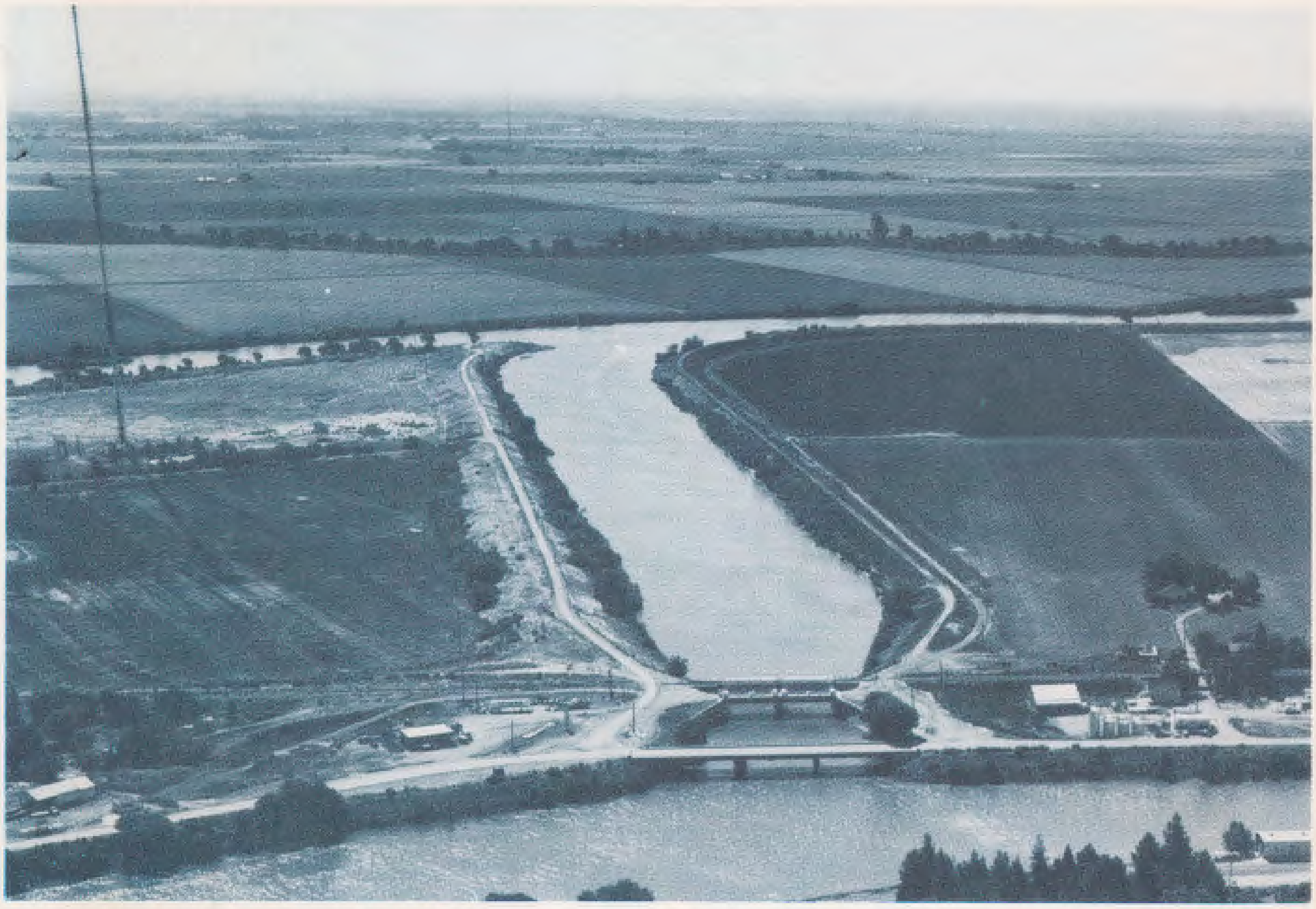
State of California
THE RESOURCES AGENCY
DEPARTMENT OF WATER RESOURCES



ALTERNATIVES FOR DELTA WATER TRANSFER

NOVEMBER 1983

ON THE COVER: The first cross-Delta water transfer facility, completed in 1952, was the Delta Cross Channel, a feature of the Federal Central Valley Project through which water flows from the Sacramento River to the pumps in the southern Delta.
DWR Photo 5435-52

FOREWORD

This report discusses physical alternatives to the Peripheral Canal for transferring water across the Sacramento-San Joaquin Delta. Four basic alternatives thought to be the most promising have been selected from a large number of alternatives considered. All four are variations of "through-Delta" plans in which water is conveyed through existing channels of the central Delta. While these plans presently appear to be most promising to the Department's staff, further evaluation and public discussion may indicate additional variations that should be considered.

The issue of Delta water transfer facilities is, of course, only one piece in the puzzle of California water development. Other related and significant issues include, but are not limited to, Delta levee reconstruction, fish and wildlife protection, area-of-origin protection, and water storage facilities. The report briefly discusses these and other issues in order to provide a framework for consideration of water transfer facilities. The Department intends to make recommendations concerning all of these issues early in 1984.

The point of departure for consideration of Delta facilities is that the existing Delta situation is unacceptable to virtually all of the interests involved. At present, 5 to 6 million acre-feet a year is transferred through the Delta channels to the export pumps in the southern Delta. The resulting problems include channel scour, fish losses, salinity intrusion, and water quality degradation. All of the basic plans deal with these problems.

The basic alternatives represent the results of a technical review, based on knowledge gained through many years of Delta investigations. At this stage we do not have a recommended plan. Our primary purpose is to focus discussion on specific alternatives as the Department formulates a comprehensive water program. The cost estimates and other data presented for each alternative are fairly rough and are intended primarily to indicate differences between plans. The data will no doubt be modified as the alternative plans are refined in the coming months.

The next step in the process of developing a program will be a series of meetings between the Department and the various interest groups. In addition, presently scheduled legislative hearings will afford an opportunity for expression of views about alternative plans and related issues.

David N. Kennedy, Director
Department of Water Resources

CONTENTS

Page

Figures

Tables

EXECUTIVE SUMMARY

The State Water Project conserves surplus water in areas where it is plentiful and transports it to areas where more water is needed. After voters in 1960 approved the Burns-Porter Act to authorize the project, the State signed contracts with 30 public agencies to deliver 4.23 million acre-feet of water for people, farms, and industries. (An acre-foot is 325,851 gallons -- enough water to meet the needs of five or six people for a year.) The contracts require that these 30 agencies repay, with interest, the costs of developing and delivering the water. The agencies provide water to 68 percent of California's people and 24 percent of its area.

Today, the State Water Project is only partly completed. Existing facilities can reliably supply only about half the amount that will be needed. While the full amount of project water will not be needed until well into the twenty-first century, there is a near-term need for additional supply.

The first step to be taken in providing more water is to solve the problems in the Sacramento-San Joaquin Delta, because the Delta plays a pivotal role for both the State Water Project and the Federal Central Valley Project in transporting surplus water from the north to areas of need south and west of the Delta. At present, these projects export up to 6 million acre-feet annually. In the Delta itself, facilities are needed to solve water transfer problems, to alleviate water quality and fish problems, and to make efficient use of existing and future water storage facilities. Local Delta problems of water supply and quality must be considered, as should plans for rehabilitating levees in the Delta.

Many years of investigation led biologists and engineers to conclude that the Peripheral Canal was the best way of providing a suitable habitat for fish while meeting the water needs of the Delta, the State Water Project, and the Federal Central Valley Project. However, voter rejection of Proposition 9 (Senate Bill 200*) in June 1982 makes advocacy of that plan impractical. Therefore, the major purpose of this report is to focus on alternative solutions to the Delta water transfer problems. Also discussed is the relationship of water transfer to Delta levee rehabilitation, local water supply and facilities, fish, and related water programs, actions, and activities outside the Delta.

In the mid-1920s, the California Water Resources Association wrote:

> "Whatever plan the Department ... may recommend for initiating the great work of state-wide water conservation and utilization, such plan must and undoubtedly will make some feasible and satisfactory recommendation covering the extremely grave problem of salt water encroachment in the Delta of the Sacramento and San Joaquin Rivers. This is one of the most vital considerations before the

* This bill, passed in 1980, authorized a large package of facilities and programs to continue development of the State Water Project toward its ultimate capacity. The Peripheral Canal was a key element of the package.

people of California today, and comprehends many and variant interests and problems." (emphasis added)

Sixty years later, California is still struggling to find acceptable solutions to the same Delta water problems.

Delta Transfer Facilities

Most of the water available for export enters the Delta from the north, flows through the Delta, and leaves the Delta at its southern edge through the State Water Project and Central Valley Project export pumps. The size of existing Delta channels limits the amount of water that can be pumped without channel scour, salinity degradation, adverse effects on fish, or release of stored water for carriage water. (Carriage water is the extra Delta outflow needed to maintain water quality at the export pumps with the present water transfer operations, over that needed without water transfer.) Selecting and building an improved Delta water transfer system is the single most important decision to be made to advance the State Water Project. The Central Valley Project would also benefit, but to a lesser degree. Operation of these projects is inseparable and must be closely coordinated.

An improved Delta water transfer system could increase the dependable supply of the State Water Project by as much as 500,000 acre-feet a year. This would increase the present level of combined export of the State Water Project and the Central Valley Project by 8 to 10 percent. The system would also improve water quality and certain other environmental conditions in the Delta that result from present water transfer operations.

In this report, many water transfer alternatives were considered. Through a selection process, described in Chapter 5, These were reduced to the four basic alternatives considered most practical. These four alternative "through-Delta" transfer systems would increase the flow of Sacramento River water through central Delta channels. Both a North Delta and a South Delta facility are needed to constitute a complete through-Delta transfer system. The basic alternatives listed below are shown in Figure 1.

Plan A - New Hope Cross Channel and Enlarged Clifton Court Forebay

Plan B - New Hope Cross Channel and Dredged South Delta Channels and New Clifton Court Forebay Intake

Plan C - New Hope Cross Channel and New Intake Channel to Clifton Court Forebay

Plan D - Enlarged North Delta Channels and Enlarged Clifton Court Forebay

There are several design options that could be considered with any of the four basic alternatives. A variety of means (pumping plants, barriers, or tidal flow controllers) can be used to enhance the transfer efficiency of any North Delta facility. Also, a variety of options are possible in attempting to protect fish through the use of fish screens. The design options thought to be practicable are illustrated in Figure 1.

The estimated cost of the four alternatives ranges from $120 million to $400 million, and the estimated dependable yield (amount of water to be gained during a critically dry period) ranges from 250,000 to 500,000 acre-feet, depending on the design options chosen. Figure 1 also lists the estimated capital cost, dependable yield, and unit cost of water for each of the four alternatives and their design options.

For all the alternatives, continued use of existing State and Federal pumps is required, plus installation by the State of four additional pumps at the Banks Pumping Plant. Planning for the pumps is proceeding independently from this study and an environmental impact report is being prepared.

Closely coordinated operation of the State Water Project and the Federal Central Valley Project would be required under all alternatives. The quality of water for each project would be substantially improved because each alternative would reduce or eliminate reverse flows and the commingling with ocean-derived salts from the western Delta. Some alternatives would require modifying the operation of the existing Delta Cross Channel, which transfers Sacramento River water into the Central Delta. This would best be done by automating the control gates of the channel.

Alternatives employing either an enlarged Clifton Court Forebay or a new intake channel to Clifton Court Forebay could be expanded at extra cost, now or in the future, to include Federal participation if authorization were achieved. While Federal participation could not increase the yield of the alternative, it would provide an opportunity for screening out small Delta fish that are now pumped into the Delta-Mendota Canal.

Elimination or reduction of reverse flows in the western Delta would improve the environment there for migrating salmon, young striped bass, and fish food organisms and would also lower the salt content in Old River for local use and export. Other environmental effects, such as on the fish food chain, are extremely complex, and the net effect is not easily estimated.

One assumption in this analysis of alternatives is that, where practical, State Water Project adverse effects on fish and wildlife will be mitigated. A basic fish and wildlife mitigation plan for any alternative would probably consist of some mix of fish screens, hatchery production, habitat restoration, and operational agreements. Any threat to rare and endangered species would be mitigated by revegetation, transplantation, and/or habitat acquisition where practical. Future work to select a specific Delta water transfer facility will include an analysis of all environmental impacts in accordance with the California Environmental Quality Act.

Delta Levees

The 60 or so islands in the heart of the Delta were built over many years by individual owners or reclamation districts and are maintained to widely varying standards. Since 1980, levees on 12 of these 60 islands have failed. Factors contributing to these levee failures include: instability of the levee section and foundation materials; subsidence; rodent burrows; erosion from wind waves and boat wakes; inadequate height (freeboard); and seepage. Because of these failures, the local districts have been assessed up to their ability to pay.

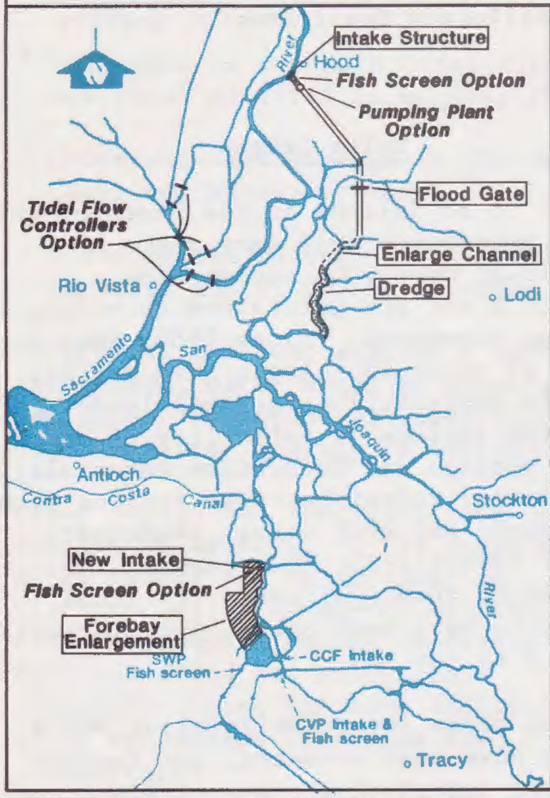
Several plans for rehabilitating Delta levees have been advanced, but funding requires legislative, congressional, and local action. Delta levees are important to the water transfer issue, because levee failures can have a serious impact on State Water Project operation.

If a levee fails and a large Delta island becomes flooded during an extended low-flow period, salty water from Suisun Bay could be drawn into the Delta. This would adversely affect Delta uses and diversions for the State Water Project and the Central Valley Project, and extra releases from upstream reservoirs would be required to flush out the salts. If the levee is repaired and the flooded island pumped out, effects on project operation would be short term. Such short-term water quality problems do not occur if a levee breaks during periods of high winter flows, which would keep salt water out of the Delta.

If a flooded island is not reclaimed, long-term water problems could affect the State Water Project and Central

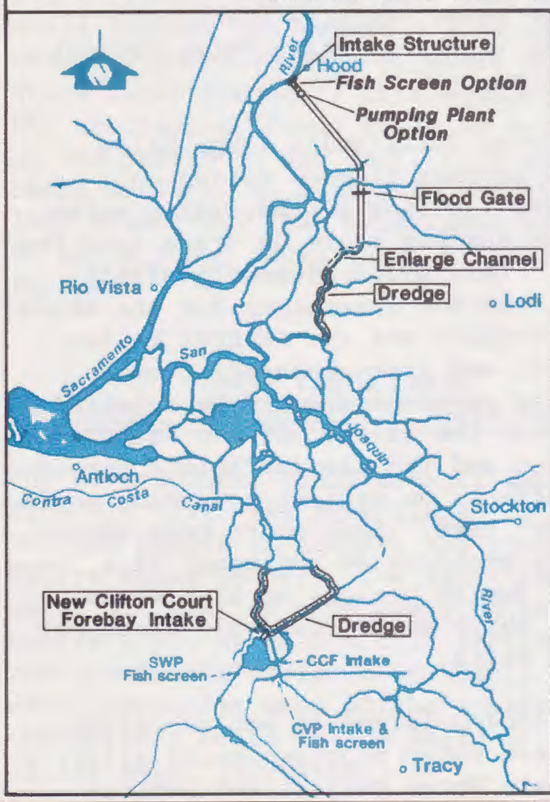
Figure 1. Alternative Through-Delta

PLAN A. NEW HOPE CROSS CHANNEL AND ENLARGED CLIFTON COURT FOREBAY.



DESIGN OPTIONS		Capital Cost in $ Million	Yield in 1000 AF/Yr	Unit Cost in $/AF	Salt Reduction in Percent
North Delta	South Delta				
Gravity Flow	Existing and New Intakes Existing Fish Screens	230	450	43	25
Tidal Flow Controllers	Existing and New Intakes Existing and New Fish Screens	340	500	57	30
Tidal Flow Controllers	Single New Intake, SWP only, with New Fish Screen	370	500	62	30
Pumping Plant with Fish Screen	Existing and New Intakes Existing Fish Screens	400	500	69	30

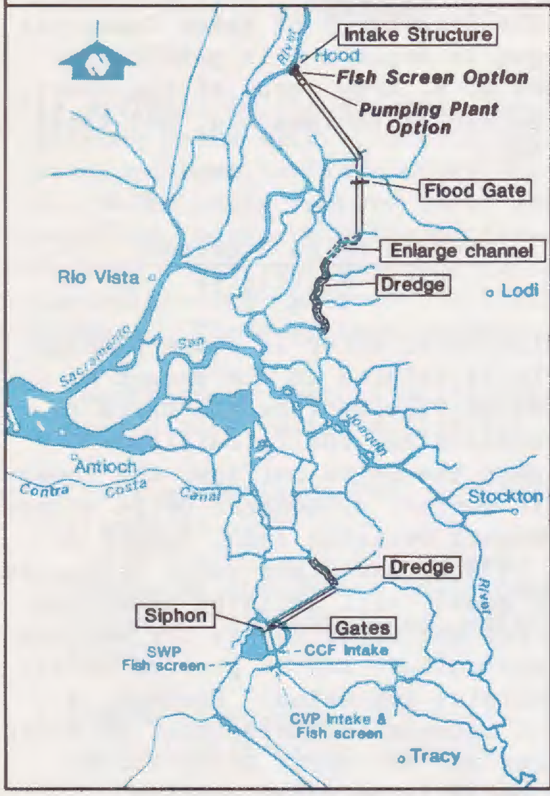
PLAN B. NEW HOPE CROSS CHANNEL, DREDGED SOUTH DELTA CHANNELS AND NEW CLIFTON COURT FOREBAY INTAKE.



DESIGN OPTIONS		Capital Cost in $ Million	Yield in 1000 AF/Yr	Unit Cost in $/AF	Salt Reduction in Percent
North Delta	South Delta				
Gravity Flow	Existing Fish Screens	210	450	39	25
Pumping Plant with Fish Screen	Existing Fish Screens	380	500	66	30

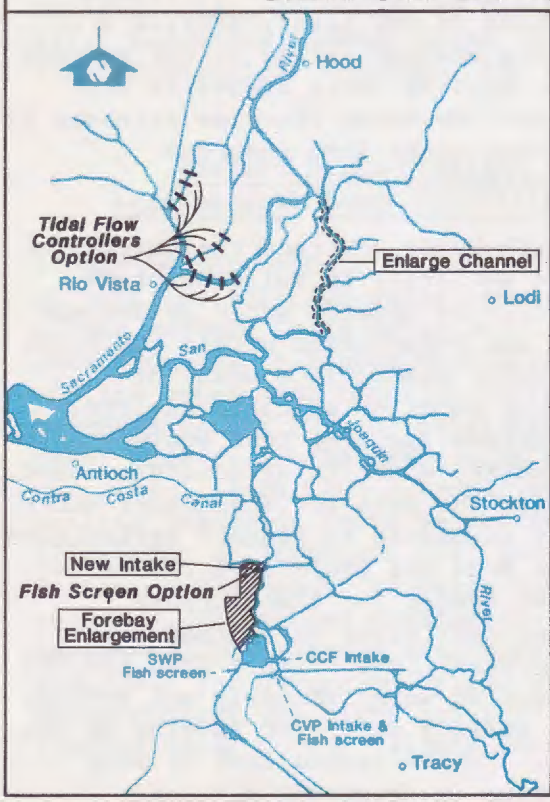
Transfer Systems.

PLAN C. NEW HOPE CROSS CHANNEL AND NEW INTAKE CHANNEL TO CLIFTON COURT FOREBAY.



DESIGN OPTIONS		Capital Cost in $ Million	Yield in 1000 AF/Yr	Unit Cost in $/AF	Salt Reduction in Percent
North Delta	South Delta				
Gravity Flow	From Middle River, SWP only, with Existing Fish Screens	230	450	44	25
Pumping Plant with Fish Screen	From Middle River, SWP only, with Existing Fish Screens	400	500	69	30

PLAN D. ENLARGED NORTH DELTA CHANNELS AND ENLARGED CLIFTON COURT FOREBAY.



DESIGN OPTIONS		Capital Cost in $ Million	Yield in 1000 AF/Yr	Unit Cost in $/AF	Salt Reduction in Percent
North Delta	South Delta				
Gravity Flow	Existing and New Intakes Existing Fish Screens	120	250	40	15
Tidal Flow Controllers	Existing and New Intakes Existing and New Fish Screens	290	500	49	30
Tidal Flow Controllers	Single New Intake, SWP only, with New Fish Screen	320	500	54	30

Valley Project. Evaporation from a flooded island exceeds the consumptive use of agriculture by up to 2 feet per year, and the State and Federal water projects would have to make up the difference. In wet or normal years there would be little loss of project yield, but in a dry year exports would have to be decreased.

In addition, permanent flooding of certain western Delta islands -- Sherman, Jersey, Bradford, Twitchell, Hotchkiss, Bethel, Webb, and Holland -- could increase salinity intrusion and cost the projects additional water to maintain water quality. (Remedial measures short of full island restoration that would prevent the loss of project yield are discussed in Chapter 6.)

There is a clear link between plans to improve Delta water transfer and plans to restore Delta levees. All water transfer alternatives discussed require channel enlargements in the South Fork Mokelumne River, and some require channel dredging near Clifton Court Forebay. These enlargements and dredging would help provide fill material for levee reconstruction, increase the carrying capacity of the channels, and lower flood stages.

Levee improvements would benefit Delta agriculture, cities, industries, natural gas fields, highways, railroads, pipelines, wildlife, water-associated recreation, and the water projects. Several of these interests also would benefit from an improved system of Delta water transfer.

While beyond the scope of this report, a plan to coordinate levee restoration with construction of a water transfer system and to share the costs according to the benefits received is being developed by Federal, State, and local interests. For example, to the extent that channel enlargements and dredging for levee rehabilitation and water transfer facilities coincide, there would be an opportunity for cost sharing. The Department of Water Resources has begun to explore this possibility with the U. S. Army Corps of Engineers, U. S. Bureau of Reclamation, and local agencies.

Western Delta Overland Water Facilities

The salinity of water in western Delta channels is related to the amount of fresh water flowing from the Delta to San Francisco Bay (Delta outflow) -- the higher the Delta outflow, the lower the salt content of western Delta water. Water Rights Decision 1485, issued in August 1978 by the State Water Resources Control Board, sets salinity standards to protect the water supply for western Delta agriculture and to prevent excessive salinity intrusion. Further, a contract between the Department of Water Resources and the North Delta Water Agency established water quality standards at specific locations and times of the year to give additional protection to the Agency service area, including Sherman Island in the western Delta. Meeting these standards with Delta outflow often requires releases of additional water from upstream reservoirs.

The North Delta contract recognizes the State's authority to build overland facilities to provide water to Sherman Island and other areas within the North Delta Water Agency as a means of providing water of suitable quality. Any overland facility that would supply high quality water to agriculture would eliminate the need for in-channel water quality standards to protect agriculture in that area and would save the Delta outflows needed for that purpose. Overland facilities on Sherman Island would prevent loss of more than 100,000 acre-feet of water annually and provide better quality water for farming on the island. The estimated cost of such facilities is about $11 million.

Contra Costa Canal

More than one-quarter million people in eastern Contra Costa County receive their water from the Contra Costa Canal, which diverts water from Old River via Rock Slough. At times, the canal receives poor quality water due to local agricultural drainage or salinity intrusion from the western Delta.

To improve the quality of this municipal and industrial supply, several proposals have been made over the years to relocate the canal intake to either the Delta-Mendota Canal or Clifton Court Forebay. In this report, no attempt has been made to estimate the benefit to the State Water Project, if any, of moving the canal intake under any of the water transfer alternatives.

All but the gravity flow options of the through-Delta water transfer alternatives would provide positive flows in the lower San Joaquin River at Antioch during all conditions of export. This means that reverse flows and salt pickup in the western Delta would be prevented. Under the gravity flow options, reverse flows would be reduced, but at times there would still be some western Delta salts drawn into the Delta. The need to relocate the canal intake will be reevaluated in future studies. Any of the four alternatives would eliminate or reduce the sea water intrusion problem. The local agricultural drainage problem could be overcome by simply installing a tide-gated structure to release water from the canal intake into Emerson Slough to provide more dilution water during low diversion periods.

Southern Delta Agriculture

At times, portions of the southern Delta suffer from poor water quality, poor water circulation, and low water levels. None of the water transfer alternatives selected for further consideration would aggravate these problems. All of the plans would improve water quality in the southwestern Delta by reducing or eliminating reverse flow and salt pickup at Antioch. Most alternatives would reduce low water problems. However, some problems such as sedimentation and poor water circulation in some channels may still remain.

A number of physical solutions to local problems of poor water quality and poor water circulation in certain southern Delta channels have been proposed in the past, but were not adopted by the Department of Water Resources or the South Delta Water Agency. These solutions include dredging existing channels, new distribution channels, and control structures. Any of these potential solutions could be made compatible with any of the suggested water transfer alternatives.

Related Activities

In addition to an improved Delta water transfer system, the State Water Project must develop additional storage capacity to regulate erratic seasonal runoff to help meet California's long-term water needs.

Construction of a South Delta facility and installation of the four additional pumps at the Banks Pumping Plant (and procurement of a Corps of Engineers permit to allow pumping at the design capacity of 10,300 cubic feet per second) would provide considerably more operational flexibility in normal and wet years. The extra capacity thus made available would allow surplus winter flows to be diverted and stored in San Luis Reservoir or go to ground water storage or new surface reservoirs south of the Delta for use when needed. This could significantly increase average annual water deliveries from the State Water Project, while reducing dry-year export needs.

Construction of a North Delta facility would enhance the water delivery efficiency of existing and future reservoirs north of the Delta, and it would reduce water transfer related fish problems in the western Delta. Without a North Delta facility, 20 to 30 percent of any new yield provided by new reservoirs north of the Delta would have to be used for carriage water (Delta outflow). Additional operational flexibility provided by these facilities may also help solve the existing fish problems.

Chapter 1. INTRODUCTION

The Delta is like a puzzle that everyone works on but no one has been able to solve. Millions of dollars invested in years of study have left California with great knowledge of the individual pieces of the puzzle. This effort led biologists and engineers to conclude that the Peripheral Canal was the best way to provide suitable habitat for fish while meeting water needs of the State Water Project and Federal Central Valley Project. But rejection of the canal and other measures by the voters in June 1982 made advocacy of that plan impractical.

As time goes by, solving the puzzle becomes more important because of continuing subsidence and deteriorating levees, and because more water must be moved across the Delta to meet growing water needs. The status quo is unacceptable to most interests, because problems in the Delta are growing worse. The challenge is to immediately move to merge the physical and technical realities with the economic and political realities.

This report is intended to help focus on possible solutions to the Delta puzzle. It presents an interim technical review of what now seem to be the most practical Delta water transfer alternatives. It also identifies the relationship between water transfer and improving Delta levees for flood control. Local water supply and Delta fish needs are also considered.

A further step will be for the Department to select and recommend a Delta water transfer plan. The selection process will include consideration of statements made at anticipated legislative hearings and coordination with affected State, Federal, and local agencies and various Delta interests groups. The coordination activities will cover Delta levees, Delta water supply, and fish concerns, as well as water transfer. The process will also include an environmental impact report, which will provide the opportunity for public review.

