150 mg/l Cl^- at Antioch might require 4,000 to 7,000 cfs of additional Delta outflow over that needed to meet other salinity standards. The Antioch standards would apply only for about 50 percent of each year. The Department estimates that the additional

Delta outflow required to meet the Antioch objective during the seven-year critical period (1928-1934) would be about 1,000,000 acre-feet per year (Department Exhibit II-11). The total municipal and industrial use in the Antioch area is about 220 acre-feet per day (RT Vol. XXIV, p. 151). Thus, for each acre-foot of water diverted offshore at Antioch for municipal and industrial purposes, an additional 25 acre-feet of Delta outflow would be required above that needed to meet other salinity objectives and carriage water requirements.

In addition to offshore supplies, an adequate substitute supply is available to municipal and industrial users in the Antioch area through the Contra Costa Canal. An equivalent supply for those users, as provided by Water Code Section 12202, at the Contra Costa Canal Intake would require substantially less Delta outflow than providing the same quality offshore at Antioch. Therefore, the municipal and industrial conceptual alternative in Column B was deleted.

The conceptual alternative in Column C of Table IV-1 was retained for further analysis since the provision of a substitute supply in lieu of providing suitable water quality offshore at Antioch appeared to be reasonable.

The alternative in Column D of Table IV-1 would provide suitable water quality at the Contra Costa Canal Intake a greater percentage of the time than the alternative in Column C. The alternative in

Column D is designed to provide relatively long periods of suitable water quality in years of high Sacramento Valley unimpaired runoff, but much shorter periods of suitable water quality in years of low unimpaired runoff. However, during dry and critical years, this alternative would not provide a substitute supply equivalent to that available offshore at Antioch as listed in Column B of Table IV-1.

There is not sufficient information to determine the economic impact of the Column D alternative on municipal and industrial users in the vicinity of Antioch. In addition, the Board has concluded that water quality levels at the Contra Costa Canal Intake should be at least as good as the offshore entitlements of those users in the Antioch area. Thus, the alternative in Column D was not retained for further consideration.

In summary, as a result of this initial evaluation, only the alternatives in Columns A and C have been retained for further consideration in the development of alternative plans.

Agriculture

As previously indicated, three conceptual alternatives have been developed for the protection of agricultural uses in the Delta. Initial screening of these alternatives did not eliminate any of them. Thus, all three have been retained for further evaluation in the development of alternative plans.

Fish and Wildlife

The three conceptual alternatives for Fish and Wildlife also have been retained for further consideration.

C. DEVELOPMENT OF ALTERNATIVE PLANS

Upon the completion of the initial evaluation of conceptual alternatives, the most appropriate conceptual alternatives for each category of use were combined into alternative plans (sets of water quality standards). Each alternative plan has been designed to reflect a consistent policy direction. Seven separate alternatives have been formulated, providing a wide range of options. The elements of these alternatives are described below.

Alternative 1A (No Action) represents the strict adherence to the water quality objectives (standards as used herein) contained in current Basin Plans. This includes compliance with the Basin 2 Plan Suisun Marsh objective which requires water quality in Marsh channels to produce a soil salinity of not more than 9000 mg/l TDS in the first foot of soil from April 15 to May 30. The Delta outflow required to achieve this soil salinity without additional facilities for the Marsh is substantial. However, this alternative does not include the extensive project constraints required to create positive net downstream flows in all Delta channels.

Alternative 1B is identical to Alternative 1A, except that the Suisun Marsh objective is not included.

Both Alternatives lA and lB assume the Board would make a determination that an alternative supply exists for the offshore water users in the Antioch vicinity.

<u>Alternative IIA</u> would provide municipal and industrial users in the Antioch area their full water supply entitlement through the Contra Costa Canal (conceptual alternative in Column C of Table IV-1). Also, Delta agriculture would be provided average seasonal without project entitlement (conceptual Alternative B). Interim protection would be provided to fishery resources (conceptual Alternative C). Interim protection would also be provided to Suisun Marsh pending the construction of necessary mitigation facilities (conceptual Alternative C).

<u>Alternative IIB</u> differs from Alternative IIA only in the agricultural objectives, which have been adjusted to more closely reflect water quality conditions that would have existed without the projects (conceptual Alternative C). Although the weighted average salinities of these agricultural objectives are the same as those contained in Alternative IIA (conceptual Alternative B), Alternative IIB would provide lower than average salinities early in the irrigation season, but higher than average salinities later in the irrigation season.

<u>Alternative IIIA</u> would provide the highest level of Delta protection of the alternatives considered. It assumes that substitute

supplies would be provided to municipal and industrial users in the Antioch area (conceptual Alternative C). Agricultural uses would be provided greater protection early in the irrigation season with less protection in the latter portion of irrigation season (conceptual Alternative C). The protection provided fish and wildlife reflects that necessary to preserve these resources at historical levels with present facilities (conceptual Alternative B). This would require substantial Delta outflows and project export curtailments for fishery protection, and high winter outflows to protect Suisun Marsh.

Alternative IIIB differs from Alternative IIIA only in requiring interim protection to Suisun Marsh (conceputal Alternative C) rather than immediate full protection. Comparison of the impacts of these two alternatives is a measure of the very large amount of additional Delta outflow needed to fully protect the Marsh at present.

Alternative IV represents the merging of some features from both Alternatives IIA and IIB (aspects of the agriculture conceptual Alternatives B and C were combined into one).

The version of this alternative appearing in the Draft EIR has been modified. The most important aspects of this modification are (1) elimination of year after critical year standards for agricultural, municipal and industrial uses, (2) modification of the Suisun Marsh interim standard to provide no more than 12.5 mmhos EC at Chipps Island from January through May regardless of year type, and (3) application of export limitations to both projects during May-July regardless of outflow. These and other changes are discussed in the Delta Plan.

Conceptual Alternatives

Table IV-1
Municipal and Industrial

MUNICIPAL AND INDUSTRIAL	A. NO ACTION (Basin Plan)			B. NEED LIMITED BY "WITHOUT PROJECT" CONDITIONS and WATER RIGHTS				C. OPTION B with RECOGNITION OF CURRENT WATER SUPPLY ALTERNATIVES			D. OPTION C with REASONABLENESS CONSIDERATION (DEPARTMENT PROPOSAL)		
LOCATION	DESCRIPTION	YEAR TYPE	VALUE	DESCRIPTION	YEAR TYPE	VALUE 150	VALUE 250	DESCRIPTION	YEAR TYPE	VALUE	DESCRIPTION	YEAR TYPE	VALUE
1. Antioch on San Joaquin River	Max 14 day TDS (mg/l) for 150 days 120 days 100 days	 Below Normal (BN) & Normal (N) Dry (D) Critical (C)	 450 450 450	Max mean daily Cl⁻ (mg/l) for No. of days shown (% of years in parens)	Wet (W) Above normal (AN) BN D C	240 (66) 190 (52) 175 (48) 165 (45) 155 (42)	265 [illegible] 220 (60) 195 (53) 185 (51) 170 (47)	Objective for this location should be dropped, provided quality of an alternative supply to these riparians is at least that shown in Option B.			SAME AS OPTION C		
2. Rock Slough at Contra Costa Canal Intake	Max mean tidal cycle (MTC) (mg/l) Max MTC 65% of year (mg/l)	All All	TDS Cl⁻ [illegible] 250 380 100	Water supply is a contract right--therefore water qualities to be provided are determined by those contracts. Public Interest Needs Max mean daily Cl⁻ (mg/l)	 All	 250		Max mean daily Cl⁻ of 150 mg/l for No. of days shown (% of years in parens) (weighted average = 53 %) Public Interest Needs Max mean daily Cl⁻ (mg/l)	W AN BN D C All	240 (66) 190 (52) 175 (48) 165 (45) 155 (42) 250	Max mean daily Cl⁻ of 150 mg/l for % of year determined by linear interpolation between values shown Public Interest Needs Max mean daily Cl⁻ (mg/l)	YEAR AFTER W or AN BN D or C (weighted average All	Sacto Valley Unimpaired Runoff Runoff in MAF < 5 8 10 > 15.7 30 45 60 90 15 30 50 80 0 15 35 65 > 65%) 250
3. Cache Slough	Max (instantaneous) (mg/l)	All	TDS CL⁻ 250 100	Public Interest Needs Max mean daily Cl⁻ (mg/l)	 All	 250		Public Interest Needs Max. mean daily Cl⁻ (mg/l)	 All	 250	Public Interest Needs Max. mean daily Cl⁻ (mg/l)	 All	 250
4. Intake to Clifton Court Forebay at West Canal				Max mean daily Cl⁻ (mg/l)	All	250		Max mean daily Cl⁻ (mg/l)	All	250			
5. Delta Mendota Canal at Tracy Pumping Plant				Max mean daily Cl⁻ (mg/l)	All	250		Max mean daily Cl⁻ (mg/l)	All	250			

Conceptual Alternatives (continued)

AGRICULTURE

A. NO ACTION (Basin Plan)

B. NEED LIMITED BY AVERAGE "WITHOUT PROJECT" CONDITIONS

C. SAME AS ALTERNATIVE B EXCEPT RECOGNIZES THAT GOOD WATER QUALITY CONDITIONS EXISTED EARLY IN THE SEASON

LOCATION	A: DESCRIPTION	A: YEAR TYPE	A: VALUE	B: DESCRIPTION	B: YEAR TYPE	B: VALUE	C: DESCRIPTION	C: YEAR TYPE	C: VALUE
WESTERN DELTA Emmaton on Sacramento River	Max 14-day [illegible] (mg/l)	All but C C	1000 Jan.-July 1000 Aug.-Dec 1300	Max 14-day EC (mmhos)	 W AN BN D C	Apr. 1-Aug. 15 0.45 0.51 0.73 0.99 2.78	Max 14-day EC (mmhos)	 W AN BN D C	0.45 EC Until / EC to Aug. 15 Aug. 15 / - July 1 / 0.63 June 20 / 1.14 June 15 / 1.67 June 15 / 5.69
	10-day avg (mg/l) some time from Apr. 1-May 31	All except D or C	700						
Jersey Point on San Joaquin River	SAME AS EMMATON			Max 14-day EC (mmhos)	 W AN BN D C	Apr. 1-Aug. 15 0.45 0.45 0.57 0.85 2.70		 W AN BN D C	0.45 EC Until / EC to Aug. 15 Aug. 15 / - Aug. 15 / - July 20 / 0.74 June 15 / [illegible] June 5 / [illegible]
[illegible] on San Joaquin River	Max 14-day EC (mmhos)	All except [illegible]	[illegible]	NOT INCLUDED			NOT INCLUDED		
CENTRAL DELTA Terminous, Rio Vista San Andreas Landing [illegible] Court Ferry	Max 14-day TDS (ppm)	W or above BN D or C	[illegible] / [illegible] / ASOND 700 / 700 / 700 700 / 700 / 800 700 / 800 / 800						
	Max monthly TDS (ppm)	W or above BN D or C	500 / 500 / 500 500 / 500 / 600 500 / 600 / 600						
	Max yearly TDS (ppm)	W or above BN D or C	450 500 500 Provided avg at all 5 stations for balance of yr does not exceed adjacent lower value						
Greens Landing	When 14-Day or mean monthly max TDS exceeds 150 mg/l		Add to Central Delta TDS levels 1.2 times the amount by which TDS at Greens Landing exceeds 150 mg/l						
Terminous Based on Central Landing				Max 14-day EC (mmhos)	 W AN BN D C	Apr. 1-Aug. 15 0.45 0.45 0.45 0.45 0.54	Max 14-day EC (mmhos)	 W AN BN D C	0.45 EC until / EC to Aug. 15 Aug. 15 / - Aug. 15 / - Aug. 15 / - Aug. 15 / - July 1 / 0.72
San Andreas Landing Based on Webb Pump				Max 14-day EC (mmhos)	W AN BN D C	0.45 0.45 0.45 0.50 0.87	Max 14-day EC (mmhos)	W AN BN D C	Aug. 15 / - Aug. 15 / - Aug. 15 / - June 25 / 0.53 June 20 / 1.40
3. SOUTHERN DELTA Vernalis on San Joaquin River	Max 30-day avg TDS (mg/l)	All	500	Max 30-day avg TDS (mg/l)	All (After New Melones Res. becomes operational and until the objective below becomes effective)	500	Max 30-day avg TDS (mg/l)	All (After New Melones Res. becomes operational and until the objective below becomes effective)	500
Eastern Delta Channels	Max mean monthly TDS (mg/l)	All	700						
Tracy Road Bridge on Old River Old River near Middle River Brandt Bridge on San Joaquin River Vernalis on San Joaquin River				Max 30-day EC (mmhos)	All (To become effective only upon the completion of suitable circulation and water supply facilities)	Apr. 1-Aug. 31 / Sept. 1-Mar. 31 0.7 / 1.0	Max 30-day EC (mmhos)	All (To become effective only upon the completion of suitable circulation and water supply facilities)	Apr. 1-Aug. 31 / Sept. 1-Mar. 31 0.7 / 1.0

Conceptual Alternatives (continued)

FISH AND WILDLIFE

A. NO ACTION (Basin Plan) — B. PRESERVATION AT HISTORICAL LEVELS* — C. INTERIM PROTECTION TO THE FISHERY AND SUISUN MARSH (4-Agency Fish Agreement, Fish and Game Exhibit 11)

LOCATION	A. DESCRIPTION	A. YEAR TYPE	A. VALUE	B. DESCRIPTION	B. YEAR TYPE	B. VALUE	C. DESCRIPTION	C. YEAR TYPE	C. VALUE
1. STRIPED BASS [illegible] Prisoners Point – San Joaquin River	Max 14-day average EC for 5 weeks when water temperature reaches 60°	All	0.550 mmhos	Max 14-day average EC for 5 weeks when water temperature reaches 60°	All	0.550 mmhos	Average EC not to exceed	All	Apr.1–May 5 0.550 mmhos
							Average Delta outflow not less	All	Apr.1–Apr.15 6,700 cfs
Antioch [illegible] River	Max 14-day average EC for 5 weeks when water temperature reaches 60°	All	1.500 mmhos	Max 14-day average EC for 5 weeks when water temperature reaches 60°	All	1.500 mmhos	Average EC not to exceed	All	Apr.15–May 5 1.5 mmhos
							Relaxation provision (replaces the above outflow and Antioch objective) when SWP and CVP apply deficiencies to firm supplies (determined by linear interpolation between values shown)	All	Total Ann.Def. (MAF) / Apr.1–May 5 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
STRIPED BASS [illegible]	Max [illegible] average [illegible]	All	[illegible]	Average outflow index (thousands of cfs) for the period not less than	W AN BN D C	May / June / July: 33.6 / [illegible] / [illegible] [illegible] / 23.0 / [illegible] 16.3 / 16.[illegible] / [illegible] [illegible] / 10.0 / 8.[illegible] 6.0 / [illegible] / [illegible]	Average outflow index (thousands of cfs) for the period not less than 1/ Subnormal Snowmelt 2/ Dry after wet, above normal or below normal 3/ Dry after dry or critical	W AN BN SnSm 1/ D 2/ D&C 3/	May 6–31 / June / July: 14.0 / 14.0 / 10.0 14.0 / 10.[illegible] / [illegible] 11.4 / 9.5 / 6.5 6.5 / 5.4 / 3.6 4.[illegible] / 3.6 / 3.2 4.3 / 3.1 / 2.9
Minimize Diversion of Young Striped Bass [illegible] Central Delta				Closure of Delta Cross Channel Gates up to 20 but no more than 2 of 4 consecutive days on 12 hrs notice by DFG	All	April 16–May 31 when outflow index > 12,000 cfs	Closure of Delta Cross Channel Gates up to 20 but no more than 2 of 4 consecutive days on 12 hrs notice by DFG	All	Apr. 16–May 31 whenever outflow index > 12,000 cfs
Minimize Diversion of Young Striped Bass from the Delta				When daily outflow index < 10,000 cfs mean monthly export rates from Delta will not exceed cfs SWP CVP	All	May–July 2,000 2,000	Mean monthly export rates from Delta will not exceed (cfs) SWP CVP	All	May–June / July 3,000 / 4,000 3,000
3. SALMON MIGRATIONS	Flow direction	All	Positive net downstream flow in all main Delta channels	(SAME AS ALT. C)			Min. 30-day average of computed net mean daily flow at Rio Vista (thousands of cfs)	W AN BN D&C	Jan. / Feb.1–Mar.15 / Mar.16–June 30 / July / Aug. / Sept.1–Dec.31: 2.5 / 3.0 / 5.0 / 3.0 / 1.0 / 5.0 2.5 / 2.0 / 3.0 / 2.0 / 1.0 / 2.5 2.5 / 2.0 / 3.0 / 2.0 / 1.0 / 2.5 1.5 / 1.0 / 2.0 / 1.0 / 1.0 / 1.5
Minimize Cross Delta Movement of Salmon				Closure of Delta Cross Channel gates	All	Jan. 1–April 15 when Delta outflow index > 12,000 cfs	Closure of Delta Cross Channel gates	All	Jan. 1–April 15 When Delta outflow index > 12,000 cfs
4. SUISUN MARSH Bays and Intertidal Sloughs of Suisun Marsh	Sufficient water quality so as not to exceed specified soil salinity (TDS in top 12" of soil)	All	April 15–June 1 9,000 mg/l	Suisun Marsh channel water EC (mmhos) (The monthly aver. of both daily high tide values not to exceed)	All	Oct. 19.0 Nov. 15.5 Dec. 15.5 Jan. 12.5 Feb. 8.0 Mar. 8.0 Apr. 11.0 May 11.0	Average Delta outflow index for the month not less than	W	February–May 10,000 cfs
	Max mean monthly TDS mg/l	All	18,000 mg/l				Min. daily outflow index for 60 consecutive days	SnSm	February–April 10,000 cfs
								AN	January–April 12,000 cfs
								BN	12,000 cfs
							Avg outflow index for each month not less than (if greater flow not required by above objective)	All	January–May 6,600 cfs Whenever storage at or above min. flood control res. envelope level at any two of: Shasta, Oroville, and CVP storage on American River
Chipps Island at O&A Ferry							Max. 28-day EC (mmhos) When no deficiencies in project scheduled water supplies In months when project water users take deficiencies in scheduled supplies 1/ From Jan. 1 to Feb. 15 objective is the same as in previous December	All	Oct.–May 1/ 12.5 15.6

* In order to approach historical levels for the fishery, positive net downstream flow in all Delta Channels is required.

CHAPTER V

ANALYSIS OF IMPACTS

As previously indicated, water quality standards have been developed to protect each beneficial use in its own right. However, it is recognized that a particular use may receive incidental benefits from water quality standards established to protect other uses. In view of this, the impacts of water quality standards of each alternative plan (described in Chapter IV) have been evaluated from two perspectives; individually and collectively. The potential impacts of each alternative plan are summarized in Table V-1 (which is bound at the end of this chapter for ease of reference). The columns of Table V-1 labeled "standard only" represent the level of protection provided solely by the specific water quality standard established for that use. Any benefits from project carriage water or the occurrence of uncontrolled flows are not included in this column.

The columns of Table V-1 labeled "composite of all standards" depict the level of protection which would be received by a particular use from the standards of each alternative plan, along with benefits from carriage flow requirements. In addition, the entries for fish and wildlife and exportable project yield under the "composite" columns also include the effects of expected uncontrolled flows (Department Exhibit II-10 and operation study of draft plan). Since current water quality models of the Delta do not include the interior Delta, it was not possible to identify the benefits from uncontrolled flows for municipal, industrial and agricultural uses.

The values tabulated under the "composite of all standards" columns should not be considered as absolute numbers. They are intended to be used only for comparative purposes between the respective alternative plans. A number of factors have not been incorporated into the environmental analysis which could, under certain circumstances, bring about conditions different from those reflected in the values shown in Table V-1. These factors include local agricultural return flows, deviations in "average" export rates for the year type evaluated, the natural tendency of the system to respond slowly to hydrologic changes, and for municipal, industrial and agricultural uses, the occurrence of uncontrolled flows.

The potential environmental impacts of the alternative plans on each use have been evaluated for the five hydrologic year types (see Figure III-2). A typical condition for each water year type was selected to represent years falling within that year type. While extremes (both wet and dry) in each year type have been eliminated, this procedure does provide a realistic base for comparison of alternatives. The impacts on exportable project yield are based on the sustained dry period from 1928 to 1934.

A. DELTA OUTFLOW

The water quality standards of the alternative plans are either in terms of specific salinity conditions or specific outflows at various locations in the Delta and Suisun Marsh. In order to facilitate the evaluation of alternative plans, these standards have been converted into Delta outflow as a common parameter. Hydrographs of the Delta outflow required under each alternative plan for the five year types are shown in the Figure V-1 series bound at the end of this chapter. These hydrographs show monthly estimates of Delta outflow required by controlling water quality standards and carriage water requirements for each alternative in each year type. The months in which the water quality standards and carriage water requirements are likely to be met by uncontrolled flows are indicated on the hydrographs. These hydrographs have been used extensively in the evaluation of municipal, industrial and agricultural environmental impacts which are summarized in Table V-1.

However, impacts on SWP and CVP exportable yield cannot be derived directly from these hydrographs. The combined exportable yield of the projects is determined by calculating the projects' capability of meeting a given level of export demands during the 1928-1934 dry period. This period is comprised of one above normal year, two below normal or dry years, and four critical years. In order to evaluate the impacts on yield, the water quality standards shown in the Figure V-1 series hydrographs must be superimposed on the actual rainfall, runoff and storage conditions that occurred during 1928-1934 period. The impacts on exportable yield are discussed in detail later in this chapter.

The Delta outflow required to satisfy each water quality standard is based on Department Exhibits 7A and 7B and information used to develop Department Exhibits 8, 9 and 9A. The controlling water quality standard during each month of each typical water year type under the various alternative plans have been determined and are depicted on the Figure V-1 series (a through g).

The estimated outflow needed to meet the carriage water needs of the projects (100 mg/l Cl^- at Clifton Court) is also shown on the Figure V-1 series. The information needed to calculate carriage water needs (project exports and San Joaquin River inflow) has been taken from Department operations studies set forth in Department Exhibits II-7, II-8 and II-10. While more current operation studies are available which reflect more closely project operations under the recommended plan (i.e., Department operation study of the March 1978 Draft Plan), the carriage water needs identified in this report would not be altered significantly by use of such studies. This information, in turn, has been converted to the needed outflow based on information used to develop Department Exhibits 8, 9 and 9A. The procedures used in estimating outflow are similar to those used by the Department in its operations studies. The relative effects of the various alternative plans on project operations can thus be viewed as the difference between the outflow necessary to meet project carriage water needs and that necessary to meet the water quality standards, when uncontrolled flows do not satisfy all Delta water quality needs.

Figures V-1(a), V-1(e), and V-1(f) do not include carriage water needs for the entire year. The alternative plans represented by these figures differ so radically from available operations studies that reliable estimates of export rates and carriage water needs could not be made for every month.

Once the carriage water needs were identified, the Delta outflow required to meet water quality standards in the interior Delta (Contra Costa Canal Intake and Old River at Rancho Del Rio) which can be affected by project export rates was determined. Based on Department Exhibits 8, 9 and 9A estimates have been made of the incremental Delta outflows required above (or below) that of the carriage water needs to satisfy standards in the interior Delta. The Delta outflows derived from this analysis are shown as a broken line in the Figure V-1 series. The water quality standards which would control outflow regardless of export rates are shown as solid lines in the Figure V-1 series.

The expected Delta outflows with 1980 upstream depletions, Basin Plan agricultural objectives (Department Exhibit II-7), and anticipated project operations (Department operation study of the draft plan) are shown on Figure V-9 and tabulated in Table V-2. The information from Table V-2 has been used to estimate when the water quality standards shown on the Figure V-1 series would be met by uncontrolled Delta outflow. Those months during which such conditions are expected to occur are indicated with an asterisk on the Figure V-1 series. During these months project operations would not be affected by water quality standards in the Delta.

B. ENVIRONMENTAL ANALYSIS

Municipal and Industrial

In order to compare the potential environmental impacts of the alternative plans on municipal and industrial uses in the Delta, the location at which the impacts would be analyzed and the level of salinity needed at that location had to be first established. As indicated in Chapter III, the Contra Costa Canal represents a common source to which all municipal and industrial uses in the western Delta have access. In addition the need for water quality of 150 mg/l ^{-}Cl or less for salt-sensitive municipal and industrial uses in the western Delta is set forth in Chapter IV. Thus, the number of days during each hydrologic year type that 150 mg/l ^{-}Cl would be available at the Contra Costa Canal intake has been determined. The Figure V-1 series has been used in this determination. Each month or portion of the month that the Delta outflows would be sufficient to achieve this quality have been totalled to arrive at the values listed in the "composite" columns of Table V-1.

None of the alternatives evaluated would guarantee ("standard only" columns) 150 mg/l chloride or better all year during any year type. However, as indicated in Table V-1, Alternatives IA and IB would provide such water quality more often than any of the other alternatives evaluated.

As might be expected, conditions at the Contra Costa Canal Intake provided by the composite of all standards for each alternative plan would be substantially better in most years than that guaranteed by the individual municipal and industrial standard itself. The exception is Alternative IB for which conditions would not differ from those required by the standard alone.

In Alternatives IIA, IIB and IV, the conditions for wet, above normal and below normal years and dry years with substantial carryover storage would be better than those required by the municipal and industrial standard alone for about one to three months of such years. In dry years without substantial carryover storage and in critical years, conditions at the Contra Costa Canal Intake would reflect more closely the individual standard established to protect salt-sensitive municipal and industrial uses at this location. Although Alternatives IIA, IIB and IV differ, the impacts on municipal and industrial uses shown under the "composite of standards" column of Table V-1 would be the same. Figures V-1(c) V-1(d), and V-1(g) indicate how the standards of these alternatives interact to result in similar impacts.

The impacts on municipal and industrial uses of the composite standards of Alternatives IA, IIIA and IIIB could not be evaluated since complete operation studies on these alternatives were not available. However, conditions under Alternatives IA, IIIA and IIIB would be at least as good as those required by the standard alone as shown in the "standard only" columns of Table V-1.

Municipal and industrial users from the Contra Costa Canal have expressed concern regarding the possible increased costs to two paper industries which require low salinity process water (150 mg/l chloride or less), interference with municipal and industrial water treatment processes, reduced reclamation potential, increase salinity impact to agricultural crops, effects on salt-sensitive landscape plants, and possible impact on human health (related to increased sodium and trihalomethane levels).

In order to quantify possible impacts related to these concerns, a detailed technical analysis is needed comparing the effects of the recommended plan (Alternative IV) with those of the "no action" alternative (IB). Such analysis requires as input precise estimates of resulting water quality under both alternatives as well as economic data on the effects of varying water quality.

The water quality determination would include not only the effects of the composite of all standards under both alternatives, but also the beneficial effects of expected uncontrolled flows and project carriage water. However, it has not been possible with available analytic tools to quantify accurately the resulting water quality at the Contra Costa Canal Intake. Various agencies including the Contra Costa County Water District have been consulted to obtain the best existing technical methods for predicting water quality at the canal intake. Based on analysis of available information in the record and current methodology, there is not sufficient knowledge to predict accurately long-term water quality conditions at the canal intake. The current predictive methods are based primarily on existing water quality conditions, expected project operations, and a good deal of judgment. These methods are useful only for short-term projection (up to six months) of Contra Costa Canal Intake quality. Notwithstanding this, current knowledge does permit a qualitative assessment as described below which does provide an indication of maximum salinity levels expected each month under both alternatives.

