BAY-DELTA OVERSIGHT COUNCIL

DRAFT

BRIEFING PAPER ON STATUS, TRENDS, AND FACTORS AFFECTING SACRAMENTO/SAN JOAQUIN DELTA WATER SUPPLIES

Bay-Delta Oversight Council

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STATUS, TRENDS AND FACTORS AFFECTING SACRAMENTO/SAN JOAQUIN DELTA WATER SUPPLIES

BAY-DELTA OVERSIGHT COUNCIL
MARCH 1994

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PREFACE

This briefing package is meant to provide basic information regarding California's present and future water supply and to highlight the role of the Bay-Delta in meeting present and future water supply needs. Additionally, some general actions for increasing that supply are discussed. To provide context, a brief review of various institutional and other factors impacting water management is included as well. The focus of this paper reflects the specific direction in the Governor's charge to the BDOC to address "effective design and operation of water export systems."

The Executive Summary seeks to provide an overview of the information presented in the briefing paper. It deserves emphasis, however, that it should not be considered a substitute for the full text. Rather, it is meant to provide merely a snapshot of the major points, as the characterization and flavor of the entire prepared document cannot be replicated in an Executive Summary.

As has been our practice, attached as addenda are several perspective papers outlining the authors' views pertaining to the issues discussed in this briefing paper. These perspective papers are reproduced here as submitted. Please note that reference is made in some of the perspective papers to a second paper, "Long-Range Planning Concepts for Managing Future Water Supply." This paper is still in process and will be presented to the Council in the near future.

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INTRODUCTION

There is general consensus today that the San Francisco Bay/Sacramento-San Joaquin Delta Estuary is no longer effectively functioning in its dual capacity as an important ecosystem and as the essential cog in the State's water supply network.

SURFACE WATER SUPPLIES AND THE DELTA

There are ten hydrologic regions in California, with the North Coast, Sacramento and San Joaquin basins containing the largest volume of runoff. The Delta receives about 40 percent of the State's runoff. The hydrologic regions with the second and third highest runoff averages in the State drain into the Delta. The Sacramento River Region has an average annual runoff of 23 MAF, and the San Joaquin River Region has an average runoff of 8 MAF.

Prior to recent changes in water allocations within the Sacramento/San Joaquin and Colorado River systems, California had roughly enough water to meet average annual urban and agricultural water demands at the 1990 level of development while complying with State Water Resources Control Board (SWRCB or Board) Water Rights Decision 1485 (D-1485), which is the currently operative water quality standard regime.

A significant portion of the water supply for the South Coast Region is imported from the Colorado River basin. There are concerns that these Colorado River supplies may decline as a result of Arizona and Nevada taking more of their allocated supplies under the (interstate) Colorado Compact.

[*Textual Note*:

Various references are made to State Water Resources Control Board Decision 1485 (D-1485) with respect to current project operations and estimates of future operational capabilities. When considering the information that references "under D-1485," the reader is advised that this reference is added to provide the criteria used for the operation studies which generated the quoted water supply impact(s). It is acknowledged that the controlling regulatory regime is changing, and thus future projections are problematic.

It should also be noted and recognized that most of the data regarding California's estimated future water budget, upon which much of the analysis in this report is based, has been derived from the Department of Water Resource's draft *California Water Plan Update*, November, 1993, (draft Bulletin 160-93).]

GROUND WATER SUPPLY

California's ground water storage is estimated at 850 MAF, in some 450 ground water basins. However, probably less than half of this total volume is usable because of prohibitive extraction costs and water quality considerations. An estimated 14 MAF of ground water is extracted to serve agricultural, municipal, and industrial uses in an average water year. Current average annual net ground water use (in simple terms, the amount of water extracted from the aquifer over and above that which returns to it) is about 8.5 MAF, including about 1.0 MAF of annual ground water overdraft. This represents nearly 20 percent of statewide applied water. In some areas, ground water accounts for as much as 90 percent of locally applied water.

Until key Delta issues are resolved and additional water management programs implemented, beneficial overdraft reductions experienced in the last decade in the San Joaquin Valley will likely decrease as more ground water is pumped to substitute for uncertain or diminished surface water supplies from the Delta.

DROUGHT

Throughout California, water agencies bought and exchanged water to meet critical needs during the recent drought. The State Drought Water Bank played a vital role in meeting some of those critical water needs. However, the Bank's effectiveness was somewhat limited by the inability to transfer water through the Delta as a consequence of physical and regulatory pumping constraints.

THE NEED AND DEMAND FOR WATER

The North Coast hydrologic region contains a majority of the State's environmental water, reflecting the large protected natural flows of the wild and scenic rivers system, which total about 17.8 MAF in an average year. The Tulare Lake Region has the largest net agricultural water demand, about 7.9 MAF in an average year, while the South Coast Region has the highest net urban water demand, about 3.5 MAF in an average year. Dedicated instream flow under D-1485 makes up the largest portion of the San Francisco Bay Region's net water demand (about 4.6 MAF), while urban and agricultural net water demands for the region amount to 1.3 MAF.

California's population is projected to increase to 49 million people by the year 2020 (from about 30 million in 1990). Even with extensive water conservation, it is estimated that annual net urban water demand will increase 3.8 MAF to 10.5 MAF by 2020.

Statewide irrigated agricultural acreage is expected to decline by nearly 400,000 acres, from the 1990 level of 9.2 million acres to a 2020 level of 8.8 million acres. Increases in agricultural water use efficiency, reductions in agricultural acreage, and shifts to less water intensive crops, are expected to decrease annual net agricultural water demand by about 2.3 MAF by 2020.

Average annual net water demand for existing environmental needs is expected to increase. There is substantial disagreement in the water community over the potential size of that increased demand.

WILL THERE BE ENOUGH WATER?

Average annual supplies calculated at the 1990 level of development would have been generally adequate to meet expected 1990 levels of water demand. However, drought conditions in the early 1990s created actual supplies that did not fully satisfy demand and resulted in a shortage of over 2.7 MAF. Continuing shortage conditions are projected even when a Delta solution is assumed. Without such a Delta "fix," many viable options that would otherwise be available to water managers to meet the estimated water deficit will be infeasible or otherwise unimplementable. Future estimated water shortages would vary from region to region and sector to sector. DWR has concluded that future projected shortages under average conditions will be chronic, indicating the need for additional long-term water management measures.

After accounting for future reductions of 1.3 MAF in net water demand resulting from various conservation actions, projected 2020 net demand for urban, agricultural, and environmental water needs amounts to 66.4 MAF in average years and 55.7 MAF in drought years. These demand projections do not include an additional estimated 1 to 3 MAF of environmental water needs, which may arise depending upon the resolution of a number of current regulatory proposals to protect aquatic resources. The reader is referred to Bulletin 160-93 for additional detail on these projected demands.

Environmental water considerations in the Delta could alter present analyses dramatically. Currently, 4.6 MAF of Delta outflow is dedicated to fish and wildlife purposes under D-1485. In recent years, though, it has become increasingly apparent that these minimum flow criteria have not created the favorable conditions for fishery resources that had been expected and additional regulatory actions are presently under review.

THE BAY-DELTA WATERSHED AND ITS IMPORTANCE TO THE STATE'S WATER SUPPLY

DELTA DESCRIPTION

The Delta includes the land and waterways bounded approximately by Sacramento on the north; Tracy on the south; Stockton on the east; and Pittsburg on the west. This area covers 750,000 acres of land and about 700 miles of navigable waterways. Much of this land is below sea level. The lands are protected by 1,100 miles of levees and form nearly 60 islands or tracts that are surrounded by waterways. About 500,000 acres are farmed annually. The pumping facilities of the SWP and CVP are located in the southwestern Delta, about 10 miles northwest of Tracy.

The SWP Delta complex consists of Clifton Court Forebay, John E. Skinner Fish Facility, an intake channel, and the Harvey O. Banks Delta Pumping Plant. The Banks Plant is designed to pump a maximum of 10,300 cubic-feet-per-second (cfs) but is currently only permitted by the USCOE to pump less than that rate on a monthly schedule which averages a maximum of 6,400 cfs.

The CVP diverts directly from Old River and also has a fish salvage and recovery facility near Tracy. The CVP has a Delta pumping capacity of 4,600 cfs. Together, these pumping plants help provide a portion of 20 million Californians' drinking water supply and irrigation water for millions of acres of some of the world's most productive agricultural land. From 1980-1992, the SWP and CVP provided over 5 MAF of average annual water supply from the Delta to their customers.

The Delta Cross Channel is a mile-long unlined canal, constructed by the U.S. Bureau of Reclamation (USBR) in 1951, that facilitates the transfer of higher quality water out of the Sacramento River channel toward the projects' export facilities in the southwestern Delta. Though it is partially effective in providing for this transfer, it is limited hydraulically with respect to the volume of water it can accommodate. Additionally, because it is not presently equiped with a fish screen, the gated inlet works are closed periodically so as to assist fish migration in the Sacramento River. This further limits its water transfer capability.

In addition to these water facilities, there are 1,800 agricultural diversions within the Delta that, under riparian rights, divert a combined seasonal peak of 4,500 cfs to irrigate about 500,000 agricultural acres.

HYDROLOGY

Sacramento River Region

The Sacramento River Region extends almost 300 miles from the Delta north to the Oregon border. The Sierra Nevada Mountain Range forms the eastern border; the northern border is bounded by the Cascade Range; and the west side is defined by the Coastal Range.

More than 40 major reservoirs lie within the Sacramento River Region. The reliability and capacity of this complex system is affected by Delta channels as well as the Delta's natural tributaries. Exports from the Sacramento River basin are taken mainly from the Delta (though there are significant upstream diversions as well) and are of paramount importance to the State's water supply.

San Joaquin River Region

The San Joaquin River Region is bordered on the east by the crest of the Sierra Nevada and on the west by the coastal mountains of the Diablo Range. It extends from the Delta and the Cosumnes River drainage southward to the Tulare Lake basin.

About 47 percent of the San Joaquin Valley's 1990 level water supply comes from local surface sources, while imported surface supplies account for 29 percent. Ground water fulfills about 19 percent of the total 1990 level of average annual water supply for the region. The remaining 5 percent is dedicated to natural flow. Because the San Joaquin River Region is more highly developed (from a water supply viewpoint) than the Sacramento River Basin, it faces tougher challenges in preserving and restoring historic fisheries in natural channels.

There are 57 major reservoirs in the San Joaquin Valley Region, fifteen of which were built primarily to serve flood control purposes, although many of these also incorporated additional storage capability for water supply and other uses in their design.

TRENDS IN WATER MANAGEMENT PROGRAMS AND DELTA TRANSFERS

The Delta influences the effectiveness of virtually all statewide water management activities and is thus a key factor in future supply scenarios.

MANAGEMENT ACTIONS AND OPTIONS

Water managers are (and have been) investigating a wide variety of management actions to supplement, improve, and more efficiently utilize existing water resources. However, recent actions taken to protect Delta fisheries have impacted the viability of many supply options formerly available to managers.

The following are some categories of actions that could help meet California's water supply needs through 2020.

Demand Management:
Water Conservation
Drought Land Fallowing and Water Bank Programs
Drought Demand Management
Land Retirement

Supply Augmentation:
Water Reclamation

Solutions to Delta Water Management Problems would make more feasible --

Increased conjunctive use and more efficient use of major ground water basins.
Additional storage facilities south of the Delta.
Increased water transfers across the Delta.

CONJUNCTIVE USE PROGRAMS

The term "conjunctive use" refers to the operation of a ground water basin in combination with a surface water storage and conveyance system, essentially involving the coordinated management of surface and ground water supplies as a single source.

Efficient use of surface and ground water through conjunctive use programs has become an extremely important water management tool. With respect to water transfers involving ground water, there are some unresolved questions about their feasibility and legality.

WATER TRANSFERS

Water transfers proved to be a valuable contingency option during the recent drought. The primary sources of water for transfer are:

Ground water substitution;.
Unallocated developed supply upstream of the Delta; and,
Temporary fallowing of irrigated crop land.

Most major water transfer actions require participation of the SWP or CVP as facilitators to convey transferred water to areas of need, and SWRCB approval of changes in the point of diversion and place of use under the water right permit governing the transferred water. Other considerations that could impair water transfers include too few willing buyers and sellers, third party impacts, and the timing of available unused facility capacity to wheel water.

The CVP's Tracy Pumping Plant is already essentially operating at full capacity to meet existing contractual commitments. However, during times of drought, there is unused CVP capacity. The SWP's California Aqueduct conveyance capability is constrained at several critical locations, which reduces the availability of excess capacity to wheel transfer water. These bottlenecks, result from capacity limits at various points in the system and compliance with regulatory mandates.

SOUTH OF THE DELTA STORAGE

Governor Wilson's water policy and the Legislature have identified storage south of the Delta as a critical means to increase future water supplies and reliability. However, current hydraulic and regulatory constraints in the Delta do not provide the major export systems with enough operational flexibility and certainty to make such storage projects feasible, and this feasibility will remain uncertain until Delta problems are resolved. Increased storage south of the Delta would allow for more reliable deliveries during low flow periods when Delta waters need to remain instream to serve environmental needs and satisfy other regulatory mandates. The major south of the Delta storage projects are Los Banos Grandes reservoir, the Kern Water Bank, and Domenigoni Reservoir.

MOVING WATER SOUTH OF THE DELTA FOR STORAGE

To take advantage of flood flow conditions, project facilities had been proposed to augment other supplies by storing flood flows south of the Delta. Added reservoir storage south of the Delta is practically dependent on implementing corrective measures in the Delta to allow for requisite pumping operations when surplus flows are available.

NORTH OF THE DELTA STORAGE

Historically, much attention has been given to storage projects north of the Delta. In recent years, these projects have received less attention because water transfer constraints present in the Delta significantly reduce the probability of reaping their potential benefits. Still, some of these north of the Delta storage options may become more feasible in the future, as Delta transfer problems are addressed.

FACTORS AFFECTING THE USE AND AVAILABILITY OF DELTA WATER SUPPLIES

HISTORICAL SETTING

Water exports directly from the Delta began in 1940, after completion of the Contra Costa Canal (a unit of the CVP). In 1951, water began being exported via the CVP's Tracy Pumping Plant into the Delta-Mendota Canal. The SWP's main California Aqueduct began operation in 1967, extracting water from the Delta near Tracy as well. The North Bay Aqueduct began diverting water from the northwestern Delta in 1987.

In addition to direct in-Delta diversions, over 10 MAF of water that would otherwise flow to and through the Delta is withdrawn upstream by San Francisco's Hetch Hetchy Project, East Bay Municipal Utility District's Mokelumne Aqueduct, the Turlock Irrigation District, the Modesto Irrigation District, the Friant unit of the CVP, the Red Bluff Diversion dam and numerous other users.

DELTA FLOWS

TIDAL

Because Delta channels are at sea level, they are affected by the tidal action of the Pacific Ocean and San Francisco Bay. The average tidal flow into and out of the Delta is 170,000 cfs, averaged over the cycle. Peak tidal flow rates can reach 330,000 to 340,000 cfs on an instantaneous flow basis.

FRESH WATER

Fresh water flows into the Delta are typically of much lower volume than tidal inflows. The average calculated Delta outflow (water that flows through the Delta past Chipps Island and into San Francisco Bay) is about 30,000 cfs. The magnitude of this flow depends on Delta inflow, export operations, and depletion of in-Delta channel water.