Background

The Legislature authorized the State Water Project in 1959, and in 1960 the voters approved a bond issue to build it. The legislation authorized (1) a complete aqueduct system, (2) initial storage facilities, and (3) additional, but unspecified, future storage facilities for local needs, for export from areas where water is plentiful to areas of need south and west of the Delta, and to augment water supplies in the Delta. The legislation also authorized "master levees, control structures, channel improvements, and appurtenant facilities in the Sacramento-San Joaquin Delta for water conservation, water supply in the Delta, transfer of water across the Delta, flood and salinity control, and related functions." [Water Code Section 12834(d) (3)].

The principal purpose of the State Water Project is to conserve water originating in areas of surplus and transport it to areas of need. The State has contracts to supply water from the State Water Project to 30 public agencies, which serve 68 percent of California's people and 24 percent of its area. Project purposes also include flood control, hydroelectric power generation, salinity control, recreation, and fish and wildlife enhancement.

Need for Water*

California's population is projected to increase from 23.8 million to 34.4 million between 1980 and 2010. Well over half of this growth will be within the 30-agency service area of the State Water Project. Irrigated farmlands are also expected to increase, but not nearly as fast as population. Not much of the water for increased irrigation will be supplied by the State Water Project, but agriculture that now depends on unreliable surplus supplies needs a more dependable supply of project water to maintain existing irrigated lands.

More people means a need for more water. Over the next 20 to 30 years, Californians are expected to need about 120,000 acre-feet more each year, even with expected conservation measures. About 50,000 acre-feet of this expected average yearly increase will be in State Water Project service areas. The increase in project needs includes water to offset the pending loss to the Southern California coastal area of more than half the water it is now entitled to from the Colorado River. In addition, the State Water Project supplies now available will diminish due to increased water use in the areas where the water originates. Adding the estimated loss in supply to the expected increase in service area requirements results in the need for an average yearly increase of 75,000 acre-feet of dependable annual supply from the State Water Project over the next 17 years. This translates into an increased need for nearly 1.3 million acre-feet of additional firm annual supply from the State Water Project by the year 2000.

About 850,000 acre-feet of this increase represents an increase in deliveries to project service areas, and 425,000 acre-feet represents the water needed to offset estimated loss of existing project yield.

Status of State Water Project

The major facilities of the State Water Project are shown in Figure 2. Although the major aqueduct and several reservoirs of the project have been built, these structures can deliver only about half to three-quarters of the water originally contracted for, depending on the wetness of the year and the amount of water in storage.

Furthermore, the Delta facilities provided for in the 1959 legislation have not been built. Instead, the State Water Project uses existing Delta channels to transport water across the Delta. This limits the amount of water that can be transported and aggravates environmental problems, including fish habitat and fish losses. Without corrective action, State Water Project water users can expect more frequent and prolonged water shortages as the need for water increases, and the Delta can expect increased problems.

Relationships between State Water Project and Central Valley Project

Two major interbasin water delivery systems -- the State Water Project and the Federal Central Valley Project -- divert water from the southern Delta. Both projects include major reservoirs north of the Delta, and both transport water released from storage to areas south and west of the Delta (Figure 2).

The use of Delta channels as conduits for conveying water supply began in 1940 with operation of the Contra Costa Canal -- the first unit of the Central

*Based on data from DWR Bulletin 160-82, "The California Water Plan -- Outlook in 1982", December 1982, Preprint Edition, and from DWR Bulletin 132-82, "The California State Water Project -- Current Activities and Future Management Plans", November 1982.

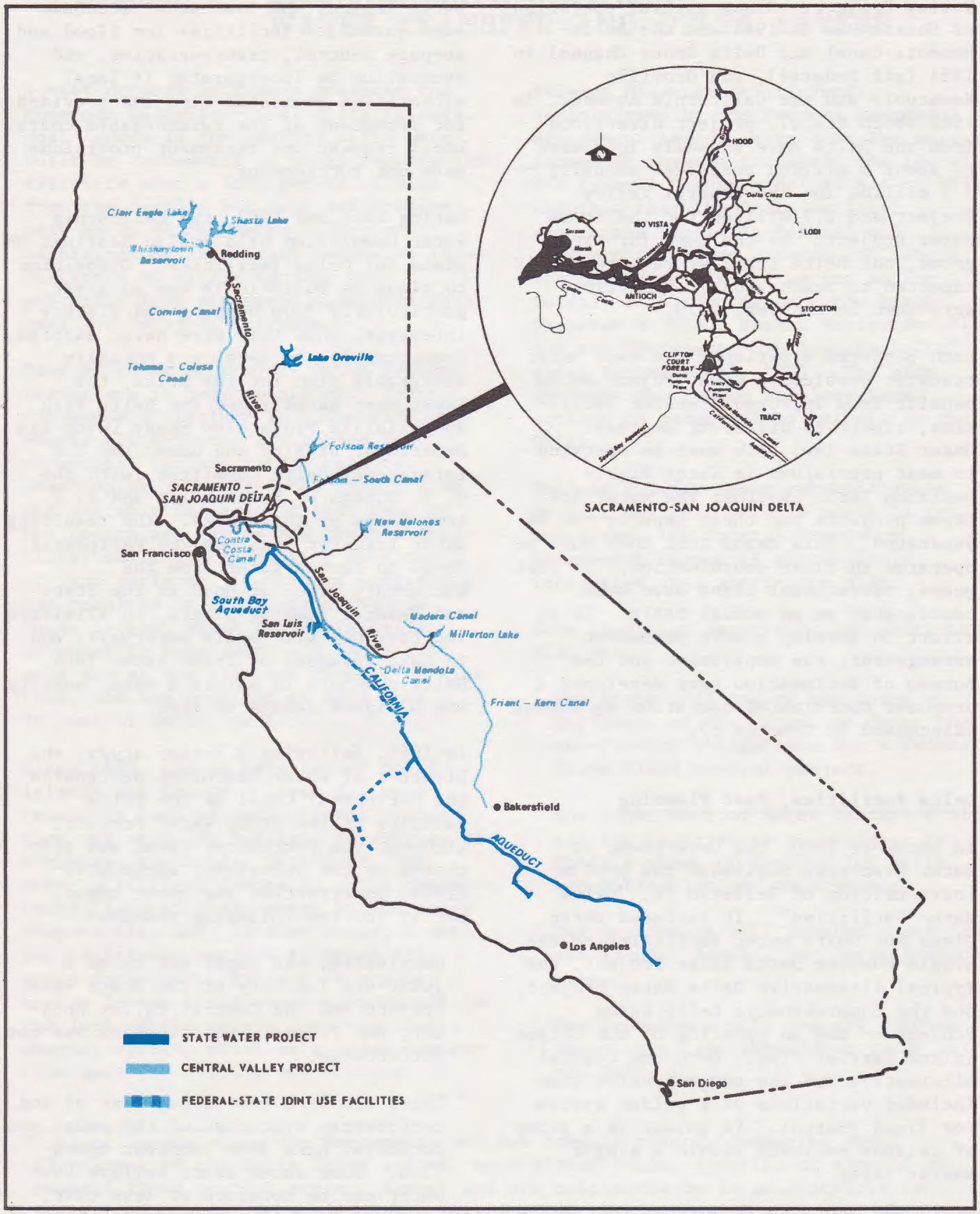


Figure 2 Major Features of the State Water Project and Central Valley Project

Valley Project. Since initial operation of Shasta Dam in 1944 and the Delta-Mendota Canal and Delta Cross Channel in 1951 (all Federal), and Oroville Reservoir and the California Aqueduct in 1968 (both State), project diversions from the Delta have steadily increased to about 6 million acre-feet annually -- 3.3 million for the Central Valley Project and 2.7 million for the State Water Project. As the need for water grows, the Delta transfer requirement is expected to reach about 7.5 million acre-feet in the year 2020.

Both projects experience the same water transfer problems. Each project would benefit from improved transfer facilities, albeit to different degrees. Under State law, both must be operated to meet provisions in Water Rights Decision 1485. Neither the water for these projects nor their impacts can be separated. This means that they must be operated in close coordination. In past years, operational plans have been coordinated on an annual basis. In an effort to develop a more permanent arrangement, the Department and the Bureau of Reclamation have developed a proposed coordinated operation agreement (discussed in Chapter 8).

Delta Facilities, Past Planning

In December 1960, the Department of Water Resources published the preliminary edition of Bulletin 76, "Delta Water Facilities". It included three plans for Delta water facilities -- the Single Purpose Delta Water Project, the Typical Alternative Delta Water Project, and the Comprehensive Delta Water Project -- and an updating of the Chipps Island Barrier Plan. Both the typical alternative and the comprehensive plan included variations of a polder system for flood control. (A polder is a group of islands enclosed within a single master levee.)

That report recommended that the Single Purpose Delta Water Project be adopted as an integral feature of the State Water Project and that other economically justified facilities for flood and seepage control, transportation, and recreation be incorporated if local authorities requested them and provided for repayment of the reimbursable costs. Local request and repayment provisions were not forthcoming.

During 1962 and 1963, the California Water Commission held public hearings on plans for Delta facilities. Opposition to plans in Bulletin 76 was so great, particularly from boating and fishery interests, that they were never adopted. Consequently, to develop a mutually acceptable plan for the Delta, the Department established the Delta Fish and Wildlife Protection Study (with the Department of Fish and Game) and the Interagency Delta Committee (with the U. S. Bureau of Reclamation and U. S. Army Corps of Engineers). The resulting water transfer plan was the Peripheral Canal to convey water from the Sacramento River at Hood to the State and Federal pumping plants, to eliminate interference with Delta waterways, and to make releases of fresh water into Delta channels to maintain water quality and mitigate damage to fish.

In 1966, following a 3-year study, the Director of Water Resources designated the Peripheral Canal as the Delta facility of the State Water Project. Although the Peripheral Canal was also chosen by two subsequent administrations, construction was never begun, partly for the following reasons:

- Originally, the canal was to be a joint-use facility of the State Water Project and the Central Valley Project, but Federal participation was not forthcoming.

- There has been continuing fear of and controversy over cost of the canal and potential harm from improper operation. Some water users believe that water can be obtained at less cost, and some Delta interests fear that, in times of water shortage, institutional, statutory, and contractual guarantees for Delta protection could be changed or ignored and water needed to protect the Delta would be exported.

A reassessment, begun by the Department in 1975, resulted in Bulletin 76, July 1978, which identified and considered numerous alternative Delta water transfer facilities.

In 1980, after a 4-year struggle, the Legislature passed and the Governor signed Senate Bill 200. This bill authorized the Peripheral Canal and provided specific guarantees to protect the Delta, as well as plans for meeting water needs of the State Water Project through the year 2000. Senate Bill 200 was subjected to a referendum vote, as Proposition 9, at the June 1982 election. It was not approved by the voters.

With that program rejected, the need to transfer more water across the Delta and at the same time meet the needs of the Delta itself still exists.

Water Transfer

The water transfer alternatives discussed in this report are limited to the most promising ones. They are designed specifically to improve the efficiency of water transfer and solve the channel capacity limitation problems of the present State Water Project operation while protecting water quality in the Delta. A number of design options were evaluated within each major alternative. This approach provides the flexibility to consider combinations of facilities that have different costs and different impacts on various Delta uses and the environment.

While there are many variations of plans that could be employed, the basic concepts for improving the water transfer system are:

- An entirely new large channel to convey all of the water for export around the Delta (the Peripheral Canal).
- Bay barriers to separate brackish water from fresh water.
- Through-Delta systems to increase flow through the central Delta channels.
- A dual system using a smaller new channel to convey about half the water for export around the Delta and the other half through existing Delta channels.

The Peripheral Canal is not considered in this report because of the voter rejection of Senate Bill 200. Some alternatives have been thoroughly evaluated in the past, such as construction of barriers (low-level dams) in the San Francisco Bay system and Delta channel conveyance plans that require extensive construction over deep peat and organic soils. Several sites and designs have been considered over the years for the bay barriers, but these too have been rejected, mainly because of cost and environmental drawbacks involving fish survival, thermal layering of western Delta water, algae blooms, levee shrinkage due to the lack of tidal action, and navigation (see Appendix).

The basic choice, therefore, is between a dual system and a through-Delta system. This still leaves many design options to be considered.

Relationships Between Water Transfer and Flood Control

In addition to the water supply and transport problems of the State Water Project, the condition of nonproject* levees in the Delta continues to worsen. Since 1980, levees have failed on 12 of the 60 or so islands in the heart of the Delta. Levees fail not only during

*"Nonproject levees" are levees built and maintained by landowners or local reclamation districts; "project levees" are Federal flood control levees (see Chapter 6).

winter's high flows but also in summer, due to the unstable nature of the Delta organic soils that comprise the levees and their foundations.

Recent studies on repairing the Delta levees have been released by the U. S. Army Corps of Engineers, the Department of Water Resources, and a Citizen's Emergency Delta Task Force established by the Assembly Committee on Water, Parks, and Wildlife.

Discussions of levees in this report are limited to the effects of levee failures on water transfer, supply, and quality; State Water Project operations; and the relationship of the alternatives to flood management and levee rehabilitation. These relationships are discussed in Chapter 6.

Other Delta Water Facilities

Certain actions in the Delta could conserve Delta outflow and thereby increase the export capability of the State Water Project and/or improve the quality of the water delivered to Delta islands and eastern Contra Costa County. These actions, discussed in Chapter 7, can be undertaken independently of the alternative water transfer systems suggested in this report.

Potential Storage Facilities of the State Water Project

To regulate the seasonal nature of California's natural runoff and meet the long-term needs of State Water Project water users, the project must develop more storage capacity. Except during the 1976-77 drought, the lack of additional storage capacity has not been important, because existing facilities have been able to meet the needs, and recent years have been wetter than normal. Now, with water deliveries exceeding firm yield and continuing to grow, the need for additional storage is becoming urgent.

While the major thrust of this report is to consider different ways of moving water through the Delta, Chapter 8 discusses overall State Water Project problems to provide a framework for judging the various Delta alternatives. The chapter discusses surface and ground water storage, water conservation, and operational measures that may be considered.

Near-Term Objectives

The Department's main near-term Delta objectives for the State Water Project are to:

- Provide overland water supply to Sherman Island to meet contracted water quality criteria more efficiently and save water for the State Water Project.

- Provide additional diversion capacity from the Sacramento River near Hood or Walnut Grove to route more water through interior Delta channels to reduce or eliminate reverse flows in the western Delta and improve water quality, to increase project yield, and to reduce project effects on fish.

- Remove channel restrictions in the southern Delta to increase project capability of exporting surplus winter flows and to reduce project effects on local water supplies and levees.

Another near-term objective is to stabilize Delta levees to the extent practical to prevent loss or damage of agriculture, urban areas, transportation facilities, and utilities; to avoid loss of fresh water for increased evaporation and outflow; to prevent disruption of export; and to preserve the unique character of the Delta.

Chapter 2. PLANNING CONCEPTS

The purpose of the State constructing a Delta water transfer system is to improve the water transfer efficiency and delivery capability of the State Water Project, while at the same time meeting the project's obligations in the Delta. Such facilities are essential for completing the State Water Project and meeting the needs of people, cities, and farms that depend on the project for a reliable water supply. The facilities would also improve the quality of water received by Federal water users, and some alternatives would provide the opportunity for the Central Valley Project to improve its fish-screening efficiency.

Most of the water available for export in the Delta comes from the Sacramento River as unregulated flow, return flow from upstream uses, or releases from reservoirs. Pumps of the State Water Project and Federal Central Valley Project are at the southern edge of the Delta, far removed from the Sacramento River. Facilities are needed to improve the transfer between the supply and the pumps.

This chapter presents the assumptions underlying the study and discusses water transfer problems and State Water Project yield.

Planning Assumptions

The planning assumptions in this evaluation are summarized below:

- The future need for water from the State Water Project is the same for any Delta water facility alternative.

- Estimates of the effects the alternatives would have on the Delta are based on operations using the existing facilities of the State Water Project and Central Valley Project, plus the four planned additional pumps at the Harvey O. Banks Delta Pumping Plant operated under existing constraints in Corps of Engineers Public Notice 5820A, Amended, October 13, 1981. The Delta Cross Channel (Federal) would not be altered physically but might be operated differently under some of the alternatives.

- The State Water Project, the Central Valley Project, and other water projects and developments have caused impacts to fish and wildlife resources. The State Water Project is responsible for mitigating its effect on fish and wildlife resources, in accordance with existing law (Davis-Dolwig Act, Water Code Section 11900 et seq.). This would probably consist of some mix of fish screens, hatchery production, habitat restoration and operation agreements. Enhancement of fish and wildlife resources is among the purposes of water projects developed by the State. Costs attributable to such enhancement that may be incorporated into a Delta facility are to be borne by the public and subject to approval and funding by the Legislature.

- Facilities used to mitigate State Water Project and Central Valley Project impacts on Suisun Marsh are needed to comply with conditions of each project's water right permits. These mitigation measures are proceeding independently of this analysis and are common to all alternatives.

- New projects outside the Delta are considered to be common to all Delta alternatives (see Chapter 8).

- State Water Resources Control Board Decision 1485, the North Delta Water Agency-DWR contract, the East Contra Costa Irrigation District-DWR contract, and State Water Project contracts establish water quality and fish flow objectives governing project operation.

- All the alternatives are analyzed as more or less independent additions to the State Water Project. Selected water transfer and local facilities would be combined to form a complete plan in the Delta for the project.

- Because conditions change, all costs and yields are approximations and will need to be refined for any alternative that might be selected. Major changes since the studies for Bulletin 76 (1978) include (1) adoption of Decision 1485, (2) signing of the North Delta Water Agency contract, (3) a proposed coordinated operation agreement between the State Water Project and the Central Valley Project, (4) revised operating criteria for Oroville Reservoir, and (5) completion of New Melones Dam.

- Time was too short in this study to make a quantitative analysis of project effects for comparing alternatives. Future work will include an analysis of all environmental impacts in accordance with the California Environmental Quality Act and the National Environmental Policy Act.

- Although some potential water transfer facilities might serve jointly as a State Water Project facility and as a Delta levee improvement project, no allocation of costs was attempted.

Water Transfer Problems

Today, most of the Delta export water for the State Water Project and Central Valley Project is drawn across the Delta through existing channels to the project pumps. Problems occur in two areas: the northern Delta and the southern Delta (see Figure 3).

Northern Delta

Channel capacities in the northern Delta limit the amount of water that can be transferred through the central Delta. Water flows from the Sacramento River via Georgiana Slough and the Delta Cross Channel (Federal) into the Mokelumne River system in the northern Delta, then through the central Delta to the State and Federal pumps. Channel limits allow only so much water to flow through Georgiana Slough and the Delta Cross Channel. Additional export water often must continue on down the Sacramento River into the western Delta and then back upstream in the San Joaquin River (reverse flow), where it blends with the cross-Delta flow on the way to the pumps (see Figure 4).

The route this water follows is significant, because the water becomes saltier as it approaches the western edge of the Delta, due to sea water intrusion from San Francisco Bay. Salinity levels in the Delta depend on the amount of water flowing out of the Delta into the Bay to repel sea water.

Operations of the State Water Project and Central Valley Project in the Delta are in accordance with the water quality objectives and criteria set forth in their water delivery contracts and in Decision 1485 of the State Water Resources Control Board. State Water Project operation must also meet criteria in a water rights contract with the North Delta Water Agency.

Under controlled flow conditions (no Delta outflow in excess of that needed to meet water quality and fish flow standards), the rates of Delta inflow, outflow, and export must be carefully balanced to assure meeting the water quality criteria and objectives in the Delta, the Contra Costa Canal and Delta-Mendota Canal of the Central

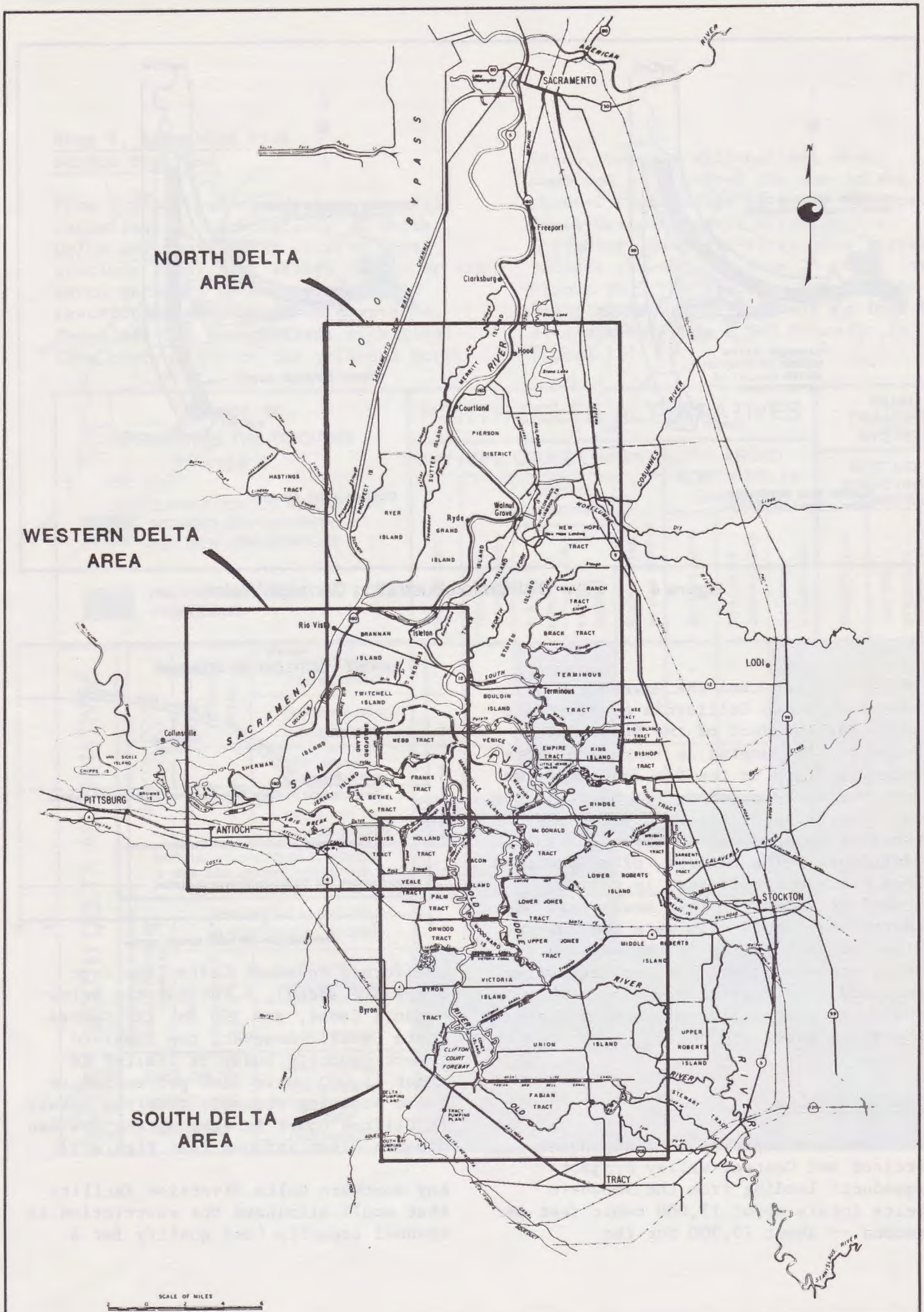


Figure 3 Location Map

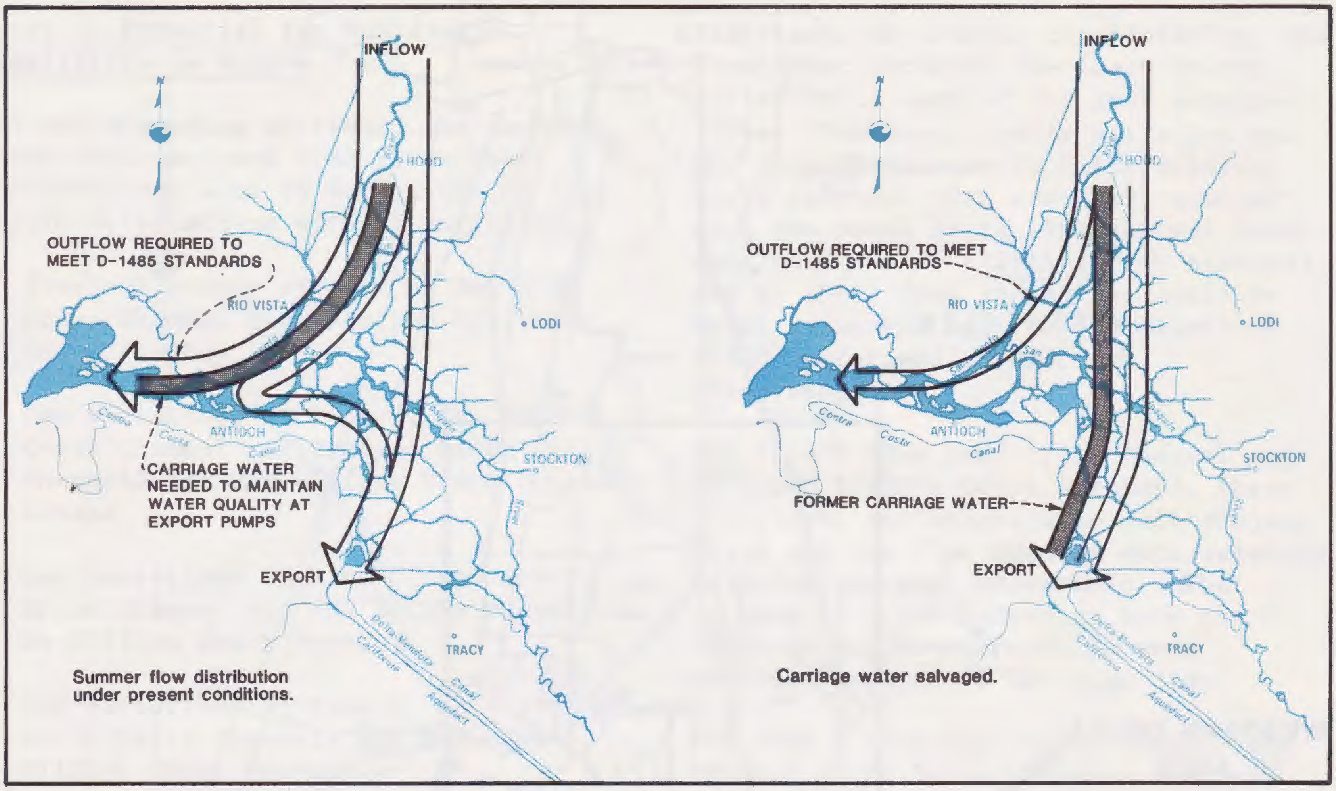


Figure 4 Flow Distribution, Illustrating Carriage Water

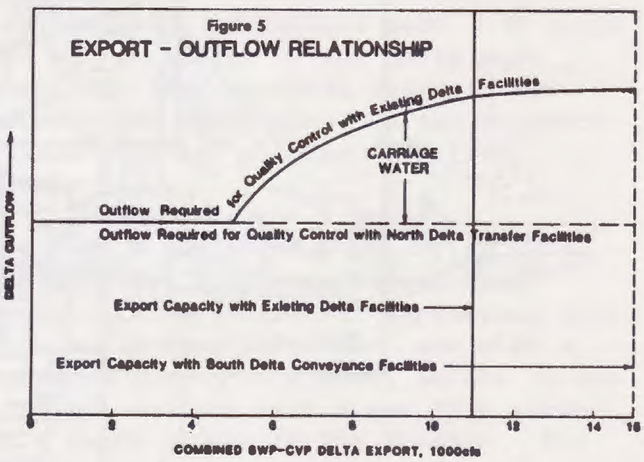


Figure 5
EXPORT - OUTFLOW RELATIONSHIP

Valley Project, and the Governor Edmund G. Brown California Aqueduct and South Bay Aqueduct of the State Water Project. As pumping is increased, more water is drawn up the San Joaquin River from the western Delta. To maintain the salinity balance, the salt water must be repelled by more Delta outflow. (This additional Delta outflow, often provided from reservoir releases, is called "carriage water".) This means that any system that would eliminate the reverse flow and salt pickup in the western Delta would conserve the carriage water required (see Figures 4 and 5). This would, of course, increase the yield of the State Water Project.

Southern Delta

The combined capacity of State Water Project and Central Valley Project aqueducts leading from the southern Delta totals about 15,000 cubic feet per second -- about 10,300 for the California Aqueduct (after the four pumps are added), 4,600 for the Delta-Mendota Canal, and 350 for the Contra Costa Canal. However, the combined export capacity today is limited to about 11,000 cubic feet per second to avoid scouring channels near the intake to Clifton Court Forebay during low San Joaquin River inflows (see Figure 5).