In wet and normal years under the "no action" alternative water quality would likely remain below 50 mg/l Cl^- through May or June due to uncontrolled flows and could then increase to a maximum monthly mean of around 170 mg/l chloride from July through October. Chloride concentrations could exceed 50 mg/l during the winter as a result of salts being leached from the surrounding agricultural lands. The July through October maximum during wet and normal years results from the Basin 5B Plan Chipps Island standard of 4,000 mg/l Cl^- and the carriage water necessary to maintain project operational water quality requirements at the SWP and CVP export pumps. Maintenance of the carriage water requirement at the export pumps (100 mg/l Cl^- for the SWP) would result in approximately 170 mg/l Cl^- at the Contra Costa Canal Intake. Water quality after October during wet and normal years under the "no action" alternative would not exceed 100 mg/l Cl^- because of Basin 5B Plan water quality standards for the canal intake. Under the recommended plan, water quality in wet or normal years would likely stay below 50 mg/l Cl^- through July and increase to 170 mg/l Cl^- in September and would probably remain at that level through December.

In dry years both alternatives would likely result in water quality below 50 mg/l Cl^- in January through March and between 50 mg/l Cl^- and 100 mg/l Cl^- in April and May. Water quality under the "no action" alternative could increase to 170 mg/l Cl^- by June through September and decrease to 100 mg/l Cl^- in October through December.

Water quality under the recommended plan could increase to 170 mg/l Cl^- by August and generally stay at this level for the remainder of the year with a possible dip in quality in October.

In critical years water quality under the "no action" alternative would remain at or below 100 mg/l Cl^- through June. It would likely then increase to 170 mg/l Cl^- in July through August, decrease to or below 100 mg/l Cl^- in October and November and increase again in December. Under the recommended plan the water quality would likely remain below the 150 mg/l chloride level for a little more than the first five months of the year and then increase to 170 mg/l Cl^- for the remainder of the year. Periodic drops in quality below 100 mg/l could occur in some months, particularly April.

The general trend in wet, normal and dry years is that conditions would stay better under the recommended plan than under the "no action" alternative for a longer period into the summer but would likely be less favorable in the fall and early winter. However, even in the fall and winter monthly conditions under the recommended plan would be better than 170 mg/l chlorides. Critical years under the recommended plan would generally result in worse water quality in all months with expected maximum monthly qualities of 170 mg/l Cl^-.

As previously indicated, technical analysis of the economic effects of the recommended plan requires not only a precise prediction of water quality conditions, but also detailed economic data, which is not available. However, based on the above qualitative analysis of salinity conditions, it appears that likely adverse environmental impacts would be limited to critical years. Increased salinity between the 50 and 170 mg/l Cl^- level of the respective alternatives, the largest expected difference in any month during critical years under the recommended plan, could result in additional water treatment costs due to higher concentrations of chloride and related ions, increased corrosion potential, higher energy consumption for water treatment, decreased water reclamation potential, and other possible costs. As levels exceed 150 mg/l chloride, the two paper industries would experience additional costs to demineralize the water (see Chapter III). Crown Zellerbach estimated that increases from 150 to 250 mg/l chloride on a year-round basis would increase mill operating costs by $200,000 (RT Vol. XXX, p. 93). However, the impact of the recommended plan on the paper industries would be only that experienced during a part of critical years when the 150 mg/l Cl^- level is exceeded as a result of salinity levels of up to (but not exceeding) 170 mg/l Cl^-. Therefore, the impact would be considerably less than that indicated by Crown. The effect on Fibreboard's operating costs would likely be somewhat higher than that on Crown due to Fibreboard's greater use of demineralizers.

An important aspect of any economic evaluation of impacts of the two alternatives is whether the standards can be met. The recommended plan, unlike the "no action" alternative, would be capable of maintaining standards in critical years. As was shown in 1977 the "no action" alternative could not do that.

Based on information from the University of California Guidelines for Interpretation of Water Quality for Agriculture (U.C. Exhibit 1), it appears that some crops exhibit specific ion toxicity for chloride. Most tree crops and woody ornamentals are sensitive to chloride and sodium. The guidelines show that chloride presents no problems due to root absorption if the concentration is less than 142 mg/l, but that increasing problems will occur if the concentration is from 142-355 mg/l, while severe problems result if the concentration is greater than 355 mg/l. A problem can also exist with these crops when sprinklers are used and irrigation water contacts the foliage when the chloride concentration exceeds 106 mg/l.

The recommended plan (Alternative IV) as opposed to "no action" (Alternative IB), would generally enhance water quality during the irrigation season in all except critical years. Though the chloride level does at times exceed the "no problem" level during wet, normal and dry years for both root and foliage absorption, chloride levels resulting from the recommended plan are lower than in the "no action" alternative except from October to December.

The chloride levels in critical years under the recommended plan generally exceed those in the "no action" alternative. Therefore, impacts in the form of decreased crop yields would be expected. The agricultural acreage within the service area of CCCWD is less than 3,000 acres. The major portion of this acreage is in tree crops, so some adverse effects due to the chloride levels could occur. Quantification of these impacts from the evidence presented at the hearing is not possible. However, the potential detriments experienced in critical years could be partially offset by expected benefits from enhanced water quality in other years.

The same impacts would apply to the woody ornamentals as to the tree crops except that some of the ornamentals could receive water during the months of October through December when conditions under the "no action" alternative would result in chloride levels less than the recommended plan. The plants in general should have very low evapotranspiration during these months. Therefore, the increase in chlorides during these months should have a minimal effect.

The Municipal and Industrial Use section of Chapter III contains a discussion on trihalomethanes and the proposed EPA regulations to control organic compounds in drinking supplies. EPA's regulations call for the installation of specific water treatment facilities by water purveyors to remove organic compounds. Only those water agencies that clearly demonstrate that their water uses are not subjected to certain levels of organic compounds are exempt.

As salinity increases at the Contra Costa Canal Intake above certain levels, a group of organic compounds called trihalomethanes are formed during the water treatment process. The factors necessary for their formation above the proposed EPA limit appear to be increased salinity and organic material in the raw water supply. Since the organic precursors to the formation of trihalomethanes are naturally present in the Delta, concern has focused on ocean derived salinity. For over one-third of the year the Basin 5B Plan did not provide for water of sufficiently low salinity at the Contra Costa Canal Intake to meet EPA's proposed criteria. Therefore, under the "no action" alternative, the Contra Costa County Water District would have been required to implement the required treatment. This will also be the case under the recommended plan. Therefore, the recommended plan would have no significant adverse impact on the District related to trihalomethanes.

The District is currently evaluating the extent of the trihalomethane problem in the Delta, various alternative treatment processes, and other means to meet EPA's proposed regulation. Preliminary information suggests that if the trihalomethane standard is revised downward (as expected) the high organic content of Delta waters will require extensive treatment for organic compounds regardless of salinity. The Board will work closely with all agencies concerned with this problem to assist them in identifying the extent of this natural water quality related problem.

Impacts on human health from increased sodium levels do not appear likely. Persons on extremely restricted sodium diets must constantly be aware of their sodium intake. If such small changes in sodium levels in drinking water (approximately 30 to 100 mg/l Na^+) would affect their health, their physician would necessarily have to be aware of these changes to advise a decrease in other sources of sodium intake (reduced use of salt) so the total dietary sodium intake would remain within the necessary limits for that individual. Therefore, the key is knowledge of the sodium levels in drinking water, not necessarily the level itself. The chloride levels of both plans are well within the recommended criteria of EPA.

The significant impacts that are expected to occur as a result of the recommended plan are based on the assumption that the projects will meet their contractual water quality commitments (for the SWP approximately 100 mg/l Cl^- at the SWP pumps). In extreme conditions of water shortage, the project water users might urge a relaxation of this quality requirement in order that larger quantities of water could be exported and delivered to them. Whether this is allowed would depend on the project's ability to satisfy State and federal environmental requirements. If this should happen, the impacts described above for a critical year would be more dramatic. It should be noted that with the "no action" alternative (Basin 5B Plan) in effect and the occurrence of critical years (1976 and 1977), emergency actions were required by the Board. The water quality at the Contra Costa Canal Intake resulting from these required emergency actions was far worse than that which would be expected under the recommended plan even if the projects relaxed their carriage water commitments.

Agriculture

A comparative analysis of environmental impacts on Delta agriculture, shown in Table V-1, has been made for the western and interior Delta. Environmental impacts on northern and southern Delta agriculture have not been investigated in detail since in the northern Delta no adverse impacts would result from any of the alternative plans considered and in the southern Delta the impacts would be the same under all of the alternative plans evaluated.

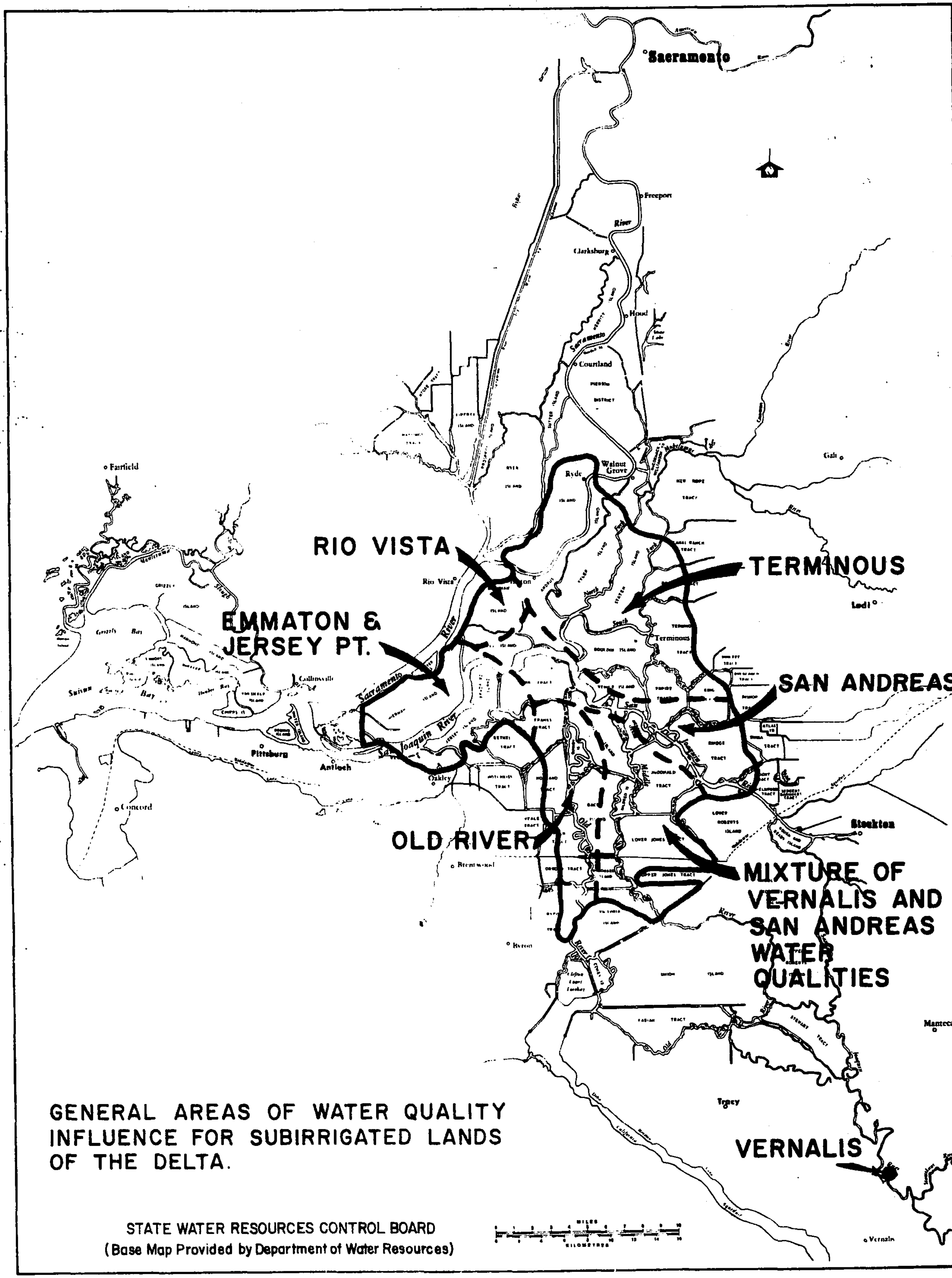
Potential impacts on western and interior Delta agriculture have been assessed by estimating the quality of in-channel water supplies during the major portion of the irrigation season (April 1 through August 15). The relationship between applied water salinities and agricultural crop yields is discussed in Chapter III.

Department Exhibits 7B, 8 and 9 have been used to estimate the resulting mean salinities under the alternative plans each month for locations in the western and interior Delta. These monthly salinities have been weighted according to their length of occurrence and averaged for the period April 1 through August 15. The average salinities have then been assigned a ranking from 10 to 1. The ranking increases in increments of 0.15 mmhos EC within a range of 0.45 to 1.65 mmhos EC. These rankings are intended to represent levels of hardship which would be experienced by Delta agriculture if water of that particular quality were used. The rank of 10 corresponds to the lowest EC value (0.45 mmhos EC) indicating the least impact on agriculture, and the rank of 1 corresponds to the highest EC value (1.65 mmhos EC) indicating the greatest impact. Therefore, a higher number of ranking would be more desirable for Delta agricultural production than a lower number. The ranges of electrical conductivity and the corresponding numerical rankings are shown in Table V-1.

The two locations selected for evaluation of salinity conditions are the Sacramento River at Emmaton for the western Delta and Old River at Rancho Del Rio for the interior Delta. The areas in the Delta whose water quality is generally represented by these two locations are shown in Figure V-3. The rankings shown in Table V-1 represent the general salinity available to the specific areas for each year type under the various alternatives. In order to facilitate the evaluation of comparative impacts, some measure of the central tendency of the values for each alternative was needed. The median of the values for the various year types of each alternative has been selected to represent this characteristic and is shown in Table V-1.

A comparison of the "standard only" columns of Table V-1 illustrates the relative inadequacies of the so-called November 19, 1965 criteria contained in the no action Alternative (IA and IB) in protecting Delta agriculture. Table V-1 further points out that previous standards did not ensure protection of Delta agriculture to the extent to which it is now believed to be entitled. Thus, there is a compelling need to modify existing agricultural standards.

The "composite of standards" columns of Table V-1 indicate that conditions for Delta agriculture under the various alternatives would be better than those required by the agricultural standards alone. In some instances, this improvement would be substantial, as in the western Delta under Alternative IIB during critical



GENERAL AREAS OF WATER QUALITY INFLUENCE FOR SUBIRRIGATED LANDS OF THE DELTA.

STATE WATER RESOURCES CONTROL BOARD
(Base Map Provided by Department of Water Resources)

years and in all of the alternatives for critical years. In addition, conditions in the interior Delta, as represented by Old River at Rancho Del Rio, would be better than those in the western Delta since the interior Delta is located further from the influence of ocean water salts.

Alternative IIA has the same comparative impact on Delta agriculture under the "standards only" column as Alternative IIB, even though the agricultural standards of these alternatives differ. The difference in the standards is significant in that Alternative IIB requires low salinity early in the irrigation season followed by higher salinity later in the irrigation season whereas Alternative IIA requires a uniform maximum salinity throughout the irrigation season with a weighted average salinity equivalent to that of Alternative IIB. However, both of these alternatives have different impacts on Delta agriculture during dry and critical years based on a comparison of the collective effect of all standards under each alternative. During critical years salinity in the western Delta would not be required to be less than that shown in rank 1 by either of these alternatives. Table V-1 shows that under Alternative IIA with the "composite" standards and expected carriage water requirements impacts would fall within rank 4.

However, as indicated in Table V-1 under Alternative IIB, agricultural interests would receive not only low salinity early in the irrigation season, but carriage water requirements and other standards would also provide lower salinity in the latter portion of the irrigation season than that required by the agricultural standards. Thus, Alternative IIB (with a rank of 8) would provide greater protection to Delta agriculture. Incidental protection also occurs to a lesser extent in dry years.

The impacts on Delta agriculture, identified in this chapter, are based on the application of certain average salinities to the soil over long periods of time. There is not sufficient information available to quantitatively identify any difference in impacts between applying low amounts of salts during the beginning of the irrigation season followed by higher amounts of salt later (Alternative IIB), and applying the same amount of salts at an even rate throughout the irrigation season (Alternative IIA). However, the application of low salinity water early in the irrigation season probably would be more beneficial than an equivalent average salinity applied throughout the irrigation season. Also, as indicated in Chapter III, water of low salinity has been available historically during the beginning of the irrigation season even in the driest of years. In view of the above, the agricultural standards requiring low salinity early in the irrigation season are believed to be more beneficial to Delta agriculture.

The agricultural standards in Alternatives IIIA and IIIB are the same as those in Alternative IIB. Alternative IV agricultural standards are the same as those of Alternative IIB in non-critical years, and Alternative IIA in critical years. In view of the similarity of the agricultural standards, the above discussion would also apply to Alternatives IIIA, IIIB and IV.

Table V-1 shows that the individual agricultural standards of the recommended plan provide for greater protection than those of the "no action" alternative. Also, shown in Table V-1 are the composite effects of the various alternative plans which include the umbrella protection provided by other standards and project carriage water needs. A comparison of these composite effects shows that western and interior Delta agriculture would receive greater protection under the recommended plan in all years except critical years. In critical years the composite protection under the recommended plan would be less than that of the "no action" alternative. Even though the resulting economic impact of this critical year decrease cannot be quantified, it has the potential of being a significant economic impact of the recommended plan.

Fish and Wildlife

Research by Fish and Game on the environmental needs of fish and wildlife resources in the Delta and Suisun Marsh has generally focused on certain key species. As discussed in Chapter III, the information necessary for a detailed evaluation of potential environmental impacts is available only for a few species in the

Delta and Suisun Marsh. Therefore, the environmental impact analysis for fish and wildlife concentrates on these key species. However, the information presented provides a sufficient base from which the relative impacts of the alternative plans can be assessed.

Four aspects of fish and wildlife have been evaluated in detail and are summarized on Table V-1. These are impacts on striped bass spawning, striped bass survival, salmon migration and Suisun Marsh waterfowl food supplies. The water quality standards designed to protect these specific environmental resources are also expected to benefit other species as well. As indicated in Chapter III, high spring and early summer outflows coupled with low export rates benefit other fish in addition to striped bass and salmon. Spring and early summer is the spawning and migration period of many species of fish which presumably are adapted to the natural high flows and, thus, more susceptible to the effects of high exports occurring during this period. A qualitative discusion of the recommended plan impacts on other fishery resources is presented below.

The needs of wildlife species found in Suisun Marsh and the Delta, other than waterfowl, are also discussed in Chapter III. This discussion indicates that rare and endangered species would not be adversely affected by any of the alternatives under consideration. Therefore, the impacts on waterfowl food supplies is sufficient to ascertain potential environmental impacts on Suisun Marsh.

In all cases, the impacts to fish and wildlife resources have been evaluated from two perspectives. First, the protection that would be provided solely from the specific fish and wildlife standard and second, the protection that would be provided from the composite of standards in each alternative plan. The latter includes the benefits due to carriage water needs of the projects and expected uncontrolled flows.

Striped Bass Spawning. As discussed in Chapter III striped bass spawning on the San Joaquin River system is related to the salinity of the water at the time of spawning. Historically, maximum suitable salinity limits for the downstream end of the San Joaquin River have been established as 1.5 mmhos EC at Antioch (see Delta Plan Table B-1) with spawning usually occurring upstream to Venice Island (approximately 17 river miles from Antioch).

Table V-1 indicates the miles of suitable spawning areas along the San Joaquin River for each alternative, which represent the distance along the San Joaquin River from Venice Island to the approximate location of the 1.5 mmhos EC salinity contour. These estimates are based on information from Department Exhibit II-9.

Many of the alternative plans evaluated (IA, IB, IIIA and IIIB) would require that the 1.5 mmhos EC move no further upstream than Antioch. The estimated outflow required to maintain the 1.5 mmhos EC at Antioch is 6700 cfs (Department Exhibit II-9, Attachment 3). The other alternative plans (IIA, IIB and IV) provide for relaxation of this condition when accompanying deficiencies in firm supplies to CVP and SWP users are taken.

The impacts of the various alternative plans on striped bass spawning are extremely difficult to assess since the actual effects of exceeding the 1.5 mmhos EC limit are uncertain. Striped bass have a pronounced tendency to return to the same spawning area each year. Thus, occasional occurrences of less than optimum salinities might have little effect on striped bass. However, prolonged occurrence of these same salinities could gradually reduce spawning in the area due to accumulative effects of either small differences in survival or migratory preferences (Fish and Game Exhibit 3, p. III-18). Current research involving the 1977 striped bass spawning season by Fish and Game will help clarify at least the short-term impacts of dramatically exceeding 1.5 mmhos EC salinity levels.

In Department Exhibit II-9, the approximate location of the 1.5 mmhos EC contour on the Sacramento River is indicated under differing export deficiencies (RT Vol. XXII, pp. 94-100). The predictions are based on computer models developed by the Department specifically for the Sacramento River. These computer models do not include the effects of project export rates. Unlike the Sacramento River, certain areas along the lower San Joaquin River, including striped bass spawning areas, are affected directly by project export rates (RT Vol. XXII, p. 100). In spite of this, the information in Exhibit II-9 can be used in extrapolating salinity conditions along the San Joaquin River, because the relaxation provisions of the alternative plans require a specific salinity at Antioch on the San Joaquin River. However, the estimated miles of suitable spawning for the San Joaquin River will hold true only when the salinity gradients upstream of Antioch on the San Joaquin River are similar to those predicted by the model for the Sacramento River.

Such salinity gradients do not usually occur on the San Joaquin River during high export periods. Since the freshwater inflow to the Delta from the Sacramento River is much greater than that from the San Joaquin River, high export rates cause the salinity gradient along the San Joaquin River to be more gradual than that along the Sacramento River. For instance, during April 1977 project export deficiencies were sufficient to relax the striped bass spawning standard to the point where other standards, controlled Delta outflow (1000 mg/l Cl^- at Emmaton on the Sacramento River)[1/].

1/ The 1977 Interim Plan was in effect at this time. The Interim Plan included relaxations to the striped bass spawning objective proportionate to deficiencies imposed on project deliveries.

Based on Department Exhibit II-9 under these conditions, the 1.5 mmhos EC would occur near Jersey Point on the San Joaquin River (7.5 miles upstream of Antioch or 9.5 miles downstream from Venice Island). However, the 1.5 mmhos EC contour during April 1977 was actually located more toward the middle of Twitchell Island, some 3.5 miles further upstream. Thus, at least during April 1977, the salinity gradient along the San Joaquin River was different than that predicted for the Sacramento River by Department Exhibit II-9.

In order to improve the reliability of such estimates of salinity gradients, more accurate predictive models for the lower San Joaquin River must be developed taking into account varying export rates. However, the values shown in Table V-1 are sufficient to evaluate the relative impacts of the alternative plans on striped bass spawning.

Alternatives IA, IB, IIIA and IIIB require minimum suitable spawning conditions each year from Prisoners Point to Antioch on the San Joaquin River (approximately 17 miles). Alternatives IIA, IIB and IV allow some reduction in suitable spawning areas along the San Joaquin River whenever deficiencies in the firm supplies are taken by project water users. The sharing of critical year year deficiencies between project water users and fish and wildlife resources is a reasonable approach at this time. However, as previously stated, the actual impacts on striped bass due to these reductions in suitable spawning areas are uncertain. Research currently being finalized by Fish and Game will provide additional data on these impacts.

Striped Bass Survival. As indicated in Chapter III, the survival of young bass through their first summer of life is expressed in terms of the Striped Bass Index. The analysis of environmental impacts of the various alternative plans on striped bass has focused on the expected survival of young bass. The outflow/striped bass relationships discussed in Chapter III provide a good tool for assessing the suitability of various environmental conditions in the Delta during the spring and summer for both young bass and other young fish.

The theoretical average Striped Bass Index that occurred historically (1922-1967), as predicted from the established relationships, is estimated at 106 index units. This average includes some benefits and detriments that have occurred due to water project development since 1945. Subtracting the effects of these projects, using the established relationships and Department Exhibit II-12, the without project Striped Bass Index would have averaged about 71 index units for the 1922-1967 period. These two averages are extremely important since many of the alternative plans require either project mitigation (71 index units) or the maintenance of fishery resources at historical levels (106 index units).

As previously stated, the striped bass project mitigation level of 71 index units is likely an underestimate of without projcet conditions. In its comments Fish and Game indicated that the Board's analysis is the best quantitative analysis that can be made of 1980 without project conditions at this time. In order to ensure that this goal is attained, something higher than the average of 71 may have to be maintained in the alternative plans considered because of the following factors:

- The striped bass analysis does not include project caused losses after July. Millions of striped bass are drawn to the CVP-SWP fish screens after July, and food supplies in the Delta are depleted by the draft of water to the pumping plants. Losses earlier in the year are more significant than losses after July, but the latter cannot be assumed to be insignificant.

- Survival will gradually decrease after 1980 as reductions in unregulated flow bring flows closer to the minimums specified by the standards.

- Project caused flow reductions earlier in the spring place stresses on striped bass. For example, as indicated earlier, the striped bass spawning standard provides minimum rather than optimum conditions, with additional stress when the dry year relaxation is in effect. The amount of this stress is uncertain at this time.

These factors could tend to reduce the striped bass index values for all alternatives considered. With available data and analytical tools, it is not possible to quantify the effect, if any, of these factors.

Also, the quantitative analysis may not adequately reflect the favorable effect of high flows available prior to June under without project conditions. This factor would tend to increase the striped bass index value of without project conditions.

Even though the current method used to determine without project levels for striped bass lacks the necessary precision to identify fully project mitigation responsibilitiy, it is sufficient to identify the immediate protection that should be afforded to the fishery resource.

In order to determine to what extent the alternative plans satisfy these goals (71 and 106 index units), environmental factors such as Delta outflow and Delta diversion rates for each year in the 50-year hydrologic study period (1922-1971) and the established outflow/striped bass relationships were used. May-June conditions were assumed to be controlling in all years except where May flows and export rates were such that June-July conditions would undoubtedly be controlling. June-July conditions were generally controlling during wet years. The outflows used in this analysis are those strictly required by the striped bass survival standard and conditions expected to occur including export rates as projected in Department operation studies. The operation studies which have been used are Department Exhibit II-10 (Basin Plan objectives, 1980 level of development) for Alternative IB and the Department's operation study of the draft plan for Alternatives IIA, IIB and IV. Alternatives IA, IIIA and IIIB differed so dramatically from available operation studies that the effects of these alternatives on striped bass survival could not be quantified. In each of these cases, however, the impacts on young bass survival can be identified qualitatively.

The controlling water quality standards assumed in the development of the Department's operation study on the draft plan are not identical to any of the alternative plans. For those alternatives (IIA, IIB and IV) where this operation study has been used, a plus sign (+) is used in Table V-1 to indicate that additional benefits to striped bass would likely occur because objectives other than those assumed in the operations study would control at higher outflow levels.

The above analysis yielded the expected Striped Bass Index for each year in the 50-year planning period. Each of these years was then categorized as to hydrologic year type, and the average Striped Bass Index expected for each year type determined. The average Striped Bass Index for each year type as well as the weighted average Striped Bass Index for the entire 50-year period are shown in Table V-1. The determination of the Striped Bass Index assumes that other factors which influence striped bass would remain the same or their influence on striped bass would not change significantly.

Alternatives IIA, IIB and IV appear to provide for mitigation of project impacts on the fishery striped bass to the extent that this level of mitigation is defined by an average Striped Bass Index of 71.

However, as previously indicated, the without project index of 71 may not fully reflect the favorable effect of high flows prior to June which would tend to increase the index, nor do the index values for Alternatives IIA, IIB, and IV include detrimental effects of high exports after July which would tend to lower the index. In view of these two effects, Alternative IV comes the closest to attaining without project level of protection.