Currently, minimum fresh water Delta outflow for most of the year is maintained by releases from SWP and CVP upstream storage reservoirs. A significant portion of this outflow is intended to establish a hydraulic barrier, utilizing the momentum and energy of these fresh water releases, to countervail tidal forces and prevent ocean water from intruding deeply into the Delta. Otherwise, Delta ecology and the quality of municipal and agricultural water supplies would be adversely affected.

REVERSE FLOW AND CARRIAGE WATER

The expression "reverse flow" identifies a Delta problem in certain channels leading to the project export pumps. When exports from the South Delta reach the upper range of interior channel capacity, sometimes water moves up the San Joaquin River in a "reverse flow" toward the pumps. There is a lively scientific debate over the significance of these reverse flows.

Currently, during operational periods when reverse flows occur, more water than is actually needed exclusively for export is released from project reservoirs to repel sea water intrusion, maintain in-Delta water quality standards, and satisfy export water quality standards. This incremental release of water from the reservoirs, in excess of the actual export need, is described as "carriage water."

Carriage water requirements in average and drought years are approximately 200,000 and 400,000 af respectively. As operational restrictions increase in the Delta, the volume of necessary carriage water may also increase. It should be noted that it is possible, when other regulatory requirements mandate increased reservoir releases, that the carriage water component of those releases may actually decrease although total project flows have increased.

The reverse flow of water in the San Joaquin River, Middle River, Old River, and some other channels has been identified as one of the causes of environmental and fishery problems. Many restrictions on exports from the Delta have been imposed in an effort to minimize these problems.

NORTH DELTA CHANNEL CAPACITY

Limited channel capacity in the North Delta has contributed to two major problems: reverse flow and repeated flooding of local levee tracts. The most critical flood control problem in the North Delta is the Mokelumne River's deficient capacity acts as a bottleneck.

SOUTH DELTA CHANNEL CAPACITY

Southern Delta channels also have limited capacity. This limited capacity contributes to poor water circulation in South Delta channels, which results in areas of stagnation and degraded water quality.

Presently, a barrier is periodically installed in Old River during the fall, near the San Joaquin River, to keep San Joaquin River water (that would otherwise flow into Old River) in the San Joaquin River channel and flowing toward the Central Delta to improve dissolved oxygen levels in the river which helps guide adult salmon upstream.

Four other temporary barriers (rock or some other form) are being tested to document water level and water quality improvements projected by modeling runs in the South Delta.

INSTITUTIONAL CONSTRAINTS

In addition to difficulties associated with Delta hydraulics, institutional constraints significantly influence water supply management in California, and will continue to do so in the future.

INSTITUTIONAL FRAMEWORK

In California, water use and supplies are controlled and managed by an intricate system of federal and State laws. Common law principles, constitutional provisions, State and federal statutes and environmental regulations, court decisions, and contracts or agreements all govern how water will be allocated, developed, or used. All of these components, along with actions by responsible State, federal, and local agencies, comprise the institutional framework for allocation and management of water resources in California. The ways that these factors and requirements are applied in the Estuary have specific impacts on the availability and reliability of Delta water supplies.

REGULATORY CONSTRAINTS

Recent regulatory activities related to endangered species, promulgation of EPA Bay-Delta water quality standards, and Central Valley Project Improvement Act (CVPIA) mandates, illustrate the imperative of a Delta "fix" to halt decreasing water supply reliability and restore environmental health. Corrective actions in the Delta can reduce project and non-project environmental impacts and thus improve future water supply reliability. Many of these potential actions can also not only reduce ecological impacts, but they can be components of strategies to restore and protect the Estuary's biological resources.

ENDANGERED SPECIES ACT

In February, 1993, NMFS issued a biological opinion for winter run salmon regulating operations of the CVP and SWP. On March 5, 1993, the USFWS officially listed the Delta smelt as a threatened species and shortly thereafter issued a biological opinion limiting project operations to protect that species and its habitat during the 1993-94 water year.

More recent regulatory actions could further condition and constrain operations of Delta exporters:

★ December 9, 1993; State listing of Delta smelt as endangered under the State's ESA became effective.

★ December 15, 1993; Federal listing of winter run salmon is changed from threatened to the more restrictive endangered classification. The USFWS proposes listing the Sacramento splittail as threatened.

★ February 15, 1994; USFWS issues revised Delta smelt biological opinion.

BAY/DELTA WATER RIGHTS AND THE CLEAN WATER ACT

The SWRCB is responsible for both issuing water rights permits under State authority and promulgating water quality standards under the federal Clean Water Act and the California's Porter-Cologne Act. The SWRCB reserves jurisdiction over its permits issued to the CVP and SWP to formulate or revise terms and conditions relative to salinity control, impacts on vested rights, and fish and wildlife protection in the Sacramento/San Joaquin Delta to protect all beneficial uses.

Decision 1485

In 1978, the SWRCB adopted Water Right Decision 1485 (D-1485). D-1485 conditioned SWP and CVP operations in the Delta, focusing on water quality standards, export limitations, and minimum flow rates. In 1980, D-1485 was "conditionally" approved by the EPA on the presumption that various EPA "interpretations" would be integrated into the proposed plan.

After triennial reviews in 1981 and 1985, the Board acknowledged the inadequacy of the 1978 plan and outlined a new hearing process to comprehensively review and update D-1485 in 1986. EPA decided to await the results of this new round of "Bay-Delta Hearings" before determining whether to promulgate its own standards under its Clean Water Act authority.

Racanelli Decision

After the Board adopted its 1978 plan, lawsuits were filed challenging D-1485. Judge Racanelli ruled against the SWRCB on many aspects of D-1485. The Court's primary holding was that the Board should consider the responsibility of other water users beyond the CVP and SWP to help meet Bay-Delta standards. The Court concluded that a "global perspective is essential to fulfill the Board's water quality planning obligations." However, the Court kept D-1485 in place and directed the Board to continue with its new hearing process to revise Bay-Delta standards.

Post D-1485 SWRCB Bay/Delta Proceedings

Hearings to adopt a revised water quality control plan and water rights decision for the Bay/Delta Estuary began in July 1987. The Board released a new draft Plan in November, 1988, which generated considerable controversy throughout the State. In January, 1989, the Board decided to withdraw its draft plan and redesign the hearing process. The Board adopted another plan in May, 1991. However, the federal EPA rejected this plan that same year and began its own promulgation process.

In response to a request in Governor Wilson's April, 1992, proposal for a comprehensive water policy program, the Board began a process to establish interim Bay/Delta water quality standards, which were released for public review in December, 1992. In April, 1993, the Governor asked the Board to turn its attention to establishing permanent water quality standards because federal actions had effectively preempted the State's proposed interim standards.

In December, 1993, the EPA announced the release of proposed Bay-Delta water quality standards, which are currently under review. These standards will be supplemented by as yet undetermined ESA take limits.

CENTRAL VALLEY PROJECT IMPROVEMENT ACT OF 1992

On October 30, 1992, President Bush signed PL 102-575 into law. Title XXXIV of that law was the Central Valley Project Improvement Act (CVPIA). Implementation of environmental restoration measures is a major goal of the CVPIA. It requires the dedication of 800,000 af of project annual yield for general fish, wildlife, and habitat needs and establishes a goal of doubling the natural production of anadromous fish in the Estuary.

BAY/DELTA ENVIRONMENTAL WATER NEEDS

The exact amount of water that may ultimately be required to meet Bay/Delta environmental needs will not be known until many of the regulatory processes currently underway are resolved and the Bay-Delta Oversight Council completes its long-range planning process. Federal and State fisheries agencies, and the federal EPA have made proposals that could substantially increase the amount of water allocated to protect the Bay/Delta's public trust resources and as a consequence reduce the amount of water available to serve other beneficial uses.

Status, Trends and Factors Affecting Sacramento/San Joaquin Delta Water Supplies

STATUS, TRENDS AND FACTORS AFFECTING SACRAMENTO/SAN JOAQUIN DELTA WATER SUPPLIES

INTRODUCTION

The San Francisco Bay/Sacramento San-Joaquin Delta Estuary is the hub of California's water supply system. The major water projects serving California (the federal Central Valley Project and the State Water Project) extract large amounts of water directly from the Delta for use by municipal, industrial and agricultural users, as well as capturing and managing upstream flows to maximize their utility throughout the year. By controlling this system for water supply purposes, the Estuary's ecology has been significantly affected. To what degree and with what implications are matters of continuing controversy and are not the subject of this paper.

Still, there is a general consensus today that the Estuary is no longer effectively functioning in its dual capacity as an important ecosystem and as the essential cog in the State's water supply network, with the consequence that economic and environmental values of statewide and national significance are increasingly at risk. This paper is intended to provide background information to the Council as it considers actions that could reduce that risk through more effective design and operation of water export systems in the Bay-Delta.

This briefing paper presents a water supply picture of where we are today, where we think we will be early in the next century, and some of the options that are available to minimize uncertainty and maximize security for California's water users. It also briefly discusses some of the institutional and other factors which affect the flexibility of the system to adjust to new demands while serving all beneficial uses. It focuses most particularly on the Delta's integral role in the present water management system and what will be its increasingly important role in the future.

SECTION I

STATUS OF DELTA WATER SUPPLIES

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STATUS OF DELTA WATER SUPPLIES

SURFACE WATER SUPPLIES AND THE DELTA

There are ten hydrologic regions in California, with the North Coast, Sacramento and San Joaquin basins (described below) containing the largest volume of runoff. The seven other hydrologic regions contribute much lower average annual runoff to the State's overall water balance. They range from a maximum of 3.3 million-acre-feet per year (MAF/yr) within the Tulare Lake Region to a low of 0.2 MAF/yr for the Colorado River Region. Generally, these other seven hydrologic regions are already being managed to maximize their utility. Current demands and intermittent supply deficits in the seven smaller hydrologic regions are usually met through agricultural land fallowing, conservation, reclamation, transfers, and water imports.

Prior to recent changes in water allocations within the Sacramento/San Joaquin and Colorado River systems, California had roughly enough water to meet average annual urban and agricultural water demands at the 1990 level of development while complying with State Water Resources Control Board (SWRCB or Board) Water Rights Decision 1485 (D-1485), which is the currently operative water quality standard regime. Average annual statewide supplies at the 1990 level of development were 63.7 MAF (including natural flows dedicated for instream use) and could have increased to 65.2 MAF by 2020 without any additional facilities or programs. The 1990 level of development drought year supplies were about 50.5 MAF and these could have increased by about 0.4 MAF by 2020 without additional storage and water management options. These increases would result from meeting new demand with water available but not currently diverted over and above present minimum regulatory requirements.

The 20,000 square-mile North Coast Region produces 29 MAF of annual runoff, the most plentiful hydrologic area of the State. However, even though the North Coast Region provides the most runoff, the area should not be considered a realistically significant potential source of additional water supplies to alleviate the State's future expected shortages. This is the case because 94 percent of the runoff has been protected as natural flows under both the state and federal Wild and Scenic Rivers Act. Although these rivers provide the largest block of identified environmental water in the State, it should be noted that they were not dedicated as wild and scenic rivers until after they had been carefully studied and the cost of developing these watersheds for transfer of their waters elsewhere was fully debated.

While a large portion of California's water supply is protected for environmental purposes, it is important to acknowledge a fundamental difference between those supplies and supplies which have been developed to meet the consumptive demands of agricultural, municipal and industrial uses. Generally, "environmental water" has not been "developed" in the traditional sense, though portions of developed water are used to meet standards established to protect environmental values. There is no environmental water corollary to the type of large-scale economic investment that created much of California's agricultural, municipal and industrial water supply system. Most environmental water could not be reallocated to consumptive uses today without a similarly considerable economic investment.

A significant portion of the water supply for the South Coast Region is imported from the Colorado River basin. During most of the 1987-92 drought, Southern California was spared from severe rationing primarily as a result of the annual availability of 600,000 acre-feet (af) of Arizona's and Nevada's unused Colorado River entitlement that was made available to the Metropolitan Water District of Southern California (MWDSC). Even with this supply, however, much of Southern California undertook significant rationing programs in 1991. There are concerns that these Colorado River supplies may decline as a result of Arizona and Nevada taking more of their allocated supplies under the (interstate) Colorado Compact.

Ground Water Supply

California's ground water storage is estimated at 850 MAF, stored in some 450 ground water basins statewide. This volume equals about 100 times the State's annual net ground water use. However, probably less than half of this total is usable because of prohibitive extraction costs and water quality considerations. Still, the large quantity of good quality ground water in storage contributes significantly to California's total water resource balance.

An estimated 14 MAF of ground water is extracted to serve agricultural, municipal, and industrial uses in an average water year. This represents nearly 20 percent of statewide applied water. In some areas, ground water accounts for as much as 90 percent of locally applied water. Because of deep percolation and extensive reuse of applied water, current average annual net ground water use (in simple terms, the amount of water extracted from the aquifer over and above that which returns to it) is about 8.5 MAF, including about 1.0 MAF of annual ground water overdraft. There could be an additional 0.2 MAF of overdraft resulting from possible degradation of ground water quality in the San Joaquin Valley. In drought years, the net use of ground water increases significantly to 13.2 MAF, which indicates both the importance of the State's ground water aquifers as storage basins to meet drought year water needs and the reliance water users place upon them as a supply buffer.

Annual ground water overdraft between 1980 and 1990 declined by 50 percent (from about 2 MAF to 1 MAF). The reduction occurred mostly in the San Joaquin Valley and was primarily attributable to the use of imported supplies in the Tulare Lake Region and conjunctive operation of reservoirs in the region.

Until key Delta issues are resolved and additional water management programs implemented, beneficial overdraft reductions experienced in the last decade in the San Joaquin Valley will likely decrease as more ground water is pumped to substitute for uncertain or diminished surface water supplies from the Delta.

DROUGHT

In response to the 1987-92 drought, many creative measures to cope with water shortages were implemented throughout California, including construction of more interconnections between local, State, and federal water delivery facilities. The City of San Francisco's connection to the State Water Project's (SWP) South Bay Aqueduct allowed emergency drought supplies to be conveyed into the city's distribution system for use by its customers, including communities along the San Francisco peninsula. The source of this emergency supply was the Delta.

Toward the end of the drought, the City of Santa Barbara constructed a sea water desalination facility and received limited SWP supplies through an emergency interconnection and a series of exchanges with other water agencies. Currently, a Coastal Branch of the California Aqueduct is under construction to connect Santa Barbara to the SWP.

Throughout California, water agencies bought and exchanged water to meet critical needs. The State Drought Water Bank played a vital role in meeting some of those critical water needs. However, the Bank's effectiveness was somewhat limited by the inability to transfer water through the Delta as a consequence of physical and regulatory pumping constraints.

THE NEED AND DEMAND FOR WATER

Table 1 shows California's regional net water demands. The North Coast hydrologic region contains a majority of the State's environmental water, reflecting the large protected natural flows of the wild and scenic rivers system, which total about 17.8 MAF in an average year. The Tulare Lake Region has the largest net agricultural water demand, about 7.9 MAF in an average year, while the South Coast Region has the highest net urban water demand, about 3.5 MAF in an average year. Dedicated instream flow under D-1485 makes up the largest portion of the San Francisco Bay Region's net water demand (about 4.6 MAF), while urban and agricultural net water demands for the region amount to 1.3 MAF.

