Levee and Channel Management

Levee construction in the Delta began over 140 years ago in order to enable development of Delta islands for agricultural purposes. These early levees prevented high tides and ordinary winter high water from flooding the islands. Such levees were typically no more than 3 feet high, quite low by today's standards.

Today's Delta levees are much higher and larger overall. The levees have been raised over the years as a consequence of ongoing subsidence: the loss of organic peat soil through oxidation. Reclaimed lands which were dried out for farming have experienced the most severe subsidence.

Benefits of Delta Levees

Delta waterways and the levees that define them are one of the most important geographical features of the State's water resources system. The Delta receives approximately 40 percent of California's fresh water runoff, including flows from the Sacramento, San Joaquin, Mokelumne, Cosumnes, and Calaveras rivers. The channels act as conduits to transport the water through the Delta while the levees protect over 700,000 acres of rich farm land, towns, cities, utilities, railroads, highways, and wildlife habitat.

Water from Delta channels is used throughout the Delta for agricultural, municipal, and industrial purposes. This same water also supports divers and extensive fish and wildlife habitat, both on Delta islands and in adjacent channels.

Levees, particularly in the western Delta, also serve to help protect water quality as barriers to salt water. If the levees were to fail, salinity intrusion could jeopardize the water supply of two-thirds of the State's population, including residents of the Bay Area, Central and Southern California.

Threats to Levees

Subsidence

As a result of subsidence, levees that once protected land that stood at about sea level 1 to 3 feet below the levee crest, today protect lands lying as much as 20 feet below the top of the levee wall.

Erosion

Loss of levee material as a result of water currents and wave wash is a serious threat to levee security. Many protective measures have been tried over the years. Thus far, the use of rocks (riprap) to protect levee slopes has been the most cost effective, though still expensive. Alternative methods are under trial to determine, hopefully, more cost effective and environmentally friendly ways to protect against erosion.

Earthquakes

Although the Delta has not suffered severely from an earthquake, the question remains as to what effect a major quake in the Delta would have. Several studies seem to suggest that earthquakes within the next 30 years will probably cause some levee damage and failure in the Delta. Studies are currently under way to reduce the uncertainties and better define the expected performance of the levees during future earthquakes.

Overtopping

Overtopping occurs when water levels exceed the height of a levee. Although Delta levees have been raised over the years to deal with subsidence, our reduced capability to control flood flows, and faster runoff as development in the region continues, the threat of overtopping during a flood still exists. Although further raising of some levees would reduce the overtopping threat, engineering and financial constraints must always be considered.

Costs and Funding

Historically, those who owned the land protected by a levee had to pay all the costs of building and maintaining the levee. In recent years, through federal and State disaster assistance legislation and State levee and maintenance and rehabilitation laws, additional funding has become available. From 1981 to 1991, levee maintenance expenditures totaled $63,300,000.

In addition, during the years 1980 through 1986, several flood events caused extensive damage to Delta levees. Levee breaks occurred during this period, flooding 17 Delta islands. Disaster expenditures totaled $97,400,000.

In March, 1988, the California Legislature, recognizing the importance of the Sacramento-San Joaquin Delta region, passed the Delta Flood Protection Act (SB 34). This legislation created the Delta Flood Protection Fund and declared legislative intent to appropriate $12 million annually for Delta flood protection for 10 years beginning July 1, 1988. Half of this amount is to be used for local assistance under the Delta Levees Maintenance Subventions Program, and the other half is for Special Flood Control Projects for the eight western Delta islands and the towns of Thornton and Walnut Grove.

For More Information

For more information relating to Delta levees, you can get a copy of the draft *Briefing Paper on Delta Levee and Channel Management Issues*. It is available free from the Bay-Delta Oversight Council, P.O. Box 942836, Sacramento, CA 94236-0001, telephone (916) 657-2666.

Water Supply and Export Operations

There is general consensus today that the Bay-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. The reliability of water supplies available for municipal, industrial, and agricultural use is increasingly uncertain; both due to increasing human needs and anticipated increases in environmental requirements.

