FACILITY DESCRIPTIONS AND UPDATED COST ESTIMATES FOR THE CHAIN OF LAKES PROJECT

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

INTRODUCTION

The *Facility Descriptions and Updated Cost Estimates for the Chain of Lakes Project* has been prepared as part of the Storage and Conveyance Component Refinement Task of the CALFED Bay-Delta Program (CALFED or Program). CALFED's mission is to develop a long-term comprehensive plan that will restore the ecological health and improve water management for beneficial uses of the San Francisco Bay/Sacramento-San Joaquin Delta (Bay-Delta) system.

This report summarizes the principal features, estimated costs, and environmental considerations of the Chain of Lakes Project. This project would function as a combined isolated storage and conveyance facility to transfer Sacramento River flows across the Delta to the Clifton Court Forebay for export. A chain of seven lakes, created by flooding existing Delta islands, would be connected by siphons. Two alternative configurations have been evaluated: the Siphon Only Alternative, which relies on gravity to transfer water between island storage facilities, and the Siphon and Pump Alternative, which supplements the conveyance capacity between island storage facilities with pumping plants. The general location of the Chain of Lakes Project is shown on Figure 1.

This evaluation and others being performed by CALFED are intended to provide a facilities evaluation and cost estimates of representative storage and conveyance components. The objectives of the Chain of Lakes Project evaluation are (1) to provide a cost estimate for the project which represents costs within the range expected if the project were to be constructed today and (2) to enable CALFED to compare this project against other projects that might be considered as part of a long-term CALFED solution strategy.

The Chain of Lakes is a relatively new concept and has not been previously studied in sufficient detail; thus, the cost estimates for the Chain of Lakes Project were developed primarily by Bookman-Edmonston Engineering. The approach involved applying current unit costs to

quantities for similar facilities found in previous reports including the 1990 California Department of Water Resources (DWR) report *North Delta Program Draft EIR/EIS* and the 1995 DWR report *Isolated Transfer Facility Cost Estimate.*

A preliminary evaluation of the environmental considerations associated with the Chain of Lakes Project is also included in this report. Fish, wildlife, plant, and cultural resources that could be affected have been described and potential impacts have been identified. The information for evaluation of environmental considerations was gathered from existing literature and databases.

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PROJECT BACKGROUND

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Reclamation of Delta marshlands began in the 1850s, and by the 1930s, nearly all of the Delta had been reclaimed into intensively farmed islands. Since then, there have been numerous studies on salinity intrusion control, water quality improvement, and overall management of the water resources in the Delta (including various water storage and conveyance concepts).

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The Chain of Lakes Project is a relatively new water storage and conveyance concept which would help improve the management of water resources in and through the Delta. Over the past several years, several studies have been completed for similar concepts which flood Delta islands to provide water storage. However, a review of DWR and the U.S. Bureau of Reclamation (Reclamation) libraries and publications revealed no previous investigations of the "Chain of Lakes Project."

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The Chain of Lakes Project concept was identified in a March 1977 CALFED technical studies report titled *Status Reports on Technical Studies for the Storage and Conveyance Refinement Process* and in the February 1997 *Preliminary Working Draft CALFED Bay-Delta Program Storage and Conveyance Component Inventories.* This Delta storage and conveyance concept has recently gained recognition and popularity through the CALFED process as a potential part of a long-term comprehensive plan that will restore the ecological health and improve water

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management of the Bay-Delta. This evaluation builds on that concept and will provide CALFED with a cost estimate and written description of the Chain of Lakes Project that will enable the Chain of Lakes Project to be compared to other projects for consideration as part of a long-term CALFED solution strategy.

FACILITIES DESCRIPTION

This section provides an overview of the major features included in the proposed Chain of Lakes Project. The preliminary layout of the Chain of Lakes Project is based on original work developed by CALFED staff and Bookman-Edmonston Engineering.

PROJECT LOCATION

The Chain of Lakes Project would be located in the Sacramento-San Joaquin Delta in Sacramento and San Joaquin Counties (see Figure 1). Figure 2 provides a detailed location map of the Chain of Lakes Project and shows the locations of all major facilities associated with the project.

PROJECT DESCRIPTION

The Chain of Lakes Project is a combined isolated storage and conveyance facility that would transfer Sacramento River flows across the Delta to the Clifton Court Forebay for export. A chain of seven Delta islands would be connected by siphons crossing existing Delta channels. These "islands-lakes" would include Tyler Island at the head end of the chain, followed in succession by Bouldin Island, Venice Island, Mandeville Island, Bacon Island, Woodward Island, and Victoria Island, which would be connected to the Clifton Court Forebay. The Chain of Lakes Project would, in effect, move the Delta export location of Sacramento River flows from the current Clifton Court Forebay site to the lower Sacramento River near the Delta Cross Channel.

Flows from the Sacramento River would be diverted through an enlarged Delta Cross Channel into the Chain of Lakes. The Delta Cross Channel gates would be enlarged to a total width of 300 feet, including two new radial gates constructed to accommodate the 15,000 cubic foot per second (cfs) conceptual design conveyance capacity of the Chain of Lakes Project. Water entering the Chain of Lakes would flow through fish screens constructed downstream of the radial gates. A low lift pump station would be located downstream of the fish screen to control the hydraulic performance of the fish screens and to lift the water into a new 500-foot-wide open channel leading to Tyler Island.

Islands in the Chain of Lakes system would be hydraulically interconnected by siphons. One of the key design considerations is minimizing the number and size of siphons required to carry the design flow within the constraint of the maximum hydraulic gradient available between the upstream end of the system at Tyler Island and the downstream end of the system at Clifton Court Forebay. The maximum upstream water surface elevation at Tyler Island would not exceed 6 feet above mean sea level (MSL) for safety considerations related to levee stability and the requirements of DWR's Division of Safety and Dams. The minimum water surface elevation at the most downstream end of the system at Clifton Court Forebay would not fall below 2 feet below MSL because of potential export pump cavitation problems. The result is a maximum total allowable hydraulic gradient of 8 feet from Tyler Island and Clifton Court Forebay.

Two alternatives were identified for this evaluation: a Siphon Only Alternative and a Siphon and Pump Alternative. Figures 3 and 4 illustrate maximum storage capacities of the islands during storage operations and during maximum conveyance operations of 15,000 cfs for the Siphon Only Alternative and the Pump and Siphon Alternative, respectively. The Chain of Lakes concept is fairly new and has not been previously studied in much detail; thus, further hydraulic analyses and studies are required to firm up the size and number of siphons required for this project.

The Siphon Only Alternative, shown in Figure 3, relies entirely on gravity flow under the available head gradient to convey the design flow of 15,000 cfs. The Siphon and Pump Alternative, shown

in Figure 4, incorporates low lift pumping plants to supplement the capacity of the siphons as well as reduce the size and number of siphons required to convey 15,000 cfs through the system. For both the Siphon Only Alternative and the Siphon and Pump Alternative, 5,000 cfs pump stations at each island would also supplement flow and facilitate filling islands from adjacent channels. Under both alternatives, the design flow would generally run south from one island to the next until reaching the Clifton Court Forebay.

PRINCIPAL FACILITIES

This section provides an overview of the major features of the Chain of Lakes Project with a design capacity of 15,000 cfs. Generally, the principal facilities include an enlarged Delta Cross Channel and fish screen, a siphon connection to Clifton Court Forebay, and isolated island storage and conveyance facilities on Tyler Island, Bouldin Island, Venice Island, Mandeville Island, Bacon Island, Woodward Island, and Victoria Island. Table 1 provides a summary of the physical characteristics of each of the major features associated with each alternative.

Enlarged Delta Cross Channel

The enlarged Delta Cross Channel would consist of an enlarged gate structure; a new 500-foot-wide open channel to Tyler Island; a multiple folded "V" fish screen and bypass system; an 11-unit, 16,610 horsepower pump station with a capacity of 10,000 cfs; and associated and miscellaneous works such as a control building, parking, access, lighting and fencing.

The current configuration of the intake facility for the Chain of Lakes Project includes a 10,000 cfs diversion from the Sacramento River through an enlarged Delta Cross Channel. The total conveyance capacity of the Chain of Lakes Project is designed to be 15,000 cfs. The additional 5,000 cfs would be provided by an intake pumping plant on Tyler Island that would draw water from the Mokelumne River.

Tyler Island

Tyler Island would form the upstream-most isolated storage/conveyance component of the Chain of Lakes Project. The island would be converted from its current land use, which is primarily agricultural, to a storage facility with an inlet from the Delta Cross Channel and an outlet to Bouldin Island. The maximum storage capacity of Tyler Island would be 185,600 acre-feet at a water surface elevation of 6 feet above MSL requiring approximately 23 miles of reinforced levees. As mentioned above, Tyler Island would also include an intake pumping facility from the Mokelumne River on the eastern levee with a capacity of 5,000 cfs.

Under the Siphon Only Alternative, Tyler Island would be connected to Bouldin Island via three 30' x 30' x 1,100' concrete box siphons under the Mokelumne River. For a conveyance capacity of 15,000 cfs under the Siphon Only Alternative, Tyler Island would be maintained at a water surface elevation of 6 feet above MSL to provide the necessary system hydraulic gradient for 15,000 cfs.

Under the Siphon and Pump Alternative, Tyler Island would also have to maintain a water surface elevation of 6 feet above MSL to create the hydraulic gradient necessary to convey 15,000 cfs from Tyler Island to Bouldin Island. The siphon connection to Bouldin Island would be reduced, however, to two 23' x 23' x 1,100' concrete box siphons.

Bouldin Island

Bouldin Island would have a maximum storage capacity of 182,900 acre-feet at a water surface elevation of 6 feet above MSL requiring approximately 18 miles of reinforced levees. Bouldin Island would be connected to Tyler Island upstream and to Venice Island downstream. Additionally, an intake pumping facility from the South Fork Mokelumne River would be included on the northern levee. The connection to Tyler Island would be via siphons without an associated

pumping facility in the Siphon Only Alternative and with a pumping facility in the Pump and Siphon Alternative.

Under the Siphon Only Alternative, Bouldin Island would have to maintain a water surface elevation of about 5.0 feet above MSL to provide the necessary system hydraulic gradient to convey 15,000 cfs. At this water surface elevation, Bouldin Island would have a storage capacity of 174,300 acre-feet. This would create a head difference of about 1 foot between Tyler and Bouldin Islands. Bouldin Island would be connected to Venice Island via three 30' x 30' x 700' concrete box siphons beneath Potato Slough.

Under the Siphon and Pump Alternative, Bouldin Island would have to maintain a water surface elevation of 0.8 feet below MSL to provide the necessary hydraulic gradient to convey 15,000 cfs from Tyler Island to Bouldin Island. At this surface elevation, Bouldin Island would have a storage volume of 129,100 acre-feet. The siphon connection between Bouldin Island and Venice Island would incorporate a 15,000 cfs pumping plant which would reestablish the maximum water surface elevation of 6.0 feet above MSL in Venice Island. The pumping plant would be an indoor type, housing 11 pumping units, including one standby unit, and would have a total of 25,080 horsepower.

Venice Island

Venice Island would have a maximum storage capacity of 92,700 acre-feet at a maximum water surface elevation of 6 feet above MSL requiring approximately 12 miles of reinforced levees. Venice Island would be connected to Bouldin Island upstream and Mandeville Island downstream. The siphon connection between Venice and Mandeville Islands would be 1,700 feet long beneath the San Joaquin River. Venice Island would also include an intake pumping facility from the San Joaquin River at the southeast corner of the island.

Under the Siphon Only Alternative, a water surface elevation of 4 feet above MSL would have to be maintained in order to provide the system hydraulic gradient required to convey 15,000 cfs. The head difference between Bouldin and Venice Islands would be approximately 1 foot. At this elevation, the storage capacity would be 85,300 acre-feet. The connection to Mandeville Island would be via three concrete box siphons with dimensions of 30' x 30' x 1,700'.

Under the Siphon and Pump Alternative, Venice Island would maintain a maximum water surface elevation of 6 feet above MSL to achieve the hydraulic gradient necessary to convey 15,000 cfs to the next downstream island, Mandeville Island. Water from Venice Island would be conveyed by gravity through two concrete box siphons to Mandeville Island. The dimensions of the two box siphons would be 23' x 23' x 1,700'. No pumping plant would be located on Venice Island.

Mandeville Island

Mandeville Island would have a maximum storage capacity of 131,000 acre-feet at a maximum water surface elevation of 6.0 feet above MSL. Mandeville Island would be connected to Venice Island upstream and Bacon Island downstream. The connection between Mandeville Island and Bacon Island would be through a 900-foot siphon beneath Connection Slough. The conversion of Mandeville Island to a storage facility would require the reinforcement of about 14 miles of levees. Mandeville Island would also include an intake pumping plant with a capacity of 5,000 cfs from the Middle River on the eastern side of the island.

Under the Siphon Only Alternative, the water surface elevation on Mandeville Island would have to be maintained at 2.8 feet above MSL to provide the necessary system hydraulic gradient to convey 15,000 cfs. The storage capacity at this elevation would be 114,700 acre-feet. The head difference created between Venice and Mandeville Islands would be 1.2 feet. The connection to Bacon Island would be via three 30' x 30' x 900' concrete box siphons.

