Delta Vision

Context Memorandum: Water Supply and Water Quality

This context memorandum provides critical information about water supply and water quality to support policy making. As they are developed, the context memos will create a common understanding and language about the critical factors in establishing a Delta Vision.

This is an iterative process and this document represents the beginning of a dialogue with you about how best to understand water supply and water quality and to inform recommendations by the Delta Vision Blue Ribbon Task Force. You have two weeks to submit comments that may be incorporated into the next iteration.

You may submit your comments in two ways: either online at dv_context@calwater.ca.gov or by mail. If you are using mail, please send your comments to: Delta Vision Context Memo: Water Supply and Water Quality, 650 Capitol Mall, 5th Floor, Sacramento, CA 95814.

Your attributed comment will be posted on the Delta Vision web site (http:www.deltavision.ca.gov). Please cite page and line number with specific comments; general comments may be keyed to sections.

Your participation in this iterative process is valuable and important and is greatly appreciated. Thank you for your comments.

Section 1. General Policy

The purpose of this context memo is to provide a succinct situational report on the water supply and water quality issues in the Delta from which the Task Force can continue to formulate policies designed to achieve a sustainable management plan for the Delta. Much of the information contained in this memo is derived wholly or in part from information in the California Water Plan Update, 2005 (Water Plan) and from data made available by the California Department of Water Resources (DWR) and the U.S. Bureau of Reclamation (Reclamation).

California's water system is designed and managed to meet a number of demands in regions throughout the State. As the Water Plan notes:

> From a statewide perspective, California meets most of its agricultural, municipal, and industrial water management objectives in most years. Most of our demands are being met with the help of advances in water conservation and recycling, combined with infrastructure improvements including new storage and conveyance facilities. [*Water Plan*]

Placed in this context, the Delta, which plays a critical water supply and conveyance role in the State, faces an array of water supply and water quality challenges to continue to meet these objectives. The Task Force's actions resulting in a "durable vision for sustainable management of the Delta" [*Executive Order*] will be grounded in the water supply and water quality issues associated with the Delta.

The following fundamental policy questions frame the presentation of factual information included in this context memo:

- Does the status quo of Delta water management serve the long-term interest of any existing beneficiary of Delta water supplies?
- Is the statewide significance of export supplies great enough to justify the impacts that existing operations and export methods are having on Delta beneficial uses?
- To what extent should in-Delta water use be modified in light of the need to manage the Delta ecosystem and water supply exports?
- Are the long-term public health needs and economic considerations of urban users reliant on Delta water supplies compatible with the continuation of current in-Delta and export water supply operations?
- Should the water quality, quantity and timing needs of "humans" and the "ecosystem" continue to be seen separately or can they be integrated?

Statewide Water Supply Context. In an average water year, California receives close to 200 million acre-feet of water in precipitation and surface water imports from the Colorado River, Oregon, and Mexico. As a representative average year, the total precipitation that fell on California in 2000 was estimated at 188 million acre-feet[1]. This quantity can vary significantly, though, with precipitation in 1998 estimated at 330 million acre-feet, but only 140 million acre-feet in 2001. Of this total annual supply, about 50 to 60 percent is either used by native vegetation; evaporates to the atmosphere; provides water for agricultural crops and managed wetlands as "effective precipitation"; or flows to Oregon, Nevada, the Pacific Ocean, and salt sinks – like saline groundwater aquifers and the Salton Sea. The remaining 40 to 50 percent (about 80 million acre-feet), called the dedicated or developed supply, is distributed among (1) urban and agricultural uses, (2) environmental uses,[2] or (3) storage in surface and groundwater reservoirs for use in future years. Statewide, urban, agricultural, and managed wetland diversions represent about half of the total dedicated supply – estimated at around 44 million acre-feet in 2000.

Figure 1 illustrates how the statewide water supply provides inflow to the Delta and subsequently flows to various destinations. In this illustration, the years 1998, 2000 and 2001 are used to reflect wet, average, and dry hydrologic conditions. To provide further relevance to the use of inflow to the Delta, Figure 1 also shows how exporting regions - shown as one of three numbered regions – combine Delta water with other supplies to meet historic needs. Interestingly, the percentage of annual total supply for any region is relatively consistent across the three years, though the total quantity of Delta derived water supply varies based on a combination of available local supply and regional demand.

Further affecting the inflow to the Delta is the myriad of upstream diversions – including those that feed the San Francisco peninsula and the East Bay – and the increasing variability associated with documented changing climatic conditions. Recent evidence of climate change, including an increase in the portion of precipitation falling as rain versus snow, indicates the likelihood of continued variation. Climate change experts contend this evidence points to less predictability in the timing and quantity of available water supplies in the coming decades.[3]

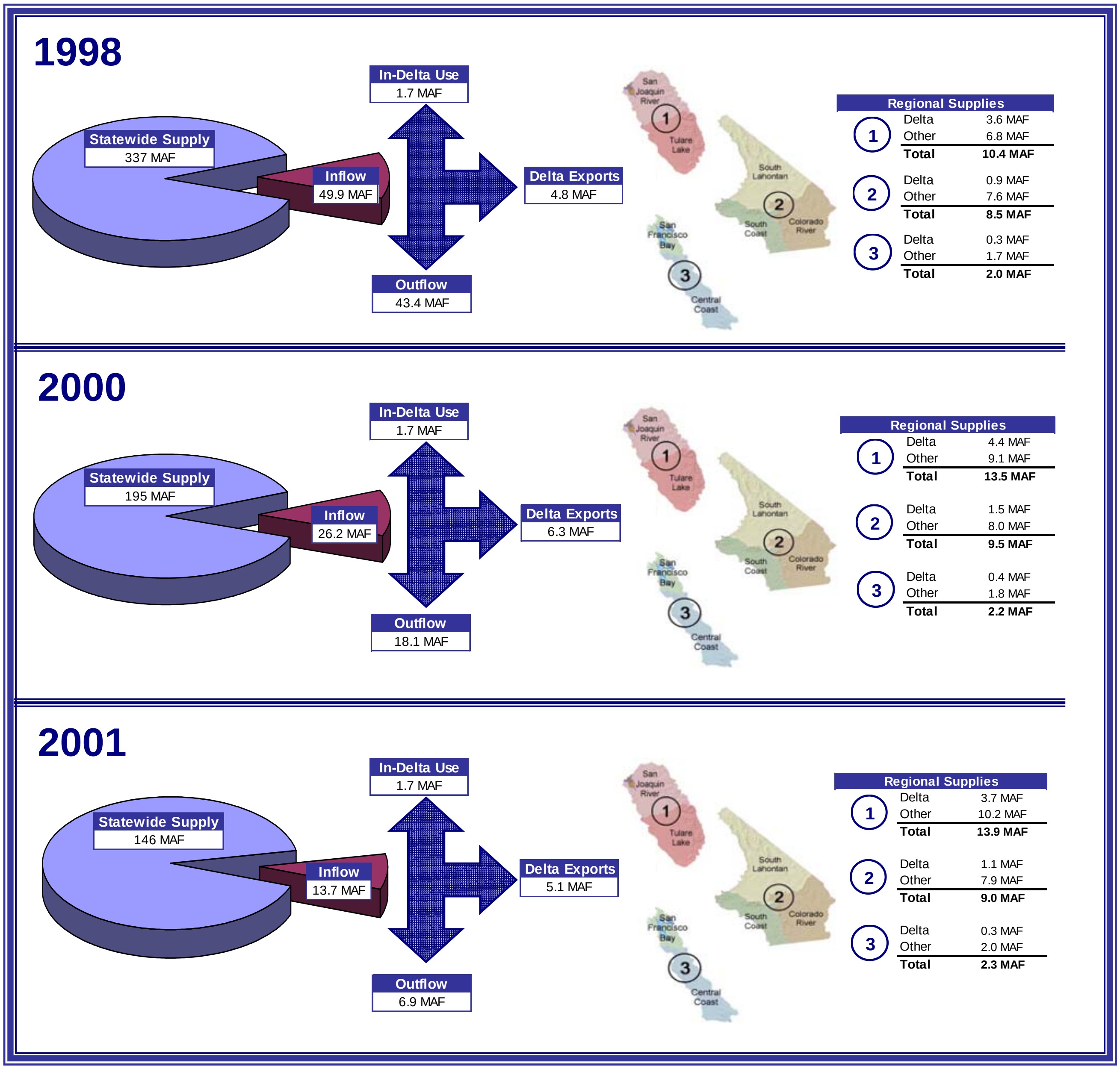
As seen in this limited set of data, flows that enter and leave the Delta vary dramatically from year to year. Some of the water entering the Delta is diverted out of channels for use within the legally defined Delta, while a larger portion is exported for uses in areas outside of the legally defined Delta. The largest portion, however, is outflow to the San Francisco Bay and Pacific Ocean, with the exception of a dry year,

[1] Statewide information is not available to differentiate what falls as snow versus rain.
[2] These include uses such as managed wetlands, wild and scenic flows, and required Delta outflow.
[3] Much of the evidence and predictions provided by climate scientists indicate regional temperature changes will become more evident after 2030 or 2040, with less noticeable changes to "average" temperatures within the coming 20 or 30 years.

when exports and outflow are relatively equal. Figure 1 does not describe monthly flow characteristics, which can show more dramatic variation between outflow and export.