The following information and conclusions are reflected in Table 1:

★ California's population is projected to increase to 49 million people by the year 2020 (from about 30 million in 1990). Even with extensive water conservation, it is estimated that annual net urban water demand will increase 3.8 MAF to 10.5 MAF by 2020. Nearly half of the State's expected population growth is expected to occur in the South Coast Region, increasing its annual water demand by 1.8 MAF.

* Statewide irrigated agricultural acreage is expected to decline by nearly 400,000 acres, from the 1990 level of 9.2 million acres to a 2020 level of 8.8 million acres. The 1980 acreage was 9.5 million acres. Reductions in projected irrigated acreage are primarily attributable to urban encroachment and land retirement in the western San Joaquin Valley. Increases in agricultural water use efficiency, reductions in agricultural acreage, and shifts to less water intensive crops, are expected to decrease annual net agricultural water demand by about 2.3 MAF by 2020.

* Environmental water need calculations include water for managed fresh water wetlands (including increases for refuges required by the Central Valley Project Improvement Act (CVPIA)), instream fishery requirements, dedicated Delta outflow, and outflow from wild and scenic rivers. Environmental water volumes are considerably lower during drought than in average years, principally because of the variability of natural flows in the North Coast wild and scenic rivers. Average annual net water demand for existing environmental needs is expected to increase. There is substantial disagreement in the water community over the potential size of that increased demand. Current draft regulatory standards for instream flows, wildlife, and Bay-Delta water quality could increase environmental requirements by 1 to 3 MAF.

Table 1. Net Water Demand by Hydrologic Region
(thousands of acre-feet)

Region	1990		2020		Change	
	average	drought	average	drought	average	drought
North Coast	20.0	9.9	20.2	10.1	0.2	0.2
San Francisco Bay	6.3	4.9	6.6	5.0	0.3	0.1
Central Coast	1.1	1.2	1.3	1.4	0.2	0.2
South Coast	4.4	4.5	5.9	6.1	1.5	1.6
Sacramento River	11.6	11.8	12.4	12.6	0.8	0.8
San Joaquin River	6.8	7.2	6.8	7.1	0.0	−0.1
Tulare Lake	8.3	8.5	8.0	8.1	−0.3	−0.4
North Lahontan	0.5	0.6	0.5	0.6	0.0	0.0
South Lahontan	0.6	0.5	0.7	0.7	0.1	0.2
Colorado River	4.1	4.1	4.0	4.0	−0.1	−0.1
Total	**63.7**	**53.2**	**66.4**	**55.7**	**2.7**	**2.5**

WILL THERE BE ENOUGH WATER?

The California water balance (Table 2, developed by DWR for its Bult-160) compares total net water demand and supplies for 1990, 2000, 2010, and 2020. (Delta supplies assume SWRCB's D-1485 without accounting for the impacts of probable endangered species actions.) To illustrate overall demand and supply availability, two water supply and demand scenarios, (average and drought years) are presented for the 1990 level of development and for future decades.

Average annual supplies calculated at the 1990 level of development would have been generally adequate to meet expected 1990 levels of water demand. However, drought conditions in the early 1990s created actual supplies that did not fully satisfy demand and resulted in a shortage of over 2.7 MAF. In drought years 1991 and 1992, these shortages were compensated for by mandatory urban water conservation/rationing, agricultural land fallowing and crop shifts, reduction of environmental flows, and short-term water transfers.

Table 2 also illustrates the critical importance of a Delta solution. It uses different scenarios to represent both the range of potential demands and drought year water-shortage challenges for future projections. These shortage conditions exist even when a Delta solution is assumed. Without such a Delta "fix,"many viable options that would otherwise be available to water managers to meet the estimated water deficit will be infeasible or otherwise unimplementable.

After accounting for future reductions of 1.3 MAF in net water demand resulting from implementation of urban Best Management Practices (BMPs) adopted in 1992, agricultural Efficient Water Management Practices (which have not yet been adopted), other increased agricultural irrigation efficiencies, and another 150,000 af reduction arising from land retirement; projected 2020 net demand for urban, agricultural, and environmental water needs amounts to 66.4 MAF in average years and 55.7 MAF in drought years. These DWR demand projections do not include an additional estimated 1 to 3 MAF of environmental water needs, which may arise depending upon the resolution of a number of current regulatory proposals to protect aquatic resources.

Since the Department of Water Resources' draft California Water Plan Update (Bul-160) was released in November, 1993, regulatory proposals, with significant ramifications for water supply projections, have been made. If enacted as proposed, it is expected that today's level of water demand would actually be much closer to that previously estimated as the year 2000 level of water demand. Proposed environmental water requirements at that level would result in a present average annual shortfall of between 1.4 and 3.4 MAF (Table 2).

Water shortages would vary from region to region and sector to sector. For example, the South Coast Region's population is expected to increase to over 25 million by 2020, requiring an additional 1.8 MAF of water annually. This population growth and accompanying increased demand, combined with the possibility of reduced supplies from the Colorado River as Arizona and Nevada claim and use more of their Colorado River apportionments, will contribute to

Table 2. California Water Balance
(millions of acre-feet)

Net Demand/Supply/Balance	1990		2000		2010		2020	
	average	drought	average	drought	average	drought	average	drought
Net Demand								
Urban — with 1990 level of conservation	6.7	7.1	8.3	8.7	9.9	10.3	11.4	11.9
- reductions due to long-term conservation measures (Level I)	--	--	-.04	−0.4	−0.7	−0.7	−0.9	−0.9
Agricultural — with 1990 level of conservation	27.0	28.3	26.5	27.9	25.9	27.3	25.5	26.8
- reductions due to long-term conservation measures (Level I)	--	--	−0.2	−0.2	−0.3	−0.3	−0.4	−0.4
- land retirement in poor drainage areas of San Joaquin Valley	--	--	−0.1	−0.1	−0.1	−0.1	−0.1	−0.1
Environmental	28.2	16.1	29.1	16.9	29.1	16.9	29.1	16.9
Other[1]	1.8	1.7	1.5	1.5	1.8	1.5	1.8	1.5
Subtotal	**63.7**	**53.2**	**65.0**	**54.4**	**65.6**	**55.0**	**66.4**	**55.7**
Proposed Additional Environmental Water Demands[2]								
Case I – Hypothetical 1 MAF	--	--	1.0	1.0	1.0	1.0	1.0	1.0
Case II – Hypothetical 2 MAF	--	--	2.0	2.0	2.0	2.0	2.0	2.0
Case III – Hypothetical 3 MAF	--	--	3.0	3.0	3.0	3.0	3.0	3.0
Total Net Demand	**63.7**	**53.2**						
Case I	--	--	**66.0**	**55.4**	**66.6**	**55.9**	**67.4**	**56.7**
Case II	--	--	**67.0**	**56.4**	**67.6**	**56.9**	**68.4**	**57.7**
Case III	--	--	**68.0**	**57.4**	**68.6**	**57.9**	**69.4**	**58.7**
Water Supplies w/Existing Facilities Under D-1485 Operating Criteria for Delta Exports for Delta Supplies								
Developed Supplies								
Surface Water	28.0	22.2	28.2	21.8	28.4	21.7	28.4	21.7
Ground Water	7.5	12.2	7.8	12.7	8.1	12.9	8.3	12.9
Ground Water Overdraft	1.0	1.0	0.8	0.8	0.8	0.8	0.7	0.7
Subtotal	**36.5**	**35.4**	**36.8**	**35.3**	**37.3**	**35.4**	**37.4**	**35.3**
Dedicated Natural Flow	27.2	15.1	27.8	15.6	27.8	15.6	27.8	15.6
Total Water Supplies	**63.7**	**50.5**	**64.6**	**50.8**	**65.0**	**51.0**	**65.2**	**50.9**
Demand/Supply Balance	**0.0**	**−2.7**						
Case I	--	--	**−1.4**	**−4.6**	**−1.6**	**−4.9**	**−2.2**	**−5.8**
Case II	--	--	**−2.4**	**−5.6**	**−2.6**	**−5.9**	**−3.2**	**−6.8**
Case III	--	--	**−3.4**	**−6.6**	**−3.6**	**−6.9**	**−4.2**	**−7.8**
Future Water Management Options Level								
Long-term Supply Augmentation								
Reclaimed	--	--	0.2	0.2	0.4	0.4	0.5	0.5
Local	--	--	0.0	0.1	0.0	0.3	0.0	0.3
Central Valley Project	--	--	0.0	0.0	0.0	0.0	0.0	0.0
State Water Project	--	--	0.3	0.6	0.7	0.9	0.7	0.9
Short-term Drought Management								
Potential Demand Management	--	1.0	--	1.0	--	1.0	--	1.0
Drought Water Transfers	--	.8	--	0.8	--	0.8	--	0.8
Subtotal — Level I Water Management Options	--	**1.8**	**0.5**	**2.7**	**1.1**	**3.4**	**1.2**	**3.5**
Net Ground Water/Surface Water Use Reduction Resulting from Level I Programs	--	--	−0.3	−0.3	−0.6	−0.3	−0.6	−0.2
Net Total Demand Reductions/Supply Augmentation	--	**1.8**	**0.2**	**2.4**	**0.5**	**3.1**	**0.6**	**3.3**
Remaining Demand/Supply Balance Requiring Future Level II	**0.0**	**−0.9**						
Case I	--	--	**−1.2**	**−2.2**	**−1.1**	**−1.8**	**−1.6**	**−2.5**
Case II	--	--	**−2.2**	**−3.2**	**−2.1**	**−2.8**	**−2.6**	**−3.5**
Case III	--	--	**−3.2**	**−4.2**	**−3.1**	**−3.8**	**−3.6**	**−4.5**

[1] Includes conveyance losses, recreation and energy production.
[2] Proposed Environmental Water Demands—Case 1—III envelope potential and uncertain demands and have immediate and future consequences on supplies available from the Delta, beginning with actions in 1992 and 1993 to protect winter run salmon and delta smelt (actions which could also protect other fish species.

possible shortages in the South Coast Region that in 2020 could amount to 400,000 af in an average year and 1 MAF in a drought year.

DWR has concluded that shortages shown under average conditions in the tables are chronic shortages indicating the need for additional long-term water management measures. Also, DWR believes that shortages shown under drought conditions can be met by both long-term and short-term measures, depending on the frequency and severity of the shortage and water service reliability requirements.

It is important to note that environmental water considerations in the Delta could alter present analyses dramatically. Currently, 4.6 MAF of Delta outflow is dedicated to fish and wildlife purposes under D-1485. These outflows essentially reflect a negotiated settlement informally agreed to by the California Department of Fish and Game (DFG), the U.S. Fish and Wildlife Service (USFWS), the California Department of Water Resources (DWR), and the U.S. Bureau of Reclamation (USBR). In dry and critical water years, flow requirements were deliberately designed to be flexible and to adjust to ensure minimum flows necessary to protect water quality for local agricultural and municipal diverters would be maintained. In recent years, it has become increasingly apparent that these minimum flow criteria have in fact not created the favorable conditions for fishery resources that had been expected.

THE BAY-DELTA WATERSHED AND ITS IMPORTANCE TO THE STATE'S WATER SUPPLY

DELTA DESCRIPTION

The Sacramento-San Joaquin Delta is the most important feature in California's water supply delivery system. Reliably meeting the State's present and future water needs is a challenge made increasingly difficult as a consequence of many complex and controversial issues related to the Delta and project operations.

The Delta includes the land and waterways bounded approximately by Sacramento on the north; Tracy on the south; Stockton on the east; and Pittsburg on the west (Figure 1). Pittsburg is about 50 miles east of San Francisco. This area covers 750,000 acres of land and about 700 miles of navigable waterways. Much of this land is below sea level. The lands are protected by 1,100 miles of levees and form nearly 60 islands or tracts that are surrounded by waterways. About 500,000 acres are farmed annually.

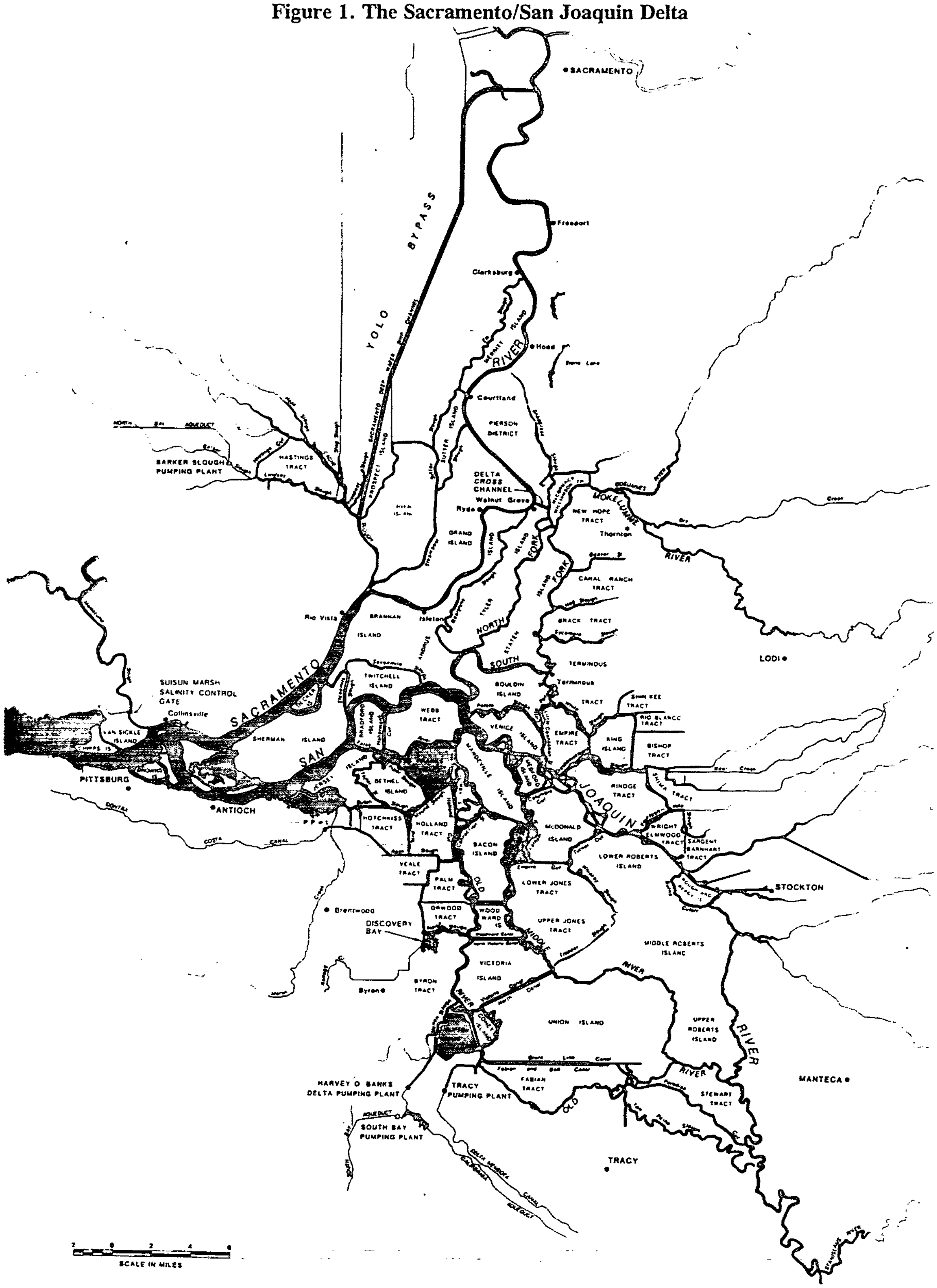
The major tributaries that flow into the Delta are the Sacramento River, flowing from the north, and the San Joaquin River, from the south. These two primary watersheds of California's Great Central Valley converge in the Delta and their confluence is located near Pittsburg. The Delta's fresh water inflow continues west through Suisun and San Francisco bays where it mixes with tidal waters of the Pacific Ocean.