Under the Siphon and Pump Alternative, Mandeville Island would have to maintain a water surface elevation of 2.0 feet below MSL to provide the necessary hydraulic gradient to convey 15,000 cfs from Venice Island to Mandeville Island. At the downstream end of Mandeville Island, a pumping plant would convey water into Bacon Island. The pumping plant would have a capacity of 15,000 cfs and would recover approximately 8 feet of head to enable Bacon Island to maintain a maximum water surface elevation of 6 feet above MSL. The siphon connection between Mandeville and Bacon Islands would require two 23' x 23' x 900' concrete box siphons beneath Connection Slough.

Bacon Island

Bacon Island would have a maximum storage capacity of 117,700 acre-feet at a maximum water surface elevation of 6 feet above MSL. Bacon Island would be connected to Mandeville Island upstream and Woodward Island downstream. The downstream connection to Woodward Island would require a 1,500-foot siphon crossing of the cut between Bacon and Woodward Islands. Approximately 14 miles of levees would have to be reinforced. Bacon Island would also include an intake pumping plant with a capacity of 5,000 cfs from the Middle River on the eastern side of the island.

Under the Siphon Only Alternative, the water surface elevation on Bacon Island would have to be maintained at 1.8 feet above MSL. The storage capacity of Bacon Island at this water surface elevation would be 98,600 acre-feet. The head difference between Mandeville and Bacon Islands would be 1 foot, which would be sufficient to provide a total flow of 15,000 cfs through three concrete box siphons connecting the islands. On the downstream end of Bacon Island, three concrete box siphons with dimensions of 30' x 30' x 1,500' would connect Bacon Island to Woodward Island.

Under the Siphon and Pump Alternative, the water surface elevation of Bacon Island would be maintained at 6.0 feet above MSL. The water surface elevation would be maintained by the

pumping plant located at the downstream end of Mandeville Island. The connection between Bacon Island and Woodward Island downstream would be made through two 23' x 23' x 1,500' concrete box siphons. No pumping plant would be located on Bacon Island.

Woodward Island

Woodward Island would have a maximum storage capacity of 20,400 acre-feet at a maximum water surface elevation of 6 feet above MSL. Woodward Island would be connected to Bacon Island upstream and Victoria Island downstream. The downstream connection to Victoria Island would require a 700-foot siphon crossing of Woodward Canal and North Victoria Canal. Woodward Island would also include a 5,000 cfs intake pumping plant from the Middle River. Approximately 9 miles of levees would have to be reinforced.

Under the Siphon Only Alternative, the water surface elevation of Woodward Island would have to be maintained at 0.7 feet above MSL. The storage capacity of Woodward Island at this water surface elevation would be 15,400 acre-feet. The head difference between Bacon Island and Woodward Island would be about 1.1 feet, sufficient to provide a total flow of 15,000 cfs through the three siphons connecting the two islands. At the downstream end of Woodward Island, three concrete box siphons, with dimensions of 30' x 30' x 700', would connect Woodward Island with Victoria Island.

Under the Siphon and Pump Alternative, the water surface elevation at Woodward Island would be maintained at 1.6 feet below MSL to provide the hydraulic gradient necessary to convey 15,000 cfs from Bacon Island to Woodward Island. At the downstream end of Woodward Island, a pumping facility would relift water into Victoria Island through two concrete box siphons with dimensions of 23' x 23' x 700'. The pumping plant would have a capacity of 15,000 cfs and 25,080 horsepower to regain approximately 7.6 feet of head. The pumping plant would be an indoor type, housing 11 pumping units, including one standby unit.

Victoria Island

Victoria Island would be the last island storage facility in the Chain of Lakes Project. Victoria Island would have a maximum storage capacity of 104,900 acre-feet at a maximum water surface elevation of 6 feet above MSL. Victoria Island would be connected to Woodward Island upstream and to Clifton Court Forebay downstream. The downstream connection to Clifton Court Forebay would be made through a 14,000-foot siphon system beneath Old River. Approximately 15 miles of levees would have to be reinforced. Victoria Island would also have an intake pumping plant with a capacity of 5,000 cfs from Old River on the island's west side.

Under the Siphon Only Alternative, the water surface elevation would be maintained at 0.2 feet below MSL when 15,000 cfs is being conveyed through the system. The storage capacity of the island at this water surface elevation would be 74,300 acre-feet. The head difference created between Woodward and Victoria Islands would be approximately 0.9 feet. The downstream connection to Clifton Court Forebay would be made through three 30' x 30' x 1,400' concrete box siphons which would include radial gate control structures at the siphon outlets to Clifton Court Forebay. The head difference between Victoria Island and Clifton Court Forebay when 15,000 cfs is being conveyed through the system would be 1.2 feet (Clifton Court Forebay water surface elevation at 1.3 feet below MSL).

Under the Siphon and Pump Alternative, the water surface elevation of Victoria Island would be maintained at 6.0 feet above MSL when 15,000 cfs is being conveyed through the system. The water surface elevation would be maintained by the pumping plant located at the downstream end of Woodward Island. The connection to Clifton Court Forebay from Victoria Island would be made through two 23' x 23' x 1,400' concrete box siphons that would have radial gate control structures located at the siphon outlets to Clifton Court Forebay.

COST ESTIMATE

The Chain of Lakes Project is a relatively new project that has not been previously studied; thus there is no specific previous information describing or estimating the cost of the project. There are, however, some studies with similar components from which comparative costs can be derived. The cost estimate for the Chain of Lakes Project was developed primarily by Bookman-Edmonston Engineering and was based on applicable portions of previous studies, experience, and engineering judgment. These previous studies include the 1990 DWR report *North Delta Program Draft EIR/EIS*, the 1995 DWR report *Isolated Transfer Facility Cost Estimate*, and the 1990 DWR report, *Los Banos Grandes Facilities Report, Appendix A: Designs and Cost Estimates.*

COST ESTIMATE METHODOLOGY

General

The cost estimates for the Chain of Lakes Project were determined by applying current unit costs to the quantities developed by Bookman-Edmonston Engineering. Some of the costs used to update this cost estimate were determined by escalating the unit cost to October 1996 dollars using the Reclamation Construction Cost Trends (CCT) indices. Additional unit costs were developed by Bookman-Edmonston Engineering based on engineering and construction experience. The cost estimate does not include the cost of environmental documentation, environmental mitigation, operation and maintenance, power, and interest during construction.

Table 2a provides a detailed breakdown of the estimated costs of a Chain of Lakes Project for the Siphon Only Alternative and Table 2b provides a detailed breakdown of a Chain of Lakes Project for the Siphon and Pump Alternative. Cost items identified in previous cost estimates have been provided, along with the unit cost of the items or an indication that the estimated cost has been developed through a lump sum approach. The tables also include the Reclamation CCT index for

the month and year in which the estimated cost was developed and for October 1996. These Reclamation cost indices are used to factor the previous cost estimate to October 1996 dollars. In some instances, only a unit cost has been provided, with no cost indices. In these cases, the unit cost has been taken from other sources. The far right-hand column of Table 2a and 2b provides the cost reference for each cost item.

Pumping Plants

The cost estimate for the Pumping Plants associated with the Chain of Lakes Project has been based on the cost and quantities from the September 1995 DWR Report, *Isolated Transfer Facility Cost Estimate*. These costs were originally priced in July 1995 dollars and have been updated to October 1996 dollars using the CCT indices described above.

Right-of-Way Costs

Right-of-way costs of $3,000 per acre were used based upon personal communication with Reclamation's Division of Land Resources staff in February 1997. The right-of-way necessary for the development of the Chain of Lakes Project would require 36,491 acres for the seven Delta islands in the system.

Contingencies and Other Costs

All contingencies and engineering, construction management, and administrative factors were determined by engineering judgement based on similar level of cost estimation. Contingencies were chosen to be 20 percent, and engineering, construction management, and administration were chosen to be 35 percent. A cost range was developed for the project by subtracting 10 percent from the estimated capital cost for the low end cost and adding 25 percent to the estimated capital cost for the high end.

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PRELIMINARY COST FINDINGS

Costs of the Chain of Lakes Project and supporting facilities have been developed to an October 1996 basis as described above. Table 3 summarizes estimated costs of the major items associated with the Chain of Lakes Project for both the Siphon Only Alternative and the Siphon and Pump Alternative.

The total estimated capital cost of the Siphon Only Alternative is estimated to be about $1,468 million with a resulting calculated cost range between $1,320 and $1,830 million.

The total estimated capital cost of the Siphon and Pump Alternative is estimated to be about $1,755 million with a resulting calculated cost range between $1,580 and $2,190 million.

ENVIRONMENTAL DOCUMENTATION

[NOTE: The environmental considerations section needs to be reevaluated by DWR to ensure consistency with the information presented in the previous section.]

This portion of the report provides a summary of environmental considerations related to the Chain of Lakes Project. Fish, wildlife, plant, and cultural resources that could be affected by the proposal are described and the extent of the impacts are identified. The information presented in this section was gathered from existing literature, with limited original research. No field work was conducted for this analysis.

WILDLIFE

This conveyance option would impact 16,000 acres of agricultural lands. No riparian areas would be affected.

Fish, Amphibians, Reptiles, and Invertebrates

The Delta supports several types of aquatic habitats including estuary, freshwater, and marine water environments. These various water environments support about 90 species of fish.

During construction, the conveyance options could affect several waterways that support both anadromous and resident game and non-game fish. Permanent residents or fish dependant on the Delta as a migration corridor or as a nursery include striped bass, chinook salmon, steelhead trout, American shad, sturgeon, catfish, largemouth bass, winter-run chinook salmon, delta smelt, Sacramento splittail, and numerous other marine and freshwater species.

Amphibians in the area include the California tiger salamander, which requires quiet, still water for breeding. The major waterways in the area are deep, swift, and subject to frequent inundation to provide suitable habitat for this species.

General Wildlife

Lands within the areas of the proposed improved Delta conveyance support a highly diverse wildlife. Important groups of wildlife dependant on the Delta environment are waterfowl and other migratory birds, game birds such as pheasant and quail, furbearers, and numerous nongame birds and mammals. The Delta is particularly important to waterfowl migrating via the Pacific Flyway. The principal attraction for waterfowl is winter flooded agricultural fields, mainly cereal crops, which provide food and extensive seasonal wetlands. Small mammals find suitable habitat in the Delta and upland areas. Vegetated levees, remanent of riparian forest, and undeveloped islands provide habitat for numerous small mammals. Small mammal species include muskrat, mink, river otter, beaver, raccoon, gray fox, and skunks. A variety of non-game wildlife such as songbirds, hawks, owl, reptiles, and amphibians can also be found in the area.

Sensitive and Listed Fish and Wildlife Species

According to the California National Diversity Database, listed species recorded in or around the area that would be directly affected by any of the proposed project include California red-legged frog (federal threatened), Swainson's hawk (State threatened), California black rail (State threatened), San Joaquin kit fox (federal endangered, State threatened), giant garter snake (federal/State threatened), and valley elderberry longhorn beetle (federal threatened).

Wildlife species that are either candidates for State and federal listing or considered "species of special concern" by the California Department of Fish and Game (CDFG) that have been known to occur in or near the area affected by any of the proposed through Delta conveyance alternatives include California tiger salamander (federal candidate/CDFG species of special concern), great blue heron, great egret, white-tailed kite, burrowing owl (CDFG/Audubon species of special concern), tricolored blackbird (federal candidate, CDFG species of special concern), Sacramento splittail (federal proposed endangered, CDFG species of special concern), San Joaquin pocket mouse (CDFG species of special concern), and western pond turtle.

Other sensitive wildlife species that are candidates for federal listing that have not been previously recorded, but may be present in the area of the proposed conveyance alignment, include the San Joaquin valley wood rat, riparian brush rabbit, greater western mastiff bat, small-footed myotis bat, long-eared myotis bat, fringed myotis bat, long-legged myotis bat, Yuma myotis bat, Pacific western big-eared bat, bells sage sparrow, western burrowing owl, feruginous hawk, mountain plover, little willow flycatcher, white faced ibis, silvery legless lizard, southwestern pond turtle, San Joaquin whipsnake, California horned lizard, western spadefoot toad, green sturgeon, river lamprey, Kern brook lamprey, Pacific lamprey, longfin smelt, Antioch Dunes anthicid beetle, Sacramento anthicid beetle, and molestan blister beetle.

Limited sporadic use of the project area may occur for wintering greater sandhill cranes. This species (State-listed threatened) is a common winter migrant to the eastern Sacramento Valley. While the crane does not nest in the project area, it could use the open grasslands for foraging.

Bald eagle, peregrine falcon, yellow-billed cuckoo, and Aleutian Canada goose have been observed in the Delta, but none are confined exclusively to the area.

Habitat suitable for the California black rail can be found in the area of Little Potato Slough at its confluence with White Slough and on the islands in the Middle River area north of Woodward Ferry.

Suitable habitat for western pond turtles occurs along all water courses in the area. Previous surveys have recorded turtles in Lost Slough, Snodgrass Slough, South Fork Mokelumne River, and the Old and Middle Rivers.