A careful reading of Tablve V-1 indicates that expected average striped bass survival under Alternatives IIA, IIB and IV "composite of standards" columns would be better than that of the "no action" Alternatives IA and IB. However, the levels of protection under Alternatives IIA, IIB and IV would be greater than the "no action" alternatives in wet years, but lower in drier years.

Alternatives IIIA and IIIB would require that historical levels of protection be provided now. As indicated in Table V-1, the impact of these alternatives on project export yield would be substantial. However, with existing project facilities the impact on project export yield would be even greater to overcome the detrimental effects of the export pumps in the southern Delta on the fishery by providing net downstream flow in the Delta channels. Under Alternatives IIIA and IIIB, the combined exportable yield of the projects would be reduced to less than half of that of the "no action" alternative.

As previously indicated, the impact on the Delta fishery of Alternative IA cannot be quantified with available operation studies. However, because of the high Delta outflows required by Alternative IA during the winter months, exports during the spring and early summer would probably be higher than those expected for Alternative IB. These higher exports under Alternative IA would have a detrimental effect on the fishery and would result in average protection to the fishery lower than that shown for Alternative IB ("composite of standards" column).

Salmon. As discussed in Chapter III, salmon migrate through the Delta virtually all year. Minimum flows in the Delta suitable for salmon migration have been recommended by Fish and Game (Fish and Game Exhibit 11).

These recommended flows have been used as standards in all of the alternative plans except the "no action" alternative (IA and IB). The necessary information to quantify the benefits of flows higher than those recommended by Fish and Game is not now available. Therefore, all of the alternatives listed in Table V-1 would provide the flows recommended by Fish and Game as minimum satisfactory flows for salmon at all times, with the possible exception of the "no action" alternatives during months of drier years.

Presented below is a qualitative comparison of the effects of the recommended plan (Alternative IV) on salmon and other fish against those of the "no action" alternative (IB).

Other Fishes. Comments received on the Draft EIR made it apparent that a more detailed discussion was needed relating the impacts of the recommended plan on fish other than striped bass. Even though the impacts on other fish species cannot be quantified, a qualitative comparison can be made of two key factors that affect fish in the Delta, Delta outflow and exports. The degree to which these factors affect each major fish species in the Delta is discussed in Chapter III.

The four fish species found in the greatest abundance at the CVP and SWP fish screens are striped bass, salmon, American shad and white catfish. The periods over which these fish are caught at these screens generally reflect the times when project operations have a direct effect on these fish. Figure V-3 shows the average monthly catches of these four fish at the CVP and SWP fish screens (1972-1976) in percent of the total annual catch. For comparative purposes, the approximately average total annual catch[2/] for each fish species is also shown.

As shown graphically on Figure V-3, the time of year and duration that these fish are most susceptible to the direct effects of project operations varies greatly. However, most of the effects occur in May, June, July and August. This highlights the need recognized in the recommended plan to develop multi-species fish and wildlife standards as additional information becomes available.

Figure V-4 shows the period during the year that 80 percent or more of each fishery is being captured at the export pumps. This reflects the period that project operations have their greatest direct impact on the fishery. Also, shown in Figure V-4 are Delta outflows and combined project export rates for typical years in each year type -- wet, normal, dry and critical. Each of the water years selected for this analysis is followed by a similar year type (e.g., 1941 and 1942 are both wet years). This allows the comparison of hydrologic conditions based on a calendar year (corresponding more closely with the time frame

2/ Total numbers are somewhat misleading since they do not convey the size of the fish caught. The catch of mature fish are more significant losses to the population than losses of fry that are still subjected to extensive mortality factors.

MONTHLY FISH CATCHES
AT THE CVP AND SWP FISH SCREENS
(1972-1976)

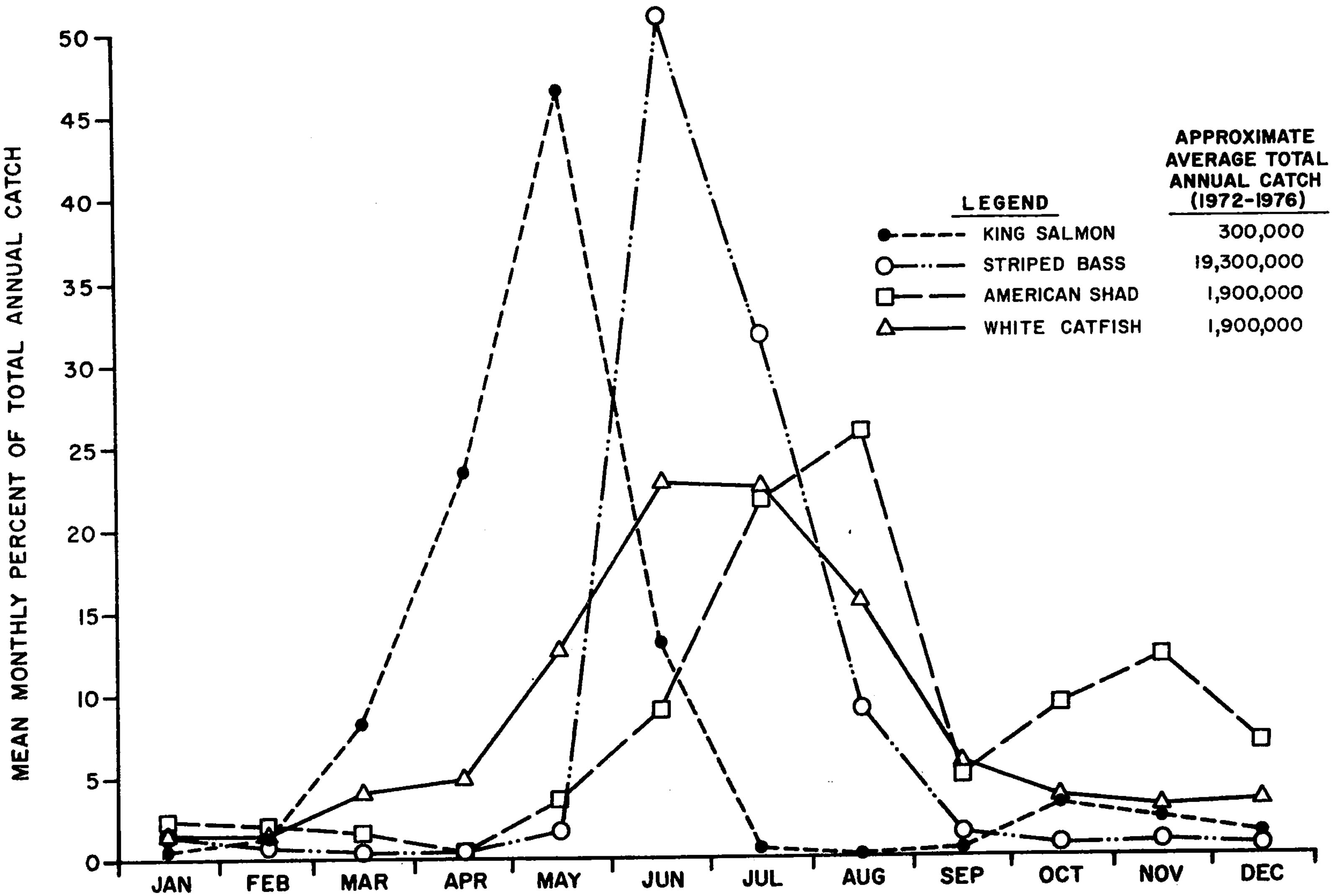
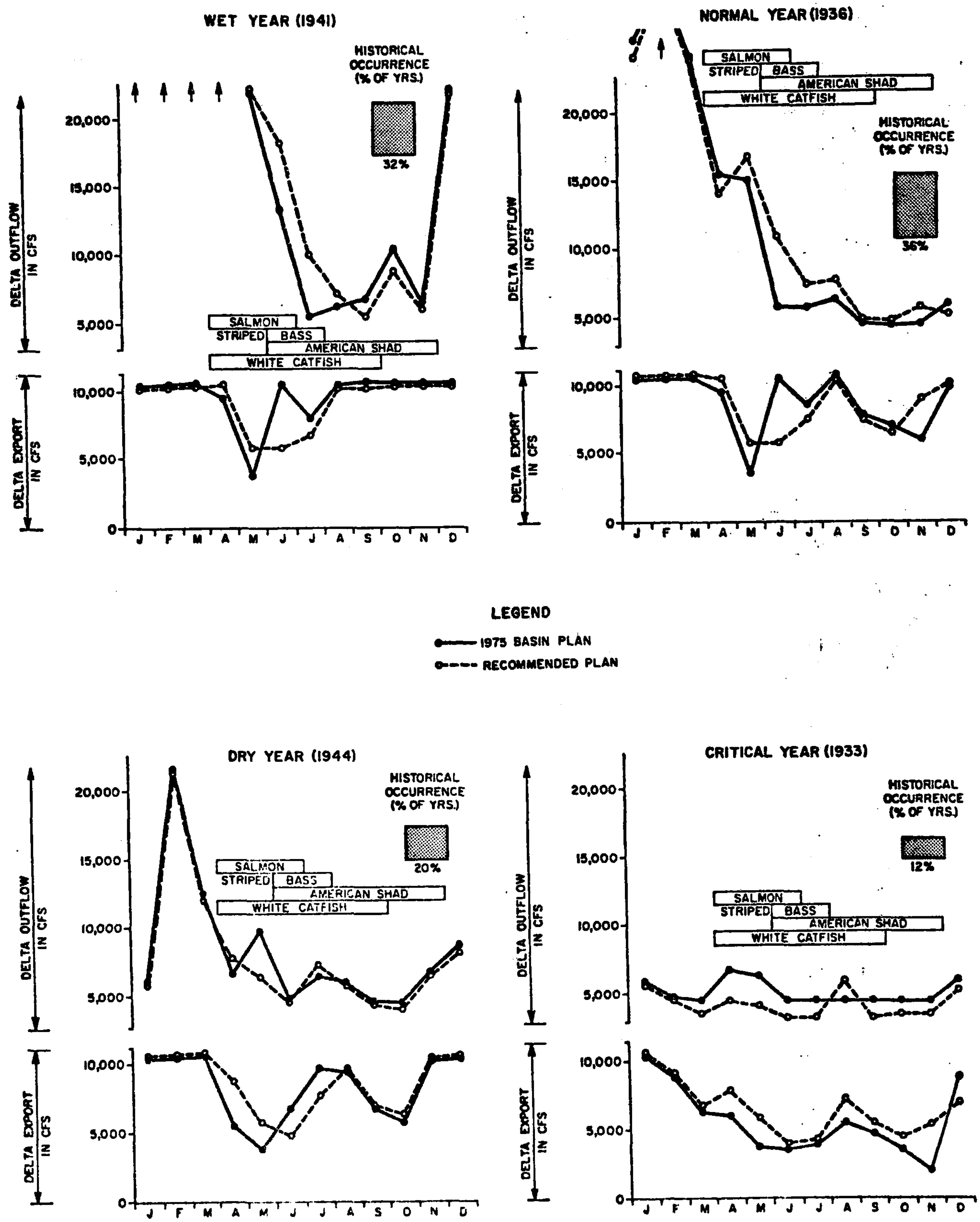


FIGURE V-3

DELTA OUTFLOW AND EXPORT
1975 BASIN PLAN (ALTERNATIVE IB) vs. THE RECOMMENDED PLAN (ALTERNATIVE IV)



that specific Delta standards apply) rather then on a water year basis (the time frame over which the year is classified). The discussion related to Figure III-32 further defines why these specific hydrologic years were selected.

In comparing the various year types depicted in Figure V-4, the historic frequency of occurrence of each year type must be kept in mind. The bar chart on Figure V-4 is intended to assist the reader in recognizing these differences in occurrence.

Figure V-4 indicates that in wet and normal years the recommended plan (Alternative IV) results in greater outflow and less export in June and July than under the "no action" alternative (IB). Conditions in and following August are about the same under both alternatives. However, the recommended plan does result in a systematic shift of exports into April and May which is expected to lessen impacts on striped bass and American shad.

Dry years show this same April-May shift in exports. Delta outflow in dry years is similar under both alternatives except for May when Delta outflow under the recommended plan is less. The difference in critical years is perhaps the most dramatic. The recommended plan results in generally lower Delta outflow and higher export rates than the "no action" alternative (IB).

The combined impacts of outflow and export likely vary for each fish species. Because of this, it is extremely difficult to relate the information on Figure V-4 to impacts on the fishery, even in a qualitative sense. Generally, however, as outflows increase and exports decrease, the impacts on the fishery would lessen. Also, at high outflows (above 20,000 cfs) the incremental effects of export would be less than at low outflows (below 10,000 cfs).

Both salmon and white catfish would generally benefit from the recommended plan in wet and above normal years, as would both striped bass and American shad. Dry years under the recommended plan show a shift in exports generally benefiting striped bass and American shad with mixed effects on salmon and catfish. In critical years there is a definite lessening of protection to all fish species under the recommended plan. These trends are similar to those previously quantified for striped bass. It is impossible to quantify these shifts in protection in terms of the overall protection afforded under the recommended plan, but it is suggested that the impacts described for striped bass are not inconsistent with the qualitative assessment shown on Figure V-4.

Upper Estuary Productivity. The patterns of Delta outflow and salinity which would result from the recommended plan would maintain fishery populations, particularly striped bass, at levels higher than those under the "no action" alternative. This assessment is based on certain relationships between Delta outflow and abundance of young of the year striped bass.

Recent information suggests that the relationships used for estimating striped bass abundance are not valid when Delta outflows are below those of the 1976 winter. Algal productivity may be insufficient under these conditions to support the expected populations of striped bass. In extremely critical years, the benefits to the Delta fishery expected under either the "no action" alternative or the recommended plan may not be fully achieved.

The recommended plan provides for re-examination of the relationships between Delta outflow and striped bass. Since modifications of these relationships could indicate need for revisions of the fishery standards, the Board will review the results of Fish and Game's analysis and consider whether further action is necessary. However, the fishery standards in the recommended plan from January through May are at least as stringent as those of the "no action" alternative which controlled in 1976. Even though there is a need for further study, the recommended plan would have no adverse impact on upper estuary productivity when compared to the "no action" alternative.

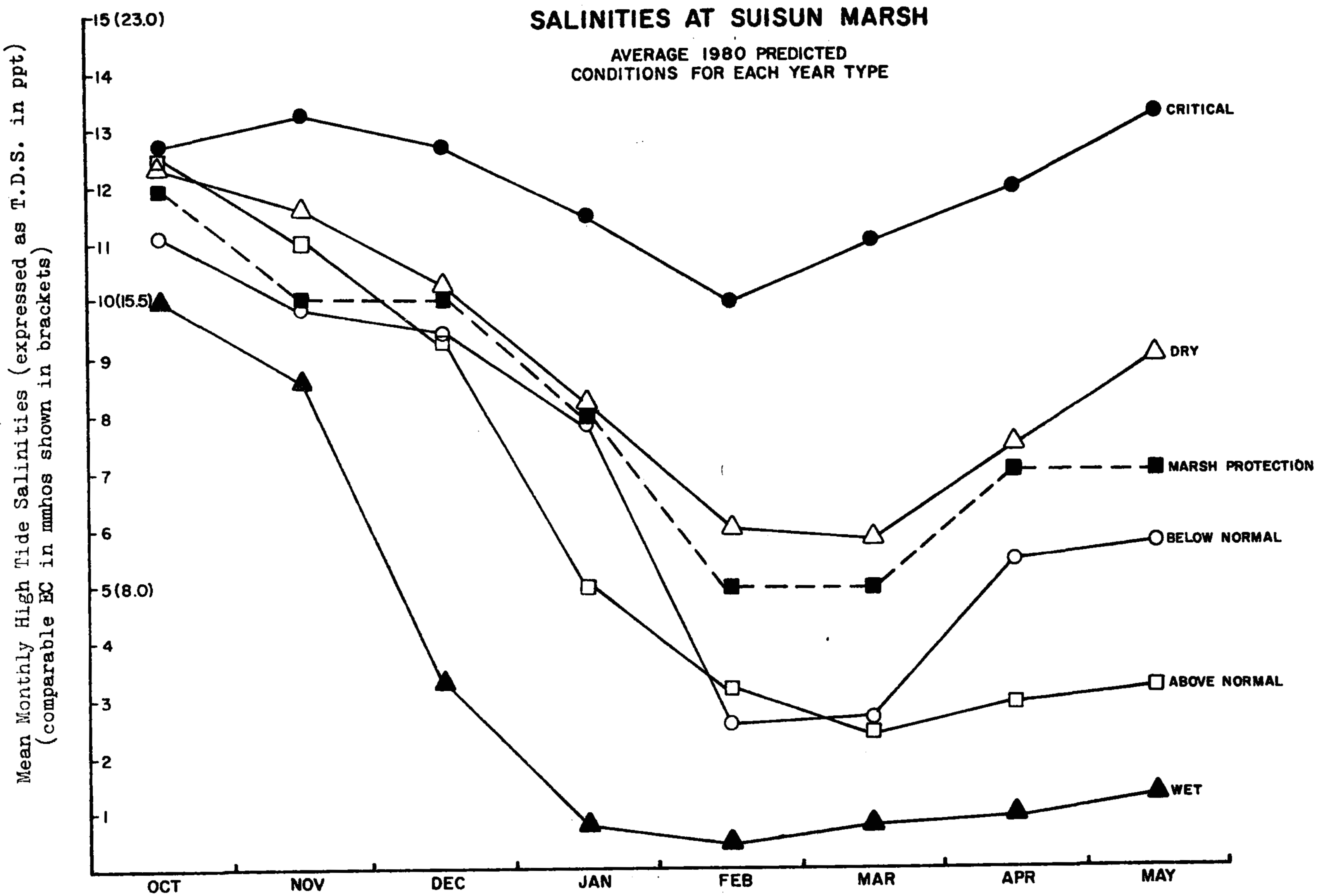
Suisun Marsh. Seeds produced from alkali bulrush are the dominant food source for waterfowl in the Marsh. Environmental factors such as duration of water submergence and soil salinity during May limit alkali bulrush seed production. Chapter III describes how management practices on the managed portions of the Marsh (approximately 89 percent of the wetland area) and salinity of the water applied during October through May can affect the soil salinities measured in May.

During the hearing Fish and Game presented information regarding the expected impacts of its recommendations on alkali bulrush seed production. (Fish and Game Exhibits 19 through 26 and RT Vol. XXIII, pp. 16-170 and RT Vol. XXIV, pp. 1-21). This information has been thoroughly reviewed and is believed to be an adequate assessment of the general impacts on large areas of Suisun Marsh.

Figure V-5 (redrawn from Fish and Game Exhibit 24) shows the expected average salinity conditions for each year type at 1980 level of development based on Department Exhibit II-7. In addition, specific salinity conditions during typical critical, dry and below normal year types have been further evaluated in Fish and Game Exhibit 26 to determine the effect of such salinities on alkali bulrush production in selected areas of the Marsh. These areas are the Suisun Slough and West Grizzly Island area and the Simmons, Wheeler and Channel Islands area (shown in Figure V-6).

The estimated values of percent reduction of alkali bulrush seed production (as measured from optimum), tabulated in Fish and Game Exhibit 26, have been converted to percent of optimum seed production. These converted values are shown in the "composite standards" columns of Table V-1.

FIGURE V-5



Predicted 1980 salinities are shown for the mouth of Suisun Slough which was estimated at 0.75 times the Port Chicago salinities and is compared to salinities to protect the marsh as set forth in the DF&G Exhibit 11 Permanent Suisun Marsh Standards, Alternative A (from DF&G Exhibit 24).

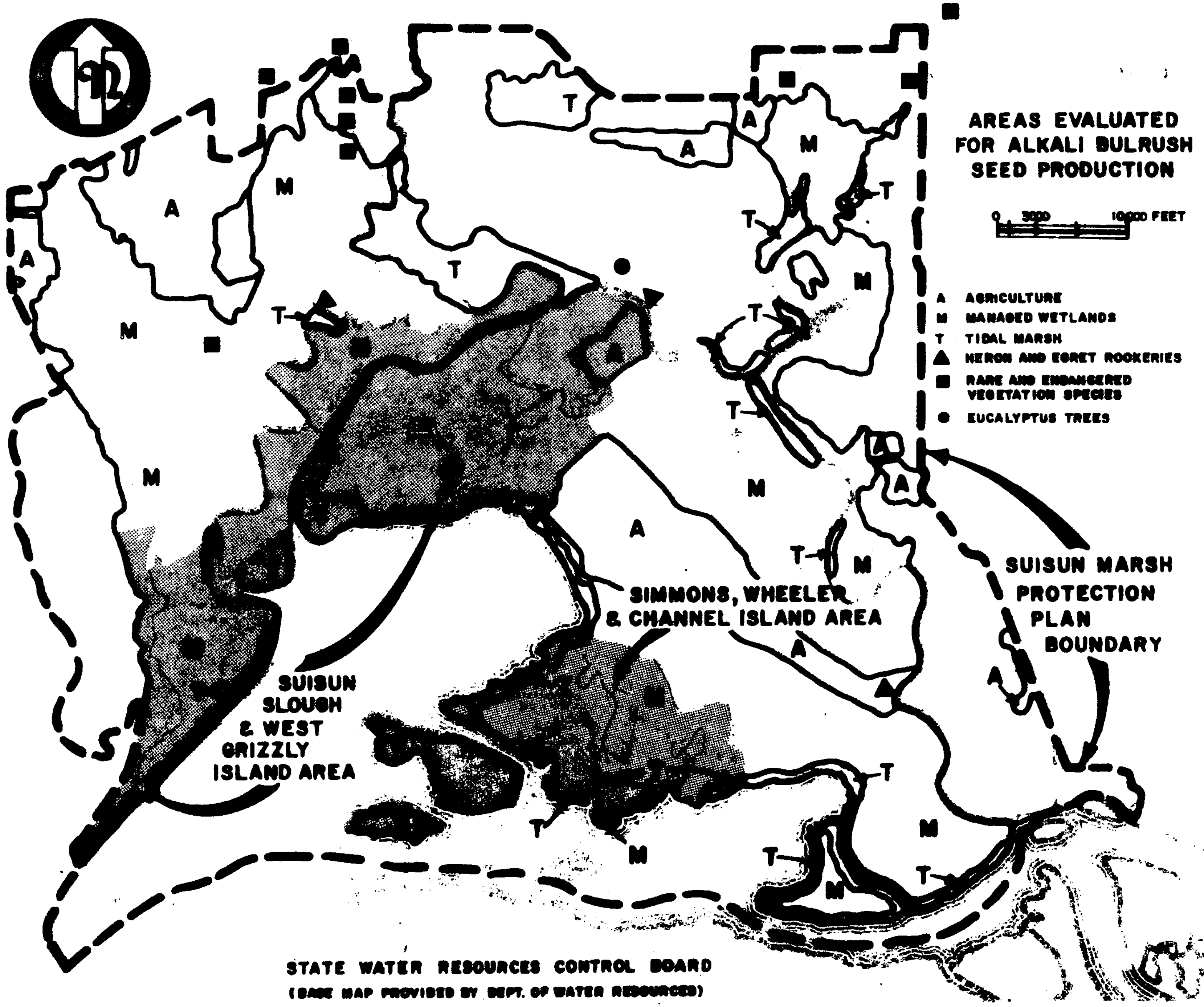

AREAS EVALUATED
FOR ALKALI BULRUSH
SEED PRODUCTION
0 3000 10000 FEET
A AGRICULTURE
M MANAGED WETLANDS
T TIDAL MARSH
HERON AND EGRET ROOKERIES
RARE AND ENDANGERED VEGETATION SPECIES
EUCALYPTUS TREES
SUISUN MARSH
PROTECTION
PLAN
BOUNDARY
SIMMONS, WHEELER
& CHANNEL ISLAND AREA
SUISUN
SLOUGH
& WEST
GRIZZLY
ISLAND AREA
STATE WATER RESOURCES CONTROL BOARD
(BASE MAP PROVIDED BY DEPT. OF WATER RESOURCES)

FIGURE V-6

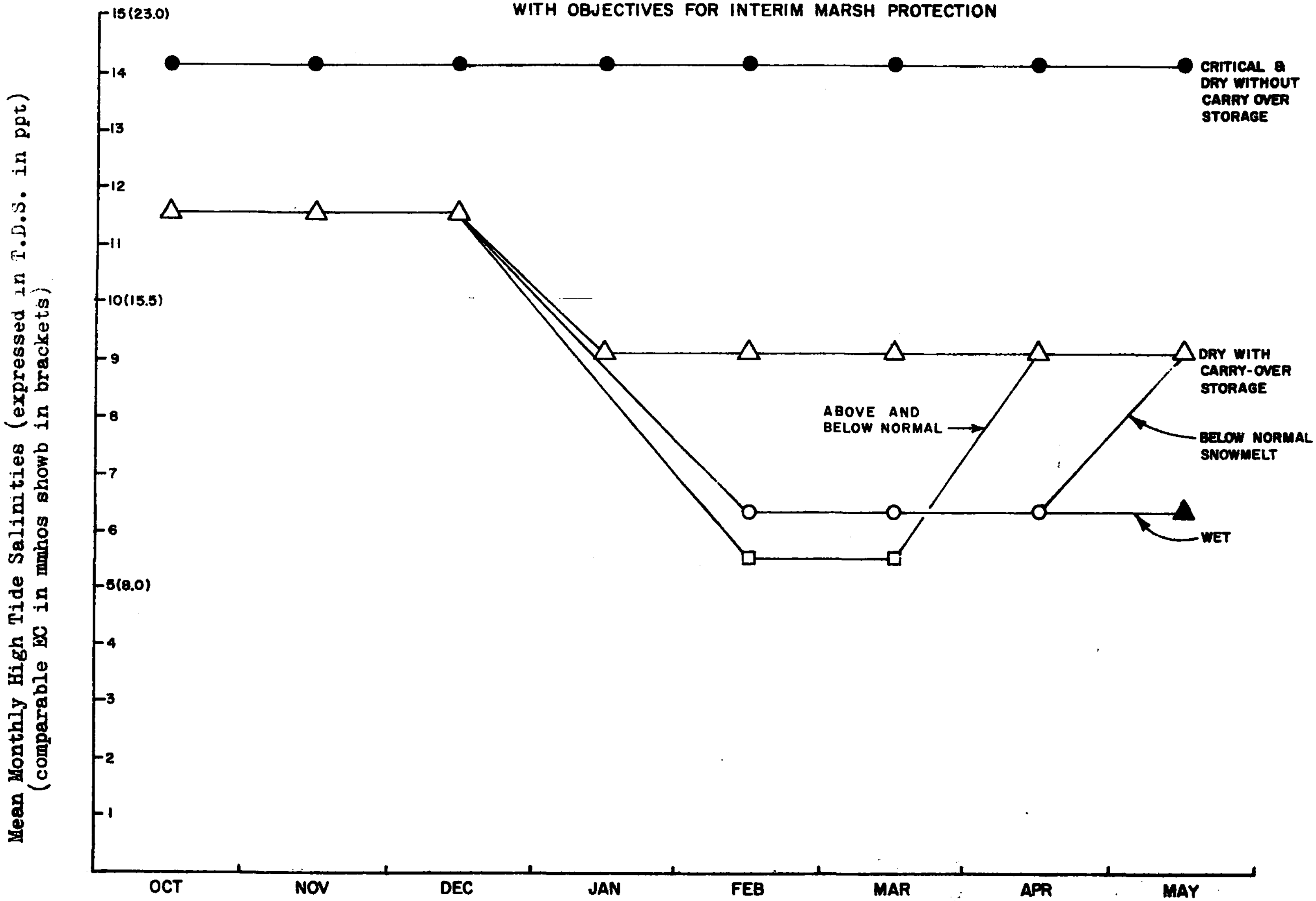
In order to determine the expected seed product of alkali bulrush under the Suisun Marsh standard alone, salinity conditions at Port Chicago and the mouth of Suisun Slough have been estimated based on the Suisun Marsh standard controlling Delta outflow. This analysis does not take into consideration benefits that would occur due to uncontrolled flows or carriage water needs of the projects.