The Delta receives about 40 percent of the State's runoff. The Sacramento River Region has an average annual unimpaired runoff of 23 million-acre-feet (MAF), and the San Joaquin River Region has an average unimpaired runoff of 8 MAF. This water contributes to the water supply for two-thirds of all Californians, as well as irrigation water for millions of acres of agricultural lands. The Bay Area, Central and Southern California all receive water from the Delta.

Water Demand

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.

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.

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 by 3.8 MAF.

On average, the State Water Project and the federal Central Valley Project have been exporting about 5 million acre-feet of water per year from the Delta over the past 12 years. In addition, Contra Costa County diverts water directly from the Delta. Also, millions of acre feet of water, which would otherwise flow to the Delta, are diverted upstream to serve municipal and agricultural uses, both in areas of origin and the distant municipalities of the Bay Area.

Environmental Water

Because management of California's water delivery network entails capturing high volumes of winter and spring runoff behind dams and releasing this water in large part during dry summer months for downstream use and export through operation of the projects, there are direct ecological impacts on the Estuary's aquatic habitat. These include altered flow rates and re-direction of flow, fluctuating salinity gradients, movement of the entrapment zone, and direct loss of fish at the project pumps.

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. 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.

Ground Water

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, representing nearly 20 percent of statewide applied water. In some areas, ground water accounts for as much as 90 percent of local supply. This usage results in about a 1.3 MAF of annual ground water overdraft.

Water Management Programs

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

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.

For More Information

For more information on water supply issues as they relate to the Bay-Delta Estuary, you can get a copy of the draft *Briefing Paper on Status, Trends, and Factors Affecting Sacramento/San Joaquin Delta Water Supplies*. It is available free from the Bay-Delta Oversight Council, P.O. Box 942836, Sacramento, CA 94236-0001, telephone (916) 657-2666.

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Water Quality

The quality of water in the Delta is vital to the economy of California. The water must meet a number of diverse uses, each of which has specific water quality requirements. The Sacramento-San Joaquin Delta is a source of drinking water to about 20 million Californians, and is a critical resource to support California agriculture, one of the State's most important industries. In addition, Delta waters benefit a complex ecosystem as part of the Bay-Delta Estuary, the largest estuary on the west coast of North America.

The Need for Good Water Quality

Elevated levels of salts and organic carbon in Delta water increases costs for water purveyors and the public. Expensive new treatment plants and operational modifications have to be made to enable Delta waters to meet new, more rigorous drinking water standards.

The primary reason water quality is of such concern to agricultural users of Delta source waters is that the salinity of applied water has a direct relationship to salt content in the soil, which in turn affects crop yields.

Also, clean water supports the myriad of organisms which live in and depend upon the water. Such organisms range from microscopic plants and animals, to small invertebrates that eat the microscopic organisms, to the fish who live on these small invertebrate animals and, ultimately, to the people who consume the fish. Wetland animals, such as migratory birds and many others, complete the picture of the web of life that depends on clean water.

Water Quality Degradation

The waters of the Bay-Delta are subject to a number of sources of quality degradation. Intensified municipal and industrial impacts, including dredging, also contribute to overall water quality decline. In addition, two of the most serious sources of Delta water quality degradation are naturally occurring; salinity and organic carbon.

Dredging

Dredging within the Bay and Delta for maintenance of channels and island levees presents an opportunity for harmful materials residing in the sediment to mobilize into the water and, perhaps, cause water quality problems.

Organic Carbon

Organic carbon, naturally occurring as a result of plant decay processes, comes from a number of sources within and to the Delta. The most significant source of organic carbon is thought to be drainage from the Delta's peat soil islands, which may contribute up to half of the total amount in Delta waters. Organic carbon levels are a problem because chemical interactions in the water treatment process create "disinfection by-products" (DBPs) that are a public health concern in drinking water, and which must also be treated by water purveyors. Treatment to reduce the organic carbon and DBPs to safe levels is expensive and is becoming increasingly so.

