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FACILITY DESCRIPTIONS AND COST ESTIMATES

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CALFED STORAGE AND CONVEYANCE COMPONENT FACILITY DESCRIPTION AND COST ESTIMATE REPORTS

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D-008456

FACILITY DESCRIPTIONS AND UPDATED COST ESTIMATES FOR SHASTA LAKE ENLARGEMENT

Prepared by the CALFED Storage and Conveyance Refinement Team
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INTRODUCTION

The *Facility Descriptions and Updated Cost Estimates for Shasta Lake Enlargement* report 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 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 enlarging the existing Shasta Dam and Lake from its present capacity of about 4.55 million acre-feet (maf) to 6.75 or 14.3 maf. The general location of Shasta Lake is shown in Figure 1. This evaluation and others being performed by CALFED are intended to provide facility descriptions and updated cost estimates of representative storage and conveyance components. The objectives of the Shasta Lake Enlargement evaluation are to: (1) provide an updated cost estimate that represents a cost within the range expected if the project were to be constructed today and (2) enable CALFED to compare this project against other projects that might be considered as part of a long-term CALFED solution strategy.

The cost estimate for the Shasta Lake Enlargement was determined by adapting and then escalating the costs found in two reports: the U.S. Bureau of Reclamation's (Reclamation) September 1983 report titled *Enlarged Shasta Lake Investigation — Preliminary Findings Report* and a Reclamation and California Department of Water Resources' (DWR) February 1988 report titled *Enlarging Shasta Lake Investigation — Office Report, Appendix 3*. The cost estimates performed by Reclamation in 1983 and by Reclamation and DWR in 1988 provide the basis of this evaluation; minor modifications were made to reflect current design and safety standards.

A preliminary evaluation of the environmental considerations associated with this proposed project has also been 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 the evaluation of environmental considerations was gathered from existing literature.

PROJECT BACKGROUND

Development of the Sacramento River at what is now Shasta Lake was originally included as part of the California's State Water Plan of 1930. The Central Valley Project Act called for Kennet Reservoir (now Shasta Lake) to be developed with a storage capacity of approximately 8.0 maf. Development of the Central Valley Project (CVP), however, was not financially feasible for California as a result of economic conditions during the Great Depression era. Reclamation secured federal authorization to construct the CVP in 1935. Shasta Dam was completed in 1945, but economic conditions during the 1930s limited the capacity of the reservoir to its present size of 4.55 maf.

Following the extreme drought of 1976 and 1977, Reclamation prepared in November 1978 the *Total Water Management Study for the Central Valley Basin, California: Enlarging Shasta Lake, Working Document No. 13.* That document addressed several alternative dam sizes and locations and concluded that enlarging the existing structure to impound up to 14.0 maf warranted further investigation.

Pursuant to the 1978 findings, Reclamation and DWR undertook follow-up studies for enlarging Shasta Dam, which resulted in Reclamation's September 1983 report titled *Enlarged Shasta Lake Investigation, Shasta Division, CVP, California, Preliminary Findings Report.* This report concluded that the plan formulation for enlarging Shasta Dam to approximately 14.0 maf was warranted. The initial stages of plan formulation included a series of memoranda compiled by

Reclamation and DWR, which were compiled in the report titled *Enlarging Shasta Lake Investigation, Office Report, Appendix 3*. Components of that report provide updates and expanded detail to the 1983 report, which together provide the basis for the present evaluation.

FACILITIES DESCRIPTION

This section provides an overview of the major features of the Shasta Lake Enlargement. This evaluation includes the description of two alternative enlargement projects — a 6.75 maf and a 14.3 maf alternative. The principal references used for this synopsis are Reclamation's 1983 report titled *Enlarged Shasta Lake Investigation, Shasta Division, CVP, California Preliminary Findings Report* and the joint Reclamation and DWR 1988 report titled *Enlarging Shasta Lake Investigation, Office Report, Appendix 3*.

PROJECT LOCATION

The proposed enlargement of Shasta Dam would be located on the Sacramento River in Shasta County about 12 miles north of the city of Redding at the present location of Shasta Lake. The enlarged reservoir would be entirely within Shasta County; its water surface would extend farther into the reaches of the upper Sacramento, McCloud, and Pit Rivers. Figure 2 provides a facilities location map for the Shasta Lake Enlargement.

PROJECT DESCRIPTION

The primary purpose of enlarging Shasta Dam and Lake would be to reduce the frequency and magnitude of projected water shortages for various uses in the Sacramento-San Joaquin Delta (Delta) by storing surplus winter and spring flows for release during dry seasons and years.

The project operation would be coordinated with other existing and future State Water Project (SWP), CVP, and proposed CALFED facilities to enhance water supply opportunities. Changes in the storage and release of water from an enlarged Shasta Lake would depend on other activities of CALFED, the Central Valley Project Improvement Act, evolving Bay-Delta Water Quality Standards, and resource management programs and requirements on the Sacramento River. As these aspects of the operations are in the formative stages, the present evaluation does not provide descriptions of water supply opportunities.

EXISTING FACILITIES

The existing facilities at Shasta Lake include Shasta Dam, Shasta Powerplant, and Keswick Dam. These facilities are described in the following section. Table 1 provides a summary of the physical characteristics of these facilities and Figure 2 shows their general location.

Shasta Dam and Lake

Shasta Lake has a storage capacity of 4.55 maf created by one of the largest concrete gravity dams ever constructed in the United States. Shasta Dam has a height of 602 feet and a crest length of 3,460 feet. The dam contains approximately 6.5 million cubic yards of concrete weighing 15 million tons. The spillway, located at the center of the dam, has a height of 487 feet and a capacity of 186,000 cubic-feet-per-second (cfs) and is controlled by three drum gates.

The dam also has a newly completed Temperature Control Device (TCD). The TCD is an 8,000-ton, 300-foot tall steel frame structure attached to the upstream face of the dam. A series of gates on the TCD structure allows for withdrawal of water from various lake levels to help control water temperatures in the upper Sacramento River while generating power in the Shasta Powerplant.

Shasta Lake impounds waters of the Sacramento, McCloud, and Pit Rivers draining a combined area of 6,665 square miles. The lake has a length of about 35 miles and approximately 365 miles of shoreline. The surface area of the lake covers 29,500 acres when Shasta Lake is at full capacity.

Shasta Powerplant

The Shasta Powerplant has an installed capacity of 539 megawatts. The powerplant houses five generating units, which receive water through five 15-foot diameter steel penstocks. The penstocks are connected to the TCD on the upstream face of the dam.

Keswick Dam and Reservoir

Keswick Dam is located on the Sacramento River 9 miles downstream of Shasta Dam. Keswick Dam creates an afterbay reservoir for regulating power generation releases from Shasta and Spring Creek Powerplants. Spring Creek Powerplant generates power from water imported from the Trinity River. Releases made at these two plants are reregulated through the Keswick Dam and Powerplant to maintain flow requirements on the upper Sacramento River. The Keswick Powerplant has three generating units with a total combined generating capacity of 90 megawatts. The reservoir formed by Keswick Dam has a capacity of 23,800 acre-feet.

PRINCIPAL FACILITIES

The following section provides a description of the facilities required to enlarge Shasta Lake to a total storage capacity of 6.75 and 14.3 maf. The physical characteristics of the facilities required for either enlargement alternative are summarized in Table 1 and their locations are shown in Figure 2. Figure 3 provides a general schematic profile of the existing Shasta Dam and of the dams required for the 6.75 and 14.3 maf enlargement alternatives. Figure 3 also shows the water

surface elevations and corresponding storage capacities of the existing reservoir and the two enlargement alternatives. Figure 4 provides area-elevation-capacity curves for Shasta Lake at the Shasta Dam site.

Shasta Lake Enlargement - 6.75 maf Alternative

Enlarging Shasta Lake to 6.75 maf would correspond to an increase of 2.2 maf of storage capacity and a rise in the maximum water surface of 63 feet to an elevation of 1,130 feet above mean sea level (MSL). The facilities required for this increase are described below and a summary of their physical characteristics is provided in Table 1.

Shasta Dam and Lake

To accommodate an additional 2.2 maf of storage capacity, the height of the existing Shasta Dam would be increased by 63 feet. Roller-compacted concrete would be added to the downstream face of the dam to facilitate raising the dam's height. The left and right abutments of the dam would also be extended with roller-compacted concrete.

The spillway of the enlarged dam would be located in the center of the structure as it is with the existing dam. The spillway would have a capacity of 253,000 cfs controlled by six radial gates 55 feet wide by 27.5 feet high. For this preliminary evaluation, it is assumed that the general configuration of the dam's outlet works and the TCD would remain the same. Modifications to both the outlet works and the TCD would be made to accommodate the increased size of the dam structure.

The rise in the maximum water surface elevation by 63 feet would inundate an additional 8,000 acres. The small increase in surface area is due to the relatively steep terrain, which comprises much of the reservoir's current shoreline. The increased water surface elevation

would require relocation of portions of Interstate 5 and the Southern Pacific Railroad (SPRR). In addition, a number of resorts would also have to be relocated.

Shasta Powerplant

Enlarging Shasta Dam by 63 feet would not require the relocation of the Shasta Powerplant. The generation capacity of the powerplant, however, would be increased to 680 megawatts to take advantage of the increased head of the enlarged reservoir.

Keswick Dam and Reservoir

Increasing the storage capacity of Shasta Dam and Lake to 6.75 maf would not require modifications to Keswick Dam, Reservoir, or Powerplant.

Transportation Relocations

This preliminary evaluation of enlarging Shasta Dam and Lake assumes that portions of Interstate 5 and the SPRR would have to be relocated for either of the enlargement alternatives (6.75 or 14.3 maf). Relocation costs were developed by Reclamation and reported in its 1983 report titled *Enlarged Shasta Lake Investigation — Preliminary Findings Report.* The costs and relocation routes developed by Reclamation in the 1983 report were used to determine the costs and extent of relocation necessary for enlarging Shasta Lake to 6.74 maf. More detailed investigations would be required, however, to determine the exact extent of the relocations required for the 63-foot rise in the maximum water surface elevation of Shasta Lake.

Interstate 5

Up to 18 miles of the Interstate 5 would have to be relocated to accommodate increased water surface elevations. The most costly component of the relocation would be the bridgework required for replacing the Bridge Bay crossing. The proposed reconstruction of the bridge at Bay Bridge would serve both SPRR and Interstate 5, and would rank among the world's longest spans for a combined facility

Southern Pacific Railroad

Up to 34 miles of the SPRR would be relocated to accommodate increased water surface elevations of an enlarged Shasta Lake. The railroad relocation would require several new tunnels and bridges. As mentioned above for the Interstate 5 relocation, the Bridge Bay crossing would be a significant portion of the relocation costs.

Shasta Enlargement — 14.3 maf Alternative

Enlarging Shasta Lake a total storage capacity of 14.3 maf would correspond to an increased storage capacity of 9.75 maf and a rise in the water surface of 202 feet to an elevation of 1,270 feet above MSL. The facilities required for this increase in storage capacity are described below and a summary of their physical characteristics is provided in Table 1.

Shasta Dam and Lake

To increase the storage capacity of Shasta Lake to 14.3 maf, Shasta Dam would be raised by 200 feet. The crest of the enlarged dam would be at an elevation of 1,280 feet above MSL and would have a total length of 5,560 feet, an increase of 2,070 feet from the existing crest length. The center dam section would be constructed with a slope of 0.6:1 on the downstream face and a

vertical slope on the upstream face. The crest of the enlarged dam would be 41 feet wide. The extension of the abutments and the dam's center section would be constructed with roller-compacted concrete.

A new spillway having a crest length of 330 feet would be located in the center of the structure. The spillway would be operated with six radial gates 55 feet wide by 27.5 feet high. The capacity would be limited to 253,000 cfs to remain within the capacity of the existing stilling basin.

Although existing planning reports include river outlet works that match the downstream capacity of 80,000 cfs for emergency release operation, these reports state that the sizing of the river outlet works would have to be reevaluated in future analyses, depending on the Corps of Engineers' findings on alternative flood control criteria. For purposes of this report, the outlet works were sized for a capacity of 190,000 cfs to meet emergency evacuation criteria set by DWR's Division of Safety of Dams.

Increasing the maximum water surface elevation to 1,270 feet above MSL would also require the construction of four saddle dams. These are: Centimudi Saddle Dam located east of the dam with a height of 120 feet, Bridge Bay Saddle Dam on the Pit River arm of the lake with a height of 30 feet, Jones Valley Saddle Dam on the Pit River arm with a height of 70 feet, and Clickapudi Creek Saddle Dam on the Pit River arm with a height of 90 feet. The locations of these saddle dams are shown in Figure 2.

As a result of increasing the water surface elevation of Shasta Lake, Pacific Gas and Electric Company's, Pit River No. 7 Power Generation Plant would be inundated. The lost generation capacity of this facility would be offset by increased power generation capacity at Shasta and Keswick Powerplants incorporated into this enlargement alternative.

Shasta Powerplant

In addition to upgrading the existing power plant penstocks and generators on the right abutment, five additional 20-foot-diameter penstocks and generators would be constructed on the left abutment of the enlarged dam. The total generation capacity would be increased from 539 megawatts to 1,000 megawatts. The additional site would permit the existing powerplant to remain in operation while construction of the new facility is under way.

Keswick Dam and Reservoir

In order to effectively regulate the added peaking capability at the Shasta Powerplant, Keswick Dam would be raised by 25 feet and its generation capacity would be increased from 75 megawatts to 150 megawatts. The storage capacity of Keswick Reservoir would be increased to 41,000 acre-feet with a corresponding water surface elevation of 612 feet above MSL.

Transportation Relocations

The relocation costs for alternative relocation routes for Interstate 5 and the SPRR were developed by DWR for the 14.3 maf enlargement alternative and were presented in the 1988 joint Reclamation and DWR report previously cited. These costs and relocation routes were incorporated into this cost estimate for enlarging Shasta Lake to 14.3 maf.

Interstate 5

Over 18 miles of Interstate 5 would have to be relocated to accommodate the 202-foot increase in water surface elevation associated with enlarging Shasta Lake to 14.3 maf. Four new bridges with a combined length of about 2 miles and four new interchanges would be required. The most

costly component of the bridgework is the Bridge Bay crossing. This bridge would also serve as the SPRR and would rank among the world's longest spans for a combined facility.

Southern Pacific Railroad

Over 34 miles of the SPRR would be relocated to accommodate raising the maximum water surface elevation of Shasta Lake to 1,270 feet above MSL. The railroad relocation would require eight new tunnels with a combined length of nearly 3 miles and six new bridges with a combined length of over 2 miles. As discussed above for the Interstate 5 relocation, the Bridge Bay crossing would be a significant portion of the relocation costs.

COST ESTIMATE

The cost estimates for the facilities described in the previous sections are based on previous estimates performed by Reclamation and DWR. Only items included in the previous estimates are included in the present cost estimate and are expressed in October 1996 dollars. This cost estimate does not include costs for modifying the Shasta Lake Temperature Control Device. Other items not included in this estimate are environmental documentation, operation and maintenance costs, power costs, reservoir filling costs, and interest during construction.

COST ESTIMATE METHODOLOGY

The two previous cost estimates developed by Reclamation and DWR form the basis of this cost estimate. These cost estimates have been reviewed and adapted for the present cost estimate update. Several items in the previous cost estimates were modified to ensure that current design standards and safety factors were incorporated.

General

The cost estimates for the Shasta Lake Enlargement were determined by escalating the costs provided in the September 1983 Reclamation report titled *Enlarged Shasta Lake Investigation - Preliminary Findings Report* and in the February 1988 Reclamation and DWR report titled *Enlarging Shasta Lake Investigation, Office Report, Appendix 3.* The costs were escalated to October 1996 dollars using Reclamation's Construction Cost Trends (CCT) indices. Tables 2a and 2b provide a detailed breakdown of the estimated costs of the Shasta Lake Enlargement 6.75 maf Alternative and 14.3 maf Alternative, respectively. These tables also include an updated cost estimate for each cost item identified in the previous cost estimates, along with the quantities of the cost item or an indication that the estimated cost has been developed through a lump sum approach. The tables also include Reclamation's CCT index for the month and year in which the estimated cost was developed and for October 1966. 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 columns of Tables 2a and 2b provide the cost reference for each cost item.

Right-of-Way Costs

A right-of-way cost of $2,000 per acre was used based on personal communications with Reclamation's Division of Land Resources staff in February 1997. The total project lands that need to be acquired include a buffer around the maximum water surface area. The ratio of total project land to maximum water surface area used in the cost estimate is 1.32 based on data from the 1990 DWR report titled *Los Banos Grandes Facilities Feasibility Report, Appendix A: Designs and Cost Estimates.*

Outlet Capacity Adjustments

In the event of potential emergency conditions, the outlet works and spillway would be required to evacuate 10 percent of the maximum water depth within ten days as required by DWR's Division of Safety of Dams. With these criteria, the emergency drawdown flow for the 6.75 maf Shasta Enlargement alternative is an estimated 2.1 maf over ten days. The release of the top 30 feet of storage (1.2 maf) through the spillway would vary from 253,000 cfs to zero cfs over 3.5 days. Assuming a uniform river outlet release rate over the entire head range yields an estimated river release capacity of 72,000 cfs to evacuate the full 58 feet within the ten-day period.