Salinity conditions at Port Chicago have been estimated by first determining the outflow required under the Suisun Marsh standards for each year type and then finding the appropriate mean monthly salinities at Port Chicago by using Department Exhibit 7B. These average monthly salinities at mean tide have been converted to average monthly salinities at high tide by the same methodology used in the preparation of Fish and Game Exhibits 19-24 (Department of Public Works Bulletin 27, plate LXII on page 196). Salinities at the mouth of Suisun Slough have been estimated by taking 0.75 of the Port Chicago salinities (the same method used in the preparation of the Fish and Game exhibits for critical years). Figure V-7 shows these theoretical ("standard only") salinities for each year type.

A comparison of the "composite standards" curves of Figure V-5 with those of Figure V-7 shows that the impacts of dry through wet years under the "standard only" conditions of Figure V-7 are bracketed by the impacts indicated in Figure V-5 for critical to dry years. Thus, under the "standard only" conditions of

SALINITIES AT SUISUN MARSH

RESULTING FROM MINIMAL COMPLIANCE
WITH OBJECTIVES FOR INTERIM MARSH PROTECTION



Estimated salinity conditions at the mouth of Suisun Slough (which was estimated at 0.75 times Port Chicago salinities) resulting from minimal compliance with standards for interim marsh protection.

FIGURE V-7

Alternatives IB, IIA, IIB, IIIB and IV the alkali bulrush seed production would be about 10-35% of optimum during dry to wet years. During critical years alkali bulrush seed production for Alternatives IB, IIA, IIB, IIIB and IV has been estimated by the same procedure as that used in the preparation of Fish and Game Exhibit 26 and would be up to 20 percent of optimum.

The environmental impacts on the Marsh are based on a Fish and Game analysis of only 23 percent of the Marsh wetland area (shown by the shaded areas in Figure V-6). However, these areas produce more than 60 percent of the alkali bulrush. In addition, during dry and critical years the managed areas, not shaded in Figure V-6, would experience conditions for alkali bulrush seed production better than those shown in Table V-1 for the Suisun Slough and West Grizzly Island. These better conditions occur for two reasons; (1) that portion of the Marsh lying east of the areas investigated experiences generally better water quality because it is further away from the influence of ocean water, and (2) that portion of the Marsh lying north of the Suisun Slough area is influenced directly by local runoff in the Suisun-Fairfield drainage basin, and is further away from the influence of ocean water.

Alternatives IA and IIIA would provide full protection of the Marsh in all year types. The level of protection provided under Alternatives IB, IIA, IIB, IIIB and IV would be less than that of Alternatives IA and IIIA. However, in all but dry and critical years, full protection would be provided by uncontrolled flows under

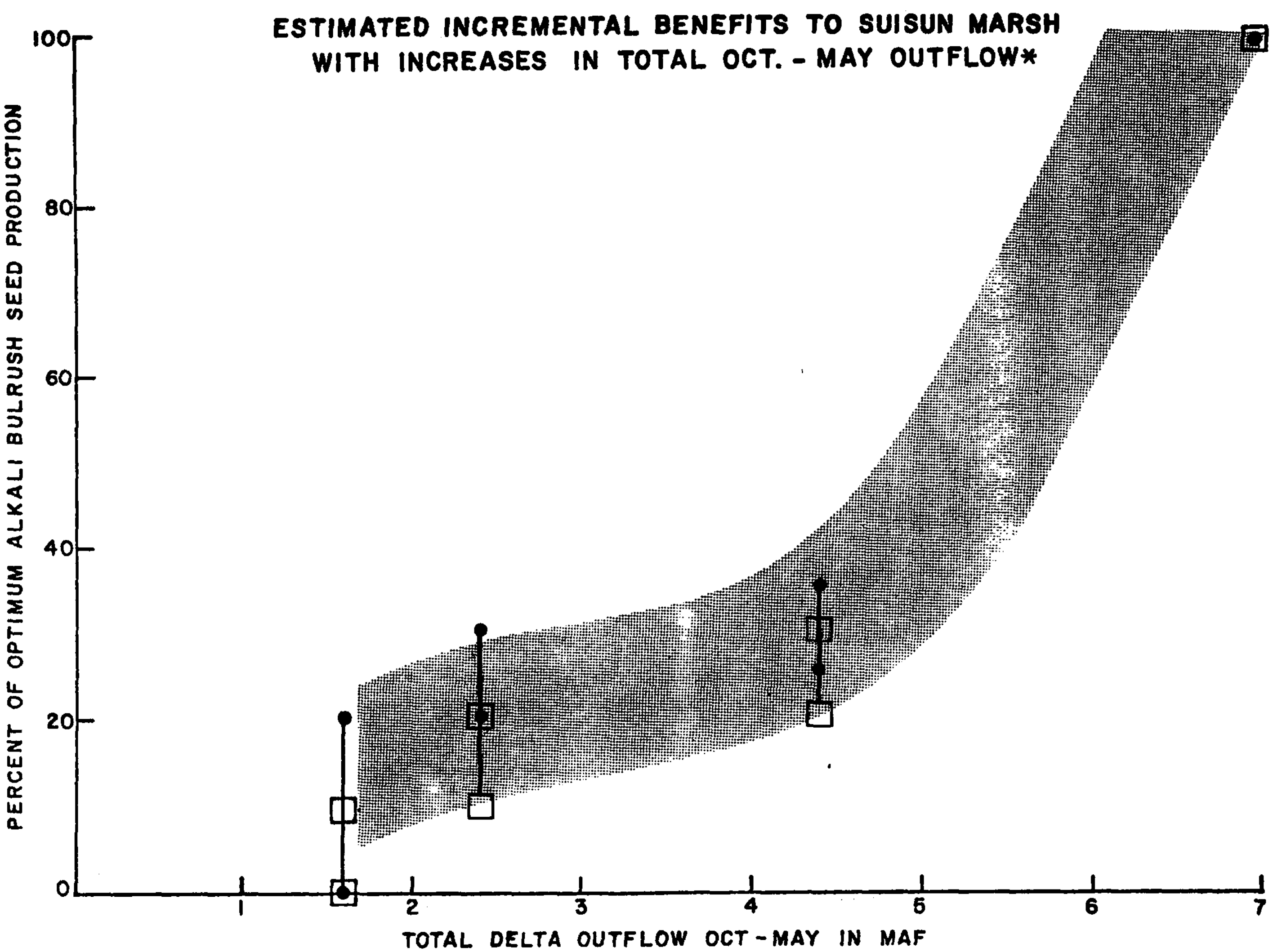
Alternatives IB, IIA, IIB, IIIB and Iv. The level of protection provided by these alternatives in dry and critical years ranges from 10 to 35 percent of optimum seed production.

As indicated in Table V-1, the interim level of protection afforded Suisun Marsh under the recommended plan (Alternative IV) is at least as good as that provided by the "no action" alternative (IB). The recommended plan protection for the Marsh differs from that presented in the Draft EIR. The recommended plan has been modified to require a greater level of interim protection for the Marsh. This substantial improvement in interim protection will make it possible to accommodate the request of the Department for additional time in implementing the required full protection of the Marsh. Under the recommended plan, as revised, full protection would be required no later than October 1, 1984.

This increased interim protection is in the form of standards that are equivalent to those in the basin plans (Alternative IB) from January through May. The recommended plan still allows for relaxation to less stringent standards in October through December when the project users are taking deficiencies in scheduled water. The relaxation during this period is not expected to affect significantly alkali bulrush seed yield because (1) Figure V-8 shows that water quality changes in the low seed yield range result in small incremental changes in seed yield; (2) the short duration of the relaxation minimizes its effect on soil salinity; and (3) active leaching occurs during the January through May period making water quality at this time of the year more important.

FIGURE V-8

ESTIMATED INCREMENTAL BENEFITS TO SUISUN MARSH WITH INCREASES IN TOTAL OCT. - MAY OUTFLOW*



Range of conditions for Suisun Slough and West Grizzly Island (represents 14% of marsh, produces 46% of alkali bulrush)

Range of conditions for Simmons and Wheeler Island and the channel islands (represents 9% of the marsh and produces 16% of the alkali bulrush)

* Outflows represents patterns typical for critical, dry and below normal years with the current projects.

(Prepared from information used to produce DF&G Exhibit 26.)

The sharp decrease in the level of protection from typical below normal years to typical dry years, and the relatively constant protection between dry and critical years have been investigated further. The purpose of this is to identify the incremental benefits to Suisun Marsh which would be experienced with increases in Delta outflow. As indicated in Figure V-8, the relationship between seed production and outflow is not linear, and reflects the sharp decrease in alkali bulrush production due to increasing salinities as shown in Figure III-30. Figure V-8 is based on information used to develop Fish and Game Exhibit 26.

Two aspects of Figure V-8 are noteworthy. First, the outflows represented are for total October through May outflow and have been developed from typical flows for dry, critical and below normal years. Increases in Delta outflow (along the horizontal axis) are based on typical patterns for these year types as represented in Department Exhibit II-7. If outflows during drier years do not follow typical patterns, the benefits to the Marsh would be different than those indicated in Figure V-8. For example, as indicated in Chapter III, if outflows are managed properly protection to the Marsh in critical years could be accomplished with an outflow of about two million acre-feet (above that needed to meet other standards), rather than the 4.6 million acre-feet which might be inferred from Figure V-8 (7 MAF - 2.4 MAF).

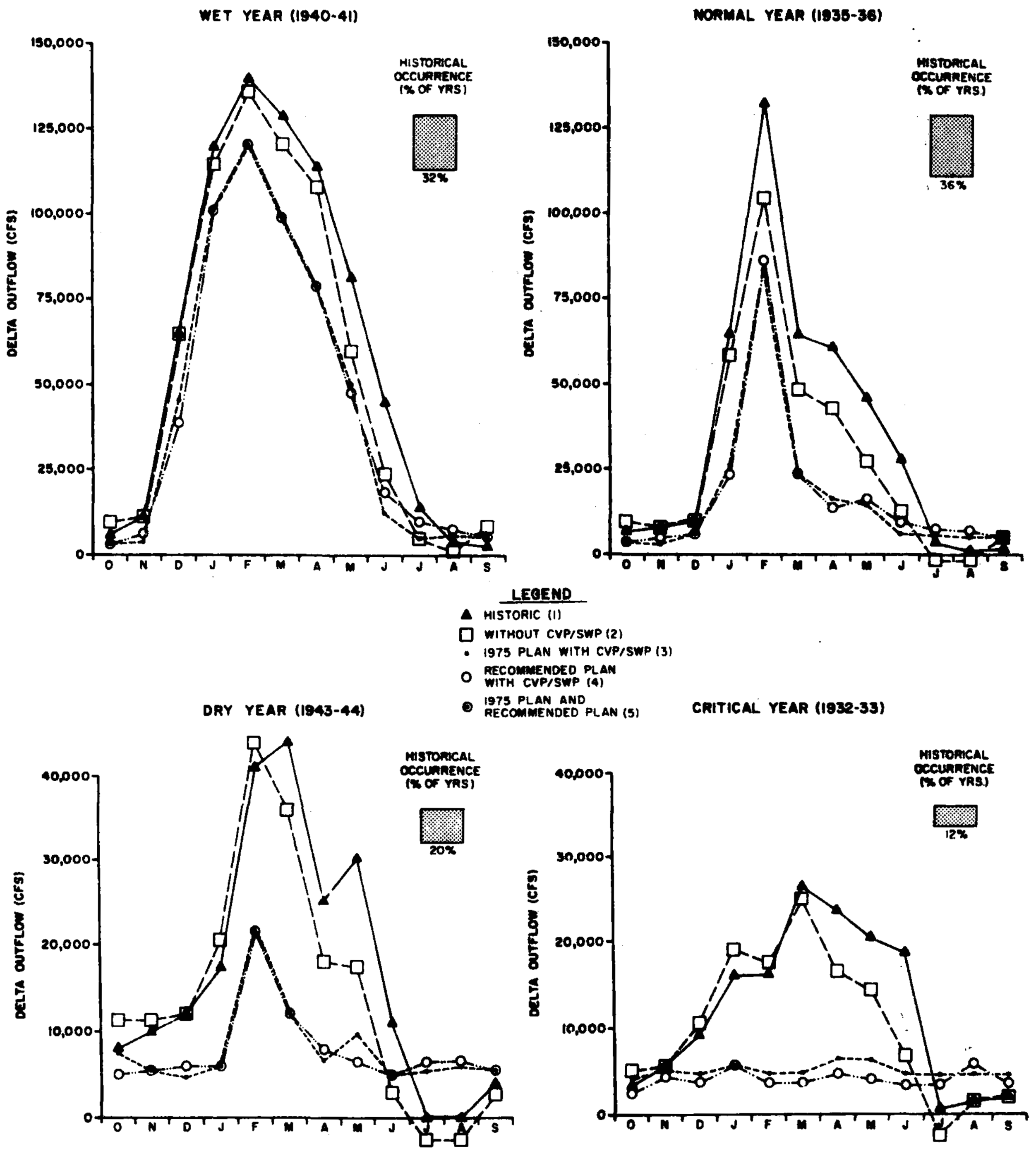
Second, even though Figure V-8 shows 100 percent alkali bulrush production with October-May outflow of 7 million acre-feet, outflows in excess of 7 million acre-feet during that period would also benefit the Marsh. However, these benefits are not quantifiable but would provide greater management flexibility (particularly to those areas that are not employing best management techniques), removal of salts concentrated in the soil profile during dry and critical years and better conditions in tidally influenced (nonmanaged) areas of the Marsh.

San Francisco Bay. As indicated in Chapter III, any impacts of the recommended plan on San Francisco Bay would be likely related to reductions in peak uncontrolled surge flows. The possible reductions in these peak flows under the recommended plan are measured against those that would be expected to occur under the "no action" alternative (IB).

Figure V-9 shows Delta outflow under various conditions (taken from Figure III-32) and the expected flows under the recommended plan. As indicated in this figure, during periods of peak winter and spring flows, only insignificant changes in monthly average flows would occur. Although the monthly flows are average conditions and not peak flow conditions, the marked similarity of these monthly flows leads to the conclusion that peak flows will not be significantly affected by the recommended plan during periods of uncontrolled flow.

FIGURE V-9

DELTA OUTFLOW UNDER DIFFERENT CONDITIONS



DELTA OUTFLOW to San Francisco Bay (1) as it actually occurred during four years prior to the construction of the CVP and SWP (pre-project), (2) how it would have been if present levels of non-CVP and -SWP related upstream development had occurred in those years and the CVP and SWP had not been constructed (without project), (3) how it would have been if present levels of upstream use and Delta export occurred in those years and assuming that the CVP and SWP operated to the 1975 basin plans (1975 basin plan), and (4) how it would have been if present levels of upstream use and Delta export occurred in those years assuming that the CVP and SWP operated to the recommended plan (recommended plan).

Table V-2 has been prepared to show median year conditions for each year type expected under the "no action" alternative and the recommended plan. This table supports the no impact conclusion indicated by Figure V-9 which is based on specific years within each year type.

Exportable Project Yield

Firm exportable yield is used by both the CVP and SWP to determine the amount of water which can be committed under long-term water supply contracts to export areas south and west of the Delta. There have been many interpretations of the meaning of this term. Department operations studies (Department Exhibits II-7, II-8, II-10 and II-11) use the following interpretation: firm exportable yield is the maximum annual water supply from the CVP and SWP expected to be available during a repetition of the 1928-1934 dry period for delivery to meet a given level of demand of contractors south and west of the Delta, with the understanding that deficiencies will be applied to this yield in some years. The California Region Framework Study Committee of the Water Resources Council (1971, p. 327) defines firm yield as "the maximum annual supply of a given water development that is expected to be available on demand [through a critical period], with the understanding that lower yields will occur in accordance with a predetermined schedule or probability".

Table V-4

TYPICAL[1] DELTA OUTFLOW FOR ALL YEAR-TYPES
1975 PLAN vs. RECOMMENDED PLAN
Cubic Feet per Second (cfs)

	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.
WET (16 Years)												
1975 Plan	5,200	7,000	36,300	80,900	83,700	41,900	51,600	39,400	18,600	5,700	5,900	8,600
Rec. Plan	5,200	6,300	39,900	79,800	84,400	41,900	49,700	37,200	23,400	10,000	7,500	6,300
ABOVE NORMAL (9 Years)												
1975 Plan	4,500	5,200	5,900	17,900	42,500	24,100	20,100	19,400	4,500	6,100	6,400	4,900
Rec. Plan	4,700	5,500	5,800	16,300	42,500	24,100	18,200	16,900	10,700	7,700	7,900	4,800
BELOW NORMAL (9 Years)												
1975 Plan	4,500	5,200	6,000	6,800	25,600	22,500	8,000	15,300	5,200	6,200	6,400	4,900
Rec. Plan	4,500	5,800	5,800	6,800[2]	24,700	22,500	8,200	13,100	9,500	7,700	7,000	4,900
DRY (10 Years)												
1975 Plan	4,500	5,300	3,900	10,100	11,100	11,600	6,700	8,400	5,200	6,300	6,000	4,500
Rec. Plan	4,500	5,200	5,400	10,100[2]	11,100	10,100	7,800	6,400	4,900	7,500	6,700	4,500
CRITICAL (6 Years)												
1975 Plan	4,500	5,200	5,100	5,300	7,300	4,800	6,700	5,900	4,500	4,700	4,700	4,500
Rec. Plan	4,100	4,600	4,800	5,000	5,500	4,500	4,600	4,500	3,100	4,000	6,000	4,100

1/ Median of mean monthly outflows of designated year-type, from Department operations studies based on 1922-71 hydrology: Department Exhibit II-10 ("1975 Basin Plan Delta Criteria") and May 16, 1978 study ("SWRCB March 1978 Recommended Delta Water Quality Objectives"), 1980-level of estimated upstream depletion and no change in existing Delta facilities. Year type frequencies are based on the year classification for fish and wildlife standards, as modified January-May due to changes in interim Marsh standards.

2/ The apparent higher January flows in median dry years compared to below normal years is due to particular annual flow distributions of the years studied.

These definitions of firm (exportable) yield do not guarantee firm yield delivery every year; rather, they allow for curtailments in critically dry years. In the case of the SWP, firm exportable yield would be available in 1928 (above normal), 1930 (dry) and 1932 (dry). Less than firm exportable yield would be available in the critical years 1929, 1931, 1933 and 1934, in accordance with deficiency allowances in SWP contracts.

Firm exportable yield is only one of several ways that project delivery capability can be characterized. It is used herein since the Department and the Bureau use firm exportable yield as a measure of delivery capability. Firm exportable yield increases with new project facilities and decreases with greater non-project demand (e.g., certain Delta water quality standards).

The CVP portion of the combined exportable yield would increase with increasing export demands to the extent that there would be adequate water supplies and export canal capacity to meet those needs. The extent of CVP exportable yield increases in this manner is unknown, and depends in part on future water supply contracts. The SWP exportable yield is essentially fixed, since supply from existing facilities is totally committed under contract.

The Department's operations study (dated May 16, 1978) of the draft plan was used for comparison to determine the relative impacts of the various alternative plans on combined exportable yield. The Department's operations studies (Department Exhibit II-10 and operations study of the draft plan) indicate that the combined exportable yield under the Basin 5B Plan would be 5.6 million acre-feet, and that under the recommended plan would be 5.8 million acre-feet. However, the Bureau's operations study of the recommended plan indicates that the combined exportable yield would be 5.7 million acre-feet. The 100,000 acre-feet difference between the Bureau and Department's studies is accounted for by Bureau revisions in assumed CVP export demands, which were reduced by about 100,000 acre-feet. This was not included in either of the Department's studies. Therefore, it is assumed that the combined firm exportable yield under the Basin 5B Plan and recommended plan would be revised to 5.5 and 5.7 million acre-feet, respectively, to reflect the reduction in CVP export demands. Finally, the <u>average</u> annual delivery to project export users through the 1928-1934 yield determining period under the recommended plan is estimated to be approximately 5 million acre-feet, due to deficiencies in yield imposed by the projects in critical years.

Utilizing information presented by the Department (Department Exhibits 7B, 8 and 9), estimates were made of the Delta outflow required to meet the water quality standards of the various alternative plans (see Figure V-1). These flow requirements have been superimposed on and compared to flows from the Department's operations study of the recommended plan. The differences in flows were used to calculate impacts on combined exportable yield, which were incorporated into Table V-1 in terms of impacts relative to the "no action" alternative. An example of these calculations is shown on Table V-3 for Alternative IV (the recommended plan). Each month in the 1928-1934 period is represented. The lines of Table V-3 labeled "Dept Study" show the flows from the Department's operations study of the recommended plan. The lines labeled Alternative IV show the estimated flows required each month to meet the water quality standards of Alternative IV. Table V-3 also identifies the conditions which would control Delta outflow during each month. The flow differences between the base case (Department operations study) and Alternative IV are indicated for each month and totaled for each year. These differences are due to changes made to the recommended plan standards, which include greater interim Marsh protection, deletion of the "year after critical year" relaxations for agricultural and municipal and industrial standards, expanded export limitations for fishery protection, deletion of agricultural standards at two locations, and allowance for compliance with the Contra Costa Canal Intake standard at both the Intake and at Antioch. The yearly totals have been combined and divided by 6-2/3[3] to determine the average decrease in yield from the base case required to meet the Alternative IV standards. The decrease in project yield for each of the alternative plans is shown in Table V-1.

3/ Operations studies begin in May of 1928 and extend through October of 1934. The total increase in flows required for this period is divided by 6-2/3. Although the 1928-1934 period represents 6-1/2 calendar years, it represents 6-2/3 years of demand due to the dominant summer irrigation deliveries. The total increase in required Delta outflow over the entire period is averaged to get reductions in yield because it is assumed that (1) outflow decreases could be recovered by the projects through increased exports and/or decreased upstream releases, (2) the outflow increases would result in proportional decreases in project deliveries, and (3) these delivery decreases would be spread evenly over each of the years in the 1928-1934 period.

CALCULATION OF DECREASE IN COMBINED SWP & CVP EXPORTABLE FIRM YIELD RESULTING FROM THE RECOMMENDED PLAN (ALTERNATIVE IV)
AS COMPARED TO DEPARTMENT OPERATIONS STUDY OF DRAFT PLAN

WATER YEAR (TYPE)		DELTA OUTFLOW, MAY 1928 to OCT. 1934																								ANNUAL CHANGE IN OUTFLOW, ALT IV vs. DEPT STUDY (ACRE-FEET)
		OCT		NOV		DEC		JAN		FEB		MAR		APR		MAY		JUN		JUL		AUG		SEP		
		AVG CFS	CONT COND	AVG CFS	CONT COND	AVG CFS	CONT COND	AVG CFS	CONT COND	AVG CFS	CONT COND	AVG CFS	CONT COND OR AF	AVG CFS	CONT COND OR AF	AVG CFS	CONT COND OR AF	AVG CFS	CONT COND OR AF	AVG CFS	CONT COND OR AF	AVG CFS	CONT COND OR AF	AVG CFS	CONT COND OR AF	
1928 (Ab. Norm) (Subnorm. Snowmelt)	DEPT STUDY															9380	UF	6200	AG	6700	AG	7950	AG/CW	4540	CW	
	ALT IV															9380	UF	6200	AG	6700	AG	7950	AG/CW	4540	CW	
	DIFF															0		0		0		0		0		0
1929 (Crit)	DEPT STUDY		SM		CW		CW		CW		UF	4780	CW	6280	SB	3930	SB/SM	3900	CW	6280	CW	6060	CW	4320	CW	
	ALT IV		SM		CW		CW		CW		UF	4780	CW	6280	SB	4500	SM	3900	CW	6280	CW	6060	CW	4320	CW	
	DIFF											0		0		570	35060	0		0		0		0		35,060
1930 (Bl. Norm.) (Dry for Fish & Wild.)	DEPT STUDY		SM		CW		CW		UF		UF	24760	UF	7910	AG	6570	UF	5090	AG	7640	AG	6850	CW	4540	CW	
	ALT IV		SM		CW		CW		UF		UF	24760	UF	7910	AG	6570	UF	5830	AG	6650	AG	6850	CW	4540	CW	
	DIFF											0		0		0		740	44040	-990	-60890	0		0		-16,850
1931 (Crit)	DEPT STUDY		CW		CW		SM		CW		CW	4360	CW	4400	SB	3630	SB/SM	3100	SB	3460	CW	3400	CW	3980	CW	
	ALT IV		CW		CW		SM		CW		CW	4500	SM	4500	SM	4500	SM	3100	SB	3460	CW	3400	CW	3980	CW	
	DIFF	NO DIFFERENCE		NO DIFFERENCE		NO DIFFERENCE		NO DIFFERENCE		NO DIFFERENCE		140	8610	100	5950	870	53510	0		0		0		0		68,070
1932 (Bl. Norm.) (Dry for Fish & Wild.)	DEPT STUDY		SM		CW		UF		UF		UF	4720	SM/AG	6200	AG	9600	UF	5360	AG	4720	AG	7220	CW	3660	CW	
	ALT IV		SM		CW		UF		UF		UF	4720	SM/AG	6200	AG	9600	UF	6100	AG	4110	AG	7220	CW	3660	CW	
	DIFF											0		0		0		740	44040	-610	-37520	0		0		6,520
1933 (Crit)	DEPT STUDY		SM		CW		CW		UF		CW	3500	SM	4540	SB	4160	UF	3100	SB	3320	CW	5870	CW	3700	CW	
	ALT IV		SM		CW		CW		UF		CW	4500	SM	4540	SB	4500	SM	3100	SB	3320	CW	5870	CW	3700	CW	
	DIFF											1000	61500	0		340	20910	0		0		0		0		82,410
1934 (Crit)	DEPT STUDY		SM		SM		CW		UF		UF	4360	CW	4650	SB	3670	SB/SM	3100	SB	3430	CW	5610	CW	3930	CW	
	ALT IV		SM		SM		CW		UF		UF	4500	SM	4650	SB	4500	SM	3100	SB	3430	CW	5610	CW	3930	CW	
	DIFF											140	8610	0		830	51050	0		0		0		0		59,660
1935	DEPT STUDY		CW																							
	ALT IV		CW																							
	DIFF																									

Controlling Conditions

AG - Agricultural Standards
CW - Carriage Water
SB - Striped Bass Standards
SM - Suisun Marsh Standards
UF - Uncontrolled Flows

Total amount of water through the yield determining period required to meet Alt. IV compared to Dept. op. study	234,870
Decrease in combined exportable firm yield from Dept. op. study to meet Alt. IV (Total ÷ 6 2/3)	35,230

An examination of Table V-3 reveals some interesting facts. Even though 1928-1934 is a drought period, 13 of the 78 months (17 percent of the time) had uncontrolled flows sufficient to meet all Delta water quality requirements under Alternative IV. Of greater significance is the fact that during this drought period carriage water needs of the projects control Delta outflow more than any other factor (44 percent of the time). Water quality standards of Alternative IV would control Delta outflow 39 percent of the time during the seven-year dry period.

The reductions in yield determined in the manner discussed above are estimates only, and should be refined through further comprehensive operations studies by the Department and Bureau.