Any southern Delta diversion facility that would eliminate the restriction in channel capacity (and qualify for a

Corps of Engineers permit) could allow the State Water Project to use its full delivery capability for capturing surplus winter flows for storage south of the Delta.

State Water Project Yield

Water project facilities are planned so that when a series of dry years occurs, the project will yield enough water to satisfy water requirements. The conventional method of estimating State Water Project yield is to determine how much water could be made available with a recurrence of the hydrologic conditions that occurred during 1928 through 1934, the worst sustained drought in the Sacramento River basin in 130 years. These years have become known as the "critical dry period" for water project yield studies. (The 1976-77 drought was more severe, but lasted only two years.)

All aspects of water development and use in the watersheds of the Central Valley affect the yield of the State Water Project at the Delta. Following are some of the more significant actions in the watersheds in recent years:

° The State Water Resources Control Board adopted Decision 1485 in August 1978.

° A Coordinated Operation Agreement for the Central Valley Project and the State Water Project has been prepared; approval will depend on completion of environmental documentation. (Provides more certainty in project operation).

° The Department of Water Resources has signed a contract with the North Delta Water Agency to operate the State Water Project to meet specified water quality criteria in that agency. (May decrease SWP yield).

° Other smaller changes in project and nonproject upstream water operations have occurred. (Varying minor effects on SWP yield).

Future changes that were assumed in the base condition for comparison of the alternatives include:

° Surplus flows in the Delta will decrease as upstream water users develop their supplies under area of origin and other prior water rights. (Decreases SWP yield).

° The four additional pumps required to bring the Banks Pumping Plant to full design capacity will be installed but operated at less than maximum capacity to avoid channel scour. (Increases SWP yield).

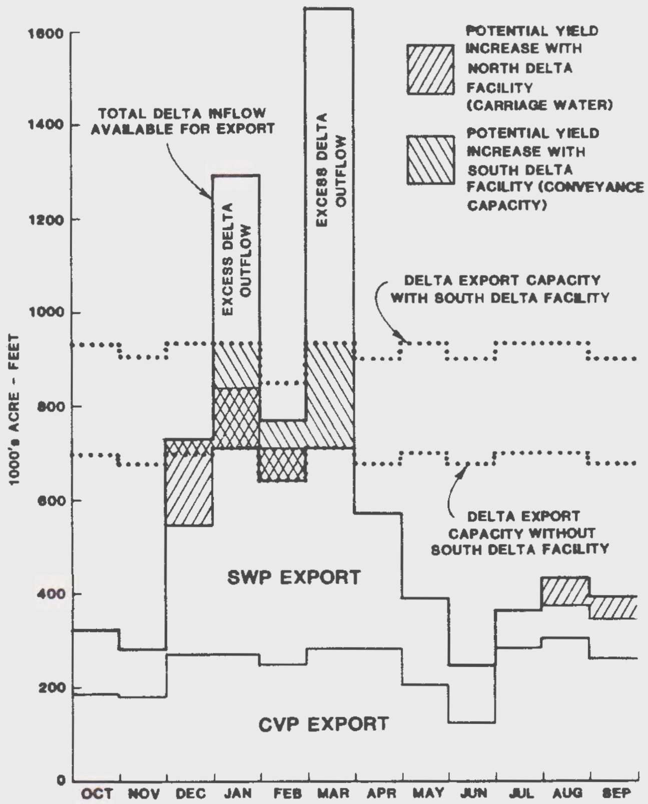
° Overland water supply facilities for Sherman Island, as provided in the North Delta Water Agency contract, will be built. (Avoids potential decrease in SWP yield, as explained in Chapter 7).

The Delta alternatives will increase the State Water Project yield by alleviating the problems of water transfer and conveyance discussed previously. The northern Delta alternatives increase transfer efficiencies and make more water available by eliminating the need for carriage water. This is illustrated in Figures 4 and 5. The southern Delta alternatives increase conveyance capacities to carry surplus winter flows and the flows no longer needed for carriage water (Figure 5).

Because the outflow required with Delta transfer facilities is based on Decision 1485, and because it varies by protected beneficial use, season, and hydrology, the scale for Delta outflow is not shown on Figure 5. Even with existing Delta facilities, the outflow required for Decision 1485 at times overrides the carriage water requirement, which is somewhat less than 7,000 cubic feet per second at maximum export rates.

The potential for increased State Water Project yield is further demonstrated in Figure 6, which illustrates monthly water operations in the Delta for water year 1929-30, during the critical dry period. Operations are for the year 2000 level of development with the base yield conditions described earlier in this section. To determine the water available for export, the amounts needed for use in the Delta itself and for outflow to meet Decision 1485 were subtracted from the total Delta inflow.

Figure 6 ILLUSTRATION OF DELTA OPERATION WITH EXISTING SYSTEM AND POTENTIAL YIELD INCREASES WITH DELTA WATER TRANSFER FACILITIES (1930 HYDROLOGY)



With Delta transfer facilities, the export could be increased by the amount of carriage water saved and by the excess outflow, up to the new capacity of the export facilities. Actual increases in export would also depend on water demands in the service areas, conveyance and reservoir storage capacities south of the Delta, Delta water quality standards required by Decision 1485, and other conditions in State Water Project water right permits.

Besides the direct increases in critical period yield, the Delta facilities would provide the flexibility to export additional surplus winter flows during wetter periods in conjunction with other new storage opportunities south of the Delta. The Delta facilities would also eliminate the need to devote part of the yield of future upstream storage facilities to carriage water. These relationships to other State Water Project facilities are discussed in Chapter 8.

Chapter 3. ALTERNATIVE WATER TRANSFER FACILITIES

The alternatives considered in this report are generally limited to two types:

- Through-Delta systems to increase flow through the central Delta channels.

- A dual system using a new channel to convey about half the export water around the Delta and the other half through existing Delta channels.

The basic alternatives for these types of systems are described in this chapter. Both a North Delta facility and a South Delta facility are needed to overcome the present problem of water transfer and to provide a basic through-Delta system. Including the dual transfer system and combinations of North and South facilities of the through-Delta system, seven basic alternatives are considered in this report, as shown in Figure 7. These basic alternatives do not include design options for boosting flow or for fish screen facilities, which are described in Chapter 4.

Through-Delta Transfer System

In this report, the many prior proposals for through-Delta alternatives have been narrowed to those of reasonable cost and, as far as possible, those in which major facilities are not built in the areas of deep peat. For a through-Delta transfer system, facilities are needed in the northern Delta to improve the efficiency of water transfer and in the southern Delta to provide enough capacity to carry increased flows. The northern and southern alternatives will be described separately.

North Delta Alternatives

Increasing transfer efficiency in the northern Delta would conserve a considerable amount of water by reducing carriage water needed to maintain quality in the western Delta and at the export facilities. Efficiency of transferring water in the northern Delta can be increased by improving the transfer

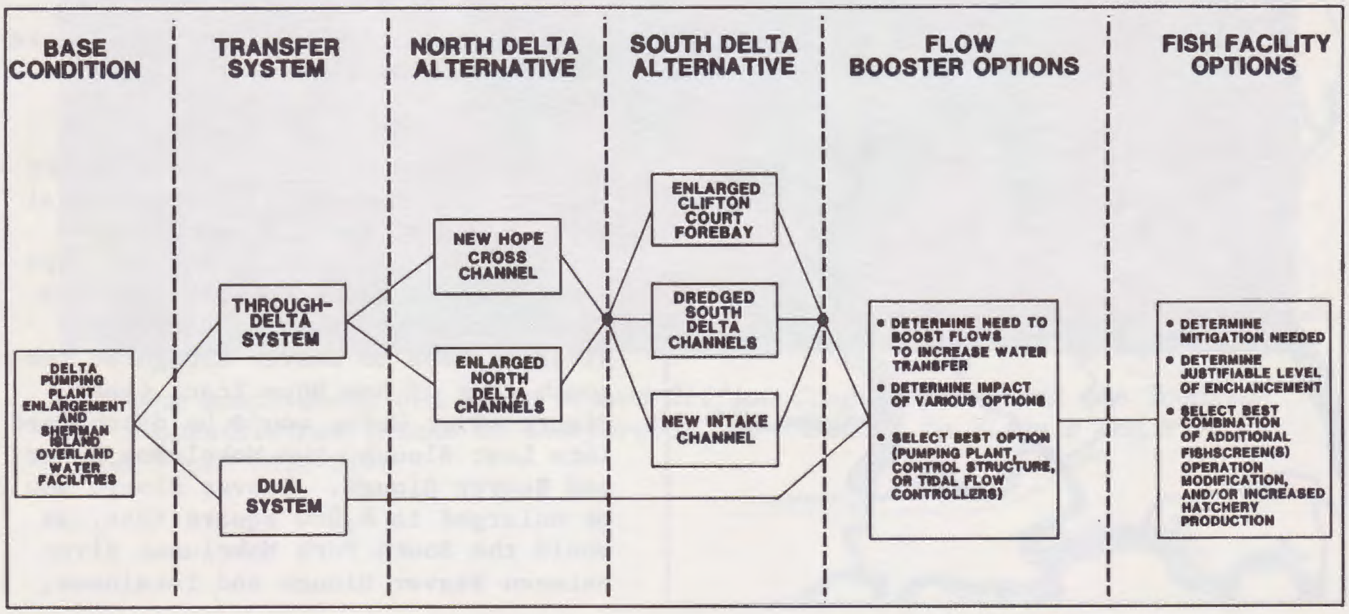


Figure 7 DELTA WATER TRANSFER ALTERNATIVES

capacity of existing channels or by adding another transfer channel.

Enlarged North Delta Channels. The present transfer of water from the Sacramento River to the central Delta via the Delta Cross Channel and Georgiana Slough could be increased by enlarging the cross section of the transfer channels. Georgiana Slough or the North or South Forks of the Mokelumne River could be enlarged. Enlarging the South Fork Mokelumne River was selected for this basic alternative, because it would require fewer levee setbacks and would cost less than would enlarging the other two channels. The South Fork Mokelumne River cross section would be increased to about 8,000 square feet by levee setbacks (up to 200 feet) from Dead Horse Cut to Hog Slough and channel dredging from Dead Horse Cut to Terminous (see Figure 8).

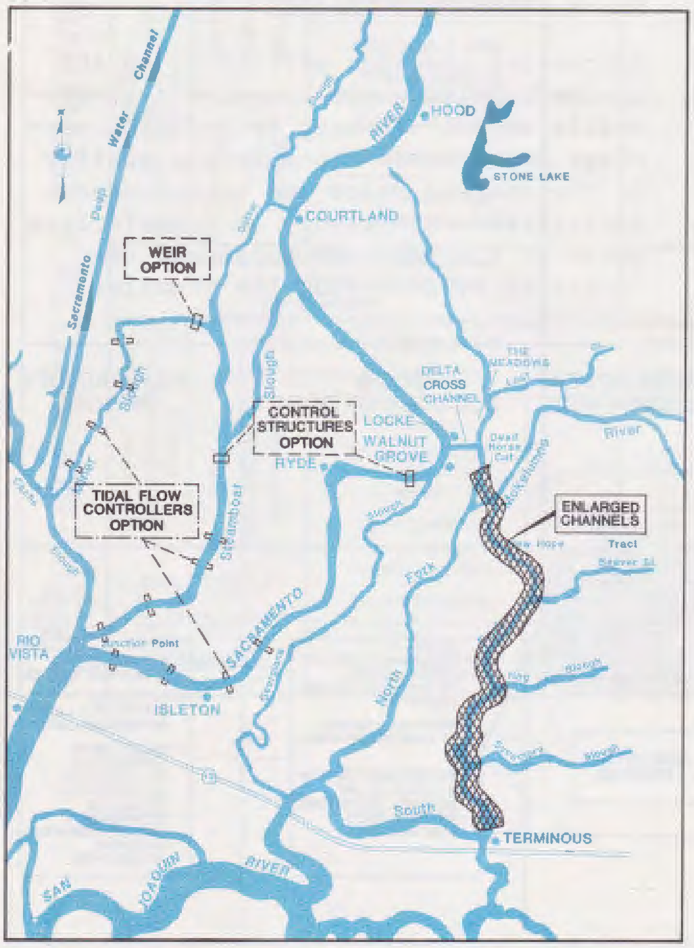


Figure 8 Enlarged North Delta Channels.

Figure 9 shows the amount of Sacramento River water transferred into the central Delta through Georgiana Slough and the Delta Cross Channel under various Sacramento River flows with existing conditions and with the South Fork Mokelumne River enlargement, under gravity flow conditions. (Flows are also shown for the New Hope Cross Channel, discussed below.)

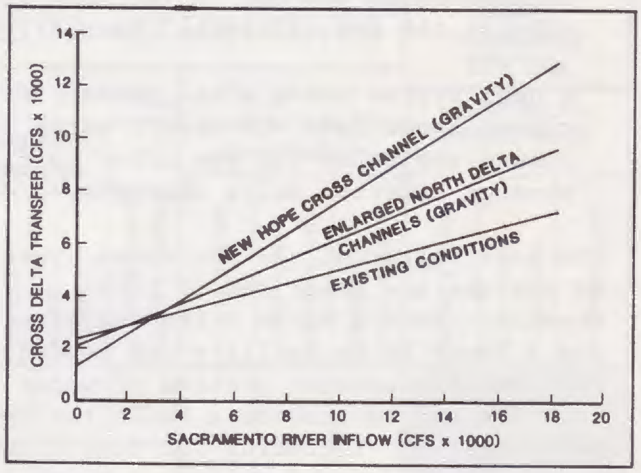


Figure 9 Relationship Between Flow in Sacramento River and Water Transfer Through the Delta.

Water transfer could be further increased by adding optional flow boosting features shown in Figure 8. These are discussed in Chapter 4. Fish screen facilities at the head of the Delta Cross Channel and Georgiana Slough are judged impractical, as explained in Chapter 4.

New Hope Cross Channel. The transfer of Sacramento River water to the central Delta could be greatly increased by building a new channel. The New Hope Cross Channel would consist of a new 12-mile channel from the Sacramento River at Hood to Beaver Slough at the south edge of New Hope Tract (see Figure 10). Water would be discharged into Lost Slough, the Mokelumne River, and Beaver Slough. Beaver Slough would be enlarged to 8,000 square feet, as would the South Fork Mokelumne River between Beaver Slough and Terminous.

Automated controls would be added to the Delta Cross Channel to prevent water transfer flows from returning to the Sacramento River during certain phases of the tide.

The New Hope Cross Channel would have a cross section of 8,000 square feet. An 8 to 1 slope between high and low water levels would control wavewash, provide beaches, and save the cost of riprap or other slope protection. The channel would cross the Mokelumne River in an open section rather than a siphon. Flood control facilities would be built to protect the new channel and to maintain or improve flood protection in the drainage areas of Stone Lake and the Mokelumne River. Figure 9 compares the amount of water now transferred into the central Delta with the amount that could be transferred with the New Hope Cross Channel, under gravity flow conditions.

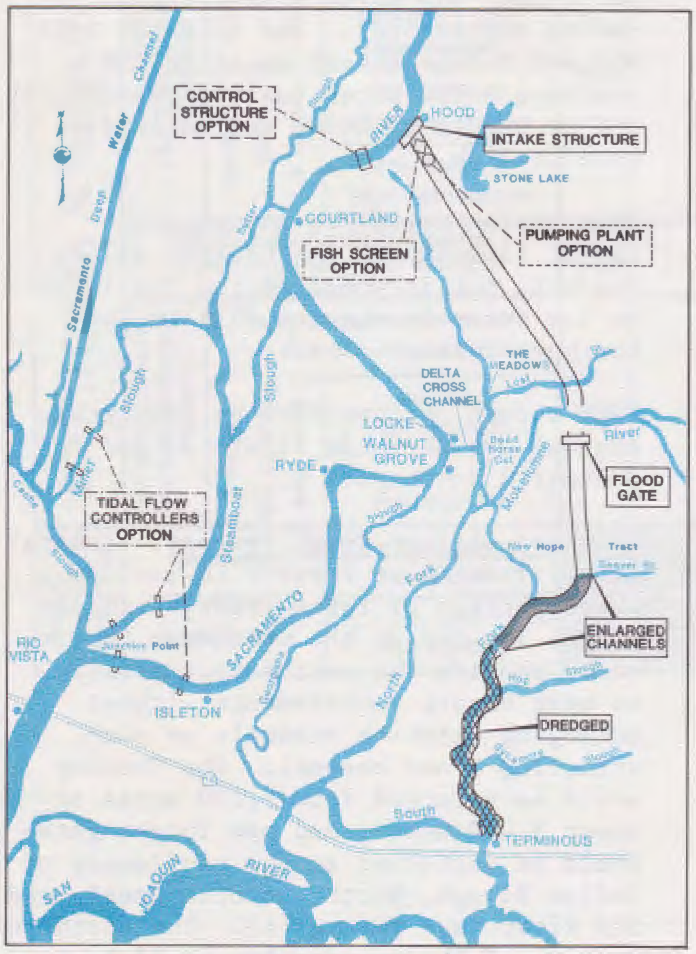


Figure 10 New Hope Cross Channel

Optional flow boosting features that could further increase the amount of water transferred are shown in Figure 10 and discussed in Chapter 4, as are optional fish screens at the head of the New Hope Cross Channel.

South Delta Alternatives

Southern Delta channels historically were sized to contain only flood and tidal flows in the area. The amount of water that can be pumped from the southern Delta without eroding the channels and levees is limited. Clifton Court Forebay was built to store water so pumping could be done during periods of the tidal cycle when channels would not be scoured and drawdown of water levels in the channels would be minimized. The forebay is big enough for the present capacity of the Harvey O. Banks Delta Pumping Plant, but to increase the Delta export capacity of the State Water Project to 10,300 cubic feet per second would require additional water-conveying capacity in the southern Delta. Any of three alternatives could provide this:

° Dredging existing channels.

° Adding a new intake channel.

° Enlarging Clifton Court Forebay.

Dredged South Delta Channels. Increased capacity through existing southern Delta channels would require channel improvements in Old River, Middle River, and Victoria Canal near Clifton Court Forebay and increased inlet capacity from these channels into the forebay (see Figure 11).

Victoria Canal now has an effective cross section of about 4,500 square feet, which could be increased to 7,200 square feet by removing the berm islands from the center of the channel. Middle River along Victoria Island would also have to be enlarged to about 7,200 square feet by deepening the channel and removing some of the channel berms. Old River probably would require only riprapping of levee and channel edges on the outside of bends.

A new intake structure with peak capacity of 8,000 cubic feet per second would be built on the northeast corner of Clifton Court. This would increase the average daily export capacity of the State Water Project by 4,000 cubic feet per second. The existing intakes to Clifton Court Forebay and the Tracy Pumping Plant would still be used.

New fish screen facilities are impractical with this alternative because of the physical limits at the intakes, which are discussed in Chapter 4.

New Intake Channel. As an alternative to removing channel islands and berms as described above, a 5-mile-long intake channel could be built from Middle River to Clifton Court Forebay (see Figure 12). The new channel would be large enough (8,000 cubic feet per second peak capacity) to increase the average daily export capacity by 4,000 cubic feet per second for the State Water Project. The facility would include a new channel paralleling the south levee of Victoria Canal, with gates, a siphon under Old River, and a levee high enough to protect against flood levels. An 8 to 1 slope between high and low water levels would control wavewash, provide beaches, and save the cost of riprap or other slope protection.

Middle River along the eastern edge of Victoria Island would probably require dredging and partial removal of berms to increase the cross section to 7,200 square feet. The existing intakes to Clifton Court Forebay and the Tracy Pumping Plant would also be used.

Another option is to take all State Water Project and Central Valley Project water through a new intake channel. In this case, the new intake channel would have a cross section of about 10,000 square feet and would extend 15 miles to the Stockton Ship Channel in the San Joaquin River. A connection would be provided between Clifton Court Forebay and the Tracy Pumping Plant intake channel. The channel would include an intake structure adjacent to the ship channel and a siphon below Old River (see Figure 13). The intake structure would prevent reverse tidal flows and adverse currents in the ship channel. The new channel would be large enough (25,000 cubic feet per second peak capacity) to increase the average daily export capacity to 15,000 cubic feet per second.

Major relocation would be required at the crossing of the Santa Fe Railroad and the Mokelumne Aqueduct. Middle River would be closed at the new channel crossing, with flood intake works and a facility to release water south into Middle River. The existing State Water Project and Central Valley Project intakes would be used only to release water into Old River or for export during emergencies. The releases into Old and Middle rivers would be for southern Delta water quality improvement and to assure positive northerly flow to benefit fish.

This option would not increase the export capacity of the Central Valley Project, but it would lessen its impact on low water levels and fish in the southern Delta.

Fish screen options for the new intake channel are shown in Figure 13 and discussed in Chapter 4.

Enlarged Clifton Court Forebay. Enlarging Clifton Court Forebay to include a major portion of Byron Tract, with the intake located at the northeast corner, could provide the necessary capacity to meet export requirements without enlarging existing channels or constructing a new channel. The forebay would be enlarged from 2,200 acres to about 5,000 acres, and new intake gates would be installed at the confluence of Indian Slough, North Victoria Canal, and Old River (see Figure 14). The northern portion of the new forebay would be

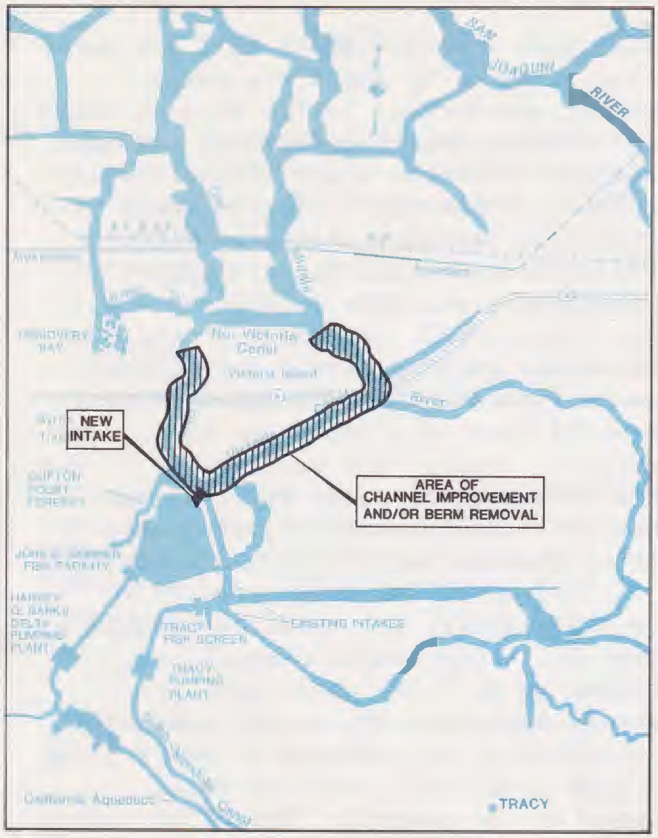


Figure 11 Dredged South Delta Channels and New Clifton Court Forebay Intake

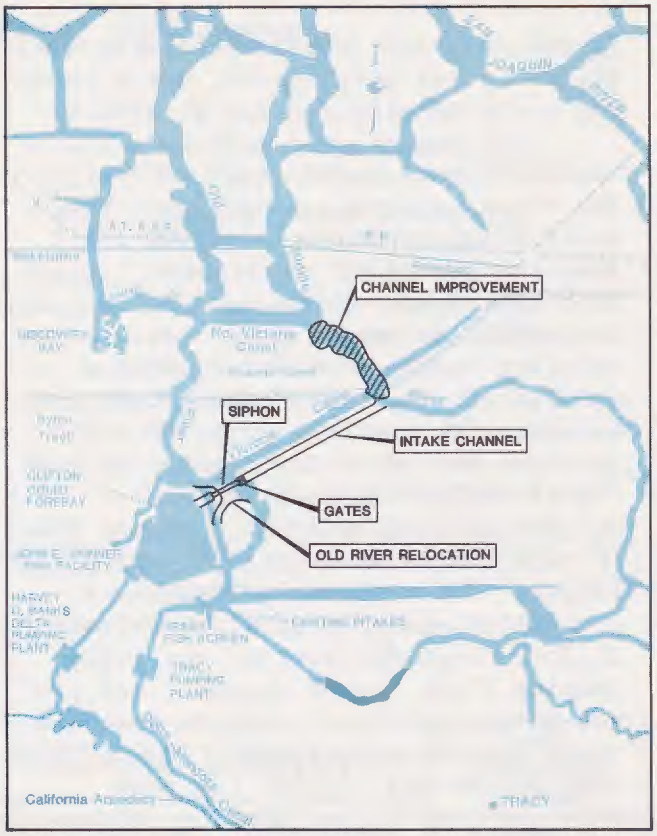


Figure 12 New Intake Channel to Clifton Court Forebay from Middle River, SWP Only

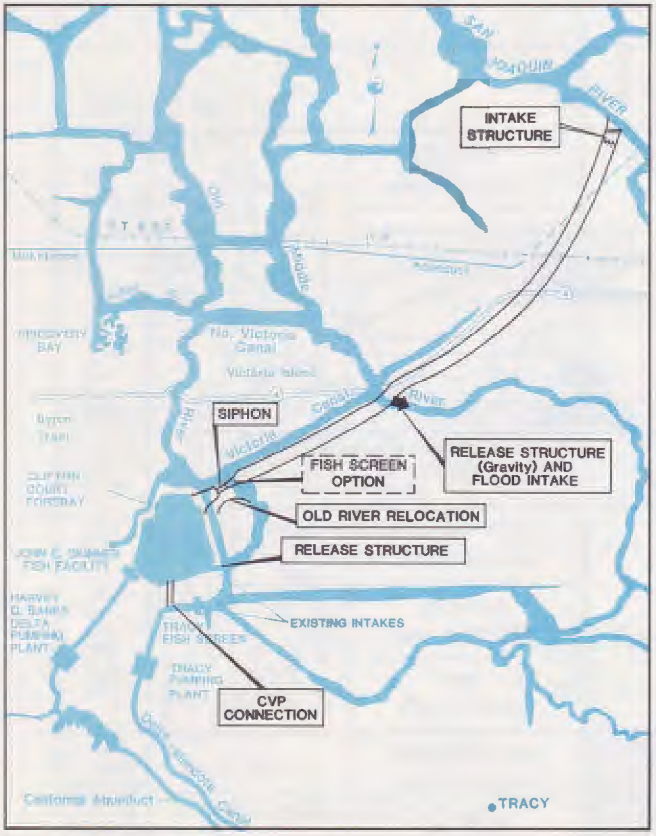


Figure 13 New Intake Channel to Clifton Court Forebay from San Joaquin River, SWP and CVP

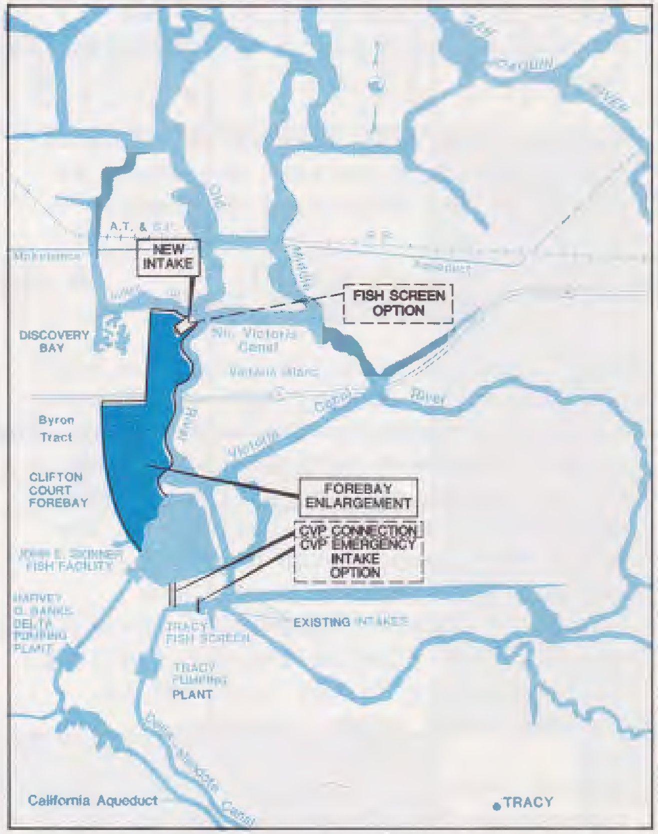


Figure 14 Enlarged Clifton Court Forebay

leveed to avoid interference with the Discovery Bay development, and a causeway would be provided for Highway 4.

