Major Delta Management Issues and Concerns

Agricultural Land Use and Levee Issues

- The Sacramento-San Joaquin Delta is one of the agricultural treasures in California. The soils are rich in alluvial mud as well as the peat soils from wetland vegetation (i.e., tules) that once grew in the Delta marshlands. As reclamation by farmers and farming corporations built levees along the channels and drained and plowed the marshland, a wide variety of crops, some unique to the Delta soils (i.e., asparagus) produced bountiful harvests.

- The peat soils have oxidized as a result of agricultural tilling and drying cycles (as well as peat fires), so that several of the Delta lowland islands are now about 15 feet below sea level. Levee maintenance and reinforcement is a continuous job accomplished by a combination of local reclamation districts and state and federal agencies.

- During periods of river flooding, as well as from unknown causes in the summer, many of the Delta levees have failed and the Delta islands have been inundated. The levee repairs and drainage of the islands is expensive, and the lost crops, agricultural equipment and facilities add to the expenses of levee failures. There are also roads, railroads, and pipelines that should be protected from flood damage.

Water Supply and Water Quality Issues

- The southwest Delta is the location of the CVP and SWP export pumping plants which supply about 6 million acre feet (maf) per year for San Joaquin and Tulare Basin irrigation water, as well as south Bay, central coast and southern California drinking water supplies.

- The Sacramento River is the major source of fresh water, and must flow about 35 miles from Walnut Grove, where the water is diverted into the Delta Cross Channel or Georgiana Slough, through several Delta channels to Old and Middle River and Victoria Canal and West Canal to the SWP and CVP export pumps.

- The San Joaquin River supplies about 10% of the fresh water inflow but also contains the major source of agricultural drainage salts and other agricultural chemicals entering the Delta. Almost all of the SJR inflow is diverted towards the CVP and SWP export pumps, and rarely does any SJR flow enter the estuary.

- The total organic carbon (TOC) concentration of the SJR is higher than the Sacramento River, so the export of most of the SJR water degrades the drinking water supply. Agricultural drainage from the Delta islands and tracts discharge agricultural drainage salts and high TOC concentrations to the Delta channels.

- During periods of low Delta outflow, saltwater intrusion (tidal mixing) from Suisun Bay enters the Delta and is transported from the vicinity of Franks Tract towards the CCWD intakes and the SWP and CVP pumping plants. Agricultural water supply in the western Delta must also be protected from seawater intrusion during the irrigation season.

Tidal Estuary Ecology Issues

- Tidal stage variation is about 3 feet (twice each day) throughout most of the Delta channels. The full tidal range from MLLW to MHHW is about 6 feet. Tidal flows are generally much larger than net flows within the Delta.

- Migrating fish enter the Delta from the Sacramento, Mokelumne, Cosumnes and San Joaquin Rivers (and Yolo Bypass during high flows). These fish must swim through many miles of Delta channels to reach the salinity gradient of the estuary in Suisun Bay. Some migrating fish may rear in the Delta channels.

- Survival of chinook smolts in the central Delta is only about 50% of the survival of fish remaining in the Sacramento River, based on CWT recoveries at Chipps Island trawl and from ocean catch.

- The San Joaquin River fish (i.e., chinook and splittail in wet years) are most vulnerable to entrainment at the CVP and SWP pumping plants. The fish salvage facilities are designed to separate many of these fish from the water before it enters the CVP or SWP pumping plants.

- The Delta aquatic habitat can be classified as intertidal, littoral (shallow nearshore), benthic, and pelagic (open water). Monitoring for pelagic fish has indicated recent low numbers for some species (striped bass and delta smelt) but other species remain in high abundance. New species of fish and invertebrates (i.e., clams, mitten crabs, jellyfish) may increase the competition for limited food, and may exert a predation pressure or other ecological stressor on native or previous residents.

- However, our understanding of the important habitat features which may increase the habitat value or use by a specific life-stage of a particular species is very limited. Many levees are rip-raped without vegetation, while other levees are vegetated with adjoining berms and shallow shelves, which support tule and other tidal vegetation. How these different levees are used by fish species is largely unknown.

- Because the Delta levees and channels have not been substantially modified for more than 50 years, and because we have generally managed salinity fluctuations for agricultural water supply through out the past 50 years, our historical fish abundance data has all been acquired during this single management period. CVP and SWP exports have increased during this 50-year sequence, but the exports have been at present levels of 5-6 maf/year for about the last 25 years.

- Because all of our habitat observations and fish abundance data have been collected during this relatively stable period of Delta management, they cannot be directly used with any confidence to identify likely changes in aquatic habitat or fish abundance patterns which may result from future changes in the managed Delta salinity fluctuations or other habitat characteristics.