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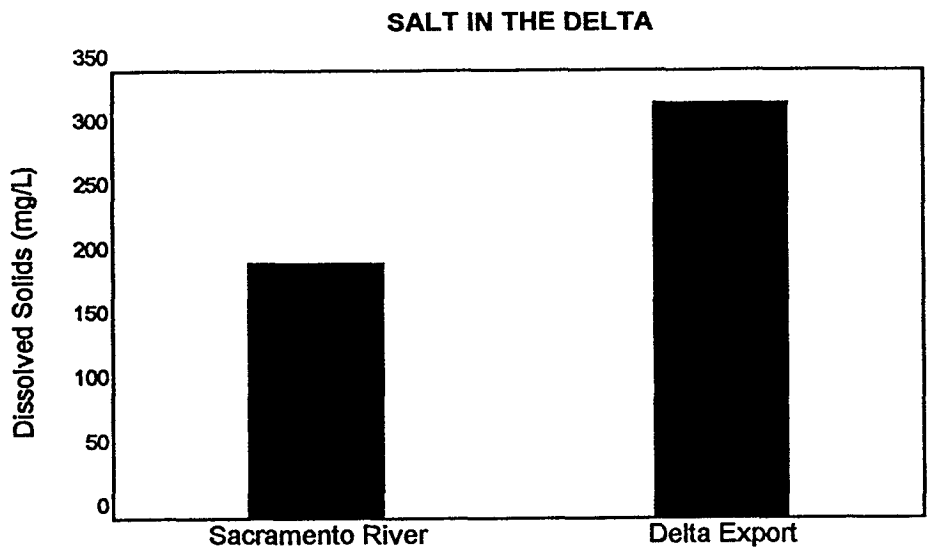
Salinity



Average over the period January 1990 - August 1993

Salt, which enters the Bay-Delta from the Bay and ocean, diminishes the useability of the Delta waters for most purposes. In higher concentrations, it can corrode the appliances of homeowners, contribute to formation of harmful chemical byproducts in drinking water, increase costs of treating drinking water, reduce the yields of agricultural crops, and negatively affect some organisms. In very high concentrations, salt makes water unfit for drinking, for growing crops, and for aquatic and wetland organisms.

Industrial and Other Sources of Pollution

Besides salt and organic carbon, there are a number of other sources of water quality degradation in the Bay-Delta. Among these are: discharges of treated industrial and municipal waste water; storm water runoff from cities; drainage from agricultural fields; and, drainage from abandoned mines upstream of the Delta.

The watersheds tributary to the Delta drain about 40 percent California's fresh water runoff; and, in those watersheds, municipal and industrial waste water discharges, drainage from agricultural lands and municipal storm drains, recreational activities, and chemical spills contribute to water quality degradation.

Though California has a rich history, it has only recently been industrialized compared to other parts of the United States. As a result, this state is fortunate not to have a long history of water pollution. While water quality problems certainly exist, solutions are possible for most of them. Solutions to the problems of the Bay-Delta include resolving water quality issues as a crucial part of the overall solution.

For More Information

For more information on Water Quality in the Estuary you can get a copy of the draft *Briefing Paper on Delta Water Quality for Drinking Water and Agricultural Uses*. It is available free from the Bay-Delta Oversight Council, P.O. Box 942836, Sacramento, CA 94236-0001, telephone (916) 657-2666.

Biological Resources

The San Francisco Bay/Sacramento-San Joaquin Delta Estuary is the largest estuary on the west coast of North and South America. Approximately 40 percent of California's fresh water runoff mixes with Pacific Ocean water in the Estuary, creating highly dynamic and complex environmental conditions which have historically supported a diverse and productive ecosystem.

A diverse assemblage of wildlife and plant species inhabits the Estuary's channels, smaller rivers, creeks, and wetlands. For several species groups, such as wintering and nesting waterfowl, the Estuary provides essential habitat. The diversity and health of the Estuary's plant communities are crucial indicators of the health of this important ecosystem.