The new intake gates could be designed for three optional capacities. They could be sized for up to 5,000 cubic feet per second of State Water Project exports (10,000 cfs peak capacity), with the remaining export taken through the existing State and Federal intakes. Under a second option, the intake could be sized for the entire 10,300 cubic feet per second of State Water Project export (18,000 cfs peak capacity), with the Central Valley Project export taken through the existing Tracy Pumping Plant intake. Under the third option, a connection could be provided between Clifton Court Forebay and the Tracy Pumping Plant intake channel, and the new intake could be sized to take all State and Federal exports, 15,000 cubic feet per second (25,000 cfs peak capacity), with the existing intakes used only for emergencies. This third option would not increase the export capacity of the Central Valley Project, but it would lessen its impact on water levels in the southern Delta and provide an opportunity for improved fish screens.

Optional new fish screens for each of the intake gate options are shown in Figure 14 and discussed in Chapter 4.

Dual Transfer System

Many fish and wildlife interests have concluded that taking all export water around the Delta is the best way to slow or halt the adverse effects on fish caused by the present system of exporting water through the Delta. On the other hand, many water users in the central and southern Delta have concluded that a system that keeps the export water flowing through existing Delta channels is the best way to protect local water supplies.

A dual transfer system would be a compromise for these two interests. Under this concept, about half the water being exported by the State Water Project and Central Valley Project would flow through existing channels and half in a new channel. A new channel could be built from Hood to Clifton Court Forebay to transfer all State Water Project flows in all but the high-flow, high-diversion months (see Figure 15).

While this facility would follow the same alignment as the Peripheral Canal, it would have only one-third the capacity. Except for small areas to the east, Delta water needs would be met from flow through existing channels rather than releases from the canal.

For this report, the capacity of this "East Delta Conveyance Channel" was assumed to be 7,500 cubic feet per second, including 300 to 500 cubic feet per second to be released to Delta lands severed from their existing water supply by the channel. The 7,500-cubic-foot-per-second capacity of the new channel would eliminate the need for carriage water. Needs of the State Water Project beyond the capacity of the

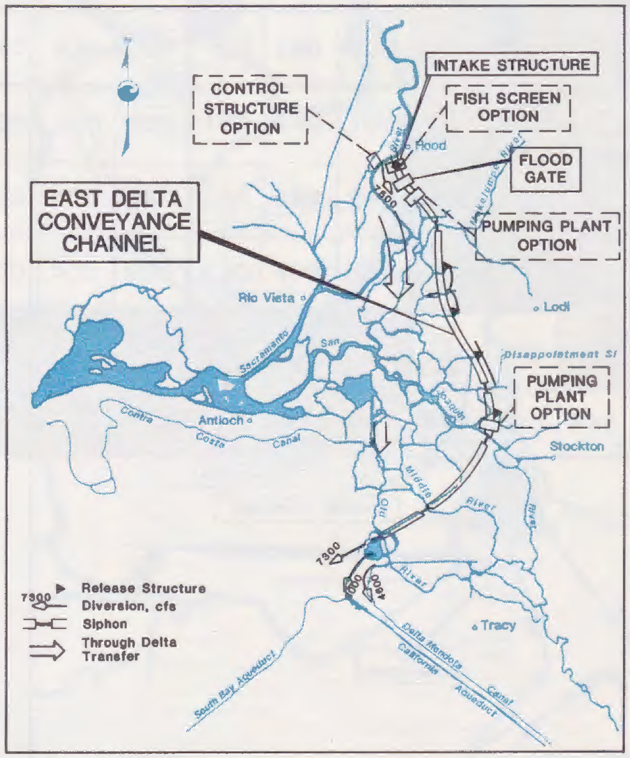


Figure 15 Dual Transfer System

East Delta Conveyance Channel would be met by existing project facilities, which take water directly from existing Delta channels. During most of the year, the State Water Project would take water only through the new channel. During high flows of winter and early spring, the State would also pump from southern Delta channels. The Central Valley Project would pump all its water directly from existing southern Delta channels, as it does today.

Under the basic alternative, the new channel would operate by gravity, with a 3-foot drop from the intake on the Sacramento River to Clifton Court Forebay. The East Delta Conveyance Channel would be about 30 feet deep and 400 feet wide at the top. An 8 to 1 slope between high and low water levels would control wavewash, provide beaches, and save the cost of riprap or other slope protection. The dimensions coincide with the size of existing pits along the proposed route, which were dug in the 1970s to supply material for highway construction. In the southern Delta, the cross section would be larger to provide enough material for the channel embankments.

The East Delta Conveyance Channel would siphon under the Mokelumne River, Disappointment Slough, San Joaquin River, Middle River, and Old River. The siphons would be deep and long enough to allow the rivers and sloughs to carry flood flows and permit fish migration.

The design options (pumping plant, fish screen, and control structure) for this system are shown on Figure 15 and are described in Chapter 4.

Chapter 4. OPTIONAL FEATURES

Several design options for boosting flow to improve water transfer and for providing additional protection for Delta fish are available for each of the basic alternatives described in Chapter 3.

Flow Boosting Options

In the through-Delta transfer systems, features could be added to the North Delta alternatives to raise the water level at the head of one or more of the main transfer channels and thus boost the water flow across the Delta. Without the optional flow boosting features, the through-Delta systems would not transfer enough water through the central Delta to eliminate reverse flows in the western Delta under all conditions. The flow boosters would eliminate these reverse flows and the need for carriage water, and thus maximize project yield from the Delta.

In the case of the dual transfer system, the system itself greatly reduces reverse flows in the western Delta and eliminates the need for carriage water. However, the flow booster options would allow design changes to reduce the size of the East Delta Conveyance Channel, including its siphons. The flow-boosting features considered in this report are pumping plants, control structures, and tidal flow controllers. These design options have varying impacts on costs, navigation, and fish.

Pumping Plants

Pumping plants could be included in the East Delta Conveyance Channel of the dual transfer system and in the New Hope Cross Channel North Delta alternative of the through-Delta systems. A pumping plant could also be constructed near the Delta Cross Channel for the remaining through-Delta alternatives with enlarged North Delta channels. However, the pumping plant option was not considered further for these alternatives because it was assumed that fish screens would be required for any pumping plant, and fish screens were judged to be impractical in the Delta Cross Channel area due to limited space and fish return problems. This area is congested by the historic town of Locke, Walnut Grove, The Meadows, and the Walnut Grove television tower. The pumping plant would, at times, create a reverse flow condition in the Sacramento River between Junction Point and the Delta Cross Channel. Returning the screened fish to such an environment would not be satisfactory, because they would be drawn toward the pumps and again subjected to screening. The alternative of transporting the screened fish to the Sacramento River in the Rio Vista area to avoid the reverse flow condition would also be unsatisfactory because of the distance involved and the need to siphon under Georgiana Slough.

The pumping plant option considered for the East Delta Conveyance Channel would have a capacity of 7,500 cubic feet per second and a lift of about 8 feet. The pumping plant could be located in the channel either near the Hood intake or just north of the San Joaquin River (see Figure 15). The location at the San Joaquin River would lower the water level and minimize potential seepage from the northern portion of the new channel, but would increase the cost to more than that shown in this report. With the pumping plant, the channel cross section could be reduced by up to 45 percent in some reaches in the northern Delta (but not where the Interstate

Highway 5 borrow pits are), compared to that required with gravity flow. The siphon sizes could be reduced by up to 65 percent.

The pumping plant considered for the New Hope Cross Channel in the through-Delta systems would have a capacity of about 17,000 cubic feet per second and a lift of about 1 foot (see Figure 10). Since the new channel would be open to the Mokelumne River system at the downstream end, as yet undeveloped fish bypass facilities for upstream migrants would be required at the pumping plant.

Control Structures

Control structures could be added to any alternative to raise the water level at the North Delta intake to the transfer channels and thus boost flow through the central Delta. The control structures would be diversion dams, with facilities for commercial and recreational navigation and fish passage and gates to pass flood flows (see Figure 16).

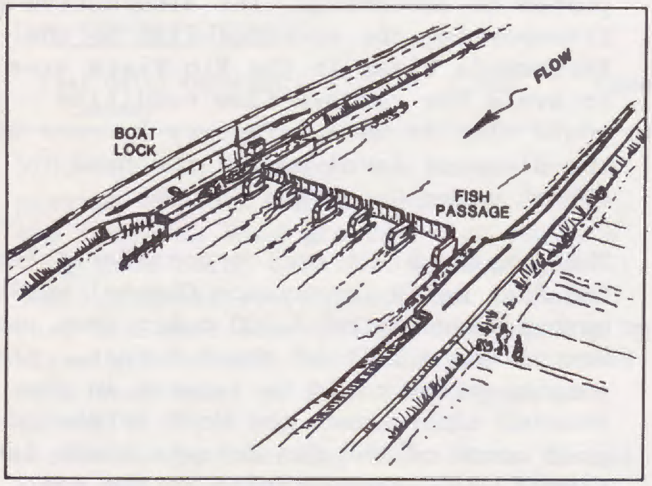


Figure 16 Illustration of a Control Structure

The control structure for the dual transfer system would be placed across the Sacramento River just downstream of the East Delta Conveyance Channel intake near Hood (see Figure 15). The water level upstream of the control structure would be raised 8 feet to reduce the size of the new channel to that described for the pumping plant option. There is some question regarding the upstream passage of striped bass through this water level differential.

The control structure for the New Hope Cross Channel alternative would be at the same location (see Figure 10), but would only need to raise the water level 1 foot or less to obtain the desired water transfer and to eliminate carriage water needs and reverse flows in the western Delta.

Three control structures would be required for the enlarged North Delta channel alternatives (see Figure 8). Full gated structures would be built across the Sacramento River downstream of Georgiana Slough and across Steamboat Slough downstream of Sutter Slough. The third structure would be a small weir across Miner Slough. In combination, these control structures would raise the water level about 1 foot near Walnut Grove to obtain the desired water transfer through the Delta Cross Channel and Georgiana Slough.

Tidal Flow Controllers

Tidal flow controllers would be similar to the control structures, except a permanent opening would be left in mid-channel to allow boats and fish to pass, and the gates would be opened to let the incoming tide pass and closed to inhibit the ebb tide (see Figure 17). All gates would be opened to pass flood flows. Each set of controllers would raise the upstream water level about 0.25 foot. For all North Delta alternatives, the controllers would be placed in the Sacramento River and Steamboat Slough above their confluence at Junction Point, and in Miner Slough upstream from Cache Slough. The openings would be about 80 feet wide in the Sacramento River and Steamboat Slough controllers and about 35 feet wide in the Miner Slough controllers.

The number of required sets of tidal flow controllers, spaced at least one-half mile apart, varies among the alternatives.

Two sets of controllers in each of the three channels (Sacramento River, Steamboat Slough, and Miner Slough) would be required with the New Hope Cross Channel alternative (see Figure 10). The controllers would boost the water transfer through the Delta Cross Channel, Georgiana Slough, and the New Hope Cross Channel enough to eliminate carriage water needs and reverse flows in the western Delta.

For the enlarged North Delta channel alternatives (see Figure 8), four sets of controllers in each of the three channels (Sacramento River, Steamboat Slough, and Miner Slough) would be required to boost water transfer enough to eliminate carriage water needs and reverse flows in the western Delta.

Tidal flow controllers were not considered practical for the East Delta Conveyance Channel, because there is no need to increase flow for water transfer and too many sets of controllers would be needed to effect the design changes that are possible with either a pumping plant or control structure.

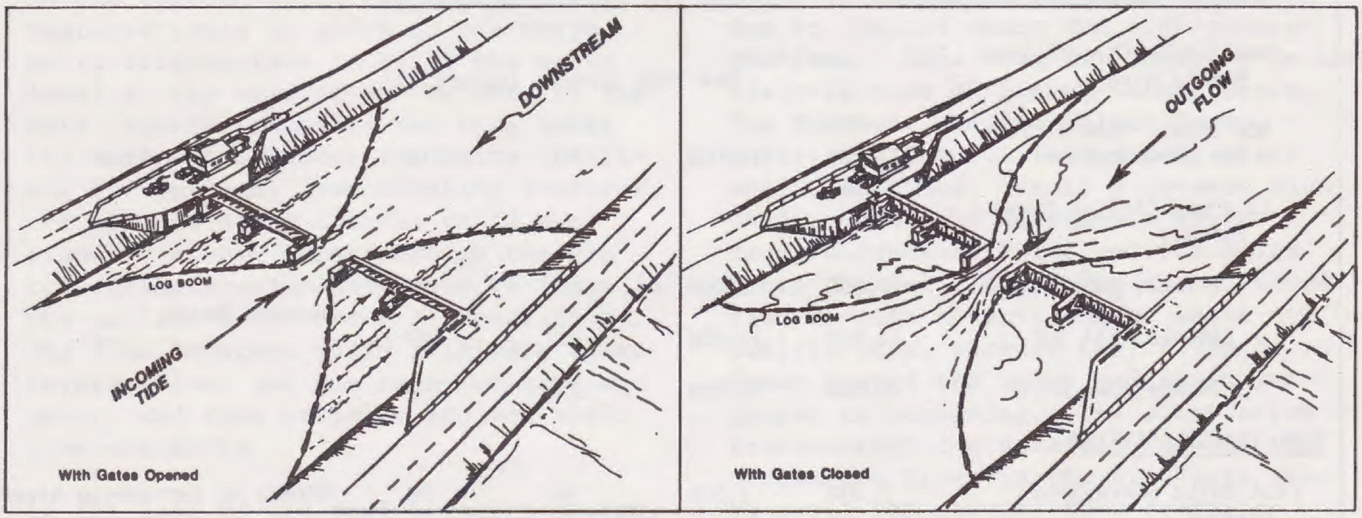


Figure 17 Illustration of a Set of Tidal Flow Controllers

Fish Facility Options

A number of options are available to reduce or mitigate damage to fish with most of the basic alternatives. Fish screen and return system options and hatcheries are discussed in the following sections.

Fish Screens and Return Systems

Because many of the alternatives involve rerouting internal Delta flows and constructing new points of diversion in the southern Delta, new, improved fish screens may be justified. Fish screen and return system options and their estimated costs for the alternatives are listed in Table 1. Following is a brief description of the components of the type of fish protective facility that would probably be built for all the alternatives.

As now perceived, the fish screens themselves would be essentially the same for all alternatives and would physically exclude any fish above a certain size from being diverted. (Since debris loads and the kinds and sizes of fish vary at different locations, detailed planning may indicate a need to vary the criteria.) The screens act like a sieve, with the hole size determined by the size of fish expected in the channels. Studies of the Sacramento River at Hood have shown that holes

Table 1

FISH SCREEN OPTIONS AND RETURN FACILITIES

Alternative	Flow at Maximum Export (cfs) Peak	Average Daily	Capital Cost (Million $) at Approach Velocity of 0.2 ft/sec	0.6 ft/sec	Return System
THROUGH-DELTA SYSTEMS					
North Delta Alternatives					
Enlarged North Delta Channels	New Fish Screens Impractical				
New Hope Cross Channel	17,000	17,000	170	80	Direct to Sacramento River
South Delta Alternatives					
Dredged South Delta Channels	New Fish Screens Impractical				
New Intake Channel from Middle River	New Fish Screens Impractical				
New Intake Channel from San Joaquin River	22,500	15,000	240	110	Direct to Old River
Enlarged Clifton Court Forebay					
Intake, Partial SWP	10,000	5,000	110	50	Truck or Barge to Western Delta
Intake, All SWP	18,000	10,300	190	90	
Intake, SWP & CVP	25,000	15,000	270	120	
DUAL TRANSFER SYSTEM					
East Delta Conveyance Channel	7,500	7,500	80	40	Direct to Sacramento River

5/32-inch in diameter are necessary to prevent chinook salmon, striped bass, and American shad greater than an inch long from being diverted with the water. Smaller holes are impractical because they are more susceptible to plugging by algae growth and debris in the channels. Fish less than an inch long, such as larval striped bass, can only be protected by limiting diversions during the time they are most abundant.

Water velocity through the screen must be low enough so that the small fish are not forced onto the screen face (impinged), where they may die. The optimum through-screen velocity depends on the species to be protected, the stage of the fish's development, and even the time of day. For species inhabiting the Delta, velocities immediately next to the screen (approach velocities) in the range of a few tenths of a foot per second will be necessary.

Studies by the Department of Water Resources and Department of Fish and Game have shown that an approach velocity of 0.6 foot per second is slow enough to prevent juvenile American shad and chinook salmon from becoming impinged under conditions with light. In the dark, 0.6 foot per second is adequate for small salmon, but the velocity must be lowered to 0.2 foot per second to protect shad (see Table 2).

To ensure that juvenile fish are protected continuously, while minimizing the cost of fish screen facilities, new

Delta water transfer facilities would be operated from July through October (the period of maximum shad abundance) at 0.6 foot per second during daylight and at 0.2 foot per second or less during the dark. There is some uncertainty whether sufficient daylight will reach the bottom of the screens in deep water (due to turbidity), but this might be overcome by artificial lighting, if necessary. Preliminary operation studies show that the required flow rates (for export, central Delta demands, and Delta outflow) can be achieved using this pumping schedule.

In Table 1, the cost of a fish facility designed for 0.2 foot per second is compared to one designed for 0.6. Costs of screens for the alternatives analyzed in Chapter 5 are based on an approach velocity of 0.6 foot per second, with operational constraints from July through October to keep the approach velocity from exceeding 0.2 foot per second at night. Considerable capital cost savings result from pumping to achieve 0.6 foot per second during the day and 0.2 at night.

The fish protective facility would be designed to include a return system that would minimize losses while allowing the screened fish to reach their original destination. At diversion points on the Sacramento River, the downstream migrating fish would be returned to the Sacramento River, where they could continue their journey. At diversions in the southern Delta (a screen for an enlarged Clifton Court Forebay, for example), the screened fish would have to be collected for transport (by truck or barge) to areas in the western Delta, beyond the influence of the pumps.

All the new screens would have common features, such as protection from flood damage, provisions for minimizing sediment buildup, and methods to ensure that the required through-screen and channel velocities are maintained. As shown on Figure 18, in all alternatives the screens will probably be in the form of "Vs" so that the total space occupied by the screens can be minimized, which in turn minimizes the length of time fish must spend in front of the screen.

Table 2

CHINOOK SALMON AND AMERICAN SHAD SWIMMING PERFORMANCE IN RELATION TO LIGHT CONDITIONS AND WATER VELOCITY

Water Velocity (ft/sec)	Percent Fish Swimming After One Hour: Salmon Light	Salmon Dark	Shad Light	Shad Dark
0.2	93	95	98	74
0.6	94	94	100	56

Source: "Long Term Swimming Performance of Juvenile American Shad, Aloesa sapidissima, and Chinook Salmon, Oncorhynchus tshawytscha", Department of Fish and Game, March 1981.

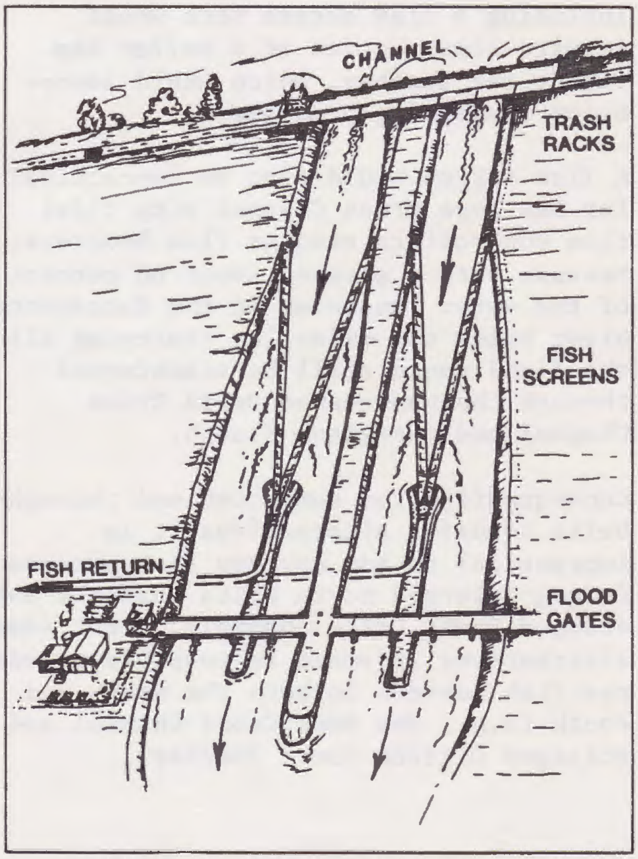


Figure 18 Illustration of Fish Screen and Fish Return System

Chapter 5. SELECTION PROCESS

As noted in Chapter 3, seven water transfer systems are evaluated -- the six alternative through-Delta transfer systems obtained by combinations of the two North Delta alternatives and the three South Delta alternatives, and the dual transfer system. These seven basic alternatives, illustrated by the bold lines on Figure 19, are shown to the right.

Considering the various flow boosting options and the fish screen options discussed in Chapter 4, there are 69 variations of the seven basic alternatives.

Plan A - New Hope Cross Channel and Enlarged Clifton Court Forebay

Plan B - New Hope Cross Channel and Dredged South Delta Channels and New Clifton Court Forebay Intake

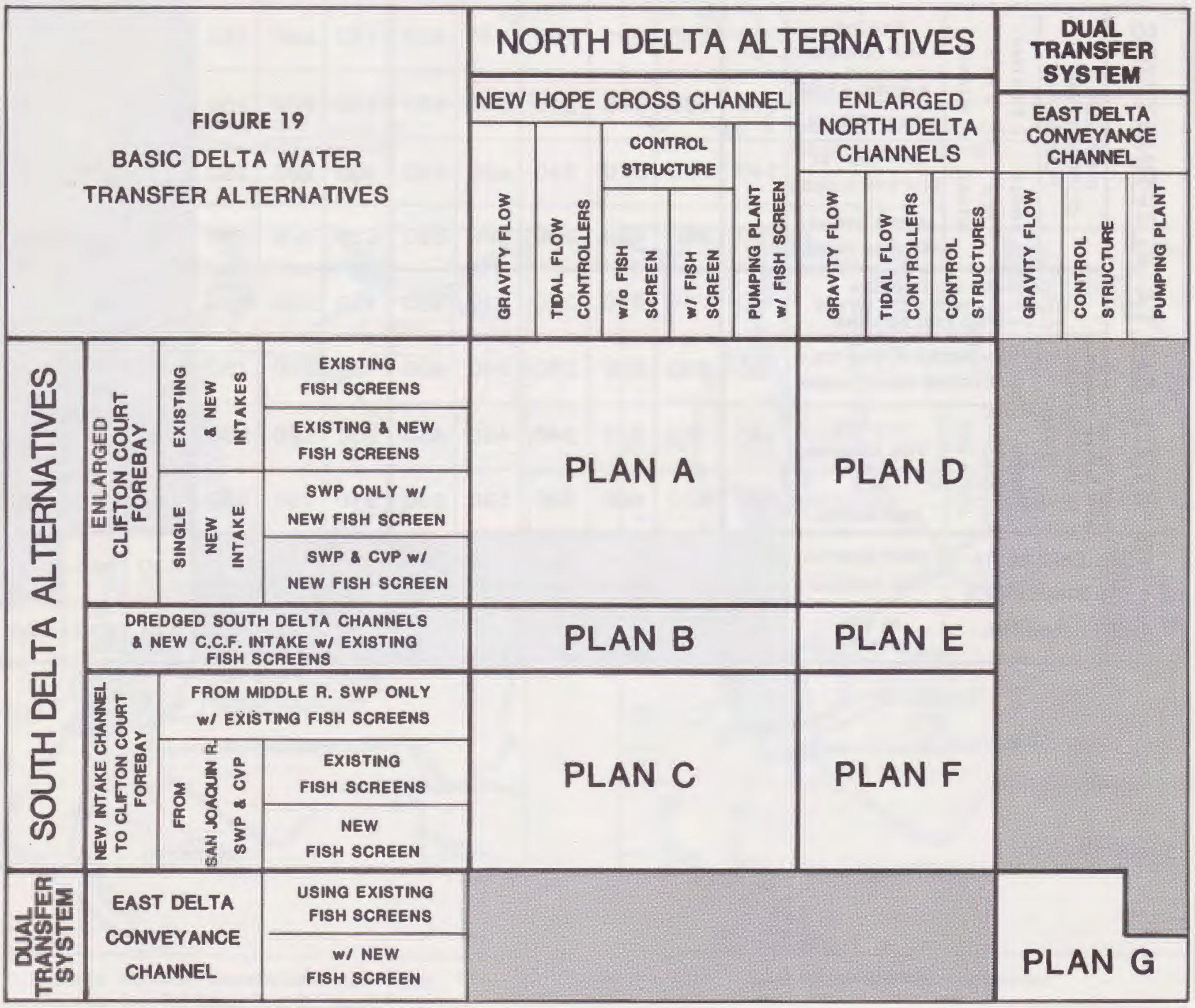
Plan C - New Hope Cross Channel and New Intake Channel to Clifton Court Forebay

Plan D - Enlarged North Delta Channels and Enlarged Clifton Court Forebay

Plan E - Enlarged North Delta Channels and Dredged South Delta Channels

Plan F - Enlarged North Delta Channels and New Intake Channel to Clifton Court Forebay

Plan G - Dual Transfer System



Estimated capital costs for the 69 variations, shown in Figure 20, range from $100 million to nearly $600 million. These costs include the physical works (including levee and channel improvement) necessary to transfer water more efficiently, but do not include rehabilitation of all Delta levees, overland facilities in the western Delta, relocation of the Contra Costa Canal intake, or South Delta water facilities. Figure 20 also shows the separate costs of the North Delta and South Delta alternatives that were added to get the cost of the 69 variations.

FIGURE 20
ESTIMATED CAPITAL COST OF VARIATIONS OF BASIC DELTA WATER TRANSFER ALTERNATIVES
(IN MILLIONS OF DOLLARS)

		North Delta Alternatives – New Hope Cross Channel: Gravity Flow	New Hope Cross Channel: Tidal Flow Controllers	New Hope Cross Channel: Control Structure w/o Fish Screen	New Hope Cross Channel: Control Structure w/ Fish Screen	New Hope Cross Channel: Pumping Plant w/ Fish Screen	Enlarged North Delta Channels: Gravity Flow	Enlarged North Delta Channels: Tidal Flow Controllers	Enlarged North Delta Channels: Control Structures	Dual Transfer System – East Delta Conveyance Channel: Gravity Flow	East Delta Conveyance Channel: Control Structure	East Delta Conveyance Channel: Pumping Plant
		170	230	200	280	340	60	180	90			
SOUTH DELTA ALTERNATIVES – Enlarged Clifton Court Forebay – Existing & New Intakes – Existing Fish Screens	60	230	290	260	340	400	120	240	150			
SOUTH DELTA ALTERNATIVES – Enlarged Clifton Court Forebay – Existing & New Intakes – Existing & New Fish Screens	110	280	340	310	390	450	170	290	200			
SOUTH DELTA ALTERNATIVES – Enlarged Clifton Court Forebay – Single New Intake – SWP Only w/ New Fish Screen	140	310	370	340	420	480	200	320	230			
SOUTH DELTA ALTERNATIVES – Enlarged Clifton Court Forebay – Single New Intake – SWP & CVP w/ New Fish Screen	190	360	420	390	470	530	250	370	280			
SOUTH DELTA ALTERNATIVES – Dredged South Delta Channels & New C.C.F. Intake w/ Existing Fish Screens	40	210	270	240	320	380	100	220	130			
SOUTH DELTA ALTERNATIVES – New Intake Channel to Clifton Court Forebay – From Middle R. SWP Only w/ Existing Fish Screens	60	230	290	260	340	400	120	240	150			
SOUTH DELTA ALTERNATIVES – New Intake Channel to Clifton Court Forebay – From San Joaquin R. SWP & CVP – Existing Fish Screens	140	310	370	340	420	480	200	320	230			
SOUTH DELTA ALTERNATIVES – New Intake Channel to Clifton Court Forebay – From San Joaquin R. SWP & CVP – New Fish Screen	250	420	480	450	530	590	310	430	340			
DUAL TRANSFER SYSTEM – East Delta Conveyance Channel – Using Existing Fish Screens										430	380	
DUAL TRANSFER SYSTEM – East Delta Conveyance Channel – w/ New Fish Screen										470	420	440

The potential additional yield of each of the seven basic alternatives is estimated to be 500,000 acre-feet per year over a 7-year critical dry period such as 1928 through 1934. However, for the gravity flow variations in the northern Delta, the actual critical dry period yield would be less -- 250,000 acre-feet for enlarged North Delta channels and 450,000 acre-feet for New Hope Cross Channel. Figure 21 shows additional yields for the 69 variations.