- Adaptive management principles are difficult to apply to Delta management because so many small yet potentially important habitat features are constantly changing. Our inflow management, export curtailments, and outflow management actions appear substantial, but these managed actions may be overruled by natural fluctuations in ocean conditions, hydrologic patterns, or ecological processes which change dramatically without known causes.

- Good luck doing anything to improve the Delta agriculture, Delta water supply and water quality, or the ecological resources that support the fish and wildlife living within or migrating through the Delta.

Delta Corridors Components and Potential Benefits

1) Conveyance of the entire San Joaquin River flow with the associated salt loading to the estuary without mixing into the CVP and SWP exports will reduce the salinity of the CVP and SWP exports.

- The SJR average annual salt load (1985-2005) at Vernalis is about 965,000 tons/year [See Table 1]. This salt load is equivalent to about one 100-ton boxcar each hour of every day (i.e., 8,760 hours per year). The average EC of the SJR is about 444 uS/cm, compared with the average EC for the Sacramento River of less than 200 uS/cm. About half of this SJR salt load can be considered "excess" compared to an equivalent amount of water with Sacramento River salinity.

Table 1. Annual Salt Load of San Joaquin River at Vernalis calculated from daily flow and EC values.

Calendar Year	Average Flow (cfs)	Average EC (uS/cm)	Annual Salt Load (tons)
1984			
1985	1,792	439	925,000
1986	5,503	292	1,320,000
1987	1,446	536	926,000
1988	1,141	612	837,000
1989	1,084	585	756,000
1990	846	586	608,000
1991	641	584	442,000
1992	701	576	479,000
1993	1,930	478	1,028,000
1994	1,070	552	699,000
1995	6,691	276	1,543,000
1996	4,381	327	1,231,000
1997	6,163	362	1,386,000
1998	8,963	193	1,685,000
1999	3,134	345	1,023,000
2000	2,915	355	975,000
2001	1,653	463	880,000
2002	1,335	478	741,000
2003	1,392	491	811,000
2004	1,350	478	749,000
2005	4,036	322	1,228,000
Average	2,770	444	965,333

Assumes EC/TDS ratio of 1.54

- The majority of the SJR flow and salt is currently exported at the CVP and SWP pumps. SJR flow only escapes to the estuary when the SJR flow is greater than the combined CVP and SWP exports. Some SJR water may escape during the VAMP period of reduced exports.

- About half of the SJR flow is diverted into Old River and flows directly to the CVP Tracy pumps. The remainder of the SJR water is mixed with Sacramento River water flowing upstream in Middle River and Old River from Franks Tract towards the pumps. The portion of the SJR flow that passes the head of Old River is distributed evenly into the remainder of the SWP and CVP exports.

- The separation of the SJR from the exports will therefore reduce the salinity of the CVP most directly. The overall reduction in the CVP and SWP salt load is expected to be about 25% [from about 2 million tons to 1.5 million tons]

- Because the DMC water deliveries would have a lower salinity, the SJR salt load that originates from agricultural drainage from the DMC deliveries may eventually be reduced accordingly. A new equilibrium salinity regime will be established along the SJR that is expected to be about 20% less than the current salinity regime. The new long-term salt load at Vernalis is expected to be about 750,000 tons per year, with an average EC of 350 uS/cm (current average 450 uS/cm).

- There may be some increased environmental toxicity impacts from discharging the current SJR loads of pesticides and other agricultural chemicals and drainage minerals (i.e., selenium) to the estuary. These chemicals have largely been recycled to the DMC irrigation areas, but will now enter the estuary and may harm aquatic organisms during periods of high concentrations. Ongoing efforts by the Water Boards and other agencies to control agricultural residuals should be strengthened to allow the SJR to be safely returned to the estuary to increase aquatic productivity and diversity without toxicity impacts.

2) The water quality of the CVP and SWP exports that supply many urban areas with drinking water will be improved (i.e., lower concentrations) by not incorporating the SJR salts and drainage chemicals.

- The salinity (EC) of the Sacramento River is substantially less than the San Joaquin River, and the chloride/EC and bromide/EC ratios for the Sacramento River are just one third of the chloride/EC and bromide/EC ratios for San Joaquin River. For example the chloride/EC ratio is about 0.15 for the San Joaquin River, but the chloride/EC ratio is just 0.05 for the Sacramento River. Therefore, the water quality improvements for chloride and bromide may be greater than the salinity (EC) reduction alone.