Figure 1 – Statewide and Delta Water Supply and Destination

(data is from the California Water Plan Update)



Attention to Delta Water Quality. Since water supplies derived from or conveyed through the Delta play a prominent role in the State's urban, agricultural, and environmental water picture, the quality of the water is constantly being scrutinized and analyzed. Water quality in the Delta is governed primarily by the 1995 Water Quality Control Plan for the San Francisco Bay/Sacramento San Joaquin River Delta (1995 Bay-

Delta Plan). The 1995 Bay-Delta Plan established beneficial uses, associated water quality objectives, and an implementation program. In Water Rights Decision 1641 (D-1641) the State Water Resources Control Board (SWRCB) primarily assigned responsibility for meeting Delta water quality objectives to the State Water Project (SWP and Central Valley Project (CVP). The quality of water reaching the Delta is also regulated by Regional Water Quality Control Boards (Regional Boards), which identify water quality objectives and control programs for the discharges to surface and groundwater in their respective basins.

Key contributors to Delta water quality concerns include:

- Ocean-derived salts associated with daily tidal cycles
- Salinity, chemicals, and pharmaceuticals from treated urban wastewater discharges from upstream and in-Delta sources
- Pollutants and organics from upstream and in-Delta storm water runoff
- Temperature, pesticides, sediment and land-derived salts[4] from upstream agricultural runoff and drainage and organics from in-Delta agricultural drainage
- The magnitude of upstream inflow and reservoir releases, the rate of export pumping, and the operation of flow management structures, such as the temporary barriers in the southern Delta and the Delta Cross Channel

Section 2. Conceptual Models and Related Science and Engineering

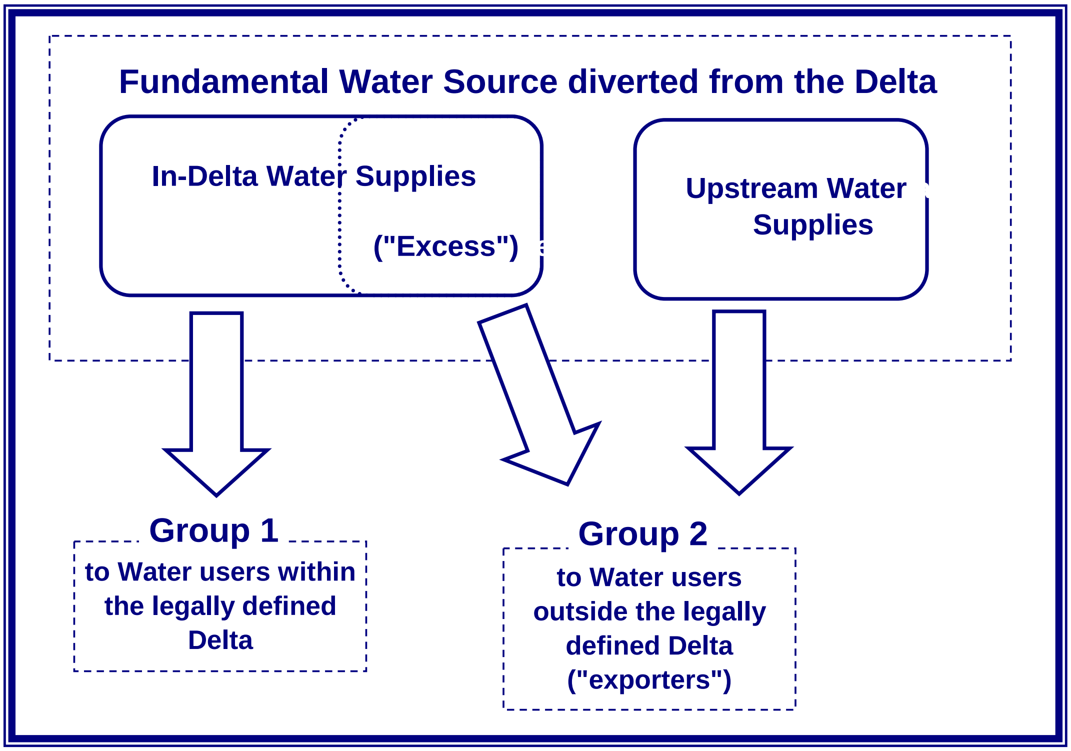
To facilitate Task Force discussions, the following conceptual model is proposed that separates water users into two primary groups:

- Group 1 - Users reliant on in-Delta derived water rights for use within the legally defined Delta
- Group 2 - Users reliant on the Delta for diversion of in-Delta or upstream water rights for use outside of the legally defined Delta (otherwise referred to as “exporters”)

Figure 2 illustrates this model. As indicated in Figure 2, Group 2 derives the majority of its water supplies from rights upstream of the Delta – such as stored water rights.

[4] Salinity in agricultural drainage primarily comes from irrigation practices on the west side of the San Joaquin Valley associated with efforts to manage salinity associated with CVP water originating from the Delta.

Figure 2 – Conceptual Model for Water User "Grouping"



However, this group also derives a portion of their supply from in-Delta water that is "excess" to the needs of in-Delta water rights holders. This concept and the implications to exported water supplies are discussed later in this memo. In contrast, Group 1 users wholly derive their water from water rights originating in the Delta.[5] Though a generalization, this conceptual model is helpful to describe: (1) the water users, (2) their water uses, and (3) the primary drivers affecting uses.[6]

To help put these groups in perspective, consider that of the nearly 28 million acre-feet[7] diverted and consumed in 2000 statewide for agricultural, urban and managed wetland uses, about 6% was for in-Delta uses, and approximately 23%[8] was for uses reliant on supplies conveyed through the Delta for export and use outside of the legally defined Delta. The remaining 70% of the statewide consumption was derived from supplies either available upstream of the defined Delta (i.e. Sacramento or San Joaquin Valleys) or from other watersheds (i.e. Colorado River, Kern River, Owens Valley). The

[5] For purposes of this memo, Contra Costa Water District is included in Group 2 although it is largely within the statutory limits of the Delta.

[6] The term "drivers" is intended to encompass those natural, operational, and regulatory impacts upon water management.

[7] According to the Water Plan, consumptive use is the amount of applied water used and no longer available as a source of supply. Applied water is estimated by the Water Plan to be approximately 44 million acre-feet annually. The average applied water value includes the consumptive use, reuse, and outflows associated with diverting water for the stated purposes.

[8] Contra Costa Water District's water diversions are included in this value. The District does have appropriative rights senior to the CVP and SWP rights, as well as a CVP water supply contract.

following discussion provides a synthesis of useful information relevant to each grouping.

Group 1. Currently, these users rely upon a suite of predominantly riparian and pre-1914 water rights to directly divert and put to use Delta water supplies [see the Delta Water Management Governance Structure context memo for more details regarding California Water Rights]. Though the primary water users in the Delta are individual farming operations, formal institutions have been established to manage Delta water. For instance:

> In November 1965, the Department of Water Resources and the U.S. Bureau of Reclamation reached agreement with some Delta interests on the quality of agricultural water to be maintained by the State Water Project and the Central Valley Project at various locations in the Delta. There was, however, no legal entity to sign the related contracts. As a result, the California Legislature created the Delta Water Agency. This Agency was replaced with three separate agencies in 1973 – the North Delta Water Agency, the Central Delta Water Agency, and the South Delta Water Agency. [*Delta Overview, 2007*]

Contra Costa Water District (CCWD), East Contra Costa Irrigation District, Byron-Bethany Irrigation District, the city of Antioch, and various industrial corporations are the remaining local water users with water rights senior to the CVP and SWP. They are located in the southwest region of the Delta. CCWD is included in the Group 2, however, because of their CVP contracts.

Current and Projected Water Use. According to the Water Plan, the in-Delta users consume approximately 1.7 million acre-feet annually of the 28 million acre-feet consumed statewide[9]. Delta agriculture is the prominent water user in this group, consuming about 1.3 million acre-feet to irrigate about 475,700 acres of crops in 2000. This use is followed by the consumptive use for channel evaporation as well as the evapotranspiration for wetlands and riparian uses.