Elderberry is widely distributed and is a common component of the mixed riparian woodland community of the Delta. These plants are considered potential habitat for the valley elderberry longhorn beetle.

VEGETATION

This Delta conveyance option would affect approximately 16,000 acres of agricultural and disturbed lands. No riparian lands would be affected.

SENSITIVE AND LISTED PLANT SPECIES

A federal candidate and State-listed rare plant, Mason's lilaeopsis, has been known to occur in the area that could be affected by the proposed conveyance option.

Candidate plant species for federal listing that may occur in the project area include Suisun Marsh aster, caper-fruited tropidocarpum, San Joaquin saltbush, Ferris's milk vetch, Delta tule pea, and recurved larkspur.

Additional plants listed by the California Native Plant Society as being rare, threatened or endangered in California and elsewhere, could also be affected by the proposed through Delta conveyance options. These plants include big tarweed, Wright's trichocoronis, marsh skullcap, California hisbiscus, heartscale, Delta mudwort, and bristly sedge.

Special-status habitats that may be found along or near the area of the proposed project include valley sink scrub, northern hardpan vernal pool, northern claypan vernal pool, alkali meadow, coastal and valley freshwater marsh, Great Valley mixed riparian forest, Great Valley oak riparian forest, and Valley Oak woodland.

Wetlands

Information gathered from the U.S. Fish and Wildlife Services' National Wetland Inventory map indicates that within the area that would be affected by the proposed project, there are approximately nine miles of farmed wetlands, three miles of scrub-shrub seasonal tidal wetlands, seven acres of scrub-shrub seasonally flooded wetlands (shallow marsh), and 28 acres of deep marsh.

Four special-status wetland habitats (northern hardpan vernal pool, northern claypan vernal pool, alkali meadow, and coastal and valley freshwater marsh) could be affected by the proposed through Delta conveyance options.

Cultural Resources

Generally, archaeological sites throughout the Delta province may be overrepresented. Historic activities connected with channel dredging, levee construction and maintenance, residential development, and agriculture have obscured, buried, and destroyed many sites since the first half of the twentieth century, when most were first found. Additionally, some may now be buried under alluvium.

Prehistoric settlements in the Delta were situated on low rises above flood level, on mounds on low knolls, on natural levees, and on higher ground along the banks of streams and rivers. Reclamation and farming activities have leveled most of these areas of higher relief. Field inspection will be necessary to verify the existence and condition of these sites for a more accurate assessment.

Historic period sites and features in the Delta province are generally underrepresented. The surveys responsible for identifying most of the archaeological sites were carried out by the University of California at Berkeley during the time when there was little concern for historic period resources. Almost all of them have been recorded since the 1970s.

In addition to farmsteads, ranches, and townsites, other resources noted on the quadrangle maps will require evaluation. These resources include levees, pumphouses, pumping stations, windmills, railroad grades, roads, bridges, pilings, piers, landings, and gas wells.

Review of the base maps and site records at the North Central (CSU at Sacramento), Central California (CSU at Stanislaus), Northwest (Sonoma State University), and Northeast Information Centers indicates that this option may affect a total of seven historic sites (non-significant). One is a trash scatter and six are associated with George Shima's agricultural operations. They represent a labor camp for Asian farm workers during the 1900-1920 period. Singly, the six

Shima farm sites are not significant, but collectively they may be eligible to the National Register of Historic Places as a Historic District.

BIBLIOGRAPHY

CALFED, 1997, *Status Reports on Technical Studies for the Storage and Conveyance Refinement Process.*

Department of Fish and Game, Natural Diversity Data Base," Update Version: 8/96, State of California.

Department of Water Resources, August 1974, *Draft Environmental Impact Report - Peripheral Canal Project*, State of California.

Department of Water Resources, 1990, *North Delta Program Draft EIR/EIS*, State of California.

Department of Water Resources, September 1990, *Los Banos Grandes Facilities Feasibility Report, Appendix A: Designs and Cost Estimates*, State of California.

Department of Water Resources, November 1993, *Program Environmental Impact Report - State Drought Water Bank*, State of California.

Department of Water Resources, 1995, *Isolated Transfer Facility Cost Estimate*, State of California.

U.S. Fish and Wildlife Service, National Wetlands Inventory Program.

U.S. Fish and Wildlife Service, September 1995, *Environmental Effects of Yield Increase Options, Technical Appendix #9 to the Final Least-Cost CVP Yield Increase Plan.*

U.S. Geological Survey, National Aerial Photography Program.

U.S. Geological Survey Topographic Maps.

Table 1
SUMMARY OF PHYSICAL CHARACTERISTICS
CHAIN OF LAKES PROJECT

	Siphon Only Alternative	Siphon and Pump Alternative
Delta Cross Channel Enlargement		
Capacity (cfs)	10,000	10,000
Pump Station Capacity (cfs)	10,000	10,000
Horsepower (HP)	16,610	16,610
Tyler Island		
Maximum Water Surface Elevation (MSL)	6.0	6.0
Maximum Water Storage Capacity (Acre-feet)	185,595	185,595
Operating Water Surface Elevation (MSL)	6.0	6.0
Operating Storage Capacity (Acre-feet)	185,595	185,595
Siphons		
Length (feet)	1,100	1,100
Boxes	3 - 30' x 30'	2 - 23' x 23'
Distributed Pump Stations		
Total Capacity (cfs)	5,000	5,000
Total Horsepower (HP)	7,570	7,570
Bouldin Island		
Maximum Water Surface Elevation (MSL)	6.0	6.0
Maximum Water Storage Capacity (Acre-feet)	182,900	182,900
Operating Water Surface Elevation (MSL)	5.0	-0.8
Operating Storage Capacity (Acre-feet)	174,300	129,130
Siphons		
Length (feet)	700	700
Boxes	3 - 30' x 30'	2 - 23' x 23'
Distributed Pump Stations		
Total Capacity (cfs)	5,000	5,000
Total Horsepower (HP)	7,570	7,570
Conveyance Pump Station		
Total Capacity (cfs)	--	15,000
Total Horsepower (HP)	--	25,080
Venice Island		
Maximum Water Surface Elevation (MSL)	6.0	6.0
Maximum Water Storage Capacity (Acre-feet)	92,700	92,700
Operating Water Surface Elevation (MSL)	4.0	6.0
Operating Storage Capacity (Acre-feet)	85,700	92,700
Siphons		
Length (feet)	1,700	1,700
Boxes	3 - 30' x 30'	2 - 23' x 23'
Distributed Pump Stations		
Total Capacity (cfs)	5,000	5,000
Total Horsepower (HP)	7,570	7,570
Mandeville Island		
Maximum Water Surface Elevation (MSL)	6.0	6.0
Maximum Water Storage Capacity (Acre-feet)	131,700	131,700
Operating Water Surface Elevation (MSL)	2.8	-2.0
Operating Storage Capacity (Acre-feet)	114,700	89,900
Sipons		

D-004987

Table 1
SUMMARY OF PHYSICAL CHARACTERISTICS
CHAIN OF LAKES PROJECT

	Siphon Only Alternative	Siphon and Pump Alternative
Length (feet)	900	900
Boxes	3 - 30' x 30'	2 - 23' x 23'
Distributed Pump Stations		
Total Capacity (cfs)	5,000	5,000
Total Horsepower (HP)	7,570	7,570
Conveyance Pump Station		
Total Capacity (cfs)	--	15,000
Total Horsepower (HP)	--	25,080
Bacon Island		
Maximum Water Surface Elevation (MSL)	6.0	6.0
Maximum Water Storage Capacity (Acre-feet)	117,700	117,700
Operating Water Surface Elevation (MSL)	1.8	6.0
Operating Storage Capacity (Acre-feet)	98,600	117,700
Siphons		
Length (feet)	1,500	1,500
Boxes	3 - 30' x 30'	2 - 23' x 23'
Distributed Pump Stations		
Total Capacity (cfs)	5,000	5,000
Total Horsepower (HP)	7,570	7,570
Woodward Island		
Maximum Water Surface Elevation (MSL)	6.0	6.0
Maximum Water Storage Capacity (Acre-feet)	20,900	20,900
Operating Water Surface Elevation (MSL)	0.7	-1.6
Operating Storage Capacity (Acre-feet)	15,400	13,400
Siphons		
Length (feet)	700	700
Boxes	3 - 30' x 30'	2 - 23' x 23'
Distributed Pump Stations		
Total Capacity (cfs)	5,000	5,000
Total Horsepower (HP)	7,570	7,570
Conveyance Pump Station		
Total Capacity (cfs)	--	15,000
Total Horsepower (HP)	--	25,080
Victoria Island		
Maximum Water Surface Elevation (MSL)	6.0	6.0
Maximum Water Storage Capacity (Acre-feet)	104,900	104,900
Operating Water Surface Elevation (MSL)	-0.2	6.0
Operating Storage Capacity (Acre-feet)	74,300	104,900
Siphons		
Length (feet)	1,400	1,400
Boxes	3 - 30' x 30'	2 - 23' x 23'
Distributed Pump Stations		
Total Capacity (cfs)	5,000	5,000
Total Horsepower (HP)	7,570	7,570

D-004988

Table 2a
ESTIMATED COSTS
CHAIN OF LAKES (SIPHON ONLY ALTERNATIVE)

DESCRIPTION	QUANTITY	UNIT[a]	USBR INDEX OCT. 90	USBR INDEX OCT. 96	UNIT COST OCT. 90	UNIT COST OCT. 96	TOTAL COST OCT. 96	COST REFERENCE
I. DELTA CROSS CHANNEL ENLARGEMENT								
Highway 160 Bridge	21,000	SF				$100	$2,100,000	1
Enlarge Gate Structure	JOB	LS	168	213	$18,612,000	$23,597,000	$23,597,000	2, page 437
Open Channel and Snodgrass Slough								
Riprap	226,100	TON	163	181	$15.00	$16.70	$3,775,870	2, page 439
Bedding (6" thick)	63,900	TON	163	181	$14.00	$15.60	$996,840	2, page 439
Geotextile (bedding)	1,438,200	SF	163	181	$0.25	$0.28	$402,696	2, page 439
Embankment	1,017,900	CY	163	181	$7.00	$7.80	$7,939,620	2, page 439
Foundation	407,300	CY	163	181	$9.80	$10.88	$4,432,324	1
Land Acquisition								
North Bank (300' wide)	19	AC				$3,000	$57,000	3
South Bank (1,000' wide)	26	AC				$3,000	$78,000	3
Fish Screens								
Fish Screen Installation	10,000	CFS				$5,000	$50,000,000	1
Pump Station (Q=10,000 cfs)	JOB	LS				$46,342,000	$46,342,000	1
Control Building	1,500	SF				$150	$225,000	1
Miscellaneous (fencing, parking)	JOB	LS				$50,000	$50,000	
SUBTOTAL DELTA CROSS CHANNEL ENLARGEMENT							$139,996,350	
II. TYLER ISLAND								
Land Acquisition	8,818	AC				$3,000	$26,454,000	
Levees								
Riprap	1,509,900	TON	163	181	$15.00	$16.70	$25,215,330	2, page 439
Bedding (6" thick)	426,800	TON	163	181	$14.00	$15.60	$6,658,080	2, page 439
Geotextile (bedding)	9,605,100	SF	163	181	$0.25	$0.28	$2,689,428	2, page 439
Embankment	490,500	CY	163	181	$7.00	$7.80	$3,825,900	2, page 439
Bridge (Thornton-Walnut Grove Road)	25,200	SF				$100	$2,520,000	1
Distributed Pump Station (Q=5,000 cfs)	JOB	LS				$30,575,000	$30,575,000	1
Tyler-Bouldin Siphon[b]								
Temporary River Alignment								
Excavation	55,451	CY	181	181	$2.50	$2.50	$138,628	5, page 7
Levees (using excavation)	55,451	CY	181	181	$3.00	$3.00	$166,353	5, page 7
Cofferdam Sheetpiling	301,600	SF	202	207	$28.00	$28.70	$8,655,920	5, page 7

D—004989

Table 2a
ESTIMATED COSTS
CHAIN OF LAKES (SIPHON ONLY ALTERNATIVE)