- The total organic carbon (TOC) concentrations for the SJR are generally higher than the Sacramento River TOC concentrations. Treated drinking water obtained from CVP and SWP exports would likely have lower concentrations of THMs, bromate, and other potentially harmful disinfection byproducts.

- The SJR concentrations of pesticides and other agricultural chemicals are higher than for the Sacramento River. These chemicals are currently diluted to relatively low concentrations in the mixture of Sacramento River and SJR water at the CVP and SWP exports. Nevertheless, the concentrations of these pesticides and other potentially harmful agricultural chemicals will be further reduced in the CVP and SWP exports if the SJR water flows to the estuary.

- The CCWD intakes at Rock Slough (Contra Costa Canal) and on Old River (Los Vaqueros) would be relocated to the Middle River water supply corridor. This will provide the same drinking water improvements for CCWD as will be achieved for the CVP and SWP exports. By relocating these intakes away from the Old River-SJR-estuary corridor, CCWD will be participating in the restoration of the San Joaquin River corridor to an estuarine habitat without entrainment risk for SJR fish.

3) All of these treated wastewater discharges along the SJR and in the southern Delta [Turlock, Modesto, Manteca, Stockton Regional, City of Tracy, Mountain House, and Discovery Bay] would be incorporated in the SJR flow to the estuary and would no longer be exported in the CVP and SWP water supply.

- The SJR flow upstream of Turner Cut will be reversed with a low-head pump near the head of Old River. The DWSC and downtown Stockton channel will be supplied with Sacramento River water. Tidal flows will continue to provide flushing of the tidal sloughs (i.e., Calaveras River, Fourteen Mile) as well as the downtown channel An upstream flow of 250 cfs will dilute the Stockton Regional treated wastewater discharge (i.e., 50 cfs) and transport the effluent upstream to the head of Old River.

- The two SDIP tidal gates planned for Middle River at Victoria Canal and Old River at the DMC will be operated as planned to tidally pump about 75-100 cfs upstream in both of these river sections. This will provide agricultural diverters along these river sections (SJR upstream of Turner, Old River upstream of the DMC, and Middle River upstream of Victoria Canal) with very low salinity water (200 uS/cm) from the Sacramento River. The Old River gate will transport Mountain House effluent upstream into the SJR flow corridor.

- The salinity of the SJR as it flows along its new route from the head of Old River to Grant Line Canal will always have a lower salinity than at Vernalis. The pumped flow of 250 cfs from the Stockton DWSC will always reduce salinity (because the Sacramento water supply EC is about 200 uS/cm). The upstream flow from the tidal gates in Old River at DMC and in Middle River will provide an additional 200 cfs of low salinity water. For example, if the Vernalis EC were 1,000 uS/cm with a flow of 1,000 cfs, these dilution flows would increase the SJR flow to about 1,450 cfs and reduce the SJR EC to about 750 uS/cm. During the irrigation season, if the Vernalis EC were 700 uS/cm with a flow of 1,500 cfs, the same dilution flows of 450 cfs would increase the SJR flow in Grant Line Canal to 1,950 cfs with an EC of 585 uS/cm.

- The dilution flows from the Sacramento River will provide additional dilution of the wastewater discharges to the SJR. Because the total discharge of all these treated wastewater discharges is less than 100 cfs, the effective dilution of the wastewater will always be at least 15:1 (with minimum SJR flow of 1,000 cfs at Vernais). With this minimum dilution, the wastewater effluent concentrations can be considerably higher than the aquatic effects water quality objectives. The wastewater will not be diverted into the drinking water supply, as it now is when it is pumped at the CVP and SWP exports.

4) The export reductions during the VAMP period in April and May will no longer be required to reduce the entrainment of SJR Chinook, because all the SJR Chinook salmon will be transported to the estuary in the new SJR corridor.

- The CVP and SWP exports would continue to be limited by the E/I ratio of 0.35 during April and May, but the additional pumping restrictions during VAMP will not be necessary to protect the SJR Chinook salmon.

- The VAMP reductions of CVP and SWP exports to about 1,500 cfs for the month-long protection period has resulted in CVP B(2) reductions or SWP EWA reductions of between about 200 taf and 300 taf. Much of this water could be pumped for a net water supply yield of perhaps 150 taf to 250 taf per year.

- The possible use of B(2) and EWA reductions in CVP and SPW pumping during the VAMP period for delta smelt protection cannot easily be estimated. The Delta Corridors project may substantially increase the lower SJR flow at Antioch, and thereby reduce the entrainment of fish from this portion of the estuary habitat.