Urban uses, including the high-water using power plants at Pittsburgh and Antioch, represent the smallest portion of water use within the Delta by sector. Urban areas in the legally defined Delta are shown in Figure 3. Though a small minority of urban communities draw water directly from the Delta, most of these communities rely on groundwater combined with rights and contracts pulling from upstream water sources.

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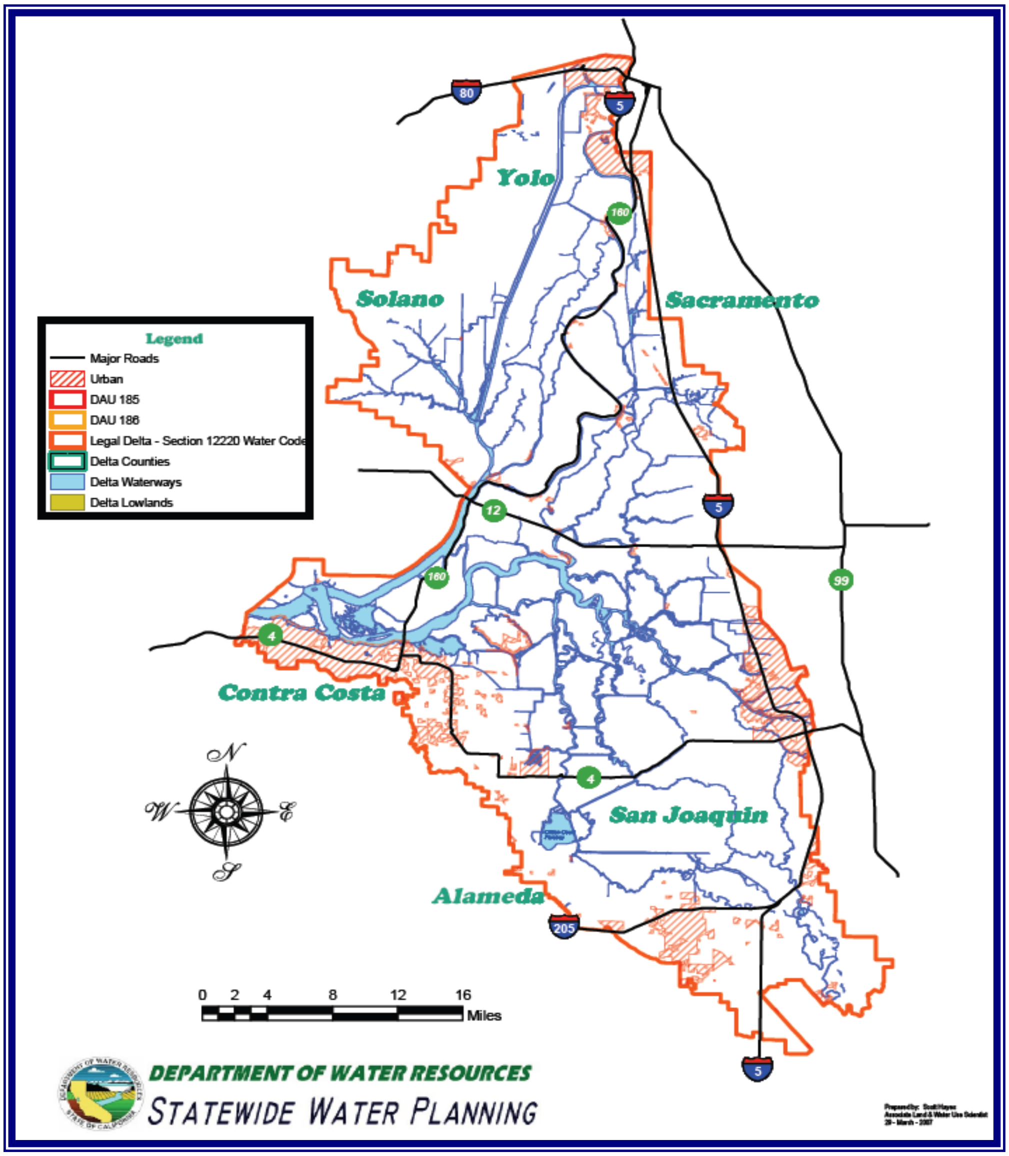
[9] Table 12-2 in Volume 3 of the Water Plan indicates consistent consumptive use regardless of a wet, average, or dry year. However, the value presented is derived from older information that is being re-evaluated as part of additional Water Plan activities. The average consumption does not noticeable vary from year-to-year because of the propensity of water available for agricultural and riparian evapotranspiration.

One exception is the City of Antioch, which diverts a combination of its own rights and purchases raw water diverted by Contra Costa Water District under its water rights.

Figure 3 – Urban Areas within the defined Delta



Projected Use. Already present and expected to continue into the near and long-term future, pressures from urbanization within the legally defined Delta are being flagged as adding to demands for this group of Delta water supplies[10]. According to the Water Plan, the Delta population in 2000 was approximately 462,000. Urbanization in

[10] Most of the planned urban growth is anticipated to occur within the Delta's "secondary zone," which is defined by the Delta Protection Commission as "all the Delta land and water area within the boundaries of the legal Delta not included within the Primary Zone, subject to the land use authority of local government, and that includes the land and water areas as shown on the map titled "Delta Protection Zones" on file with the California State Lands Commission."

areas around Tracy, Stockton, Lathrop, Brentwood, Antioch, and West Sacramento will increase this population.

Many of these communities do not intend to rely upon Delta water supplies to meet the demands of growth. For instance, Stockton has received approvals under California Water Code §1485 to re-divert discharged, treated wastewater. The cities of Tracy and Lathrop have entered into long-term contracts with the South San Joaquin Irrigation District for delivery of water under SSJID's water rights. The extent of indirect impacts to Delta water supplies from potential increases in upstream diversions for these needs, however, is not discussed here.

Agricultural use in the "primary zone" of the Delta will likely continue to decline slightly, as indicated in the Status and Trends of the Delta Suisun Services report[11].

Primary Drivers. The users in Group 1 have many drivers that implicate their policy positions, management decisions, and financial investments. Since agriculture is by far the greatest water user in this group, the primary drivers are focused on agricultural production and preservation. Briefly, these include:

- Agricultural commodity prices and other economic elements that affect decisions of what to grow
- Water quality for irrigated crops
- Cost of levee maintenance and/or land reclamation after a catastrophic event so as to maintain agricultural production practices
- Supply reliability associated with the in-Delta water elevation impacts of the Delta export facilities

Group 2. Currently, the Group 2 users rely upon the Delta's natural (and controlled) channels as a conduit to move water from one location to another. The water being diverted for export to a wide array of locations and uses is generally controlled by water rights permits issued by the State Water Resources Control Board (SWRCB) [see the *Delta Water Management Governance Structure* context memo for more details regarding California Water Rights]. The most prominent of these diverters having the greatest impact on the management of water in the Delta, are the State Water Project (SWP), the Central Valley Project (CVP) and Contra Costa Water District.

Though the majority of the water exported annually by the CVP and SWP are the result of water rights derived from upstream storage facilities, these exporters also benefit from the ability to divert water considered in "excess" in the Delta (see Figure 2).

[11] The Status and Trends report indicated a decline of approximately 6% in agricultural land use between 1990 and 2004.

Excess conditions in the Delta often result when sufficient water is available to meet all beneficial needs, and the CVP and SWP are not required to make releases from reservoir storage (e.g. as may occur during periods of high runoff). At such times, flows from Delta tributaries such as the Cosumnes, the Mokelumne and the Tuolumne rivers, which are not controlled by the CVP or SWP, can be a benefit to exporters. Diversions during excess conditions, though still governed by various determinations and rules, can derive a percentage of the total exports from "excess" Delta water. Based on information provided by the SWP and CVP Joint Operations Center (JOC), approximately 100%, 40%, and 20% of total exports in 1998, 2000, and 2001, respectively, occurred during defined "excess" conditions. Though the quantitative contribution of water exported based upon in-Delta appropriation rights cannot easily be determined, it is likely that the quantity exported during excess conditions based upon in-Delta rights can be significant, especially in wet years or wet months.