The emergency drawdown flow for the 14.3 maf alternative is estimated at 4.5 maf over ten days. The release of the top 30 feet of storage (2.0 maf) through the spillway would vary from 253,000 cfs to zero over 3.5 days. Assuming a uniform river outlet release rate over the entire head range yields an estimated required river release capacity of 190,000 cfs to evacuate the full 72 feet within the ten-day period.

The estimated cost for river outlet works required for either enlargement alternative was determined using the following empirical equation:

$$\frac{(Cost)_1}{(Cost)_2} = \frac{Q_1^{3/4}}{Q_2^{3/4}}$$

where Q is equal to capacity.

The known cost used in the above equation was for the 80,000 cfs outlet works facility reported in the February 1988 Reclamation and DWR report. This cost factor formula is typically valid over moderate ranges in capacity; the validity over larger ranges is undetermined. However,

because the estimated cost of the outlet works is a relatively low percentage of the total project cost, the impact of any error resulting from utilizing this ratio beyond its valid range is considered to be within the range of the accuracy of the estimate.

Contingencies and Other Costs

All contingencies and engineering, construction management, and administrative factors were selected by historical engineering judgment based on a review of previous studies with similar levels of cost estimation. Contingencies were chosen to be 20 percent; 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 15 percent to the estimated capital cost for the high-end cost. Costs for the initial filling of the reservoirs, interest during construction, and environmental mitigation are not included in this estimate.

PRELIMINARY COST FINDINGS

Costs of enlarging Shasta Dam and its supporting facilities have been updated to an October 1996 basis as described above. Table 3 summarizes estimated costs within selected project categories for the two enlargement alternatives. The total cost of the Shasta Lake Enlargement 6.75 maf alternative is estimated to be about $2.7 billion with a resulting calculated range of costs between $2.5 and $3.2 billion. The Shasta Dam and Powerplant reconstruction costs constitute 22 percent of the construction cost, or $587 million. Transportation relocation costs constitute about 31 percent, or $850 million, of the estimated cost of enlarging Shasta Lake to 6.75 maf.

The total cost of the Shasta Lake Enlargement 14.3 maf alternative is estimated to be about $4.8 billion with a resulting calculated range of costs between $4.3 and $5.5 billion. The cost of

reconstructing Shasta Dam and Powerplant constitutes nearly 28 percent of the project construction costs, or $1.3 billion. The costs of enlarging Keswick Dam and Powerplant make up 4 percent of the project's cost, or $196 million. Relocation of transportation systems are slightly more than 22 percent, or $1.04 billion, of the construction costs of enlarging Shasta Lake to 14.3 maf. Nearly half of the transportation relocation costs are for a combined railroad and freeway crossing at Bridge Bay.

ENVIRONMENTAL CONSIDERATIONS

[NOTE: The Environmental Considerations section of this report needs to be reevaluated by DWR to ensure consistency with the information presented in the previous sections.]

This discussion provides a summary of environmental considerations for the Lake Shasta Enlargement. Fish, wildlife, plant, and cultural resources that could be affected by the proposed project have been described, and the extent of the potential impacts has been identified. In general, the information presented in this section was gathered from existing literature, with limited original research. No field work was conducted for this analysis.

WILDLIFE

Enlarging Shasta Lake to 14.3 maf would inundate approximately 30,000 acres of additional terrestrial wildlife habitat within the Shasta-Trinity National Recreation Area and up to 42 miles of additional riparian stream habitat. The project area supports over 200 species of resident and migratory birds, more than 50 species of mammals, and several species of reptiles, invertebrates, and amphibians.

Terrestrial Resources

Lands within the Shasta Lake Enlargement area support a diverse faunal assemblage. Mammals found in the area include black bear, grey squirrels, elk, and black-tailed deer.

The lower elevation areas in the McCloud, Sacramento, and Pit River and Squaw Creek drainage areas provide winter range for deer use. Winter range for elk is available in the McCloud and Pit River peninsulas. One of the more significant results of enlarging Shasta Lake would be the loss of approximately 30,000 acres of deer and elk winter habitat, which represents about 80 percent of the available winter range in the area.

The narrow bands of montane riparian areas provide valuable habitat for numerous wildlife species. These areas are typically cooler, moister, and more diverse and productive than surrounding habitats. This habitat provides cover and food for numerous bird species, such as warbler and vireo, and a variety of shrew species. Herbivores and omnivores that frequent streamside vegetation include towhee, sparrow, and squirrel. Black-tailed deer make extensive use of these habitats for fawning, foraging, and escape cover.

Fishery Resources

Shasta Lake and its tributaries provide habitat for a number of coldwater and warmwater fish species. Representative game fish species include rainbow trout, brown trout, smallmouth bass, green sunfish, channel catfish, white catfish, brown bullhead, landlocked white sturgeon, and landlocked silver salmon. Representative nongame fish species include hard head, Sacramento squawfish, golden shiner, and threadfin shad.

Enlarging Shasta Lake would result in the loss of about 42 miles of stream habitat including a portion of Squaw Creek, 6 miles of the McCloud River, and 16 miles of the Sacramento River,

both designated Wild and Scenic Rivers. Loss of this habitat would adversely affect trout production. Additionally, inundated old mines would create potential water quality problems from mining waste, affecting fisheries both in the lake and downstream.

Sensitive and Listed Fish and Wildlife Species

Several State or federally listed fish species are known to exist within the area of the proposed Shasta Lake Enlargement. According to the California Department of Fish and Game's (CDFG) Natural Diversity Data Base (NDDB) (Version 8/96), five wildlife species that are State or federally listed and seven wildlife species that are either candidates for listing or species designated by CDFG as species of special concern are known to exist in the project area. Also, the U.S. Fish and Wildlife Service (USFWS) has identified 22 wildlife species that are federal candidates for listing and six federally listed wildlife species that could potentially be affected by the proposed project.

Based on NDDB records, listed wildlife species known to occur in or near the project area include Shasta salamander (State threatened), rough scalpin (State threatened), bald eagle (federal threatened/State endangered), northern spotted owl (federal threatened), and California wolverine (State threatened). Additional species identified by the USFWS include American peregrine falcon (federal endangered), winter-run chinook salmon (federal endangered), Delta smelt (federal threatened), Shasta crayfish (federal endangered), vernal pool fairy shrimp (federal threatened), and valley elderberry longhorn beetle (federal threatened).

Wildlife species that are either candidates for State or federal listing or considered species of special concern by the CDFG and that could be affected by the proposed enlargement of Shasta Lake include tailed frog (federal candidate/CDFG species of special concern), foothill yellow-legged frog (federal candidate/State species of special concern), hardhead (CDFG species of special concern), northwestern pond turtle (federal candidate/CDFG species of special concern),

Shasta sideband snail (federal candidate), Pacific fisher (federal candidate/CDFG species of special concern), and pale big-eared bat (CDFG species of special concern). Additional species identified by the USFWS include California red-legged frog and Sacramento splittail (both proposed federal threatened) and spotted bat, long-eared myotis, fringed myotis bat, Yuma myotis bat, northern goshawk, tricolored blackbird, ferruginous hawk, little willow flycatcher, white-faced ibis, California horned lizard, western spadefoot toad, McCloud River redband trout, green sturgeon, river lamprey, pit roach, longfin smelt, Siskiyou ground beetle, and Trinity Alps ground beetle (all federal candidates).

VEGETATION

Vegetation at the Shasta Lake Enlargement area consists primarily of woodlands (94 percent). The woodlands are comprised mostly of northern yellow pine forest, Sierra montane forest, and blue oak-grey pine forest. Riparian vegetation occurs along the numerous rivers and streams in the area and account for approximately 4 percent of the area that would be affected by the proposed enlargement. Approximately 2 percent of the area affected by the enlargement has been physically altered.

The riparian communities along the rivers and streams of the area are classified as montane. They differ from valley foothill communities because the floodplain is constricted to narrow canyon bottoms that limit river meandering and the lateral extent of the floodplain aquifer. The multilayered vegetation is nearly continuous along the bank, with Fremont cottonwood, white alder, willows, western sycamore, and Oregon ash prevailing as common canopy species. A relatively dense shrub layer of willows, buttonbrush, spicebush, creek dogwood, mule fat, and poison oak are typical. Because of its proximity to adjacent woodlands and forest, dogwood, canyon live oak, Douglas fir, and incense cedar are often intermixed.

Sensitive and Listed Plant Species

To date, no federal- or State-listed plant species have been recorded in the proposed lake enlargement area.

Several plant species or plants that are candidates for federal or State listing are found in the area. According to DFG's NDDB records, candidate plant species for federal listing that may occur in the project area include silky crypantha, Scott Mountain phacelia, Bellinger's meadowfoam, and Henderson's bent grass. Another candidate plant that has been identified by the USFWS as possibly being affected by an enlarged Shasta Lake is the thread-leaved penstemon.

Two additional plants, Cantelow's lewisia and Shasta snow wreath, listed by the California Native Plant Society as being rare, threatened, or endangered in California and elsewhere, could also be affected by the project.

WETLANDS

Based on wetland information from USFWS's National Wetlands Inventory Maps, approximately 13 miles of intermittent streambeds, 17 miles of upper perennial open water, 4 miles of shrub-scrub wetlands, 19 miles of forested wetlands, 17 acres of upper perennial unconsolidated shore, 1 acre of intermittently flooded wetland, and 11 acres of shrub-scrub semipermanent seasonally flooded wetlands are within the area of the proposed enlargement of Shasta Lake.

CULTURAL RESOURCES

There are 335 known archeological sites and 126 ethnographic sites within the area that would be affected by enlargement of Shasta Lake.

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U.S. Geological Survey Topographic Maps: Bella Vista; Bohemotash Mountain; Bollibokka Mountain; Devils Rock; Goose Gap; Hanland Peak; Lamoine; Minnesota Mountain; Montgomery Creek; Oak Run; O'Brien; Project City; Roaring Creek; and Shasta Dam.

Table 1
SUMMARY OF PHYSICAL CHARACTERISTICS
SHASTA LAKE ENLARGEMENT

	Existing	Shasta Lake Enlargement 6.75 maf	Shasta Lake Enlargement 14.3 maf
Reservoir			
Normal Maximum Water Surface Elevation (feet MSL)	1,068	1,130	1,270
Maximum Capacity (maf)	4.55	6.75	14.30
Maximum Reservoir Area (acres)	30,000	37,500	60,500
Main Dam			
Type (Material and Design)	Curved concrete gravity	Curved concrete gravity with roller-compacted concrete	
Height (feet)	602	665	802
Top of Dam (feet MSL)	1,078	1,141	1,280
Downstream Face Slope (horizontal on vertical)	0.8:1	0.6:1	0.6:1
Upstream Face Slope (horizontal on vertical)	Vertical	Vertical	Vertical
Spillway			
Invert Elevation (feet MSL)	1,037	1,103	1,243
Length (feet)	330	330	330
Design Flow (cfs)	253,000	253,000	253,000
River Outlet Works (Sized for Emergency Release Excavation)			
Design flow (cfs)	80,000	80,000	190,000
Saddle Dams			
Number Required	0	0	4
Keswick Reregulation Storage			
Normal Maximum Water Surface (feet MSL)	586	586	611
Power Capacity			
Shasta (MW)	539	680	1,000
Keswick (MW)	75	75	150

Table 2a
ESTIMATED COSTS
SHASTA LAKE ENLARGEMENT (6.75 MAF ALTERNATIVE)

COST ITEM	QUANTITY	Unit[a]	USBR INDEX JAN. 82[b]	USBR INDEX OCT. 96	UNIT COST JAN. 82[b]	UNIT COST OCT. 96	TOTAL COST OCT. 96	COST REFERENCE
I. RESORT RELOCATION AND LAND RIGHTS	JOB	LS	144	217	$24,000,000	$36,166,667	$36,166,667	2, page 18
II. PUBLIC RECREATION RELOCATION	JOB	LS	144	217	$108,000,000	$162,750,000	$162,750,000	2, page 18
III. RESERVOIR CLEARING	8,000	AC				$1,097	$8,776,000	3, item IV-a
IV. RECREATION FACILITIES	JOB	LS	144	217	$21,600,000	$32,550,000	$32,550,000	2, page 18
V. SACRAMENTO RIVER SEEPAGE MITIGATION	JOB	LS	144	217	$9,600,000	$14,466,667	$14,466,667	2, page 18
COST ITEM	**QUANTITY**	**Unit[a]**	**USBR INDEX APR. 84 or JAN. 85**	**USBR INDEX OCT. 96**	**UNIT COST APR. 84 or JAN. 85[b]**	**UNIT COST OCT. 96**	**TOTAL COST OCT. 96**	**COST REFERENCE**
VI. SOUTHERN PACIFIC RAILROAD RELOCATION (APR 84)								
Earthwork	JOB	LS	154	219	$91,500,000	$130,120,130	$130,120,130	4, page 4-45
Railroad	JOB	LS	154	219	$38,300,000	$54,465,584	$54,465,584	4, page 4-45
Bridges	JOB	LS	155	226	$53,300,000	$77,714,839	$77,714,839	4, page 4-45
Tunnels	JOB	LS	161	226	$67,100,000	$94,190,062	$94,190,062	4, page 4-45
SUBTOTAL SPRR RELOCATION							$356,490,615	
Cost Factor[c]	0.639							
TOTAL SPRR RELOCATION							$227,797,503	
VII. I-5 RELOCATION (APR 84)								
Earthwork	JOB	LS	154	219	$57,500,000	$81,769,481	$81,769,481	4, page 4-45
Roadway	JOB	LS	154	219	$22,700,000	$32,281,169	$32,281,169	4, page 4-45
Bridges	JOB	LS	155	226	$43,500,000	$63,425,806	$63,425,806	4, page 4-45
Interchanges	JOB	LS	154	219	$3,750,000	$5,332,792	$5,332,792	4, page 4-45
Land Acquisition	JOB	LS	155	217	$700,000	$980,000	$980,000	4, page 4-45
SUBTOTAL I-5 RELOCATION							$183,789,248	
Cost Factor[c]	0.639							
TOTAL I-5 RELOCATION							$117,441,329	
VIII. BRIDGE BAY CROSSING (APR 84)	JOB	LS	155	226	$345,840,000	$504,257,032	$504,257,032	4, page 4-45
(Combined Hwy & RR)								

Table 2a
ESTIMATED COSTS
SHASTA LAKE ENLARGEMENT (6.75 MAF ALTERNATIVE)

COST ITEM	QUANTITY	Unit[a]	USBR INDEX APR. 84 or JAN. 85	USBR INDEX OCT. 96	UNIT COST APR. 84 or JAN. 85[b]	UNIT COST OCT. 96	TOTAL COST OCT. 96	COST REFERENCE
IX. REMOVE EXISTING STRUCTURES (JAN 85)	JOB	LS	155	203	$8,000,000	$10,477,419	$10,477,419	4, page 4-34
Cost Factor [c]	0.424							
TOTAL REMOVE EXISTING STRUCTURES							$4,442,426	
X. DAM STRUCTURE (JAN 85)	JOB	LS	155	203	$464,000,000	$607,690,323	$607,690,323	4, page 4-34
Cost Factor [c]	0.424							
TOTAL DAM STRUCTURE							$257,660,697	
XI. SPILLWAY (JAN 85)	JOB	LS	155	203	$23,200,000	$30,384,516	$30,384,516	4, page 4-34
Cost Factor [c]	0.424							
TOTAL SPILLWAY							$12,883,035	
XII. RIVER OUTLET WORKS (JAN 85)	JOB	LS	155	203	$43,200,000	$56,578,065	$56,578,065	4, page 4-34
Cost Factor [c]	0.424							
TOTAL RIVER OUTLET WORKS							$23,989,099	
XIII. POWERPLANT	JOB	LS				$426,156,000	$426,156,000	1
Cost Factor [c]	0.430							
TOTAL POWERPLANT							$183,247,080	
XIV. SWITCHYARD (JAN 85)	JOB	LS	156	190	$67,200,000	$81,846,154	$81,846,154	4, page 4-34
XV. ABUTMENT COFFERDAMS (JAN 85)	JOB	LS	139	176	$42,400,000	$53,686,331	$53,686,331	4, page 4-34
Cost Factor [c]	0.424							
TOTAL ABUTMENT COFFERDAMS							$22,763,004	
SUBTOTAL							$1,691,000,000	
CONTINGENCIES @ 20%							$338,200,000	
ESTIMATED CONSTRUCTION COST							$2,029,200,000	
ENGR., LEGAL, AND ADMIN. @ 35%							$710,200,000	
ESTIMATED CAPITAL COST							$2,739,400,000	
ESTIMATED CAPITAL COST RANGE								
LOW (-10%)							$2,465,000,000	
HIGH (+15%)							$3,150,000,000	

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Table 2a
ESTIMATED COSTS
SHASTA LAKE ENLARGEMENT (6.75 MAF ALTERNATIVE)

COST ITEM	QUANTITY	Unit[a]	USBR INDEX APR. 84 or JAN. 85	USBR INDEX OCT. 96	UNIT COST APR. 84 or JAN. 85[b]	UNIT COST OCT. 96	TOTAL COST OCT. 96	COST REFERENCE

Footnotes:

[a] LS=lump sum; AC=acres

[b] Total costs do not include the 25% contingencies which were included in the cost references.