A comparison of Alternatives IA with IB and IIIA with IIIB indicates that protection of Suisun Marsh solely with outflow would reduce the project yield by about 1.6 to 1.7 million acre-feet beyond that required to meet other standards contained in these alternative plans. The magnitude of this impact indicates the need to protect the Marsh by means other than solely by Delta outflow. Chapter IV of this report addresses the long-term protection needs of the Marsh in more detail.

Some of the alternative plans would have very substantial impacts on yield, and it is expected that the projects would alter their export patterns somewhat to minimize these impacts. However, the impacts on yield of Alternatives IA, IIIA and IIIB shown in Table V-1 would be quite substantial under any envisioned export pattern. In addition, it appears highly unlikely that the projects would be able to withstand the reoccurrence of the 1928-1934 drought period under Alternatives IA, IIIA and IIIB.

The other alternatives shown in Table V-1 represent varying degrees of impact on exportable yield that are either close to or less than the "no action" alternative (IB). The impact on yield of Alternative IV is much less than the no action alternative (IB). Thus, no discussion of possible adverse environmental impacts of this alternative on the projects or their water users is necessary.

In addition, Alternative IV has an almost negligible effect (less than 1%) on yield over that of the Four-Agency Fish Agreement alone. In its closing brief on page 34, the Department recommended that the Board incorporate the Four-Agency Fish Agreement standards (set forth in Fish and Game Exhibit II) into the water quality control plan. Although refinement of these impacts on yield is necessary, Alternative IV will not significantly affect yield beyond that recommended by the Department.

C. SUMMARY OF IMPACTS OF THE RECOMMENDED PLAN

The results of the impact analysis are shown in Table V-1. Based on this analysis, Alternative IV has been selected as the recommended plan. The level of protection provided beneficial uses and the impact on export yield of the projects under each alternative can be compared readily with those of the recommended plan.

Under the recommended plan, the level of protection provided municipal, industrial and agricultural uses would be at least equal to or better than that which would be experienced under without project conditions. Generally, the level of protection provided by a water quality standard established for a particular use would be increased by standards established for other uses, carriage water needs of the projects, and uncontrolled Delta outflow.

The recommended plan would provide water users of the Contra Costa Canal with fewer days of 150 mg/l Cl^- water than under the "no action" alternative. This reduction ranges from about 10 days in above normal years to 80 days in critical years. However, in wet years the recommended plan would provide better conditions than those expected under the no action alternative.

Conditions would generally be worse in critical years under the recommended plan. The impacts of the recommended plan on Contra Costa Canal users are not quantifiable, but the expected maximum chloride levels should not exceed 170 mg/l at the canal intake.

The recommended plan would provide greater protection to agricultural uses than that provided under the "no action" alternative (Alternative IB), except in the western Delta under limited circumstances. As shown in Table V-1, the specific agricultural standards ("standard only" column) for the western Delta contained in the recommended plan provide substantially greater protection than those of the "no action" alternative. A similar comparison of the composite of all standards of the two alternatives indicates that only during critical years would the "no action" alternative provide greater protection to the western Delta. This critical year benefit to the western Delta is a result of the incidental protection provided by the basin plan fish and wildlife standards which make no provision for wide fluctuations in hydrologic conditions.

The "no action" composite standards would require about 160,000 acre-feet of project yield over that required by the recommended plan. Such impact on exportable yield cannot be justified on the basis of the projects' effects on Delta vested water rights. The impacts of the recommended plan on western Delta agriculture during critical years cannot be quantified because the extent of such impacts are more dependent on the management options available to western Delta agricultural users. Also, current negotiations between representatives of western Delta agricultural interests, Department and Bureau may lead to an agreement to firm-up such water supplies during a critical year. In accordance with the

Delta Protection Act, Delta water users seeking such firm supplies from the project operators would be required to pay only for benefits in excess of their vested rights.

Fishery resources (specifically striped bass) would be maintained at higher levels under the recommended plan than under the "no action" alternative. The recommended plan levels for striped bass would approach those levels which would occur under without project conditions. In addition to suitable salinity and flow conditions, maintenance of fishery resources at without project levels is dependent on curtailment of project exports during periods when striped bass eggs and young of striped bass, salmon and white catfish are present in greatest numbers in the Delta. The curtailments proposed by Fish and Game in their Exhibit 11 (draft Four-Agency Fish Agreement) appear to have tacit concurrence of the Department and the Bureau. The curtailments of project exports are an essential element of Fish and Game's recommendation toward mitigation of project impacts on the fishery resources. The curtailments have been modified to apply regardless of outflow. It is appropriate for the Board to include conditions in the permits for the CVP and SWP which will require the curtailments.

With the occurrence of uncontrolled flows the water quality available for waterfowl seed production in the managed areas of Suisun Marsh would be suitable in all but dry and critical years and about 1/2 of the below normal years. Full protection of the Marsh solely with outflow would require a one-third reduction in combined SWP and CVP exportable yield. Fish and Game, U. S. Fish and Wildlife

Service, the California Waterfowl Association, and the Suisun Resource Conservation District believe that any adverse impacts on wildlife habit which might be sustained by the Marsh in dry and critical years can be mitigated through the construction of facilities and provision of substitute water supplies for the Marsh. Under without project conditions, Suisun Marsh would have experienced better water quality for the next six years than that provided under the recommended plan. The project operators have a responsibility to mitigate adverse impacts of project operations. In view of this, appropriate terms and conditions will be incorporated in the water right permits for the SWP and CVP to ensure mitigation of such adverse impacts to Suisun Marsh.

The recommended plan would have substantially less impact on project yield than the "no action" alternatives (Alternatives IA and IB). A comparison of the recommended plan with Alternative IA (Basin Plans with Suisun Marsh Protection) indicates that about 1.7 to 1.8 million acre-feet of exportable project yield would be conserved under the recommended plan. A similar comparison of the recommended plan and Alternative IB (Basin Plan without Suisun Marsh protection) indicates that 160,000 acre-feet would be conserved.

The recommended plan reflects a closer fit to hydrologic conditions and available water supplies than the "no action" alternatives. Even though the recommended plan would require less freshwater outflow because of a more efficient use of Delta outflow and a better understanding of beneficial use needs in the Delta, the overall protection under the recommended plan is greater than the "no action" alternatives. In addition, the recommended plan would require full mitigation of all project adverse impacts on Suisun Marsh by October 1, 1984.

TABLE V-1
SHEET 1

ALTERNATIVE PLAN

SUMMARY OF POTENTIAL ENVIRONMENTAL IMPACTS

		IA No Action		IB No Action		IIA		IIB		IIIA		IIIB		IV Recommended Plan	
		BASIN PLANS WITH SUISUN MARSH		BASIN PLANS WITHOUT SUISUN MARSH		M&I – Substitute Supply 1/ Ag. – Average Salinity during Irrigation Season F & W – Interim Protection		M&I – Substitute Supply 1/ Ag. – Low Salinity Early In Irrigation Season F & W – Interim Protection		M&I – Substitute Supply 1/ Ag. – Low Salinity Early In Irrigation Season F&W – Preservation of Fishery and Marsh at Historical Levels		M&I – Substitute Supply 1/ Ag. – Low Salinity Early In Irrigation Season F&W – Fishery: Preservation at Historical Levels Marsh: Interim Protection		M&I – Substitute Supply 1/ Ag. – Low Salinity in W, Ab, Bl, D Years; Average Salinity in Critical Years F & W – Interim Protection	
		Standard Only	Composite of all IA Standards	Standard Only	Composite of all IB Standards	Standard Only	Composite of all IIA Standards	Standard Only	Composite of all IIB Standards	Standard Only	Composite of all IIIA Standards	Standard Only	Composite of all IIIB Standards	Standard Only	Composite of all IV Standards
MUNICIPAL AND INDUSTRIAL (M&I)		DAYS YEAR		DAYS YEAR		DAYS YEAR		DAYS YEAR		DAYS/YEAR		DAYS YEAR		DAYS YEAR	
Contra Costa Canal Intake No. of days of 150 mg l Cl⁻ or less per year	Wet	234		234	234	240	285	240	285	240		240		240	285
	Ab.N.	234		234	234	190	225	190	225	190		190		190	225
	Bl.N.	234		234	234	175	225	175	225	175		175		175	225
	Dry	234	3/	234	234	165	255/165 2/	165	255/165 2/	165	3/	165	3/	165	255/165 2/
	Crit.	234		234	234	155	155	155	155	155		155		155	155
	Median	234		234	234	175	225	175	225	175		175		175	225
		RANK *		RANK		RANK		RANK		RANK		RANK		RANK	
AGRICULTURAL (AG.) Western Delta (Sacramento River at Emmaton)	Wet	1		1	8	10	10	10	10	10	10	10	10	10	10
	Ab.N.	1	3/	1	8	9	10	9	10	9	10	9	10	9	10
	Bl.N.	1		1	8	8	10	8	10	8	10	8	10	8	10
	Dry	1		1	8	6	9/8 2/	6	9	6	10	6	10	6	9
	Crit.	1		1	7	1	4	1	8	1	3/	1	3/	1	4
	Median	1		1	8	8	10	8	10	8	10	8	10	8	10
Interior Delta 4/ (Old River near Rancho Del Rio)	Wet	7		7	9	10	10	10	10	10	10	10	10	10	10
	Ab.N.	7		7	9	10	10	10	10	10	10	10	10	10	10
	Bl.N.	7	3/	7	9	10	10	10	10	10	10	10	10	10	10
	Dry	6		6	8 5/	9	9	9	9	9	10	9	10	9	9
	Crit.	6		6	9	7	8	7	9	7	3/	7	3/	7	8
	Median	7		7	9	10	10	10	10	10	10	10	10	10	10
Northern Delta 6/															
Southern Delta 7/															

*** Agricultural Water Quality Rankings**

EC in mmhos	Rank	EC in mmhos	Rank
< .45	10	1.05 - 1.20	5
.45 - .60	9	1.20 - 1.35	4
.60 - .75	8	1.35 - 1.50	3
.75 - .90	7	1.50 - 1.65	2
.90 - 1.05	6	> 1.65	1

ALTERNATIVE PLAN

SUMMARY OF POTENTIAL ENVIRONMENTAL IMPACTS

		IA NO ACTION		IB NO ACTION		IIA		IIB		IIIA		IIIB		IV RECOMMENDED PLAN	
		BASIN PLANS WITH SUISUN MARSH		BASIN PLANS WITHOUT SUISUN MARSH		M&I - Substitute Supply [1] Ag. - Average Salinity during Irrigation Season F & W - Interim Protection		M&I - Substitute Supply [1] Ag. - Low Salinity Early In Irrigation Season F & W - Interim Protection		M&I - Substitute Supply [1] Ag. - Low Salinity Early In Irrigation Season F&W - Preservation of Fishery and Marsh at Historical Levels		M&I - Substitute Supply [1] Ag. - Low Salinity Early In Irrigation Season F&W - Fishery: Preservation at Historical Levels Marsh: Interim Protection		M&I - Substitute Supply [1] Ag. - Low Salinity in W, Ab, Bl, D Years; Average Salinity in Critical Years F & W - Interim Protection	
		Standard Only	Composite of all IA Standards with Expected Conditions	Standard Only	Composite of all IB Standards with Expected Conditions	Standard Only	Composite of all IIA Standards with Expected Conditions	Standard Only	Composite of all IIB Standards with Expected Conditions	Standard Only	Composite of all IIIA Standards with Expected Conditions	Standard Only	Composite of all IIIB Standards with Expected Conditions	Standard Only	Composite of all IV Standards with Expected Conditions
FISH AND WILDLIFE		MILES OF "SUITABLE" SPAWNING		MILES OF "SUITABLE" SPAWNING		MILES OF "SUITABLE" SPAWNING		MILES OF "SUITABLE" SPAWNING		MILES OF "SUITABLE" SPAWNING		MILES OF "SUITABLE" SPAWNING		MILES OF "SUITABLE" SPAWNING	
Striped Bass Spawning [9] (Miles of "suitable" spawning areas along the San Joaquin River	Wet-Dry	17	17	17	17	17	17	17	17	17	17	17	17	17	17
	10% Del. [8]	17	17	17	17	16.5	16.5	16.5	16.5	17	17	17	17	16.5	16.5
	25% Del.	17	17	17	17	14	14	14.5	14.5	17	17	17	17	14.5	14.5
	50% Del.	17	17	17	17	9.5	9.5	9.5	9.5	17	17	17	17	9.5	9.5
		STRIPED BASS INDEX		STRIPED BASS INDEX		STRIPED BASS INDEX		STRIPED BASS INDEX		STRIPED BASS INDEX		STRIPED BASS INDEX		STRIPED BASS INDEX	
Striped Bass Survival Young striped bass survival in terms of the striped bass index	Wet			34	70	90	94	90	94	121		121		90	105
	Ab.N.			43	64	74	74	74	74	116		116		74	89
	Bl.N.	10		39	55	73	71	73	71	109		109		73	81
	Bn.Sm.			-	-	49	64	49	64	-		-		49	75
	Dry			43	58	35 [11]	62 [11]	35 [11]	62 [11]	97	13	97	13	35 [11]	61 [11]
	Crit.			57	62	21 [12]	41 [12]	21 [12]	41 [12] ++	64		64		21 [12]	40 [12]
	Weighted Average	< 41	< 63	41	63	62	71	62	71 +	106	106 -	106	106 +	62	79
		PERCENT		PERCENT		PERCENT		PERCENT		PERCENT		PERCENT		PERCENT	
Suisun Marsh - % of Optimum Alkali Bulrush Seed Production Suisun Slough and West Grizzly Island	Wet Ab. N Bl.N	100	100	UP TO 25	100	20-35	100	20-35	100	100	100	20-35	100	20-35	100
	Dry	100	100	UP TO 25	25-35	20-35	25-35	20-35	25-35	100	100	20-35	25-35	20-35	25-35
	Crit.	100	100	UP TO 25	20-30	UP TO 20	20-30	UP TO 20	20-30	100	100	UP TO 20	20-30	UP TO 20	20-30
Simmons and Wheeler Islands and the Channel Islands	Wet Ab. N. Bl. N.	100	100	UP TO 20	100	10-30	100	10-30	100	100	100	10-30	100	10-30	100
	Dry	100	100	UP TO 20	20-30	10-30	20-30	10-30	20-30	100	100	10-30	20-30	10-30	20-30
	Crit.	100	100	UP TO 20	20-30	UP TO 10	10-20	UP TO 10	10-20	100	100	UP TO 10	10-20	10-30	20-30
Salmon [14]															
PROJECT EXPORTS		ACRE-FEET		ACRE-FEET		ACRE FEET		ACRE-FEET		ACRE-FEET		ACRE-FEET		ACRE-FEET	
Change in Combined SWP CVP Firm Dry Period Export Yield Compared to No Action Alternative IB (5,500,000 acre feet) [15]		1,600,000 (-29%)		— — —		+220,000 (+4%)		-60,000 (-1%)		-2,500,000 [16] TO -2,700,000 (-45% TO -49%)		-800,000 [16] TO -1,000,000 (-15% TO -22%)		+160,000 (+3%)	

SUMMARY OF POTENTIAL ENVIRONMENTAL IMPACTS
Explanation of Table Headings

TABLE 1
SHEET 3

Columns headed "Standard Only" represent potential environmental impacts, assuming the standard for the beneficial use in question is met as the controlling standard in the Delta.

Columns headed "Composite of Standards" represent potential environmental impacts, assuming the composite of standards contained in the alternative plan in question are met as the controlling standards in the Delta. The outflow necessary to meet the State Water Project operational need of 100 mg/l Cl^- at Clifton Court is also included.

Columns headed "Composite of Standards with Expected Conditions" evaluate potential environmental impacts under the same assumptions used in columns headed "Composite of Standards", except that effects of expected uncontrolled flows are included.

The impacts corresponding to a specific year type represent expected average conditions for that classification.

FOOTNOTES

1/ Initial assessment of alternative municipal and industrial objectives eliminated all but the substitute supply alternative from this analysis of impacts (see page IV–17).

2/ The first number represents dry years with substantial carryover storage. The second number represents dry years without substantial carryover storage.

3/ In order to quantify the impacts to municipal, industrial and agriculture uses under this alternative, a complete operation study is needed to define carriage water needs throughout the year. Conditions would be no worse than those shown in the column headed "Standard Only".

4/ The "Standard Only" column reflects the protection afforded the Interior Delta by the Jersey Point standard.

5/ High exports in June and July of dry years draw more seawater toward the export pumps, causing conditions in Old River to worsen.

6/ The water quality standards for the western and interior Delta control the water quality available in the northern Delta, which is substantially better than that found in other areas of the Delta. In addition, water quality needs in the northern Delta are less restrictive because the soils in this area allow for surface irrigation. Although not analyzed in detail, significant adverse impacts to agriculture in the northern Delta are not expected from any of the alternatives evaluated.

7/ The alternatives considered for protection of southern Delta agriculture would have the same near term environmental impacts as the no action alternative. These near term impacts have not been quantified. The recommended plan would provide greater long-term protection than the no action alternatives.

8/ "Def." represents deficiencies in firm supplies of the CVP and SWP. See Table VI–1 for definition of firm supplies. At the 1980 level of development 10% deficiency equates to .7 MAF cutback in deliveries, 25% deficiency to 1.9 MAF and 50% to 3.7 MAF.

9/ "Suitable" spawning areas were determined as those between Venice Island and the approximate occurrence of the 1.5 mmhos EC line on the San Joaquin River. The estimates in this table of the location of the 1.5 mmhos EC line, and thus the remaining area "suitable" for striped bass spawning, apply only when the salinity gradients along the lower San Joaquin River are similar to those predicted for the Sacramento River by the computer model used to develop Department Exhibit II–9. Better estimation of the San Joaquin River salinity gradient must await the development of more accurate models for the lower San Joaquin River under varying export rates.

10/ In order to quantify the impacts on striped bass under this alternative, a complete project operation study would be needed to define the May, June and July export rates. The operation study has not been done. Under this alternative, it is likely that export rates during May, June and July would be higher than under Alternative II–B. This would cause the striped bass index to be less than that shown for Alternative II–B.

11/ Dry year following a wet, above normal, or below normal year.

12/ Critical years and dry years following a dry or critical year.

13/ A project operation study would be needed to define May, June and July exports, and thus quantitatively define the striped bass index for each year type under this alternative. The weighted average index under this alternative plan would, however, be at least as high as that required under the adjacent "standard only" column.

14/ Flows for salmon migration for all alternatives, except perhaps some months during drier years under the no action alternatives, never fall below those listed by Fish and Game as "minimum satisfactory flows for salmon" as identified in Fish and Game Exhibit 11, p. 9.

15/ The base case used to determine yield decreases is that presented in the Department's Operations Study (dated May 16, 1978) of the Draft Plan. The estimated decreases in yield were determined by subtracting from this base. Complete operation studies are needed to better define the projects' firm dry period export yield under these alternatives.

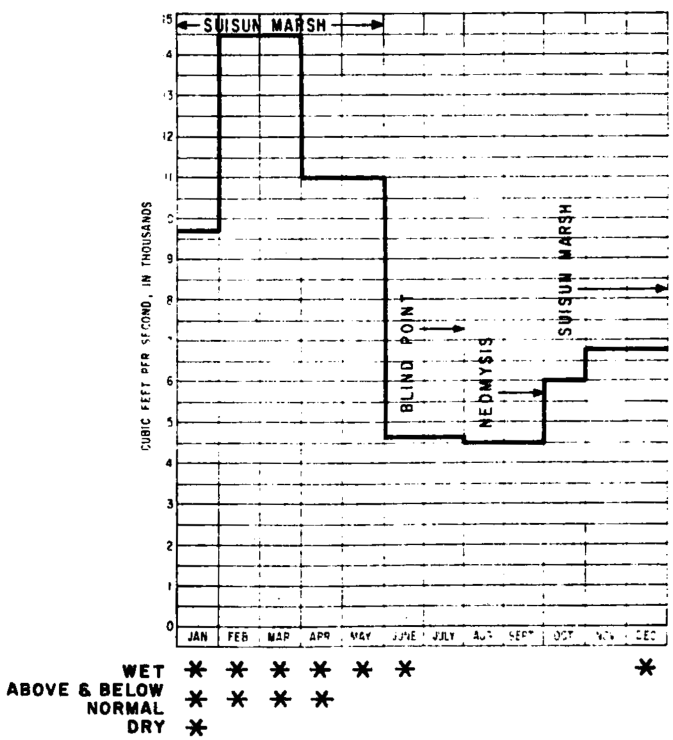
16/ Impacts on yield do not include the extensive constraints necessary to attain the positive net downstream flow requirement of this alternative.

FIGURE V-1(a)

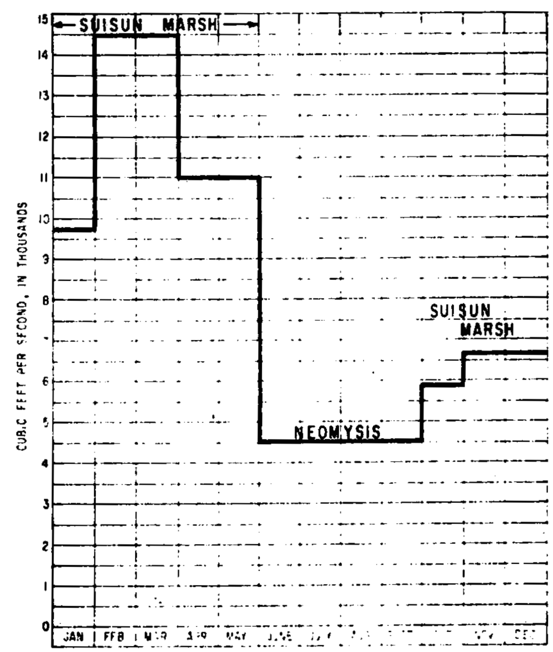
DELTA OUTFLOW RESULTING FROM ALTERNATIVE WATER QUALITY CONTROL PLANS

NO ACTION
ALTERNATIVE PLAN 1-A

WET, ABOVE NORMAL, BELOW NORMAL and DRY YEAR



CRITICAL YEAR



CONTROLLING STANDARDS

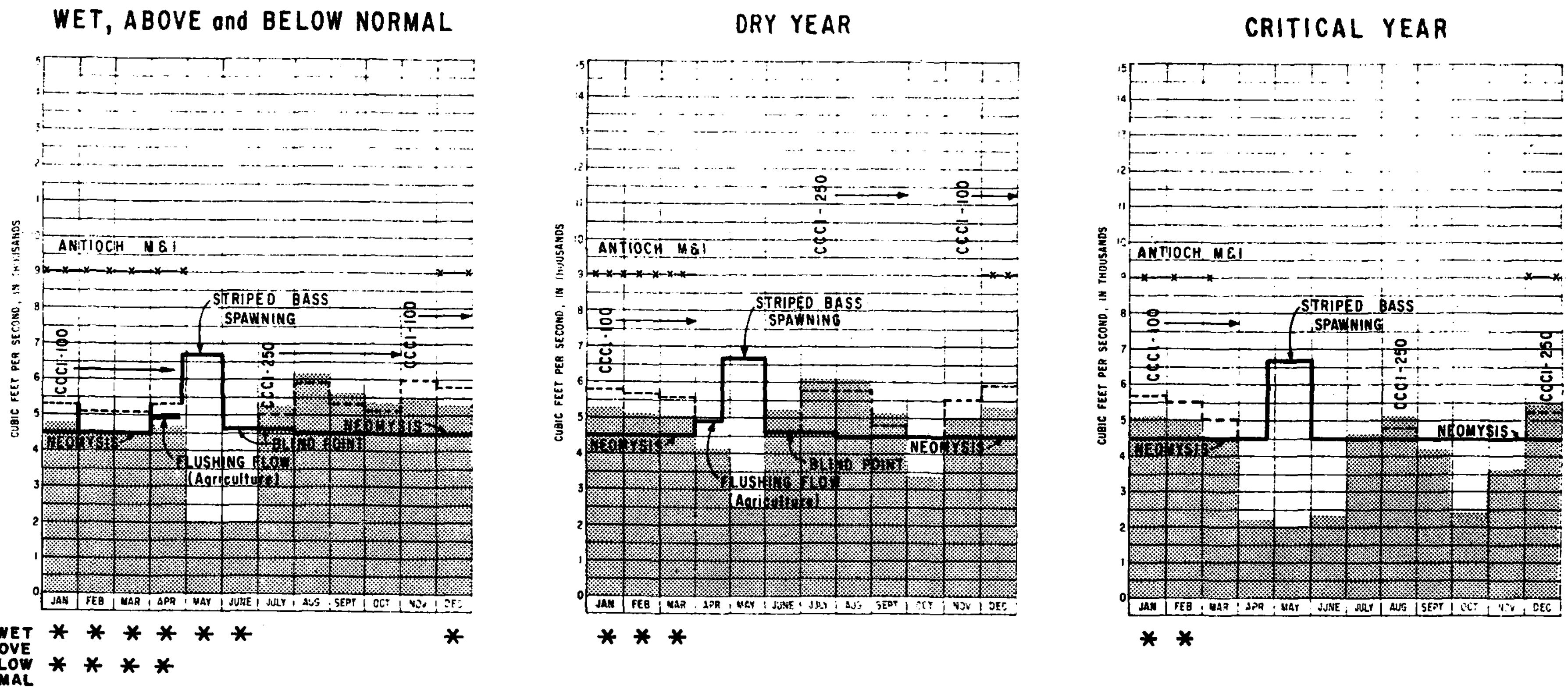
A FULL OPERATIONAL STUDY IS NEEDED TO DETERMINE CARRIAGE WATER REQUIREMENTS.

STANDARDS DEPENDENT ON PROJECT EXPORTS ARE NOT INCLUDED.