FIGURE 21

APPROXIMATE ADDITIONAL DRY-PERIOD YIELD TO THE SWP BY DELTA WATER TRANSFER ALTERNATIVES

(IN THOUSANDS OF ACRE-FEET/YEAR)

<table>
<tr><th colspan="4" rowspan="4"></th><th colspan="8">NORTH DELTA ALTERNATIVES</th><th colspan="3">DUAL TRANSFER SYSTEM</th></tr>
<tr><th colspan="5">NEW HOPE CROSS CHANNEL</th><th colspan="3">ENLARGED NORTH DELTA CHANNELS</th><th colspan="3">EAST DELTA CONVEYANCE CHANNEL</th></tr>
<tr><th rowspan="2">GRAVITY FLOW</th><th rowspan="2">TIDAL FLOW CONTROLLERS</th><th colspan="2">CONTROL STRUCTURE</th><th rowspan="2">PUMPING PLANT w/ FISH SCREEN</th><th rowspan="2">GRAVITY FLOW</th><th rowspan="2">TIDAL FLOW CONTROLLERS</th><th rowspan="2">CONTROL STRUCTURES</th><th rowspan="2">GRAVITY FLOW</th><th rowspan="2">CONTROL STRUCTURE</th><th rowspan="2">PUMPING PLANT</th></tr>
<tr><th>w/o FISH SCREEN</th><th>w/ FISH SCREEN</th></tr>
<tr><td rowspan="9">SOUTH DELTA ALTERNATIVES</td><td rowspan="4">ENLARGED CLIFTON COURT FOREBAY</td><td rowspan="2">EXISTING & NEW INTAKES</td><td>EXISTING FISH SCREENS</td><td rowspan="4">450</td><td colspan="4" rowspan="4">500</td><td rowspan="4">250</td><td colspan="2" rowspan="4">500</td><td colspan="3" rowspan="9"></td></tr>
<tr><td>EXISTING & NEW FISH SCREENS</td></tr>
<tr><td rowspan="2">SINGLE NEW INTAKE</td><td>SWP ONLY w/ NEW FISH SCREEN</td></tr>
<tr><td>SWP & CVP w/ NEW FISH SCREEN</td></tr>
<tr><td colspan="3">DREDGED SOUTH DELTA CHANNELS & NEW C.C.F. INTAKE w/ EXISTING FISH SCREENS</td><td>450</td><td colspan="4">500</td><td>250</td><td colspan="2">500</td></tr>
<tr><td rowspan="3">NEW INTAKE CHANNEL TO CLIFTON COURT FOREBAY</td><td colspan="2">FROM MIDDLE R. SWP ONLY w/ EXISTING FISH SCREENS</td><td rowspan="3">450</td><td colspan="4" rowspan="3">500</td><td rowspan="3">250</td><td colspan="2" rowspan="3">500</td></tr>
<tr><td rowspan="2">FROM SAN JOAQUIN R. SWP & CVP</td><td>EXISTING FISH SCREENS</td></tr>
<tr><td>NEW FISH SCREEN</td></tr>
<tr><td rowspan="2">DUAL TRANSFER SYSTEM</td><td colspan="2" rowspan="2">EAST DELTA CONVEYANCE CHANNEL</td><td>USING EXISTING FISH SCREENS</td><td colspan="8" rowspan="2"></td><td colspan="3" rowspan="2">500</td></tr>
<tr><td>w/ NEW FISH SCREEN</td></tr>
</table>

The unit costs of water (dollars per acre-foot) for the 69 variations are shown in Figure 22. These unit costs are based on the critical dry period yields shown in Figure 21 and on repayment of capital costs shown in Figure 20, assuming a 50-year repayment period at 8 percent interest. In some cases, the unit cost of water is different between plans having the same capital cost and yield because annual operation and maintenance costs, which are included, are different. The unit cost of water varies from $23 to $103 per acre-foot.

FIGURE 22
APPROXIMATE UNIT COST OF WATER FROM DELTA WATER TRANSFER ALTERNATIVES
(DOLLARS PER ACRE-FOOT)
INTEREST AND REPAYMENT OVER 50-YEARS AT 8% INTEREST

				NORTH DELTA ALTERNATIVES								DUAL TRANSFER SYSTEM		
				NEW HOPE CROSS CHANNEL					ENLARGED NORTH DELTA CHANNELS			EAST DELTA CONVEYANCE CHANNEL		
						CONTROL STRUCTURE								
				GRAVITY FLOW	TIDAL FLOW CONTROLLERS	w/o FISH SCREEN	w/ FISH SCREEN	PUMPING PLANT w/ FISH SCREEN	GRAVITY FLOW	TIDAL FLOW CONTROLLERS	CONTROL STRUCTURES	GRAVITY FLOW	CONTROL STRUCTURE	PUMPING PLANT
SOUTH DELTA ALTERNATIVES	ENLARGED CLIFTON COURT FOREBAY	EXISTING & NEW INTAKE	EXISTING FISH SCREENS	43	49	44	57	69	40	41	26			
			EXISTING & NEW FISH SCREENS	53	57	53	66	78	57	49	34			
		SINGLE NEW INTAKE	SWP ONLY w/ NEW FISH SCREEN	59	62	58	71	83	67	54	39			
			SWP & CVP w/ NEW FISH SCREEN	69	61	66	79	91	83	63	48			
	DREDGED SOUTH DELTA CHANNELS & NEW C.C.F. INTAKE w/ EXISTING FISH SCREENS			39	45	41	54	66	33	37	23			
	NEW INTAKE CHANNEL TO CLIFTON COURT FOREBAY	FROM MIDDLE R. SWP ONLY w/ EXISTING FISH SCREENS		44	49	44	57	69	40	41	26			
		FROM SAN JOAQUIN R. SWP & CVP	EXISTING FISH SCREENS	59	62	58	71	83	67	54	39			
			NEW FISH SCREEN	79	80	76	89	101	103	72	58			
DUAL TRANSFER SYSTEM	EAST DELTA CONVEYANCE CHANNEL		USING EXISTING FISH SCREENS									72	64	
			w/ NEW FISH SCREEN									79	70	75

Narrowing the Choices

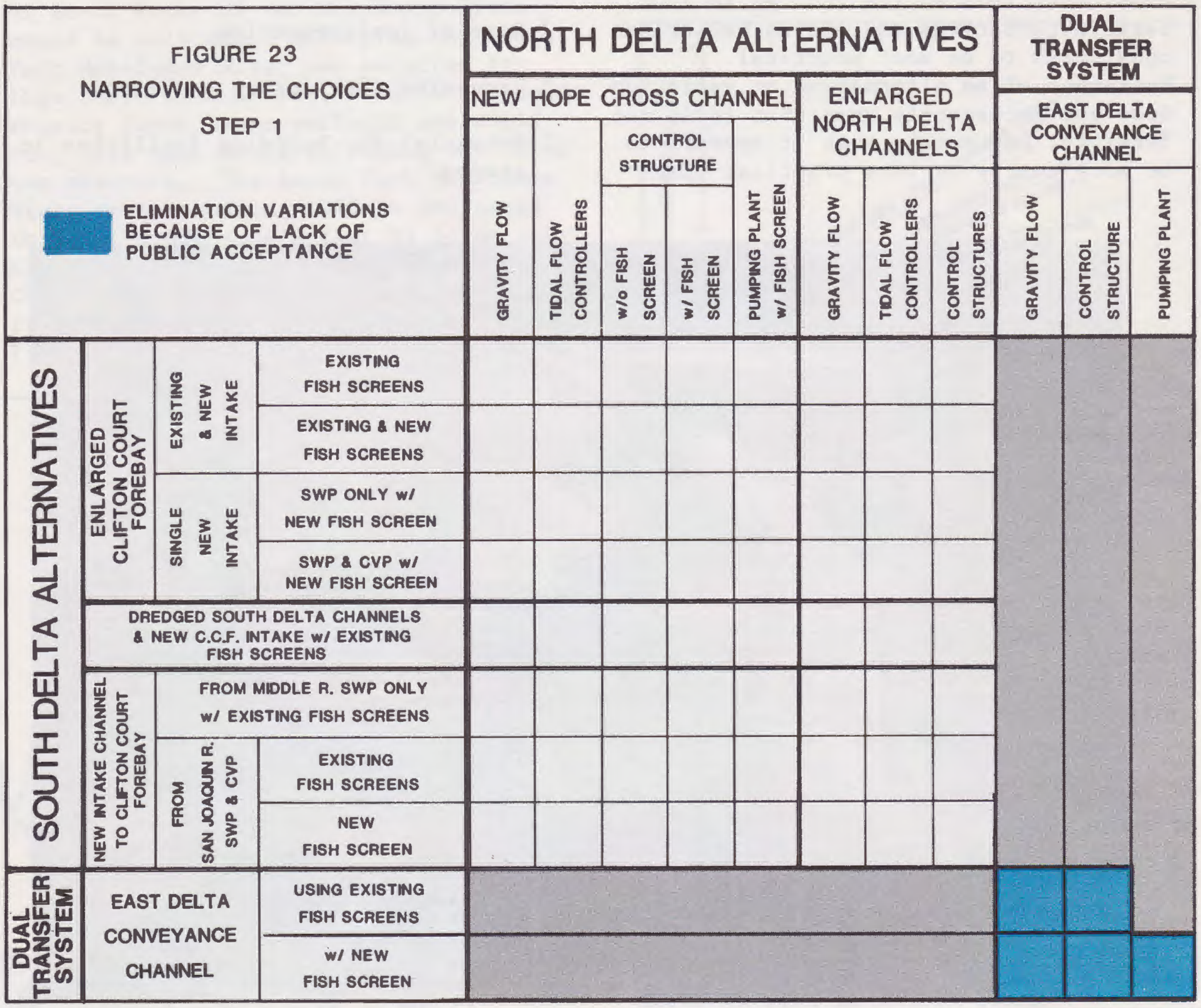
The selection process is not as simple as choosing the least costly option. Yield and effects on established Delta uses and activities, such as boating and agriculture, vary from plan to plan. Using a five-step process, the Department reduced the choices to four basic alternatives and eleven variations considered to be most practical. Exclusion of an alternative or variation does not necessarily mean that it is not feasible, but merely that it appears to be more costly or less practical than the other alternatives and options. Factors used to reduce the choices to a manageable number include:

- Public attitude.
- Compatibility with established activities.
- Ease of implementation.
- Excessive fish screen problems.
- Potential for building facilities in stages.

Looking south along Old River toward Clifton Court Forebay and the location of a possible new intake to the forebay, as included in Plans B and E. (DWR Photo 5435-36)

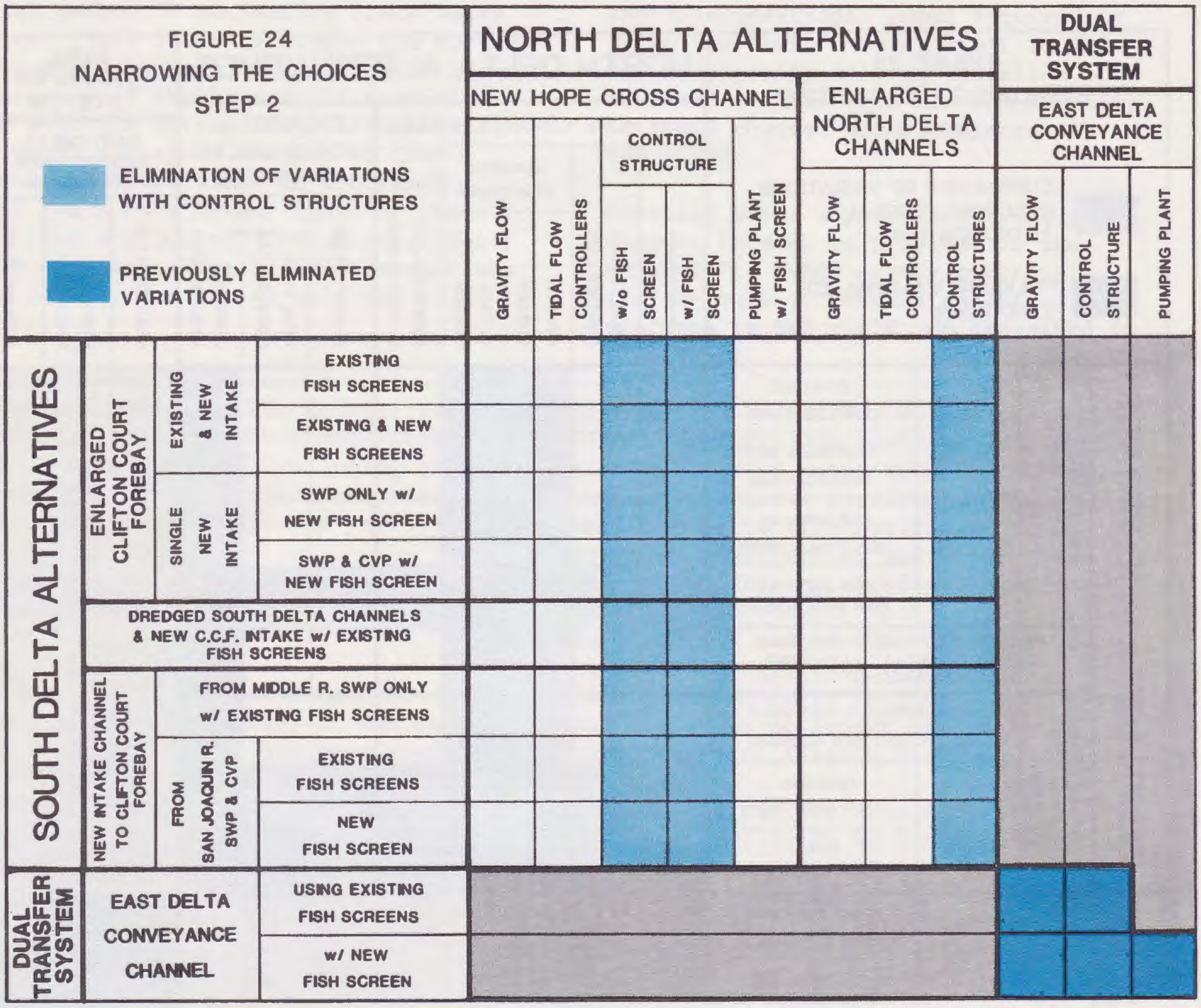
Step 1, Public Attitude

The concept of transporting part of the export water around the Delta and part of it through the Delta channels has been considered before. It is technically feasible and would reduce project effects on fish. However, because of its similarity to the Peripheral Canal, lack of public acceptance remains to any facility that would take export water around the Delta instead of through the central Delta channels. Therefore, the dual transfer system is eliminated from further consideration. This action reduces the number of basic alternatives from seven to six by eliminating Plan G (see Figure 19). The number of choices is reduced from 69 to 64 (see Figure 23).



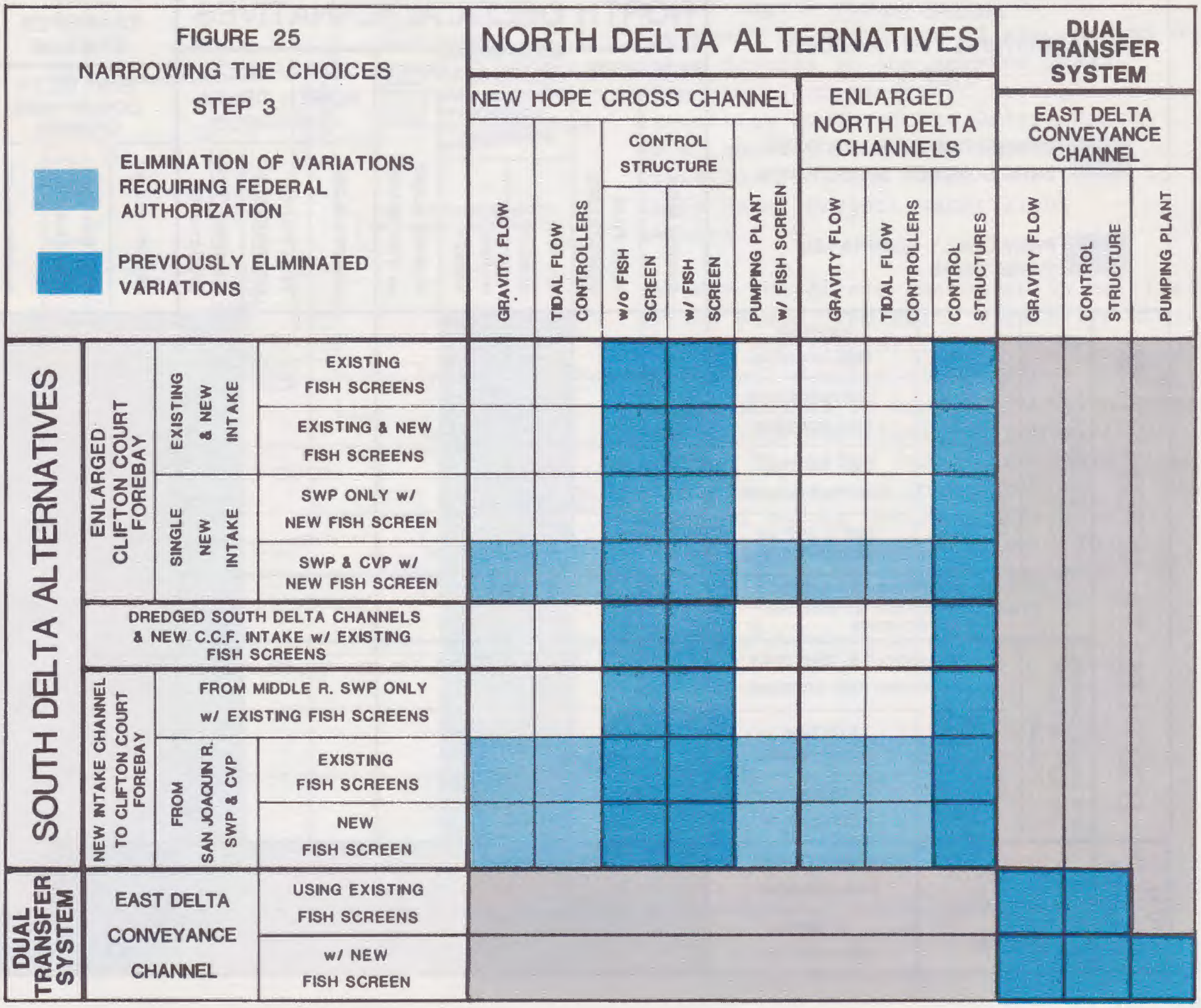
Step 2, Compatibility With Established Activities

Figure 22 shows that control structures (barriers) are the most cost-effective flow boosters for any of the alternative water transfer systems. Historically, however, such river closures have been strongly opposed by boating and fishery interests, even though this type of structure would be equipped with fish and boat passage facilities. In fact, this was a significant factor in the Department's decision not to adopt the Single Purpose Delta Water Project proposed in 1960. The 24 remaining control structure variations have been eliminated because they are less acceptable than other options. This reduces the choices from 64 to 40 (see Figure 24).



Step 3, Ease of Implementation

Some of the variations of the enlarged Clifton Court Forebay and the new intake channel to Clifton Court Forebay alternatives would require Federal participation, which would require congressional authorization. Budget and other problems make Federal participation unlikely for some time. Because the State Water Project needs action now, and since the State needs to maintain its autonomy for completing the project, the 15 variations requiring Federal authorization are less attractive than variations that could be implemented solely by the State. Therefore, those 15 variations have been eliminated, reducing the choices from 40 to 25 (see Figure 25). Such elimination does not necessarily exclude Federal participation now or in the future. If Federal authorization were achieved, the South Delta alternatives could be expanded to include the Central Valley Project.



Step 4, Excessive Fish Screen Problems

From a practical standpoint, several variations of combinations of North Delta and South Delta alternatives preclude a new fish screen in either the north or south because of physical restrictions explained in Chapter 4. These are the alternatives with tidal flow controllers or the enlarged North Delta channels alternative, when combined with either the new intake channel from Middle River or the dredged South Delta channels alternatives. Excluding these six variations further reduces the choices from 25 to 19 (see Figure 26). This action reduces the basic alternatives from six to four by eliminating Plans E and F (refer to Figure 19).

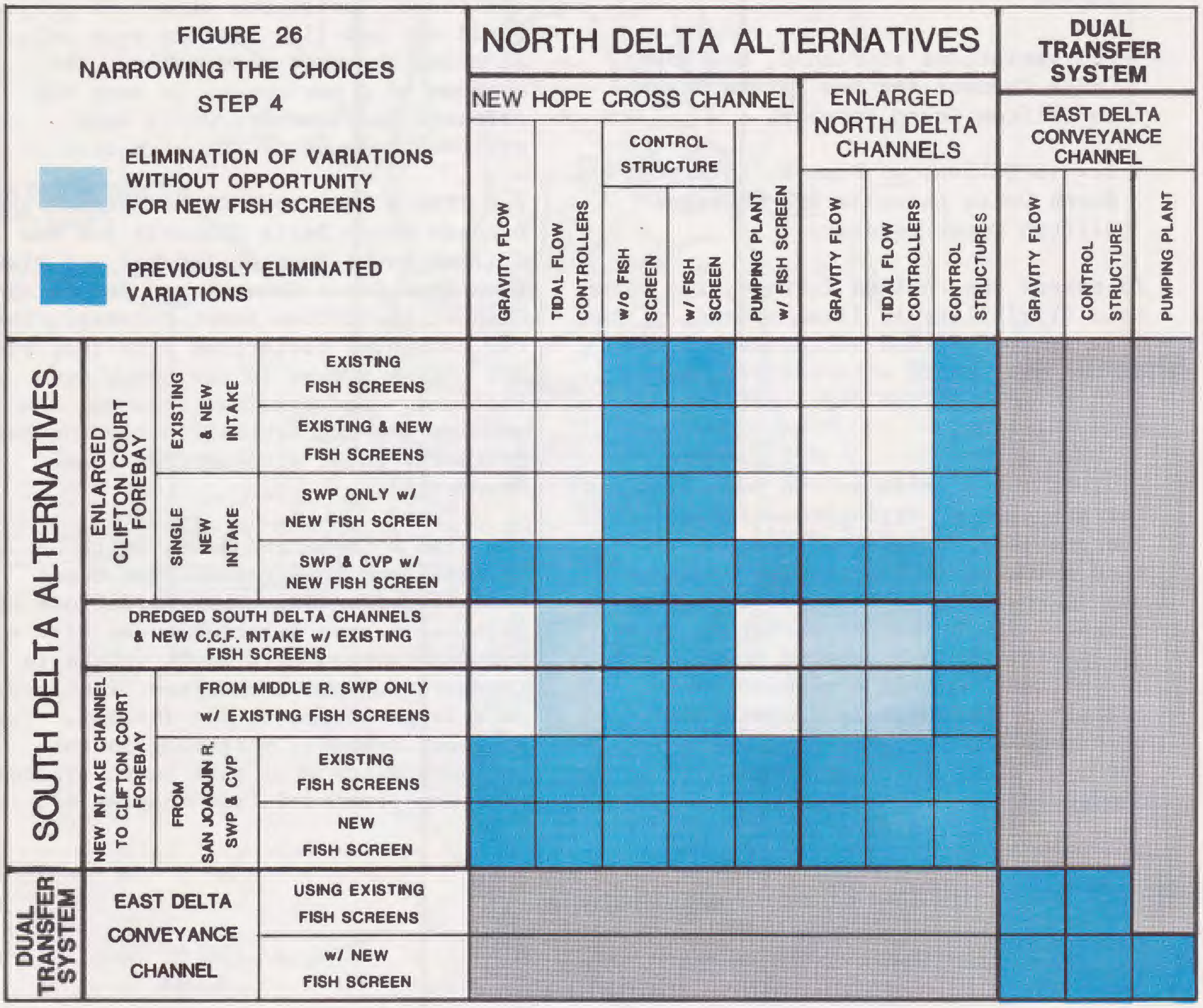


FIGURE 26
NARROWING THE CHOICES
STEP 4

Step 5, Potential for Building Facilities in Stages

In the preceding sections, the choices have been narrowed from seven basic alternatives with 69 variations to four basic alternatives with 19 variations:

- Nine variations of Plan A, New Hope Cross Channel and Enlarged Clifton Court Forebay
- Two variations of Plan B, New Hope Cross Channel and Dredged South Delta Channels and New Clifton Court Forebay Intake
- Two variations of Plan C, New Hope Cross Channel and New Intake Channel to Clifton Court Forebay
- Six variations of Plan D, Enlarged North Delta Channels and Enlarged Clifton Court Forebay

To narrow the choices further, yet maintain flexibility in final selection, the Department retained variations of each of the four basic alternatives, but reduced them to the ones that seemed most practical.

Part of the problem in the past has been the approach of trying to solve all of the problems at once. Since the ultimate solution to the complex problems may be years away, a flexible program suitable for staged construction seems desirable. Such a program would consist of relatively small economical units geared to meet clearly demonstrated needs now and that could be added to later to solve other problems as needed.

Since cost is a major consideration, the Department retained the least costly variation of each of the four alternatives. The least costly variation was the gravity-flow North Delta alternatives (without fish screens), coupled with the South Delta alternatives (with continued use of existing fish screens). Any of these four variations could be built in stages to provide additional yield and/or additional fish protection.

For Plan A (New Hope Cross Channel and Enlarged Clifton Court Forebay), three additional variations with full project yield and new fish screens were selected as being the most acceptable. The options of a new screen in both the northern and southern Delta were excluded because of the high cost.

For Plan B (New Hope Cross Channel and Dredged South Delta Channels and New Clifton Court Forebay Intake) and Plan C (New Hope Cross Channel and New Intake Channel to Clifton Court Forebay), the two remaining variations with full yield and a fish screen in the north were included. For physical reasons, new screens are impractical in the southern Delta for these alternatives (see Chapter 4).

For Plan D (Enlarged North Delta Channels and Enlarged Clifton Court Forebay), two additional variations with full yield were selected: one with a new fish screen on a small intake to the forebay, and one with a new fish screen on a large intake to the forebay. For physical reasons, screening in the northern Delta with this basic alternative was precluded (see Chapter 4).

By selecting these variations of the four basic alternatives, eight other variations were excluded, reducing the variations from 19 to 11 (see Figure 27).

The costs, yields, and unit costs of water for the 11 variations of the four selected alternatives are summarized in Figure 28. The alternatives can be built in stages. The gravity-flow variations (with existing fish screens in the southern Delta) could be built first, and flow boosting and new fish screen options could be added later.