Further, the contribution of water during excess conditions from sources other than upstream CVP and SWP reservoirs could potentially be restricted or completely unavailable if SWP and CVP diversion facilities were relocated upstream of the primary Delta and, at the same time, pumping at existing south Delta facilities was stopped (i.e. using an isolated intake facility on the Sacramento River, as has been proposed with a peripheral canal)

SWP Water Users. During the 1960s, as the (SWP) was being constructed, long-term contracts were signed with public water agencies, known as the State Water Project contractors (see Attachment A for listing of contractors and annual Table A allocations). They receive annual allocations of water derived from SWP water rights under the terms of their contracts. These contracts will expire in 2035. In return for the water supply, the contractors repay the principal and interest on both the general obligation bonds that initially funded the Project's construction and the revenue bonds that paid for additional facilities. The contractors also pay all costs, including labor and power, to maintain and operate the Project's facilities. Lastly, contractors fund all recreational facilities at many SWP lakes and reservoirs, and they contribute to costs to mitigate for any environmental impacts the Project's operations may have on fishery and wildlife.

Current and Projected SWP Water Use. As shown in Attachment A, over 60% of the Table A allocation is directed to urban uses in Southern California (approx. 2.6 million acre-feet of 4.2 million acre-feet). Of this, the vast majority is contracted to the Metropolitan Water District of Southern California (MWD). However, because of many factors, the SWP deliveries to MWD have recently been 70% to 90% of its allocation (with the exception of 2001, when supplies were at 40%)[12].

A second major SWP contractor is the Kern County Water Agency (KCWA), which accounts for approximately 20% of the Table A allocation, at one million acre-feet. The predominant use in KCWA is agricultural irrigation. Recent deliveries have ranged from 65% to 90% of their allocation (with the exception of 2001, when supplies were at 40%).

Together, these two agencies represent 30-40% of all of the supplies exported from the Delta (approximately 6.5 million acre-feet exported in 2000, of which about 2.4 million acre-feet were allocated to MWD and KCWA).

Projected SWP Use. Figure 4 shows historic export pumping by DWR to satisfy SWP contractor demands from 1993 to 2005. Predicting how these uses may change (increase or decrease) is speculative considering the ultimate delivery is a function of (1) the annual demand among all contractors, and (2) the availability of water under regulatory and operational constraints.[13] However, to help frame the order of magnitude of increased or decreased deliveries, three hypothetical scenarios are presented:

- Scenario 1 – delivery rates seen between 2000 and 2005 will continue. Under this scenario, contractors such as MWD and KCWA will continue to receive about 2.4 million acre-feet annually. Deliveries will continue to average 70-90% of Table A allocations (except for dry years).
- Scenario 2 – delivery rates will increase to closer meet or fully match contract entitlements. Under this scenario, deliveries would be about 90-100% of Table A allocations. This would represent a 0.5 to 1.0 million acre-foot increase in SWP exported deliveries.
- Scenario 3 – delivery rates decrease on average. Under this scenario, deliveries would be about 50-70% of Table A allocations. This would represent a 0.5 to 1.0 million acre-foot reduction in SWP exported deliveries.

CVP Water Users. The Central Valley Project (CVP) plays a key role in California's strong economy, providing water for 6 of the top 10 agricultural counties in California. According to Reclamation's web site, it has been estimated that the value of crops and related service industries has returned 100 times Congress' $3 billion investment in the CVP. In addition to providing water for farms, homes, and industry in California's Central Valley, the CVP provides significant water supplies to major urban centers in the San

[12] Values are based on information from DWR's website for State Water Project Analysis Office (SWPAO). These percentages are higher than the long-term (1972-2003) average reported by the Water Plan of 700,000 acre-feet. This is due to a combination of factors including dry years and limited requests by MWD.

[13] Often in wet years, a large percentage of Table A allocations are not fulfilled due to lack of demand (i.e. local precipitation, climate, and local water supplies reduce the need for imported water), while in dry years, allotments have been lower because of regulatory and operational constraints.

Francisco Bay Area, such as the Silicon Valley. The CVP is also the primary source of water for much of California's vital wetlands (outside of the Delta-Suisun).

Similar to its SWP counterpart, CVP contractors have an obligation to pay for the water supply and operations of the project, including the cost of ecosystem restoration activities mandated in 1992 by the Central Valley Project Improvement Act (CVPIA). However, overall CVP project repayment criteria can differ because of authorizing legislation, project purpose, and historical and projected use of the individual facility. Repayment for a project purpose may be reimbursable, nonreimbursable, or both. Costs allocated to water supply and power are predominately reimbursable, costs allocated to fish and wildlife may be reimbursable or nonreimbursable, depending on legislation, and costs allocated to flood control, navigation, recreation and water quality improvement are traditionally nonreimbursable.

Attachment B, includes a list of the south-of-Delta CVP contractors, which represents an array of water service contractors, settlement/exchange contractors, water rights holders and wildlife refuges that rely upon the Delta as a conduit to deliver vital water supplies[14].

<u>Current and Projected CVP Water Use</u>. As shown in Attachment B, the water purveyors served with water supplies exported from the Delta have contracts for nearly 3.3 million acre-feet annually. However, as shown in Figure 5, historic deliveries have averaged around 2.5 million acre-feet (CVP exports in 2000 were 2.48 million acre-feet, Water Plan). Of the contracts, about 60% are agricultural water service contracts, while 25% are exchange/settlement contracts. This difference is important since the contractors with a water service contract face more frequent and greater reductions when supplies are not available. With the exception of dry-years, exchange/settlement contractors routinely receive 100% of their allocation. Thus, in dry years or during critical months when pumping may be constrained because of regulatory requirements, exchange/settlement contractors will be the highest priority.

<u>Projected CVP Use</u>. Figure 4 shows historic deliveries for CVP contracts. Predicting how these uses may change (increase or decrease) is speculative. Many of the CVP contractors have recently undergone or are undergoing contract renegotiations, which may modify future conditions. Additionally, the federal government is negotiating with primary south-of-Delta CVP contractors for resolution of long-standing issues related to the management of agricultural drainage. These negotiations may include permanent land retirement, modified control of the operations of the CVP Delta export facilities, and other measures that will impact future operations and management of Delta water exports. However, to help frame the order of magnitude of increased or decreased deliveries, three hypothetical scenarios are presented:

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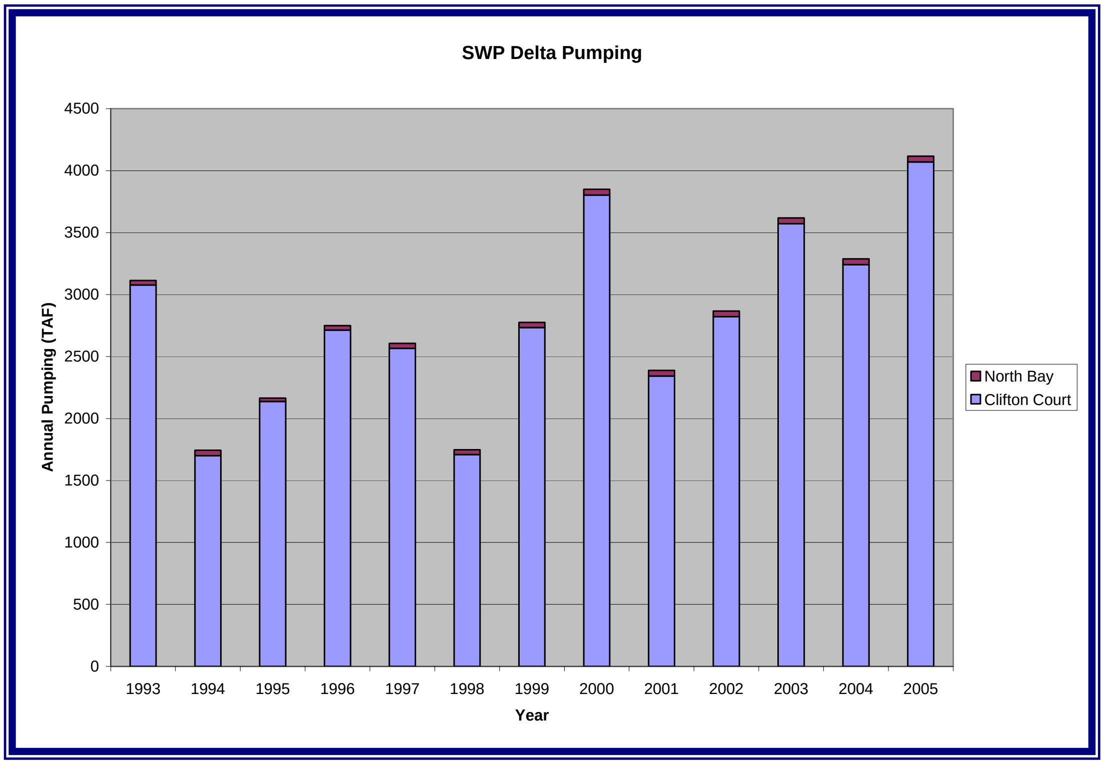
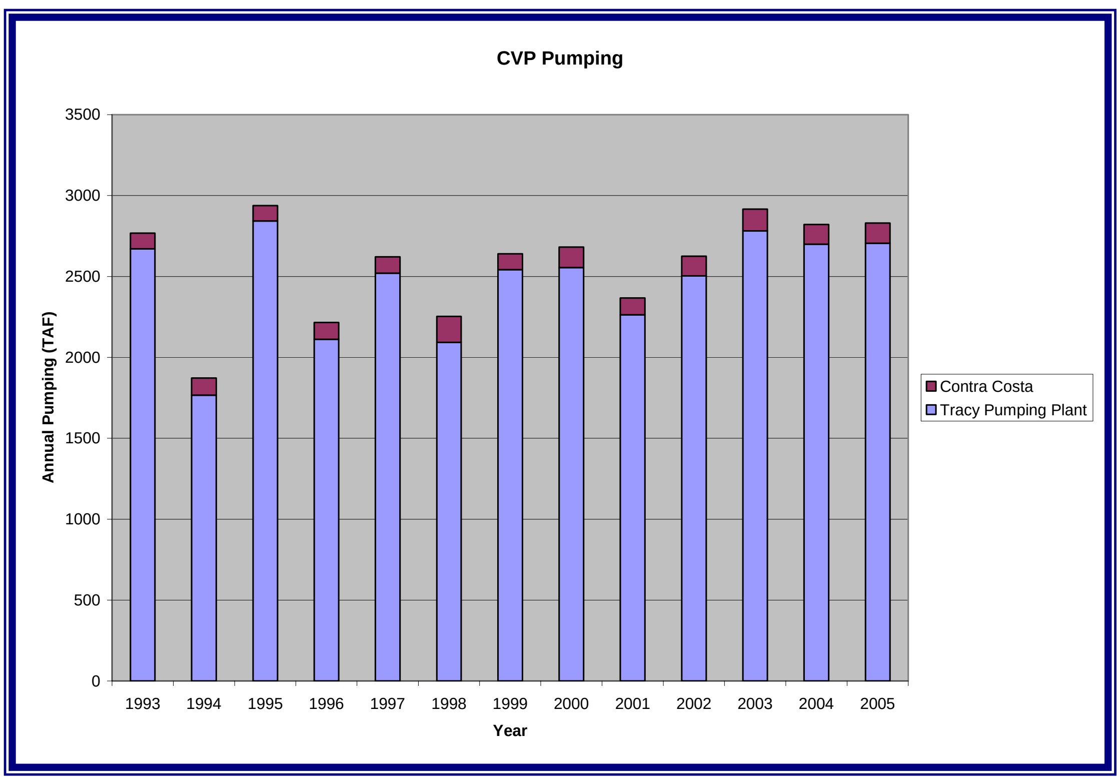
[14] CVP contractors north of the Delta are not included on this list, but play a vital role in the current and future planning and operations of the CVP.