The pumping facilities of the SWP and CVP are located in the southwestern Delta, about 10 miles northwest of Tracy.

The SWP Delta complex consists of Clifton Court Forebay, John E. Skinner Fish Facility, an intake channel, and the Harvey O. Banks Delta Pumping Plant. The Forebay intake gates generally limit diversions during times of high water conditions and are located at the junction of Old River and West Canal in the South Western Delta. The Banks Plant is designed to pump a maximum of 10,300 cubic-feet-per-second (cfs) but is currently only permitted by the USCOE to pump less than that rate on a monthly schedule which averages about 6,400 cfs.

The CVP diverts directly from Old River and also has a fish salvage and recovery facility near Tracy. The CVP has a Delta pumping capacity of 4,600 cfs. Together, the SWP and CVP pumping plants help provide a portion of 20 million Californians' drinking water supply and irrigation water for millions of acres of some of the world's most productive agricultural land. From 1980-1992, the SWP and CVP provided over 5 MAF of average annual water supply to their customers from the Delta.

Figure 1. The Sacramento/San Joaquin Delta



Other major diversion facilities in the Delta include the Contra Costa Canal, the North Bay Aqueduct, the South Bay Aqueduct, and the Delta Cross Channel. The Contra Costa Canal diverts up to 350 cfs from Rock Slough in the South Delta and serves 400,000 people in Contra Costa County. The North Bay Aqueduct has a 150 cfs capacity and serves users in Napa and Solano counties. The South Bay Aqueduct, with a capacity of 350 cfs, rediverts water below the Banks Pumping Plant and provides water to users in Alameda and Santa Clara counties. These diverters all require source water that can be affordably treated to meet increasingly stringent drinking water quality requirements. The San Felipe project rediverts Delta water from San Luis Reservoir to serve the South-West San Francisco Bay Area.

The Delta Cross Channel is a mile-long unlined canal, constructed by the U.S. Bureau of Reclamation (USBR) in 1951, that facilitates the transfer of higher quality water out of the Sacramento River channel toward the projects' export facilities in the southwestern Delta. Though it is partially effective in providing for this transfer, it is limited hydraulically with respect to the volume of water it can accommodate. Additionally, because it is not presently equiped with a fish screen, the gated inlet works are closed periodically so as to assist fish migration in the Sacramento River. This further limits its water transfer capability.

In addition to these water facilities, there are 1,800 agricultural diversions within the Delta that, under riparian rights, divert a combined seasonal peak of 4,500 cfs to irrigate about 500,000 agricultural acres.

HYDROLOGY

The Delta receives about 40 percent of the State's runoff. The hydrologic regions with the second and third highest runoff averages in the State drain into the Delta. The Sacramento River Region has an average annual runoff of 23 MAF, and the San Joaquin River Region has an average runoff of 8 MAF. Urban and agricultural diversions from the Sacramento and San Joaquin rivers and the Delta to serve the current demand level is nearly 17 MAF in an average year.

Sacramento River Region

The Sacramento River Region extends almost 300 miles from the Delta north to the Oregon border. The Sierra Nevada Mountain Range forms the eastern border; the northern border is bounded by the Cascade Range; and the west side is defined by the Coastal Range. Major tributaries draining into the Sacramento River are the American, Feather, and Yuba rivers. There are numerous smaller tributary streams as well. Additionally, some basin supplies are imported from other watersheds. These significant imports include about 880,000 to 900,000 acre-feet of Trinity River water annually drawn from Claire Engle Reservoir. This water is transferred through Clear Creek Tunnel into Whiskeytown Reservoir. There are several major upstream diversions as well, including Red Bluff diversion dam which provides water to the west side of the Sacramento Valley, with unconsumed waters returning to the river. Exports from the Sacramento River basin are taken mainly from the Delta and are of paramount importance to the State's water supply. Approximately 6 MAF is exported out of the Delta south and west of the region through local, State, and federal export facilities (Figures 2 and 3).

More than 40 major reservoirs lie within the Sacramento River Region. The region's water supply is transported through a complex natural and engineered system. Major SWP and CVP reservoirs include Oroville, Shasta, Whiskeytown, and Folsom. These storage facilities are managed to store portions of annual runoff to then release these supplies later in the year for instream, urban, agricultural, and other beneficial uses. The reliability and capacity of this complex system is affected by Delta channels as well as the Delta's natural tributaries.

San Joaquin River Region

The San Joaquin River Region is bordered on the east by the crest of the Sierra Nevada and on the west by the coastal mountains of the Diablo Range. It extends from the Delta and the Cosumnes River drainage southward to the Tulare Lake basin. The region comprises about 10 percent of California's total land area.

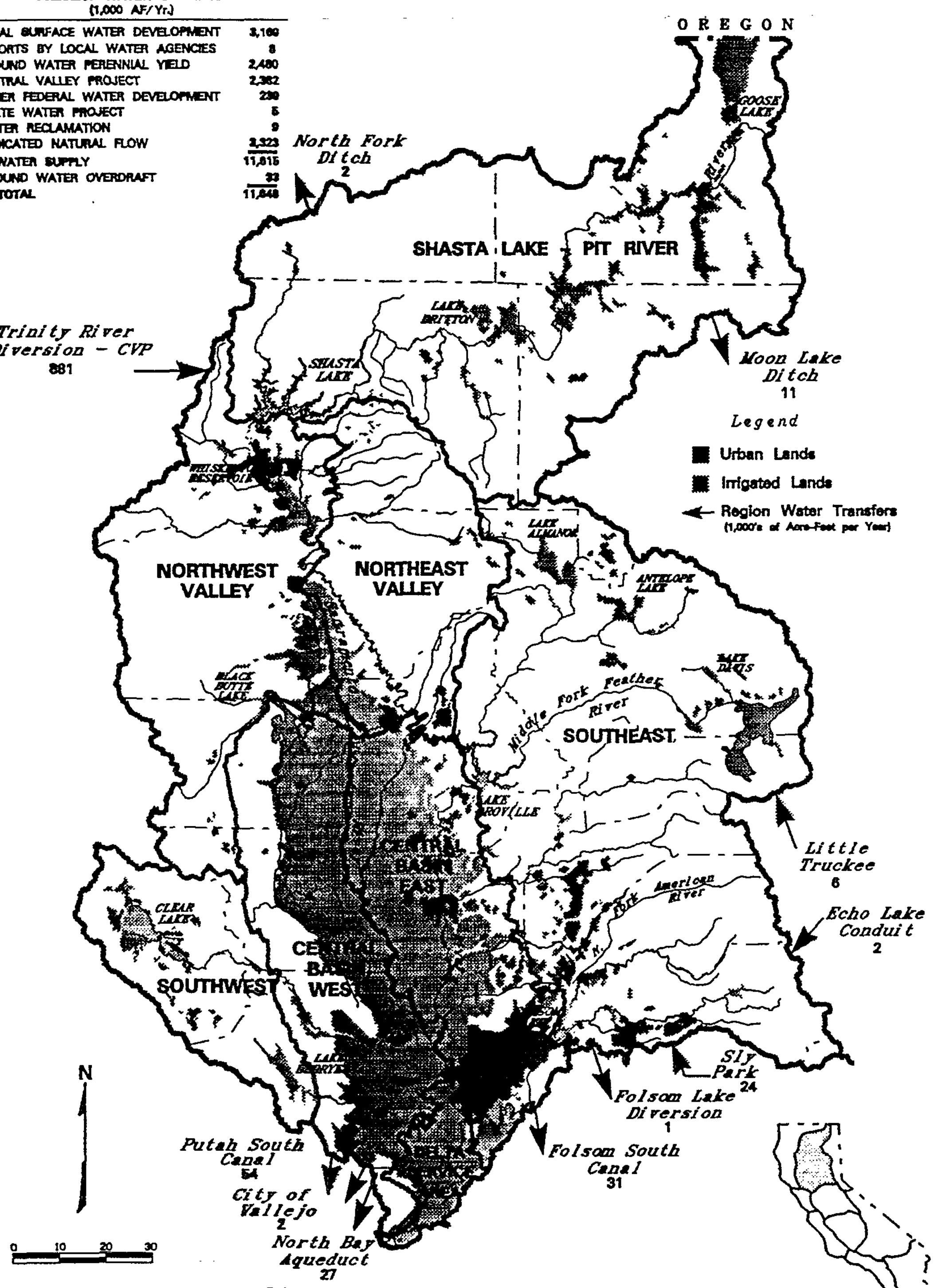
About 47 percent of the San Joaquin Valley's 1990 level water supply comes from local surface sources, while imported surface supplies account for 29 percent. Ground water fulfills about 19 percent of the total 1990 level average annual water supply for the region. The remaining 5 percent of water in the system is dedicated to natural flow.

The CVP delivers Delta water to serve about 63 percent of the water supply for the west side of the San Joaquin Valley. The Hetch Hetchy reservoir system, on the Tuolumne River, captures and delivers water to the San Francisco Bay Area through a system of reservoirs, power plants, and aqueducts. The East Bay Municipal Utility District (EBMUD) conveys water for its use from Pardee and Camanche reservoirs on the Mokelumne River via the Mokelumne Aqueduct. Both the Hetch Hetchy and the Mokelumne aqueducts divert water upstream of the Delta, to which it would otherwise flow. This allows San Francisco and EBMUD to avoid most, if not all, of the flow, environmental, water quality and other regulatory issues to which direct Delta exporters' operations must conform.

Surface water systems in the San Joaquin River Region fill reservoirs that gather and store snowmelt in the upper mountain valleys of the Sierras. This water is generally utilized for hydropower generation at the time it is released to serve local communities consumptive uses, and most is subsequently recaptured in other downstream reservoirs. Water released downstream in the river channel is ultimately diverted for irrigation and other beneficial uses along the valley floor as it flows toward the Delta. Because the San Joaquin River Region is more highly developed (from a water supply viewpoint) than the Sacramento River Basin, it faces tougher challenges in preserving and restoring historic fisheries in the natural channels. Figure 3 shows the region's 1990 level of imports, exports, and water supplies.

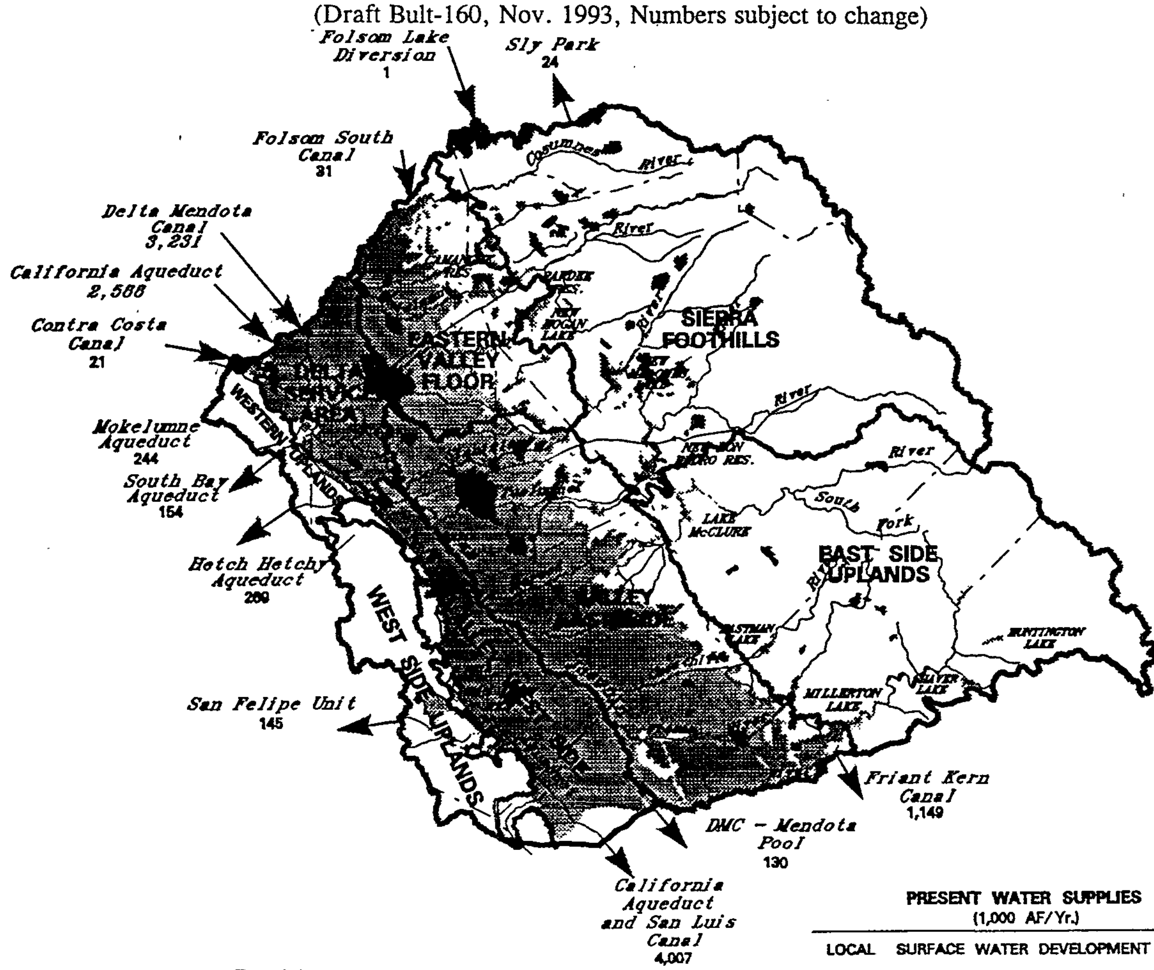
Figure 2. The Sacramento River Region
Imports, Exports, and Water Supplies
(Draft Bult-160, Nov. 1993, Numbers subject to change)

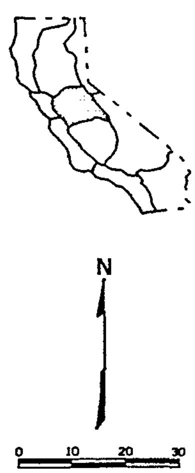
PRESENT WATER SUPPLIES (1,000 AF/Yr.)	
LOCAL SURFACE WATER DEVELOPMENT	3,169
IMPORTS BY LOCAL WATER AGENCIES	8
GROUND WATER PERENNIAL YIELD	2,480
CENTRAL VALLEY PROJECT	2,362
OTHER FEDERAL WATER DEVELOPMENT	239
STATE WATER PROJECT	5
WATER RECLAMATION	9
DEDICATED NATURAL FLOW	3,323
WATER SUPPLY	11,815
GROUND WATER OVERDRAFT	33
TOTAL	11,848



SACRAMENTO RIVER REGION
LAND USE, IMPORTS, EXPORTS AND WATER SUPPLIES

Figure 3. The San Joaquin River Region
Imports, Exports, and Water Supplies
(Draft Bult-160, Nov. 1993, Numbers subject to change)





PRESENT WATER SUPPLIES
(1,000 AF/Yr.)