DESCRIPTION	QUANTITY	UNIT[a]	USBR INDEX OCT. 90	USBR INDEX OCT. 96	UNIT COST OCT. 90	UNIT COST OCT. 96	TOTAL COST OCT. 96	COST REFERENCE
Cofferdam Gravel Fill	29,600	CY	202	207	$21.00	$21.50	$636,400	5, page 7
Backfill	55,451	CY	181	181	$4.00	$4.00	$221,804	5, page 7
Dewatering	JOB	LS	202	207	$100,000	$102,500	$102,500	5, page 7
Siphon								
Excavation-Structural	172,755	CY	181	181	$6.00	$6.00	$1,036,530	5, page 7
Concrete	17,952	CY	198	213	$275	$296	$5,313,792	5, page 7
Reinforcing Steel	3,590,642	LBS	198	213	$0.60	$0.65	$2,333,917	5, page 7
Backfill	89,826	CY	181	181	$4.00	$4.00	$359,304	5, page 7
Riprap	27,379	TON	181	181	$27.00	$27.00	$739,233	5, page 7
Access Roads	0.18	MI	231	237	$500,000	$513,000	$92,340	5, page 7
Inlet and Outlet Transition								
Excavation	59,267	CY	181	181	$2.25	$2.25	$133,351	5, page 7
Concrete Slab	1,576	CY	198	213	$225	$242	$381,392	5, page 7
Concrete Walls	1,252	CY	198	213	$350	$377	$472,004	5, page 7
Reinforcing Steel	565,600	LBS	198	213	$0.60	$0.65	$367,640	5, page 7
Backfill	13,211	CY	181	181	$4.00	$4.00	$52,844	5, page 7
Miscellaneous @ 20%							$4,240,790	
SUBTOTAL TYLER ISLAND							$123,382,480	
III. BOULDIN ISLAND								
Land Acquisition	5,913	AC				$3,000	$17,739,000	3
Purchase Homes	4	EA				$200,000	$800,000	1
Levees								
Riprap	1,189,300	TON	163	181	$15.00	$16.70	$19,861,310	2, page 439
Bedding (6" thick)	336,200	TON	163	181	$14.00	$15.60	$5,244,720	2, page 439
Geotextile (bedding)	7,565,500	SF	163	181	$0.25	$0.28	$2,118,340	2, page 439
Embankment	386,400	CY	163	181	$7.00	$7.80	$3,013,920	2, page 439
Bridge	21,000	SF				$100	$2,100,000	1
Elevated Roadway								
Riprap	590,300	TON	163	181	$15.00	$16.70	$9,858,010	2, page 439
Bedding (6" thick)	166,900	TON	163	181	$14.00	$15.60	$2,603,640	2, page 439
Geotextile (bedding)	3,755,300	SF	163	181	$0.25	$0.28	$1,051,484	2, page 439
Embankment	2,663,400	CY	163	181	$7.00	$7.80	$20,774,520	2, page 439
Foundation	1,269,000	CY	163	181	$9.80	$10.88	$13,809,523	1

D-004990

Table 2a
ESTIMATED COSTS
CHAIN OF LAKES (SIPHON ONLY ALTERNATIVE)

DESCRIPTION	QUANTITY	UNIT[a]	USBR INDEX OCT. 90	USBR INDEX OCT. 96	UNIT COST OCT. 90	UNIT COST OCT. 96	TOTAL COST OCT. 96	COST REFERENCE
Aggregate Base	15,510	TON				$19.15	$297,017	4, item V-d
Asphalt Concrete	7,050	TON				$58.92	$415,386	4, item V-e
Distributed Pump Station (Q=5,000 cfs)	JOB	LS				$30,575,000	$30,575,000	1
Bouldin-Venice Siphon[b]								
Temporary River Alignment								
Excavation	35,287	CY	181	181	$2.50	$2.50	$88,218	5, page 7
Levees (using excavation)	35,287	CY	181	181	$3.00	$3.00	$105,861	5, page 7
Cofferdam Sheetpiling	150,800	SF	202	207	$28.00	$28.70	$4,327,960	5, page 7
Cofferdam Gravel Fill	14,800	CY	202	207	$21.00	$21.50	$318,200	5, page 7
Backfill	35,287	CY	181	181	$4.00	$4.00	$141,148	5, page 7
Dewatering	JOB	LS	202	207	$100,000	$102,500	$102,500	5, page 7
Siphon								
Excavation-Structural	109,935	CY	181	181	$6.00	$6.00	$659,610	5, page 7
Concrete	11,424	CY	198	213	$275	$296	$3,381,504	5, page 7
Reinforcing Steel	2,284,954	LBS	198	213	$0.60	$0.65	$1,485,220	5, page 7
Backfill	57,162	CY	181	181	$4.00	$4.00	$228,648	5, page 7
Riprap	17,423	TON	181	181	$27.00	$27.00	$470,421	5, page 7
Access Roads	0.11	MI	231	237	$500,000	$513,000	$56,430	5, page 7
Inlet and Outlet Transition								
Excavation	59,267	CY	181	181	$2.25	$2.25	$133,351	5, page 7
Concrete Slab	1,576	CY	198	213	$225	$242	$381,392	5, page 7
Concrete Walls	1,252	CY	198	213	$350	$377	$472,004	5, page 7
Reinforcing Steel	565,600	LBS	198	213	$0.60	$0.65	$367,640	5, page 7
Backfill	13,211	CY	181	181	$4.00	$4.00	$52,844	5, page 7
Miscellaneous @ 20%							$2,554,590	
SUBTOTAL BOULDIN ISLAND							$145,589,410	
IV. VENICE ISLAND								
Land Acquisition	3,103	AC				$3,000	$9,309,000	3
Levees								
Riprap	817,300	TON	163	181	$15.00	$16.70	$13,648,910	2, page 439
Bedding (6" thick)	231,000	TON	163	181	$14.00	$15.60	$3,603,600	2, page 439
Geotextile (bedding)	5,199,000	SF	163	181	$0.25	$0.28	$1,455,720	2, page 439
Embankment	265,500	CY	163	181	$7.00	$7.80	$2,070,900	2, page 439

D—004991

Table 2a
ESTIMATED COSTS
CHAIN OF LAKES (SIPHON ONLY ALTERNATIVE)

DESCRIPTION	QUANTITY	UNIT[a]	USBR INDEX OCT. 90	USBR INDEX OCT. 96	UNIT COST OCT. 90	UNIT COST OCT. 96	TOTAL COST OCT. 96	COST REFERENCE
Distributed Pump Station (Q=5,000 cfs)	JOB	LS				$30,575,000	$30,575,000	1
Venice-Mandeville Siphon[b]								
Temporary River Alignment								
Excavation	85,697	CY	181	181	$2.50	$2.50	$214,243	5, page 7
Levees (using excavation)	85,697	CY	181	181	$3.00	$3.00	$257,091	5, page 7
Cofferdam Sheetpiling	527,800	SF	202	207	$28.00	$28.70	$15,147,860	5, page 7
Cofferdam Gravel Fill	51,800	CY	202	207	$21.00	$21.50	$1,113,700	5, page 7
Backfill	85,697	CY	181	181	$4.00	$4.00	$342,788	5, page 7
Dewatering	JOB	LS	202	207	$100,000	$102,500	$102,500	5, page 7
Siphon								
Excavation-Structural	266,985	CY	181	181	$6.00	$6.00	$1,601,910	5, page 7
Concrete	27,744	CY	198	213	$275	$296	$8,212,224	5, page 7
Reinforcing Steel	5,549,174	LBS	198	213	$0.60	$0.65	$3,606,963	5, page 7
Backfill	138,822	CY	181	181	$4.00	$4.00	$555,288	5, page 7
Riprap	42,313	TON	181	181	$27.00	$27.00	$1,142,451	5, page 7
Access Roads	0.27	MI	231	237	$500,000	$513,000	$138,510	5, page 7
Inlet and Outlet Transition								
Excavation	59,267	CY	181	181	$2.25	$2.25	$133,351	5, page 7
Concrete Slab	1,576	CY	198	213	$225	$242	$381,392	5, page 7
Concrete Walls	1,252	CY	198	213	$350	$377	$472,004	5, page 7
Reinforcing Steel	565,600	LBS	198	213	$0.60	$0.65	$367,640	5, page 7
Backfill	13,211	CY	181	181	$4.00	$4.00	$52,844	5, page 7
Miscellaneous @ 20%							$6,768,552	
SUBTOTAL VENICE ISLAND							$101,274,440	
V. MANDEVILLE ISLAND								
Land Acquisition	5,214	AC				$3,000	$15,642,000	3
Levees								
Riprap	953,800	TON	163	181	$15.00	$16.70	$15,928,460	2, page 439
Bedding (6" thick)	269,600	TON	163	181	$14.00	$15.60	$4,205,760	2, page 439
Geotextile (bedding)	6,067,600	SF	163	181	$0.25	$0.28	$1,698,928	2, page 439
Embankment	309,900	CY	163	181	$7.00	$7.80	$2,417,220	2, page 439
Distributed Pump Station (Q-5,000 cfs)	JOB	LS				$30,575,000	$30,575,000	1
Mandeville-Bacon Siphon[b]								

Table 2a
ESTIMATED COSTS
CHAIN OF LAKES (SIPHON ONLY ALTERNATIVE)

DESCRIPTION	QUANTITY	UNIT[a]	USBR INDEX OCT. 90	USBR INDEX OCT. 96	UNIT COST OCT. 90	UNIT COST OCT. 96	TOTAL COST OCT. 96	COST REFERENCE
Temporary River Alignment								
Excavation	45,369	CY	181	181	$2.50	$2.50	$113,423	5, page 7
Levees (using excavation)	45,369	CY	181	181	$3.00	$3.00	$136,107	5, page 7
Cofferdam Sheetpiling	226,200	SF	202	207	$28.00	$28.70	$6,491,940	5, page 7
Cofferdam Gravel Fill	22,200	CY	202	207	$21.00	$21.50	$477,300	5, page 7
Backfill	45,369	CY	181	181	$4.00	$4.00	$181,476	5, page 7
Dewatering	JOB	LS	202	207	$100,000	$102,500	$102,500	5, page 7
Siphon								
Excavation-Structural	141,345	CY	181	181	$6.00	$6.00	$848,070	5, page 7
Concrete	14,688	CY	198	213	$275	$296	$4,347,648	5, page 7
Reinforcing Steel	2,937,798	LBS	198	213	$0.60	$0.65	$1,909,569	5, page 7
Backfill	73,494	CY	181	181	$4.00	$4.00	$293,976	5, page 7
Riprap	22,401	TON	181	181	$27.00	$27.00	$604,827	5, page 7
Access Roads	0.14	MI	231	237	$500,000	$513,000	$71,820	5, page 7
Inlet and Outlet Transition								
Excavation	59,267	CY	181	181	$2.25	$2.25	$133,351	5, page 7
Concrete Slab	1,576	CY	198	213	$225	$242	$381,392	5, page 7
Concrete Walls	1,252	CY	198	213	$350	$377	$472,004	5, page 7
Reinforcing Steel	565,600	LBS	198	213	$0.60	$0.65	$367,640	5, page 7
Backfill	13,211	CY	181	181	$4.00	$4.00	$52,844	5, page 7
Miscellaneous @ 20%							$3,397,177	
SUBTOTAL MANDEVILLE ISLAND							$90,850,431	
VI. BACON ISLAND								
Land Acquisition	5,066	AC				$3,000	$15,198,000	
Levees								
Riprap	914,600	TON	163	181	$15.00	$16.70	$15,273,820	2, page 439
Bedding (6" thick)	258,500	TON	163	181	$14.00	$15.60	$4,032,600	2, page 439
Geotextile (bedding)	5,818,200	SF	163	181	$0.25	$0.28	$1,629,096	2, page 439
Embankment	297,100	CY	163	181	$7.00	$7.80	$2,317,380	2, page 439
Distributed Pump Station (Q=5,000 cfs)	JOB	LS				$30,575,000	$30,575,000	1
Bacon-Woodward Siphon[b]								
Temporary River Alignment								
Excavation	75,615	CY	181	181	$2.50	$2.50	$189,038	5, page 7

Table 2a
ESTIMATED COSTS
CHAIN OF LAKES (SIPHON ONLY ALTERNATIVE)

DESCRIPTION	QUANTITY	UNIT[a]	USBR INDEX OCT. 90	USBR INDEX OCT. 96	UNIT COST OCT. 90	UNIT COST OCT. 96	TOTAL COST OCT. 96	COST REFERENCE
Levees (using excavation)	75,615	CY	181	181	$3.00	$3.00	$226,845	5, page 7
Cofferdam Sheetpiling	226,200	SF	202	207	$28.00	$28.70	$6,491,940	5, page 7
Cofferdam Gravel Fill	22,200	CY	202	207	$21.00	$21.50	$477,300	5, page 7
Backfill	75,615	CY	181	181	$4.00	$4.00	$302,460	5, page 7
Dewatering	JOB	LS	202	207	$100,000	$102,500	$102,500	5, page 7
Siphon								
Excavation-Structural	235,575	CY	181	181	$6.00	$6.00	$1,413,450	5, page 7
Concrete	24,480	CY	198	213	$275	$296	$7,246,080	5, page 7
Reinforcing Steel	4,896,330	LBS	198	213	$0.60	$0.65	$3,182,615	5, page 7
Backfill	122,490	CY	181	181	$4.00	$4.00	$489,960	5, page 7
Riprap	37,335	TON	181	181	$27.00	$27.00	$1,008,045	5, page 7
Access Roads	0.24	MI	231	237	$500,000	$513,000	$123,120	5, page 7
Inlet and Outlet Transition								
Excavation	59,267	CY	181	181	$2.25	$2.25	$133,351	5, page 7
Concrete Slab	1,576	CY	198	213	$225	$242	$381,392	5, page 7
Concrete Walls	1,252	CY	198	213	$350	$377	$472,004	5, page 7
Reinforcing Steel	565,600	LBS	198	213	$0.60	$0.65	$367,640	5, page 7
Backfill	13,211	CY	181	181	$4.00	$4.00	$52,844	5, page 7
Miscellaneous @ 20%							$4,532,117	
SUBTOTAL BACON ISLAND							$96,218,595	
VII. WOODWARD ISLAND								
Land Acquisition	1,565	AC				$3,000	$4,695,000	3
Levees								
Riprap	561,600	TON	163	181	$15.00	$16.70	$9,378,720	2, page 439
Bedding (6" thick)	158,800	TON	163	181	$14.00	$15.60	$2,477,280	2, page 439
Geotextile (bedding)	3,572,400	SF	163	181	$0.25	$0.28	$1,000,272	2, page 439
Embankment	182,500	CY	163	181	$7.00	$7.80	$1,423,500	2, page 439
Distributed Pump Station (Q=5,000 cfs)	JOB	LS				$30,575,000	$30,575,000	1
Woodward-Victoria Siphon[b]								
Temporary River Alignment								
Excavation	35,287	CY	181	181	$2.50	$2.50	$88,218	5, page 7
Levees (using excavation)	35,287	CY	181	181	$3.00	$3.00	$105,861	5, page 7
Cofferdam Sheetpiling	150,800	SF	202	207	$28.00	$28.70	$4,327,960	5, page 7