*MONTHS WHEN STANDARDS ARE LIKELY TO BE MET BY UNCONTROLLED OUTFLOW

DELTA OUTFLOW RESULTING FROM ALTERNATIVE WATER QUALITY CONTROL PLANS

NO ACTION
ALTERNATIVE PLAN I-B



CONTROLLING STANDARDS

CONTROLLING STANDARDS DEPENDENT ON EXPORT RATES

ESTIMATED CARRIAGE WATER REQUIREMENTS

NOT EVALUATED AS A CONTROLLING WATER QUALITY OBJECTIVE

* MONTHS WHEN STANDARDS ARE LIKELY TO BE MET BY UNCONTROLLED OUTFLOW

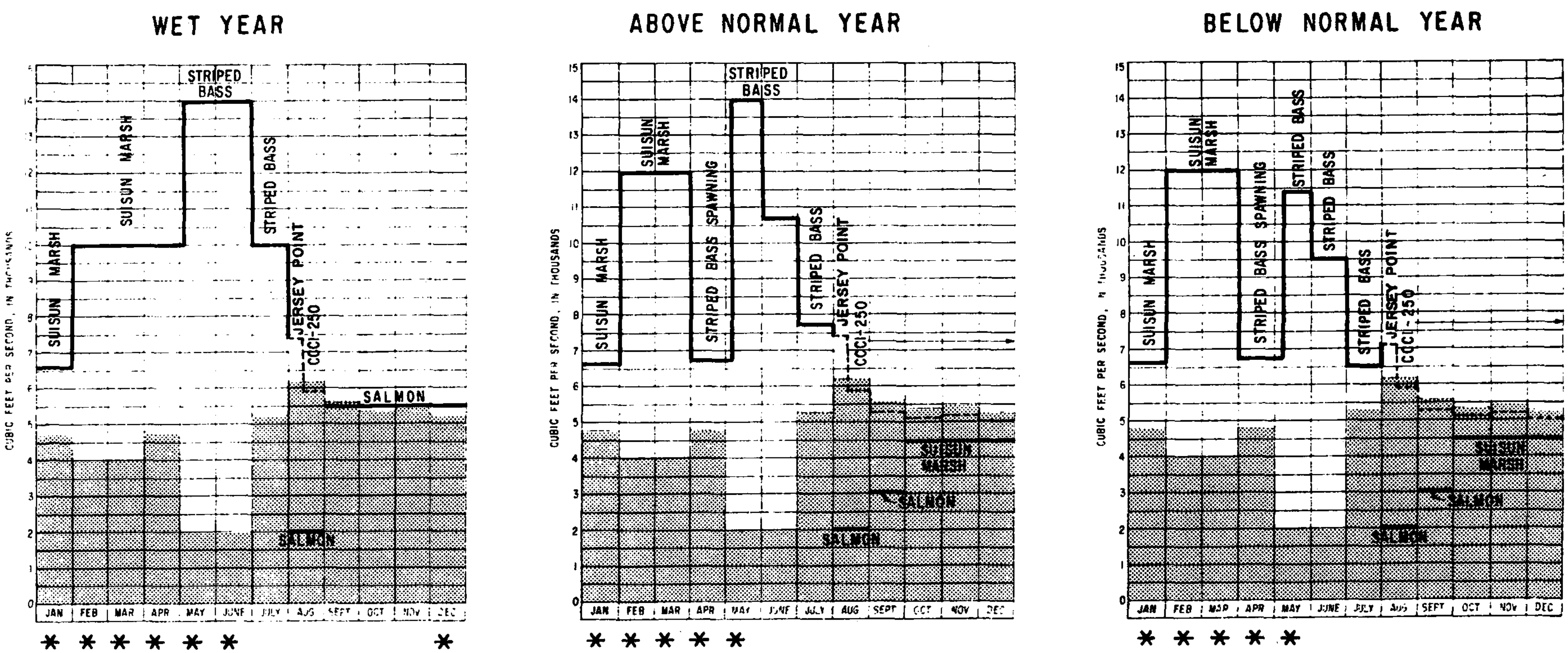
FIGURE V-1(b)

FIGURE V-1(c)
SHEET 1

DELTA OUTFLOW RESULTING FROM ALTERNATIVE WATER QUALITY CONTROL PLANS

ALTERNATIVE PLAN II-A

(DRY and CRITICAL YEARS on FOLLOWING PAGE)



CONTROLLING STANDARDS

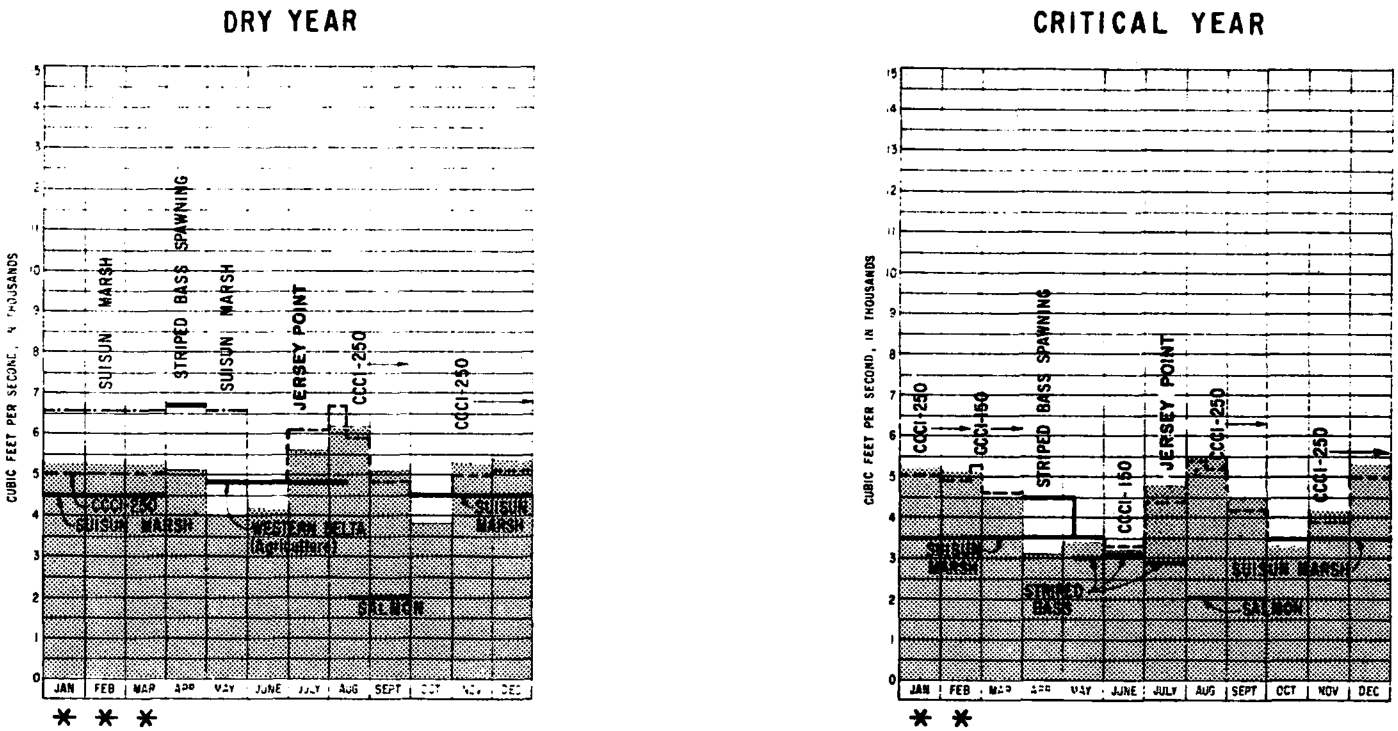
CONTROLLING STANDARDS DEPENDENT ON EXPORT RATES

ESTIMATED CARRIAGE WATER REQUIREMENTS

* MONTHS WHEN STANDARDS ARE LIKELY TO BE MET BY UNCONTROLLED OUTFLOW

DELTA OUTFLOW RESULTING FROM ALTERNATIVE WATER QUALITY CONTROL PLANS

ALTERNATIVE PLAN II-A
(WET and NORMAL YEARS on PRECEEDING PAGE)



CONTROLLING STANDARDS
CONTROLLING STANDARDS DEPENDENT ON EXPORT RATES
ESTIMATED CARRIAGE WATER REQUIREMENTS
* MONTHS WHEN STANDARDS ARE LIKELY TO BE MET BY UNCONTROLLED OUTFLOW

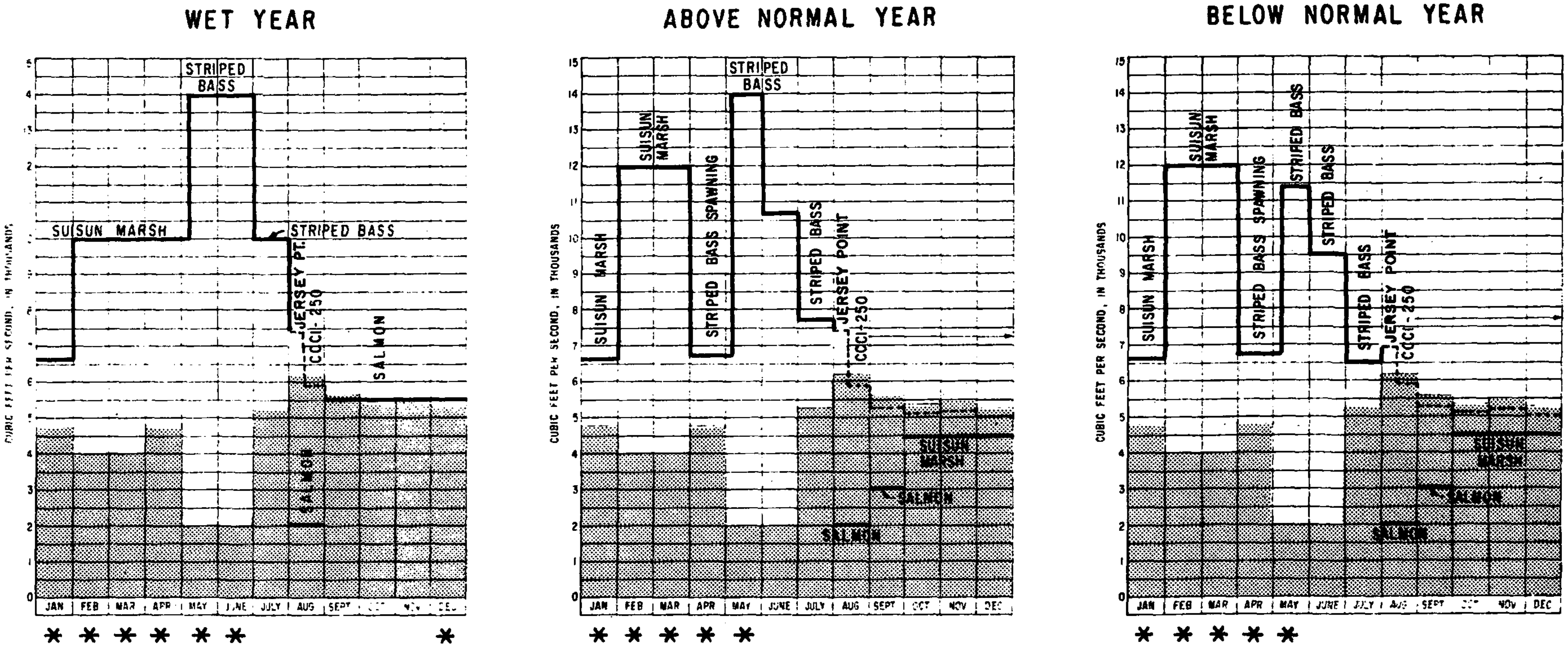
FIGURE V-1(c)
SHEET 2

FIGURE V-1(d)
SHEET 1

DELTA OUTFLOW RESULTING FROM ALTERNATIVE WATER QUALITY CONTROL PLANS

ALTERNATIVE PLAN II-B

(DRY and CRITICAL YEARS on FOLLOWING PAGE)



CONTROLLING STANDARDS

CONTROLLING STANDARDS DEPENDENT ON EXPORT RATES

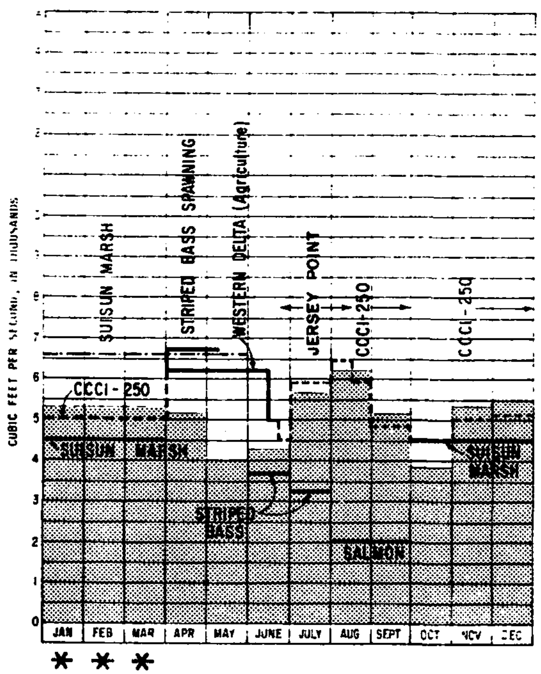
ESTIMATED CARRIAGE WATER REQUIREMENTS

*MONTHS WHEN STANDARDS ARE LIKELY TO BE MET BY UNCONTROLLED OUTFLOW

DELTA OUTFLOW RESULTING FROM ALTERNATIVE WATER QUALITY CONTROL PLANS

ALTERNATIVE PLAN II-B
(WET and NORMAL YEARS on PRECEEDING PAGE)

DRY YEAR



CRITICAL YEAR

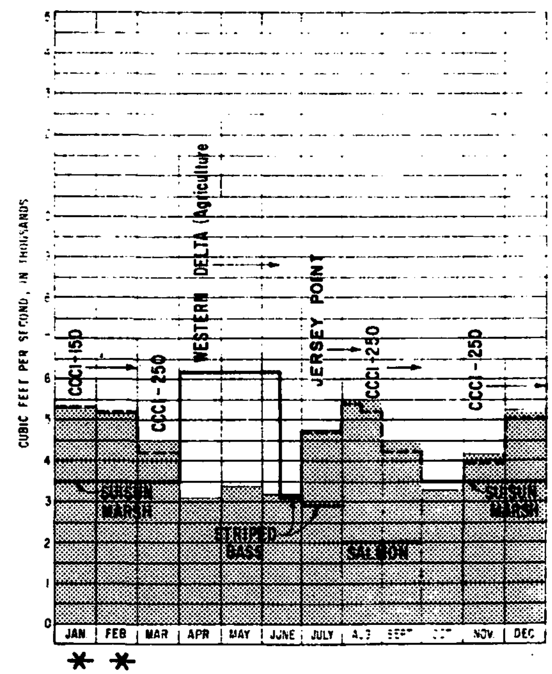


FIGURE V-1(d)
SHEET 2

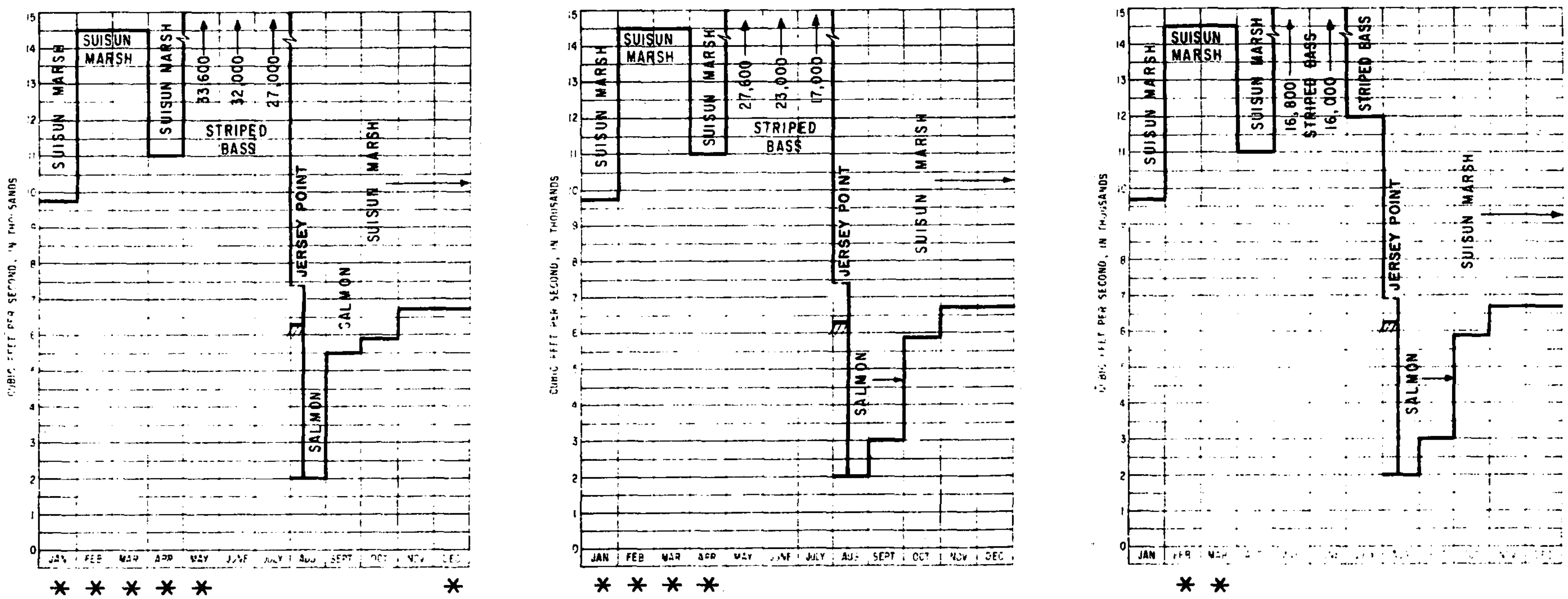
CONTROLLING STANDARDS (W/O SUBSTANTIAL CARRYOVER STORAGE)
CONTROLLING STANDARDS (WITH SUBSTANTIAL CARRYOVER STORAGE)
CONTROLLING STANDARDS DEPENDENT ON EXPORT RATES
ESTIMATED CARRIAGE WATER REQUIREMENTS
* MONTHS WHEN STANDARDS ARE LIKELY TO BE MET BY UNCONTROLLED OUTFLOW

CONTROLLING STANDARDS
CONTROLLING STANDARDS DEPENDENT ON EXPORT RATES
ESTIMATED CARRIAGE WATER REQUIREMENTS
* MONTHS WHEN STANDARDS ARE LIKELY TO BE MET BY UNCONTROLLED OUTFLOW

DELTA OUTFLOW RESULTING FROM ALTERNATIVE WATER QUALITY CONTROL PLANS

ALTERNATIVE PLAN III-A

(DRY and CRITICAL YEARS on FOLLOWING PAGE)



* MONTHS WHEN STANDARDS ARE LIKELY TO BE MET BY UNCONTROLLED OUTFLOW

CONTROLLING STANDARDS

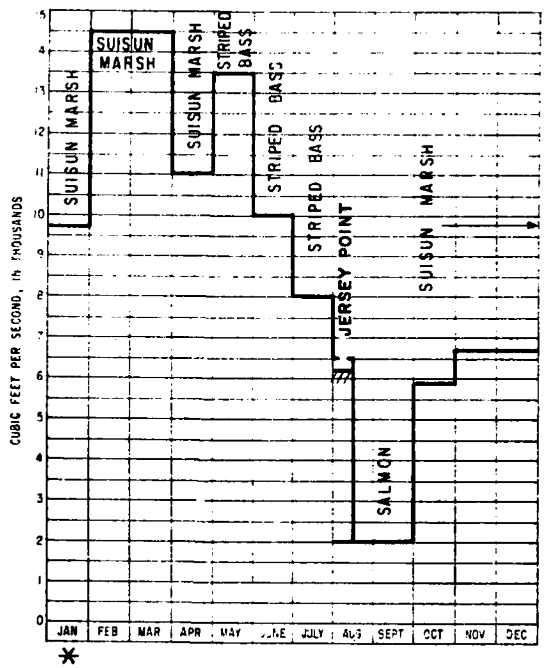
CONTROLLING STANDARDS DEPENDENT ON EXPORT RATES

CARRIAGE WATER REQUIREMENT FOR MONTHS SHOWN WAS ESTIMATED BY USING DWR EXHIBIT II-8. A FULL OPERATIONS STUDY IS NEEDED TO DETERMINE CARRIAGE WATER REQUIREMENTS AND WATER QUALITY STANDARDS DEPENDENT ON PROJECT EXPORTS FOR THE REMAINING MONTHS.

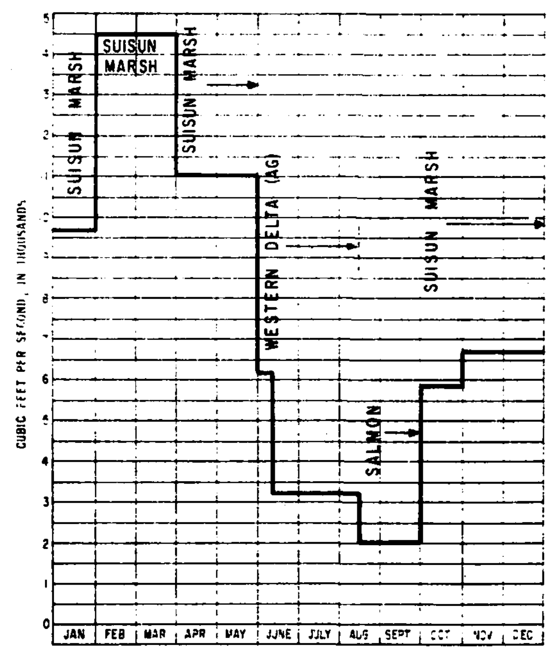
DELTA OUTFLOW RESULTING FROM ALTERNATIVE WATER QUALITY CONTROL PLANS

ALTERNATIVE PLAN III-A
(WET and NORMAL YEARS on PRECEEDING PAGE)

DRY YEAR



CRITICAL YEAR



* MONTHS WHEN STANDARDS ARE LIKELY TO BE MET BY UNCONTROLLED OUTFLOW

CONTROLLING STANDARDS

CONTROLLING STANDARDS DEPENDENT ON EXPORT RATES

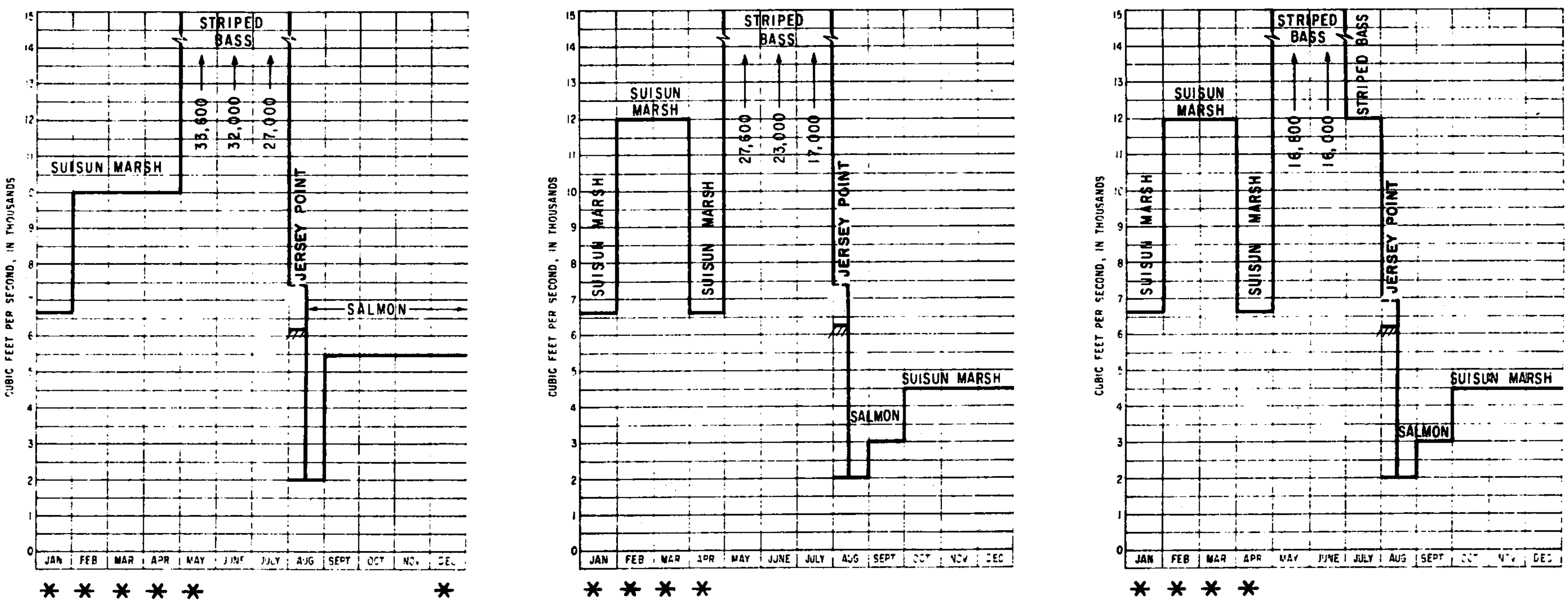
CARRIAGE WATER REQUIREMENT FOR MONTHS SHOWN WAS ESTIMATED BY USING DWR EXHIBIT II-8. A FULL OPERATIONS STUDY IS NEEDED TO DETERMINE CARRIAGE WATER REQUIREMENTS AND WATER QUALITY STANDARDS DEPENDENT ON PROJECT EXPORTS FOR THE REMAINING MONTHS.

FIGURE V-1(e)
SHEET 2

DELTA OUTFLOW RESULTING FROM ALTERNATIVE WATER QUALITY CONTROL PLANS

ALTERNATIVE PLAN III-B
(DRY and CRITICAL YEARS on FOLLOWING PAGE)

WET YEAR | ABOVE NORMAL YEAR | BELOW NORMAL YEAR



*MONTHS WHEN STANDARDS ARE LIKELY TO BE MET BY UNCONTROLLED OUTFLOW

CONTROLLING STANDARDS

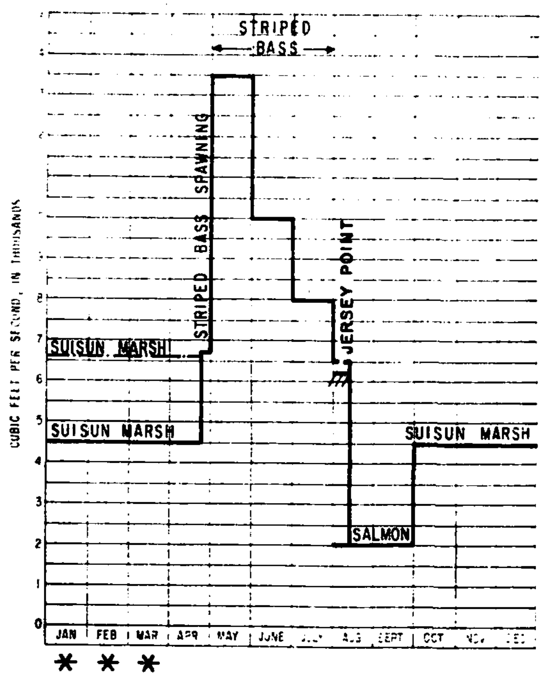
CONTROLLING STANDARDS DEPENDENT ON EXPORT RATES

CARRIAGE WATER REQUIREMENT FOR MONTHS SHOWN WAS ESTIMATED BY USING DWR EXHIBIT II-8. A FULL OPERATIONS STUDY IS NEEDED TO DETERMINE CARRIAGE WATER REQUIREMENTS AND WATER QUALITY STANDARDS DEPENDENT ON PROJECT EXPORTS FOR THE REMAINING MONTHS.

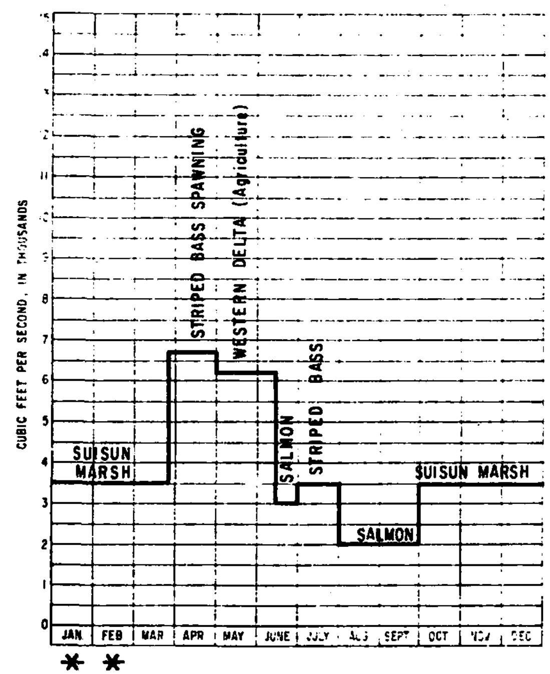
DELTA OUTFLOW RESULTING FROM ALTERNATIVE WATER QUALITY CONTROL PLANS

ALTERNATIVE PLAN III-B
(WET and NORMAL YEARS on PRECEEDING PAGE)

DRY YEAR



CRITICAL YEAR



CONTROLLING STANDARDS (W/O SUBSTANTIAL CARRYOVER STORAGE)

CONTROLLING STANDARDS (WITH SUBSTANTIAL CARRYOVER STORAGE)

CONTROLLING STANDARDS DEPENDENT ON EXPORT RATES

CARRIAGE WATER REQUIREMENT FOR MONTHS SHOWN WAS ESTIMATED BY USING DWR EXHIBIT II-8. A FULL OPERATIONS STUDY IS NEEDED TO DETERMINE CARRIAGE WATER REQUIREMENTS AND WATER QUALITY STANDARDS DEPENDENT ON PROJECT EXPORTS FOR THE REMAINING MONTHS.