Figure 4 – Representation of Historic SWP and CVP Pumping

(Derived from data provided by the JOC)





- Scenario 1 – delivery rates seen between 2000 and 2006 will continue. Under this scenario, deliveries will continue to average 65-85% of contract entitlements for water service contracts, and normally 100% for exchange contractors.
- Scenario 2 – delivery rates will increase to closer meet or fully match contract entitlements. Under this scenario, deliveries would be about 90-100% of contract entitlements for water service contracts. This would represent a 0.5 to 0.75 million acre-foot increase in CVP exports.
- Scenario 3 – delivery rates decrease on average. Under this scenario, deliveries would be about 50% or less for water service contracts (with exchange contracts still maintained at 100%). This would represent a 0.3 to 0.5 million acre-foot reduction in CVP exports.

<u>Primary Drivers for SWP and CVP Users</u>. CVP and SWP water exporters have many drivers that implicate their policy positions, management decisions, and financial investments. Though a water agency customer (e.g. farmer, resident, industry) may have slightly different drivers than the water agency, the primary drivers outlined below are from the water agency perspective.

- Agricultural water quality, especially concentrations of salinity that can impact crop performance, require greater water to leach from the root zone, and further complicate drainage issues.
- Farm economics, including the cost and reliability of water as it relates to crop choices. Current crop trends see permanent crops (i.e. nut trees) replacing annual crops. Permanent crops require greater supply reliability, since it now becomes impractical to leave the land "fallow" when water supplies are lacking.
- Drinking water quality that translates into treatment costs and health risks.
- Urban economics, including the cost and reliability of water from alternative sources as it relates to minimizing the cost of water management.

Delta Water Quality. Delta water quality is driven by a complicated array of hydrodynamics resulting from the natural ebb and tide of ocean interfacing with the natural and controlled inflow from upstream sources. Coupled with actions and facilities intended to facilitate exports, manage for species and habitats, and meet the needs of in-Delta users (see Group 1 discussion, previously), the water quality parameters in the Delta are in a constant state of flux. Placed upon this dynamic are the demands of Delta water users, who each have unique source water quality needs – which at times contradict one another. For instance, urban exporters want to minimize salinity, organic carbon, and nutrients, throughout the year, to minimize the associated treatment challenges and to optimize blending with water sources other than the Delta. In-Delta and export agriculture also want to minimize salinity, but often rely solely on the Delta as its source, eliminating opportunities to use other sources to help manage quality dynamics. Finally, in-Delta fish and wildlife are sensitive to location and timing of salinity concentrations, water temperatures, and toxics, including metals and pesticides.

The variability in Delta water quality is driven by a number of factors, including numerous inputs to the Delta system such as the Sacramento and San Joaquin Rivers and their tributaries. These rivers and streams have varying water quality depending upon reservoir operations, upstream diversion patterns, and the timing and quantity of storm runoff from urban and rural areas.[15] On top of the upstream inputs are the water quality impacts of the tidal influences, which significantly alter the salinity of the Delta ecosystem. Affects of regional climate change on the tidal cycle, though not yet well understood or predicted, will likely only serve to further complicate current efforts to manage Delta water quality for the existing Delta water users.

At present, Delta Water Quality is primarily governed by the 1995 Water Quality Control Plan. The State Water Resources Control Board issued Decision 1641 (D-1641) in March of 2000 to implement the Plan. Though no new decision has been issued, the SWRCB updated the Plan in December of 2006 (see the *Delta Water Management Governance Structure* context memo for further information). Upstream water quality objectives have been addressed in other basin plans, which can have a direct benefit to Delta water quality objectives.

The following brief discussions elaborate on the water quality parameters of interest to urban, agricultural, and environmental Delta water beneficiaries.

Urban Water Quality: Urban purveyors receiving Delta water are concerned about salinity. Salinity is a broad water quality category that includes constituents in water that when treated result in byproducts that are probable carcinogens. Also, salts contribute to taste and odor problems and impact residential and industrial operations by corroding appliances and machinery. Salinity in the Delta is typically assessed by considering bromide and chloride concentrations. Bromide and chloride concentrations are important because they contribute to formation of trihalomethanes (THM) and

[15] Predicted continuations in temperature and runoff trends resulting from regional climate changes will also greatly influence these factors.

bromate. Bromate and THMs are suspected human carcinogens. Bromide concentrations in the Delta are impacted by both seawater intrusion and runoff from San Joaquin Valley agricultural lands to the San Joaquin River (that are attempting to manage bromide imported with Delta water supplies). Water returns to the Delta via the San Joaquin River with higher bromide concentrations relative to other freshwater inflow to the Delta. From a drinking water perspective, the primary concern with organic carbon compounds in source water is the potential formation of THMs. Nutrients such as nitrogen and phosphorus are naturally present in the Delta and are critical for maintaining plant life in the Delta. Nitrogen and phosphorus, however, can reduce dissolved oxygen which can increase organic carbon and algae toxins and cause taste and odor problems and filtration issues. Finally, pathogens represent a potential health risk and urban purveyors are seeking opportunities to minimize pathogen concentrations in source water.

Urban water purveyors seek source water quality protection as a component of a comprehensive water quality management program. Urban purveyors receiving source waters from Central Valley watersheds and the Delta have actively sought opportunities to minimize runoff of water containing constituents that directly impact treatment or result in the development of disinfection byproducts after treatment. Source water protection programs have varied from incentive-based efforts to regulatory efforts such as the Central Valley Drinking Water Policy. An additional challenge faced by SWP purveyors or other diverse purveyor associations is the variation in willingness to expend funds beyond that required to treat water to meet regulatory standards. In some instances this variation is highlighted as an environmental justice issue.