D—004994

Table 2a
ESTIMATED COSTS
CHAIN OF LAKES (SIPHON ONLY ALTERNATIVE)

DESCRIPTION	QUANTITY	UNIT[a]	USBR INDEX OCT. 90	USBR INDEX OCT. 96	UNIT COST OCT. 90	UNIT COST OCT. 96	TOTAL COST OCT. 96	COST REFERENCE
Cofferdam Gravel Fill	14,800	CY	202	207	$21.00	$21.50	$318,200	5, page 7
Backfill	35,287	CY	181	181	$4.00	$4.00	$141,148	5, page 7
Dewatering	JOB	LS	202	207	$100,000	$102,500	$102,500	5, page 7
Siphon								
Excavation-Structural	109,935	CY	181	181	$6.00	$6.00	$659,610	5, page 7
Concrete	11,424	CY	198	213	$275	$296	$3,381,504	5, page 7
Reinforcing Steel	2,284,954	LBS	198	213	$0.60	$0.65	$1,485,220	5, page 7
Backfill	57,162	CY	181	181	$4.00	$4.00	$228,648	5, page 7
Riprap	17,423	TON	181	181	$27.00	$27.00	$470,421	5, page 7
Access Roads	0.11	MI	231	237	$500,000	$513,000	$56,430	5, page 7
Inlet and Outlet Transition								
Excavation	59,267	CY	181	181	$2.25	$2.25	$133,351	5, page 7
Concrete Slab	1,576	CY	198	213	$225	$242	$381,392	5, page 7
Concrete Walls	1,252	CY	198	213	$350	$377	$472,004	5, page 7
Reinforcing Steel	565,600	LBS	198	213	$0.60	$0.65	$367,640	5, page 7
Backfill	13,211	CY	181	181	$4.00	$4.00	$52,844	5, page 7
Miscellaneous @ 20%							$2,554,590	
SUBTOTAL WOODWARD ISLAND							$64,877,312	
VIII. VICTORIA ISLAND								
Land Acquisition	6,767	AC				$3,000	$20,301,000	3
Levees								
Riprap	973,500	TON	163	181	$15.00	$16.70	$16,257,450	2, page 439
Bedding (6" thick)	275,200	TON	163	181	$14.00	$15.60	$4,293,120	2, page 439
Geotextile (bedding)	6,192,500	SF	163	181	$0.25	$0.28	$1,733,900	2, page 439
Embankment	316,200	CY	163	181	$7.00	$7.80	$2,466,360	2, page 439
Bridge	21,000	SF				$100	$2,100,000	1
Elevated Roadway (Highway 4)								
Riprap	570,200	TON	163	181	$15.00	$16.70	$9,522,340	2, page 439
Bedding (6" thick)	161,200	TON	163	181	$14.00	$15.60	$2,514,720	2, page 439
Geotextile (bedding)	3,627,500	SF	163	181	$0.25	$0.28	$1,015,700	2, page 439
Embankment	819,800	CY	163	181	$7.00	$7.80	$6,394,440	2, page 439
Foundation	740,100	CY	163	181	$9.80	$10.88	$8,053,923	
Aggregate Base	14,980	TON				$19.15	$286,867	4, item v-d

D—004995

Table 2a
ESTIMATED COSTS
CHAIN OF LAKES (SIPHON ONLY ALTERNATIVE)

DESCRIPTION	QUANTITY	UNIT[a]	USBR INDEX OCT. 90	USBR INDEX OCT. 96	UNIT COST OCT. 90	UNIT COST OCT. 96	TOTAL COST OCT. 96	COST REFERENCE
Asphalt Concrete	6,810	TON				$58.92	$401,245	4, item v-e
Distributed Pump Station	JOB	LS				$30,575,000	$30,575,000	1
Victoria-CCFB Siphon[b]								
Temporary River Alignment								
Excavation	70,574	CY	181	181	$2.50	$2.50	$176,435	5, page 7
Levees (using excavation)	70,574	CY	181	181	$3.00	$3.00	$211,722	5, page 7
Cofferdam Sheetpiling	150,800	SF	202	207	$28.00	$28.70	$4,327,960	5, page 7
Cofferdam Gravel Fill	14,800	CY	202	207	$21.00	$21.50	$318,200	5, page 7
Backfill	70,574	CY	181	181	$4.00	$4.00	$282,296	5, page 7
Dewatering	JOB	LS	202	207	$100,000	$102,500		5, page 7
Siphon								
Excavation-Structural	219,870	CY	181	181	$6.00	$6.00	$1,319,220	5, page 7
Concrete	22,848	CY	198	213	$275	$296	$6,763,008	5, page 7
Reinforcing Steel	4,569,908	LBS	198	213	$0.60	$0.65	$2,970,440	5, page 7
Backfill	114,324	CY	181	181	$4.00	$4.00	$457,296	5, page 7
Riprap	34,846	TON	181	181	$27.00	$27	$940,842	5, page 7
Access Roads	0.22	MI	231	237	$500,000	$513,000	$112,860	5, page 7
Inlet and Outlet Transition								
Excavation	59,267	CY	181	181	$2.25	$2.25	$133,351	5, page 7
Concrete Slab	1,576	CY	198	213	$225	$242	$381,392	5, page 7
Concrete Walls	1,252	CY	198	213	$350	$377	$472,004	5, page 7
Reinforcing Steel	565,600	LBS	198	213	$0.60	$0.65	$367,640	5, page 7
Backfill	13,211	CY	181	181	$4.00	$4.00	$52,844	5, page 7
Radial Gates and Hoist Assemblies	2	EA				$255,000	$510,000	
Miscellaneous @ 20%							$3,959,502	
SUBTOTAL VICTORIA ISLAND							$129,673,077	
IX. SEEPAGE INTERCEPTION WELLS	JOB	LS				$13,927,000	$13,927,000	1
SUBTOTAL FOR CHAIN OF LAKES (SIPHON ONLY ALTERNATIVE)							905,800,000	
CONTINGENCIES @ 20%							$181,200,000	
ESTIMATED CONSTRUCTION COST FOR CHAIN OF LAKES (SIPHON ONLY ALTERNATIVE)							$1,087,000,000	
ENGR., LEGAL, AND ADMIN. @ 35%							$380,500,000	

D—004996

Table 2a
ESTIMATED COSTS
CHAIN OF LAKES (SIPHON ONLY ALTERNATIVE)

DESCRIPTION	QUANTITY	UNIT[a]	USBR INDEX OCT. 90	USBR INDEX OCT. 96	UNIT COST OCT. 90	UNIT COST OCT. 96	TOTAL COST OCT. 96	COST REFERENCE
ESTIMATED CAPITAL COST FOR CHAIN OF LAKES (SIPHON ONLY ALTERNATIVE)							$1,467,500,000	
ESTIMATED CAPITAL COST RANGE								
LOW (-10 %)							$1,320,000,000	
HIGH (+25%)							$1,830,000,000	

Footnotes:

[a] SF=square foot; LS=lump sum; CY=cubic yard; AC=acre; CFS=cubic feet per second; HP=horsepower; LBS=pound; MI=mile; EA=each.

[b] The USBR index date for all siphons is September 95, not the October 1990 date shown above.

Cost References:

1. Cost developed by Bookman-Edmonston Engineering.
2. California Department of Water Resources, *North Delta Program Draft EIR, EIS*, November 1990.
3. U.S. Bureau of Reclamation, Land Resources Branch, Graham McMullen, February 1997.
4. California Department of Water Resources, *Los Banos Grandes Facilities Report, Appendix A: Designs and Cost Estimates, December 1990.*
5. California Department of Water Resources, *Isolated Transfer Facility Cost Estimate,* September 1995.
6. U.S. Bureau of Reclamation, *Reconnaissance Estimate, Delta Division--Peripheral Canal*, October 1964.

Table 2b
ESTIMATED COSTS
CHAIN OF LAKES (SIPHON AND PUMP ALTERNATIVE)

DESCRIPTION	QUANTITY	UNIT[a]	USBR INDEX OCT. 90	USBR INDEX OCT. 96	UNIT COST OCT. 90	UNIT COST OCT. 96	TOTAL COST OCT. 96	COST REFERENCE
I. DELTA CROSS CHANNEL ENLARGEMENT								
Highway 160 Bridge	21,000	SF				$100	$2,100,000	1
Enlarge Gate Structure	JOB	LS	168	213	$18,612,000	$23,597,000	$23,597,000	2, page 437
Open Channel and Snodgrass Slough								
Riprap	226,100	TON	163	181	$15.00	$16.70	$3,775,870	2, page 439
Bedding (6" thick)	63,900	TON	163	181	$14.00	$15.60	$996,840	2, page 439
Geotextile (bedding)	1,438,200	SF	163	181	$0.25	$0.28	$402,696	2, page 439
Embankment	1,017,900	CY	163	181	$7.00	$7.80	$7,939,620	2, page 439
Foundation	407,300	CY	163	181	$9.80	$10.88	$4,432,324	1
Land Acquisition								
North Bank (300' wide)	19	AC				$3,000	$57,000	3
South Bank (1,000' wide)	26	AC				$3,000	$78,000	3
Fish Screens								
Fish Screen Installation	10,000	CFS				$5,000	$50,000,000	1
Pump Station (Q=10,000 cfs)	JOB	LS				$46,342,000	$46,342,000	1
Control Building	1,500	SF				$150	$225,000	1
Miscellaneous (fencing, parking)	JOB	LS				$50,000	$50,000	
SUBTOTAL DELTA CROSS CHANNEL ENLARGEMENT							$139,996,350	
II. TYLER ISLAND								
Land Acquisition	8,818	AC				$3,000	$26,454,000	
Levees								
Riprap	1,509,900	TON	163	181	$15.00	$16.70	$25,215,330	2, page 439
Bedding (6" thick)	426,800	TON	163	181	$14.00	$15.60	$6,658,080	2, page 439
Geotextile (bedding)	9,605,100	SF	163	181	$0.25	$0.28	$2,689,428	2, page 439
Embankment	490,500	CY	163	181	$7.00	$7.80	$3,825,900	2, page 439
Bridge (Thornton-Walnut Grove Road)	25,200	SF				$100	$2,520,000	1
Distributed Pump Station (Q=5,000 cfs)	JOB	LS				$30,575,000	$30,575,000	1
Tyler-Bouldin Siphon[b]								
Temporary River Alignment								
Excavation	55,451	CY	181	181	$2.50	$2.50	$138,628	5, page 7
Levees (using excavation)	55,451	CY	181	181	$3.00	$3.00	$166,353	5, page 7
Cofferdam Sheetpiling	301,600	SF	202	207	$28.00	$28.70	$8,655,920	5, page 7

D-004998

Table 2b
ESTIMATED COSTS
CHAIN OF LAKES (SIPHON AND PUMP ALTERNATIVE)