[c] Cost factors were developed from the ratio of costs found in Reference 2, Page 18, and were applied to the 14.3 MAF alternative cost estimates.

Cost References:

1. Cost developed by Bookman-Edmonston Engineering.
2. U.S. Bureau of Reclamation, *Enlarged Shasta Lake Investigation*, September 1987.
3. California Department of Water Resources, *Los Banos Grandes Facilities Report, Appendix A: Designs and Cost Estimates*, December 1990.
4. U.S. Bureau of Reclamation and California Department of Water Resources, *Enlarging Shasta Lake Investigation*, Office Report, Appendix 3, February 1988.

Table 2b
ESTIMATED COSTS
SHASTA LAKE ENLARGEMENT (14.3 MAF ALTERNATIVE)

COST ITEM	QUANTITY	Unit[a]	USBR INDEX JAN. 82[b]	USBR INDEX OCT. 96	UNIT COST JAN. 82[b]	UNIT COST OCT. 96	TOTAL COST OCT. 96	COST REFERENCE
I. RESORT LOCATION AND LAND RIGHTS	JOB	LS	144	217	$40,000,000	$60,277,778	$60,277,778	2, page 18
II. PUBLIC RECREATION RELOCATION	JOB	LS	144	217	$108,000,000	$162,750,000	$162,750,000	2, page 18
III. RESERVOIR CLEARING	30,500	AC				$1,097	$33,458,500	3, item IV-a
IV. ENLARGED KESWICK DAM	JOB	LS	153	203	$40,000,000	$53,071,895	$53,071,895	2, page 18
V. ENLARGED KESWICK DAM POWERPLANT	JOB	LS				$143,345,600	$143,345,600	1
VI. RECREATION FACILITIES	JOB	LS	144	217	$29,600,000	$44,605,556	$44,605,556	2, page 18
VII. SACRAMENTO RIVER SEEPAGE MITIGATION	JOB	LS	144	217	$44,800,000	$67,511,111	$67,511,111	2, page 18
VIII. SADDLE DIKES	JOB	LS	141	159	$32,800,000	$36,987,234	$36,987,234	2, page 18
COST ITEM	QUANTITY	Unit[a]	USBR INDEX APR. 84 or JAN. 85	USBR INDEX OCT. 96	UNIT COST APR. 84 or JAN. 85[b]	UNIT COST OCT. 96	TOTAL COST OCT. 96	COST REFERENCE
IX. SOUTHERN PACIFIC RAILROAD RELOCATION (APR 84)								
Earthwork	JOB	LS	154	219	$91,500,000	$130,120,130	$130,120,130	4, page 4-45
Railroad	JOB	LS	154	219	$38,300,000	$54,465,584	$54,465,584	4, page 4-45
Bridges	JOB	LS	155	226	$53,300,000	$77,714,839	$77,714,839	4, page 4-45
Tunnels	JOB	LS	161	226	$67,100,000	$94,190,062	$94,190,062	4, page 4-45
SUBTOTAL SPRR RELOCATION							$356,490,615	
X. I-5 RELOCATION (APR 84)								
Earthwork	JOB	LS	154	219	$57,500,000	$81,769,481	$81,769,481	4, page 4-45
Roadway	JOB	LS	154	219	$22,700,000	$32,281,169	$32,281,169	4, page 4-45
Bridges	JOB	LS	155	226	$43,500,000	$63,425,806	$63,425,806	4, page 4-45
Interchanges	JOB	LS	154	219	$3,750,000	$5,332,792	$5,332,792	4, page 4-45
Land Acquisition	JOB	LS	155	217	$700,000	$980,000	$980,000	4, page 4-45
SUBTOTAL I-5 RELOCATION							$183,789,248	
XI. BRIDGE BAY CROSSING (APR 84) (Combined Hwy & RR)	JOB	LS	155	226	$345,840,000	$504,257,032	$504,257,032	4, page 4-45

Table 2b
ESTIMATED COSTS
SHASTA LAKE ENLARGEMENT (14.3 MAF ALTERNATIVE)

COST ITEM	QUANTITY	Unit[a]	USBR INDEX APR. 84 or JAN. 85	USBR INDEX OCT. 96	UNIT COST APR. 84 or JAN. 85[b]	UNIT COST OCT. 96	TOTAL COST OCT. 96	COST REFERENCE
XII. REMOVE EXISTING STRUCTURES (JAN 85)	JOB	LS	155	203	$8,000,000	$10,477,419	$10,477,419	4, page 4-34
XIII. DAM STRUCTURE (JAN 85)	JOB	LS	155	203	$464,000,000	$607,690,323	$607,690,323	4, page 4-34
XIV. SPILLWAY (JAN 85)	JOB	LS	155	203	$23,200,000	$30,384,516	$30,384,516	4, page 4-34
XV. RIVER OUTLET WORKS (JAN 85)	JOB	LS	155	203	$59,746,000	$78,247,987	$78,247,987	4, page 4-34
XVI. POWERPLANT	JOB	LS				$426,156,000	$426,156,000	1
XVII. SWITCHYARD (JAN 85)	JOB	LS	156	190	$67,200,000	$81,846,154	$81,846,154	4, page 4-34
XVIII. ABUTMENT COFFEREDAMS (JAN 85)	JOB	LS	139	176	$42,400,000	$53,686,331	$53,686,331	4, page 4-34
COST ITEM SUBTOTAL							$2,935,000,000	
CONTINGENCIES @ 20%							$587,000,000	
ESTIMATED CONSTRUCTION COST							$3,522,000,000	
ENGR., LEGAL, AND ADMIN. @ 35%							$1,232,700,000	
ESTIMATED CAPITAL COST							$4,754,700,000	
ESTIMATED CAPITAL COST RANGE								
LOW (-10%)							$4,279,000,000	
HIGH (+15%)							$5,468,000,000	

Footnotes:

[a] LS=lump sum; AC=acres

[b] Total costs do not include the 25% contingencies which were included in the cost references.

[c] The river outlet works release capacity was increased from 80,000cfs to 190,000cfs to satisfy DWR's Division of Safety of Dams emergency release requirements. Costs for the river outlet works were factored by the ratio of the capacities to the 3/8 power.

Cost References:

1. Cost developed by Bookman-Edmonston Engineering.
2. U.S. Bureau of Reclamation, *Enlarged Shasta Lake Investigation*, September 1987.
3. California Department of Water Resources, *Los Banos Grandes Facilities Report, Appendix A: Designs and Cost Estimates*, December 1990.
4. U.S. Bureau of Reclamation and California Department of Water Resources, *Enlarging Shasta Lake Investigation*, Office Report, Appendix 3, February 1988.

Table 3
SUMMARY OF ESTIMATED COSTS
SHASTA LAKE ENLARGEMENT

Cost Item	Estimated Cost ($ Millions) 6.75 maf Alternative	14.3 maf Alternative
Recreation and Resort	231.4	267.6
Reservoir Clearing and River Seepage Mitigation	23.2	101.0
Transportation Relocations		
Interstate 5	117.4	183.8
Southern Pacific Railroad	227.8	356.5
Combined I-5 and Southern Pacific Bridge	504.3	504.3
SUBTOTAL:	849.5	1,044.6
Shasta Dam		
Main Shasta Dam	284.9	671.9
Outlet Works and Spillway	36.9	108.6
Saddle Dams	n/a	37.0
Power Plant and Switchyard	265.1	507.9
SUBTOTAL:	586.9	1,325.4
Keswick Dam		
Dam Enlargement	n/a	53.1
Powerplant Enlargement	n/a	143.3
SUBTOTAL:	0.0	196.4
COST ITEM SUBTOTAL	1,691.0	2,935.0
Contingencies (20%)	338.2	587.0
ESTIMATED CONSTRUCTION COST	2,029.2	3,522.0
Engineering, Legal, and Project Administration (3	710.2	1,232.7
ESTIMATED CAPITAL COST	2,739.4	4,754.7
CAPITAL COST RANGE (minus 10% - plus 15%)	2.465 - 3.150	4.279 - 5.468

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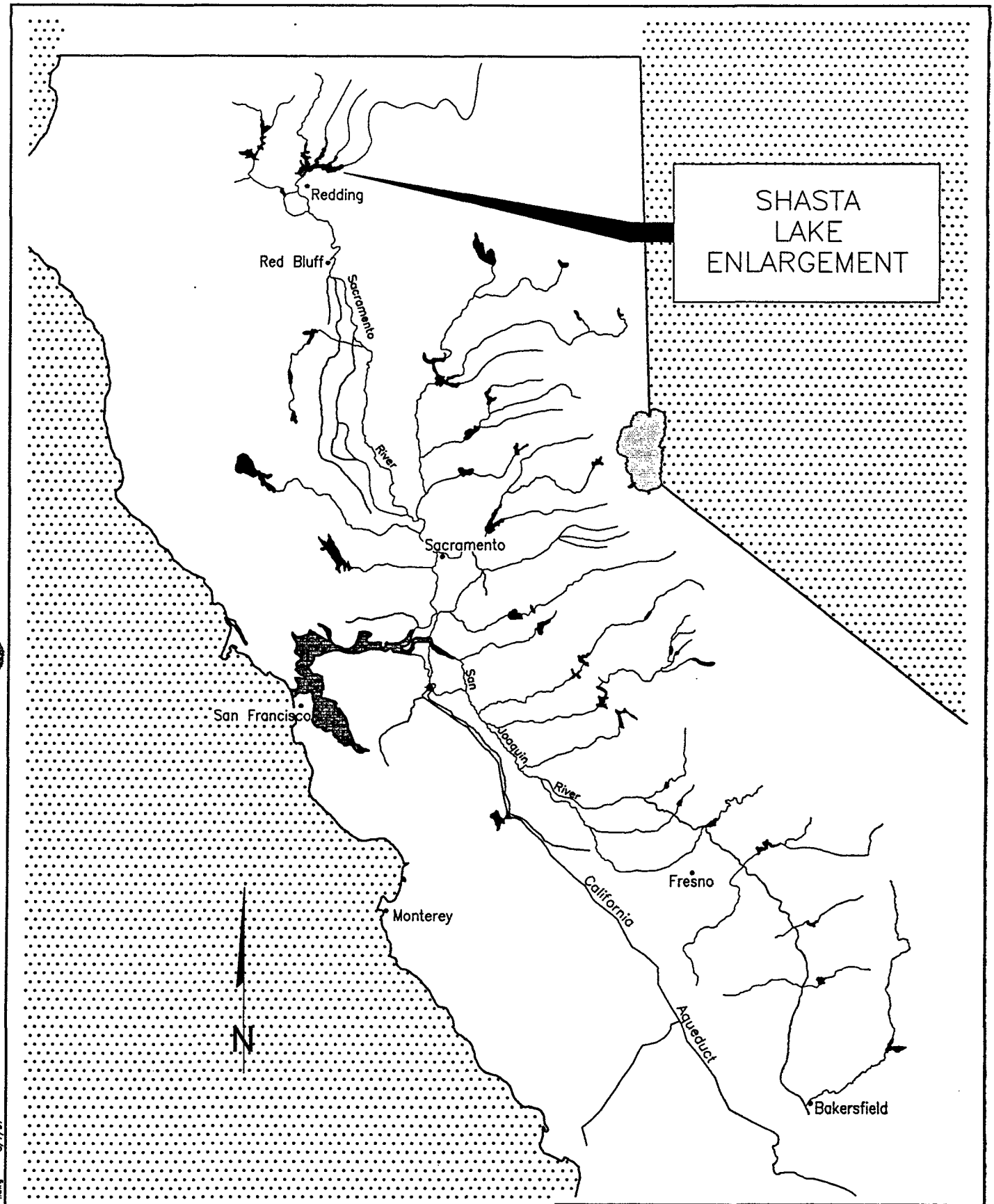

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Figure 1
Project Location Map
Shasta Lake Enlargement