LOCAL SURFACE WATER DEVELOPMENT	3,015
GROUND WATER PERENNIAL YIELD	1,071
CENTRAL VALLEY PROJECT	1,997
STATE WATER PROJECT	5
OTHER FEDERAL WATER DEVELOPMENT	155
WATER RECLAMATION	24
DEDICATED NATURAL FLOW	330
WATER SUPPLY	6,597
GROUND WATER OVERDRAFT	210
TOTAL	6,807

Legend
Urban Land
Irrigated Land
Region Water Transfer (1,000's of Acre-Feet per Year)

SAN JOAQUIN RIVER REGION
LAND USE, IMPORTS, EXPORTS AND WATER SUPPLIES

There are 57 major reservoirs in the San Joaquin Valley Region, fifteen of which were built primarily to serve flood control purposes, although many of these also incorporated additional storage capability for water supply and other uses in their design. Four of the Region's reservoirs provide storage capacity exceeding 1 MAF each, and 12 others have capacities of greater than 100,000 af. The major facilities are owned and operated by the CVP and local irrigation districts, and are generally managed to serve multipurpose uses.

D-000825

SECTION II

TRENDS IN WATER MANAGEMENT PROGRAMS AND DELTA TRANSFERS

SECTION II

TRENDS IN WATER MANAGEMENT PROGRAMS AND DELTA TRANSFERS

The Delta influences the effectiveness of virtually all statewide water management activities and is thus a key factor in future supply scenarios.

MANAGEMENT ACTIONS AND OPTIONS

Water managers are (and have been) investigating a wide variety of management actions to supplement, improve, and more efficiently utilize existing water resources.

Recent actions taken to protect Delta fisheries have impacted the viability of many supply options formerly available to managers. Yuba County Water Agency's operation of New Bullards Bar Reservoir is a good example of these impacts. In the past, water to supplement supplies south of the Delta was available from Bullards Bar, utilizing natural channels to deliver water to the Sacramento River and eventually the project pumps. However, present physical and operational constraints in the Delta cannot accommodate the desired volume of water for transfer nor efficiently move the water to the projects for export. As a result, the potential of transfers to act as a buffer for supplies delivered south of the Delta is significantly limited. These same limitations apply to many of the options described in the following sections.

Tables 3, 4 and 5, prepared by DWR as part of its update to the State Water Plan, Bult-160, summarize many of the types of actions that it believes can be taken to maximize water management opportunities. By implementing some of these and other actions, it is believed that California's water future should become more secure. So-called "Level I" options have generally already undergone extensive investigation and environmental analyses and could likely be implemented by 2020 if desired. "Level II" options have not been as comprehensively investigated.

The following are some actions DWR has recommended for implementation in Bult-160 to help meet California's water supply needs through 2020. Some of these options still require additional environmental documentation, permitting studies, and, in some instances, alternative analyses. Moreover, before these programs move to implementation, environmental water needs must be comprehensively identified and prioritized. Also, funding questions associated with achieving the desired results must be addressed.

Table 3. Level I Water Supply Management Option

Programs	Type	Capacity (1,000 AF)	Annual Supply (1,000 AF) Average	Annual Supply (1,000 AF) Drought	Economic Unit Cost ($/AF)[1]	Comments
Statewide Water Management:						
Long-term Delta Solution	Delta Water Management Program	–	200	400	Not Available	Water supply benefit is elimination of carriage water under D-1485.
Interim South Delta Water Management Program	South Delta Improvement	–	66	95	60	Final draft is scheduled to be released in late 1994
Los Banos Grandes Reservoir [2]	Offstream Storage	1,730[3]	250-300	260	260	Schedule now coincides with BDOC process
Kern Water Bank [2]	Ground Water Storage	3,000[3]	44	430	140	Schedule now coincides with BDOC process
Coastal Branch-Phase II (Santa Ynez Extension)	SWP Conveyance Facility	57	N/A	N/A	630-1,110	Notice of Determination was filed in July 1992. Construction began in late 1993.
American River Flood Control [4]	Flood Control Storage	545[3]	–	–	–	Feasibility report and environmental documentation completed in 1991.
Local Water Management:						
Waste Water Recycling	Reclamation	800	450	450	125-840	Fresh water displaced
Ground Water Reclamation	Reclamation	200	100	100	350-900	Primarily in South Coast
El Dorado County Water Agency Water Program	Diversion from South Fork American R.		24	23[5]	280	Certified final Programmatic EIR identifying preferred alternative; water rights hearings,new CVP contract following EIR/EIS preparation
Los Vaqueros Reservoir-Contra Costa Water District	Offstream Storage Emergency Supply	100	N/A	N/A	320-950	T&E species, inundation of ag. land. Costs vary with different operation scenarios.
EBMUD	Conjunctive Use and Other Options		N/A	20-70	370-1,830	Investigating 6 alternatives; Draft EIR/EIS released in Dec. 1992
New Los Padres Reservoir - MPWMD	Enlarging existing reservoir	24	22	18	410	T&E species, steelhead fishery in Carmel River
Domenigoni Valley Reservoir - MWDSC	Offstream storage of SWP and Colorado River water, drought yr. supply	800	0	264	410	Final EIR certified.
Inland Feeder-MWDSC	Conveyance Facilities	–	–	–	–	
San Felipe Extension - PVWA	CVP Conveyance Facility		N/A	N/A[5]	140	Capital costs only. Convey 18,000 AF annually.

[1] Economic costs include capital and OMP&R costs discounted over a 50-year period at 6 percent discount rate. These costs do not include applicable transportation and treatment costs.
[2] **These programs are only feasible if a Delta water management program is implemented.**
[3] Reservoir capacity.
[4] Folsom Lake flood control reservation would return to original 0.4 MAF.
[5] Yield of this project is in part or fully comes from the CVP.
[6] NA: Not Applicable

Table 4. Level II Water Management Options

Programs	Type	Supply Augmentation or Demand Reduction (1,000 AF)	Comments, Concerns, Problems
Demand Management:			
Agricultural Water Conservation	Demand Reduction	300 [1]	Increased agricultural water use efficiency.
Urban Water Conservation	Demand Reduction	220 [1]	Increased urban water use efficiency
Land Retirement	Demand Reduction	477 [1]	Retirement of land with poor drainage in west side San Joaquin Valley
Water Transfer	–	800 [2]	Institutional constraints.
Statewide Supply Management:			
Stanislaus-Calaveras River Water Use Program	Conjunctive Use	80 [3]	DWR, USBR, and local agencies are conducting studies.
Sacramento Valley Conjunctive Use Program	Conjunctive Use	100 [3]	Initial studies underway by DWR and local agencies.
Red Bank Project	Storage	40 [3]	
Shasta Lake Enlargement	Storage	1,450 [3]	
Clair Engle Lake Enlargement	Storage	700 [3]	
Westside Sacramento Valley Project	Conveyance	–	
Westside Reservoirs	Storage	up to 2,000 [3]	
Mid-Valley Canal	Conveyance	–	
Folsom South Canal Extension	Conveyance	–	
American River Water Resources Investigation	Storage	–	
Local Water Management:			
Use of Gray Water	Reclamation	180 [3]	Requires investment in separate plumbing; health concerns.
Waste Water Recycling	Reclamation	150-700 [3]	Estimated ultimate potential.
Water Desalting	Reclamation	390 [3]	
Reuse of Agricultural Brackish Water	Reclamation	–	High salt accumulation in soil.
San Diego Emergency Water Storage Project	Storage	100 [3]	
Santa Clara Valley Water Management	–	–	Studies by district in progress. Will need 100,000-150,000 AF additional supplies by 2020.
Delta Storage	Storage	–	Water quality, THM concerns.
Watershed Management	–	100 [3]	Increases runoff from the watershed. Environmental concerns.

[1] Reduction in applied water.
[2] Reallocation of supply for short- or long-term transfers.
[3] Annual supply

Table 5. California Water Supply with Level I Water Management Options
(Decision 1485 Operating Criteria without Endangered Species Actions for Delta Supplies)
(millions of acre-feet)

Supply	1990		2020		Change	
	Average	Drought	Average	Drought	Average	Drought
Surface:						
Local	10.1	8.2	10.3	8.4	0.2	0.2
Imports by local agencies[1]	1.0	0.7	1.0	1.0	0.0	0.3
Colorado River	5.2	5.1	4.4	4.4	−0.8	−0.7
CVP	7.5	5.0	7.9	5.1	0.4	0.1
Other federal	1.2	0.8	1.2	0.8	0.0	0.0
SWP [1]	2.8	2.2	4.1	3.0	1.3	0.8
Reclaimed	0.2	0.2	0.7	0.7	0.5	0.5
Ground water	7.5	12.2	7.8	12.8	0.3	0.7
Ground water overdraft	1.0	1.0	0.5	0.5	−0.5	−0.5
Dedicated Natural Flow	27.2	15.1	27.8	15.6	0.6	0.5
Total	**63.7**	**50.5**	**65.7**	**52.3**	**2.0**	**1.8**

[1] 1990 SWP supplies are normalized and do not reflect additional supplies needed to offset reduction of supplies from the Mono and Owens basins to the South Coast hydrologic region.

DEMAND MANAGEMENT

Water Conservation. By 2020, implementation of urban BMPs is expected to reduce annual urban applied water demand by an amount conservatively estimated at 1.3 MAF, with a reduction in net water demand of 0.9 MAF, accounting for reuse. Similar measures known as agricultural Efficient Water Management Practices are currently under discussion. When adopted and implemented, these practices are expected to reduce agricultural applied water demands by about 1.7 MAF and net water demand by 0.3 MAF, accounting for reuse. Further, lining the All-American Canal would reduce net water demand by 70,000 af, which would otherwise result in seepage to groundwater aquifers.

Drought Land Fallowing and Water Bank Programs. Temporary, compensated reductions of agricultural net water demand and purchase of surplus water supplies could reallocate at least 800,000 af of drought year supply by 2020.

Drought Demand Management. Voluntary rationing averaging 10 percent statewide during drought, could reduce annual urban applied and net water demand by 1 MAF in 2020.

Land Retirement. Retirement of 45,000 acres of land with poor sub-surface drainage on the west side of the San Joaquin Valley could reduce annual applied and net agricultural water demand by 130,000 af by 2020.

SUPPLY AUGMENTATION

Water Reclamation. By 2020, waste water recycling and treatment of poor quality groundwater are expected to yield an amount conservatively estimated at 1 MAF. The net increase in water supplies from this level of recycling, after accounting for reuse and other factors, would be nearly 600,000 af. Additional investigation of water recycling could reveal a much larger potential for reuse of developed supplies.

Solutions to Delta Water Management Problems. If Delta problems are resolved, improved water transfer efficiency could supplement annual net water supplies by as much as 200,000 to 400,000 af (under D-1485). A Delta solution could also make the following options feasible to supply more water:

★ Increased conjunctive use and more efficient use of major ground water basins. Conjunctive use programs, including projects like the Kern Water Bank, could provide an additional 500,000 af of drought year net water supplies (under D-1485).

★ Additional storage facilities, including Los Banos Grandes (SWP), could store 300,000 af, and MWDSC's Domenigoni Valley Reservoir could provide 200,000 af of supplemental drought year net water supplies.

★ Water transfers across the Delta, which currently "lose" up to 30 percent to carriage water requirements, would no longer be subject to such losses.

CONJUNCTIVE USE PROGRAMS

The term "conjunctive use" refers to the operation of a ground water basin in combination with a surface water storage and conveyance system. Water is stored in the ground water basin for later use by intentionally recharging the basin during years of above-average surface water supply, either by direct recharge or by providing surface water so that groundwater normally pumped for consumptive uses is left in the aquifer. The ground water basin essentially acts as a reservoir in which portions of surplus surface water supplies can be stored on a when-available basis, thus avoiding the high capital costs and possible environmental impacts associated with constructing a reservoir. Conjunctive use essentially involves the coordinated management of surface and ground water supplies as a single source.

Elements necessary to implement an effective conjunctive use program include a surface water supply source, a ground water basin with available storage capacity, a suitable recharge site (when direct recharge is required), conveyance facilities (which may be natural channels) to move surface water to the recharge site, and extraction and conveyance facilities to pump the stored ground water back into the surface water supply system. Establishment of a conjunctive use program also requires adequate institutional assurances that the water recharged into an aquifer may later be recovered from it.

In recent years, more efficient use of surface and ground water through conjunctive use programs has become an extremely important water management tool. Conjunctive use programs are generally less costly than new surface water projects because they increase efficiencies of existing water supply systems and generally have less mitigation costs arising from adverse environmental impacts than surface water reservoirs. Even so, conjunctive use programs can cause loss of native vegetation and wetland habitat, adverse third party impacts, degradation of fish and wildlife, land subsidence, and degradation of water quality in the aquifer. There are also questions about the feasibility and legality of water transfers involving ground water.

In the San Joaquin Valley, water users have long relied on ground water (as evidenced by overdraft that has occurred) to supplement scant surface water supplies. In contrast, greater availability of surface water in the Sacramento Valley has resulted in comparatively less use of ground water. Water supplies in the Sacramento Valley could be increased by making more efficient use of the timing and availability of surface flows through more intensive conjunctive use programs. Such programs would entail making arrangements with local water agencies to recharge aquifers with surface water in wet years and extract ground water in dry years, so that surface water normally diverted by those agencies would remain instream for downstream uses in dry years. DWR has been evaluating several possible Sacramento Valley locations where conjunctive use programs could be carried out to augment State Water Project supplies. However, current institutional and in-Delta hydraulic conveyance limitations restrict potential maximization of conjunctive use opportunities and impose transportation losses on water transferred from northern ground water basins for use within and south of the Delta.

WATER TRANSFERS

Water transfers proved to be a valuable contingency option during the recent drought. However, delivering this transferred water required dedicating up to 30 percent of the amount for carriage use to counter possible reverse flow impacts. Moreover, each additional regulatory restriction on Delta water operations further complicates water marketing and could decrease its potential benefits.

Water transfers can augment an area's water supplies on a short- or long-term basis. The 1987-92 drought caused water agencies and individuals to begin seriously looking at the potential of a water market to augment otherwise shaky supplies.

The primary sources of water for transfer are:

★ <u>Ground water substitution</u>; which makes surface irrigation water available for transfer by pumping an equivalent amount of ground water to use on irrigated lands.

- ★ *Unallocated developed supply upstream of the Delta*; water which would otherwise stay in storage, unless spilled for flood control purposes, could be utilized to more frequently and reliably meet future projected needs through transfers if approved by the SWRCB.

- ★ *Temporary fallowing of irrigated crop land*; this is the water transfer alternative with the most potential for providing short-term water supply during drought, thus improving water supply reliability for areas receiving the water. By not planting a crop, withholding irrigation from a crop already planted, or shifting from a water intensive crop to a low-water-use crop, growers are able to free irrigation supplies for transfer.