Agricultural Water Quality: Agricultural water users have specific water quality issues associated with Delta supplies that vary by location. In-Delta agricultural water users, particularly those in the Central and South Delta are heavily influenced by the water quality impacts associated with CVP and SWP export operations, and San Joaquin River runoff. Numerous regulatory efforts have been initiated to try to limit the impact of highly saline water from the San Joaquin River that is drawn through the South Delta when the project pumps are exporting water at a sufficient rate.

San Joaquin Valley agricultural interests are impacted by salinity as well, in large part because the CVP operations export water that has high volumes of bromide attributable to seawater intrusion mixing with fresh water inflows. This problem is exacerbated on the Westside of the San Joaquin Valley where perched groundwater conditions require the continual drainage of salty water from the rootzone. San Joaquin Valley agricultural interests as well as the CVP have invested extensively in underground drainage systems to try to limit salinity concentrations in the soil that have resulted from export water deliveries.

Ecosystem Water Quality: The Delta estuary is heavily influenced by the location and timing of salinity concentrations in the water and water temperature, as well as a myriad of other factors including metals, pesticides, exotic species and human actions. Salinity concentrations throughout the Delta are directly impacted by the natural balance between runoff and seawater intrusion and the controlled efforts to move water across the Delta for export. To the extent runoff patterns are altered, either naturally or by reservoir operations, there is an impact on Delta water quality and thus on the associated habitats and species. Scientific investigations are diligently working to better understand the correlations between Delta water quality and ecosystem health. For instance, several efforts to understand the decline in pelagic organisms have been underway the past few years, but have yet to identify any one obvious causal relationship. Thus, efforts to protect species and habitats primarily rely upon regulatory mechanisms (see the *Delta Water Management Governance Structure* context memo for additional information on regulatory mechanisms in the Delta.)

What is known is that salinity has an impact on (1) the food sources that various aquatic species rely upon, and (2) the biological systems of the species themselves. Both impact the spatial distribution of the species throughout the Delta and may limit the historic opportunities that species once had to move throughout the ecosystem more extensively to take advantage of additional food sources and minimize predation.

Future Impacts on these Systems: Given the direct relationship between runoff and Delta salinity concentrations, it may be important to consider the potential impacts of climate change on Delta water quality. Experts in the field, including information published by DWR, indicate that spring and summer runoff may be on a declining trend due to reduced snowpack. Such a reduction in natural runoff may necessitate alteration in upstream water management of the reservoirs to maintain desired water quality in the Delta. Downstream of reservoirs, the potential for increase runoff may be accompanied by increased introduction of nutrients and increased cold/warm water stratification, which can impact algal blooms and deplete oxygen in water.

Section 3. History, Institutions, Policies, and Economics of Water Supply and Water Quality

Annually diverting nearly 8 million acre-feet of water from the Delta entails a multitude of management and operational decisions made by an array of individuals as well as federal and State institutions. As described in the *Delta Water Management Governance Structure* context memo, these decisions are made within a tangled, often controversial setting of laws, regulations, and agreements.

SWP and CVP Operations. Primary State and federal institutions involved in making operations and management decisions for Delta water supplies include the Department of Water Resources' State Water Project Analysis Office (SWPAO) and the U.S. Bureau of Reclamation's Central Valley Operations Office (CVO). SWPAO administers policies and procedures to ensure that the State Water Project delivers water to the millions of Californians depending on it for at least a portion of their water needs. CVO manages the CVP facilities to serve CVP contractors at farms, homes, and industry in California's Central Valley as well as the major urban centers in the San Francisco Bay Area; it is also the primary source of water for much of California's wetlands.

Table 1 provides a quick overview of the laws, directives, and orders affecting CVP and SWP operations. The information in the table was obtained from Reclamation's June 2004 CVP-OCAP document and augmented with additional input from Iteration 1 reviewers. A few of the key agreements used to manage water exports from the Delta are discussed below, including the Coordinated Operating Agreement (COA) and the Environmental Water Account (EWA).

<u>Coordinated Operating Agreement</u>. Dating back to 1960, the Coordinated Operating Agreement (COA) was a settlement between Reclamation and the State regarding protests to the SWP water rights applications. Since the CVP and SWP both use the Sacramento River and the Delta as a conveyance facility, the COA ensures that each project obtains its share of water and performs its commitment to protect beneficial uses in the Delta. Specifically, the CVP and SWP coordinate their reservoir releases and Delta exports to ensure each receives a benefit from the shared supply and each has a shared responsibility for meeting water quality standards in the Delta.

<u>Environmental Water Account.</u> The Environmental Water Account (EWA) consists of two primary elements: (1) implementing fish actions that protect species of concern in the Delta; and (2) acquiring and managing assets to compensate for the supply effects of those actions. Actions that protect fish species include pumping reductions at the SWP and CVP export facilities. Project pumping varies by season and hydrologic year and can affect fish at times when fish are near the pumps or moving through the Delta. This was made readily evident during the recent shut-down of the SWP export facilities in early June 2007 to protect the Delta Smelt. Reducing pumping can reduce water supply reliability for the SWP and CVP service areas, causing conflicts between fishery and water supply interests. A key feature of the EWA is use of water assets to replace supplies that are lost during pump reductions. The EWA assets can also provide other benefits such as augmenting instream flows and Delta outflows.

The EWA was initially identified as a 4-year cooperative effort intended to operate from 2001 through 2004 but was extended through 2007 by agreement among the EWA agencies. Efforts to further extend the EWA through 2010 are currently underway. It is uncertain, however, whether the EWA will exist after 2010.

Table 1 – Laws, Directives, and Orders Affecting CVP and SWP Operations

(Table entries are excerpts from Table 1-1 of the June 2004 CVP-OCAP available at: http://www.usbr.gov/mp/cvo/ocapBA.html)

Coordinated Operating Agreement	1986	Agreement between the State and feds to determine the respective water supplies of the CVP and SWP while allowing for a negotiated sharing of Delta excess outflows and the satisfaction of in-basin obligations between the projects
SWRCB Orders 90-5, 91-1	1990 1991	Modified Reclamation water rights to incorporate temperature control objectives in the Upper Sacramento River
NMFS BO for Winter-run Chinook Salmon	1992 1993 1995	Established operation to protect winter-run and provided for "incidental taking"
CVPIA	1992	Mandated changes to the CVP particularly for the protection, restoration and enhancement of fish and wildlife
FWS BO for Delta Smelt and Sacramento Splittail	1993 1994 1995	Established operational criteria to protect Delta Smelt
Bay-Delta Plan Accord and SWRCB Order WR 95-06	1994 1995	Agreement and associated SWRCB order to provide for the operations of the CVP and SWP to protect Bay-Delta water quality. Also provided for development of a new Bay-Delta operating agreement (being pursued through CALFED)
Monterey Agreement	1995	Agreement between DWR and SWP contractors to manage contractor operations
SWRCB Revised Water Right Decision 1641	2000	Revised order to provide for operations of the CVP and SWP to protect Delta water quality
CALFED ROD	2000	Presented a long-term plan and strategy designed to fix the Bay-Delta
CVPIA ROD	2001	Implemented provisions of CVPIA including allocating 800,000 acre-feet of CVP yield for environmental purposes
NMFS BO for Spring-run Chinook Salmon and Steelhead	2001 2002 2004	Established criteria for operations to protect spring-run Chinook salmon and steelhead
SWRCB Order 2006-0006	2006	Draft Cease and Desist Order against DWR and Reclamation

SWP 4-Pumps Agreement.[16] This 1986 agreement between DWR and the Department of Fish and Game provides for offsetting adverse fishery impacts caused by the diversion of water at the SWP export facilities. Direct losses of Chinook salmon, steelhead, and striped bass are offset or mitigated through the funding and implementation of fish mitigation projects. DWR and DFG work closely with the Fish Advisory Committee to implement the agreement and projects funded under the

[16] This information was obtained from the following web site: www.des.water.ca.gov/mitigation_restoration_branch/fourpumps/

agreement. The Fish Advisory Committee is made up of representatives of the State Water Contractors, sport and commercial fishing groups, and environmental groups.

South Delta Improvements Program. Since 1990, DWR has installed temporary barriers in the south delta between April and November to minimize the migration of salmon into the south Delta via Old River and to control water levels and maintain water quality in the south Delta for agricultural diversions. The need for these barriers was driven in large part by the export pumping in the south Delta, which has impacted flow conditions, often to the detriment of the environment and in-Delta agricultural water users. Currently, pumping capacity at Banks Pumping Plant is 6,680cfs. This capacity presents operational constraints when the demand for water by SWP and CVP contractors south of the delta is greater than the amount of water that can safely be pumped from the Delta.