CALFED BAY-DELTA PROGRAM

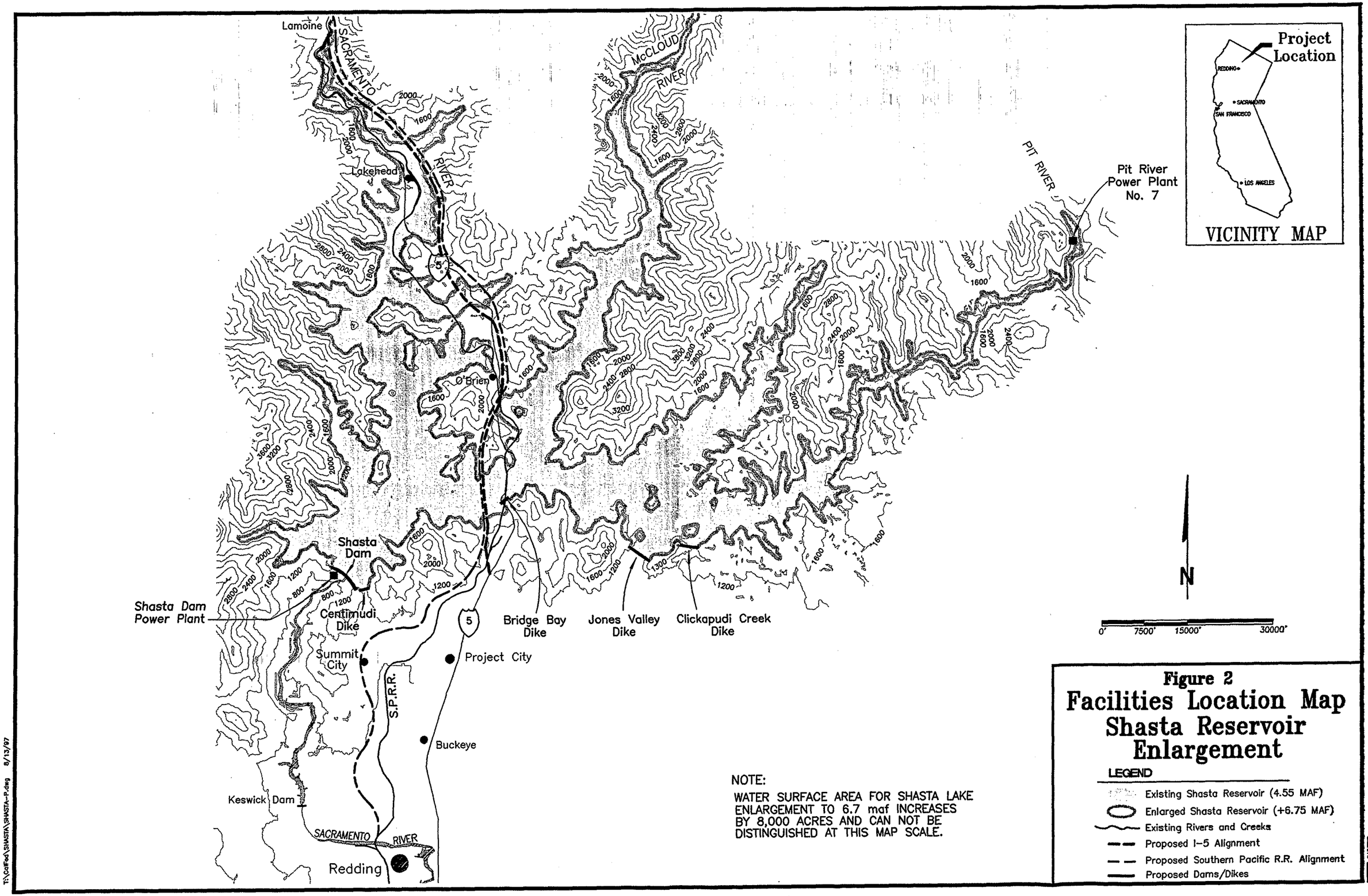

Figure 2

Facilities Location Map Shasta Reservoir Enlargement

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SHASTA LAKE ENLARGEMENT AND RELATED FACILITIES

Schematic Profile

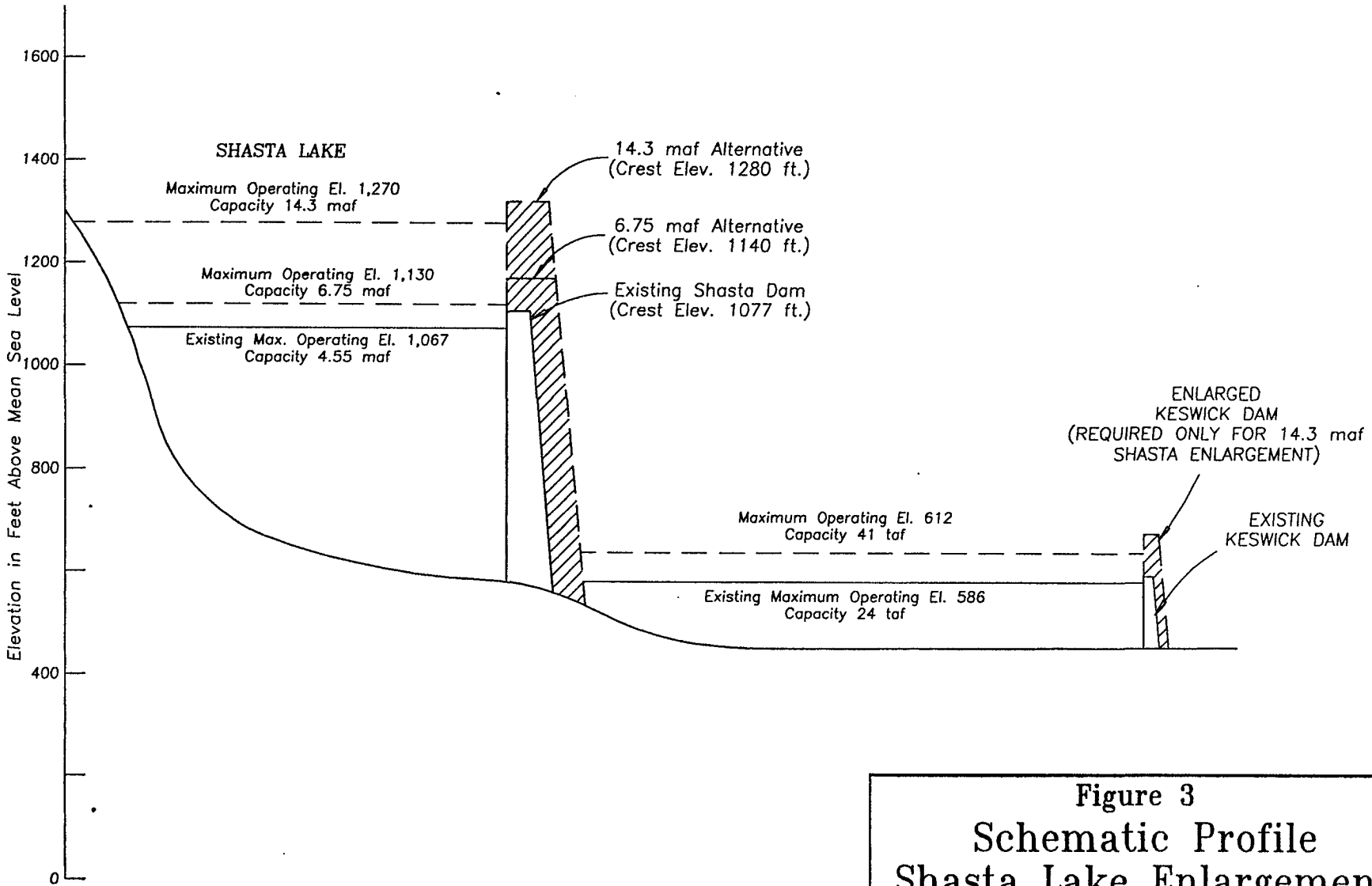

Figure 3

Schematic Profile
Shasta Lake Enlargement
and Related Facilities

CALFED BAY-DELTA PROGRAM

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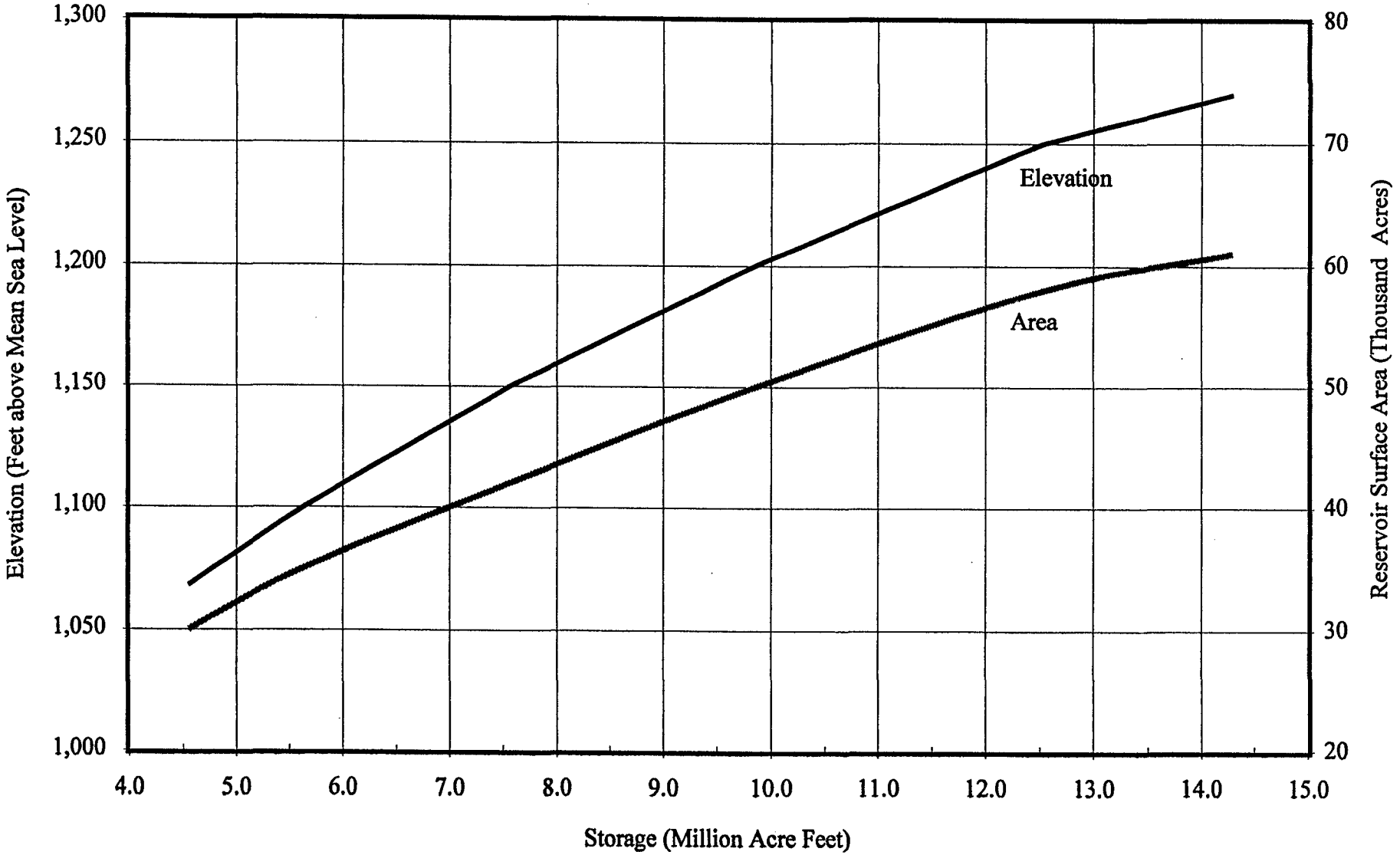
Figure 4
Area-Elevation-Capacity Curves
Shasta Lake Enlargement



FACILITY DESCRIPTIONS AND UPDATED COST ESTIMATES FOR THOMES-NEWVILLE RESERVOIR PROJECT

Prepared by the CALFED Storage and Conveyance Refinement Team
October 1997

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INTRODUCTION

The *Facility Descriptions and Updated Cost Estimates for Thomes-Newville Reservoir 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 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 constructing the Thomes-Newville Reservoir Project. The Thomes-Newville Reservoir Project would develop flows from Stony and Thomes Creeks as well as surplus flows from the Sacramento River. This evaluation considered two alternative storage capacities at the Thomes-Newville Reservoir site: 1.84 million acre-feet (maf) and 3.08 maf. The general location of the Thomes-Newville Reservoir Project is shown in Figure 1.

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

The cost estimate for the Thomes-Newville Reservoir Project was determined by escalating the costs in the Department of Water Resources (DWR), Division of Design and Construction, September 1981 report titled *SWP Future Supply Program, Thomes-Newville Plan, Addendum to the Cost Estimate for Thomes-Newville Project Plan I and II, Vol. I, Memorandum Report, June 1980*, and in the DWR, Northern District, November 1980 report titled *Thomes-Newville and Glenn Reservoir Plans, Engineering Feasibility.* The cost estimates presented by DWR in these

reports have been reviewed and adapted for this evaluation. Modifications have been made to reflect current design and safety standards where appropriate.

A preliminary evaluation of the environmental considerations associated with this project has also been 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 the evaluation of environmental considerations was gathered from existing literature and databases.

PROJECT BACKGROUND

Water supply planning on Stony and Thomes Creeks watersheds dates back to the 1860s. The first canal diverted water from Stony Creek in 1866, and in the late 1890s several irrigation districts had been formed to divert water from Stony and Thomes Creeks.

Variations of the Thomes-Newville Reservoir Project were investigated in the early 1900s. In 1957, DWR completed *The California Water Plan* (Bulletin No. 3), a 10-year study investigating California's water resources and formulating plans for their orderly development. This report included Paskenta Reservoir on Thomes Creek, which would spill excess flows into a Newville Reservoir located on the North Fork Stony Creek. Under that proposed plan, Newville Reservoir supplies would be supplemented by additional diversions from upper Stony Creek and Grindstone Creek, a tributary to Stony Creek.

After completing Bulletin No. 3, DWR focused on identifying potential sites within the Sacramento Valley for storage of water diverted from the Eel, Trinity, and Klamath Rivers. One potential storage component identified in Bulletin No. 3 was the Millsite-Newville Reservoir that required dams on the mainstem of Stony Creek and on the North Fork Stony Creek. Detailed investigations revealed, however, that the topography of the Millsite location was not as favorable as the Rancheria Dam site three miles upstream. DWR formally introduced the

combined Newville and Rancheria Reservoirs as the Glenn Reservoir Complex in the 1961 report titled *Progress Report on North Coastal Area Investigation*. In 1964, DWR published a report titled *North Coastal Area Investigation* (Bulletin No. 136) suggesting that upper Eel River water could be routed either through Clear Lake or elements of Glenn Reservoir to supplement Delta water supplies.

In 1975, DWR began to reevaluate tributary storage opportunities on the upper Sacramento River. DWR completed a report titled *Major Surface Water Development Opportunities in the Sacramento Valley* which identified four plans in detail: (1) the Tributary Storage Plan, (2) the Tuscan Buttes Reservoir, (3) the Glenn Reservoir-River Diversion Plan, and (4) the Colusa Reservoir-River Diversion Plan. The Glenn Reservoir-River Diversion Plan was the first formal consideration of using Glenn Reservoir for off-stream storage of Sacramento River water.

The Thomes-Newville Reservoir Plan Concept, completed by DWR in 1978, proposed a much smaller project than the Glenn Reservoir-River Diversion Plan. DWR's perception at that time was that the Thomes-Newville Reservoir Plan would be easier to implement and would not preempt the U.S. Bureau of Reclamation's (Reclamation) planned West Sacramento Canal Unit, which was to supply Sites Reservoir in Colusa County through the Tehama-Colusa Canal.

In November 1980, DWR's Northern District released a report titled *Thomes-Newville and Glenn Reservoir Plans, Engineering Feasibility* (Glenn Reservoir Feasibility Report) presenting three water supply plans: (1) the Thomes-Newville Plan, (2) the Glenn Reservoir Plan, and (3) the staged Glenn Reservoir Plan. This report assessed the physical and operational feasibility of these plans. DWR concluded that both the Thomes-Newville and Glenn Reservoirs were feasible from an engineering standpoint. Further, DWR stated in that report that the Thomes-Newville Plan would better meet expected future demands. Construction was tentatively scheduled for the mid-1990s.

The conclusions of the 1980 DWR report led to the preparation by DWR's Division of Design and Construction of a memorandum report titled *SWP Future Supply Program, Thomes-Newville Plan: Addendum to the Reconnaissance Study and Cost Estimate for Thomes-Newville Project Plan I and II, Vol. I, Memorandum Report, June 1980* (Thomes-Newville Plan Report) that developed cost estimates for Thomes-Newville Reservoir with three alternative water surface elevations: 870, 900, and 920 feet above mean sea level (MSL). The Thomes-Newville Reservoir alternative, with a water surface elevation of 900 feet MSL, served as the basis of the reservoir configurations utilized in this evaluation.

FACILITIES DESCRIPTIONS

This section provides an overview of the major features of the Thomes-Newville Reservoir Project and of existing projects in the Thomes and Stony Creek watershed. The principal reference used for this synopsis was the Thomes-Newville Plan Report, which provides a cost estimate and facilities description for the Newville Reservoir. Additional information for associated facilities was taken from the Glenn Reservoir Feasibility Report.

The Thomes-Newville Reservoir Project has been evaluated at two storage capacities: 1.84 maf and 3.08 maf. The Thomes-Newville Project would provide on-stream storage for available flows from Thomes, North Fork Stony, and Stony Creeks, and off-stream storage for available flows from the Sacramento River. The Thomes-Newville Reservoir facilities include the following features: Thomes-Newville and Tehenn Reservoirs located on North Fork Stony Creek; a diversion facility from Thomes Creek to Thomes-Newville Reservoir; a two-way conveyance facility from Tehenn Reservoir to the existing Black Butte Reservoir on the mainstem of Stony Creek; and a two-way conveyance canal facility from the Tehama-Colusa Canal to Black Butte Reservoir. The Tehama-Colusa Canal would provide water from the Sacramento River.

EXISTING FACILITIES

There are currently three storage facilities constructed on Stony Creek: East Park, Stony Gorge, and Black Butte Reservoirs. No storage facilities have been developed on Thomes Creek.

The East Park Reservoir was constructed by the U.S. Reclamation Service (predecessor to Reclamation) in 1909 in the upper watershed of the mainstem of Stony Creek. This reservoir was the first facility constructed for the Orland Project. The Orland Project, part of the Central Valley Project (CVP), serves approximately 20,000 acres of irrigated land around the town of Orland in Glenn County. This area is located west of the Sacramento River, about 100 miles north of Sacramento (see Figure 1). Stony Gorge Reservoir, completed in 1928, and Black Butte Reservoir, completed in 1970, are also facilities of the Orland Project.

Development of the three existing reservoirs on Stony Creek resulted from investigations by the U.S. Geological Survey (USGS), the U.S. Reclamation Service, and the U.S. Army Corp of Engineers (COE). Investigations by the USGS and the Reclamation Service in the early 1900s led to the development of East Park and Stony Gorge Reservoirs. Investigations by the COE, beginning in the mid-1940s, led to development of Black Butte Reservoir, in part for flood control on lower Stony Creek. The Black Butte Reservoir is the main regulating facility for the distribution system of the Orland Project.

PROJECT LOCATION

The Thomes-Newville Reservoir Project would be located on the North Fork Stony Creek and would develop flows of the North Fork Stony Creek, the mainstem of Stony Creek, and the flows of Thomes Creek. Additional water would be developed from surplus flows diverted from the Sacramento River through the existing Red Bluff Diversion Facility and Tehama-Colusa Canal.

The watershed of Stony Creek upstream of Black Butte Dam, which includes the North Fork, is about 740 square miles and has an annual runoff of about 400,000 acre-feet per year (AF/year). The drainage area includes portions of Lake, Colusa, Glenn, and Tehama Counties at elevations ranging from 400 to 6,300 feet above MSL. The Thomes Creek drainage basin is located north and west of the Newville Reservoir site, drains an area of roughly 194 square miles, and has average annual runoff of about 200,000 AF/year upstream of the gage at the Town of Paskenta. The diversion facility on Thomes Creek would be located 5 miles upstream of the Paskenta gage and would receive about 97 percent of the estimated flows at the Paskenta gage.

The Newville Dam site would be located about 10 miles upstream of Black Butte Dam. Newville Dam would fill a low gap in the north-south trending Rocky Ridge. The dam site is within the Coast Range geomorphic province immediately west of the boundary with the Great Valley geomorphic province. This is an area of low-to-moderate seismicity. There are several known faults in the area, including the Stony Creek Fault, Coast Range Thrust Fault, and Paskenta Fault Zone. It is possible that additional undiscovered faults could be located in this area.