Physical limitations to water transfers also exist within the conveyance capability of various regional and local water systems. The San Francisco Bay, the South Coast, the west side of the San Joaquin Valley, and the Tulare Lake regions are regions that experience intermittent water shortages and that would likely be primary purchasers of transferable water. The Delta is integral to prospective water transfers involving these regions because potential sellers of surplus water for interregional water transfers, such as the Sacramento River Region and to a lesser degree, the San Joaquin River Region, would necessarily rely on the Delta as the transfer junction.

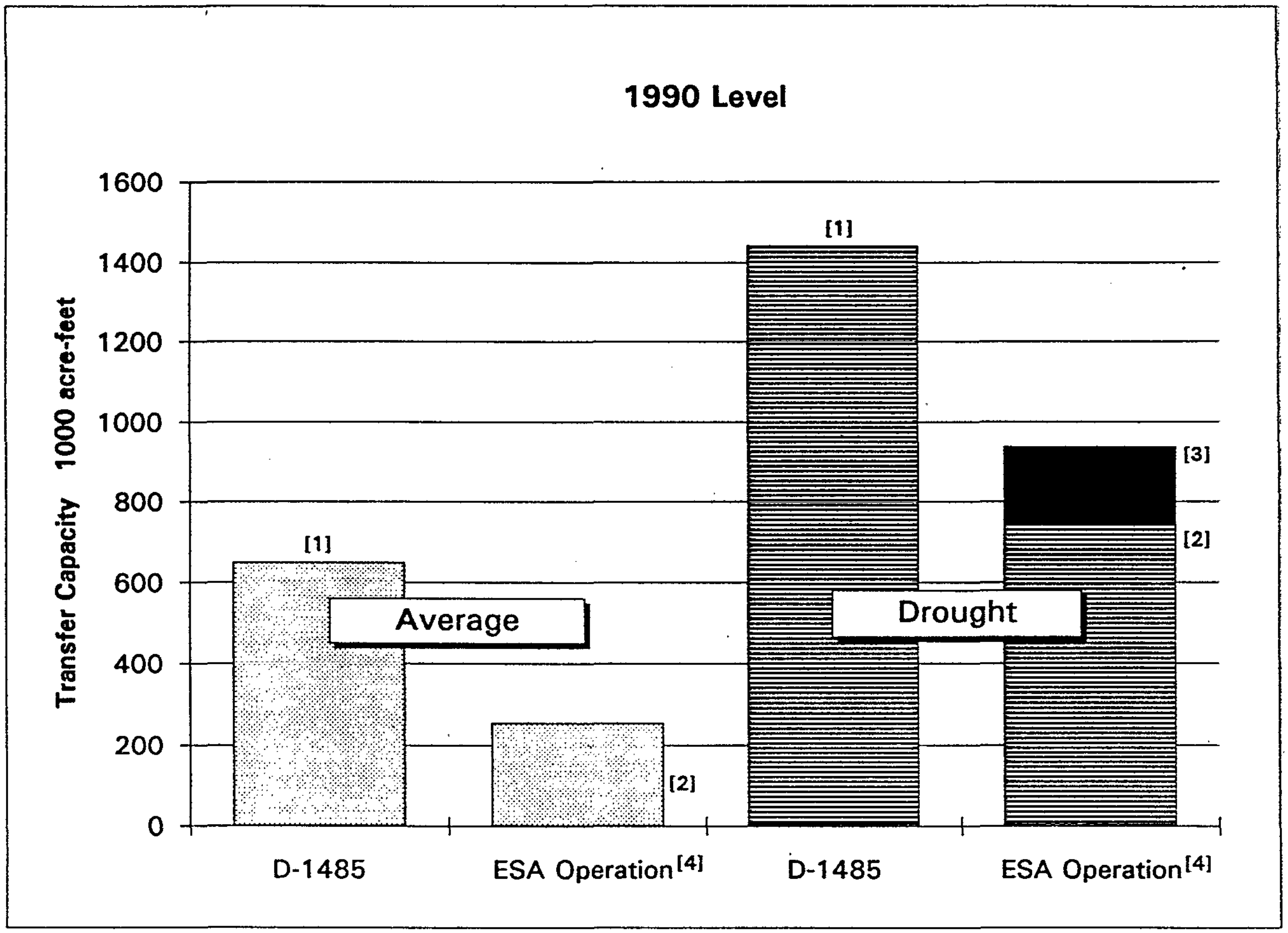
Most major water transfer actions require participation of the SWP or CVP as facilitators to convey transferred water to areas of need, and SWRCB approval of changes in the point of diversion and place of use under the water right permit governing the transferred water.

The CVP's Tracy Pumping Plant is already essentially operating at full capacity to meet existing contractual commitments. However, during times of drought, there is unused CVP capacity. The SWP's California Aqueduct conveyance capability is constrained at several critical locations, which reduces the availability of excess capacity to wheel transfer water. These bottlenecks, resulting from capacity limits and regulatory restrictions, affect Banks Pumping Plant, Reach 13 of the California Aqueduct upstream of Buena Vista Pumping Plant in the lower San Joaquin Valley, and Edmonston Pumping Plant at the foot of the Tehachapis.

The Banks Pumping Plant is physically capable of pumping 10,300 cfs. However, it is currently restricted to pumping about 6,400 cfs with limited additional capacity in winter and spring. If USCOE pumping restrictions were modified, capacity could increase to 10,300 cfs under certain conditions. Edmonston Pumping Plant would then become the critical constraint in conveying water to the South Coast Region. ESA operational criteria also constrain the Tracy and Banks pumping plants' water transfer capabilities.

Figure 4 compares the SWP and CVP water transfer capacity from the Delta to the South Coast Region under D-1485 and endangered species criteria. In average and drought years, at the 1990-level, usable transfer capacities of the SWP and CVP are reduced to about 300,000 and 700,000 af respectively when projects are operated under endangered species criteria for winter run salmon and Delta smelt. It should be noted that usable transfer capabilities discussed here do not reflect probable additional pumping limitations likely to be imposed by ESA take limits.

Figure 4. Usable Transfer Capacity with Existing SWP/CVP Facilities from the Delta to the South Coast Region (in thousands of acre-feet)



(1) Usable transfer capacity from the Delta under D-1485 conditions.

(2) Usable transfer capacity from the Delta under historic Delta flow patterns with ESA restrictions.

(3) Usable transfer capacity including capability to transfer south of the Delta source supplies that do not add to reverse flow problems thus allowing more water to be pumped than under historic Delta flow patterns.

(4) Based on 1993 Delta Smelt Biological Opinion and Winter Run Salmon Biological Opinion. However, figures do not reflect pumping curtailments due to "take" limitations.

Transfers of source water from south of the Delta, because it would not go through the Delta, would not have reverse flow limitations. They might, however, be subject to other potential regulatory pumping restrictions. Transfers of San Joaquin River source water could allow an additional pumping of about 200,000 af in drought years (Figure 4).

Other considerations that could impair water transfers include too few willing buyers and sellers, third party impacts, and the timing of available unused facility capacity to wheel water.

SOUTH OF THE DELTA STORAGE

Governor Wilson's water policy and the Legislature have identified storage south of the Delta as a critical means to increase future water supplies and reliability. However, current hydraulic and regulatory constraints in the Delta do not provide the major export systems with enough operational flexibility and certainty to make these storage projects feasible, and the feasibility of these storage projects will remain uncertain until Delta problems are resolved.

Los Banos Grandes. In 1984, after an examination of 18 sites, a DWR study recommended that Los Banos Grandes be investigated for placement of a reservoir and to determine the most cost-effective reservoir size, and its engineering, economic, and environmental feasibility. The proposed facilities would be located on Los Banos Creek in western Merced County, southwest of Los Banos and about 5 miles upstream from the existing Los Banos Detention Dam.

Based on the feasibility investigation, a 1.73 MAF reservoir was planned to help offset projected future SWP water shortages and provide the highest net benefits to the SWP. Recent endangered species actions in the Delta, and other regulatory uncertainty, has forced a reassessment of the feasibility of the project. The fate of Los Banos Grandes is now essentially dependent upon the implementation of a long-term solution that will resolve fishery issues and maximize the ability to store flood flow surpluses.

Los Banos Grandes facilities could augment SWP supplies in drought years by about 260,000 af (under D-1485).

The Kern Water Bank, established under an agreement between DWR and the Kern County Water Agency, is designed to take advantage of available opportunities to store and extract SWP water in the Kern County ground water basin. There are eight potential separate components to the Kern Water Bank; seven sponsored by local water districts and the eighth (the Kern Fan Element) by DWR. DWR is awaiting analyses of future water supply impacts of pending regulatory actions in the Delta. Once the supply impacts are identified and if it appears adequate water will be available, the First Stage Kern Fan Element will be reassessed, and further feasibility studies for the local elements will be initiated.

Initial studies indicated that the Kern Fan Element could be developed to annually store as much as 1 MAF and contribute as much as 140,000 af to the SWP in drought years under D-1485. The seven local elements are still under various stages of investigation.

There is considerable variation in size and potential among the local elements. Combined, the local elements have the potential to provide over 2 MAF of ground water storage and a capability to contribute about 370,000 af annually to the system (under D-1485). A preliminary estimate indicates that the seven local elements have the potential to increase the average annual water supply of the SWP by 115,000 af and the drought year supply by about 290,000 af.

In a 1990 demonstration program sponsored by DWR and Semitropic Water Storage District, about 100,000 af of SWP supply was stored in the ground water basin underlying Semitropic WSD. More recently, MWDSC and Semitropic WSD agreed to an exchange program that basically encompasses the first two phases of the SWP Semitropic banking component. This program allows MWDSC to temporarily store a portion of its SWP entitlements underground for later withdrawal and delivery to MWDSC's service area. Approximately 48,000 af of MWDSC's 1992 SWP carryover water was stored under an initial agreement executed in 1993.

Domenigoni Reservoir is being constructed by MWDSC to provide emergency water service, carryover and seasonal storage, and to enhance the operational reliability of MWDSC's system. The reservoir will also assist ground water basin recharge as part of a regional conjunctive use program. About half of the reservoir will be allocated to emergency storage and the remainder will augment MWDSC supplies by 230,000 af per year during drought years (under D-1485). The reservoir, with an originally proposed capacity of 800,000 af, could be filled with water from either MWDSC's Colorado River Aqueduct or from the SWP. MWDSC has certified the project's final environmental impact report and anticipates the project being operational by the end of this decade.

Moving Water South of the Delta for Storage

To take advantage of flood flow conditions, project facilities had been proposed to augment other supplies by storing flood flows south of the Delta. However, current hydraulic limitations in South Delta channels and regulatory constraints limit the projects' ability to bank these surplus waters. Increased storage south of the Delta would allow for reliable deliveries during low flow periods when Delta waters need to remain instream to serve environmental needs and satisfy other regulatory mandates. Added reservoir storage south of the Delta is practically dependent on implementing corrective measures in the Delta to allow for requisite pumping operations when surplus flows are available.

NORTH OF THE DELTA STORAGE

Historically, much attention has been given to storage projects north of the Delta. In recent years, these projects have received less attention because water transfer constraints present in the Delta significantly reduce the probability of reaping their potential benefits. Still, some of these north of the Delta storage options may become more feasible in the future, as Delta transfer problems are addressed.

SECTION III

FACTORS AFFECTING THE USE AND AVAILABILITY OF DELTA WATER SUPPLIES

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FACTORS AFFECTING THE USE AND AVAILABILITY OF DELTA WATER SUPPLIES

HISTORICAL SETTING

Water exports directly from the Delta began in 1940, after the Contra Costa Canal (a unit of the federal CVP) was completed. In 1951, water began being exported via the CVP's Tracy Pumping Plant into the Delta-Mendota Canal. The SWP began delivering water through the South Bay Aqueduct in 1962, utilizing an interim connection to the CVP's Delta-Mendota Canal. The SWP's main California Aqueduct began operation in 1967, extracting water from the Delta near Tracy as well. Also in 1967, the South Bay Aqueduct shifted its supply source from the Delta-Mendota Canal to the State's California Aqueduct. The North Bay Aqueduct began diverting water from the northwestern Delta in 1987. Most of the water exported directly from the Delta is either uncontrolled winter runoff or water that has been released from upstream CVP and SWP reservoirs into the Sacramento River system later in the year.

In addition to direct in-Delta diversions, over 10 MAF of water that would otherwise flow to and through the Delta is diverted upstream. This includes over 1 MAF of water withdrawn from the system by San Francisco's Hetch Hetchy Project, East Bay Municipal Utility District's Mokelumne Aqueduct, the Turlock Irrigation District, and the Modesto Irrigation District. Also, the Friant unit of the CVP redirects much of the San Joaquin River to serve the east side of the San Joaquin Valley, and the Red Bluff Diversion dam diverts some Sacramento River water to serve the west side of the Sacramento Valley. Both of these areas do provide return flows but they are reduced through consumptive use and transportation losses. Numerous other users divert additional water out of the system upstream of the Delta for storage and use as well.

To facilitate movement of Sacramento River water to pumping facilities in the South Delta, the USBR completed the Delta Cross Channel in 1951. This channel provides a water conduit from the Sacramento River to the Mokelumne River system. The flow from the Sacramento River into the Cross Channel is controlled by two 60-foot gates on the Sacramento River near Walnut Grove. Downstream from the Delta Cross Channel, Georgiana Slough is a natural connection linking the Sacramento River to the Mokelumne River system, providing another pathway for Sacramento River water to flow into the Central Delta. Many Delta hydrodynamic experts believe that the combined Cross Channel and Georgianna Slough carrying capacities are presently inadequate to maximize efficient project operations.

DELTA FLOWS

TIDAL

Most Delta issues focus on how water moves into, through, and out of the Delta. Because Delta channels are at sea level, they are affected by the tidal action of the Pacific Ocean and San Francisco Bay. This tidal action can be measured upstream, even beyond the City of Sacramento. Twice a day, the Pacific Ocean tides cause water to move into and out of the Delta through Suisun and Honker bays (Figure 5). The average tidal flow into and out of the Delta is 170,000 cfs, averaged over the cycle. Peak tidal flow rates can reach 330,000 to 340,000 cfs on an instantaneous flow basis. These tremendous tidal forces can change quickly and unpredictably as a consequence of fluctuations in wind and barometric pressure. Such conditions make daily operational decisions, focusing on moving water while simultaneoulsy satisfying in-Delta regulatory requirements, very challenging and complex.