The South Delta Improvements Program (SDIP) purpose is to: (1) reduce migration of Chinook salmon into the south Delta through Old River, (2) maintain adequate water levels and water quality for agricultural diversions in the south Delta, and (3) increase pumping capacity to serve SWP and CVP contractors south of the Delta. DWR and USBR are evaluating SDIP in two stages – Stage 1 (physical/structural component) and Stage 2 (operational component). Stage 1 includes analysis and issuance of a decision concerning the nature of permanent operable gates in the south delta, channel dredging, and extending agricultural diversions to deeper water. Stage 2 will entail issuance of a decision on the proposed operational component, including expanding permitted pumping capacity at Banks Pumping Plant to 8,500 cfs. In December 2006, SDIP issued a draft EIR/EIS for Stage 1 actions and efforts are currently underway to implement the improvements, though recent delays anticipate the physical improvements will not be implemented until 2011.[17] Stage 2 is on hold.

Flooding and Droughts – the Impact of Hydrologic Variability on Delta Water Management. Hydrologic variability – resulting in high-water events or water supply shortages – add to the complexity of managing water supplies in the Delta. Predictions of future climate change may only increase this variability. In short, water operations can be affected in the following manner:

- Flooding. With the exception of events that cause areas normally kept dry to become inundated with water, high flows from heavy runoff generally do not have a significant affect on Delta water operations. Such events provide opportunities to "flush" salts out of the Delta and to make water available for export with minimal impact to ecosystem. High runoff events, however, create difficult

[17] DWR is anticipating the obtaining necessary permits and biological opinions will be delayed, thus delaying project implementation from previous estimates of 2008.

situations for reservoir operators tasked with managing the balance of flood safety and water storage at reservoirs upstream of the Delta. When high flows or other events cause a breach in the system of levees protecting fertile Delta lands (i.e. a flood), Delta water operations can suddenly be severely impacted. As evident with the flooding of Jones Tract in the midst of summer 2004, both in-Delta and export water diversions were temporarily curtailed as salt water flowed back into the Delta. Many experts have stated that the Delta is at significant risk for additional levee failures, resulting in potentially lengthy delays in exporting water for CVP and SWP contractors. Furthermore, concepts have been proposed to permanently flood select Delta islands to improve the Delta ecosystem. The impact of permanent flooding to export water operations and overall Delta hydrodynamics is a key concern raised by SWP and CVP contractors in opposition to these proposals.

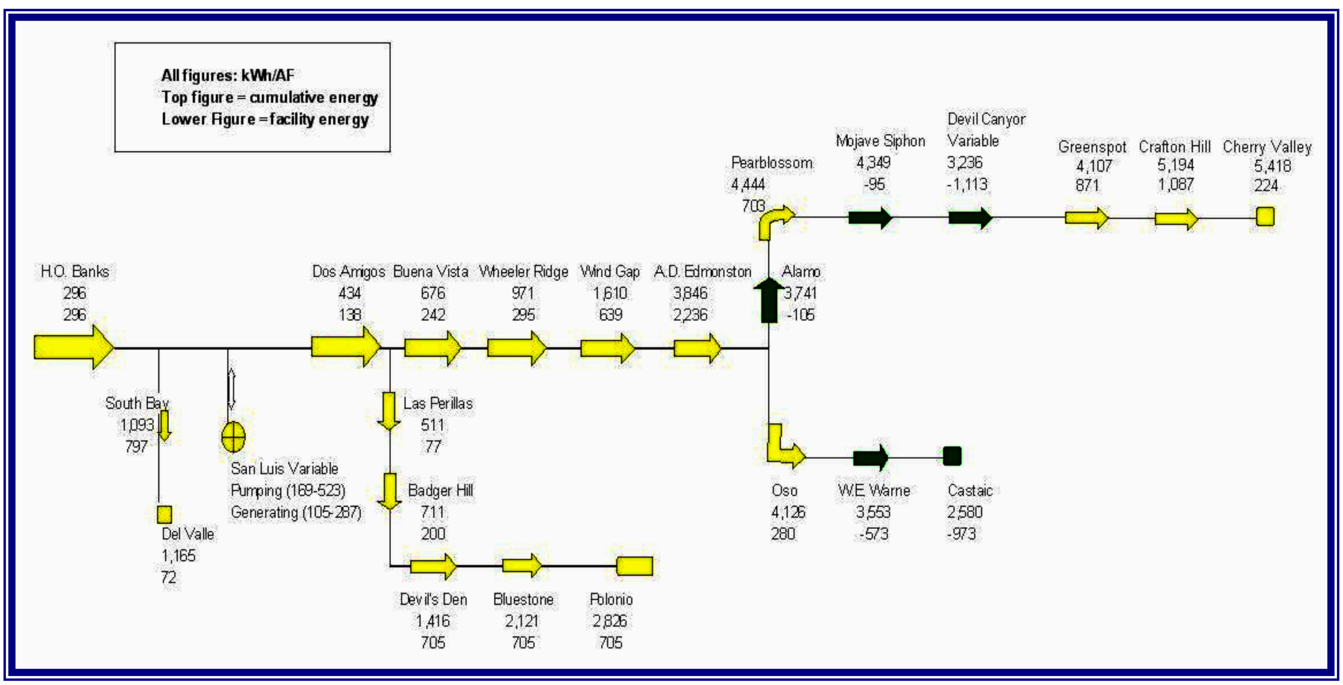
- Droughts. During drought conditions, especially when water supplies in upstream reservoirs are depleted, the need to control in-Delta water quality and protect Delta fish and wildlife (per agreements and statues) often takes priority over and raises additional conflicts with export pumping. SWRCB's D-1641 illustrates this conflict with the inclusion of an import/export ratio intended to protect fish in the Delta from the effects of the export pumps relative to the amount of water coming into the Delta. In summer months, this ratio can require two units of water to flow out Carquinez Straits for every one unit exported from the CVP/SWP facilities. The unpredictability of drought conditions is also apparent in the methods used by CVP and SWP operators when proposing initial contract allocations for any given water year. Allocations are based on probability curves and other scientific tools, all designed to maximize the probability that any allocation made early in January and February will be met, even if expected precipitation is not realized. For agricultural producers, this early allocation greatly influences cropping decisions for the coming year. If allocations are overly conservative for a particular year (e.g. a wet March/April occur after an initial low allocation), farmers are generally unable to make adjustments to take additional allocations.

Economics of Pumping Water. In addition to the complex array of laws, directives and orders, and hydrologic variability, operations of the CVP and SWP need to incorporate the economics of pumping water. Pumping millions of acre-feet annually results in a large demand for energy, especially for water that is pumped over the Tehachapis to serve SWP contractors in Southern California. The cost of pumping is passed on to the water purveyors, who in turn pass the cost on to consumers in their water bills. As energy prices vary, attempting to maintain consistent, or at least predictable, energy costs becomes more daunting. As an illustration of the impact water pumping can have, consider this excerpt from the California Energy Commission[18]:

> The State and federal projects require substantial pumping to transport water from the Sacramento Valley to the Central Valley, the San Francisco Bay Area, and Southern California. The lift of SWP water to the top of the Tehachapis for delivery to Southern California is the largest of these pumping efforts and requires over 2,200 kWh per acre-foot of water pumped. Reservoirs also generate electrical energy, and water projects are most often net producers of electrical energy. The net energy demands of surface water suppliers vary from project to project. For the SWP, energy demand also varies from customer to customer. For example, SWP water delivered to Bakersfield in the Kern County Agency requires a net energy input of 366 kWh/acre-foot; for water delivered to Los Angeles (at Castaic Lake Reservoir), a net of 1,666 kWh/acre-foot; and for water delivered to the San Bernardino Valley Municipal Water District, a net of 3,824 kWh/acre-foot.