The Estuary's biological resources have experienced major disturbances and transformations over the last 150 years. These transformations started with physical, chemical, and biological changes during California's gold rush in the mid-1800's. Many other factors have reduced the abundance of estuarine species.

Estuarine Habitats and Species

The Estuary includes diverse habitats which support large numbers of aquatic, terrestrial, and plant species. Some of the habitats and species that occupy them include:

- **Wetlands**, including freshwater and brackish marshes, seasonal wetlands, and diked wetlands. These areas are very important to wildlife in the Estuary. Wetlands have been greatly reduced in area as land in the Estuary has been filled and reclaimed. As a result, many wetland plants are threatened or endangered. Historically tens of millions of shorebirds and waterfowl, or two-thirds of the waterfowl in the Pacific Flyway, used the Estuary for a wintering and migratory haven. Today, roughly a quarter million ducks, geese, and swans use the Estuary every winter.

- **Open water**, ranging from salt water in the bay to fresh water in the upper reaches of the Delta. Many of the native aquatic species of the Estuary have declined. All Sacramento and San Joaquin salmon runs are in decline. The winter run Chinook salmon is listed as an endangered species under the Endangered Species Act. The delta smelt is listed as threatened, and other fish species are proposed for listing. Some tiny planktonic organisms, which live suspended in the water, are also declining.

- **Riparian woodland** once lined the banks of many Delta channels. The value of riparian woodlands depends on the plant species, maturity and diversity of the vegetation. Some larger trees such as cottonwoods, sycamores, alders, willows and oaks may take 30 to 40 years to reach maturity. These woodlands provide important habitat for many species. They also provide shade over water near the banks, keeping this water cooler and more hospitable for small fish. These woodlands were reduced as land was cleared for agriculture and construction of levees. Maintenance of levees to protect them from erosion has resulted in significant losses of shaded riverine aquatic habitat.

Problems in the Estuary

Human activities have resulted in deliberate and inadvertent changes in the Estuary. Historically, mining and changes in land use caused massive disruption. Today, many estuarine species are in decline. Although several factors contribute to these declines, there is disagreement over the degree of causation in the decline of biological resources. The factors include:

- **Construction and operation of water projects**. Delta water exports cause direct losses of fish at the pumps, and draw other fish from river channels into the Delta where their migration is impeded and they may be exposed to predators for longer periods. Water projects also regulate flow of water into and out of the Estuary, affecting two related factors important to aquatic life: outflow and salinity.

- **Introduced species**. When plants or animals from other places are introduced into the Estuary, they can compete with native organisms for food and habitat, or prey on native organisms. Some of the most prominent introduced fish species in the Estuary are the striped bass and white catfish. Other introductions such as planktonic organisms and clams are less prominent but may have significant effects on the food chain.

- **Toxic Contaminants**. In the past many toxic substances were discharged into the Estuary. Although such discharges have been reduced, old deposits and continuing discharges may affect aquatic species. Primary sources of contaminants in the Estuary include urban runoff, non-urban runoff, riverine inflows from agricultural lands of the Central Valley, discharges from municipal waste treatment facilities, industrial effluent including that from oil refineries, dredging and dumping spoils, runoff from abandoned mines and oil spills. Contaminants adversely affect wildlife through direct mortality, by reducing the abundance of species that are part of the food chain, and by diminishing the value and productivity of habitat.

- **Harvest**. Harvest of fish and other species through fishing and hunting can affect their populations. Legal harvest is regulated but illegal harvest may cause species to decline.

- **In-Delta water diversions**. Water is diverted from the Delta for local agricultural, urban, and industrial uses. Many of these diversions are not screened to protect fish, and many eggs and larvae may be lost.

For More Information

For more information on biological resources of the Estuary you can get a copy of the draft *Briefing Paper on Biological Resources of the San Francisco Bay/Sacramento-San Joaquin Delta Estuary*. It is available free from the Bay-Delta Oversight Council, P.O. Box 942836, Sacramento, CA 94236-0001, telephone (916) 657-2666.