FRESH WATER

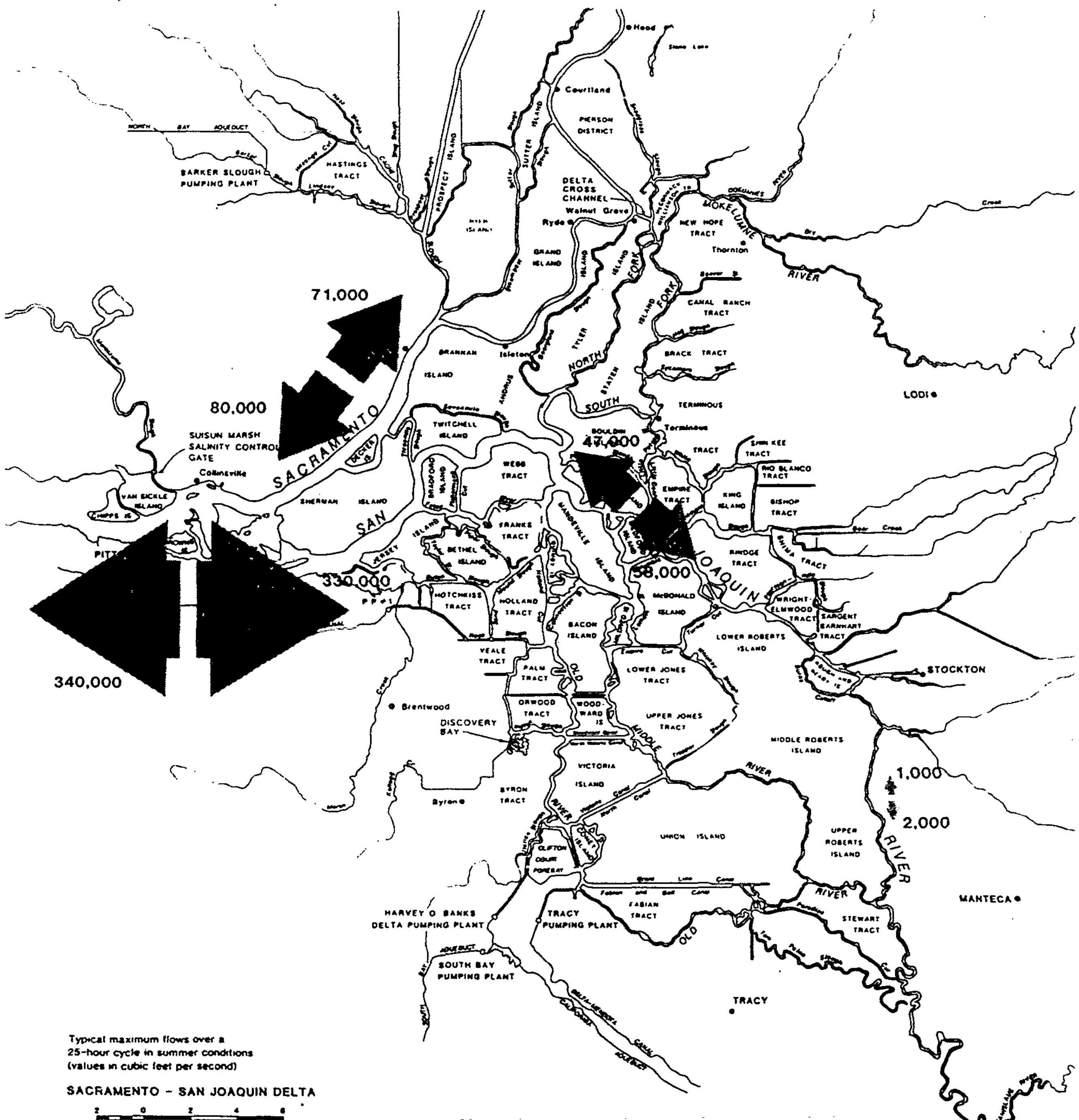
Fresh water flows into the Delta are typically of much lower volume than tidal inflows (Figure 6). The average calculated Delta outflow (water that flows through the Delta past Chipps Island and into San Francisco Bay) is about 30,000 cfs (21 MAF/yr). The magnitude of this flow depends on Delta inflow, export operations, and depletion of in-Delta channel water. During the summer of dry years, Delta outflow is often maintained at a level as low as an average of 3,000 cfs.

Fresh water enters the Delta from three major sources: the Sacramento River, the San Joaquin River, and east side streams. The Sacramento River (including the Yolo Bypass) contributes about 77 percent of the fresh water flows, the San Joaquin River contributes approximately 15 percent, and streams on the east side, including the Mokelumne River, provide the remainder.

Currently, minimum fresh water Delta outflow for most of the year is maintained by releases from SWP and CVP upstream storage reservoirs. A significant portion of this outflow is intended to establish a hydraulic barrier, utilizing the momentum and energy of these fresh water releases, to countervail tidal forces and prevent ocean water from intruding deeply into the Delta. Otherwise, Delta ecology and the quality of municipal and agricultural water supplies would be adversely affected. Under current regulatory requirements, the hydraulic barrier is generally maintained near the western Delta confluence of the Sacramento and San Joaquin rivers. During flood flows, the hydraulic barrier moves west toward the Bay.

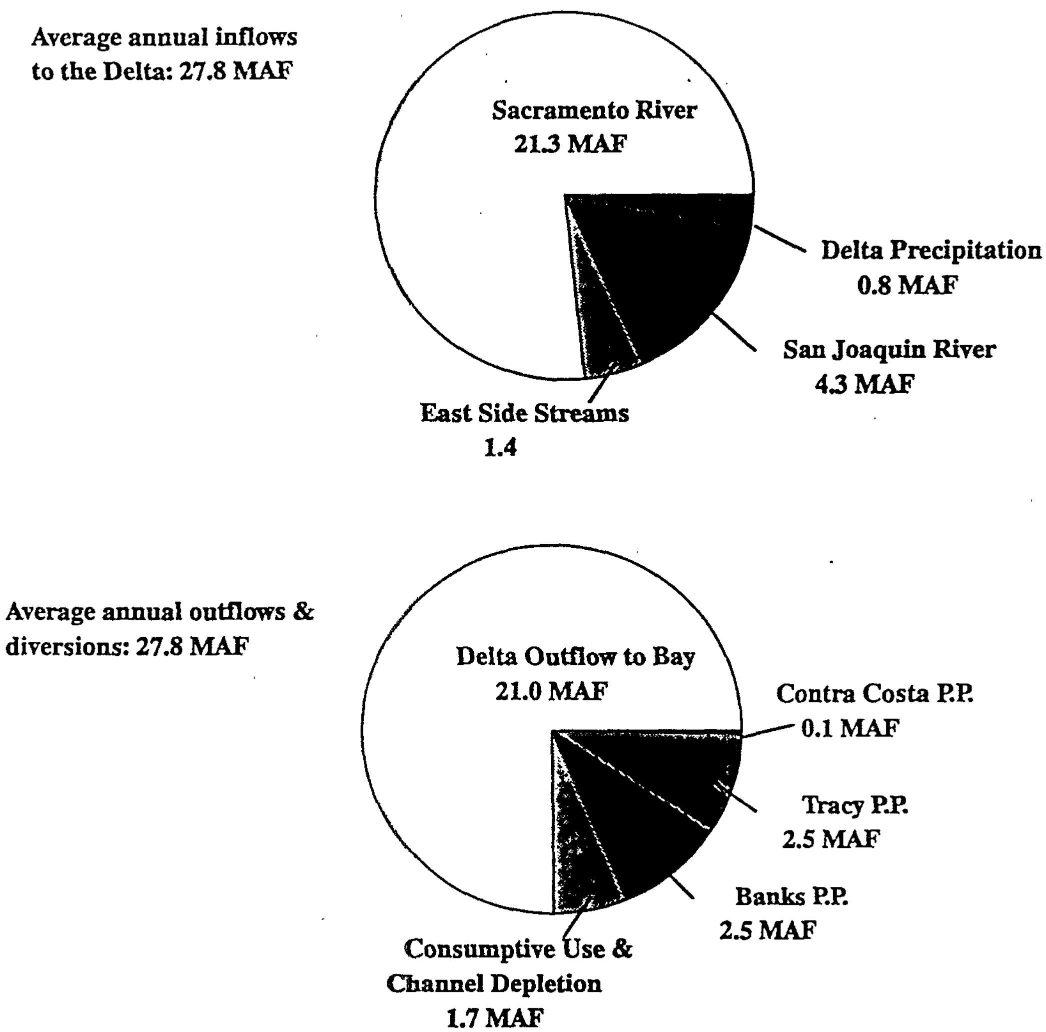
D-000840

Figure 5. Tidal Flows in the Sacramento/San Joaquin Delta
(From the Delta Atals)



Delta Tidal Flows

Figure 6. Delta Flows — Components and Comparisons



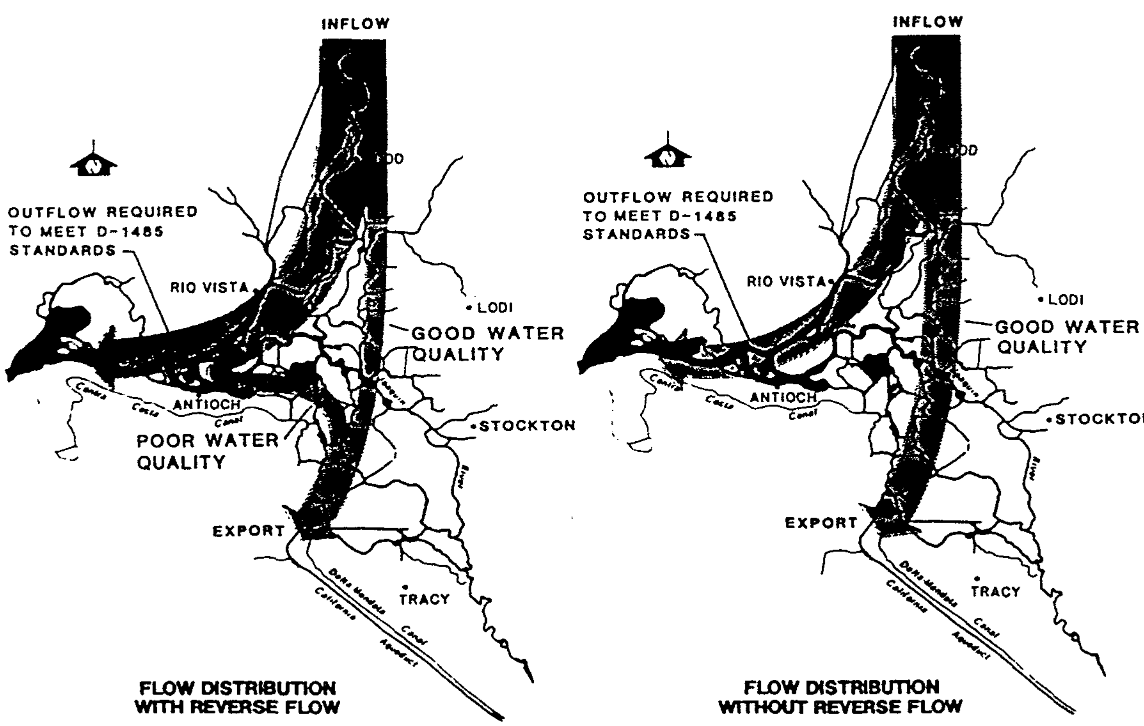
The major components of the Delta water supply are illustrated above, along with the components which use this supply. These figures contain average annual values for the recent period of 1980-92. The average annual inflow to the Delta is 27.8 MAF, with the Sacramento and San Joaquin rivers contributing over 90 percent. Average annual Delta water use, outflow, and exports also totals 27.8 MAF.

D-000842

Reverse Flow and Carriage Water

The expression "reverse flow" identifies a Delta problem in certain channels leading to the project export pumps (Figure 7). CVP and SWP water supply exports are obtained from uncontrolled Delta inflows (when available) and from upstream reservoir releases when natural Delta inflow is low. Most of these uncontrolled flows and releases enter the Delta via the Sacramento River and then flow by various routes to the project pumps in the southern Delta. Most of these flows move toward the SWP and CVP pumps through interior Delta channels, facilitated by the CVP's Delta Cross Channel and Georgiana Slough. When exports from the South Delta reach the upper range of interior channel capacity, water from the Sacramento River sometimes flows through Three-mile Slough to its confluence with the San Joaquin River in the western Delta and back up the San Joaquin River in a "reverse flow" toward the pumps.

Figure 7. Flow Distribution; With and Without Reverse Flows



When fresh water Delta inflow is low, water in the western Delta becomes brackish as it mixes with saltier ocean water entering from the west as tidal inflow. This low quality water can also be drawn upstream (reverse flow) into the San Joaquin River and other channels by pumping plant operations, particularly when San Joaquin River outflow is low and project pumping levels are high. Reverse flows can also occur in the San Joaquin River past Stockton under certain conditions. Currently, there is a lively debate over the significance of reverse flows. Some experts believe that the massive amount of water driven in and out of the Delta by tidal action dwarfs the actual unimpeded fresh water outflow and considerably complicates assessment of the reverse flow issue and its supposed impacts. Others assert that project operations above and within the Delta are responsible for disrupting and distorting the natural estuarine tidal phenomenon, with consequent harm to the ecosystem.

Currently, during operational periods when reverse flows occur, more water than is actually needed exclusively for export is released from project reservoirs to repel sea water intrusion, maintain in-Delta water quality standards, and satisfy export water quality standards. This incremental release of water from the reservoirs, in excess of the actual export need, is described as "carriage water."

Presently, carriage water requirements average between 200,000 and 400,000 af in average and drought years respectively. As operational restrictions increase in the Delta, the volume of necessary carriage water may increase. For example, if the Delta Cross Channel gates are closed to meet fishery regulatory requirements and the Delta is under controlled conditions (which exist whenever meeting any portion of in-basin or export demand requires reservoir releases upstream), more (carriage) water must be released to repel salinity intrusion and dampen any reverse flows that might occur. It should be noted that it is possible, when other regulatory requirements mandate increased reservoir releases, that the carriage water component of those releases may actually decrease although total project flows have increased.

The reverse flow of water in the San Joaquin River, Middle River, Old River, and some other channels has been identified as one of the causes of environmental and fishery problems. Many aquatic biologists familiar with the Delta believe that adult fish migrating upstream and young fish migrating toward the ocean seemingly get confused when reverse flow conditions exist and that many of the young fish follow the flow toward the export pumps, believing they are swimming toward the ocean, particularly if overall flows in the Delta are low. In addition, reverse flow can cause a net flow toward the export pumps which can cause a net movement of fish eggs, larvae, phytoplankton, and zooplankton away from the Estuary's mixing zone and nursery area. Many restrictions on exports from the Delta have been imposed in an effort to minimize this problem.

North Delta Channel Capacity

Limited channel capacity in the North Delta has contributed to two major problems: reverse flow and repeated flooding of local levee tracts.

D-000844

The most critical flood control problem in the North Delta is the Mokelumne River bottleneck. Its narrow channels are often too small to handle high winter flows. Since 1980, there have been 14 levee failures in the North Delta, threatening more than 2,000 people, their homes, and thousands of acres of agricultural lands.

SOUTH DELTA CHANNEL CAPACITY

Southern Delta channels also have limited capacity. This limited capacity also contributes to poor water circulation in South Delta channels, which results in areas of stagnation and degraded water quality. Upstream development on the San Joaquin River has reduced summer river flows and agricultural drainage has increased salinity levels in the lower river. Siltation has further reduced channel capacity and the CVP and SWP operations at times alters flow patterns. DWR's current Interim South Delta Program proposes a plan for dredging in some channels to increase channel capacity to convey higher volumes of water to the Banks pumping plant. To accomplish these improvements, a modification to the Section 10 Navigation permit that currently controls operations at the Banks Pumping Plant is required, among other permits.

Presently, a barrier which is periodically installed in Old River, near the San Joaquin River, keeps San Joaquin River water (that would otherwise flow into Old River) in the San Joaquin River channel and flowing toward the Central Delta. This barrier has been installed in the fall for the past two decades to improve dissolved oxygen levels in the San Joaquin River which helps guide adult salmon upstream. Spring installation of this barrier has been proposed to help guide juvenile salmon to the ocean and reduce their inadvertent detours into the interior Delta.