Figure 5, prepared by Dr. Robert Wilkinson, graphically depicts the energy requirements to move a unit of water through the SWP facilities.[19]

Figure 5 – Energy requirements to move water in the SWP

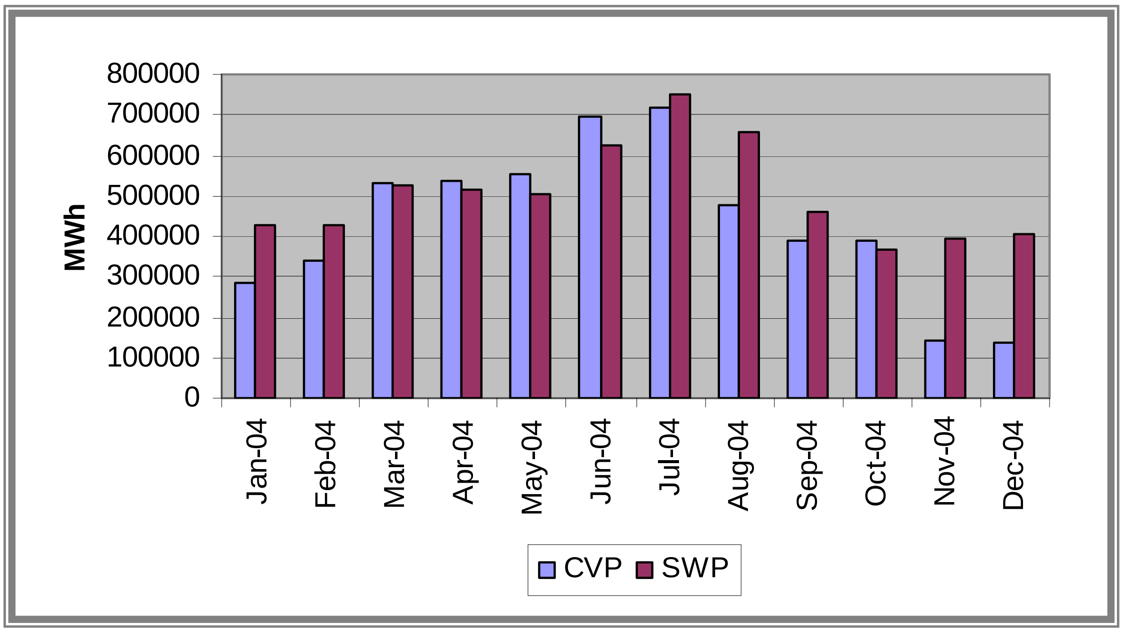


[18] Excerpt was taken from the following web site: http://energy.ca.gov/pier/iaw/industry/water.html, last updated in August of 2004.
[19] Dr. Robert Wilkinson is Director of the Water Policy Program at the Bren School of Environmental Science and Management at the University of California, Santa Barbara.

As also noted in the CEC's excerpt and in Figure 5, the SWP and CVP projects generate significant energy resources, much of which is used to meet the energy demands of the projects. Figure 6 provides a representation of hydropower production in 2006 generated by the CVP and SWP.

Figure 6 – CVP and SWP Power Generation for 2004

(Derived from (1) CVP data for 2004 for Shasta, Keswick, Trinity, JF Carr, Spring Creek, Folsom, Nimbus, New Melones, Stampede, O'Neill, and San Luis, and (2) SWP data for 2004 for Hyatt-Thermalito, Gianelli, Alamo, Mojave Siphon, Devil Canyon, Reid Gardner Unit 4, and Warne)



Electrical generation is produced as a direct result of releases of water through power facilities at CVP and SWP storage reservoirs. The ability to generate power however is complicated by demands placed on these same reservoirs to release cold water under certain conditions to facilitate fishery survival, as well as the need to meet downstream flow requirements and flood control releases that may not be optimally timed with power production. With the potential for more varied storage conditions under projected climatic changes, the opportunity, and overall production of hydropower will be further complicated. A discussion of beneficial or adverse impacts to power production associated with climate change is not included in this memo.

Section 4. References

To be developed

Attachment A – SWP Water Users and Maximum Table A Amounts

(obtained from Appendix C of the 2005 SWP Delivery Reliability Report – April 2006)

Table C-1 Maximum Annual SWP Table A Amounts

SWP Contractors	Maximum Table A	SWP Contractors	Maximum Table A
Delivered from the Delta		**Southern California**	
North Bay		Antelope Valley-East Kern WA	141,400
Napa County FC&WCD	29,025	Castaic Lake WA	95,200
Solano County WA	47,756	Coachella Valley WD	121,100
Subtotal	**76,781**	Crestline-Lake Arrowhead WA	5,800
		Desert WA	50,000
South Bay		Littlerock Creek ID	2,300
Alameda County FC&WCD, Zone 7	80,619	Mojave WA	75,800
Alameda County WD	42,000	Metropolitan WDSC	1,911,500
Santa Clara Valley WD	100,000	Palmdale WD	21,300
Subtotal	**222,619**	San Bernardino Valley MWD	102,600
		San Gabriel Valley MWD	28,800
San Joaquin Valley		San Gorgonio Pass WA	17,300
Oak Flat WD	5,700	Ventura County FCD	20,000
County of Kings	9,305	**Subtotal**	**2,593,100**
Dudley Ridge WD	57,343		
Empire West Side ID	3,000	**Delta Subtotal**	**4,132,986**
Kern County WA	998,730		
Tulare Lake Basin WSD	95,922	**Feather River**	
Subtotal	**1,170,000**	County of Butte	27,500
		Plumas County FC&WCD	2,700
Central Coastal		City of Yuba City	9,600
San Luis Obispo County FC&WCD	25,000	**Subtotal**	**39,800**
Santa Barbara County FC&WCD	45,486		
Subtotal	**70,486**	**Grand Total**	**4,172,786**

1 **Attachment B – Modeled CVP South-of-Delta Delivery Assumptions**

CVP South-of-the-Delta as used for CACMP Future No Action Assumptions					
CVP CONTRACTOR	**CVP Water Service Contracts (TAF/yr)**		**Settlement / Exchange Contractor (TAF/yr)**	**Water Rights / Non-CVP (TAF/yr)**	**Level 2 Refuges (TAF/yr)**
	AG	**M&I**			
Byron-Bethany ID	20.6				
		20.0			
Banta Carbona ID	20.0				
Del Puerto WD	12.1				
Davis WD	5.4				
Foothill WD	10.8				
Hospital WD	34.1				
Kern Canon WD	7.7				
Mustang WD	14.7				
Orestimba WD	15.9				
Quinto WD	8.6				
Romero WD	5.2				
Salado WD	9.1				
Sunflower WD	16.6				
West Stanislaus WD	50.0				
Patterson WD	16.5			6.0	
Westlands WD #1 (Centinella WD)	2.5				
Panoche WD	6.6				
San Luis WD	65.0				
Broadview WD	27.0				
Laguna WD	0.8				
Eagle Field WD	4.6				
Mercy Springs WD	2.8				
Westlands WD #2	4.2				
Oro Loma WD	4.6				
Westlands WD #1 (Widren WD)	3.0				
Central California ID			140.0		
Grasslands via CCID					78.0
Los Banos WMA					8.3
Kesterson NWR					10.4
Freitas - SJBAP					5.5
Salt Slough - SJBAP					6.9
China Island - SJBAP					7.2
Volta WMA					13.0
Grassland via Volta Wasteway					22.1
Westlands WD (incl. Barcellos)	50.0				
Fresno Slough WD	4.0			0.9	
James ID	35.3			9.7	
Coelho Family Trust	2.1			1.3	

CVP South-of-the-Delta as used for CACMP Future No Action Assumptions (cont.)					
CVP CONTRACTOR	**CVP Water Service Contracts (TAF/yr)**		**Settlement / Exchange Contractor (TAF/yr)**	**Water Rights / Non-CVP (TAF/yr)**	**Level 2 Refuges (TAF/yr)**
	AG	**M&I**			
Tranquillity ID	13.8			20.2	
Tranquillity PUD	0.1			0.1	
Reclamation District 1606	0.2			0.3	
Exchange Contractors					
Central California ID			392.4		
Columbia Canal Co.			59.0		
Firebaugh Canal Co.			85.0		
San Luis Canal Co.			163.6		
M.L. Dudley Company				2.3	
Grasslands WD					29.9
Los Banos WMA					9.2
San Luis NWR					19.8
Mendota WMA					27.6
West Bear Creek NWR					7.5
East Bear Creek NWR					0.0
San Benito County WD (Ag)	35.6				
Santa Clara Valley WD (Ag)	33.1				
Pajaro Valley WD	6.3				
San Benito County WD (M&I)		8.3			
Santa Clara Valley WD (M&I)		119.4			
San Luis WD	60.1				
CA, State Parks and Rec	2.3				
Affonso/Los Banos Gravel Co.	0.3				
Panoche WD	87.4				
Pacheco WD	10.1				
Westlands WD: CA Joint Reach 4	219.0				
Westlands WD: CA Joint Reach 5	570.0				
Westlands WD: CA Joint Reach 6	219.0				
Westlands WD: CA Joint Reach 7	142.0				
Avenal, City of		3.5		3.5	
Coalinga, City of		10.0			
Huron, City of		3.0			
Cross Valley Canal - CVP					
Fresno, County of	3.0				
Hills Valley ID-Amendatory	3.3				
Kern-Tulare WD	40.0				
Lower Tule River ID	31.1				
Pixley ID	31.1				
Rag Gulch WD	13.3				
Tri-Valley WD	1.1				
Tulare, County of	5.3				
Kern NWR					10.4
Pixley NWR					0.0
Total CVP South-of-Delta	1987.1	164.2	840.0	44.3	255.8
				Total	3291.4