PRINCIPAL FACILITIES

This section provides a description of the principal facilities associated with the Thomes-Newville Reservoir Project. Table 1 provides a summary of the physical characteristics of the major features of the Thomes-Newville Project for the two alternative storage capacities of 1.84 maf and 3.08 maf. Figure 2 shows the locations of the features which would be developed by the Thomes-Newville Reservoir Project.

The Thomes-Newville Reservoir would receive inflows from four water sources: (1) North Fork Stony Creek, which would discharge directly into the reservoir; (2) Thomes Creek flows, which would be diverted from Thomes Creek and conveyed into the reservoir via a gravity canal; (3)

mainstem Stony Creek, which would be conveyed from Black Butte Reservoir to Thomes-Newville Reservoir via Tehenn Canal, Tehenn Pumping-Generating Plant, Tehenn Reservoir, and the Newville Pumping-Generating Plant; and (4) flows from the Sacramento River, which would be diverted into the Tehama-Colusa Canal and conveyed into Black Butte Reservoir via Sour Grass Canal and Sour Grass Pumping-Generating Plant and from Black Butte Reservoir into Thomes-Newville Reservoir via the Tehenn Canal and Reservoir. Figure 3 shows a schematic representation of the Thomes-Newville Reservoir Project.

Thomes-Newville Reservoir — 1.84 maf Alternative

Thomes-Newville Reservoir, with a storage capacity of 1.84 maf, would have a normal pool elevation of 900 feet above MSL. The reservoir would have a surface area of 13,900 acres at normal pool. Newville Dam would consist of a zoned earthfill dam with an embankment volume of about 16 million cubic yards, which would rise 320 feet above the existing streambed. The crest of the dam would be at an elevation of 920 feet above MSL, with a crest length of approximately 2,400 feet. Area-elevation-capacity curves for Thomes-Newville Reservoir are shown on Figure 4.

Inlet-Outlet Works

The inlet-outlet works for Newville Dam would have a capacity of 5,000 cfs to convey water pumped into the reservoir and to facilitate releases from the reservoir. The primary features of the inlet-outlet works would be a 2,100 foot-long tunnel through the right abutment of the dam and a sloping intake conduit with nine evenly spaced levels of inlets between the minimum and normal pool elevations.

Spillway

The spillway for the 1.84 maf Newville Reservoir would have a capacity of 35,700 cfs and would be located 200 feet west of the right dam abutment. The spillway would consist of two submerged radial gates in a rectangular reinforced concrete-lined channel. The gates would be 20 feet wide and 30 feet high. The gate sill would be at an elevation of 850 feet above MSL. The emergency spillway would consist of two uncontrolled weirs, each 20 feet long at a crest elevation of 905 feet above MSL. The emergency spillway would have a capacity of 8,000 cfs. The gated spillway and the emergency spillway would discharge into a common concrete-lined tailrace and stilling basin.

In the event of a potential emergency condition, the outlet works and spillway must be capable of evacuating 10 percent of the maximum water depth within ten days, as required by DWR's Division of Safety of Dams. With this criterion, the emergency drawdown release for Newville Reservoir would be about 21,000 cfs. This release requirement is within the capacity of the gated spillway; thus no adjustment to the outlet works would be required.

Saddle Dams

For a storage capacity of 1.84 maf, only one saddle dam, the Burrow's Gap Saddle Dam, would be required. Burrow's Gap Saddle Dam would be located about 3 miles south of Newville Dam at a saddle in Rocky Ridge. It would consist of a 70-foot-high earthfill dam with an embankment volume of approximately 197,000 cubic yards. It would have a crest length of approximately 520 feet at an elevation of 920 feet above MSL.

Thomes-Newville Reservoir — 3.08 maf Alternative

Thomes-Newville Reservoir, with a storage capacity of 3.08 maf, would have a normal pool elevation of 980 feet above MSL. The reservoir would have a surface area of 16,700 acres at normal pool. Figure 3 contains a schematic of the Thomes-Newville Reservoir Project and Figure 4 shows the area-elevation-capacity curves for Newville Reservoir. Both figures contain information for the 1.84 and 3.08 maf alternatives.

For the 3.08 maf alternative, Newville Dam would be an earthfill embankment structure with a volume of approximately 25 million cubic yards. The dam would rise 400 feet above the existing streambed to an elevation of 1,000 feet above MSL. The crest length of the dam would be approximately 3,200 feet.

Inlet-Outlet Works

The configuration and capacity (5,000 cfs) of the inlet-outlet works for the 3.08 maf reservoir would be identical to the inlet-outlet works for the 1.84 maf reservoir.

Spillway

The maximum spillway capacity would be 35,700 cfs for the 3.08 maf Newville Reservoir, identical to the 1.84 maf reservoir. The configuration and dimensions of the submerged radial gates would also be the same for both alternative storage volumes. The sill of the gates would be at an elevation of 930 feet above MSL. The emergency spillway would consist of two uncontrolled weirs, each 20 feet long at an elevation of 985 feet above MSL. As with the 1.84 maf reservoir, the emergency spillway for the 3.08 maf reservoir would have a capacity of 8,000 cfs. The gated spillway and the emergency spillway would discharge into a common concrete-lined tailrace and stilling basin.

The emergency release requirement of the 3.08 maf reservoir would be 32,000 cfs. This release can be made through the gated spillway and the inlet-outlet works of the dam; therefore, no adjustment to the outlet works is necessary to comply with DWR's Division of Safety of Dams.

Saddle Dams

Increasing the storage capacity to 3.08 maf would require ten saddle dams. The largest saddle dam would be Chrome Dike, with an earthfill embankment volume of approximately 2.9 million cubic yards. The remaining saddle dams would be located on Rocky Ridge on the eastern and northern boundaries of the reservoir. The estimated embankment volume for all the required saddle dams is 4.7 million cubic yards.

Newville Pumping-Generating Plant

The configuration of the Newville Pumping-Generating Plant would be the same for either a 1.84 maf or 3.08 maf Newville Reservoir. The plant would be located at the toe of Newville Dam to lift water from Tehenn Reservoir into Newville Reservoir and to generate power from releases from Newville Reservoir into Tehenn Reservoir. The plant would have a total capacity of 5,000 cfs. For the 1.84 maf Newville Reservoir, the required total dynamic head for the pumping facility would be 300 feet, with a power requirement of about 136,000 horsepower. For the 3.08 maf Newville Reservoir, the required total dynamic head would be 380 feet, with a power requirement of about 287,000 horsepower.

Thomes Creek Diversion Structure and Canal

The Thomes Creek Diversion Structure would be identical for either storage volume alternative. The diversion structure would be located in Thomes Creek approximately 9.0 miles upstream of Paskenta.

The diversion structure would consist of a conventional concrete gravity dam founded on the Stony Creek Formation. The dam crest would be about 90 feet above the existing streambed at an elevation of 1,050 feet above MSL. A 500-foot-wide overflow section with a crest elevation of 1,035 feet above MSL would be located on the left abutment. Two additional 20-foot-wide and 50-foot-high radial gates located in the right abutment would have a capacity of 41,000 cfs. The sill of the gates would be located 25 feet above the original streambed. These gates would be opened to allow flood flows to pass and flush accumulated sediment out of the diversion pool. During most of the winter, the gates would be closed so water could be diverted to Newville Reservoir.

A concrete-lined canal would convey water 13,100 feet from Thomes Creek to Thomes-Newville Reservoir. The canal would have a rectangular cross-section 30 feet wide and 16.5 feet deep. The canal would have a capacity of 10,000 cfs.

Tehenn Reservoir

Tehenn Reservoir would be located on North Fork Stony Creek immediately downstream of Newville Dam (see Figure 2). Tehenn Reservoir would inundate Stony Creek back to the base of Newville Dam. Tehenn Reservoir would have a gross storage capacity of 32,500 acre-feet at a normal pool elevation of 610 feet above MSL. Tehenn Dam would rise 112 feet above the original streambed. The dam would have a crest length of 2,500 feet and a total embankment volume of 2.6 million cubic yards.

The spillway for Tehenn Reservoir would be a concrete-lined ungated chute-type on the left abutment with a capacity of 50,000 cfs. The chute would extend 1,300 feet ending in a concrete stilling basin. The spillway crest length would be 250 feet. The inlet-outlet works for Tehenn Dam would consist of a cut-and-cover, steel-lined, concrete conduit under the left abutment with a capacity of 5,000 cfs.

Tehenn Pumping-Generating Plant

The Tehenn Pumping-Generating Plant would lift water from Black Butte Reservoir and the Tehenn Canal into Tehenn Reservoir and would also generate power from releases from Tehenn Reservoir to Black Butte Reservoir. The plant would have a total capacity of 5,000 cfs. The total dynamic head would be 190 feet, with a power requirement of about 144,000 horsepower.

Tehenn Canal

Tehenn Canal would deliver a maximum flow of 5,000 cfs in either direction between Black Butte Reservoir and the Tehenn Pumping-Generating Plant. It would be approximately 5 miles long, and the alignment would roughly follow the natural channel of North Fork Stony Creek. The canal would be trapezoidal in shape and unlined. The canal would have an invert elevation of 410 feet above MSL, and the water surface elevation would fluctuate with the storage in Black Butte Reservoir. The minimum flood control drawdown of Black Butte Reservoir is at an elevation of 430 feet above MSL. The long canal and low invert elevation would allow continuous pumping from Black Butte Reservoir to Tehenn Reservoir at low water levels. The canal would require a maximum cut of 120 feet.

Black Butte Pumping-Generating Plant

The Black Butte Pumping-Generating Plant would lift water from the Black Butte Canal into Black Butte Reservoir and would generate power from releases from Black Butte Reservoir to the Black Butte Canal. The plant would be located just downstream of the existing Black Butte Dam and would be connected to the dam's inlet-outlet works by a new 1,800-foot tunnel. The pumping-generating plant would have a capacity of 5,000 cfs. The total dynamic head would be 144 feet, with a power requirement of about 109,000 horsepower.

Black Butte Canal

The Black Butte Canal would be a two-way conveyance facility connecting the Black Butte Pumping-Generating Plant and Black Butte Reservoir with the Sour Grass Pumping-Generating Plant. The Black Butte Canal would have a capacity of 5,000 cfs, matching the capacity of the pumping-generating plants. The canal would have a total length of 4.5 miles between the Black Butte and Sour Grass Pumping-Generating Plants. The canal would be trapezoidal in shape and concrete-lined. The invert elevation of the canal would be at an elevation of 310 feet above MSL and the water surface elevation would be about 340 feet above MSL. Near Black Butte, the canal would require a maximum cut of about 190 feet.

Sour Grass Pumping-Generating Plant

The Sour Grass Pumping-Generating Plant would lift flow into the Black Butte Canal during pumping operations and would generate power during release operations from Black Butte Reservoir. Releases would be made through this plant and the Black Butte Pumping-Generating Plant to supply supplemental water from storage in Newville Reservoir for use in the Tehama-Colusa Canal.

The pumping-generating plant would have a capacity of 5,000 cfs. The total dynamic head would be 115 feet, with a power requirement of about 87,000 horsepower.

Sour Grass Canal

The Sour Grass Canal would convey water, in either direction, from the Tehama-Colusa Canal to the Sour Grass Pumping-Generating Plant. The canal would have a capacity of 5,000 cfs and would have a total length of 4.5 miles. The canal alignment would generally follow Sour Grass

Creek. The canal would be trapezoidal in shape and concrete-lined. The canal would have a water surface elevation of about 235 feet above MSL and an invert of about 205 feet above MSL.

Road Relocations

This area is sparsely populated with relatively few structures. Approximately 8 miles of public roads exist within the inundation area of the Thomes-Newville Reservoir. The Paskenta-Round Valley Road, a paved two-lane county road, passes through the north end of the reservoir, and another county road crosses northwestward through the reservoir from the dam site to Paskenta-Round Valley Road. These roads would be relocated and upgraded to current county road standards. The total length of new road construction would be about 10 miles.

COST ESTIMATE

The estimated capital cost of the facilities identified in the previous sections are based on DWR's September 1981 report titled *Thomes-Newville Plan Report* and DWR's November 1980 report titled *Glenn Reservoir Feasibility Report.* Project costs not identified in the DWR reports are not included in the present updated cost estimate. Some of these additional costs include environmental documentation and mitigation, operation and maintenance, power, filling of the reservoir, recreational development, and interest during construction.

COST ESTIMATE METHODOLOGY

The 1981 DWR cost estimates have been reviewed and adapted for the present cost estimate update. Several items in the previous cost estimates were modified to incorporate current design standards and safety factors.

General

The cost estimates for the Thomes-Newville Reservoir Project were determined by escalating the costs provided in the 1980 DWR report titled *Thomes-Newville and Glenn Reservoir Plans, Engineering Feasibility* report and the 1981 DWR report titled *SWP Future Supply Program, Thomes-Newville Plan, Addendum to the Cost Estimate for Thomes-Newville Project Plan I and II, Volume I, Memorandum Report.* The cost estimates provided in these reports were escalated to October 1996 dollars using the Reclamation's Construction Cost Trends (CCT) indices and by applying current unit costs to quantities found in these reports. Tables 2a and 2b provide a detailed breakdown of the estimated capital costs of the Thomes-Newville Reservoir Project, with a storage capacity of 1.84 and 3.08 maf, respectively. These tables include an updated cost estimate for each cost item identified in the previous cost estimates, along with the quantities of the cost item or an indication that the estimated cost has been developed through a lump sum approach. The table also includes the CCT index for the month and year in which the estimated cost was developed and for October 1996. The 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 Tables 2a and 2b provide the cost reference for each cost item.

Right-of-Way Costs

Right-of-way costs of $1,500 per acre were based on land use costs developed by Reclamation, Land Resource Branch (Personal Communication, February 1997). Reclamation provided land use cost estimates at a subappraisal level for all storage and conveyance components reviewed by CALFED. The total project lands associated with the reservoirs include a buffer around the maximum water surface area. The ratio of total project land acquired for a reservoir to maximum water surface area used in the cost estimate is 1.32, based on data from the September 1990 report titled *Los Banos Grandes Facility Feasibility Report, Appendix A: Design and Cost.*

Estimates by DWR. The total right of way needed would be 18,350 and 22,060 acres for the 1.84 maf and 3.08 maf alternatives, respectively.

Canal Costs

To develop costs for Black Butte and Tehenn Canals, the cost estimates provided in the DWR 1980 report titled *Glenn Reservoir Facilities Report* were updated and factored by the following empirical equation:

$$\frac{(Cost)_1}{(Cost)_2} = \frac{Q_1^{\frac{3}{4}}}{Q_2^{\frac{3}{4}}}$$

where Q is equal to capacity.

The capacities of the two canals in the 1980 report were 3,000 cfs. The empirical equation was used to factor the cost to a capacity of 5,000 cfs.

The cost factor formula is typically valid over moderate ranges in capacity; the validity over larger ranges is undetermined. The impact of any error resulting from utilizing this ratio beyond its valid range is considered to be within the range of accuracy of the estimate.

Pumping-Generating Plant Costs

The pumping-generating plant cost estimates are based on actual construction costs for the Waddell Pumping-Generating Plant in Arizona, which was completed in 1994 and is similar in size and scope to the generating facilities. To develop a cost for pumping-generating facilities, the actual construction cost of the Waddell Pumping-Generating Plant (escalated to October 1996 dollars) was factored by the following empirical equation:

$$\frac{(Cost)_1}{(Cost)_2} = \frac{HP_1^{6/10}}{HP_2^{6/10}}$$

where HP is equal to horsepower.

This cost factor formula is typically valid over moderate ranges in horsepower; the validity over larger ranges is undetermined. The impact of any error resulting from utilizing this ratio beyond its valid range is also expected to be within the range of the accuracy of the estimate.

Reservoir Clearing

The total area that needs to be cleared is assumed to be 10 percent of the water surface area (based on the DWR report titled *SWP Future Supply Program Thomes-Newville Plan*, September 1981). The reservoir clearing areas needed would be 1,390 and 1,670 acres for the 1.84 maf and 3.08 maf alternatives, respectively.

Contingencies and Other Costs

All contingencies and engineering, construction management, and administrative factors were determined by engineering judgment based on a similar level of cost estimation. Contingencies were chosen to be 20 percent; 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 15 percent to the estimated capital cost for the high-end cost.

PRELIMINARY COST FINDINGS

The total estimated cost associated with constructing the Thomes-Newville Reservoir Project with a storage capacity of 1.84 maf is $1,514 million with a calculated cost range of $1,363 to $1,741 million. The estimated cost of constructing the Thomes-Newville Reservoir Project with a capacity of 3.08 maf is $1,723 million with a cost range of $1,550 to $1,981 million. The difference in cost of the two alternatives is attributed primarily to the difference in Thomes-Newville Reservoir storage capacity.

ENVIRONMENTAL CONSIDERATIONS

[NOTE: The Environmental Considerations section of this report needs to be reevaluated by DWR to ensure consistency with the information in the previous sections.]