CONTROLLING STANDARDS

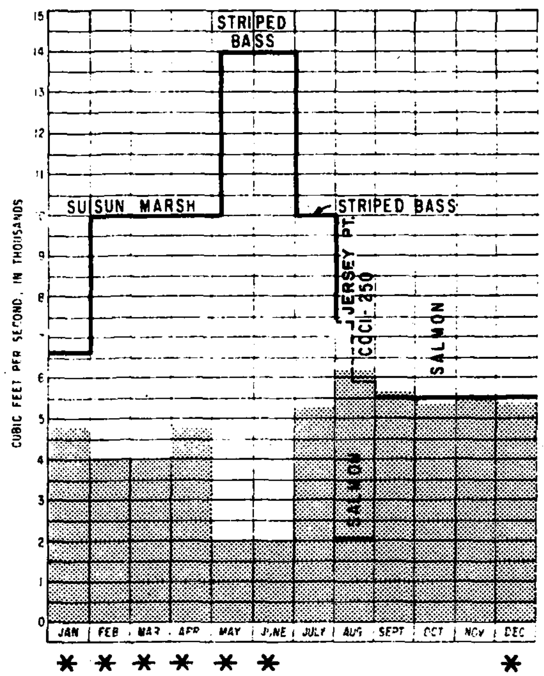
* MONTHS WHEN STANDARDS ARE LIKELY TO BE MET BY UNCONTROLLED OUTFLOW

FIGURE V-1(f)
SHEET 2

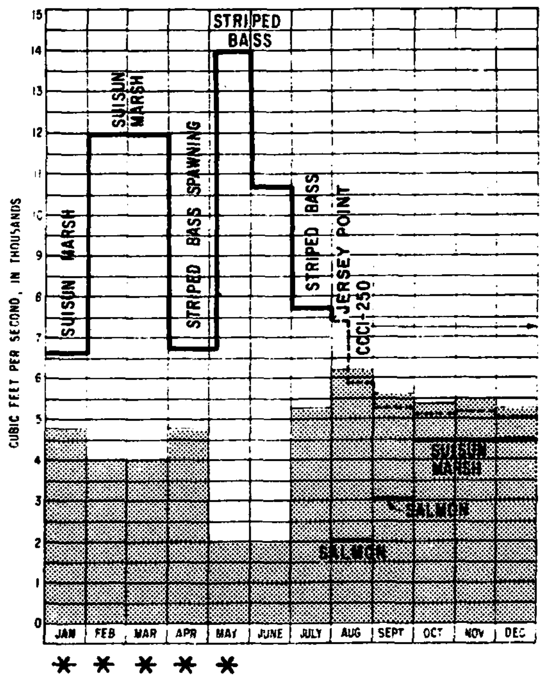
DELTA OUTFLOW RESULTING FROM ALTERNATIVE WATER QUALITY CONTROL PLANS

RECOMMENDED PLAN
ALTERNATIVE PLAN IV
(DRY and CRITICAL YEARS on FOLLOWING PAGE)

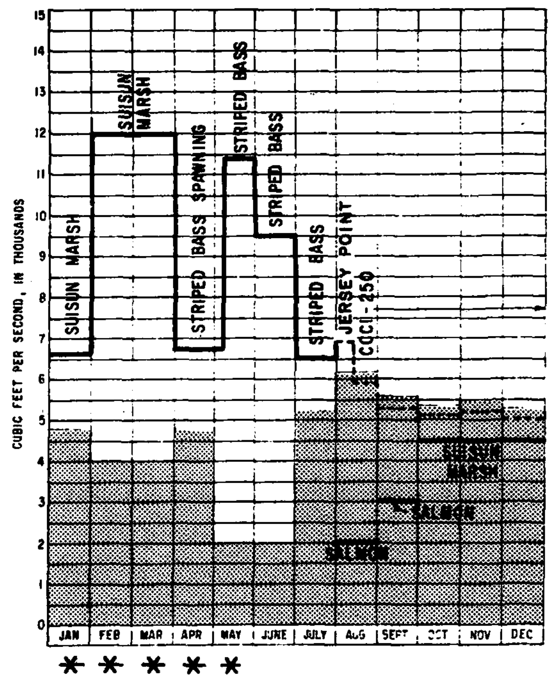
WET YEAR



ABOVE NORMAL YEAR



BELOW NORMAL YEAR

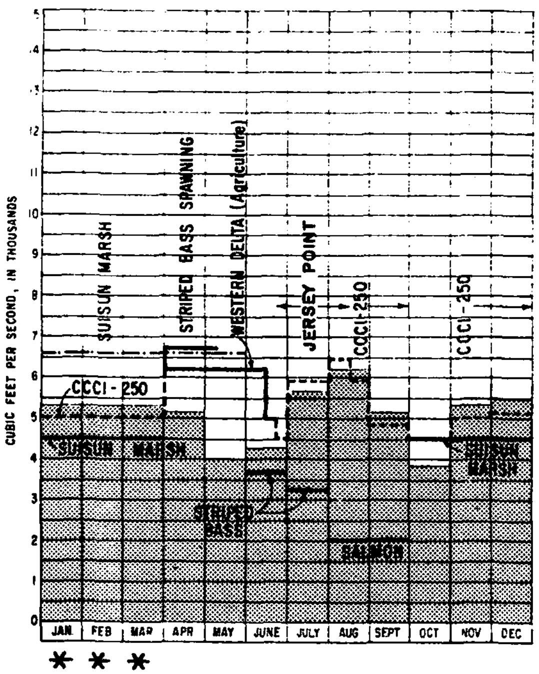


——— CONTROLLING STANDARDS
— — — — CONTROLLING STANDARDS DEPENDENT ON EXPORT RATES
▒▒▒ ESTIMATED CARRIAGE WATER REQUIREMENTS
* MONTHS WHEN STANDARDS ARE LIKELY TO BE MET BY UNCONTROLLED OUTFLOW

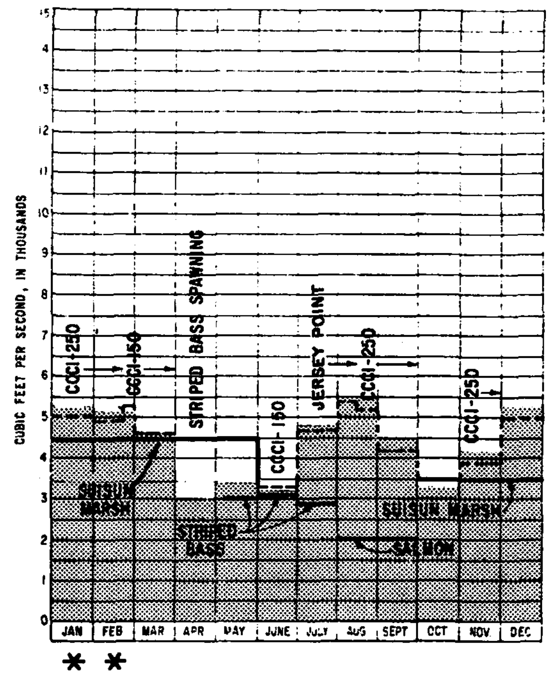
DELTA OUTFLOW RESULTING FROM ALTERNATIVE WATER QUALITY CONTROL PLANS

RECOMMENDED PLAN
ALTERNATIVE PLAN IV
(WET and NORMAL YEARS on PRECEEDING PAGE)

DRY YEAR



CRITICAL YEAR



CONTROLLING STANDARDS (W/O SUBSTANTIAL CARRYOVER STORAGE)
CONTROLLING STANDARDS (WITH SUBSTANTIAL CARRYOVER STORAGE)
CONTROLLING STANDARDS DEPENDENT ON EXPORT RATES
ESTIMATED CARRIAGE WATER REQUIREMENTS
*MONTHS WHEN STANDARDS ARE LIKELY TO BE MET BY UNCONTROLLED OUTFLOW

CONTROLLING STANDARDS
CONTROLLING STANDARDS DEPENDENT ON EXPORT RATES
ESTIMATED CARRIAGE WATER REQUIREMENTS
*MONTHS WHEN STANDARDS ARE LIKELY TO BE MET BY UNCONTROLLED OUTFLOW

FIGURE V-1(g)
SHEET 2

CHAPTER VI

DESCRIPTION OF PROPOSED BOARD ACTION

The water quality control plan for the Sacramento-San Joaquin Delta and Suisun Marsh has been prepared under the Board's water quality control authority and represents the culmination of thirty-two days of evidentiary hearing initiated on November 15, 1976, and concluded on October 7, 1977. Section 13170 of the Water Code provides that the Board may adopt water quality control plans for waters for which water quality standards are required by the Federal Water Pollution Control Act, as amended. Such plans when adopted supersede any regional water quality control plan (Basin Plan) for the same waters to the extent of any conflict.

The evidentiary record will be used also in formulating a water right decision to implement applicable provisions of the plan through revisions of terms and conditions in permits of the Department and Bureau. The jurisdiction reserved by the Board to revise or formulate additional terms and conditions in these permits covers three general areas: (1) salinity control, (2) protection of fish and wildlife, and (3) coordination of terms and conditions of the respective permits for the SWP and CVP.

The plan is designed to preserve Delta water quality and to protect beneficial uses of these supplies over the next ten years. The plan consists of three essential elements: (1) designation of beneficial uses to be protected, (2) establishment of water quality standards for reasonable protection of beneficial uses, and (3) establishment of a program of implementation needed for achieving these water quality standards.

The recommended water quality standards for the Sacramento-San Joaquin Delta and Suisun Marsh are shown in Table VI-1 at the end of this chapter. The table also contains operational controls to ensure the protection of beneficial uses at desired levels.

A. PROGRAM OF IMPLEMENTATION

The program of implementation (Chapter VII of the water quality control plan) contains not only the control actions necessary for implementation of the water quality control plan, but offers policy assistance to the project operators for use in their long-range planning activities. Included also is a monitoring program to assess the effectiveness of the plan in protecting beneficial uses.

Control Actions

Implementation of the program and achievement of the water quality standards relies primarily upon the Board's control authorities. However, successful implementation is also dependent on actions by other state, federal and local agencies. Only a brief discussion of the major actions is set forth below (for a more detailed discussion see Chapter VII of the plan).

State Water Resources Control Board. At the time it adopts the water quality control plan, the Board will adopt a corresponding water right decision amending terms and conditions for permits of the SWP and CVP. However, a series of other actions by the Board will be required in order to implement the plan more fully and resolve all the concerns which cannot now be fully addressed for various reasons.

Department and Bureau. To the full extent of their operational capabilities, the Department and Bureau are responsible for meeting the water quality standards of the water quality control plan. These water quality standards will be incorporated into their respective water right permits through the corresponding water right decision.

Protection of the Suisun Marsh is a mitigation responsibility of both the SWP and CVP. For this reason, the Department and Bureau will be required by conditions in their water right permits to:

1. Develop a satisfactory work plan by July 1, 1979 to mitigate fully the adverse impacts of project operations on Suisun Marsh.
2. Complete initial components of such Suisun Marsh plan by January 1, 1980.
3. Satisfy specific standards for full Marsh protection by October 1, 1984.

The most practical solution for the long-term protection of southern Delta agriculture is through the construction of physical facilities to provide adequate circulation, and provision of supplemental supplies. If necessary physical facilities are constructed, the circulation flows needed may be only a moderate increase above those already committed from New Melones Reservoir.

Current negotiations between the project operators and the South Delta Water Agency concerning the construction of circulation facilities and provision of supplemental supplies in the southern Delta appear to be directed toward the most practical solution for long-term protection of southern Delta agriculture. These negotiations should be concluded as soon as practicable, at least by January 1980. If an agreement is not executed by January 1, 1980, the Board will examine in detail southern Delta water rights, determine the causes and sources of any encroachment, and take appropriate enforcement action.

Monitoring Program

The effectiveness of and compliance with a water quality control plan cannot be assessed without a carefully designed monitoring program. The monitoring program set forth in Chapter VII of the plan provides for collection of the data necessary to measure compliance with the water quality standards, and presents the special studies that are needed to address the major concerns that cannot be resolved now due to lack of data. The monitoring program will be implemented cooperatively by the Department and Bureau through conditions in their respective water right permits.

Changing Conditions

This element of the implementation program is intended to provide guidance to project operators for the longer term, beyond the effective period of this plan. Changing conditions have been divided into two basic categories: those having a potential significant impact on future project facilities and those which could have an impact on current project operations.

Impact on Future Facilities. Water development agencies in the state are currently planning substantial new facilities. As part of this planning process, these agencies must make sound determinations of the firm yield expected from such proposed facilities. The yield of future Department and Bureau facilities in the Sacramento River Basin will depend largely on the amount of unregulated flow available for appropriation from this source.

The factors listed below may greatly affect the amount of unregulated flow available for future appropriation. In this section the Board provides general guidance on these factors in order to assist the Department and Bureau in planning their activities for conditions substantially beyond the effective period of the plan. This general guidance is directed toward concerns regarding provision of unregulated Delta outflow for San Francisco Bay ecological needs and adequate winter-spring outflows for upper estuary productivity, maintenance of fishery resources at historical levels, and the restoration of natural net downstream flows in all Delta channels (see Chapter VII of the plan for a full discussion of this subject).

o San Francisco Bay

1. Operation studies for planning of future facilities should allow for surges in Delta outflow. Surges are incremental increases in flow occurring during a short period of time. These higher flow rates need not be maintained for any specific period of time. Surges should be at least 10,000 cfs within a five to ten day interval on an average of four times per year for the historical hydrologic period from 1939 to 1976, based on average historical conditions. This means that neither additions to upstream storage facilities nor increased exports of unregulated Delta inflow should interfere with these short term bursts of increased Delta outflow.

2. Surges (incremental increases) in Delta outflow of at least 10,000 cfs should occur within a five to ten day interval at least once each year over the yield-determining seven year dry cycle (1928-1934).

o Upper Estuary Productivity. Until the effect of extended periods of low-flow conditions prior to June on the flow-abundance relationships for Neomysis and young striped bass is more fully understood, the following general guidance for long-term water development planning has been established:

> The 14-day mean electrical conductivity values at Pittsburg during January, February and March should not exceed those experienced for the same period in 1976, throughout the 50-year hydrologic planning period (1922-1971).

o Maintenance of Fishery Resources at Historical Levels. Based on existing conditions the Board has determined that fishery resources in the Bay-Delta estuary should be maintained at levels that at least approach those levels that would have existed had the CVP and SWP not been built. Higher levels of fishery resources are desirable, but cannot be attained in the public interest with current project facilities. However, any future Delta transfer facility or upstream project facilities should:

(1) ensure the maintenance of fishery resources in the estuary on the average at historical levels (1922-1967) (Conditions upstream of the estuary may limit the abundance of some species; this policy deals only with those factors in the Bay-Delta estuary that limit species abundance), and

(2) include a fish screen system capable of salvaging 95 percent of the fish more than 1¼ inches long.

o Net Downstream Flows in Delta Channels. Project caused net flow reversals in Delta channels are detrimental to the fishery that live in or pass through the Delta. Any future Delta water transfer facilities should:

(1) restore net downstream flows at all times in all Delta channels, and

(2) provide water in the San Joaquin River upstream of the Mokelumne River, in Old River and in Middle River to be primarily of San Joaquin River origin from September 1 through November 30.

Impact on Current Project Operations. There are also other factors which could have impacts (both favorable and adverse) on current project operations. These factors can be addressed now only in a general way because of a lack of adequate technical information and the uncertainty of future actions by other agencies.

Current knowledge related to salinity requirements in subirrigated soils must be expanded. The areas of special concern involve the relationships between the applied water and soil water salinities, salinity tolerances at different stages of plant development, and water quality needs outside the irrigation season. Additional information and refinement of technical approaches will be essential in these areas in the future review of the agricultural standards contained in the Delta Plan. The Board and other state and local agencies will be participating with the U. C. Cooperative Extension in research programs to yield a fuller understanding in these areas of concern.

Also overland supplies to the western Delta are currently being considered by the project operators and Delta interests as a possible method to conserve water and fully protect western Delta agriculture. If such supplies are provided, it is possible that the Emmaton and Jersey Point water quality standards for agriculture could be modified. However, before any decision is made, the Board would have to be assured that other beneficial uses protected by the above standards would not be affected adversely.

B. REVIEW OF BOARD ACTION

The purpose of a water quality control plan is to provide positive and firm direction for water quality control. As additional information is gathered on the Delta, the Board will review water quality standards to ensure that beneficial uses of Delta supplies are fully protected. Section 303(c)(1) of the Federal Water Pollution Control Act (PL 92-500) requires periodic review (at least once every three years) of water quality standards established in water quality control plans. Periodic review is important in the Delta in view of the complexity of the estuary and the continuing accumulation of pertinent data.

Table VI-1
WATER QUALITY STANDARDS
FOR THE SACRAMENTO–SAN JOAQUIN DELTA AND SUISUN MARSH[1]

BENEFICIAL USE PROTECTED and LOCATION	PARAMETER	DESCRIPTION	YEAR TYPE[2]	VALUES	
MUNICIPAL and INDUSTRIAL					
Contra Costa Canal Intake at Pumping Plant No. 1	Chloride	Maximum Mean Daily Cl^- in mg/l	All	250	
Contra Costa Canal Intake at Pumping Plant No. 1 or Antioch Water Works Intake on San Joaquin River	Chloride	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 Year shown in parenthesis)		Number of Days Each Calendar Yea Less than 150 mg/l Chloride	
			Wet	240 (66%)	
			Ab. Normal	190 (52%)	
			Bl. Normal	175 (48%)	
			Dry	165 (45%)	
			Critical	155 (42%)	
City of Vallejo Intake at Cache Slough	Chloride	Maximum Mean Daily Cl^- in mg/l	All	250	
Clifton Court Forebay Intake at West Canal	Chloride	Maximum Mean Daily Cl^- in mg/l	All	250	
Delta Mendota Canal at Tracy Pumping Plant	Chloride	Maximum Mean Daily Cl^- in mg/l	All	250	
AGRICULTURE				0.45 EC April 1 to Date Shown	EC from Date Shown[3] to Aug. 15
WESTERN DELTA					
Emmaton on the Sacramento River	Electrical Conductivity	Maximum 14-day Running Average of Mean Daily EC in mmhos	Wet	Aug. 15	––
			Ab. Normal	July 1	0.63
			Bl. Normal	June 20	1.14
			Dry	June 15	1.67
			Critical	––	2.78
Jersey Point on the San Joaquin River	Electrical Conductivity	Maximum 14-day Running Average of Mean Daily EC in mmhos	Wet	Aug. 15	––
			Ab. Normal	Aug. 15	––
			Bl. Normal	July 20	0.74
			Dry	June 15	1.35
			Critical	––	2.20
INTERIOR DELTA					
Terminous on the Mokelumne River	Electrical Conductivity	Maximum 14-day Running Average of Mean Daily EC in mmhos	Wet	Aug. 15	––
			Ab. Normal	Aug. 15	––
			Bl. Normal	Aug. 15	––
			Dry	Aug. 15	––
			Critical	––	0.54
San Andreas Landing on the San Joaquin River	Electrical Conductivity	Maximum 14–day Running Average of Mean Daily EC in mmhos	Wet	Aug. 15	––
			Ab. Normal	Aug. 15	––
			Bl. Normal	Aug. 15	––
			Dry	June 25	0.58
			Critical	––	0.87
SOUTHERN DELTA					
Vernalis on the San Joaquin River	Total Dissolved Solids	Maximum 30-day Running Average of Mean Daily TDS in mg/l	All (after New Melones Reservoir becomes operational and until the standards below become effective)	500	
				Apr. 1 to Aug. 31	Sept. 1 to March 31
Tracy Road Bridge on Old River Old River near Middle River Brandt Bridge on San Joaquin River Vernalis on San Joaquin River	Electrical Conductivity	Maximum 30-day Running Average of Mean Daily EC in mmhos	All (to become effective only upon the completion of suitable circulation and water supply facilities)[4]	0.7	1.0

Table VI-1
WATER QUALITY STANDARDS
FOR THE SACRAMENTO-SAN JOAQUIN DELTA AND SUISUN MARSH[1]

BENEFICIAL USE PROTECTED and LOCATION	PARAMETER	DESCRIPTION	YEAR TYPE[2]	VALUES		
FISH AND WILDLIFE						
• *STRIPED BASS SPAWNING*						
Prisoners Point on the San Joaquin River	*Electrical Conductivity*	*Average of mean daily EC for the period not to exceed*	*All*	*April 1 to May 5* 0.550 mmhos		
Chipps Island	*Delta Outflow Index in cfs*	*Average of the daily Delta outflow index for the period, not less than*	*All*	*April 1 to April 14* 6700 cfs		
Antioch Waterworks Intake on the San Joaquin River	*Electrical Conductivity*	*Average of mean daily EC for the period, not more than*	*All*	*April 15 to May 5* 1.5 mmhos		
Antioch Waterworks Intake	*Electrical Conductivity (Relaxation Provision – replaces the above Antioch and Chipps Island Standard whenever the projects impose deficiencies in firm supplies [5]*	*Average of mean daily EC for the period, not more than the values corresponding to the deficiencies taken (linear interpolation to be used to determine values between those shown)*	*All – whenever the projects impose deficiencies in firm supplies [5]*	*Total Annual Imposed Deficiency MAF*	*April 1 to May 5 EC in mmhos*	
				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	
• *STRIPED BASS SURVIVAL*						
Chipps Island	*Delta Outflow Index in cfs*	*Average of the daily Delta outflow index for each period shown not less than*		*May 6–31*	*June*	*July*
			Wet	14,000	14,000	10,000
			Ab. Normal	14,000	10,700	7,700
			Bl. Normal	11,400	9,500	6,500
			Subnormal Snowmelt	6,500	5,400	3,600
			Dry [6]	4,300	3,600	3,200
			Dry [7] or Critical	3,300	3,100	2,900
• *SALMON MIGRATIONS*						
Rio Vista on the Sacramento River	*Computed net stream flow in cfs*	*Minimum 30-day running average of mean daily net flow*		*Jan.*	*Feb. 1– Mar. 15*	*Mar. 16– June 30*
			Wet	2,500	3,000	5,000
			Ab. Normal	2,500	2,000	3,000
			Bl. Normal	2,500	2,000	3,000
			Dry or Critical	1,500	1,000	2,000
				July	*Aug.*	*Sept. 1– Dec. 31*
			Wet	3,000	1,000	5,000
			Ab. Normal	2,000	1,000	2,500
			Bl. Normal	2,000	1,000	2,500
			Dry or Critical	1,000	1,000	1,500
• *SUISUN MARSH*				*Jan.–May*	*Oct.–Dec.*	
Chipps Island at O&A Ferry Landing	*Electrical Conductivity*	*Maximum 28-day running average of mean daily EC*	*Wet*	12.5 mmhos	12.5 mmhos	
			Ab. Normal	12.5 mmhos	12.5 mmhos	
			Bl. Normal	12.5 mmhos	12.5 mmhos	
			Dry or Critical	12.5 mmhos	15.6 mmhos	
		(The 15.6 mmhos EC Standard applies only when project water users are taking deficiencies in scheduled water supplies [8] otherwise the 12.5 mmhos EC remains in effect.)				
Chipps Island	*Delta Outflow Index in cfs*	*Average of the daily Delta outflow index for each month, not less than values shown*	*Wet*	*February–May* 10,000 cfs		
			Subnormal Snowmelt	*February–April* 10,000 cfs		
		Minimum daily Delta outflow index for 60 consecutive days in the period	*Ab. Norm. and Bl. Norm.*	*January–April* 12,000 cfs		

Table VI-1
WATER QUALITY STANDARDS
FOR THE SACRAMENTO-SAN JOAQUIN DELTA AND SUISUN MARSH[1]

BENEFICIAL USE PROTECTED and LOCATION	PARAMETER	DESCRIPTION	YEAR TYPE[2]	VALUES
FISH AND WILDLIFE				
• SUISUN MARSH				
Chipps Island (continued)	Delta Outflow Index in cfs	Average of the daily Delta outflow index for each month, not less than values shown	All (if greater flow not required by above standard)—whenever storage is at or above the minimum level in the flood control reservation envelope at two out of three of the following: Shasta Reservoir, Oroville Reservoir, and CVP storage on the American River	Jan.-May: 6,600 cfs
Collinsville on Sacramento River (C-2) Miens Landing on Montezuma Slough (S-64) Montezuma Slough at Cutoff Slough (S-48) Montezuma Slough near mouth Suisun Slough near Volanti Slough (S-42) Suisun Slough near mouth (S-31) Goodyear Slough south of Pierce Harbor (S-35) Cordelia Slough above S. P. R.R. (S-32)	Electrical Conductivity	The monthly average of both daily high tide values not to exceed the values shown (or demonstrate that equivalent or better protection will be provided at the location)	All - To become effective Oct. 1, 1984	Month / EC in mmhos: Oct. 19.0 Nov. 15.5 Dec. 15.5 Jan. 12.5 Feb. 8.0 Mar. 8.0 Apr. 11.0 May 11.0
• OPERATIONAL CONSTRAINTS				
Minimize diversion of young striped bass from the Delta	Diversions in cfs	The mean monthly diversions from the Delta by the State Water Project (Department) not to exceed the values shown.	All	May 3,000; June 3,000; July 4,600
		The mean monthly diversions from the Delta by the Central Valley Project (Bureau), not to exceed the values shown	All	May 3,000; June 3,000
Minimize diversion of young striped bass into Central Delta		Closure of Delta cross channel gates for up to 20 days but no more than two out of four consecutive days at the discretion of the Department of Fish and Game upon 12 hours notice	All - whenever the daily Delta outflow index is greater than 12,000 cfs	April 16-May 31
Minimize cross Delta movement of Salmon		Closure of Delta Cross Channel gates (whenever the daily Delta outflow index is greater than 12,000 cfs)	All	Jan. 1-April 15

Table VI-1
WATER QUALITY STANDARDS FOR THE SACRAMENTO-SAN JOAQUIN DELTA AND SUISUN MARSH [1/]

FISH PROTECTIVE FACILITIES

Maintain appropriate records of the numbers, sizes, kinds of fish salvaged and of water export rates and fish facility operations.

STATE FISH PROTECTIVE FACILITY

The facility is to be operated to meet the following standards to the extent that they are compatible with water export rates:

(a) King Salmon – from November through May 14, standards shall be as follows:
- (1) Approach Velocity – 3.0 to 3.5 feet per second
- (2) Bypass Ratio – maintain 1.2:1.0 to 1.6:1.0 ratios in both primary and secondary channels
- (3) Primary Bay – not critical but use Bay B as first choice
- (4) Screened Water System – the velocity of water exiting from the screened water system is not to exceed the secondary channel approach velocity. The system may be turned off at the discretion of the operators.