DESCRIPTION	QUANTITY	UNIT[a]	USBR INDEX OCT. 90	USBR INDEX OCT. 96	UNIT COST OCT. 90	UNIT COST OCT. 96	TOTAL COST OCT. 96	COST REFERENCE
Cofferdam Gravel Fill	29,600	CY	202	207	$21.00	$21.50	$636,400	5, page 7
Backfill	55,451	CY	181	181	$4.00	$4.00	$221,804	5, page 7
Dewatering	JOB	LS	202	207	$100,000	$102,500	$102,500	5, page 7
Siphon								
Excavation-Structural	172,755	CY	181	181	$6.00	$6.00	$1,036,530	5, page 7
Concrete	17,952	CY	198	213	$275	$296	$5,313,792	5, page 7
Reinforcing Steel	3,590,642	LBS	198	213	$0.60	$0.65	$2,333,917	5, page 7
Backfill	89,826	CY	181	181	$4.00	$4.00	$359,304	5, page 7
Riprap	27,379	TON	181	181	$27.00	$27.00	$739,233	5, page 7
Access Roads	0.18	MI	231	237	$500,000	$513,000	$92,340	5, page 7
Inlet and Outlet Transition								
Excavation	59,267	CY	181	181	$2.25	$2.25	$133,351	5, page 7
Concrete Slab	1,576	CY	198	213	$225	$242	$381,392	5, page 7
Concrete Walls	1,252	CY	198	213	$350	$377	$472,004	5, page 7
Reinforcing Steel	565,600	LBS	198	213	$0.60	$0.65	$367,640	5, page 7
Backfill	13,211	CY	181	181	$4.00	$4.00	$52,844	5, page 7
Miscellaneous @ 20%							$4,240,790	
SUBTOTAL TYLER ISLAND							$123,382,480	
III. BOULDIN ISLAND								
Land Acquisition	5,913	AC				$3,000	$17,739,000	3
Purchase Homes	4	EA				$200,000	$800,000	1
Levees								
Riprap	1,189,300	TON	163	181	$15.00	$16.70	$19,861,310	2, page 439
Bedding (6" thick)	336,200	TON	163	181	$14.00	$15.60	$5,244,720	2, page 439
Geotextile (bedding)	7,565,500	SF	163	181	$0.25	$0.28	$2,118,340	2, page 439
Embankment	386,400	CY	163	181	$7.00	$7.80	$3,013,920	2, page 439
Bridge	21,000	SF				$100	$2,100,000	1
Elevated Roadway								
Riprap	590,300	TON	163	181	$15.00	$16.70	$9,858,010	2, page 439
Bedding (6" thick)	166,900	TON	163	181	$14.00	$15.60	$2,603,640	2, page 439
Geotextile (bedding)	3,755,300	SF	163	181	$0.25	$0.28	$1,051,484	2, page 439
Embankment	2,663,400	CY	163	181	$7.00	$7.80	$20,774,520	2, page 439
Foundation	1,269,000	CY	163	181	$9.80	$10.88	$13,809,523	1

D—004999

Table 2b
ESTIMATED COSTS
CHAIN OF LAKES (SIPHON AND PUMP ALTERNATIVE)

DESCRIPTION	QUANTITY	UNIT[a]	USBR INDEX OCT. 90	USBR INDEX OCT. 96	UNIT COST OCT. 90	UNIT COST OCT. 96	TOTAL COST OCT. 96	COST REFERENCE
Aggregate Base	15,510	TON				$19.15	$297,017	4, item V-d
Asphalt Concrete	7,050	TON				$58.92	$415,386	4, item V-e
Distributed Pump Station (Q=5,000 cfs)	JOB	LS				$30,575,000	$30,575,000	1
Bouldin-Venice Siphon[b]								
Temporary River Alignment								
Excavation	35,287	CY	181	181	$2.50	$2.50	$88,218	5, page 7
Levees (using excavation)	35,287	CY	181	181	$3.00	$3.00	$105,861	5, page 7
Cofferdam Sheetpiling	150,800	SF	202	207	$28.00	$28.70	$4,327,960	5, page 7
Cofferdam Gravel Fill	14,800	CY	202	207	$21.00	$21.50	$318,200	5, page 7
Backfill	35,287	CY	181	181	$4.00	$4.00	$141,148	5, page 7
Dewatering	JOB	LS	202	207	$100,000	$102,500	$102,500	5, page 7
Siphon								
Excavation-Structural	109,935	CY	181	181	$6.00	$6.00	$659,610	5, page 7
Concrete	11,424	CY	198	213	$275	$296	$3,381,504	5, page 7
Reinforcing Steel	2,284,954	LBS	198	213	$0.60	$0.65	$1,485,220	5, page 7
Backfill	57,162	CY	181	181	$4.00	$4.00	$228,648	5, page 7
Riprap	17,423	TON	181	181	$27.00	$27.00	$470,421	5, page 7
Access Roads	0.11	MI	231	237	$500,000	$513,000	$56,430	5, page 7
Inlet and Outlet Transition								
Excavation	59,267	CY	181	181	$2.25	$2.25	$133,351	5, page 7
Concrete Slab	1,576	CY	198	213	$225	$242	$381,392	5, page 7
Concrete Walls	1,252	CY	198	213	$350	$377	$472,004	5, page 7
Reinforcing Steel	565,600	LBS	198	213	$0.60	$0.65	$367,640	5, page 7
Backfill	13,211	CY	181	181	$4.00	$4.00	$52,844	5, page 7
Miscellaneous @ 20%							$2,554,590	
Pump Station (Q=15,000 CFS)	JOB	LS				$59,106,000	$59,106,000	6
SUBTOTAL BOULDIN ISLAND							$204,695,410	
IV. VENICE ISLAND								
Land Acquisition	3,103	AC				$3,000	$9,309,000	3
Levees								
Riprap	817,300	TON	163	181	$15.00	$16.70	$13,648,910	2, page 439
Bedding (6" thick)	231,000	TON	163	181	$14.00	$15.60	$3,603,600	2, page 439
Geotextile (bedding)	5,199,000	SF	163	181	$0.25	$0.28	$1,455,720	2, page 439

D-005000

Table 2b
ESTIMATED COSTS
CHAIN OF LAKES (SIPHON AND PUMP ALTERNATIVE)

DESCRIPTION	QUANTITY	UNIT[a]	USBR INDEX OCT. 90	USBR INDEX OCT. 96	UNIT COST OCT. 90	UNIT COST OCT. 96	TOTAL COST OCT. 96	COST REFERENCE
Embankment	265,500	CY	163	181	$7.00	$7.80	$2,070,900	2, page 439
Distributed Pump Station (Q=5,000 cfs)	JOB	LS				$30,575,000	$30,575,000	1
Venice-Mandeville Siphon[b]								
Temporary River Alignment								
Excavation	85,697	CY	181	181	$2.50	$2.50	$214,243	5, page 7
Levees (using excavation)	85,697	CY	181	181	$3.00	$3.00	$257,091	5, page 7
Cofferdam Sheetpiling	527,800	SF	202	207	$28.00	$28.70	$15,147,860	5, page 7
Cofferdam Gravel Fill	51,800	CY	202	207	$21.00	$21.50	$1,113,700	5, page 7
Backfill	85,697	CY	181	181	$4.00	$4.00	$342,788	5, page 7
Dewatering	JOB	LS	202	207	$100,000	$102,500	$102,500	5, page 7
Siphon								
Excavation-Structural	266,985	CY	181	181	$6.00	$6.00	$1,601,910	5, page 7
Concrete	27,744	CY	198	213	$275	$296	$8,212,224	5, page 7
Reinforcing Steel	5,549,174	LBS	198	213	$0.60	$0.65	$3,606,963	5, page 7
Backfill	138,822	CY	181	181	$4.00	$4.00	$555,288	5, page 7
Riprap	42,313	TON	181	181	$27.00	$27.00	$1,142,451	5, page 7
Access Roads	0.27	MI	231	237	$500,000	$513,000	$138,510	5, page 7
Inlet and Outlet Transition								
Excavation	59,267	CY	181	181	$2.25	$2.25	$133,351	5, page 7
Concrete Slab	1,576	CY	198	213	$225	$242	$381,392	5, page 7
Concrete Walls	1,252	CY	198	213	$350	$377	$472,004	5, page 7
Reinforcing Steel	565,600	LBS	198	213	$0.60	$0.65	$367,640	5, page 7
Backfill	13,211	CY	181	181	$4.00	$4.00	$52,844	5, page 7
Miscellaneous @ 20%							$6,768,552	
SUBTOTAL VENICE ISLAND							$101,274,440	
V. MANDEVILLE ISLAND								
Land Acquisition	5,214	AC				$3,000	$15,642,000	3
Levees								
Riprap	953,800	TON	163	181	$15.00	$16.70	$15,928,460	2, page 439
Bedding (6" thick)	269,600	TON	163	181	$14.00	$15.60	$4,205,760	2, page 439
Geotextile (bedding)	6,067,600	SF	163	181	$0.25	$0.28	$1,698,928	2, page 439
Embankment	309,900	CY	163	181	$7.00	$7.80	$2,417,220	2, page 439
Distributed Pump Station (Q-5,000 cfs)	JOB	LS				$30,575,000	$30,575,000	1

D-005001

Table 2b
ESTIMATED COSTS
CHAIN OF LAKES (SIPHON AND PUMP ALTERNATIVE)

DESCRIPTION	QUANTITY	UNIT[a]	USBR INDEX OCT. 90	USBR INDEX OCT. 96	UNIT COST OCT. 90	UNIT COST OCT. 96	TOTAL COST OCT. 96	COST REFERENCE
Mandeville-Bacon Siphon[b]								
Temporary River Alignment								
Excavation	45,369	CY	181	181	$2.50	$2.50	$113,423	5, page 7
Levees (using excavation)	45,369	CY	181	181	$3.00	$3.00	$136,107	5, page 7
Cofferdam Sheetpiling	226,200	SF	202	207	$28.00	$28.70	$6,491,940	5, page 7
Cofferdam Gravel Fill	22,200	CY	202	207	$21.00	$21.50	$477,300	5, page 7
Backfill	45,369	CY	181	181	$4.00	$4.00	$181,476	5, page 7
Dewatering	JOB	LS	202	207	$100,000	$102,500	$102,500	5, page 7
Siphon								
Excavation-Structural	141,345	CY	181	181	$6.00	$6.00	$848,070	5, page 7
Concrete	14,688	CY	198	213	$275	$296	$4,347,648	5, page 7
Reinforcing Steel	2,937,798	LBS	198	213	$0.60	$0.65	$1,909,569	5, page 7
Backfill	73,494	CY	181	181	$4.00	$4.00	$293,976	5, page 7
Riprap	22,401	TON	181	181	$27.00	$27.00	$604,827	5, page 7
Access Roads	0.14	MI	231	237	$500,000	$513,000	$71,820	5, page 7
Inlet and Outlet Transition								
Excavation	59,267	CY	181	181	$2.25	$2.25	$133,351	5, page 7
Concrete Slab	1,576	CY	198	213	$225	$242	$381,392	5, page 7
Concrete Walls	1,252	CY	198	213	$350	$377	$472,004	5, page 7
Reinforcing Steel	565,600	LBS	198	213	$0.60	$0.65	$367,640	5, page 7
Backfill	13,211	CY	181	181	$4.00	$4.00	$52,844	5, page 7
Miscellaneous @ 20%							$3,397,177	
Pump Station (Q=15,000 cfs)	JOB	LS				$59,106,000	$59,106,000	6
SUBTOTAL MANDEVILLE ISLAND							$149,956,431	
VI. BACON ISLAND								
Land Acquisition	5,066	AC				$3,000	$15,198,000	
Levees								
Riprap	914,600	TON	163	181	$15.00	$16.70	$15,273,820	2, page 439
Bedding (6" thick)	258,500	TON	163	181	$14.00	$15.60	$4,032,600	2, page 439
Geotextile (bedding)	5,818,200	SF	163	181	$0.25	$0.28	$1,629,096	2, page 439
Embankment	297,100	CY	163	181	$7.00	$7.80	$2,317,380	2, page 439
Distributed Pump Station (Q=5,000 cfs)	JOB	LS				$30,575,000	$30,575,000	1
Bacon-Woodward Siphon[b]								

Table 2b
ESTIMATED COSTS
CHAIN OF LAKES (SIPHON AND PUMP ALTERNATIVE)

DESCRIPTION	QUANTITY	UNIT[a]	USBR INDEX OCT. 90	USBR INDEX OCT. 96	UNIT COST OCT. 90	UNIT COST OCT. 96	TOTAL COST OCT. 96	COST REFERENCE
Temporary River Alignment								
Excavation	75,615	CY	181	181	$2.50	$2.50	$189,038	5, page 7
Levees (using excavation)	75,615	CY	181	181	$3.00	$3.00	$226,845	5, page 7
Cofferdam Sheetpiling	226,200	SF	202	207	$28.00	$28.70	$6,491,940	5, page 7
Cofferdam Gravel Fill	22,200	CY	202	207	$21.00	$21.50	$477,300	5, page 7
Backfill	75,615	CY	181	181	$4.00	$4.00	$302,460	5, page 7
Dewatering	JOB	LS	202	207	$100,000	$102,500	$102,500	5, page 7
Siphon								
Excavation-Structural	235,575	CY	181	181	$6.00	$6.00	$1,413,450	5, page 7
Concrete	24,480	CY	198	213	$275	$296	$7,246,080	5, page 7
Reinforcing Steel	4,896,330	LBS	198	213	$0.60	$0.65	$3,182,615	5, page 7
Backfill	122,490	CY	181	181	$4.00	$4.00	$489,960	5, page 7
Riprap	37,335	TON	181	181	$27.00	$27.00	$1,008,045	5, page 7
Access Roads	0.24	MI	231	237	$500,000	$513,000	$123,120	5, page 7
Inlet and Outlet Transition								
Excavation	59,267	CY	181	181	$2.25	$2.25	$133,351	5, page 7
Concrete Slab	1,576	CY	198	213	$225	$242	$381,392	5, page 7
Concrete Walls	1,252	CY	198	213	$350	$377	$472,004	5, page 7
Reinforcing Steel	565,600	LBS	198	213	$0.60	$0.65	$367,640	5, page 7
Backfill	13,211	CY	181	181	$4.00	$4.00	$52,844	5, page 7
Miscellaneous @ 20%							$4,532,117	
SUBTOTAL BACON ISLAND							$96,218,595	
VII. WOODWARD ISLAND								
Land Acquisition	1,565	AC				$3,000	$4,695,000	3
Levees								
Riprap	561,600	TON	163	181	$15.00	$16.70	$9,378,720	2, page 439
Bedding (6" thick)	158,800	TON	163	181	$14.00	$15.60	$2,477,280	2, page 439
Geotextile (bedding)	3,572,400	SF	163	181	$0.25	$0.28	$1,000,272	2, page 439
Embankment	182,500	CY	163	181	$7.00	$7.80	$1,423,500	2, page 439
Distributed Pump Station (Q=5,000 cfs)	JOB	LS				$30,575,000	$30,575,000	1
Woodward-Victoria Siphon[b]								
Temporary River Alignment								