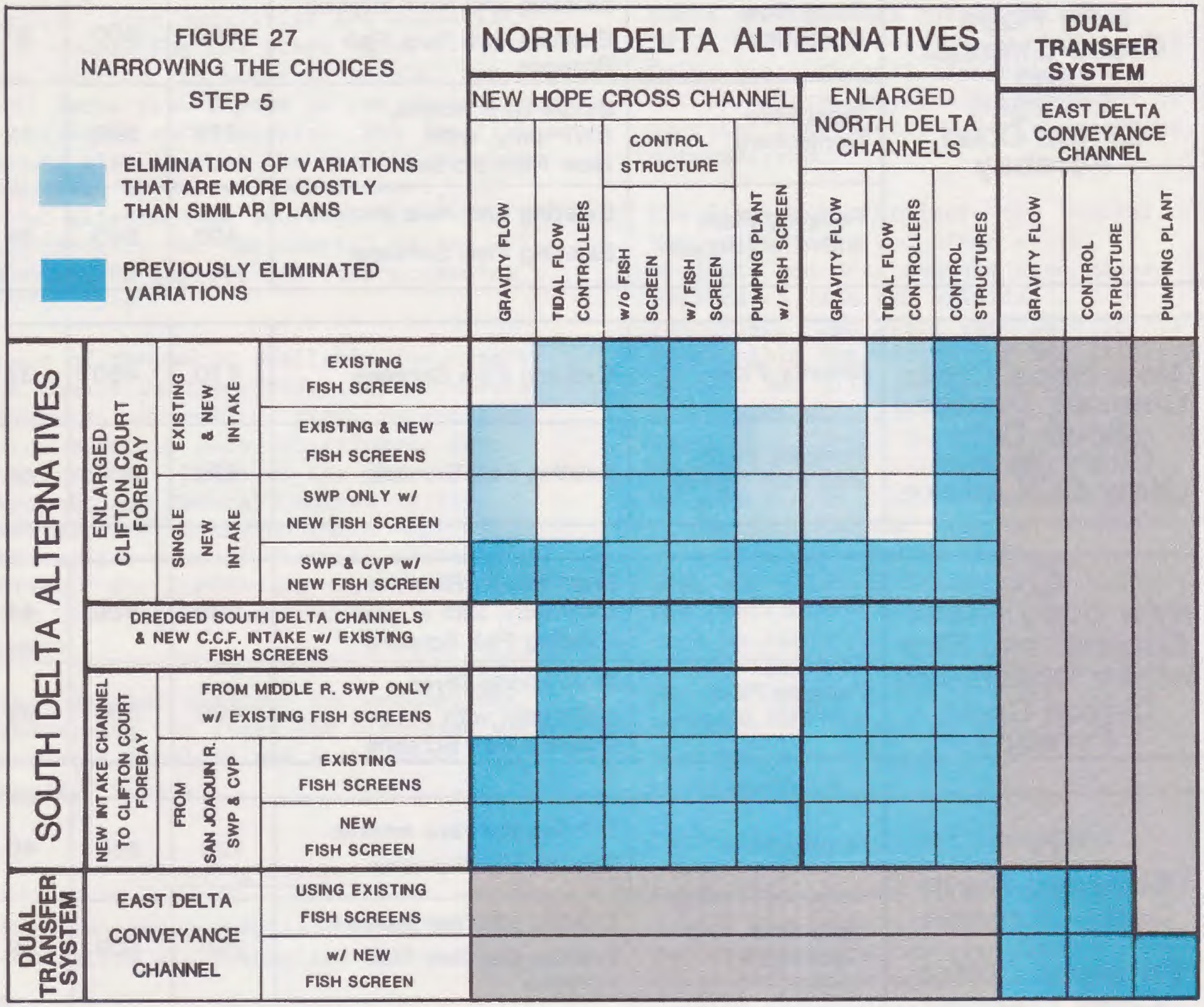


FIGURE 27
NARROWING THE CHOICES
STEP 5

Figure 28 Summary of Remaining Alternatives

ALTERNATIVE	DESIGN OPTIONS: NORTH DELTA	DESIGN OPTIONS: SOUTH DELTA	CAPITAL COST IN $ MILLION	YIELD IN 1,000 AF/YR	UNIT COST $/AF
A New Hope Cross Channel and Enlarged Clifton Court Forebay	Gravity Flow	Existing and New Intakes Existing Fish Screens	230	450	43
	Tidal Flow Controllers	Existing and New Intakes Existing and New Fish Screens	340	500	57
	Tidal Flow Controllers	Single New Intake, SWP only, with New Fish Screen	370	500	62
	Pumping Plant with Fish Screen	Existing and New Intakes Existing Fish Screens	400	500	69
B New Hope Cross Channel, Dredged South Delta Channels and New CCF Intake	Gravity Flow	Existing Fish Screens	210	450	39
	Pumping Plant with Fish Screen	Existing Fish Screens	380	500	66
C New Hope Cross Channel and New Intake Channel to Clifton Court Forebay	Gravity Flow	From Middle River, SWP only, with Existing Fish Screens	230	450	44
	Pumping Plant with Fish Screen	From Middle River, SWP only, with Existing Fish Screens	400	500	69
D Enlarged North Delta Channels and Enlarged Clifton Court Forebay	Gravity Flow	Existing and New Intakes Existing Fish Screens	120	250	40
	Tidal Flow Controllers	Existing and New Intakes Existing and New Fish Screens	290	500	49
	Tidal Flow Controllers	Single New Intake, SWP only, with New Fish Screen	320	500	54

Export Water Quality

The Delta is a complex system of waters with great differences in quality at different times and locations. Some of the constituents in these waters can have economic impacts, are of concern because of possible health hazards when used for domestic purposes, or both. About 16 million people live in communities that receive a portion of their water supply via exports from the southern Delta.

The quality of such supplies would be substantially improved under each water transfer alternative due to reduction or elimination of reverse flows and the commingling with ocean-derived salts in the western Delta.

While time was too short in this study to make detailed salt routings for the various alternatives, the order of magnitude of long-term average water quality indicators was approximated from results of past studies (see Table 3).

In a December 1982 report,* a panel of seven scientists found that treated Delta water being consumed by the public generally meets drinking water standards, but expressed concern due to uncertainties with regard to the health effects of trihalomethanes (THMs), the high level of sodium in parts of the Delta, and the amount of asbestos.

Sodium is closely associated with chloride and would show similar improvement with the various water transfer alternatives. Asbestos is a micro-fine siliceous fibrous material present in many waters throughout California, including the Delta. There are presently insufficient data to know if there would be any differences in asbestos concentrations between the various water transfer alternatives.

Table 3

ESTIMATED LONG-TERM AVERAGE EXPORT WATER QUALITY (in parts per million)

Water Transfer Alternative	TDS[1]	Chlorides[2]	Hardness[3]
Base Conditions, Existing Channel Configuration	280	85	100
Gravity Flow Variations of Alternatives With Enlarged North Delta Channels	240	70	90
Gravity Flow Variations of Alternatives With New Hope Cross Channel	210	55	80
All Other Through-Delta Alternatives	200	50	80
Dual Transfer System	160	30	60

[1]TDS (total dissolved solids) is a measure of the total salt content.
[2]Chlorides, while found in small quantities in most natural waters, are the dominant ion of sea water.
[3]Hardness is a measure of the total dissolved calcium and magnesium salts expressed as equivalent parts per million of calcium carbonate ($CaCO_3$).

THMs are suspected cancer-causing substances formed in drinking water when certain substances in raw water react with chlorine during water treatment. (Alternative, more costly, treatment processes that reduce the levels of THMs formed are available and are in use.) The panel found that the potential for THM formation is greater in water from Clifton Court Forebay and Rock Slough than it is in the Sacramento River at Hood because of the greater concentrations of precursors such as fulvic and humic acids from decaying plants and organic soils.

Bromides are also a key factor in assessing the potential risks of THMs. The prime source of bromides in Delta export water is from the intrusion of sea water through the western Delta. The concentration of bromides under present conditions and with the various

*"Public Health Aspects of the Sacramento-San Joaquin Delta Water Supplies", a panel report for the California Department of Water Resources, December 31, 1982.

alternatives would vary proportionately with the concentration of chlorides, shown in Table 3. The Department and other concerned agencies are beginning an interagency health-related water quality monitoring program in the Delta to provide a basis for improved water management for all agencies using Delta water for human consumption. This program will be closely coordinated with followup studies to perfect a Delta water transfer plan.

Chapter 6. RELATIONSHIPS BETWEEN WATER TRANSFER AND DELTA LEVEES

A vast network of levees protects the numerous below-sea-level Delta islands. Most levees in the central Delta were built by landowners or local reclamation districts over a long period of time from the fertile but soft and erosive peat soils of the Delta. They are maintained by individual owners or local districts to widely varying and generally less stringent standards than used for "project"* levees.

Many of these nonproject Delta lowland levees are in poor condition. Their frequency of failure is increasing, and nearly all failures are caused by structural failure rather than by overtopping. The failures result from the unstable Delta soils that make up the nonproject levees and their foundations, and the accompanying subsidence of land surfaces. Continued subsidence has resulted in a situation wherein these levees, which were originally intended to keep water off lands that were dry at low tide but flooded at high tide, are now required to hold back 20 feet of water, or more.

Since 1980, levees have failed on 12 islands and tracts. Levee failures result in loss of agricultural production and wildlife habitat; disruption of highways, railroads, pipelines, and other utilities; damage to urban communities; loss of fresh water by increased evaporation; and, in some cases, a need for additional outflow to repel salt water intrusion. Failure to repair broken levees could eventually result in the loss of the unique estuarine Delta channel system, which is a major recreation area for fishing and boating.

Federal Disaster Relief Funds, administered by the Federal Emergency Management Agency, have been the main source of revenue to repair the levees. The Federal Disaster Relief Act of 1974 requires that the State or local government receiving Federal aid evaluate the flood hazards and, where appropriate, take mitigating action. To fulfill this requirement, the State prepared a "Flood Hazard Mitigation Plan for the Sacramento-San Joaquin Delta", dated September 15, 1983. The plan includes short-term and long-term actions to reduce flood hazards in the Delta.

Because a major levee rehabilitation project may take 6 to 10 years to get under way, the Federal Emergency Management Agency is particularly interested in a short-term plan.

Some important aspects of the short-term plan are:

- ° The State will assure the Corps of Engineers of its intent to cover the non-Federal obligations for a Federal-State flood control project.
- ° The Department of Water Resources will ask the Legislature to increase the State's share of funding for Delta rehabilitation and maintenance.
- ° The Department will develop a program and request funding for levee inspection.
- ° The Department will request funding to reevaluate land subsidence rates in the Delta.

---

*Project levees along the Sacramento and San Joaquin rivers, composing about 35 percent of the Delta levee system, were either built, rebuilt, or adopted as Federal flood control project levees and are maintained by local districts to Federal standards. There are also levees along the deep-water ship channels, called "direct agreement levees", where Federal funds help maintain nonproject levees.

The Legislature must authorize and appropriate money before the short-term plan can be carried out.

The long-term plan calls for the State to develop a comprehensive Federal-State-local flood control project and to seek legislation to finance the non-Federal share. Three reports that address the long-term rehabilitation of nonproject levees have recently been completed: one by the Army Corps of Engineers, one by the Department of Water Resources, and one by the Citizen's Emergency Delta Task Force appointed by the State Assembly. Each report considers somewhat different plans for upgrading nonproject levees around individual islands.

The Corps of Engineers estimated that $910 million would be needed to rehabilitate levees on 53 islands, but recommended that only 15 be rehabilitated (which would cost $326 million). An additional $90 million to $100 million would be required for recreation and wildlife enhancement. The Department estimated that $930 million would be needed to rehabilitate levees on 53 islands <u>and</u> periodically add material to the levees to compensate for continuing subsidence over 50 years. Recreation and wildlife enhancement would add $100 million. The Emergency Delta Task Force report presented a plan for rehabilitating 53 islands at an estimated cost of only $316 million.

In the coming months, the Department intends to work closely with the Corps of Engineers, the Bureau of Reclamation, and local interests to develop a comprehensive Federal-State-local flood control project that would consider all islands and interests in the Delta. The extent of Federal interest could be determined by Congress. Such determination should include an appraisal of public health and safety, national economic development, preservation of natural and cultural resources, and funding requirements. Cost sharing and funding must be resolved by the Congress, the Legislature, and local interests working together. The Department will request special language in the authorizing legislation that will allow credit to the State and local districts for work done toward upgrading levees to Federal standards prior to implementation of the joint levee rehabilitation project. This could include levee improvements made in connection with construction of a water transfer system.

This report is not intended to evaluate the various levee plans, to recommend a particular flood control plan, or to determine an allocation to the State Water Project. Rather, it considers the flood management and levee rehabilitation concepts as they relate to water transfer across the Delta for the State Water Project and Federal Central Valley Project. These water transfer relationships fall into three categories: transfer channels and levees in the northern and southern Delta; effects of island flooding; and remedial measures. Polder levees are also discussed briefly. These two problems -- water transfer and levee rehabilitation -- can be pursued separately, but they are so related that both should be considered together.

Northern and Southern Delta Water Transfer Channels

Most of the Delta water transfer alternatives recommended in this report require channel enlargements in the South Fork Mokelumne River (including levee setbacks), and a few require channel dredging near Clifton Court Forebay. To increase transfer and minimize scour, the Emergency Delta Task Force report also recommended enlarging the South Fork Mokelumne River and channels adjacent to Deadhorse Island and near Clifton Court Forebay. It also recommended levee setbacks in certain reaches of the Mokelumne. Together, these enlargements and setbacks would help provide fill for reconstructing levees, would increase channel carrying capacity for the water projects, and would lower the local flood plain. These are the same channels that would require enlargement for some of the alternative transfer facilities considered in this report. To the extent that enlargements and setbacks coincide with the Delta water transfer plans, there would be an opportunity to share the cost between the two projects.

Effects of Island Flooding on Water Transfer

Delta island flooding can affect water transfer in the Delta. Whether the effects are short term or long term depends on the size and location of the flooded island.

Potential Short-Term Problems

If a large island floods during an extended low-flow period, excessive salinity intrusion into the Delta could degrade the water supply for local use and export. This happened in the summer of 1972 when the Andrus Island levee broke, flooding about 13,000 acres. Chloride concentration (salinity) increased from 250 to 1,500 parts per million at Jersey Point, from 125 to 750 ppm at Franks Tract, and from about 60 to 250 ppm at Clifton Court Forebay. It took a large volume of extra reservoir releases to flush out salts from the western Delta and 6 to 8 weeks for the Central Valley Project to pump the salts from the interior Delta, during which time State Water Project diversions from the Delta were sharply curtailed. After the levee was repaired, water lost to the flooded island was recovered by pumping out the island. The extra water used to flush the salts out of the Delta was replaced in project reservoirs the following winter, which fortunately was wet. The ability to flush salts from the central Delta would be improved with any of the alternative transfer facilities considered in this report.

Short-term water quality problems do not occur if a levee breaks during high winter flows. Nor do water quality problems necessarily occur with all summer levee breaks or at all locations in the Delta, as demonstrated when McDonald Island flooded in the summer of 1982 with little or no impact on water quality or project operations.

Potential Long-Term Problems

As deep peat areas of the Delta continue to subside, the increasing difference between the land and the higher surrounding water will increase water pressure on the levees and island floors. This will require increased maintenance and structural improvement to retain the Delta islands in agriculture. The day is approaching when the farming economy may not be able to afford these costs. There is already some evidence that it cannot always support reclamation costs after a levee fails.

Long-term water supply problems could occur if a Delta levee breaks, the island is allowed to remain flooded, and no remedial action is taken.

Evaporation from a flooded island exceeds the consumptive use of an equivalent area of irrigated agriculture by about 1 or 2 feet per year. This increase would require the State and Federal water projects to release more stored water to meet Delta criteria, thereby reducing yield. There would be little effect on project deliveries in a wet or normal year, when enough water would be available to refill project reservoirs. In a dry year, exports would decrease.

Permanent flooding of certain islands in the western Delta, where brackish water and fresh water meet, could increase the upstream movement of ocean salts. This would require the projects to provide more outflow to repel the salts and maintain water quality in the Delta and at the export pumps. Providing more outflow would reduce project yields. Islands most vulnerable in this regard include Sherman, Jersey, Bradford, and Twitchell Islands and Hotchkiss Tract (see Figure 29). Flooding of these islands would increase the mixing of saline water with the fresh water either by: (1) flow in and out of a single levee break, which would be out of phase with tidal flows in the main channel and thus temporarily store and mix the two waters; or (2) flow through multiple levee breaks, which could directly disperse saline water upstream across the flooded island.

Levees protecting Webb and Holland Tracts and Bethel Island are somewhat less important, but could still be significant to water project operations. Flooding of these areas could increase salinity-carrying tidal flows in Dutch Slough and False River, or otherwise provide a more direct route to Old River, which supplies the export pumps.

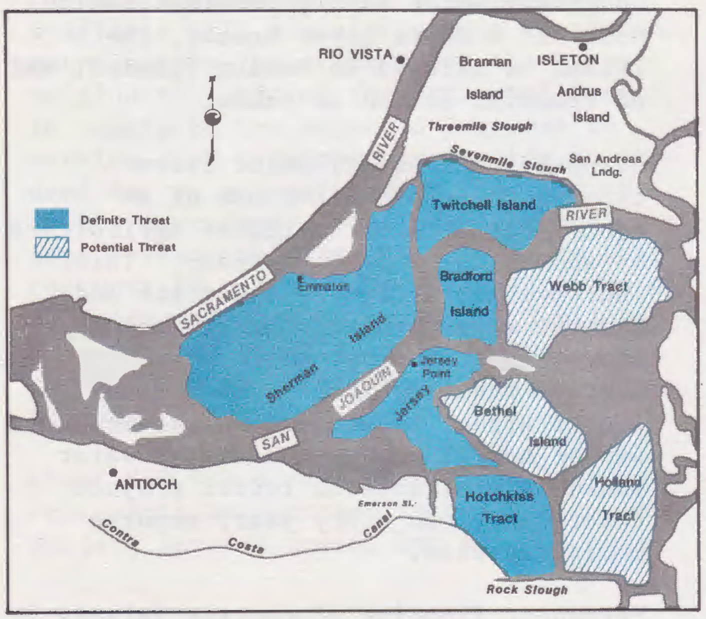


Figure 29 Islands Posing Threat to Water Quality if Permanently Flooded

Delta Island Inundation Study

A cooperative interagency study of Delta island inundation (herein referred to as the FEMA study) using the U. S. Army Corps of Engineers' Bay-Delta hydraulic model at Sausalito was initiated in July 1982. The objective of the study was to evaluate the extent of salinity intrusion that might be caused by flooding individual or multiple Delta islands. To determine the long-term effect of flooding McDonald Island, Webb Tract, Bouldin Island, and Sherman Island under different conditions of inflow to and export from the Delta, 18 tests were conducted. The Corps of Engineers conducted these tests for the Federal Emergency Management Agency with the help of the California Conservation Corps, the Bureau of Reclamation, and the Department of Water Resources.

A draft report by the Corps of Engineers indicates that flooding individual islands may have less effect on Delta salinities than previously thought. However, tests with 19 islands flooded simultaneously indicated salinity intrusion throughout the Delta.

The Bay-Delta model has recently been upgraded with new electronic instrumentation. The Federal Emergency Management Agency has requested six additional tests, using the new instrumentation, to confirm results of the prior tests. The Corps of Engineers plans to release a final report in November 1983 and to include results from the additional tests.

Remedial Measures

Remedial measures, short of full island restoration, are available that would prevent the loss of project yield.

A flooded island could be stabilized by closing the breach with a new levee section and placing riprap on the inside of the levees to prevent erosion. In the western Delta this would prevent additional mixing of saline and fresh water and thereby eliminate the need for additional outflow to control salinity.

A higher level of remedial action would be operation of the flooded island as a reservoir to help meet the water needs of the State Water Project. This would retain the unique channel configuration of the Delta for recreation and fish. It would also avoid increased maintenance costs on adjacent levees that would result from wind-generated waves after the flooded island levees eroded away. It could be applied to most Delta islands. For each 1,000 acres of usable storage area, the additional potential yield to the State Water Project would be about 6,500 acre-feet each year during a 7-year critical period such as 1928-34.

Allowing for constuction, right-of-way, operation, maintenance, and pumping costs, the unit cost of yield is estimated to be significantly lower than the cost from potential surface water projects in the Sacramento Valley. For example, on a per acre-foot basis, the estimated composite cost of water from the Los Vaqueros, Thomes-Newville, and Cottonwood Creek projects is two to three times higher than the estimated cost of water from converting the now-flooded Mildred Island into a reservoir. However, the quantity of potential yield from Mildred Island is very small when compared to these other projects.

Polders

In 1973, the Legislature adopted a policy of maintaining the Delta in essentially its present configuration (Water Code Section 12981). All of the recent reports on Delta levee improvements recognize this policy. However, the Corps of Engineers did evaluate several variations of the "polder levee" concept, which would enclose groups of islands within a single levee. Various Department reports have also considered polders. This approach reduces the miles of levee needed to protect each group of islands, but it also closes off channels between the islands within the polders. Islands could be grouped in any of many combinations, but the remaining channels must have the capacity to pass flood flows and water for the State Water Project and Federal Central Valley Project.

Although the cost of protecting Delta islands would be less with polders than with individual islands, the economic loss would be much larger if a polder levee were to break, because a much larger area could be flooded. This is because the interior Delta levees would no longer be maintained and would continue to subside with time and be subject to overtopping. Also, much of the unique estuarine environment for recreation and fish habitat would be lost.

Before a polder plan could be carried out, the Legislature would have to change its policy of maintaining the present Delta configuration (Water Code Section 12981).

Chapter 7. OTHER DELTA ACTIONS

In addition to the alternatives for solving Delta water transfer and conveyance problems, certain other actions in the Delta could improve local water supplies, conserve Delta outflow, and, in some cases, increase the delivery capability and yield of the State Water Project. These actions include:

- Constructing western Delta overland agricultural water facilities.
- Changing Decision 1485 agricultural standards.
- Improving the Contra Costa Canal municipal and industrial water supply.
- Improving southeastern Delta agricultural water supplies.

Carrying out these actions would require contracts or agreements with the beneficiaries, or action by the State Water Resources Control Board in the case of changing Decision 1485.

Western Delta Overland Agricultural Water Facilities

It may be more economical and efficient to meet agricultural water requirements in the western Delta by an overland water conveyance system that brings good quality water from interior Delta channels rather than by maintaining water quality in the western Delta channels. If the agricultural water quality standards could be relaxed or eliminated at locations that now determine the amount of Delta outflow required, the excess outflow could be conserved. This would make more water available for diversion by the State Water Project and might provide better quality water to the islands receiving the overland supply. The current western Delta agricultural water quality standards are contained in State Water Resources Control Board Decision 1485 and in the North Delta Water Agency contract.

Decision 1485 Agricultural Standards

Salinity in the Delta is related to the amount of Delta outflow into San Francisco Bay. Decision 1485, adopted by the State Water Resources Control Board in 1978, contains water quality standards to protect Delta uses from excessive salinity intrusion. The rights of the State Water Project and the Federal Central Valley Project to export water from the Delta are subject to maintaining those standards.

Agricultural standards protect the water quality rights of Delta agricultural water users to the extent they would have been protected if the State Water Project and Federal Central Valley Project had not been built (without-project conditions). Standards were developed in two steps:

- The water quality needs of a representative crop were estimated, from research by others, attempting to account for Delta soil conditions and irrigation practices.
- The extent to which water quality needs would have been satisfied under without-project conditions was estimated.

The Board chose corn as the representative crop, because it is salt sensitive and widely grown in the Delta. A "Committee of Consultants", convened by the University of California at Davis, has established that there is a "threshold" salinity level for crops grown in mineral soils. If soil salinity exceeds this threshold, 3.4 mmho per centimeter electrical conductivity (an index of salt content in the water), crop yield declines in proportion to increases in salinity above that threshold.

In establishing water quality standards for Delta agriculture, the State Water Resources Control Board, in 1978, assumed that applied irrigation water would concentrate 7.5 times in becoming soil water available to plant roots. To provide soil water at a concentration of 3.4 mmho per centimeter electrical conductivity for a concentration factor of 7.5, the comparable irrigation water salinity must be 0.45 mmho per centimeter electrical conductivity, the standard set by the State Board for agriculture in Decision 1485. Historical electrical conductivity in the western Delta was rarely as low as 0.45 mmho throughout the entire irrigation season.

Figure 30 conceptually shows the variation of typical without-project water quality, compared to the standard that was developed. For wet, above normal, below normal, and dry years, the standards require an early season value of 0.45 mmhos electrical conductivity when that value or lower would have existed under without-project conditions. The standard for the rest of the irrigation season, combined with the early standard, provides without-project seasonal average salinity. The standards were designed to provide crop yield equal to without-project conditions. Figure 31 also shows an example of such a water quality standard and the standard for critical years, which is a single value for the entire irrigation season.

Possible Changes to Delta Agricultural Standards. By 1986 the State Water Resources Control Board plans to reexamine Delta water quality standards, including agricultural standards. In May 1983, the Department, the State Board, the University of California, and the U. S. Soil Salinity Laboratory completed an investigation to further define the water quality needs of corn in the Delta through a study of the effect of salinity on the growth of corn and to identify a reasonable threshold value. The recommendation of the University and the Soil Salinity Laboratory is expected to significantly increase the magnitude of the threshold electrical conductivity values. This could mean less freshwater outflow is needed to protect Delta agriculture and could make more water available for other project purposes.

Delta Standards Versus Overland Supply Facilities. The maximum service area for overland facilities is about 30,000 acres. In past studies, such facilities were proposed for all or parts of Sherman, Jersey, Bethel, Bradford, Twitchell, and Brannan islands and Hotchkiss and Webb tracts. In recent years only Sherman Island, Jersey Island, and Hotchkiss Tract have been considered for overland facilities.

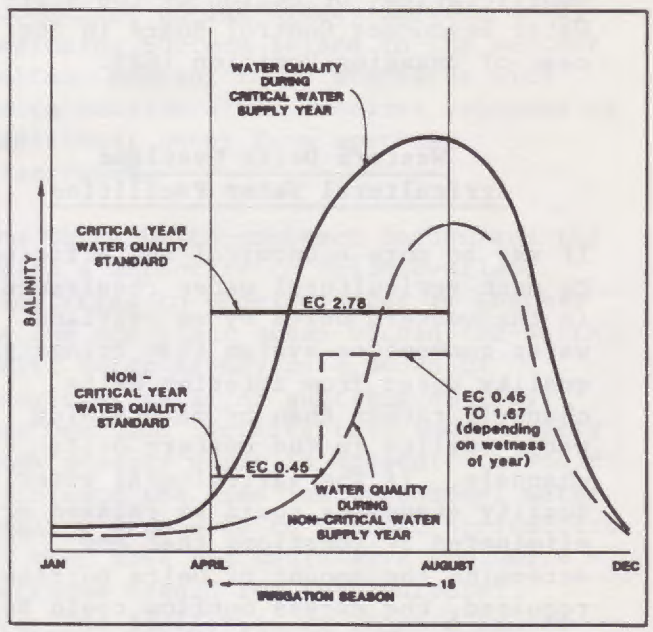


Figure 30 Typical Without-Project Conditions and Agricultural Standards at Emmaton

Since water quality standards are based on without-project conditions, better quality standards apply for the interior of the Delta than for the western Delta. This reflects the greater influence of salt water in the western Delta. Providing overland supplies in the western Delta would not release the Department from providing adequate quality water to interior Delta farmers on islands and tracts adjacent to Sherman Island. Several critical factors must be considered:

- It is more difficult for the State Water Project and Central Valley Project to protect certain areas of the Delta than others, because of the complex nature of the Delta channels and the operational limits of project facilities.

- Delta agricultural standards may be changed substantially as a result of the "corn study", which would change the benefits of overland facilities.

- Delta fish and wildlife standards may change, which could change the benefits of overland facilities.

- The State Water Resources Control Board is making a study, to be completed by January 1984, to determine when water is not available to upstream water users after the obligation of meeting Decision 1485 water quality standards has been met. The Department supports this sharing of Delta protection.

After considering the above factors and the State Water Resources Control Board reexamination of Delta standards, the Department will evaluate the need for agricultural overland supplies in the western Delta. However, as discussed in the following section, overland facilities for Sherman Island are needed now under provisions of the North Delta Water Agency contract.

North Delta Water Agency Contract

The North Delta Water Agency represents agricultural water users in northern and western portions of the Delta. In January 1981, the Department and the Agency signed a contract that provided a dependable water supply of adequate quality to the Agency. The contract sets water quality standards to be met by the State Water Project and requires the Agency to pay for benefits arising from project operations. (The Bureau of Reclamation is not a party to this contract.) The standards are parallel to Decision 1485 standards, but at times are more stringent. The extra outflow required to meet these more stringent standards could reduce the critical period yield of the State Water Project by more than 100,000 acre-feet per year. The contract also provides that "the State may provide diversion and overland facilities to supply and distribute water to Sherman Island", and that "after the facilities are constructed and operating, the water quality criteria ... shall apply at the intake of the facilities."

The North Delta Water Agency contract is binding on the Department of Water Resources regardless of future changes in Decision 1485 standards. However, due to differences between water quality standards in Decision 1485 and the North Delta Water Agency contract, it is appropriate to consider Sherman Island separately from other western Delta islands.

Preliminary plans for an overland system for Sherman Island show that it must deliver up to 6,500 acre-feet per month. The system would consist of:

- Diversion from Threemile Slough through automatically controlled siphons. If diversion at Threemile Slough does not provide good enough quality water, the point of diversion would be moved upstream to a point where contract quality could be maintained.

- Transport to the Main Canal through a new canal parallel to Highway 160.
- Conveyance and storage in the Main Canal and Mayberry Slough.
- Distribution through seven gravity laterals and five pump laterals.