(b) Striped Bass and White Catfish – from May 15 through October, standards shall be as follows:
- (1) Approach Velocity – in both the primary and secondary channels, maintain a velocity as close to 1.0 feet per second as is possible
- (2) Bypass Ratio
  - (i) When only Bay A (with center wall) is in operation maintain a 1.2:1.0 ratio
  - (ii) When both primary bays are in operation and the approach velocity is less than 2.5 feet per second, the bypass ratio should be 1.5:1.0
  - (iii) When only Bay B is operating the bypass ratio should be 1.2:1.0
  - (iv) Secondary channel bypass ratio should be 1.2:1.0 for all approach velocities.
- (3) Primary Channel – use Bay A (with center wall) in preference to Bay B
- (4) Screened Water Ratio – if the use of screened water is necessary, the velocity of water exiting the screened water system is not to exceed the secondary channel approach velocity
- (5) Clifton Court Forebay Water Level – maintain at the highest practical level.

TRACY FISH PROTECTIVE FACILITY

The secondary system is to be operated to meet the following standards, to the extent that they are compatible with water export rates:

(a) The secondary velocity should be maintained at 3.0 to 3.5 feet per second whenever possible from February through May while salmon are present

(b) To the extent possible, the secondary velocity should not exceed 2.5 feet per second and preferably 1.5 feet per second between June 1 and August 31, to increase the efficiency for striped bass, catfish, shad, and other fish. Secondary velocities should be reduced even at the expense of bypass ratios in the primary, but the ratio should not be reduced below 1:1.0

(c) The screened water discharge should be kept at the lowest possible level consistent with its purpose of minimizing debris in the holding tanks

(d) The bypass ratio in the secondary should be operated to prevent excessive velocities in the holding tanks, but in no case should the bypass velocity be less than the secondary approach velocity.

FOOTNOTES

1/ Except for flow, all values are for surface zone measurements. Except for flow, all mean daily values are based on at least hourly measurements. All dates are inclusive.

2/ The year type shall be determined as described in FIGURE III-2. The type determined for any year shall remain in effect until the February forecast for Bulletin 120 or until an earlier estimate becomes available.

3/ When no date is shown in the adjacent column, EC limit in this column begins on April 1.

4/ If contracts to ensure such facilities and water supplies are not executed by January 1, 1980, the Board will take appropriate enforcement actions to prevent encroachment on riparian rights in the southern Delta.

5/ For the purpose of this provision firm supplies of the Bureau shall be any water the Bureau is legally obligated to deliver under any CVP contract of 10 years or more duration, excluding the Friant Division of the CVP, subject only to dry and critical year deficiencies. Firm supplies of the Department shall be any water the Department would have delivered under Table A entitlements of water supply contracts and under prior right settlements had deficiencies not been imposed in that dry or critical year.

6/ Dry year following a wet, above normal or below normal year.

7/ Dry year following a dry or critical year.

8/ Scheduled water supplies shall be firm supplies for USBR and DWR plus additional water ordered from DWR by a contractor the previous September, and which does not exceed the ultimate annual entitlement for said contractor.

NOTE: EC values are mmhos/cm at 25°C.

CHAPTER VII

ENVIRONMENTAL ASSESSMENT OF PROPOSED BOARD ACTION

The California Environmental Quality Act requires public agencies to identify systematically the significant effects of proposed actions and the feasible alternatives or mitigation measures which will avoid or substantially lessen such significant effects. Significant effects may be defined as substantial, or potentially substantial, adverse changes in the environment (Section 21068, Public Resources Code). Potentially significant impacts are listed in Appendix G of the State EIR Guidelines (Title 14, California Administrative Code). The factors considered in mandatory findings of significance are set forth in Section 15082 of the Guidelines. In accordance with the above guidance, the Board has made the following assessment of potential environmental impacts of the proposed action.

Current salinity controls (Basin 5B and 2 Plans and Decision D 1275) and operations of the CVP and SWP have brought about certain changes in the pattern of Delta outflow and salinity in the Sacramento-San Joaquin Delta and Suisun Marsh. These conditions comprise the "no action" alternative. The current outflow and salinity patterns reflect the needs of municipal, industrial and agricultural water users in the Delta. In addition, these conditions are intended to provide protection to key fish and wildlife species in the Delta and Suisun Marsh.

Since the adoption of the basin plans considerable information regarding the Delta and Suisun Marsh has been developed. Many concerns which were unanswered in the Basin Plans can now be addressed. However, as indicated in the draft plan, the proposed Board action is not intended as the final solution for the Delta and Suisun Marsh.

The proposed action would bring about changes in current patterns of outflow and salinity in the Delta and Marsh. In view of this, an attempt has been made to identify all significant environmental impacts on major beneficial uses in the Delta and Marsh. The final step in the environmental assessment is a comparison of the impacts of the "no action" alternative and the proposed Board action (Alternative IV).

The overall protection under the proposed action would be greater than the "no action" alternative while requiring less freshwater outflow. This reduction in Delta outflow is made possible by a more efficient use of Delta water supplies and a better understanding of beneficial use needs in the Delta. However, the proposed action does have some potential adverse impacts. The purpose of this chapter is to discuss these impacts and the measures taken to mitigate them.

It should be kept in mind that "no action" under CEQA is not intended to limit the consideration of factors to current conditions, but rather also includes conditions relatively certain to occur without the proposed action. In this context, during 1977 it was necessary for the Board to relax the basin plan standards to conserve limited upstream supplies and to mitigate the impact of the 1976-77 drought on beneficial uses of Delta supplies throughout the tate. This emergency action by the Board was supported by essentially all affected agencies and parties.

In view of substantial improvements in the water supply situation and Delta recovery from salinity intrusion, the Board repealed this emergency action on February 2, 1978. Even though emergency actions have not been incorporated in the definition of "no action", it is highly probable, if conditions similar to the 1976-77 drought occur in the future, that such emergency actions would be necessary under the "no action" alternative to avoid depleting upstream supplies and losing complete control of Delta salinity.

The proposed action deals with a limited resource and involves essentially the allocation of water shortages. The proposed action provides a reasonable level of protection to all uses of Delta supplies, recognizing the severe consequences if upstream supplies are exhausted.

A. DISCUSSION OF POTENTIALLY SIGNIFICANT IMPACTS

Municipal and Industrial - Contra Costa Canal Intake

Under the proposed action municipal and industrial water users of Contra Costa Canal supplies would receive fewer days of 150 mg/l chloride water in all years except wet years, than under the "no action" alternative. The reduction in the number of days of 150 mg/l chloride or better water could range from about 10 days in above normal years to 80 days in a critical year. The economic impact of this reduction in the availability of suitable water quality cannot be quantified, but is a potentially significant impact attributable to the proposed action. Other impacts related to critical year conditions are also potentially significant. These critical year impacts could increase costs of water treatment for industrial process water and other uses, reduce the reclamation potential of wastewater, and increase the potential for some crop decrement to salt-sensitive tree crops and ornamental shrubs that are sprinkler irrigated.

The proposed action (Alternative IV) would ensure municipal and industrial users in the Antioch area of a substitute supply from the Contra Costa Canal comparable to their entitlement offshore at Antioch.

Rights of users of Contra Costa Canal water, other than those who have rights to divert from the San Joaquin River, are contractual. These contracts with the Bureau do not specify any limit to salinity of water which may be delivered. However, in view of the water quality levels required under the proposed action for the Contra Costa Canal, these water users would be assured a water quality better than that for which they have contracted.

As previously indicated, during 1977 emergency actions by the Board were required to protect the Delta during the unprecedented 1976-77 drought. The salinity conditions experienced by Contra Costa Canal water users during the 1977 critical year were considerably worse than those provided for critical years under the proposed action. Under the "no action" alternative, it is highly probable that in future critical years, relaxation of Delta water quality standards would be required to avoid depleting upstream reservoirs to dangerous levels and losing the capability to provide any protection at all to the Delta. Such periodic relaxations could create conditions worse than those provided for in the proposed action for critical years.

During the entire 1977 calendar year the water quality provided Contra Costa Canal water users was never as good as 150 mg/l chloride and was as high as 300 mg/l chloride. While none of the industrial customers in the Antioch area were forced to close due to adverse water quality conditions, financial impacts were likely sustained by these industries, and other users.

Agriculture

The proposed action would result in patterns of Delta outflow and salinity which are approximately equal to or better than the water quality available under the "no action" alternative. No significant environmental impacts are expected to occur to agriculture in the Delta other than in the western Delta as discussed below.

Western Delta. The composite of standards under the proposed action would provide better water quality conditions in dry, below normal, above normal and wet years than those of the "no action" alternative. Only in critical years would conditions under the proposed action be worse than those of the "no action" alternative. The economic effect of increased salinity during critical years is not quantifiable with available information. However, this increase in salinity would constitute a potentially significant impact.

Individually, the agricultural standards in the proposed action offer greater protection than those of the "no action" alternative during wet, above normal, below normal and dry years. In critical years the same level of protection is provided by the agricultural standards of both the proposed action and the "no action" alternative.

As discussed above, it is highly probable under the "no action" alternative that relaxation of Delta water quality standards would be required during critical years. These periodic relaxations could create conditions worse than those of the proposed action. For instance, during the 1977 irrigation season western Delta agriculture experienced considerably worse water quality than that of the proposed action for critical years. Based on available information, it does not appear that these high salinities have resulted in any severe impacts to agriculture in the western Delta.

Fish and Wildlife

Striped Bass Spawning. The proposed action would require maintenance of suitable conditions for striped bass spawning in all but extremely water short years. During water short years when deficiencies are imposed by the CVP and SWP on the firm supplies of project water users, increases in Delta salinity are allowed which could reduce the striped bass spawning area in the lower San Joaquin River. The impact on striped bass abundance of this short-term reduction in spawning areas cannot be determined with available information. The potential of a significant environmental impact to striped bass spawning from the proposed action is considered insignificant. In any event, studies currently underway by Fish and Game should determine if these impacts of spawning area reductions are significant. The Board will consider Fish and Game's findings and recommendations from these studies in its periodic review of standards.

Productivity of Aquatic Life.

NOTE: Based on modifications made to the plan the potentially significant adverse impacts of the proposed action on productivity of aquatic life has been avoided.

Suisun Marsh.

NOTE: Revisions have been made to the plan to ensure interim protection to Suisun Marsh comparable to the "no action" alternative. These revisions will ensure that potentially significant adverse impacts are avoided.

B. MITIGATION MEASURES TO REDUCE OR AVOID SIGNIFICANT IMPACTS

As indicated above, changes in salinity of Delta waterways allowed by the proposed action could have potentially significant impacts on the following: (1) municipal and industrial users of the Contra Costa Canal, and (2) agriculture in the western Delta.

The level of protection provided these municipal, industrial and agriculture uses in the proposed action is consistent with the vested water rights of such users. No attempt has been made to enhance the water quality entitlements of those users. In accordance with the Delta Protection Act, if these water users desire additional benefits in excess of their vested rights, such benefits can be obtained from the project operators through contracts providing for payment for the benefits received.

C. THE RELATIONSHIP BETWEEN LOCAL SHORT-TERM USES OF MAN'S ENVIRONMENT AND THE MAINTENANCE AND ENHANCEMENT OF LONG-TERM PRODUCTIVITY

Fish and Wildlife - Suisun Marsh

The proposed action would provide long-term protection of Suisun Marsh through mitigation measures which the Department and Bureau would be required to implement. In the near-term, prior to full implementation of the mitigation facilities, waterfowl food production could be reduced during dry and critical years unless the required interim measures of the recommended plan are implemented. If the Board attempted to require full protection of the Marsh solely with outflow during dry and critical years, there is a risk of complete exhaustion of upstream water supplies and disastrous damage to the Delta and Suisun Marsh. However, the recommended plan would not result in any long-term detriment to the Marsh or to waterfowl populations feeding in the Marsh. If a dry or critical year were to occur during the interim period resulting in shortage of food in the Marsh, artificial feeding could be conducted by government and private agencies to avoid any significant impact on the waterfowl.

Also, the proposed action is a necessary step toward the improvement of Marsh management and would insure a continued commitment by private landowners to maintain the land for waterfowl purposes. The proposed action is consistent with the intent of the Suisun Marsh Protection Act and would assist in accomplishing the purposes of the Act.

Fish and Wildlife - Striped Bass Spawning

As indicated by Fish and Game, the fishery resources possess natural reproduction mechanisms which insure their recovery from drought and low flow conditions, much like other beneficial uses. Recognizing this rebound capability, the Board believes that some reduction in striped bass spawning is reasonable during periods of extreme water shortage. However, such reduction must be commensurate with deficiencies imposed on firm supplies to SWP and CVP water users. Fish and Game is continuing to assess the impact of spawning area reduction which occurred in 1977. If the actual impacts sustained by the fishery are more severe than anticipated, the Board will make the necessary revisions to the fishery standards to ensure the needed protection.

San Francisco Bay

In making allocations of the remaining unregulated Delta outflows, consideration must be given to the outflow needs in San Francisco Bay. However, there is not now enough information available to quantify the beneficial effects or magnitude of unregulated flows needed. In view of this, the Board has not proposed any specific outflow standards for San Francisco Bay. Since no additional project facilities are expected to be completed for at least ten years, current levels of unregulated Delta outflow should not be appreeiably reduced during the effective period of the proposed action. Thus, the Board's decision to wait until the needed information is gathered appears to be most reasonable. In the meantime, however, the Board has provided general policy guidance in the recommended plan to water development agencies to consider certain outflow needs of the Bay in evaluating possible future water development facilities.

D. GROWTH INDUCING IMPACT

The proposed action will not remove obstacles to population growth nor foster economic growth in the Delta. The water quality standards set forth in the recommended plan are designed to protect municipal, industrial and agricultural uses of Delta and Suisun Marsh waters from adverse levels of salinity.

Water exported from the Delta is used in the San Joaquin Valley to support a productive agricultural economy and in Southern California for municipal and industrial uses. These export supplies are provided through long-term water supply contracts with the SWP and CVP. For some water supply contractors, project water is the only feasible supply. Also, economic growth in most areas served by the SWP and CVP is dependent on obtaining project water deliveries in accordance with specific build-up schedules.

The water supplies needed to satisfy these build-up schedules far exceeds the current exportable yield capabilities of the SWP and CVP. Development of the additional yield to satisfy current build-up schedules could be accomplished through the construction of physical works and water management schemes. The proposed action would have less impact on project yield (as compared to "no action" alternative) and, thus, influence the choice and/or sequence of yield increasing actions and facilities by the SWP and CVP. However, the proposed action would have no effect on the commitments by SWP and CVP to meet those demands. Thus, within the scope of the Board's authority the proposed action will not have a significant growth inducing effect.

E. <u>ENERGY RELATED IMPACTS</u>

No adverse impacts on energy conservation are anticipated with the proposed action. In fact, there is an indication that the proposed action may be beneficial with respect to energy conservation as compared to the "no action" alternative (IB). However, no attempt has been made to quantify the benefits.

The water quality standards set forth in the recommended plan reflect a closer fit to hydrologic conditionsand available water supplies than the "no action" alternative. These hydrologically tailored standards allow more water to be conserved by the projects in upstream reservoirs during critical periods when hydropower resources are most affected. Hydroelectric power is the most efficient means of generating peak power in California. The more efficient use of hydroelectric energy made possible by the proposed action should conserve oil and gas supplies which would otherwise be expended to generage additional peak power.

REFERENCES

Baldwin, Frank B. III. 1969. Legal Control of Water Pollution. U.C.D. Law Review, Volume I.

Banner, A.H. 1954. New Records of Mysedaceo and Euphauseacia from the Northeastern Pacific and Adjacent Areas. Pacific Science 8. pp. 128-131

BCDC Staff, 1976. Suisun Marsh Environment, prepared for the San Francisco Bay Conservation and Development Commission.

California Department of Fish and Game. 1968. Fish and Wildlife Resources of San Francisco Bay and Delta; Description, Environmental Requirements, Problems, Opportunities and the Future, Task VII-1B, prepared for the San Francisco Bay-Delta Water Quality Control Program.

California Department of Fish and Game, California Department of Water Resources, United States Fish and Wildlife Service, and the United States Bureau of Reclamation. 1975. Fourth Annual Report (1974), Interagency Ecological Study Program for the Sacramento-San Joaquin Estuary.

California Department of Water Resources. 1967. Delta and Suisun Bay Water Quality Investigation, Bulletin No. 123.

California Department of Water Resources. 1974a. California State Water Project: History, Planning, and Early Progress. Bulletin 200, Volume I.

California Department of Water Resources. 1974b. Draft Environmental Impact Report, Peripheral Canal Project.

California Region Framework Study Committee, for Pacific Southwest Inter-Agency Committee, Water Resources Council. 1971. Comprehensive Framework Study, California Region, Appendix V, Water Resources.

California Regional Water Quality Control Board, Central Valley Region. 1975. Water Quality Control Plan Report: Sacramento River Basin (5A); Sacramento-San Joaquin Delta Basin (5B); and San Joaquin River Basin (5C).

Chadwick, H.K. 1972. Phytoplankton and Their Environmental Requirements. In: Ecological Studies of the Sacramento-San Joaquin Estuary, Delta Fish and Wildlife Study Report No. 8, California Department of Fish and Game. pp. 20-25.

CH_2M Hill. 1976. Salinity Study Suisun Bay/Delta, prepared for United States Army Corps of Engineers, San Francisco District.

Conomos. T.J. and D.H. Peterson. 1977. Suspended-particle Transport and Circulation in San Francisco Bay: An Overview in Estuarine Processes. Vol. II. Academic Press Inc., New York.

Daniel, Dick. 1972. Zoobenthos. In: Ecological Studies of the Sacramento-San Joaquin Estuary, Delta Fish and Wildlife Protection Study Report No. 8, California Department of Fish and Game. pp. 32-35.

Delta Advisory Planning Council. August 1975. Draft Delta Plan Technical Supplement, Chapter III, Delta Natural Resources.

Fry, Donald H. Jr. 1973. Anadromous Fish of California, California Department of Fish and Game.

Hallock, R.J., R. F. Elwell and D. H. Fry. 1970. Migrations of Adult King Salmon (Oncorhynchus Tshawyscha) in the San Joaquin Delta as Demonstrated by the Use of Sonic Tags. California Department of Fish and Game, Fish Bulletin 151.

Hazel, C.R. and D.W. Kelley. 1966. Zoobenthos of the Sacramento-San Joaquin Delta. In: Ecological Studies of the Sacramento-San Joaquin Estuary, Part I, Fish Bulletin 133, California Department of Fish and Game. pp. 113-132.

Imberger, J., W.B. Kirkland, Jr., and H.B. Fischer. 1977. The Effect of Delta Outflow on the Density Stratification in San Francisco Bay. Prepared for the Association of Bay Area Governments. Report HBF-77/02.

Jensen, Paul. 1972. King Salmon. In: Ecological Studies of the Sacramento-San Joaquin Estuary, Delta Fish and Wildlife Study Report No. 8, California Department of Fish and Game. pp. 44-51.

Jones & Stokes Associates, Inc. and EDAW Inc. 1975. Fish and Wildlife Element Suisun Marsh Protection Plan.

Kelly, D. W. and W. E. Tippets, 1977. Delta Outflow and San Francisco Bay, A report prepared for the Delta Environmental Advisory Committee of the California Department of Water Resources.

Kohlhorst, David H. 1976. Sturgeon Spawning in the Sacramento River as Determined by Distribution of Larvae. In: California Fish and Game 62(1) pp. 32-40.

Kost, A.L. and A.W. Knight. 1975. The Food of Neomysis mercedis Holmes in the Sacramento-San Joaquin Estuary. In: California Fish and Game, 61(1). pp. 35-46.

Leach, Howard. 1978. Personal communication from Howard Leach, Fish and Wildlife Management Branch, California Department of Fish and Game, to Ray Dunham, State Water Resources Control Board, on January 27, 1978.

Means, Thomas H. 1928. Saltwater Problem San Francisco Bay and Delta of Sacramento and San Joaquin Rivers.

Miller, A.W., R.S. Miller, H.C. Cohen and R.F. Schultze. 1975. Suisun Marsh Study, U.S. Department of Agriculture, Soil Conservation Service.

Miller, L.W. 1972. White Sturgeon. In: Ecological Studies of the Sacramento-San Joaquin Estuary, Delta Fish and Wildlife Protection Study Report No. 8, California Department of Fish and Game. pp. 54-56.

Nuttonson, M.Y. 1963. The Physical Environment and Agriculture of the Sacramento-San Joaquin Delta Region of California with Reference to the Similar Peat Soil Areas of the Hulah Region of Israel. American Institute of Crop Ecology. Washington, D.C.

Painter, R.E. 1966. Zoobenthos of San Pablo and Suisun Bays. In: Ecological Studies of the Sacramento-San Joaquin Estuary, Part I, Fish Bulletin 133, California Department of Fish and Game. pp. 40-56.

Peterson, David H., T. J. Conomos, W. W. Broenkow and P. C. Doherty. 1975. Location of the Non-tidal Current Null Zone in Northern San Francisco Bay. In: Estuarine and Coastal Marine Science 3. pp. 1-11.

Radtke, Larry D. 1966. Distribution of Smelt, Juvenile Sturgeon and Starry Flounder in the Sacramento-San Joaquin Delta with Observations on Food of Sturgeon. In: Ecological Studies of the Sacramento-San Joaquin Delta, Part II, Fish Bulletin 136, California Department of Fish and Game. pp. 115-129.

Schaub, David. 1971. Salt Marsh Harvest Mouse Survey 1971. Wildlife Management Branch, California Department of Fish and Game.

Simmons, M.A., R. M. Sitts, J. T. Allen, and A. W. Knight. 1974a. The Nomenclature for Mysids in the Sacramento-San Joaquin Delta Estuary. In: California Fish and Game, 60(1). pp. 23-25.

Simmons, M.A., R. M. Sitts, J. T. Allen, and A. W. Knight. 1974b. Further Contribution on Nomenclature for Mysids in the Sacramento-San Joaquin Delta Estuary. In: California Fish and Game, 60(4). pp. 211-212.

Simmons, M.A., and A. W. Knight. 1975. Respiratory Response of Neomysis intermedia (Crustecea, Mysisecea) to Changes in Salinity, Temperature and Season. In: Comp. Biochemm. Physiol. Volume 50A. pp. 191-193.

Skinner, J.E. 1972. Ecological Studies of the Sacramento-San Joaquin Estuary, Delta Fish and Wildlife Study Report No. 8, California Department of Fish and Game.

Smith, B. 1966. The Tides of San Francisco Bay. Prepared for the San Francisco Bay Conservation and Development Commission.

Turner, J.L. 1966a. Distribution of Cyprinid Fishes in the Sacramento-San Joaquin Delta. In: Ecological Studies of the Sacramento-San Joaquin Delta, Part II, Fish Bulletin 136, California Department of Fish and Game. pp. 154-159.

Turner, J.L. 1966b. Distribution of Threadfin Shad, *Porosoma petenense*; Tule Perch, *Hysterocarpus traskil*; Sculpin Spp. and Crayfish spp. in the Sacramento-San Joaquin Delta. In: Ecological Studies of the Sacramento-San Joaquin Delta, Part II, Fish Bulletin 136, California Department of Fish and Game, pp. 160-168.

United States Bureau of Reclamation. 1972. A Progress Report on the Delta San Luis Drain Surveillance Portion of the Program, Delta-Suisun Bay Surveillance Program.

United States Bureau of Reclamation. 1977. Phytoplankton Growth and Chlorophyll Levels in the Sacramento-San Joaquin Delta Through San Pablo Bay.

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California Waterfowl Association
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South Delta Water Agency
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San Francisco Bay Conservation and Development Commission
Marin Conservation League
Association of Bay Area Governments

Bethel Island Municipal Improvement District

Central Delta Water Agency

Shasta-Cascade Wonderland Association

Sacramento County Water Agency

North Delta Water Agency

East Contra Costa Irrigation District

Contra Costa County Water Agency

Contra Costa County Water District

Crown-Zellerbach Corporation

Fibreboard Corporation

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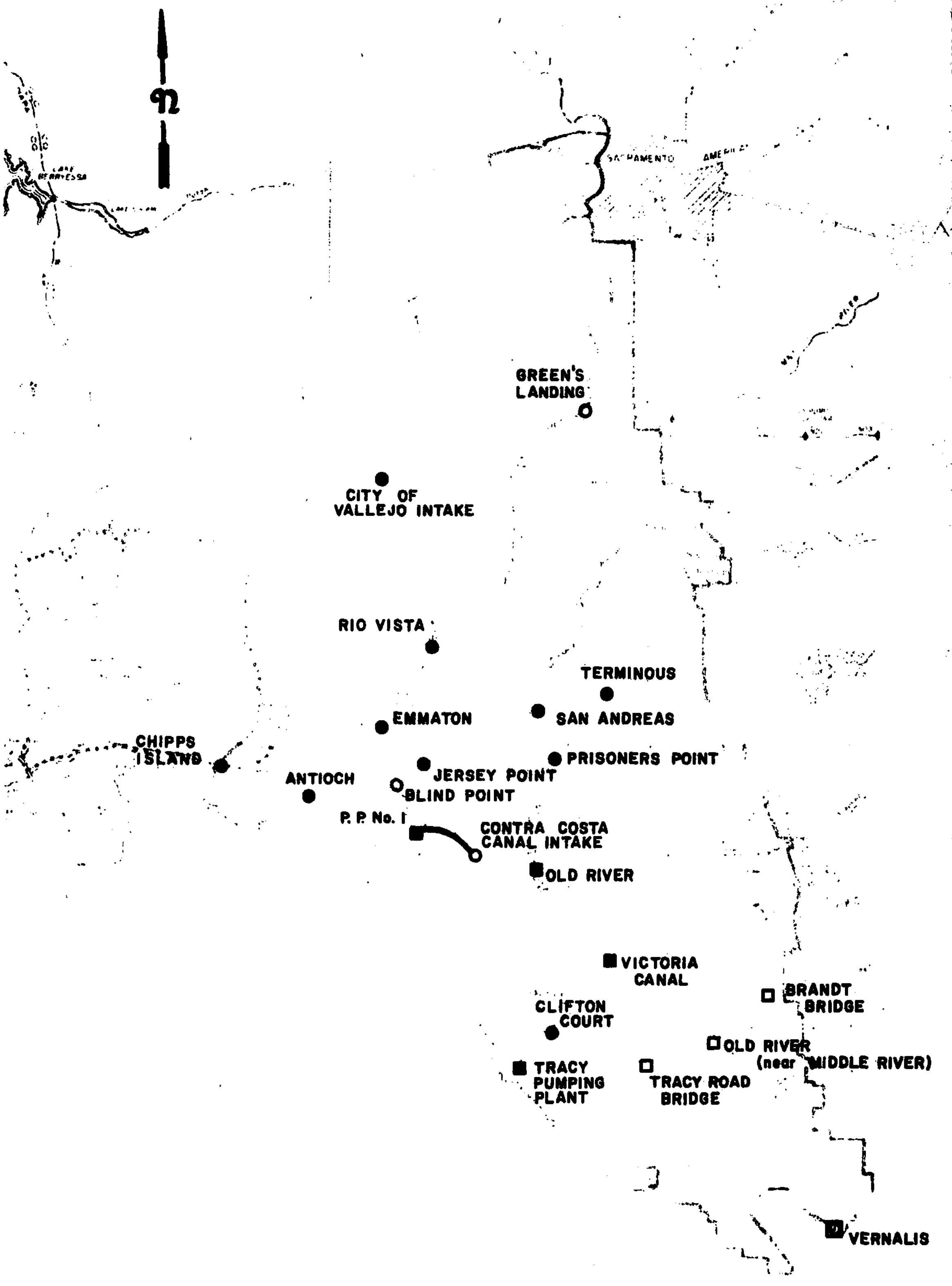

● HISTORICAL & CURRENT WATER QUALITY CONTROL STATION

○ HISTORICAL WATER QUALITY CONTROL STATION

■ NEW WATER QUALITY CONTROL STATION

□ POSSIBLE FUTURE WATER QUALITY CONTROL STATION

PLATE I