Table 2b
ESTIMATED COSTS
CHAIN OF LAKES (SIPHON AND PUMP ALTERNATIVE)

DESCRIPTION	QUANTITY	UNIT[a]	USBR INDEX OCT. 90	USBR INDEX OCT. 96	UNIT COST OCT. 90	UNIT COST OCT. 96	TOTAL COST OCT. 96	COST REFERENCE
Excavation	35,287	CY	181	181	$2.50	$2.50	$88,218	5, page 7
Levees (using excavation)	35,287	CY	181	181	$3.00	$3.00	$105,861	5, page 7
Cofferdam Sheetpiling	150,800	SF	202	207	$28.00	$28.70	$4,327,960	5, page 7
Cofferdam Gravel Fill	14,800	CY	202	207	$21.00	$21.50	$318,200	5, page 7
Backfill	35,287	CY	181	181	$4.00	$4.00	$141,148	5, page 7
Dewatering	JOB	LS	202	207	$100,000	$102,500	$102,500	5, page 7
Siphon								
Excavation-Structural	109,935	CY	181	181	$6.00	$6.00	$659,610	5, page 7
Concrete	11,424	CY	198	213	$275	$296	$3,381,504	5, page 7
Reinforcing Steel	2,284,954	LBS	198	213	$0.60	$0.65	$1,485,220	5, page 7
Backfill	57,162	CY	181	181	$4.00	$4.00	$228,648	5, page 7
Riprap	17,423	TON	181	181	$27.00	$27.00	$470,421	5, page 7
Access Roads	0.11	MI	231	237	$500,000	$513,000	$56,430	5, page 7
Inlet and Outlet Transition								
Excavation	59,267	CY	181	181	$2.25	$2.25	$133,351	5, page 7
Concrete Slab	1,576	CY	198	213	$225	$242	$381,392	5, page 7
Concrete Walls	1,252	CY	198	213	$350	$377	$472,004	5, page 7
Reinforcing Steel	565,600	LBS	198	213	$0.60	$0.65	$367,640	5, page 7
Backfill	13,211	CY	181	181	$4.00	$4.00	$52,844	5, page 7
Miscellaneous @ 20%							$2,554,590	
Pump Station (Q=15,000 cfs)	JOB	LS				$59,106,000	$59,106,000	6
SUBTOTAL WOODWARD ISLAND							$123,983,312	
VIII. VICTORIA ISLAND								
Land Acquisition	6,767	AC				$3,000	$20,301,000	3
Levees								
Riprap	973,500	TON	163	181	$15.00	$16.70	$16,257,450	2, page 439
Bedding (6" thick)	275,200	TON	163	181	$14.00	$15.60	$4,293,120	2, page 439
Geotextile (bedding)	6,192,500	SF	163	181	$0.25	$0.28	$1,733,900	2, page 439
Embankment	316,200	CY	163	181	$7.00	$7.80	$2,466,360	2, page 439
Bridge	21,000	SF				$100	$2,100,000	1
Elevated Roadway (Highway 4)								
Riprap	570,200	TON	163	181	$15.00	$16.70	$9,522,340	2, page 439
Bedding (6" thick)	161,200	TON	163	181	$14.00	$15.60	$2,514,720	2, page 439

Table 2b
ESTIMATED COSTS
CHAIN OF LAKES (SIPHON AND PUMP ALTERNATIVE)

DESCRIPTION	QUANTITY	UNIT[a]	USBR INDEX OCT. 90	USBR INDEX OCT. 96	UNIT COST OCT. 90	UNIT COST OCT. 96	TOTAL COST OCT. 96	COST REFERENCE
Geotextile (bedding)	3,627,500	SF	163	181	$0.25	$0.28	$1,015,700	2, page 439
Embankment	819,800	CY	163	181	$7.00	$7.80	$6,394,440	2, page 439
Foundation	740,100	CY	163	181	$9.80	$10.88	$8,053,923	
Aggregate Base	14,980	TON				$19.15	$286,867	4, item v-d
Asphalt Concrete	6,810	TON				$58.92	$401,245	4, item v-e
Distributed Pump Station	JOB	LS				$30,575,000	$30,575,000	1
Victoria-CCFB Siphon[b]								
Temporary River Alignment								
Excavation	70,574	CY	181	181	$2.50	$2.50	$176,435	5, page 7
Levees (using excavation)	70,574	CY	181	181	$3.00	$3.00	$211,722	5, page 7
Cofferdam Sheetpiling	150,800	SF	202	207	$28.00	$28.70	$4,327,960	5, page 7
Cofferdam Gravel Fill	14,800	CY	202	207	$21.00	$21.50	$318,200	5, page 7
Backfill	70,574	CY	181	181	$4.00	$4.00	$282,296	5, page 7
Dewatering	JOB	LS	202	207	$100,000	$102,500		5, page 7
Siphon								
Excavation-Structural	219,870	CY	181	181	$6.00	$6.00	$1,319,220	5, page 7
Concrete	22,848	CY	198	213	$275	$296	$6,763,008	5, page 7
Reinforcing Steel	4,569,908	LBS	198	213	$0.60	$0.65	$2,970,440	5, page 7
Backfill	114,324	CY	181	181	$4.00	$4.00	$457,296	5, page 7
Riprap	34,846	TON	181	181	$27.00	$27	$940,842	5, page 7
Access Roads	0.22	MI	231	237	$500,000	$513,000	$112,860	5, page 7
Inlet and Outlet Transition								
Excavation	59,267	CY	181	181	$2.25	$2.25	$133,351	5, page 7
Concrete Slab	1,576	CY	198	213	$225	$242	$381,392	5, page 7
Concrete Walls	1,252	CY	198	213	$350	$377	$472,004	5, page 7
Reinforcing Steel	565,600	LBS	198	213	$0.60	$0.65	$367,640	5, page 7
Backfill	13,211	CY	181	181	$4.00	$4.00	$52,844	5, page 7
Radial Gates and Hoist Assemblies	2	EA				$255,000	$510,000	
Miscellaneous @ 20%							$3,959,502	
SUBTOTAL VICTORIA ISLAND							$129,673,077	
IX. SEEPAGE INTERCEPTION WELLS	JOB	LS				$13,927,000	$13,927,000	1

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Table 2b
ESTIMATED COSTS
CHAIN OF LAKES (SIPHON AND PUMP ALTERNATIVE)

DESCRIPTION	QUANTITY	UNIT[a]	USBR INDEX OCT. 90	USBR INDEX OCT. 96	UNIT COST OCT. 90	UNIT COST OCT. 96	TOTAL COST OCT. 96	COST REFERENCE
SUBTOTAL FOR CHAIN OF LAKES (SIPHON ONLY ALTERNATIVE)							1,083,100,000	
CONTINGENCIES @ 20%							$216,600,000	
ESTIMATED CONSTRUCTION COST FOR CHAIN OF LAKES (SIPHON ONLY ALTERNATIVE)							$1,299,700,000	
ENGR., LEGAL, AND ADMIN. @ 35%							$454,900,000	
ESTIMATED CAPITAL COST FOR CHAIN OF LAKES (SIPHON ONLY ALTERNATIVE)							$1,754,600,000	
ESTIMATED CAPITAL COST RANGE								
LOW (-10 %)							$1,579,000,000	
HIGH (+25%)							$2,193,000,000	

Footnotes:

[a] SF=square foot; LS=lump sum; CY=cubic yard; AC=acre; CFS=cubic feet per second; HP=horsepower; LBS=pound; MI=mile; EA=each.

[b] The USBR index date for all siphons is September 95, not the October 1990 date shown above.

Cost References:

1. Cost developed by Bookman-Edmonston Engineering.
2. California Department of Water Resources, *North Delta Program Draft EIR, EIS*, November 1990.
3. U.S. Bureau of Reclamation, Land Resources Branch, Graham McMullen, February 1997.
4. California Department of Water Resources, *Los Banos Grandes Facilities Report, Appendix A: Designs and Cost Estimates, December 1990.*
5. California Department of Water Resources, *Isolated Transfer Facility Cost Estimate,* September 1995.
6. U.S. Bureau of Reclamation, *Reconnaissance Estimate, Delta Division--Peripheral Canal*, October 1964.

Table 3
SUMMARY OF ESTIMATED COSTS
CHAIN OF LAKES PROJECT

Cost Item	Estimated Costs ($Million)	
	Siphon Only Alternative	Siphon and Pump Alternative
Delta Cross Channel Enlargement	140.0	140.0
Tyler Island Conversion	123.4	123.4
Bouldin Island Conversion	145.6	204.7
Venice Island Conversion	101.3	101.3
Mandeville Island Conversion	90.9	150.0
Bacon Island Conversion	96.2	96.2
Woodward Island Conversion	64.9	124.0
Victoria Island Conversion	129.7	129.7
Seepage Interception Wells	13.9	13.9
SUBTOTAL	905.8	1,083.1
Contingencies (20%)	181.2	216.6
ESTIMATED CONSTRUCTION COST	1,087.0	1,299.7
Engineering, Legal, and Project Administration (35%)	380.5	454.9
ESTIMATED TOTAL CAPITAL COST	1,467.5	1,754.6
Capital Cost Range (minus 10% - plus 25%)	1,321-1,834	1,579-2,193