To provide the best available water for the system, water would be diverted (to the extent possible) at lower tides, when the river quality is better.

Final design and specifications would be subject to approval of the North Delta Water Agency and of Reclamation District 341. The Agency or its transferee would assume ownership and full operation and maintenance responsibilities for such facilities after successful operation was demonstrated.

Estimated cost of the facilities is $11 million. Building such facilities would prevent the possible loss of more than 100,000 acre-feet of yield to the State Water Project. This assumes that the contract criteria would be measured at the intake of the facilities and that there would be no change in Decision 1485 standards. The Department intends to build these facilities in the near future.

Contra Costa Canal Municipal and Industrial Water Supply

The Contra Costa Canal diverts water from Old River via Rock Slough to about 300,000 people in eastern and central Contra Costa County. The canal supplies water all year to most users in the Contra Costa Water District service area and provides a replacement supply for many industries when offshore water in the western Delta is too salty because of sea water intrusion.

Decision 1485 requires that the Central Valley Project and State Water Project be operated so as to prevent the mean daily chloride content at the Contra Costa Canal intake from exceeding 250 milligrams per liter at any time, and 150 mg/L for varying lengths of time depending on the wetness of the year.

Over the last two decades, many proposals have been made to relocate the intake of the Contra Costa Canal. Water quality problems historically have been caused during low-flow periods by ocean salts from the western Delta being pulled into the Old River-Rock Slough area, from which the canal draws its supply. Also, during the winter and with high Delta outflow, when canal diversion rates are low, local agricultural drainage constitutes a high percentage of the water in Rock Slough, resulting in poor quality water.

The value of extending Contra Costa Canal to Clifton Court Forebay varies with transfer alternatives presented in this report. All but the gravity-flow options of the selected through-Delta alternatives would give positive control of the flows in the lower San Joaquin River at Antioch (no reverse flow) and would exclude the intrusion of ocean salinity into the Rock Slough area. These alternatives would provide essentially the same quality at the confluence of Rock Slough and Old River as would exist in Clifton Court Forebay. Therefore, the only difference would be effects of local drainage on the canal's water supply.

This local drainage problem could be overcome by providing a flap-gated culvert in the canal intake at Emerson Slough (refer to Figure 29), near the Marsh Creek crossing, which would discharge into Dutch Slough. During periods of low winter export, water would be released from the Contra Costa Canal intake into Emerson Slough, thereby inducing a dilution flow from Old River to mitigate the adverse effects of local drainage.

With water transfer alternatives providing positive control of flow in the lower San Joaquin River, it may be desirable to reevaluate the need for relocating the intake to the Contra Costa Canal.

In the case of the water transfer alternatives with gravity flow, there still would be reverse flows at times in the lower San Joaquin River. These alternatives would continue to allow ocean salts into the Rock Slough area at times and, therefore, may justify extending the Contra Costa Canal intake to Clifton Court Forebay.

For this report, no attempt was made to estimate the benefit, if any, to the State Water Project of relocating the Contra Costa Canal with any of the alternatives.

Southern Delta Agriculture

Various portions of the southern Delta area suffer from one or more of the following problems: poor water quality, inadequate water quantity, poor water circulation, and low water levels at certain times and locations. These problems can be attributed, in varying degrees, to one or more of five basic causes:

° Central Valley Project operations.
° State Water Project operations.
° Nonproject water users.
° San Joaquin River degraded inflow.
° Existing channel conditions.

Middle River, between Highway 4 and Old River, is choked with sediment and vegetation. At low tide, there is insufficient water for diversion or dilution of returned drainage water.

Stagnation in Old River between the Tracy Pumping Plant intake and Salmon Slough is due mainly to channel configuration and sedimentation at the connection of Salmon Slough.

Diversion into Tom Paine Slough is controlled by a tide gate that opens at high tide, allowing the slough to fill for use as a diversion reservoir, and then closes as the tide lowers to prevent the stored water from ebbing with the rest of the Delta channels. Problems include:

° At times, export pumping does not allow the tide to reach its full height at the entrance to Tom Paine Slough, preventing the "reservoir" from filling to its maximum.

° Sedimentation in the slough behind the tide gates restricts inflow during high tide.

° Water circulation is insufficient to flush out salts that accumulate from reusing agricultural drainage.

At times, quantities and qualities of inflow to the Delta from the San Joaquin River do not meet minimum needs of the Delta agricultural diversions in the southeastern Delta. This problem is accentuated by water use upstream in the San Joaquin Valley and poor quality irrigation return flows, although since its completion, releases from New Melones Reservoir have lessened the problem.

The alternatives that include the enlarged Clifton Court Forebay would lessen or eliminate the drawdown effects of State Water Project diversions on water levels. To the extent possible, the existing intake to Clifton Court Forebay is operated to divert water during the outgoing (ebb) tide and to remain closed at high and low tides. Therefore, the State Water Project normally has little, if any, effect on water levels at either high or low tides. However, at times of high export, primarily in the winter, the project must take some of its water during rising tides; this has some effect on the level of high tide. By moving the Clifton Court intake north, as would be the case with the enlarged Clifton Court alternative, the State Water Project's effect on low water levels would be greatly reduced.

To alleviate the remaining southern Delta problems, several alternative physical solutions have been proposed in the past. These include:

° Control structures, which would induce higher water levels and circulation.

° New distribution channels.

° Dredging existing channels.

° Extension of Tom Paine Slough to the San Joaquin River so that water can be pumped from Old River into Tom Paine Slough and then into the San Joaquin River to provide circulation.

° Modification of operating criteria of New Melones Reservoir to provide additional dilution and increased flows to raise water levels.

The South Delta Water Agency has filed a suit against the U. S. Bureau of Reclamation and the Department of Water Resources alleging damage to the southern Delta because of the effects of the Central Valley Project and State Water Project on water quality and water levels. Responsibility for alleviating these problems has not been determined.

Although neither the Department of Water Resources nor the South Delta Water Agency has adopted a plan, most (if not all) of the solutions suggested in the past could be made compatible with the Delta water transfer alternatives suggested in this report.

Chapter 8. RELATED ACTIVITIES

Selecting an improved Delta water transfer system is of paramount importance in advancing the State Water Project. However, many decisions remain on which additional facilities should be built and what actions should be taken over the long term. Some of these decisions and facilities relate closely to a Delta water transfer system, others only casually. South Delta facilities would provide considerably more flexibility for developing additional yield from new facilities south of the Delta using winter excess flows. North Delta facilities would greatly improve the water delivery efficiency of existing and future reservoirs north of the Delta.

This chapter describes activities that relate in some fairly definitive way to a Delta water transfer system. Regardless of what happens to these programs, however, an improved Delta water transfer system is the most pressing need.

Water Conservation

Water conservation means making more efficient use of existing water supplies. In the State Water Project service areas, conserving water that is not already subject to reuse will extend the use of existing supplies and reduce the risk of shortages. The Department of Water Resources supports and encourages local efforts to conserve water, and its projections of water needs reflect an expected reduction in water use resulting from such efforts. The 1977 drought demonstrated that, in times of severe shortage, extraordinary water conservation measures in urban areas can be taken temporarily. In planning for the future, the Department will consider mutually acceptable amendments of the delivery schedule and repayment provisions in the State Water Project contracts to match them more closely to expected water needs, including critical year deficiency provisions for urban contractors.

Coordination of State Water Project and Central Valley Project Operations

A Delta water transfer system mutually benefits the two major projects that export water from the Delta, and operation of the system must consider the needs of both projects. The Department of Water Resources and the Bureau of Reclamation have recently developed a draft agreement for coordinated operation of the projects that:

- Defines estimated project yields.
- Allots available supplies and shortages between the projects, after meeting the in-basin obligations including Delta water quality objectives.
- Defines a water quality monitoring program.
- Provides for sharing facilities.
- Provides for periodic review.

Environmental documentation on this proposed agreement is in progress.

Purchase of Central Valley Project Water

The Department is exploring the possibility of purchasing firm yield from the Federal Central Valley Project on an interim basis to provide additional water for the State Water Project soon, before major permanent facilities can be made ready for use. Some of the water already developed by the Federal project may not be needed by its contractors for several years or decades. Furthermore, the Central Valley Project will need increased conveyance capacity before it can deliver some of the developed water to its contractors. The Delta water transfer system will increase State Water Project capability and efficiency in using the Central Valley Project interim water.

A number of issues must be resolved before an agreement can be reached on purchasing Central Valley Project water, including execution of the coordinated operation agreement, place of use, water rights, effect of reclamation law (acreage limitation), cost, and potential availability during droughts when other Central Valley Project water users are taking deficiencies.

Operational Flexibility and Storage Opportunities South of the Delta

A Delta water transfer system would make it possible to move significant amounts of additional water into vacant storage space in ground water basins and/or into new offstream surface reservoirs south of the Delta during months of surplus Delta flows. South Delta facilities would provide the State Water Project considerable operational flexibility in normal and wet years for filling San Luis Reservoir and making extra capacity available for diversion of surplus winter flows. The area in Figure 31 identified as "Seasonally Available Capacity" represents about 1.8 million acre-feet of additional capacity that could be available in the California Aqueduct below San Luis Reservoir, where it enters the project's agricultural service area. With planned expansions of southern project facilities, up to 200,000 acre-feet per year more than maximum entitlement deliveries could be moved on into Southern California. The estimated amount of additional winter surplus water that could be conveyed to San Luis and beyond under conditions of maximum annual entitlement deliveries is shown below.

Frequency (% of Years)	Minimum Additional Flows Available (Acre-Feet)
70	100,000
60	250,000
45	500,000
25	800,000

This intermittent supply could go to surface or ground water storage, or it might be predelivered as future contractor entitlement water. If diverted to surface storage, it would either be retained for long-term, carry-over storage or made available later in the same year on a normal delivery schedule. To increase ground water storage, the water could be stored directly in the ground or could be used for preirrigation in winter and direct irrigation in spring in lieu of pumping ground water.

Another alternative would be for the Metropolitan Water District of Southern California to use the water in lieu of Colorado River water, which would be "banked" in reservoirs on the Colorado River system. This could be done only after the Central Arizona Project begins operation and at times when vacant storage in Lake Mead is great enough to minimize the risk of having to spill the banked water in wet years.

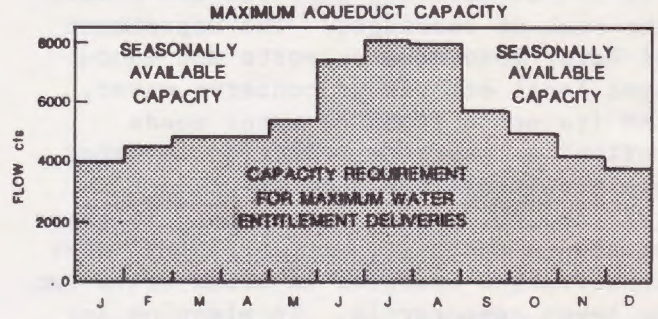


Figure 31 California Aqueduct at Kettleman City, the Northern Edge of the SWP Agricultural Service Area

Such banking programs would require considerable institutional and contractual arrangements, including dry year sharing formulas, financial arrangements for local facilities, reallocation of costs of State Water Project aqueduct facilities, and modified State Water Project repayment provisions. Each of these would have to be equitable to all project contractors as well as financially attractive to the banking agency.

If a service area banking program of significant size could be developed, it would also provide more operational flexibility for State Water Project surface storage facilities north of the banking area, such as Oroville and San Luis reservoirs. During normal years, the drawdown level at Oroville is now limited to about 2.4 million acre-feet to ensure sufficient carry-over storage to provide Delta protection and minimum delivery needs if the next year should be dry. However, if insurance were provided for part or all of the minimum delivery needs through a banking program, this minimum could be lowered significantly and present facilities would provide greater long-term average water deliveries. This same principle could be applied to future State Water Project reservoirs north of the Delta.

Ground Water Management by Local Agencies

With completion of South Delta facilities, local water managers could use the additional intermittently available water to enhance the conjunctive operation of their surface water and ground water resources to optimize local water uses and, with appropriate contract provisions, benefit all agencies served by the project.

San Joaquin Valley. The San Joaquin Valley contains the largest ground water basin in the State. The basin, overdrafted for many years, now has an estimated 30 million acre-feet of usable, empty storage capacity, some of which underlies agencies served by the State Water Project. The San Joaquin Valley ground water basin in Kern County has been identified as the most promising area for conjunctive use operation with water from the State Water Project. The principal method of increasing the supply to this area is transporting surplus water from the Delta during wet periods to recharge the basin, either directly by recharge or indirectly by using the imported water to irrigate crops in lieu of ground water pumping. Such a ground water storage program would require full participation and cooperation of local agencies and the State.

South Coastal Region. This area offers potential for increased underground storage in areas of high water use, especially in Orange, Los Angeles, Riverside, and San Bernardino counties. However, greater ground water storage would require long-distance delivery of surplus water from the Delta. A considerable amount of storage space is available in some basins, but limited aqueduct capacity in certain reaches must be alleviated to increase the permanent, long-term yield of these basins.

By 1990, the need of the Metropolitan Water District of Southern California for State Water Project water will exceed the existing capacity in the East Branch of the California Aqueduct. An environmental impact report for enlarging the East Branch is nearly complete. The enlargement will facilitate additional deliveries of entitlement water to the rapidly growing eastern Metropolitan service area and provide a means for conjunctive use of the California Aqueduct with Southern California ground water basins or with a Colorado River banking program. Other basins, now essentially full as a result of recent wet year recharge, could be pumped down and refilled later with surplus water from the State Water Project. The ground water basins would be managed by local agencies.

The Chino and San Bernardino ground water basins are of most current interest. The Department of Water Resources study of a State Water Project ground water program in the San Bernardino basin should be completed as planned. The recently completed feasibility investigation of ground water storage in the Chino basin indicated that up to 186,000 acre-feet of new yield could be developed. The proposed project would store up to 25,000 acre-feet per year by direct recharge, 25,000 acre-feet by exchange for new treated water supply, and 6,100 acre-feet per year by exchanging with users in the Cucamonga basin. Metropolitan Water District has developed and begun a 10-year implementation program for the project.

South Bay Area. This area offers some opportunity for increased use of ground water storage because it is near the Delta and can receive water through the Federal San Felipe Project and the State Water Project's South Bay Aqueduct. This would augment the surface-ground water management program that has been practiced in Santa Clara Valley for many years. The Department is studying the possibility.

Central Coastal Basins. There are several small ground water basins in this area. The potential for increasing State Water Project supplies through conjunctive use of imported supplies should be studied as part of the Coastal Aqueduct studies and local project studies in Santa Barbara and San Luis Obispo counties.

Offstream Surface Storage

Additional offstream surface storage south of the Delta would increase the yield of the State Water Project. Storage sites near the Delta and the California Aqueduct would result in more efficient use of the available conveyance capacity. Winter surplus flows could be pumped into storage and then released for conveyance at a more uniform rate.

The Department is conducting an appraisal investigation of the alternative offstream storage sites listed below. A report of preliminary findings, scheduled for completion late in 1983 or early in 1984, will present a comparison of the projects with regard to size, cost, yield, energy, and significant environmental issues. A plan may be selected and proposed for feasibility investigation.

Reservoir/Stream	Location (County)
Los Vaqueros	Contra Costa
Kellogg	Contra Costa
Del Puerto	Stanislaus
Salada Creek	Stanislaus
Little Salada Creek	Stanislaus
Crow Creek	Stanislaus
Orestimba	Stanislaus
Garzas	Stanislaus
Quinto	Merced
Enlarged Los Banos Detention Reservoir	Merced
Los Banos Grandes	Merced
Ortigalita Creek	Merced
Enlarged Little Panoche Creek Reservoir	Fresno
Sunflower	Kern

Storage North of the Delta

Delta water transfer must be improved if efficient use is to be made of State Water Project water conserved in new reservoirs north of the Delta. Otherwise, from 20 to 30 percent of any new supply would be lost to additional carriage water (Delta outflow) in transporting it across the Delta.

Enlarged Shasta Reservoir

This project, which could provide 10 million acre-feet of additional storage capacity and 1.5 million acre-feet of new yield from Central Valley streams, is being evaluated under a joint feasibility study by the Department of Water Resources and the Bureau of Reclamation. The Department is proceeding on the basis that the water and power from the project would be shared equally by the State Water Project and Central Valley Project.

Cottonwood Creek Project

The U. S. Army Corps of Engineers is completing an environmental impact study of a two-reservoir project on Cottonwood Creek. As presently proposed, the Corps of Engineers would construct the project and the Department would buy storage space to conserve water for delivery through State Water Project facilities. The Federal Government is considering changing the cost-sharing formula for Federal projects, whereby non-Federal interests would have to contribute to the up-front financing of the project, rather than simply repaying the non-Federal share over a period of years. This issue must be resolved before the State Water Project can participate in the project.

Thomes-Newville Reservoir

The Department has made extensive feasibility studies of this site. The Department has stopped planning studies and has prepared wrap-up reports and memoranda documenting and summarizing status and results of work performed. No additional work is proposed now, but the option remains open.

Marysville Reservoir

There have been a number of studies of the feasibility of this site for other than State Water Project uses. It could be built and operated to provide water for local use, for State Water Project use, or both. Local users don't need more water but they do need reregulation of their supply to more nearly match their pattern of use. Agreement on operation and an acceptable definition of the project service areas is needed. It is proposed for consideration in reformulating the State Water Project future supply program.

Auburn Reservoir

The Bureau of Reclamation is reformulating this project to determine its feasibility for the Central Valley Project. The Department supports this effort. The Bureau is interested in partnership arrangements with non-Federal agencies. In reformulating the State Water Project future supply program, the Department of Water Resources will consider becoming a partner. A smaller project at this site, such as considered in the past, will also be investigated.

Other Storage Sites in Tributaries to the Delta

There have been a number of other surface storage proposals in the upper Sacramento River watershed, including Millville, Wing, Schoenfield, Gallatin, Sites, Garden Bar, and Nashville reservoirs. Some of these are being considered by other agencies, and the Department will determine whether it is feasible for the State Water Project to become a partner or to purchase water on an interim basis.

The North Coast Rivers

The 1972 California Wild and Scenic Rivers Act prohibits the State from building dams and reservoirs on major segments of certain rivers: Klamath, Trinity, Smith, Eel, and American. Legislation would be required before these streams could be considered as sources for the State Water Project. However, the Act places the Eel River in special status. It directs the Department of Water Resources to report to the Legislature after March 1985 on the need for water supply and flood control projects on the Eel River so the Legislature can consider whether the Eel should be removed from the Wild and Scenic Rivers System. Determination of such need involves more than the State Water Project. The Department is not now studying the potential of reservoirs on the Eel River.

Local Projects

It is policy of the Department of Water Resources to fund local water supply projects within State Water Project service areas as units of the State Water Project if they are engineeringly feasible, economically and environmentally sound, and financially feasible. Such projects can include supplies from surface water, ground water, or reclaimed water resources. While the amounts of water from such projects are usually relatively small, they do represent a potential supply for the project that could be developed in lieu of importing water from the Delta. When requested by a contracting agency, the Department will evaluate including such projects in the State Water Project. Early construction of such facilities would reduce potential risk of water shortages while Delta facilities are being completed.

Local Water Purchases and Transfers

On a temporary basis during drought years, it may be possible to increase the State Water Project supply by buying water from farmers, water districts, and others in the Sacramento Valley. Some local interest has been expressed in such an arrangement. Before such a program could be implemented, contractual arrangements would have to be made to establish specific criteria as to amounts of water to be purchased, advance notice and timing of water deliveries, and payment provisions. Negotiations and analysis are needed to determine the appropriate arrangements and the practical potential of increasing the project water supply by this means. Completion of North Delta facilities would make such purchases more effective.

Mid-Valley Canal

The Bureau of Reclamation has proposed and studied the Mid-Valley Canal as an addition to the Central Valley Project. This canal would transport water from the San Luis Reservoir complex south and east to alleviate ground water overdraft from Merced to Kern County. This would require either enlargement of the Delta-Mendota Canal or use of seasonally available capacity in the California Aqueduct. Either alternative would require an improved water transfer system in the Delta.

Submerged Sill in Carquinez Strait

The U. S. Army Corps of Engineers has proposed a submerged sill in Carquinez Strait as a way to mitigate any significant increases in salinity intrusion resulting from deepening the deep water ship channels. The submerged sill has also been suggested as a way to reduce intrusion of ocean water into the Delta and thereby reduce the need for the water projects to release fresh water to repel salinity.

If a sill or other measures are needed to mitigate channel deepening, the measures would be common to all Delta transfer alternatives.

The proposed sill would extend from the bottom of Carquinez Strait to about 50 feet below the water surface at mean lower-low water. The Corps of Engineers has already tested the sill at the San Francisco Bay-Delta model in Sausalito. One test indicated that, at an outflow of 410,000 cubic feet per second,*

*"Sacramento River Deep Water Ship Channel, California", July 1980. Corps of Engineers, App 5.

some high tide levels in the internal Delta would rise by about 0.2 foot, and up to 0.4 foot in Suisun Bay.

Studies show that the 50-year design flood for a comprehensive Delta water project would have a peak flow of about 700,000 cubic feet per second.* With this flow, the sill might raise the high tide in the Delta by more than 0.2 foot. Because of the sensitivity of the Delta levees to overtopping, measures should be considered to protect the levees. Impacts in Suisun Bay should also be considered.

On February 3, 1981, the Corps of Engineers and the Department of Water Resources entered into a Memorandum of Understanding, which, in part, provides that the Corps will use the Bay-Delta model to evaluate salinity intrusion that may result from deepening the Sacramento Ship Channel. (While not part of the agreement, similar tests would also be needed if the Corps proceeded with the authorized deepening of the Baldwin Ship Channel.) If tests show that deepening the Sacramento Ship Channel would increase salinity intrusion, the Corps will conduct special studies of a sill in Carquinez Strait to determine its effectiveness and will pursue mitigation measures, if needed. If the Corps does test a sill again, tests will be coordinated with the Department of Water Resources and the Department of Fish and Game.

Reports on Delta levee improvement have recently been completed by the Department, the Corps of Engineers, and the Emergency Delta Task Force authorized by the State Assembly. After these reports were released, a number of legislative bills were presented to protect the levees. In conjunction with general levee rehabilitation, the levees could be raised an additional increment to protect them against higher water levels attributed to the sill.

*Appendix to DWR Bulletin 76, "Channel Hydraulics and Flood Channel Design", July 1962, unpublished.

APPENDIX. INITIAL ELIMINATION OF ALTERNATIVES

Selection of water transfer alternatives for this reassessment of Delta facilities was based on past studies of Delta alternatives. To reduce the number to the most viable alternatives, the following alternative concepts were eliminated from consideration for the reasons discussed.

Bay Barriers

Barriers in the San Francisco Bay system to physically separate saline water of the bay from the fresh water of the Delta have been proposed and studied many times since the late 1800s. The numerous barrier sites studied have ranged from a few miles upstream of the Golden Gate up to Chipps Island. Bay barriers have repeatedly been rejected in favor of other courses of action.

There are several important reasons for rejecting the bay barrier concept. Large gate structures would be required to pass flood flows, and navigation locks would be needed to allow seagoing ships to reach the inland ports. The locks, which must prevent upstream dispersion of salts, are complex and expensive, as well as time consuming for the passage of ships. The U. S. Public Health Service has recommended that all municipal and industrial waste discharges be extended to a terminal point downstream from the barrier. Barriers were judged to be functionally infeasible due to uncertainty of water quality in the upstream barrier pool.

The cost of barriers and the related offsite facilities would be relatively high. For comparison, in 1964 the Chipps Island Barrier plan was shown to be 43 percent more costly than the Peripheral Canal plan. Using construction cost indexes and allowing for a more elaborate fish screen at the Peripheral Canal, it appears that the barrier plan would be about 15 percent more costly than the Peripheral Canal. (All the water transfer alternatives discussed in this report are less costly than the Peripheral Canal.)

A major problem with bay barriers is the loss of tidal action in the Delta, which leads to several areas of concern, including esthetics, fish protection, and levee stability.

The loss of tidal currents from the channels in the western Delta adjacent to the industrial complexes would lead to thermal stratification due to the discharge of cooling water. This would result in a layer of water near the surface about 15 degrees warmer than the underlying water. Biologists differ on the extent of the problem, but most agree to a potential for excess algae production, which would make the aquatic environment unpleasant to sight and smell. Another concern is the further spread of water hyacinth throughout the Delta. At present, most of the water hyacinth production is in channels with weak tidal currents, but they could spread throughout the Delta without the flushing influence of tidal currents.

Delta fish populations could suffer in several ways with bay barriers and loss of tidal currents. In the 1963-64 annual report, "Delta Fish and Wildlife Protection Study", the Department of Fish and Game stated that the Chipps Island barrier plan is the least desirable project of the alternatives studied. The barrier would eliminate the salinity gradient and tidal currents in the Delta channels. A similar effect would occur with a barrier in Carquinez Strait. Anadromous fish, which come up through the bay to spawn in fresh water, would have to pass through a fishway in the barrier. Several fish, including striped bass and shad, are not known to be able to make the physiological changes required in such a short transition from saline to fresh water. The loss of tidal currents would allow suspended solids and striped bass eggs to settle. The settling of suspended solids would increase light transmissibility, which could cause excessive algal blooms and might also result in greater predation of small fish. Striped bass eggs, when allowed to settle to the bottom, are known to suffocate.

Several past studies have concluded that tidal action tends to keep the expansive soils of the Delta levees moist and thereby enable them to retain their form. These studies also concluded that the barrier, with minimum pool levels in the summer and fall, would allow the levees to dry out and shrink, causing cracks that would leak during the succeeding winter high flow periods. This would lead to considerably more levee failures. Studies have shown that downstream of a Chipps Island barrier, the tidal range would double. U. S. Army Corps of Engineers studies, reported in Appendix H, "Hydraulic Model Studies", Volume I (March 1963), showed the effects of a barrier at Chipps Island. Tests using the Corps' model indicate that the tidal range would increase 3 to 5 feet with a barrier. A barrier at Dillon Point (Carquinez Strait) would increase tidal range about 3 feet. This would affect all the waterfront and would lead to considerable potential for flooding along the shorelines of southern Solano County and northern Contra Costa County.

The Dutch have had problems with their barriers. In 1953, before the barriers were built, a storm and high tides flooded much of the reclaimed land along the North Sea. The Dutch plan to prevent future flooding called for large barriers to block the main estuaries from the sea, create freshwater reservoirs behind the barriers, and provide protection from storms and high tides. The barrier project was to be completed in the late 1970s; however, the project took more time and money than expected. After three of four main estuaries were blocked, the ecological price was realized. Algal blooms occurred in the freshwater reservoirs, the shell fish industry disappeared, and tidal nurseries were severely damaged. The fourth estuary was not closed; a storm barrier was built that would be closed only in times of high storm tides and the fourth estuary remained open to the sea and tidal flows.

Construction on
Deep Peat and Organic Soils

Construction of large facilities on deep unconsolidated peat could lead to many construction and maintenance problems. Peat foundations of the Delta levees have had many decades to consolidate. The construction of large new embankments across deeply subsided, unconsolidated peaty areas could be risky. Also, this leads to many unknowns in the area of seismic stability, since no large earthquakes have occurred in the vicinity in recent decades. The large differential between water levels of the channels and the landward side of existing or new levees results in a high risk factor for assuring transfer of State Water Project water. Therefore, plans requiring construction across deep peat subsided areas have been omitted.

Alternative plans examined in Appendix B to DWR Bulletin 76, July 1978, and excluded from consideration in this report because they involve construction in deep peat include:

° Waterway Control Plan
° Cross-Delta Transfer Plan
° Central Delta Plan
° Combination Waterway Control and Central Delta Plan
° Central Delta Canal
° West Delta Canal
° Mathena Landing Cross Channel
° Isleton Cross Channel

CALIFORNIA DEPARTMENT OF WATER RESOURCES
Room 1115-16, Resources Building
1416 Ninth Street
Sacramento, CA 95814
Phone: (916) 445-4501

NEWS RELEASE
November 4, 1983

SACRAMENTO -- An improved system for moving water across the Sacramento-San Joaquin Delta for the State Water Project would cost up to $400 million and deliver up to 500,000 acre-feet of additional water a year, the Department of Water Resources (DWR) said today.