- However, because all the CVP and SWP exports (as well as the 450 cfs of SJR dilution flow) would come from the DCC, Georgiana Slough, eastside rivers or from Threemile Slough, there may be periods of increased reverse flows in the SJR upstream of False River. More evaluation is needed of the effects from potential net flow shifts in the lower SJR estuary habitat (downstream of Mokelumne River) on delta smelt entrainment risk.

- Delta smelt adults may disperse to spawn into the tidal sloughs of the SJR or Middle River channels. These fish, as well as their offspring, would be more vulnerable to entrainment effects because of the stronger net reverse flows in Middle River towards the CVP and SWP export pumps.

- However, the CVP and SWP salvage facilities might be improved to operate more specifically to salvage delta smelt and other vulnerable species because the water hyacinth and other debris loads would be reduced, and the SJR fish would no longer be salvaged. Only fish from the Mokelumne River channels, the SJR upstream of False River, or from Middle River channels would be vulnerable to entrainment.

5) Fish Screens on the Delta Cross Channel and Georgiana Slough will effectively separate these Sacramento River water supply diversions from fish migrating downstream, and prevent these fish from entering the Mokelumne River and central Delta channels where lower survival has been measured.

- The diversion of 20%-40% of the Sacramento River flow to the central Delta by way of the DCC and Georgiana Slough results in a large proportion of juvenile Chinook salmon (and other migratory species) migrating downstream into the central Delta.

- Recent studies of relative fry, yearling, and smolt survival using paired releases of coded-wire-tagged (CWT) fish suggest that fish entering the central Delta have a lower survival rate than those that remain in the Sacramento River. Although the factors contributing to lower survival for fish passing through the Central Delta are not known, SWRCB adopted (1995 WQCP) new operating criteria (e.g., gate closure periods) for the DCC to minimize winter-run Chinook salmon entry into the central Delta.

- The DCC and Georgiana Slough fish screens would each be 2,000 feet long and would be located at the entrances to these channels on the east bank of the Sacramento River, with a channel depth of about 25 feet. The fish screens would extend 1,000 feet upstream and downstream to provide fish protection during both upstream and downstream tidal flows. The fish screens would be similar in design to the screens at GCID, but each screen panel would include a 5-feet high concrete panel at the bottom of the screen panel to prevent bottom migrating fish from encountering the screens. A 10-feet high concrete panel at the top of the screen panel to prevent debris, boats, and surface migrating fish from encountering the screens. The screen panel (i.e., the screen mesh) would be situated in the middle between the concrete panels and would be 15 feet high. The screen area would be 30,000 square feet, and would allow a maximum of 6,000 cfs diversion into DCC or Georgiana Slough with an approach velocity of 0.2 ft/sec (delta smelt criteria).

- Because the Sacramento River at Walnut Grove is tidally influenced, and because of unknown behavioral response of juvenile Chinook salmon to these tidal conditions, the proportion of juvenile Chinook salmon that are entrained by these diversions may be greater than or less than the proportion of flow diverted.

- The proposed fish screens could injure or kill fish migrating past the fish screens. The potential for fish to be injured or killed by the fish screens is governed by the length of the screen, the size of fish screen material, the sweeping velocity (parallel to the screen face), the approach velocity (perpendicular to the screen face), fish behavior and local hydraulics. The surface and bottom panels may reduce the fraction of the migrating fish encountering the screens.

- Appropriate fish passage facilities must be provided for migrating adults that use the DCC and Georgiana Slough as a migration pathway to the Sacramento River system. Potential designs that could reduce the potential for blocked passage include incorporating a fish ladder or fish lock or including screen panels that can be rotated or removed during the adult migration season.

- Although fish emigrating from the Mokelumne River under existing conditions could enter the downstream end of the DCC and Georgiana Slough, most emigrating juveniles and smolts of these species likely disperse or migrate down the North and South Forks of the Mokelumne River in the central Delta to the San Joaquin River.

- Striped bass and other predatory species (e.g., Sacramento pikeminnow) may experience a reduction in the prey base as a result of the reduction in Sacramento River fish diverted to the central Delta. This reduction in the prey base may result in an increase in predation pressure on Mokelumne River emigrants. Predators may move to the Sacramento River and exert a greater predation pressure downstream of the DCC and Georgiana Slough screens.

- Opening the DCC will increase the net flow in the San Joaquin River downstream of Threemile Slough (i.e., Jersey Point) to reduce the movement of water (and fish) from the estuary habitat in the vicinity of the confluence (i.e., Sherman Lake and Big Break).