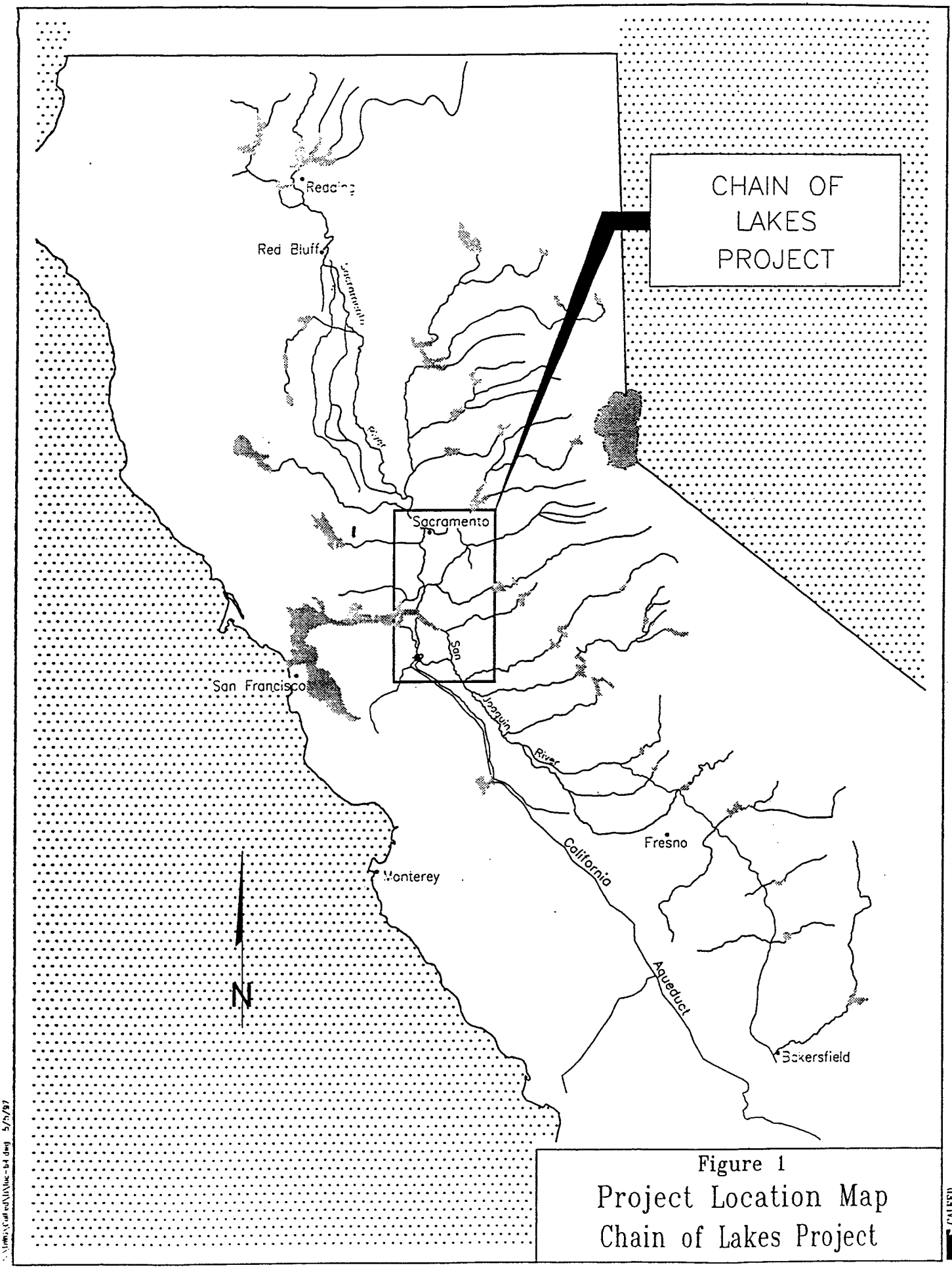

Figure 1
Project Location Map
Chain of Lakes Project

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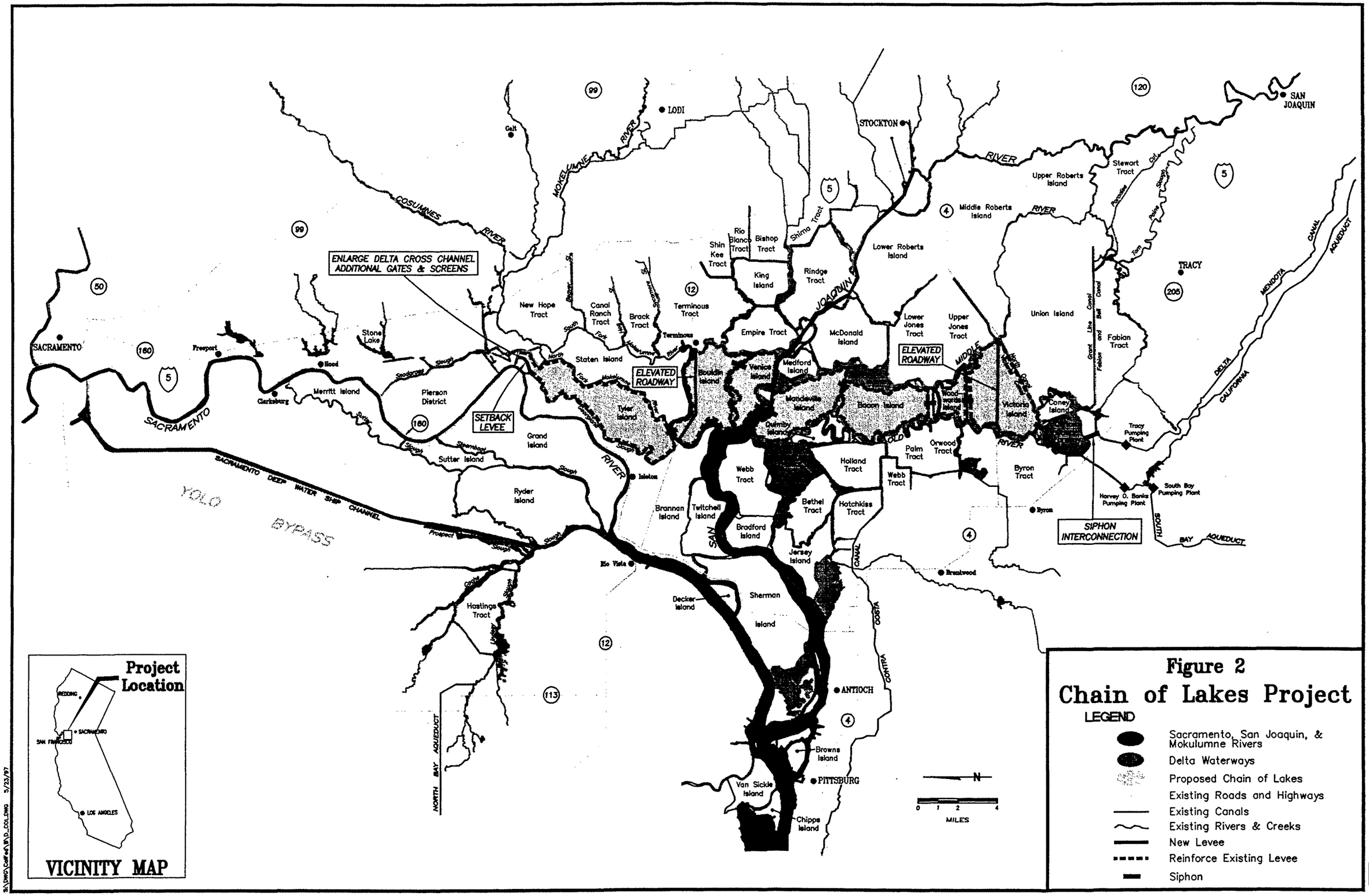

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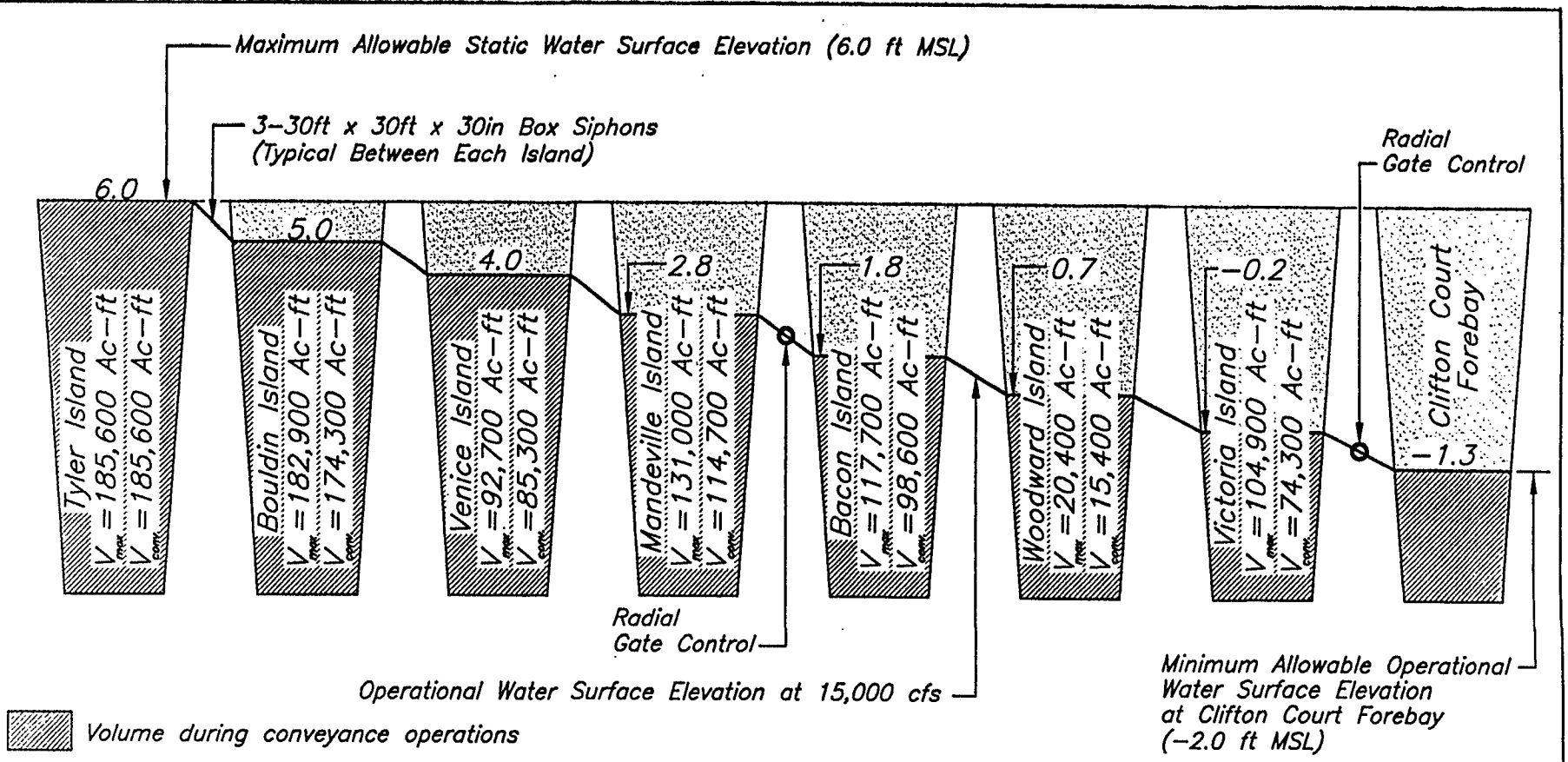

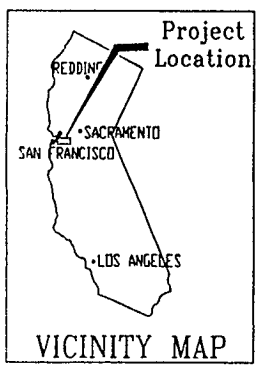

NOTES:

1. Levee elevations to be raised accordingly such that the static water surface elevation in all reservoirs is 6.0 feet MSL.
2. $V_{conv.}$ = Maximum storage capacity while conveying 15,000 cfs through the entire system.
   = 748,200 Ac-ft
3. V_{max} = Maximum static storage capacity of island.
   = 835,200 Ac-ft

Figure 3

Chain of Lakes

Siphon Only Alternative

CALFED BAY-DELTA PROGRAM

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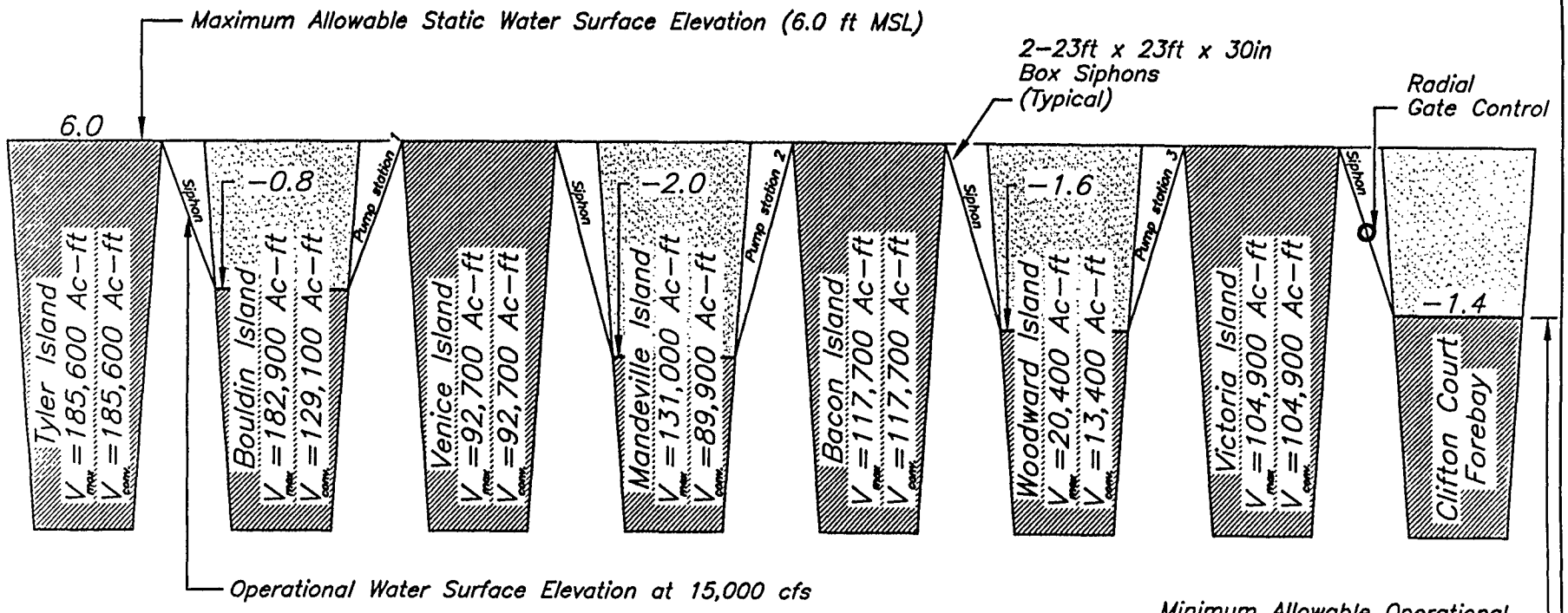

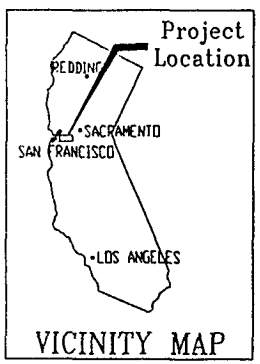

NOTES:

1. Levee elevations to be raised accordingly such that the static water surface elevation in all reservoirs is 6.0 feet MSL.
2. $V_{conv.}$ = Maximum storage capacity while conveying 15,000 cfs through the entire system. = 733,300 Ac–ft
3. V_{max} = Maximum static storage capacity of island. = 835,200 Ac–ft

Figure 4

Chain of Lakes

Pump and Siphon Alternative

CALFED BAY–DELTA PROGRAM

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