This portion of the report provides a summary of environmental considerations related to the proposal for developing a Thomes-Newville Reservoir Project. This section describes the fish, wildlife, plant, and cultural resources that could be affected and identifies, where possible, the extent of the effect of the proposal on these resources. For the most part, the information presented in this section was gathered from existing literature, with limited original research. No field work was conducted for this analysis.

WILDLIFE

Depending on the reservoir configuration selected, the project could inundate up to 13,900 acres of terrestrial wildlife habitat and up to 35 miles of perennial stream habitat.

One of the more significant results of constructing this complex would be the loss of over 2,000 acres of critical winter range for an estimated 1,100 deer of the Thomes Creek (Lake

Hollow) herd and the displacement of over 600 migratory and resident deer. Potential impacts to steelhead and salmon may also result from the loss of a portion of their periodic run. The impact of run blockage for Sacramento squawfish and suckers is expected to be significant. Indirect fish losses can be expected at the project's Sacramento River diversion.

Fish, Amphibians, Reptiles, and Invertebrates

Aquatic habitat in the project area include perennial pools and seasonally flowing streams, with some cooler streams from the mountains. The streams and numerous tributaries within the potential inundation zone provide habitat for a number of cold- and warm-water fish species. Fish habitat zones within the project area include the Rainbow Trout, California Roach, and Squawfish-Sucker-Hardhead zones. Representative species that are supported by these zones include rainbow trout, brown trout, chinook salmon, smallmouth bass, green sunfish, redear sunfish, channel catfish, white catfish, brown bullhead, black bullhead, threespine stickleback, Pacific lamprey, hard head, Sacramento squawfish, Sacramento sucker, hitch, golden shinner, mosquitofish, and prickly sculpin. The principal gamefish are trout and bass. Small numbers of chinook salmon and steelhead enter Stony and Thomes Creeks during the fall and winter.

The project could result in creek flow reductions, which would limit spawning and rearing habitat for small populations of chinook salmon and steelhead trout. Flow reductions in Thomes Creek may also limit spawning and rearing opportunities for non-game species such as Sacramento squawfish and Sacramento suckers. The latter impact is expected to be greater because of the much larger size of the squawfish and sucker runs. Altered stream flows could cause the composition in some of the area's creeks to change. In some cases, stabilized water levels in the new reservoirs will have a beneficial effect on warm water fish species such as striped bass.

In addition, indirect effects on fish in the Sacramento River and Delta could occur as a result of stoppage of gravel recruitment causing eventual degradation of additional spawning, incubation, and rearing habitat. Other effects include reduced insect production due to increased current velocities over rifle areas, increased backwater fish production due to higher flows, increased estuarine productivity due to higher flows that would transport more nutrients and detritus, a possible increase in aquatic organism survival due to the dilution of toxicant caused by higher flows, possible changes in the timing and location of striped bass spawning due to streamflow alterations, possible improvement of American shad survival due to higher flows, increased salmon mortalities at alternative Sacramento River pump diversions, and unknown estuary changes in the Delta due to reductions in uncontrolled flows.

The Thomes-Newville Reservoir Project supports 12 different species of amphibians and over 20 species of reptiles.

General Wildlife

Lands within the Thomes-Newville Reservoir Project area support diverse wildlife. The primary game species include black-tailed deer, California quail, mourning dove, wild turkey, and furbearers. Non-game species include numerous species of songbirds and mammals. The grasslands within the project area provide valuable foraging opportunities for raptors such as golden eagles and prairie falcons. Previous surveys have identified up to 145 species of birds in four different habitat types within the project area.

The project would provide benefits to water-associated birds by increasing available habitat.

Significant numbers of wintering deer migrate through sections of the project area and use the area as wintering habitat. About 19 percent of the current winter range of the Thomes Creek (Lake Hollow) deer herd would be inundated by the proposed facilities. It may be possible to

lessen this impact by improving habitats in the Thomes Creek drainage upstream of the proposed Newville Reservoir.

Sensitive and Listed Fish and Wildlife Species

Several State or federally listed fish species are known to exist within the area of the proposed Thomes-Newville Reservoir Project. According to the California Department of Fish and Game's (CDFG) Natural Diversity Data Base (Version 8/96), there are two wildlife species that are State or federally listed and two wildlife species that are either candidates for listing and/or species designated by CDFG as species of special concern.

Listed wildlife species that have been known to occur in or near the area affected by the proposed complex include bald eagle (federal threatened/State endangered) and northern spotted owl (federal threatened). Other listed species that may be found in the project area include bank swallow, willow flycatcher, and Swainson's hawk.

Wildlife species that are either candidates for State or federal listing or considered species of special concern by the CDFG that could be affected by the proposed project include northern goshawk tailed frog (federal candidate/CDFG species of special concern) and prairie falcon CDFG species of special concern). Other CDFG species of special concern that may be found using the project area include golden eagle, osprey, Cooper's hawk, yellow warbler, and tricolored blackbird.

Wintering southern bald eagles currently use the riparian areas within the project complex for roosting. Reductions in riparian habitat will reduce roosting habitat for eagles and a reduction of squawfish and suckers would reduce forage opportunities for eagles. Maintenance of riparian habitat below project diversions and sustained fish populations in the new reservoirs could lessen

the impact of the project on these wintering eagles. Golden eagles, most abundant during the winter, can be found using the project area year-round.

Bank swallows are summer visitors to the project area. Nesting colonies have been known to occur in the past along Thomes Creek.

VEGETATION

Vegetation at the Thomes-Newville Reservoir Project consists primarily of grasslands, oak-pine woodland, and chaparral. Riparian vegetation occurs along the numerous rivers and streams in the area. Vernal pools have been scattered throughout the project area in the past.

Sensitive and Listed Plant Species

One listed plant species, Indian valley brodiaea (federal candidate, State endangered), is known to occur within the area proposed for the Thomes-Newville Reservoir. Other sensitive plant species or plants that are candidates for federal or State listing could possibly be found in the project area. These species include drymaria-like western flax, Tehama County western flax, Brandegee's eriastrum, adobe lily, Ahart's paronychia, Shasta clarkia, and Butte County fritillary.

Two additional plants, diamorphic snapdragon and dwarf soaproot, listed by the California Native Plant Society as being rare, threatened or endangered in California and elsewhere could also be affected by the proposed project.

There are two special-status habitats in the area affected by the proposed project: Great Valley cottonwood riparian forest and northern interior cypress forest.

Wetlands

Based on wetland information from USFWS's National Wetlands Inventory Maps, the following lands would be directly affected by the project: 36 miles of intermittent streambeds; 35 miles of perennial streams, 10 miles of emergent seasonally flooded wetlands (shallow marsh), 1 mile of emergent temporarily flooded wetlands (wet meadow), 1 mile of shrub-scrub wetlands, 1 mile of forested wetlands, 1 mile of forested/scrub-shrub wetland, 71 acres of open water, artificially flooded wetlands, 25 acres of forested wetland (wet meadow), 7 acres of shrub-scrub (wet meadow), 4 acres of emergent shallow marsh, and 45 acres of ponds.

CULTURAL RESOURCES

There are 188 non-significant and an estimated 35 significant prehistoric sites in the proposed project's area. There is also an estimate of 50 non-significant, 20 significant historic sites, and 35 ethnographic sites.

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Table 1

SUMMARY OF PHYSICAL CHARACTERISTICS
THOMES-NEWVILLE RESERVOIR PROJECT

FACILITIES	1.84 MAF	3.08 MAF
Thomes-Newville Reservoir		
Normal Pool Elevation (feet above MSL)	900	980
Capacity at Normal Pool Elevation (MAF)	1.84	3.08
Inundation Area (acres)	13,900	16,700
Newville Dam		
Type	Zoned Earthfill	Zoned Earthfill
Height Above Streambed (feet)	320	400
Top of Dam (feet above MSL)	920	1,000
Embankment Volume (million cubic yards)	16,000,000	25,000,000
Freeboard (feet)	20	20
Downstream Face Slope (horizontal on vertical)	2.5:1	2.5:1
Upstream Face Slope (horizontal on vertical)	3.25:1	3.25:1
Crest Length (feet)	2,400	3,200
Spillway Capacity (cfs)	35,700	35,700
Emergency Spillway (cfs)	8,000	8,000
Inlet/Outlet Capacity (cfs)	5,000	5,000
Saddle Dams		
Number Required	1	10
Embankment Volume (cubic yards)	197,000	4,700,000
Thomes Creek Diversion Structure and Canal		
Dam Type	Conventional Concrete Gravity	
Height Above Streambed (feet)	90	90
Top of Dam (feet above MSL)	1,050	1,050
Overflow Section Width (feet)	500	500
Overflow Section Elevation (feet above MSL)	1,035	1,035
Gated Spillway Capacity (cfs)	41,000	41,000
Conveyance Canal Length (feet)	13,100	13,100
Conveyance Canal Capacity (cfs)	10,000	10,000
Concrete Chute Length (feet)	2,150	0
Tehenn Reservoir		
Normal Pool Elevation (feet above MSL)	610	610
Capacity at Normal Pool Elevation (acre-feet)	32,500	32,500

Table 1 (Continued)
SUMMARY OF PHYSICAL CHARACTERISTICS
THOMES-NEWVILLE RESERVOIR PROJECT

FACILITIES	1.84 MAF	3.08 MAF
Tehenn Dam		
Type	Earthfill	Earthfill
Embankment Volume (cubic yards)	2,600,000	2,600,000
Height Above Streambed (feet)	112	112
Crest Length (feet)	2,500	2,500
Spillway Capacity (cfs)	50,000	50,000
Outlet Works Capacity (cfs)	5,000	5,000
Tehenn Canal		
Invert Elevation (feet above MSL)	410	410
Capacity (cfs)	5,000	5,000
Length (MI)	5.0	5.0
Pumping Plants		
Capacity (cfs)		
Newville	5,000	5,000
Tehenn	5,000	5,000
Black Butte	5,000	5,000
Sour Grass	5,000	5,000
Total Dynamic Head (feet)		
Newville	300	380
Tehenn	190	190
Black Butte	144	144
Sour Grass	115	115
Horsepower Requirement		
Newville	226,912	287,422
Tehenn	143,711	143,711
Black Butte	108,918	108,918
Sour Grass	86,983	86,983
Black Butte Canal		
Invert Elevation	310	310
Capacity (cfs)	5,000	5,000
Length (mile)	4.5	4.5
Sour Grass Canal		
Invert Elevation	205	205
Capacity (cfs)	5,000	5,000
Length (mile)	4.5	4.5
Black Butte Reservoir (Existing)		
Normal Pool Elevation (feet above MSL)	474	474
Capacity at Normal Pool Elevation (acre-feet)	392,000	392,000

Table 2a
ESTIMATED CAPITAL COSTS
THOMES-NEWVILLE RESERVOIR PROJECT - 1.84 MAF ALTERNATIVE

DESCRIPTION	QUANTITY	UNIT*	USBR INDEX JAN. 81	USBR INDEX OCT. 96	UNIT COST JAN. 81	UNIT COST OCT. 96	TOTAL COST OCT. 96	COST REFERENCE
I. LANDS								
Newville Reservoir Right of Way	18,350	AC				$1,500	$27,525,000	5
Thomes Creek Diversion Right of Way	125	AC				$1,500	$187,500	5
Tehenn Reservoir right of Way	1,250	AC				$1,500	$1,875,000	5
Tehenn Canal Right of Way	212	AC				$1,500	$318,000	5
Black Butte Canal Right of Way	191	AC				$1,500	$286,500	5
Sour Grass Canal Right of Way	191	AC				$1,500	$286,500	5
SUBTOTAL LANDS							$30,478,500	
II. DAM								
Mobilization	JOB	LS	132	159	$2,300,000	$2,770,455	$2,770,455	1, page 39
Care of Water	JOB	LS	132	159	$150,000	$180,682	$180,682	1, page 39
Foundation Excavation and Stripping	1,946,670	CY				$3.23	$6,287,744	2, item I-d
Imported Borrow - Impervious	4,301,200	CY				$3.22	$13,849,864	2, item I-e
Place and Compact Impervious Material	3,910,200	CY				$0.95	$3,714,690	2, item I-f
Furnish and Compact Filter and Drain	1,595,300	CY				$8.54	$13,623,862	2, item I- i &j
Furnish and Compact Random Material	1,677,800	CY				$3.11	$5,217,958	2, item I-l
Furnish and Compact Sand and Gravel	8,816,930	CY				$5.90	$52,019,887	2, item I- g&h
Drill Grout Holes	35,300	LF				$18.70	$660,110	2, item I-q
Grout Connections	380	EA	132	159	$50.00	$60.00	$22,800	1, page 39
Grouting	870	CY	132	159	$190.00	$229	$199,230	1, page 39
Grout Pipe	1,140	LF	132	159	$8.00	$10.00	$11,400	1, page 39
Instrumentation	JOB	LS	132	159	$350,000	$421,591	$421,591	1, page 39
SUBTOTAL DAM							$98,980,273	
III. OUTLET WORKS								
Dewatering	JOB	LS	141	206	$100,000	$146,099	$146,099	1, page 42
Excavations for:								
Gate Chamber	1,500	CY	141	206	$100	$146	$219,000	1, page 42
Intake and Gate Chamber	12,000	CY				$6.76	$81,120	2, item VI - I
Penstocks and Tunnel	37,000	CY				$128.27	$4,745,990	2, item VI - s
Portal	127,000	CY	141	206	$6.00	$9.00	$1,143,000	1, page 42
By-pass and Trifureation	9,000	CY	141	206	$4.00	$6.00	$54,000	1, page 42
Shaft	1,000	CY				$147	$146,590	2, item II - c
Diversion Channel	71,000	CY	141	206	$4.00	$6.00	$426,000	1, page 42
Compaction Backfill	7,000	CY	141	206	$20.00	$29.00	$203,000	1, page 42
Granular Structural Backfill	2,000	CY				$18.99	$37,980	2, item VI - h
Concrete								
Penstock-Tunnel	10,500	CY				$321	$3,367,140	2, item VI - t
Intake and Gate Chamber Access Tunnel	3,600	CY				$321	$1,154,448	2, item VI - t
Gate Chambers	700	CY				$340	$237,650	2, item VI - k
Low Intake	500	CY				$340	$169,750	2, item VI - k

Table 2a
ESTIMATED CAPITAL COSTS
THOMES-NEWVILLE RESERVOIR PROJECT - 1.84 MAF ALTERNATIVE

DESCRIPTION	QUANTITY	UNIT[a]	USBR INDEX JAN. 81	USBR INDEX OCT. 96	UNIT COST JAN. 81	UNIT COST OCT. 96	TOTAL COST OCT. 96	COST REFERENCE
Low Intake Foundation	400	CY				$270	$108,180	2, item VI - j
Control Valve House	700	CY				$340	$237,650	2, item VI - k
Vertical Shaft	300	CY				$340	$101,850	2, item VI - k
Grouting Cement	21,000	BBL	141	206	$18.00	$26.00	$546,000	1, page 42
Mass Concrete	4,000	CY				$293	$1,172,360	2, item III - d
Ring Girder	72,000	LBS	141	206	$2.00	$3.00	$216,000	1, page 42
Overhead Hoist Rails	150,000	LBS				$3.63	$544,500	2, item VI - p
2 1/2 " x 2 1/2 " x 1/4 " Angles	27,000	LBS				$3.63	$98,010	2, item VI-m
1 1/2 " x 30 " x 20 " Bearing Plate	30,000	LBS				$3.63	$108,900	2, item VI-m
Walkway Plate	54,000	LBS				$3.63	$196,020	2, item VI-m
Gantry Crane (20 ton)	1	EA	141	206	$195,000	$284,894	$284,894	1, page 41
Trashrack 6 ' x 18 '	6	EA	141	206	$10,000	$14,610	$87,660	2, item VI-q
60 " Dia. Gate Valve	12	EA	141	206	$77,000	$112,496	$1,349,952	1, page 41
84 " Dia. Howell Bunger Valve	2	EA	141	206	$300,000	$438,298	$876,596	1, page 41
84 " Dia. Gate Valve	2	EA	141	206	$310,000	$452,908	$905,816	1, page 41
90 " Dia Gate Valve	1	EA	141	206	$350,000	$511,348	$511,348	1, page 41
Valve Thimbles	12	EA	141	206	$15,000	$21,915	$262,980	1, page 41
Valve Operator	12	EA	141	206	$20,000	$29,220	$350,640	1, page 41
120 " Dia. Steel Penstock	1,050,000	LBS				$1.65	$1,732,500	2, item VII-c
90 " Dia. Steel By-pass	200,000	LBS				$1.65	$330,000	2, item VII-c
72 " Dia. Steel By-pass	50,000	LBS				$1.65	$82,500	2, item VII-c
60 " Dia. Steel By-pass	97,000	LBS				$1.65	$160,050	2, item VII-c
Grouting Pipe	13,630	LBS	132	159	$8.00	$10.00	$136,300	1, page 41
Bifurcation 10 ' to 8 '	2	EA	141	206	$17,000	$24,837	$49,674	1, page 41
Reducer 10 ' to 6'	1	EA	141	206	$10,000	$14,610	$14,610	1, page 41
Bifurcation 10 ' to 5 '	2	EA	141	206	$14,000	$20,454	$40,908	1, page 41
Timber for Tunnel Supports	300	MBF				$1,930	$579,000	2, item VI - w
Grout Drilling Holes	18,500	LF				$17.70	$327,450	2, item I - g
Standby Generator	1	EA	141	206	$45,000	$65,745	$65,745	1, page 41
Architectural Features	JOB	LS	141	206	$300,000	$438,298	$438,298	1, page 41
Cathodic Protection	JOB	LS	141	206	$35,000	$51,135	$51,135	1, page 41
Protective Coatings	JOB	LS	141	206	$100,000	$146,099	$146,099	1, page 41
SUBTOTAL							$24,245,392	
Increase Capacity from 1,500 cfs to 5,000 cfs, factor cost by $(5,000/1,500)^{3/8} = 1.57$								
SUBTOTAL OUTLET WORKS							$38,065,265	
IV. SPILLWAY								
Mobilization	JOB	LS	143	186	$300,000	$390,210	$390,210	1, page 44
Drill Grout Holes	920	LF				$18.70	$17,204	2, item I-g
Grout Connections	15	EA	143	186	$25.00	$33.00	$495	1, page 44
Grouting	23	CY	143	186	$280	$364	$8,372	1, page 44
Grout Pipe	68	LF	132	159	$8.00	$10.00	$680	1, page 44