- The Mokelumne River and Cosumnes River channel could be re-routed to the Sacramento River above Locke through Snodgrass Slough and The Meadows Slough. This would reduce the loss of Mokelumne and Cosumnes juveniles and smolts in the central Delta, and allow the adults to find the rivers more easily. This would also provide a more direct connection with floodplain habitat along the lower Cosumnes River that might be suitable for delta smelt and splittail spawning and rearing..

6) Estuarine habitat would be extended along the lower SJR from Antioch into Franks Tract. This estuarine habitat would be separated from possible entrainment at the CVP and SWP exports.

- The elevated SJR turbidity may provide benefits to this estuarine corridor, by reducing the dominance of the Egaria (waterweed) in Franks Tract. The SJR phytoplankton (algae) may provide a food source for the estuarine and pelagic organisms.

- The separation of the estuarine habitat from the water supply corridor would be maintained with a positive net flow in the SJR upstream of False River. This will prevent any SJR water from being returned to the water supply corridor as it flows from Franks Tract through False River to the lower SJR.

- The combined diversions from the Sacramento River through the DCC, Georgiana Slough, and Threemile Slough must be greater than the combined exports plus the dilution flows provided by the tidal gates on Middle River at Victoria Canal, on Old River at DMC and by the pumping facility on the SJR at the head of Old River.

- An additional tidal gate installed at Threemile Slough would allow this net SJR flow upstream of False River to be increased, by closing the gates during ebb tides when the normal tidal flow moves from the SJR to the Sacramento.

- The Threemile Slough tidal gate could also be used in the fall to increase the salinity in the lower SJR and in Franks Tract, by closing the gate during flood tides when the normal tidal flow moves from the Sacramento River to the SJR.

7) The risk of water supply interruption following a major levee failure from flooding or earthquake damage would be reduced by the separation of the SJR-estuary corridor from the Delta water supply corridor.

- The separation of the SJR-estuary corridor along Old River from the Delta water supply corridor along Middle River will reduce the risk of landward movement of salinity following a major levee breach.

- The 50-mile levee along the west side of Middle River and the south side of the SJR (Bradford Island, Webb Tract, Mandeville Island, Bacon Island, Woodward Island, Victoria Island) should be strengthened and reinforced.

- This 50-mile separation levee is the only section of Delta levees that needs to be immediately repaired following a major levee failure.

- SJR inflows could be easily routed directly to the CVP and SWP pumps following a major levee failure,

- The separation of the water supply corridor will allow more rapid flushing with Sacramento River water or SJR water in the weeks following a major levee failure.

- Levee failures within the estuary corridor or within the water supply corridor can be repaired slowly without water supply consequences.

8) The possible conversion of Webb Tract and Bacon Tract to Delta water storage facilities would become more easily accomplished without water quality concerns.

- Because Webb Tract and Bacon Tract are located along the boundary between the SJR-estuary corridor and the Delta water supply corridor, the Delta storage can be filled from the water supply corridor and discharged into the SJR-estuary corridor. This would allow the higher TOC in the Delta storage water to be released into the estuary to supply required Delta outflow. The exports would be increased during the discharge from the Delta storage without any impacts from higher DOC.

- Delta storage might be used in the fall to increase salinity intrusion desired for habitat variability and increased salinity pulses along the SJR-estuary corridor. The Delta storage could be used to create an intrusion of 225 taf (125 taf from Franks Tract to Webb Tract and 100 taf from Old River to Bacon Island). This would increase the salinity of the lower SJR downstream of Franks Tract without increasing salinity along the Sacramento River. The water would subsequently be released to the estuary to allow winter storage of fresh water for water supply.

- The Delta storage would therefore be used twice each year, once for water supply and once for estuarine salinity management purposes. The habitat effects from this potential salinity management can only be evaluated with a demonstration project (trial and adaptive management).

9) Substantial portions of delta smelt spawning habitat in the lower SJR, Franks Tract, and Old River channels and sloughs would be protected from possible entrainment in CVP and SWP exports.

- Natural transport flows towards the confluence would be established along the SJR-estuary corridor. All juvenile delta smelt spawned in these channels and connecting sloughs should be effectively transported to the confluence and their preferred rearing habitat.

- Delta smelt spawning in the north Delta, or along the SJR upstream of the Mokelumne River, or in the Middle River channels and sloughs would remain vulnerable to entrainment in the CVP and SWP exports.

- The CVP and SWP salvage facilities might be modified to be more effective in successfully salvaging delta smelt and other small fish. Because the number of fish being salvaged will be substantially reduced (by the Sacramento fish screens and by the separation of the SJR fish), the effectiveness of the salvage facilities should be improved. The removal of the high load of water hyacinth from the CVP salvage facility should also allow increased CVP salvage effectiveness.