Four alternative systems for Delta water transfer were presented to the California Water Commission by DWR Director David N. Kennedy. They propose digging a cross channel, known as the New Hope Cross Channel, in the north Delta or enlarging existing north Delta channels, and in the south Delta enlarging the existing Clifton Court Forebay, enlarging the forebay intake, and/or dredging channels. Water for the state project is taken into the forebay before it is pumped into the California Aqueduct.

The Delta facilities proposed are not new concepts, but were shelved in the past in favor of the Peripheral Canal proposal. The canal, however, was soundly rejected by California voters in 1982. On taking office in June, Kennedy gave additional impetus to studies of alternative Delta improvements.

(more)

The study presented today made no recommendation among the four proposals, but Kennedy called them the "most promising" of many possible systems studied for the Delta. Any of the four would increase the delivery capability of the water project, and would improve Delta water conditions over the existing method.

The systems proposed, with their costs and water yield:

A. New Hope Cross Channel and enlarging Clifton Court Forebay. Depending on design options chosen, $230 to $400 million and a yield of 450,000 to 500,000 acre-feet a year. (An acre-foot, 325,581 gallons, is about what an average famaily uses in a year.)

B. New Hope Cross Channel, dredging south Delta channels, and enlarging the Clifton Court intake. $310 to $380 million, 210,000 to 380,000 acre-feet.

C. New Hope Cross Channel, new intake to Clifton Court. $230 to $400 million, 450,000 to 500,000 acre-feet.

D. Enlarged north Delta channels, enlarged Clifton Court Forebay. $120 to $320 million, 250,000 to 500,000 acre-feet.

The New Hope channel would be dug from the Sacramento River near Courtland to the Mokelumne River near Walnut Grove, improving the flow of water toward the pumps.

In his presentation, Kennedy emphasized that no one plan has been selected, but said DWR is leaning toward plans that can be built in stages, since they are probably most economical and have the most potential to reduce fish and wildlife losses in the Delta.

(more)

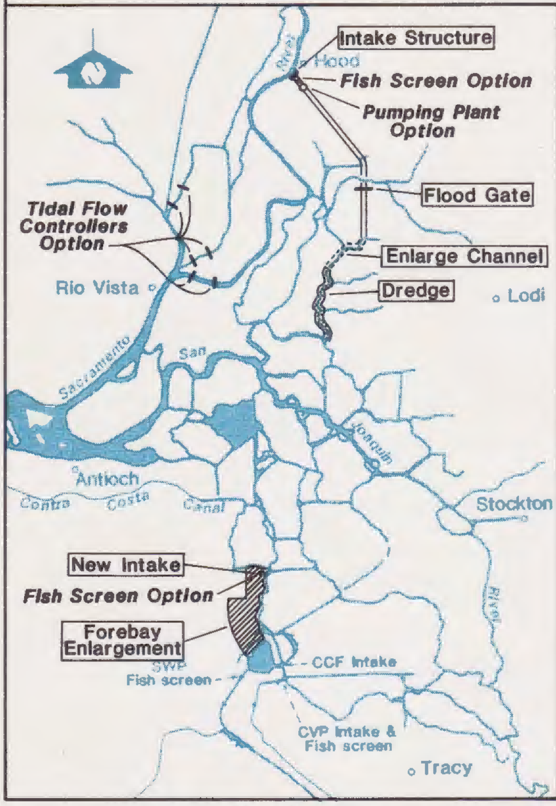
The existing Delta situation, with 5 to 6 million acre-feet a year flowing to pumps of the state and federal water projects, causes problems which include scouring of channels, fish losses, intrusion of salt water, and degradation of water quality. The alternatives attempt to deal with those problems, Kennedy said.

Kennedy said Delta levee problems must be considered when talking about water transfer plans. DWR supports legislation to spend $10 million a year of tidelands oil revenue to rehabilitate fragile Delta levees.

The next step, Kennedy said, is to schedule meetings between DWR and various interest groups. Scheduled legislative committee hearings also will provide a chance to discuss the Delta alternatives, he said.

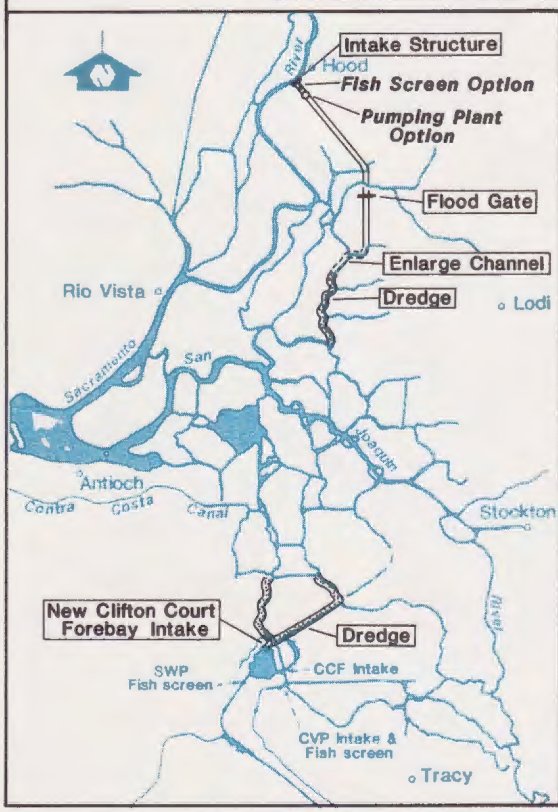
#

PLAN A. NEW HOPE CROSS CHANNEL AND ENLARGED CLIFTON COURT FOREBAY.



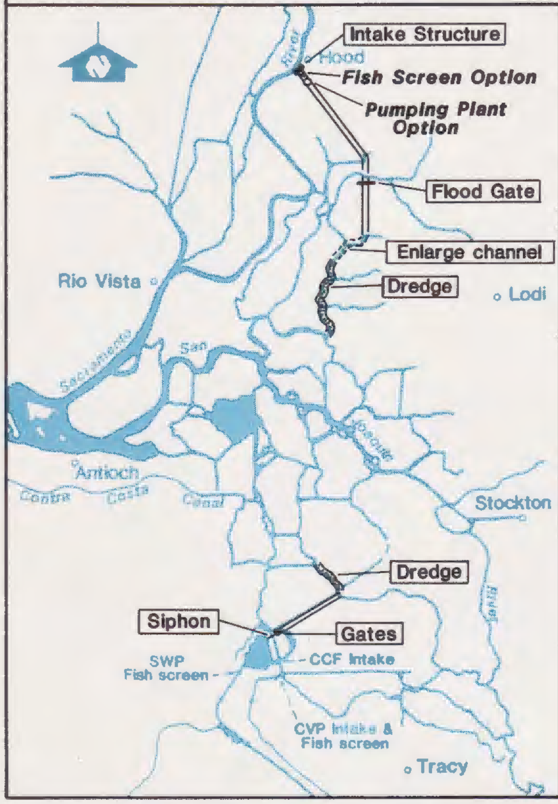
DESIGN OPTIONS		Capital Cost in $ Million	Yield in 1000 AF/Yr	Unit Cost in $/AF	Salt Reduction in Percent
North Delta	South Delta				
Gravity Flow	Existing and New Intakes Existing Fish Screens	230	450	43	25
Tidal Flow Controllers	Existing and New Intakes Existing and New Fish Screens	340	500	57	30
Tidal Flow Controllers	Single New Intake, SWP only, with New Fish Screen	370	500	62	30
Pumping Plant with Fish Screen	Existing and New Intakes Existing Fish Screens	400	500	69	30

PLAN B. NEW HOPE CROSS CHANNEL, DREDGED SOUTH DELTA CHANNELS AND NEW CLIFTON COURT FOREBAY INTAKE.



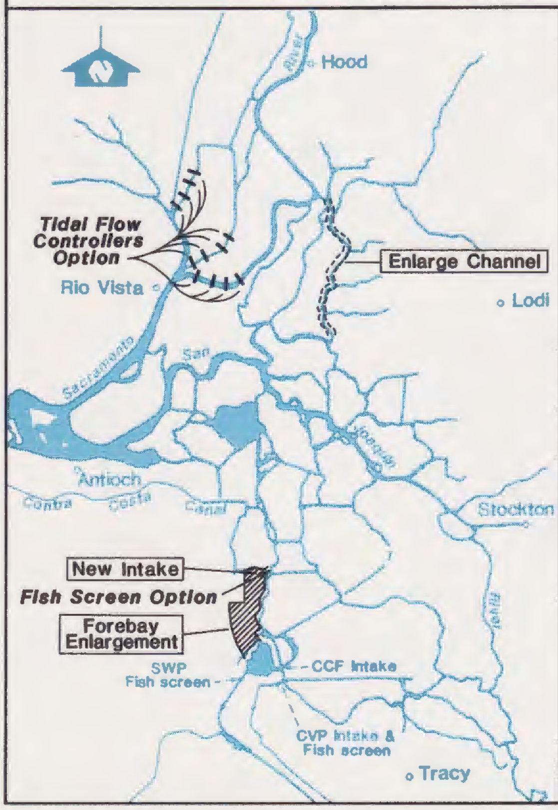
DESIGN OPTIONS		Capital Cost in $ Million	Yield in 1000 AF/Yr	Unit Cost in $/AF	Salt Reduction in Percent
North Delta	South Delta				
Gravity Flow	Existing Fish Screens	210	450	39	25
Pumping Plant with Fish Screen	Existing Fish Screens	380	500	66	30

PLAN C. NEW HOPE CROSS CHANNEL AND NEW INTAKE CHANNEL TO CLIFTON COURT FOREBAY.



DESIGN OPTIONS		Capital Cost in $ Million	Yield in 1000 AF/Yr	Unit Cost in $/AF	Salt Reduction in Percent
North Delta	South Delta				
Gravity Flow	From Middle River, SWP only, with Existing Fish Screens	230	450	44	25
Pumping Plant with Fish Screen	From Middle River, SWP only, with Existing Fish Screens	400	500	69	30

PLAN D. ENLARGED NORTH DELTA CHANNELS AND ENLARGED CLIFTON COURT FOREBAY.



DESIGN OPTIONS		Capital Cost in $ Million	Yield in 1000 AF/Yr	Unit Cost in $/AF	Salt Reduction in Percent
North Delta	South Delta				
Gravity Flow	Existing and New Intakes Existing Fish Screens	120	250	40	15
Tidal Flow Controllers	Existing and New Intakes Existing and New Fish Screens	290	500	49	30
Tidal Flow Controllers	Single New Intake, SWP only, with New Fish Screen	320	500	54	30

ALTERNATIVES TO THE PERIPHERAL CANAL

By
David N. Kennedy
Director
Department of Water Resources
The Resources Agency
State of California

The Department's staff is pleased to present to your Commission today our report outlining alternatives to the Peripheral Canal. As I have mentioned to you previously, the staff began working on the report earlier this year. Our purpose is to focus public discussion about water transfer across the Delta on the alternative plans which appear to have the most promise. At the same time, we recognize that Delta transfer problems must be considered and resolved within the larger framework of a number of related concerns including protection of the areas of origin and protection of fish and wildlife resources.

In this statement, I will briefly summarize the plans analyzed in the report. First, however, I want to make a few comments about the report itself.

It is essentially a technical review of available information, based on knowledge gained through many years of Delta investigations. We did not make detailed layouts of the alternatives. The cost estimates and other data are fairly

---

Presented before the California Water Commission, Sacramento, November 4, 1983.

rough. Data will no doubt be modified as the alternative plans are refined in the coming months. However, we believe the cost estimates are adequate for comparing alternative plans.

The report presents a large number of physical alternatives and from these selects four as being most promising. All are variations of "through-Delta" plans in which the exported water is conveyed through existing channels. While these particular plans presently appear to be most promising to the Department's staff, further evaluation and public discussion may indicate additional variations.

The report makes no recommendations, nor does it draw any conclusions about a "preferred plan". We see both advantages and disadvantages with virtually all of the plans. If we are leaning in any direction, however, it is towards those plans that present the greatest opportunity for step-by-step staging. Such plans are probably most economical and also have the most potential for mitigation of existing fish and wildlife problems.

The point-of-departure for consideration of Delta facilities is that the existing Delta situation is unacceptable to virtually all of the interests involved. At present, 5 to 6 million acre-feet a year is transferred through the Delta channels to the State and Federal export pumps in the south Delta. The resulting problems include channel scour, fisheries losses, salinity intrusion and water quality degradation. All of the plans in this report represent attempts to deal with these problems.

Now, I will describe briefly the plans which we have selected as being most promising. There are sketch maps attached to this statement to which you may wish to refer.

The first three plans, A, B, and C, would all use the same basic facility for increasing conveyance capacity in the north Delta but would differ in what would be done in the south Delta. All three plans would involve a New Hope Cross Channel in the north, although there could be some variation in its specific design and operation. In the south Delta, Plan A would include an enlargement of Clifton Court Forebay; Plan B would involve only the dredging of south Delta channels and construction of a new intake to the existing Clifton Court Forebay; and Plan C would include construction of a new intake channel to the existing Clifton Court Forebay.

The fourth alternative, Plan D, would not involve construction of any entirely new channels. Rather, in the north Delta, the Mokelumne River channel would be widened and deepened and in the south Delta, Clifton Court Forebay would be enlarged. In its basic form, this plan would have only half the water yield of the first three alternatives. However, a possible design option for increasing the yield would be to construct what we call "tidal flow controllers" in the Sacramento River. These partial barriers, which in themselves would be somewhat controversial, would have the effect of forcing more Sacramento River water through the existing Cross Channel, while at the same time permitting passage of boats.

As you are aware, until last week we were also considering a fifth plan, which would be a dual system involving the so-called mini-canal. This plan had been considered over the years by technical people as a possible compromise to a full-size Peripheral Canal. During the preparation of our report, we initially intended to include it for that reason. However, as discussion of the plan moved from the technical to the policy level over the last few months, and particularly in the last three weeks since I mentioned it at a meeting of the State Board of Agriculture, it became clear that it was no more acceptable to opponents of the Peripheral Canal than the canal itself. The Governor has repeatedly stressed his desire to see the Delta matter resolved in a spirit of accomodation and last Friday, after discussing it with me, he decided to delete the "mini-canal" from further consideration.

The sketch maps indicate that each of the plans can be modified with design options to give them more hydraulic capacity or to give more opportunity for fisheries mitigation. For instance, the flow across the north Delta can be increased through construction of tidal flow controllers or partial barriers, and can be further increased with a pumping plant.

Selection of a single plan is going to require a good deal of additional analysis. In particular, protection of fish and wildlife will be a major factor in determining a recommended plan. On the one hand, development of more hydraulic capacity across the north Delta will mitigate existing fish problems caused by reverse flows in the lower San Joaquin River. On the other hand, additional flows across the north Delta could result in more fish winding up at the export pumps. Balancing these factors leads us to speculate that a staged plan of development is the most promising way to proceed. In any event, the Department of Water Resources intends to negotiate an agreement with the Department of Fish and Game to outline the mitigation measures which will be undertaken with respect to Delta water transfer facilities.

One of the assumptions inherent in all of the alternative plans is that the State's Delta Pumping Plant (Harvey O. Banks Pumping Plant) will be completed by installing the final four pumping units. The additional units are essential for diverting more water in the winter months into off-stream storage south of the Delta. They are particularly important if we are to be successful in our goals of developing additional off-stream storage facilities and in enlarging our conjunctive use programs with ground water storage.

It is probably not realistic to talk about Delta water transfer plans without discussing Delta levee problems. In the last few months we have taken several steps toward a comprehensive levee rehabilitation and reconstruction program. In September, the Administration indicated to the Federal Emergency Management Agency (FEMA) that we will support State legislation to redirect $10 million a year of Tidelands Oil Revenue into the State's Levee Subventions Program. This will be a positive step toward indicating State and local willingness to protect the Delta levees. We also have had several meetings with the Corps of Engineers and the Bureau of Reclamation about possible Federal involvement. Our objective is to work out a cooperative program in which local, State and Federal financing will be coordinated in an overall program that preserves the Delta in essentially its present configuration.

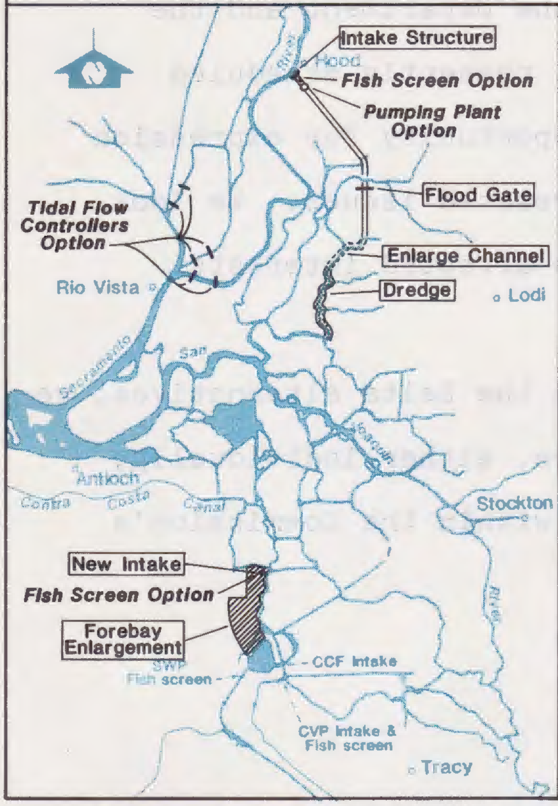
There is one final area on which I wish to comment -- the relationship between the State Water Project and the Federal Central Valley Project. Late last year our Department and the Bureau of Reclamation completed negotiation of a Coordinated Operations Agreement (COA) for the two projects. During the summer we held a number of public scoping sessions to determine the level of environmental documentation needed before the agreement can be executed. Our agencies are now working on an Environmental Impact Statement which will be ready for public review early next year.

The next step in developing a comprehensive program will be a series of meetings between the Department and the various interest groups. In addition, presently scheduled legislative hearings will afford an opportunity for expression of views about alternative plans and related issues. We look forward to discussions with all of the affected interests.

In the process of evaluating the Delta alternatives, we will value any input which you may have, either individually, or on behalf of the areas represented within the Commission's geographic makeup.

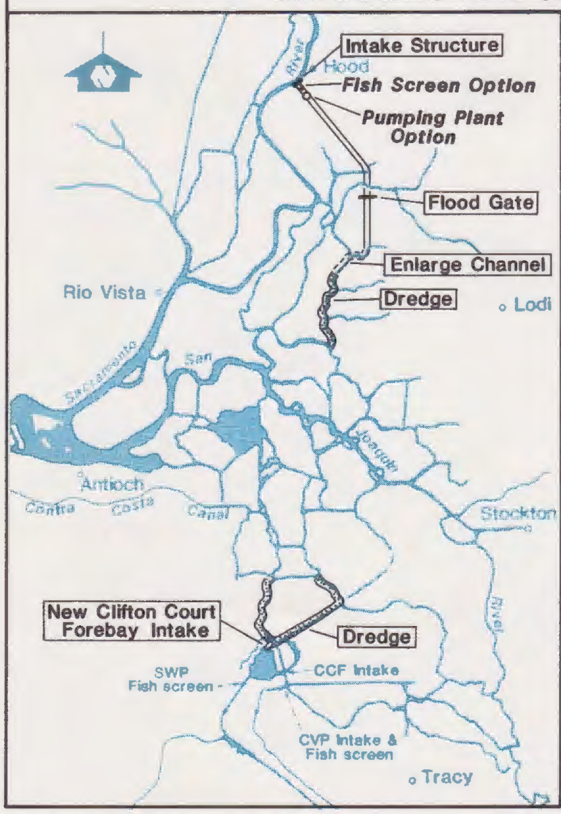
Attachments

PLAN A. NEW HOPE CROSS CHANNEL AND ENLARGED CLIFTON COURT FOREBAY.



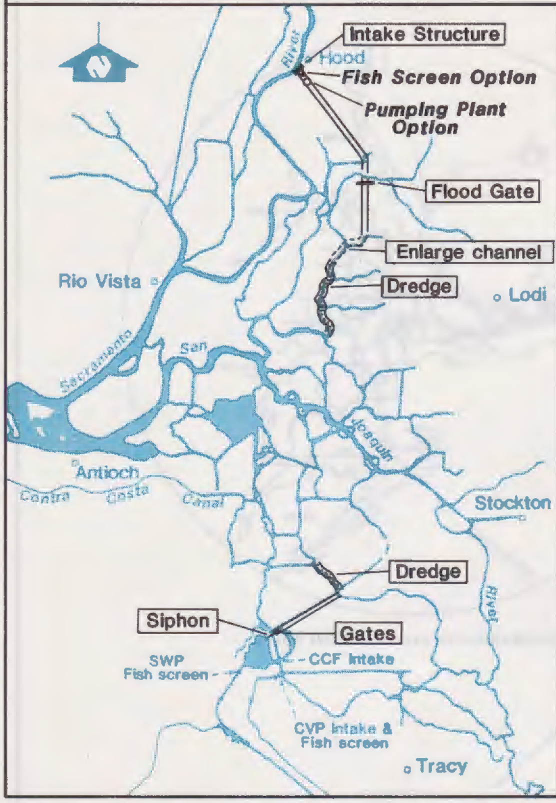
DESIGN OPTIONS: North Delta	DESIGN OPTIONS: South Delta	Capital Cost in $ Million	Yield in 1000 AF/Yr	Unit Cost in $/AF	Salt Reduction in Percent
Gravity Flow	Existing and New Intakes Existing Fish Screens	230	450	43	25
Tidal Flow Controllers	Existing and New Intakes Existing and New Fish Screens	340	500	57	30
Tidal Flow Controllers	Single New Intake, SWP only, with New Fish Screen	370	500	62	30
Pumping Plant with Fish Screen	Existing and New Intakes Existing Fish Screens	400	500	69	30

PLAN B. NEW HOPE CROSS CHANNEL, DREDGED SOUTH DELTA CHANNELS AND NEW CLIFTON COURT FOREBAY INTAKE.



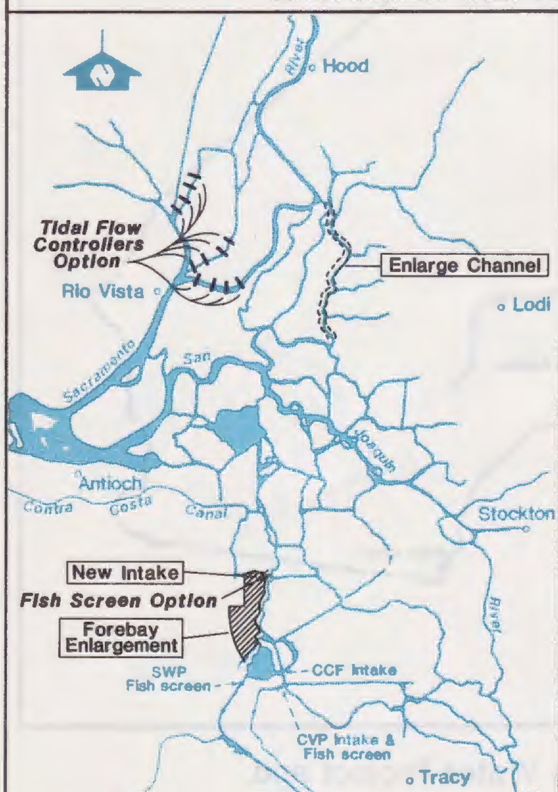
DESIGN OPTIONS: North Delta	DESIGN OPTIONS: South Delta	Capital Cost in $ Million	Yield in 1000 AF/Yr	Unit Cost in $/AF	Salt Reduction in Percent
Gravity Flow	Existing Fish Screens	210	450	39	25
Pumping Plant with Fish Screen	Existing Fish Screens	380	500	66	30

PLAN C. NEW HOPE CROSS CHANNEL AND NEW INTAKE CHANNEL TO CLIFTON COURT FOREBAY.

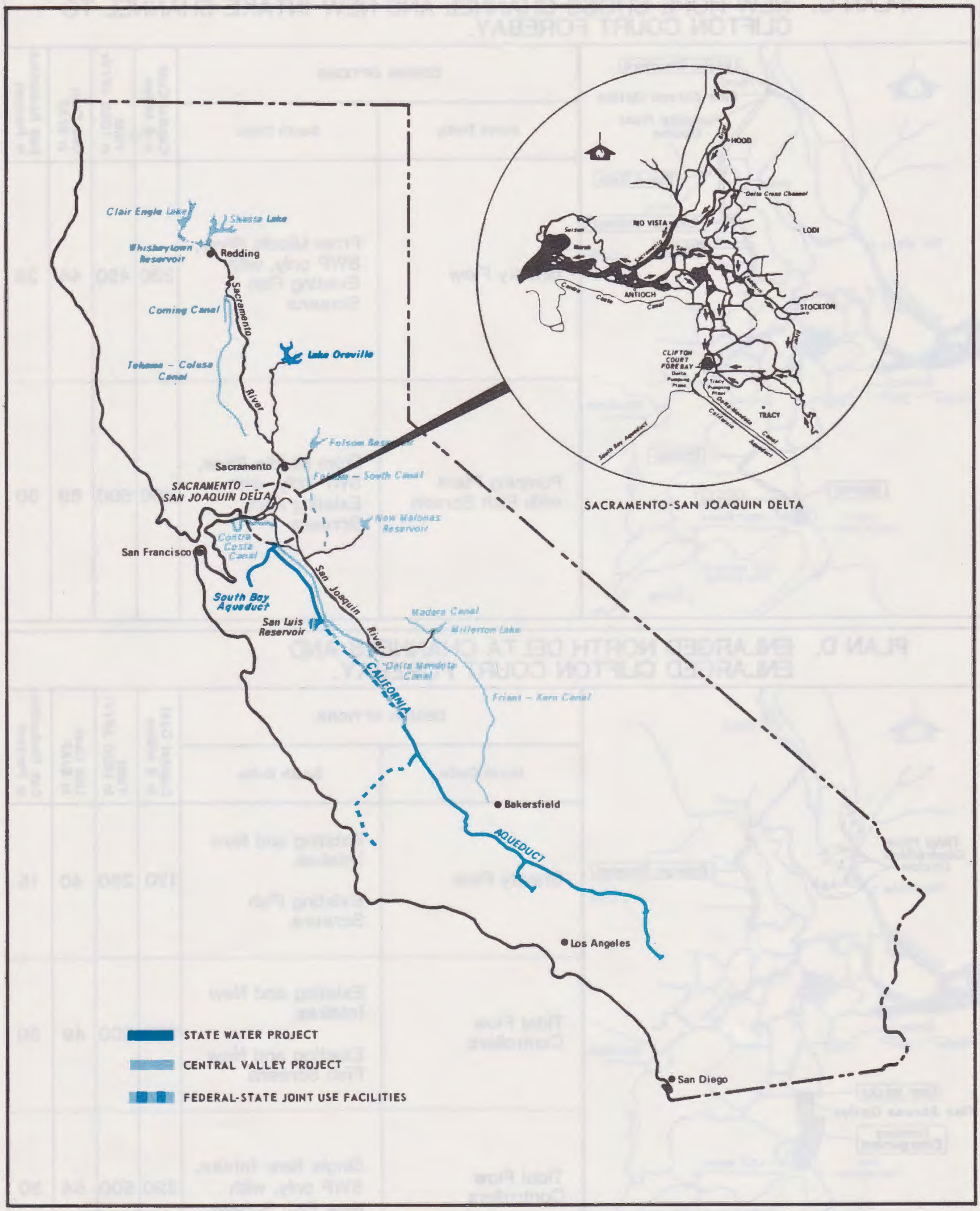


DESIGN OPTIONS		Capital Cost in $ Million	Yield in 1000 AF/Yr	Unit Cost in $/AF	Salt Reduction in Percent
North Delta	South Delta				
Gravity Flow	From Middle River, SWP only, with Existing Fish Screens	230	450	44	25
Pumping Plant with Fish Screen	From Middle River, SWP only, with Existing Fish Screens	400	500	69	30

PLAN D. ENLARGED NORTH DELTA CHANNELS AND ENLARGED CLIFTON COURT FOREBAY.



DESIGN OPTIONS		Capital Cost in $ Million	Yield in 1000 AF/Yr	Unit Cost in $/AF	Salt Reduction in Percent
North Delta	South Delta				
Gravity Flow	Existing and New Intakes Existing Fish Screens	120	250	40	15
Tidal Flow Controllers	Existing and New Intakes Existing and New Fish Screens	290	500	49	30
Tidal Flow Controllers	Single New Intake, SWP only, with New Fish Screen	320	500	54	30



Major Features of the State Water Project and Central Valley Project