Table 2a
ESTIMATED CAPITAL COSTS
THOMES-NEWVILLE RESERVOIR PROJECT - 1.84 MAF ALTERNATIVE

DESCRIPTION	QUANTITY	UNIT[a]	USBR INDEX JAN. 81	USBR INDEX OCT. 96	UNIT COST JAN. 81	UNIT COST OCT. 96	TOTAL COST OCT. 96	COST REFERENCE
Excavation (blasting)	725,000	CY				$7.66	$5,553,500	2, item V-b3
Excavation	249,000	CY				$4.03	$1,003,470	2, av. item IIa, IIIa
Rock Riprap	2,000	CY				$31.64	$63,280	2, item I-n
Granular Backfill	5,800	CY				$45.09	$261,522	2, item II-n
Structural Backfill	8,100	CY	143	186	$20.00	$26.00	$210,600	1, page 44
Compacted Backfill	44,700	CY				$8.17	$365,199	2, item III-f
Aggregate Base	480	TON				$19.15	$9,192	2, item V-d
Asphalt Concrete	400	TON				$58.92	$23,568	2, item V-e
Mass Concrete	6,200	CY				$293	$1,817,158	2, item III-d
Structural Concrete	20,700	CY				$401	$8,307,117	2, av. item IIh, IIIc
Embedded Metal	JOB	LS	143	186	$35,000	$45,524	$45,524	1, page 44
Misc. Metal	JOB	LS	143	186	$50,000	$65,035	$65,035	1, page 44
Radial Gate (20 ' x 30 ')	2	EA	143	186	$270,000	$351,189	$702,378	1, page 44
Radial Gate Hoist Assembly	2	EA	143	186	$90,000	$117,063	$234,126	1, page 44
Stop Log (6 ' x 21 ')	12	EA	143	186	$14,000	$18,210	$218,520	1, page 44
Stop Log Storage Rack	JOB	LS	143	186	$20,000	$26,014	$26,014	1, page 44
Stop Log Lifting Beam	JOB	LS	143	186	$5,000	$6,503	$6,503	1, page 44
Electrical Work	JOB	LS	143	186	$30,000	$39,021	$39,021	1, page 44
Control Building (12 ' x 16 ')	JOB	LS	143	186	$26,000	$33,818	$33,818	1, page 44
Standby Generator	JOB	LS	143	186	$40,000	$52,028	$52,028	1, page 44
SUBTOTAL SPILLWAY							$19,454,534	
V. **RESERVOIR**								
Reservoir Clearing (Newville and Tehenn)	1,515	AC				$1,097	$1,661,955	2, item IV-a
Improvements	JOB	LS	137	176	$30,000	$38,540	$38,540	1, page 47
Construction Facilities	JOB	LS	137	176	$20,000	$25,693	$25,693	1, page 47
Excavate Overlook	48,400	CY	137	176	$14.00	$18.00	$871,200	1, page 47
Aggregate Base for Overlook	2,000	TON				$19.15	$38,300	2, item V-d
Asphalt Concrete for Overlook	511	TON				$58.92	$30,108	2, item v-e
Liquid Asphalt Prime and Seal	85	TON				$324.03	$27,543	2, av. item V- f&g
Landscaping Overlook	JOB	LS	137	176	$24,000	$30,832	$30,832	1, page 47
Visitor's Center	JOB	LS	137	176	$200,000	$256,934	$256,934	1, page 47
SUBTOTAL RESERVOIR							$2,981,105	
VI. **OVERLOOK ACCESS ROAD**								
Excavation	106,000	CY				$3.98	$421,880	2, item V-b1
Class II Aggregate Base	5,710	TON				$19.15	$109,347	2, item V-d
Asphalt Concrete	941	TON				$58.92	$55,444	2, item V-e
Liquid Asphalt Prime and Seal Coat	157	TON				$324	$50,873	2, av. item V-f&g
Guard Rail	2,650	LF	160	237	$20.00	$30.00	$79,500	1, page 50
18 " CMP	180	LF				$44.78	$8,060	2, item V-j
24 " CMP	490	LF				$53.53	$26,230	2, item V-k

Table 2a
ESTIMATED CAPITAL COSTS
THOMES-NEWVILLE RESERVOIR PROJECT - 1.84 MAF ALTERNATIVE

DESCRIPTION	QUANTITY	UNIT*	USBR INDEX JAN. 81	USBR INDEX OCT. 96	UNIT COST JAN. 81	UNIT COST OCT. 96	TOTAL COST OCT. 96	COST REFERENCE
30 " CMP	200	LF	160	237	$45.00	$67.00	$13,400	1, page 50
Structure Excavation	350	CY	160	237	$12.00	$18.00	$6,300	1, page 50
Structure Backfill	270	CY	160	237	$20.00	$30.00	$8,100	1, page 50
SUBTOTAL OVERLOOK ACCESS ROAD							$779,133	
VII. ROAD RELOCATIONS								
Newville to Paskenta								
48 " CSP	140	LF	146	219	$60.00	$90.00	$12,600	1, page 51
26 " CSP	240	LF	146	219	$40.00	$60.00	$14,400	1, page 51
24 " CSP	160	LF	146	219	$30.00	$45.00	$7,200	1, page 51
18 " CSP	570	LF	146	219	$25.00	$38.00	$21,660	1, page 51
Structure Excavation	4,700	CY	146	219	$25.00	$38.00	$178,600	1, page 51
Structure Backfill	4,400	CY	146	219	$45.00	$68.00	$299,200	1, page 51
Roadway Excavation	1,033,000	CY				$3.98	$4,111,340	2, item V-b1
Aggregate Base	31,000	TON				$19.15	$593,650	2, item V-d
Asphalt Concrete	15,000	TON				$58.92	$883,800	2, item V-e
Down Drains	24	EA	146	219	$1,000	$1,500	$36,000	1, page 51
Fence	66,800	LF	146	219	$2.00	$3.00	$200,400	1, page 51
SUBTOTAL NEWVILLE TO PASKENTA ROAD							$6,358,850	
Cattle Crossings (6 total)								
11' - 5" x 73 " Multiple Steel Pipe	432	LF	146	219	$180	$270	$116,640	1, page 51
Structure Excavation	1,710	CY	146	219	$25.00	$38.00	$64,980	1, page 51
Structure Backfill	1,100	CY	146	219	$45.00	$68.00	$74,800	1, page 51
SUBTOTAL CATTLE CROSSINGS							$256,420	
Round Valley Road								
48 " CSP	300	LF	146	219	$60.00	$90.00	$27,000	1, page 51
24 " CSP	2,120	LF	146	219	$30.00	$45.00	$95,400	1, page 51
Roadway Excavation	233,000	CY	146	219		$3.98	$927,340	2, item V-b1
Structure Excavation	2,000	CY	146	219	$25.00	$38.00	$76,000	1, page 51
Structure Backfill	1,600	CY	146	219	$45.00	$68.00	$108,800	1, page 51
Aggregate Base	9,100	TON				$19.15	$174,265	2, item V-d
Asphalt Concrete	4,400	TON				$58.92	$259,248	2, item V-e
Down Drains	12	EA	146	219	$1,000	$1,500	$18,000	1, page 51
Fence	20,000	LF	146	219	$2.00	$3.00	$60,000	1,page 51
Compacted Embankment and Overhaul	211,000	CY				$1.36	$286,960	2, item V-c1
Bridge D/S of Newville Spillway	6,800	SF				$100	$680,000	3
SUBTOTAL ROUND VALLEY ROAD							$2,713,013	
Chrome to Burrows Gap Road								
60 " CSP	250	LF	146	219	$70.00	$105	$26,250	1, page 52

Table 2a
ESTIMATED CAPITAL COSTS
THOMES-NEWVILLE RESERVOIR PROJECT - 1.84 MAF ALTERNATIVE

DESCRIPTION	QUANTITY	UNIT*	USBR INDEX JAN. 81	USBR INDEX OCT. 96	UNIT COST JAN. 81	UNIT COST OCT. 96	TOTAL COST OCT. 96	COST REFERENCE
24 " CSP	920	LF	146	219	$30.00	$45.00	$41,400	1, page 52
Roadway Excavation	202,000	CY				$3.98	$803,960	2, item V-b1
Structure Excavation	1,600	CY	146	219	$25.00	$38.00	$60,800	1, page 52
Structure Backfill	1,800	CY	146	219	$45.00	$68.00	$122,400	1, page 52
Aggregate Base	9,100	TON				$19.15	$174,265	2, item V-d
Asphalt Concrete	5,300	TON				$58.92	$312,276	2, item V-e
Fence	53,000	LF	146	219	$2.00	$3.00	$159,000	1, page 52
Bridge over Stony Creek Diversion	6,800	SF				$100	$680,000	3
SUBTOTAL CHROME TO BURROWS GAP ROAD							$2,380,351	
SUBTOTAL ROAD RELOCATIONS							$11,708,634	
VIII. BURROWS GAP SADDLE DAM								
Mobilization	JOB	LS	132	159	$86,000	$103,591	$103,591	1, page 54
Clear and Grub	3	AC	132	159	$4,000	$4,818	$14,454	1. page 54
Foundation Excavation	87,400	CY				$3.23	$282,302	2, item I-d
Drill Grout Holes	2,700	LF				$18.70	$50,490	2, item I-g
Grout Connections	50	EA	132	159	$50.00	$60.00	$3,000	
Grouting	67	CY	132	159	$280	$337	$22,579	
Grout Pipe	225	LF	132	159	$8.00	$10.00	$2,250	
Borrow - Impervious Material	176,500	CY				$3.22	$568,330	2, item I-e
Filter and Drain Material	26,600	CY				$8.54	$227,164	2, item I- i&j
Riprap	6,640	CY				$31.64	$210,090	2, item I-n
Riprap Bedding	3,320	CY				$1.79	$5,943	2, item I-m
Placed Impervious	160,500	CY				$0.95	$152,475	2, item I-f
Instrumentation	JOB	LS	132	176	$50,000	$66,667	$66,667	1, page 54
SUBTOTAL CONVEYANCE FACILITIES							$1,709,334	

DESCRIPTION	QUANTITY	UNIT*	USBR INDEX OCT. 79	USBR INDEX OCT. 96	UNIT COST OCT. 79	UNIT COST OCT. 96	TOTAL COST OCT. 96	COST REFERENCE
IX. THOMES CREEK DIVERSION FACILITIES								
Diversion Structure	JOB	LS	121	207	$7,940,000	$13,583,306	$13,583,306	4, page 4-13
Intake Structure	JOB	LS	122	213	$1,150,000	$2,007,787	$2,007,787	4, page 4-13
Canal and Roads	JOB	LS	120	199	$21,740,000	$36,052,167	$36,052,167	4, page 4-13
Outlet Chute	JOB	LS	122	213	$1,860,000	$3,247,377	$3,247,377	4, page 4-13
SUBTOTAL THOMES CREEK DIVERSION FACILITIES							$54,890,637	

Table 2a
ESTIMATED CAPITAL COSTS
THOMES-NEWVILLE RESERVOIR PROJECT - 1.84 MAF ALTERNATIVE

DESCRIPTION	QUANTITY	UNIT[a]	USBR INDEX APR. 80	USBR INDEX OCT. 96	UNIT COST APR. 80	UNIT COST OCT. 96	TOTAL COST OCT. 96	COST REFERENCE
X. CONVEYANCE FACILITIES								
Tehama Colusa Canal Turnout	JOB	LS				$1,543,000	$1,543,000	3
Sour Grass Canal	JOB	LS	127	199	$13,220,222	$20,715,151	$20,715,151	4- page 9-17
Sour Grass Pumping-Generating Plant								
Q=5,000 cfs, TDH = 115 ft. , HP = 86,983	JOB	LS				$97,528,800	$97,528,800	3
Black Butte Canal , factored by $(5,000/10,000)^{3/8}$	JOB	LS	127	199	$15,453,000	$24,213,756	$24,213,756	4- page 9-17
Black Butte Pumping-Generating Plant								
Q=5,000 cfs, TDH = 144 ft. , HP =108,918	JOB	LS				$111,617,600	$111,617,600	3
Tehenn Canal, factored by $5,000/3,000)^{3/8}$	JOB	LS	127	199	$47,658,000	$74,676,709	$74,676,709	4- page 5-19
Tehenn Reservoir	JOB	LS	127	176	$29,010,000	$40,202,835	$40,202,835	4- page 5-19
Tehenn Pumping-Generating Plant								
Q=5,000 cfs, TDH = 190 ft., HP = 143,711	JOB	LS				$131,816,000	$131,816,000	3
Newville Pumping-Generating Plant								
Q=5,000 cfs, TDH = 300 ft., HP = 226,912	JOB	LS				$173,376,000	$173,376,000	3
SUBTOTAL CONVEYANCE FACILITIES							$675,689,851	
SUBTOTAL COST ITEMS FOR THOMES-NEWVILLE RESERVOIR PROJECT 1.84 MAF ALTERNATIVE							$934,700,000	
CONTINGENCIES @ 20%							$186,900,000	
ESTIMATED CONSTRUCTION COST							$1,121,600,000	
ENG., LEGAL, AND ADM. @ 35%							$392,600,000	
ESTIMATED CAPITAL COST FOR THOMES-NEWVILLE							$1,514,200,000	
ESTIMATED CAPITAL COST RANGE FOR THOMES-NEWVILLE								
LOW (-10%)							$1,363,000,000	
HIGH (+15%)							$1,741,000,000	

Footnotes:

[a]CY=cubic yard; LB=pound; EA=each; LS=lump sum; LF=linear foot; SF=square foot; TON=ton; MI=mile; AC=acre

Cost Reference:

1. California Department of Water Resources, *SWP Future Supply Program, Thomes-Newville Plan*, September 1981.
2. California Department of Water Resources, *Los Banos Grandes Facilities Report, Appendix A: Designs and Cost Estimates*, December 1990.
3. Cost developed by Bookman-Edmonston Engineering.
4. California Department of Water Resources, *Thomes-Newville and Glenn Reservoir Plans - Engineering Feasibility*, November 1980.
5. U.S. Bureau of Reclamation, Land Resources Branch, Graham McMullen, February 1997.