Currently, four temporary barriers (rock or some other form) are set to be tested to document water level and water quality improvements projected by modeling runs in the South Delta at:

- ★ Old River, one-half mile east of the Tracy Pumping Plant intake and about 8 miles northwest of the City of Tracy;
- ★ Old River, where it splits off from the San Joaquin River, about 10 miles south of Stockton;
- ★ Middle River, just south of the confluence of Middle River, Trapper Slough, and North Canal; and,
- ★ Grant Line Canal, one-quarter mile east of Clifton Court Forebay.

This temporary barriers project includes an extensive monitoring program to collect data measuring impacts on water levels, water quality, flow, fisheries, vegetation, and recreational boating. A report analyzing this data is produced annually under the project's U.S. Army Corps of Engineers' (USCOE) permit.

INSTITUTIONAL CONSTRAINTS

In addition to difficulties associated with Delta hydraulics, institutional and environmental constraints significantly influence water supply management in California, and will continue to do so in the future.

INSTITUTIONAL FRAMEWORK

In California, water use and supplies are controlled and managed by an intricate system of federal and State laws. Common law principles, constitutional provisions, State and federal statutes, court decisions, and contracts or agreements all govern how water will be allocated, developed, or used. All of these components, along with actions by responsible State, federal, and local agencies, comprise the institutional framework for allocation and management of water resources in California.

The following is a list of some of the primary institutional factors and statutory requirements which influence the management of Delta water resources. The reader is referred to Bulletin 160-93 for an in-depth discussion of the issues related to these factors and requirements.

- California Constitution Article X, Section 2
- Fish and Game Codes
- Riparian and Appropriative Rights
- Water Rights Permit and Licenses
- Ground Water Management
- Natural Community Conservation Planning
- Public Trust Doctrine
- Federal Power Act
- Area of Origin Statutes
- Statutes Protecting Fish and Wildlife (*partial list*);
  - Endangered Species Act
  - California Endangered Species Act
  - Dredge and Fill Permits (Section 404, CWA)
  - Public Interest Terms and Conditions
  - Streambed Alteration Agreements
  - Migratory Bird Treaty Act
- Statutes on Environmental Review and Mitigation (*partial list*);
  - California Environmental Quality Act

National Environmental Policy Act
Fish and Wildlife Coordination Act

Statutes on Protection of Wild and Natural Areas;

Federal Wild and Scenic Rivers System
California Wild and Scenic Rivers System
Wild Trout Streams
National Wilderness Act

Statues on Water Quality Protection (*partial list*);

Porter-Cologne Water Quality Control Act
Federal Clean Water Act
Federal Safe Drinking Water Act

Protections for the San Francisco Bay and Sacramento - San Joaquin Delta;

Decision 1485
Racanelli Decision
Coordinated Operations Agreement
SWRCB Bay-Delta Proceedings
Fish Protection Agreement
Suisun Marsh Preservation Agreement

These institutional factors and statutory requirements provide the framework for managing water resources on a statewide basis. The ways that these factors and requirements are applied in the Estuary have specific impacts on the availability and reliability of Delta water supplies. The remainder of this section will discuss some of the most important impacts.

REGULATORY CONSTRAINTS

Recent regulatory activities related to endangered species, promulgation of EPA Bay-Delta water quality standards, and Central Valley Project Improvement Act (CVPIA) mandates, illustrate the imperative of a Delta "fix" to halt decreasing water supply reliability and restore environmental health. The recent ESA listing of the winter run salmon and Delta smelt has been followed by a proposed listing of the Sacramento splittail. Similar petitions may be filed for additional species, including spring run salmon and green sturgeon. Corrective actions in the Delta can reduce project and non-project environmental impacts and thus improve future water supply reliability. Many of these potential actions can also not only reduce ecological impacts, but they can be components of strategies to restore and protect the Estuary's biological resources.

As State and federal regulations to protect the public and its public trust resources have been implemented, California's developed water supplies have become less reliable and more costly for urban and agricultural users. High compliance costs and the absence of consensus among the State's major water constituencies (agricultural, environmental, urban) on the best water management course to follow have brought California's water development, both with regard to infrastructure and management policies, to an impasse. Water resource managers have implemented a number of strategies to help Californians become more efficient in their water use, thus "stretching" existing supplies. But California's increasing demand for water to meet the needs of a growing population while concurrently protecting and restoring the environment highlights the necessity of addressing Delta and system-wide problems and opportunities. Cost-effective and environmentally-sound water supply development in conjunction with more efficient water management need to be implemented if increased water supply reliability is to be achieved.

Clearly, environmental regulations are inextricably intertwined with all of the State's major water supply components (storage, allocation, distribution, use, etc.) and consequently they will continue to play a central role in the formulation of water policy and planning activities.

ENDANGERED SPECIES ACT

In February, 1993, NMFS issued a biological opinion for winter run salmon regulating operations of the CVP and SWP. On March 5, 1993, the USFWS officially listed the Delta smelt as a threatened species and shortly thereafter issued a biological opinion limiting project operations to protect that species and its habitat during the 1993-94 water year.

More recent regulatory actions could further condition and constrain operations of Delta exporters:

- December 9, 1993; State listing of Delta smelt as endangered under the State's ESA became effective.

- December 15, 1993; Federal listing of winter run salmon is changed from threatened to the more restrictive endangered classification. The USFWS proposes listing the Sacramento splittail as threatened.

- February 15, 1994; USFWS issues revised Delta smelt biological opinion.

BAY/DELTA WATER RIGHTS AND THE CLEAN WATER ACT

The SWRCB is responsible for both issuing water rights permits under State authority and promulgating water quality standards under the federal Clean Water Act and the California's Porter-Cologne Act. The SWRCB reserves jurisdiction over its permits issued to the CVP and SWP to formulate or revise terms and conditions relative to salinity control, impacts on vested rights, and fish and wildlife protection in the Sacramento/San Joaquin Delta to protect all beneficial uses.

The history of the dedication of water to protect beneficial uses in the Bay-Delta is reflected in the positions of many of the parties dealing with water issues today. Initial planning for the CVP and SWP was based on an expectation that dedicating 1,200 to 1,800 cfs for Delta outflow would be sufficient at all times. This was an estimate of the amount of flow needed to assure 1,000 parts-per-million (ppm) chlorides at control points on the lower Sacramento and San Joaquin rivers to protect water quality for in-Delta agriculture. Water in excess of these amounts was assumed to be surplus to local needs and available for export, creating an expectation of developing high project yields by diverting uncontrolled flows.

The first evidence of greater flow needs for fish and wildlife was developed in the late 1960s. That evidence was presented to the SWRCB in the first joint hearing held on water rights permits for the CVP and SWP. The resulting decision (D-1379) included fish and wildlife water quality provisions which at times were more restrictive than those already established for agriculture.

By 1976, when the Board initiated the hearing process leading to D-1485 (discussed below), it was clear that the flows needed to meet a 1,000 ppm chloride standard were approximately twice the original planning estimates. Also, fish and wildlife needs agreed to by the state and federal water and wildlife agencies would require higher minimum flows than those included in D-1379.

In the 16 years since D-1485 was adopted, identified needs for fish and wildlife continue to increase, demands for municipal supplies have increased and water development proposals have been stymied for a variety of reasons.

Decision 1485

In 1978, the SWRCB adopted Water Right Decision 1485 (D-1485). D-1485 conditioned SWP and CVP operations in the Delta, focusing on water quality standards, export limitations, and minimum flow rates.

In formulating D-1485, the Board asserted that the SWP and the CVP should be operated to meet "without project" conditions, i.e., what the prevailing conditions would have been if the projects had not been built. D-1485 standards were flexible in that they were designed to reflect variations in hydrologic conditions during different water year types.

Recognizing that the complexities of project operations and water quality conditions would change over time, the Board also specified that water rights hearings would be reopened within 10 years of the date of adoption of D-1485, depending on changing conditions in the Bay/Delta region and the availability of new evidence pertaining to beneficial uses of water.

In 1980, D-1485 was "conditionally" approved by the EPA on the presumption that various EPA "interpretations" would be integrated into the proposed plan. The Board informed the EPA it accepted those interpretations.

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In 1981, the first statutorily required triennial review of the Water Quality Control Plan (D-1485) was completed, with the EPA urging the Board to make D-1485 consistent with the interpretations it had accepted. The second triennial review was completed in 1985, with the EPA interpretations still absent.

In 1986, the Board acknowledged the inadequacy of the 1978 plan and outlined a new hearing process to comprehensively review and update D-1485. EPA decided to await the results of this new round of "Bay-Delta Hearings" before determining whether to promulgate its own standards under its Clean Water Act authority.

Racanelli Decision

After the Board adopted its 1978 plan, a multitude of lawsuits were filed by water contractors challenging D-1485 both with respect to its scope and alleged procedural irregularities. Combined into one action on appeal. Judge Racanelli ruled against the SWRCB on many aspects of D-1485. However, the Court kept D-1485 in place and directed the Board to continue with its new hearing process to revise Bay-Delta standards.

Although there were numerous specific references in the Court's decision with respect to various problems with D-1485, the primary holding was that the Board should consider the responsibility of other water users beyond the CVP and SWP to help meet Bay-Delta standards. The Court concluded that a "global perspective is essential to fulfill the Board's water quality planning obligations."

Despite the Court of Appeal's action on D-1485, it has remained the operative water quality regime in California since its adoption in 1978. Of course, it has been supplemented by other regulatory mandates, particularly requirements imposed by the federal Endangered Species Act.

Post D-1485 SWRCB Bay/Delta Proceedings

Hearings to adopt a revised water quality control plan and water rights decision for the Bay/Delta Estuary began in July 1987.

The Board released a draft Water Quality Control Plan for Salinity (which established salinity and flow objectives to protect beneficial uses of water in the Delta and Suisun Marsh) and a Pollutant Policy Document (intended to provide solutions to specific pollutant problems in the Delta) in November, 1988. The Pollutant Policy Document was subsequently adopted in June, 1990. However, the draft water quality control plan, which represented a significant departure from the 1978 plan, generated considerable controversy throughout the State. In January, 1989, the Board decided to withdraw its draft plan and redesign the hearing process. This redesign included separating water quality issues from those related to flow and exports; with the former addressed in water quality proceedings and the latter in water right proceedings. After many

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workshops and revisions to the water quality control plan, the Board adopted a final plan in May, 1991. However, the federal EPA, under its Clean Water Act (CWA) authority, rejected this plan that same year and began its own promulgation process. EPA's primary concern was related to the scope of the 1991 Water Quality Control Plan in that it did not, it its view, comprehensively address the multitude of factors affecting fish and wildlife resources in the Estuary.

In response to a request in Governor Wilson's April, 1992, proposal for a comprehensive water policy program, the Board decided to proceed with a process to establish interim Bay/Delta water quality standards, which would span a minimum of 5 years, to stabilize ecological conditions in the Bay/Delta Estuary. Water rights hearings were conducted from July through August, 1992, and draft interim standards (proposed Decision 1630 (D-1630)) were released for public review in December, 1992. In April, 1993, the Governor suggested that the Board turn its attention to establishing permanent standards for protection of the Delta because recent federal actions had effectively preempted the State's proposed interim standards and were already regulating project operations to protect the Bay/Delta environment.

In December, 1993, in accordance with a consent decree entered in a lawsuit filed by the Sierra Club Legal Defense Fund, the EPA announced the release of proposed Bay-Delta water quality standards, which are currently under review. Since the final outcome of these standards is unknown, the range of potential impacts to Delta water exports may be substantial. These standards, it should be noted, will be supplemented by as yet undetermined ESA take limits, which have historically further constrained project operations.

CENTRAL VALLEY PROJECT IMPROVEMENT ACT OF 1992

On October 30, 1992, President Bush signed PL 102-575 into law. Title XXXIV of that law was the Central Valley Project Improvement Act (CVPIA). The CVPIA mandates significant changes in the management of the CVP by initiating a complex set of new programs and requirements applicable to the project(s).

Implementation of environmental restoration measures is a major goal of the CVPIA. It establishes fish and wildlife mitigation, protection, and restoration as an equal project purpose with domestic and irrigation uses of water. Also, fish and wildlife enhancement is put on a par with hydropower generation. The CVPIA requires the dedication of 800,000 af of project annual yield for general fish, wildlife, and habitat needs and establishes a goal of doubling the natural production of anadromous fish in Central Valley rivers and streams by 2002 (except for part of the San Joaquin River, which is treated separately).

BAY/DELTA ENVIRONMENTAL WATER NEEDS

The exact amount of water that may ultimately be required to meet Bay/Delta environmental needs will not be known until many of the regulatory processes currently underway are resolved and the Bay-Delta Oversight Council completes its long-range planning process. The difficulty in predicting the amount of water that may be necessary to dedicate to environmental protection is complicated by the variety of actions that may evolve to correct both problems in the Delta ecosystem and constraints on the conveyance of water through the Delta for export. Federal and State fisheries agencies, and the federal EPA have made proposals that could substantially increase the amount of water allocated to protect the Bay/Delta's public trust resources and as a consequence reduce the amount of water available to serve other beneficial uses. These possible environmental water dedications could require up to an additional 3 MAF in additional instream supplies annually (Table 2).

GLOSSARY OF TERMS

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Conjunctive Use -- The use of ground water in combination with surface water. Water is stored in a ground water basin for later use during dry years by intentionally recharging the basin during years of above-average supply.

Demand Management -- methods of balancing water supply and demand that rely on reducing demand rather than augmenting supply. Water conservation measures are demand management measures.

Development level -- the water supply and delivery facilities that exist at a point in time, that can be expected to yield a predicted amount of water with given weather conditions.

Entitlement -- the full amount of water that is to be delivered to a customer on an annual basis under a contract or agreement.

Instream flow -- flow of water that does not require diversion from its natural watercourse. For example, the use of water for navigation, waste disposal, recreation, fish and wildlife, esthetics, and scenic enjoyment.

Natural flow -- the flow past a specified point on a natural stream that is unaffected by stream diversion, storage, import, export, changes in channel configuration, return flow, or change in use caused by modifications in land use.

Net water demand -- the amount of water that would be needed in a water service area to meet all requirements with no restrictions on use. It is the sum of evapotranspiration of applied water in an area, the irrecoverable losses from the distribution system, and the outflow leaving the service area.

Net water use -- the amount of water used in a water service area that is not later made available for reuse. Net water use includes evapotranspiration of applied water and water that flows to an irrecoverable source, but not water that is used and then discharged to a stream where it is used again by others.

Overdraft -- the amount of water pumped from a ground water basin that exceeds natural or artificial recharge.

Reuse -- the additional use of previously used water.

Water demand -- the amount of water needed in a water service area to fully meet all identified uses, without consideration of reuse.

Water transfer -- a transaction in which water is moved from an area where the water supply has traditionally been used, to another area. The water may be excess to local needs, or may be made available by fallowing land, partially withholding irrigation, or substitution of groundwater for the surface water that is transferred.

Urban Best Management Practices -- certain water conservation measures that have been found by urban water suppliers and public interest groups to be cost-effective and appropriate for nearly all urban areas in California. Over 100 urban water suppliers have agreed to implement Best Management Practices or BMPs at specified levels of effort through 2001.

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