Table 2b
ESTIMATED CAPITAL COSTS
THOMES-NEWVILLE RESERVOIR PROJECT - 3.08 MAF ALTERNATIVE

DESCRIPTION	QUANTITY	UNIT[a]	USBR INDEX JAN. 81	USBR INDEX OCT. 96	UNIT COST JAN. 81	UNIT COST OCT. 96	TOTAL COST OCT. 96	COST REFERENCE
I. LANDS								
Newville Reservoir Right of Way	22,060	AC				$1,500	$33,090,000	5
Thomes Creek Diversion Right of Way	107	AC				$1,500	$160,500	5
Tehenn Reservoir Right of Way	1,250	AC				$1,500	$1,875,000	5
Tehenn Canal Right of Way	212	AC				$1,500	$318,000	5
Black Butte Canal Right of Way	191	AC				$1,500	$286,500	5
Sour Grass Canal Right of Way	191	AC				$1,500	$286,500	5
SUBTOTAL LANDS							$36,016,500	
II. DAM								
Mobilization	JOB	LS	132	159	$2,300,000	$2,770,455	$2,770,455	1, page 39
Care of Water	JOB	LS	132	159	$150,000	$180,682	$180,682	1, page 39
Foundation Excavation and Stripping	2,994,000	CY				$3.23	$9,670,620	2, item I-d
Imported Borrow - Impervious	6,615,300	CY				$3.22	$21,301,266	2, item I-e
Place and Compact Impervious Material	6,013,900	CY				$0.95	$5,713,205	2, item I-f
Furnish and Compact Filter and Drain	2,453,600	CY				$8.54	$20,953,744	2, item I- i &j
Furnish and Compact Random Material	2,580,500	CY				$3.11	$8,025,355	2, item I-l
Furnish and Compact Sand and Gravel	13,560,400	CY				$5.90	$80,006,360	2, item I- g&h
Drill Grout Holes	54,290	LF				$18.70	$1,015,223	2, item I-q
Grout Connections	585	EA	132	159	$50.00	$60.00	$35,100	1, page 39
Grouting	1,340	CY	132	159	$190.00	$229	$306,860	1, page 39
Grout Pipe	1,755	LF	132	159	$8.00	$10.00	$17,550	1, page 39
Instrumentation	JOB	LS	132	159	$350,000	$421,591	$421,591	1, page 39
SUBTOTAL DAM							$150,418,011	
III. OUTLET WORKS								
Dewatering	JOB	LS	141	206	$100,000	$146,099	$146,099	1, page 42
Excavations for:								
Gate Chamber	1,500	CY	141	206	$100	$146	$219,000	1, page 42
Intake and Gate Chamber	12,000	CY				$6.76	$81,120	2, item VI - I
Penstocks and Tunnel	37,000	CY				$128.27	$4,745,990	2, item VI - s
Portal	127,000	CY	141	206	$6.00	$9.00	$1,143,000	1, page 42
By-pass and Trifurcation	9,000	CY	141	206	$4.00	$6.00	$54,000	1, page 42
Shaft	1,000	CY				$147	$146,590	2, item II - c
Diversion Channel	71,000	CY	141	206	$4.00	$6.00	$426,000	1, page 42
Compaction Backfill	7,000	CY	141	206	$20.00	$29.00	$203,000	1, page 42
Granular Structural Backfill	2,000	CY				$18.99	$37,980	2, item VI - h
Concrete								
Penstock-Tunnel	10,500	CY				$321	$3,367,140	2, item VI - t
Intake and Gate Chamber Access Tunnel	3,600	CY				$321	$1,154,448	2, item VI - t
Gate Chambers	700	CY				$340	$237,650	2, item VI - k
Low Intake	500	CY				$340	$169,750	2, item VI - k

Table 2b
ESTIMATED CAPITAL COSTS
THOMES-NEWVILLE RESERVOIR PROJECT - 3.08 MAF ALTERNATIVE

DESCRIPTION	QUANTITY	UNIT*	USBR INDEX JAN. 81	USBR INDEX OCT. 96	UNIT COST JAN. 81	UNIT COST OCT. 96	TOTAL COST OCT. 96	COST REFERENCE
Low Intake Foundation	400	CY				$270	$108,180	2, item VI - j
Control Valve House	700	CY				$340	$237,650	2, item VI - k
Vertical Shaft	300	CY				$340	$101,850	2, item VI - k
Grouting Cement	21,000	BBL	141	206	$18.00	$26.00	$546,000	1, page 42
Mass Concrete	4,000	CY				$293	$1,172,360	2, item III - d
Ring Girder	72,000	LBS	141	206	$2.00	$3.00	$216,000	1, page 42
Overhead Hoist Rails	150,000	LBS				$3.63	$544,500	2, item VI - p
2 1/2 " x 2 1/2 " x 1/4 " Angles	27,000	LBS				$3.63	$98,010	2, item VI-m
1 1/2 " x 30 " x 20 " Bearing Plate	30,000	LBS				$3.63	$108,900	2, item VI-m
Walkway Plate	54,000	LBS				$3.63	$196,020	2, item VI-m
Gantry Crane (20 ton)	1	EA	141	206	$195,000	$284,894	$284,894	1, page 41
Trashrack 6 ' x 18 '	6	EA	141	206	$10,000	$14,610	$87,660	2, item VI-q
60 " Dia. Gate Valve	12	EA	141	206	$77,000	$112,496	$1,349,952	1, page 41
84 " Dia. Howell Bunger Valve	2	EA	141	206	$300,000	$438,298	$876,596	1, page 41
84 " Dia. Gate Valve	2	EA	141	206	$310,000	$452,908	$905,816	1, page 41
90 " Dia Gate Valve	1	EA	141	206	$350,000	$511,348	$511,348	1, page 41
Valve Thimbles	12	EA	141	206	$15,000	$21,915	$262,980	1, page 41
Valve Operator	12	EA	141	206	$20,000	$29,220	$350,640	1, page 41
120 " Dia. Steel Penstock	1,050,000	LBS				$1.65	$1,732,500	2, item VII-c
90 " Dia. Steel By-pass	200,000	LBS				$1.65	$330,000	2, item VII-c
72 " Dia. Steel By-pass	50,000	LBS				$1.65	$82,500	2, item VII-c
60 " Dia. Steel By-pass	97,000	LBS				$1.65	$160,050	2, item VII-c
Grouting Pipe	13,630	LBS	132	159	$8.00	$10.00	$136,300	1, page 41
Bifurcation 10 ' to 8 '	2	EA	141	206	$17,000	$24,837	$49,674	1, page 41
Reducer 10 ' to 6'	1	EA	141	206	$10,000	$14,610	$14,610	1, page 41
Bifurcation 10 ' to 5 '	2	EA	141	206	$14,000	$20,454	$40,908	1, page 41
Timber for Tunnel Supports	300	MBF				$1,930	$579,000	2, item VI - w
Grout Drilling Holes	18,500	LF				$17.70	$327,450	2, item I - g
Standby Generator	1	EA	141	206	$45,000	$65,745	$65,745	1, page 41
Architectural Features	JOB	LS	141	206	$300,000	$438,298	$438,298	1, page 41
Cathodic Protection	JOB	LS	141	206	$35,000	$51,135	$51,135	1, page 41
Protective Coatings	JOB	LS	141	206	$100,000	$146,099	$146,099	1, page 41
SUBTOTAL							$24,245,392	
Increase Capacity from 1,500 cfs to 5,000 cfs, factor cost by $(5,000/1,500)^{3/8} = 1.57$								
SUBTOTAL OUTLET WORKS							$38,065,265	
IV. SPILLWAY								
Mobilization	JOB	LS	143	186	$300,000	$390,210	$390,210	1, page 44
Drill Grout Holes	1,150	LF				$18.70	$21,505	2, item I-g
Grout Connections	19	EA	143	186	$25.00	$33.00	$627	1, page 44
Grouting	29	CY	143	186	$280	$364	$10,556	1, page 44
Grout Pipe	85	LF	132	159	$8.00	$10.00	$850	1, page 44

Table 2b
ESTIMATED CAPITAL COSTS
THOMES-NEWVILLE RESERVOIR PROJECT - 3.08 MAF ALTERNATIVE

DESCRIPTION	QUANTITY	UNIT*	USBR INDEX JAN. 81	USBR INDEX OCT. 96	UNIT COST JAN. 81	UNIT COST OCT. 96	TOTAL COST OCT. 96	COST REFERENCE
Excavation (blasting)	906,000	CY				$7.66	$6,939,960	2, item V-b3
Excavation	311,000	CY				$4.03	$1,253,330	2, av. item IIa, IIIa
Rock Riprap	2,500	CY				$31.64	$79,100	2, item I-n
Granular Backfill	7,300	CY				$45.09	$329,157	2, item II-n
Structural Backfill	10,100	CY	143	186	$20.00	$26.00	$262,600	1, page 44
Compacted Backfill	55,900	CY				$8.17	$456,703	2, item III-f
Aggregate Base	600	TON				$19.15	$11,490	2, item V-d
Asphalt Concrete	500	TON				$58.92	$29,460	2, item V-e
Mass Concrete	7,750	CY				$293	$2,271,448	2, item III-d
Structural Concrete	25,900	CY				$401	$10,393,929	2, av. item IIh, IIIc
Embedded Metal	JOB	LS	143	186	$35,000	$45,524	$45,524	1, page 44
Misc. Metal	JOB	LS	143	186	$50,000	$65,035	$65,035	1, page 44
Radial Gate (20 ' x 30 ')	2	EA	143	186	$270,000	$351,189	$702,378	1, page 44
Radial Gate Hoist Assembly	2	EA	143	186	$90,000	$117,063	$234,126	1, page 44
Stop Log (6 ' x 21 ')	12	EA	143	186	$14,000	$18,210	$218,520	1, page 44
Stop Log Storage Rack	JOB	LS	143	186	$20,000	$26,014	$26,014	1, page 44
Stop Log Lifting Beam	JOB	LS	143	186	$5,000	$6,503	$6,503	1, page 44
Electrical Work	JOB	LS	143	186	$30,000	$39,021	$39,021	1, page 44
Control Building (12 ' x 16 ')	JOB	LS	143	186	$26,000	$33,818	$33,818	1, page 44
Standby Generator	JOB	LS	143	186	$40,000	$52,028	$52,028	1, page 44
SUBTOTAL SPILLWAY							$23,873,892	
V. RESERVOIR								
Reservoir Clearing (Newville and Tehenn)	1,795	AC				$1,097	$1,969,115	2, item IV-a
Improvements	JOB	LS	137	176	$30,000	$38,540	$38,540	1, page 47
Construction Facilities	JOB	LS	137	176	$20,000	$25,693	$25,693	1, page 47
Excavate Overlook	48,400	CY	137	176	$14.00	$18.00	$871,200	1, page 47
Aggregate Base for Overlook	2,000	TON				$19.15	$38,300	2, item V-d
Asphalt Concrete for Overlook	511	TON				$58.92	$30,108	2, item v-e
Liquid Asphalt Prime and Seal	85	TON				$324.03	$27,543	2, av. item V- f&g
Landscaping Overlook	JOB	LS	137	176	$24,000	$30,832	$30,832	1, page 47
Visitor's Center	JOB	LS	137	176	$200,000	$256,934	$256,934	1, page 47
SUBTOTAL RESERVOIR							$3,288,265	
VI. OVERLOOK ACCESS ROAD								
Excavation	106,000	CY				$3.98	$421,880	2, item V-b1
Class II Aggregate Base	5,710	TON				$19.15	$109,347	2, item V-d
Asphalt Concrete	941	TON				$58.92	$55,444	2, item V-e
Liquid Asphalt Prime and Seal Coat	157	TON				$324	$50,873	2, av. item V-f&g
Guard Rail	2,650	LF	160	237	$20.00	$30.00	$79,500	1, page 50
18 " CMP	180	LF				$44.78	$8,060	2, item V-j
24 " CMP	490	LF				$53.53	$26,230	2, item V-k

Table 2b
ESTIMATED CAPITAL COSTS
THOMES-NEWVILLE RESERVOIR PROJECT - 3.08 MAF ALTERNATIVE

DESCRIPTION	QUANTITY	UNIT*	USBR INDEX JAN. 81	USBR INDEX OCT. 96	UNIT COST JAN. 81	UNIT COST OCT. 96	TOTAL COST OCT. 96	COST REFERENCE
30 " CMP	200	LF	160	237	$45.00	$67.00	$13,400	1, page 50
Structure Excavation	350	CY	160	237	$12.00	$18.00	$6,300	1, page 50
Structure Backfill	270	CY	160	237	$20.00	$30.00	$8,100	1, page 50
SUBTOTAL OVERLOOK ACCESS ROAD							$779,133	
VII. ROAD RELOCATIONS								
Newville to Paskenta								
48 " CSP	140	LF	146	219	$60.00	$90.00	$12,600	1, page 51
26 " CSP	240	LF	146	219	$40.00	$60.00	$14,400	1, page 51
24 " CSP	160	LF	146	219	$30.00	$45.00	$7,200	1, page 51
18 " CSP	570	LF	146	219	$25.00	$38.00	$21,660	1, page 51
Structure Excavation	4,700	CY	146	219	$25.00	$38.00	$178,600	1, page 51
Structure Backfill	4,400	CY	146	219	$45.00	$68.00	$299,200	1, page 51
Roadway Excavation	1,033,000	CY				$3.98	$4,111,340	2, item V-b1
Aggregate Base	31,000	TON				$19.15	$593,650	2, item V-d
Asphalt Concrete	15,000	TON				$58.92	$883,800	2, item V-e
Down Drains	24	EA	146	219	$1,000	$1,500	$36,000	1, page 51
Fence	66,800	LF	146	219	$2.00	$3.00	$200,400	1, page 51
SUBTOTAL NEWVILLE TO PASKENTA ROAD							$6,358,850	
Cattle Crossings (6 total)								
11'- 5" x 73 " Multiple Steel Pipe	432	LF	146	219	$180	$270	$116,640	1, page 51
Structure Excavation	1,710	CY	146	219	$25.00	$38.00	$64,980	1, page 51
Structure Backfill	1,100	CY	146	219	$45.00	$68.00	$74,800	1, page 51
SUBTOTAL CATTLE CROSSINGS							$256,420	
Round Valley Road								
48 " CSP	300	LF	146	219	$60.00	$90.00	$27,000	1, page 51
24 " CSP	2,120	LF	146	219	$30.00	$45.00	$95,400	1, page 51
Roadway Excavation	233,000	CY	146	219		$3.98	$927,340	2, item V-b1
Structure Excavation	2,000	CY	146	219	$25.00	$38.00	$76,000	1, page 51
Structure Backfill	1,600	CY	146	219	$45.00	$68.00	$108,800	1, page 51
Aggregate Base	9,100	TON				$19.15	$174,265	2, item V-d
Asphalt Concrete	4,400	TON				$58.92	$259,248	2, item V-e
Down Drains	12	EA	146	219	$1,000	$1,500	$18,000	1, page 51
Fence	20,000	LF	146	219	$2.00	$3.00	$60,000	1,page 51
Compacted Embankment and Overhaul	211,000	CY				$1.36	$286,960	2, item V-c1
Bridge D/S of Newville Spillway	6,800	SF				$100	$680,000	3
SUBTOTAL ROUND VALLEY ROAD							$2,713,013	
Chrome to Burrows Gap Road								
60 " CSP	250	LF	146	219	$70.00	$105	$26,250	1, page 52

Table 2b
ESTIMATED CAPITAL COSTS
THOMES-NEWVILLE RESERVOIR PROJECT - 3.08 MAF ALTERNATIVE

DESCRIPTION	QUANTITY	UNIT*	USBR INDEX JAN. 81	USBR INDEX OCT. 96	UNIT COST JAN. 81	UNIT COST OCT. 96	TOTAL COST OCT. 96	COST REFERENCE
24 " CSP	920	LF	146	219	$30.00	$45.00	$41,400	1, page 52
Roadway Excavation	202,000	CY				$3.98	$803,960	2, item V-b1
Structure Excavation	1,600	CY	146	219	$25.00	$38.00	$60,800	1, page 52
Structure Backfill	1,800	CY	146	219	$45.00	$68.00	$122,400	1, page 52
Aggregate Base	9,100	TON				$19.15	$174,265	2, item V-d
Asphalt Concrete	5,300	TON				$58.92	$312,276	2, item V-e
Fence	53,000	LF	146	219	$2.00	$3.00	$159,000	1, page 52
Bridge over Stony Creek Diversion	6,800	SF				$100	$680,000	3
SUBTOTAL CHROME TO BURROWS GAP ROAD							$2,380,351	
SUBTOTAL ROAD RELOCATIONS							$11,708,634	
VIII. SADDLE DAMS								
Mobilization	JOB	LS	132	159	$86,000	$103,591	$103,591	1, page 54
Clear and Grub	88	AC	132	159	$4,000	$4,818	$423,984	1. page 54
Foundation Excavation	2,572,300	CY				$3.23	$8,308,529	2, item I-d
Drill Grout Holes	79,470	LF				$18.70	$1,486,089	2, item I-g
Grout Connections	1,470	EA	132	159	$50.00	$60.00	$88,200	
Grouting	1,970	CY	132	159	$280	$337	$663,890	
Grout Pipe	6,620	LF	132	159	$8.00	$10.00	$66,200	
Borrow - Impervious Material	5,194,600	CY				$3.22	$16,726,612	2, item I-e
Filter and Drain Material	782,860	CY				$8.54	$6,685,624	2, item I- i&j
Riprap	195,420	CY				$31.64	$6,183,089	2, item I-n
Riprap Bedding	97,710	CY				$1.79	$174,901	2, item I-m
Placed Impervious	4,723,700	CY				$0.95	$4,487,515	2, item I-f
Instrumentation	JOB	LS	132	176	$50,000	$66,667	$66,667	1, page 54
SUBTOTAL CONVEYANCE FACILITIES							$45,464,891	
DESCRIPTION	**QUANTITY**	**UNIT***	**USBR INDEX OCT. 79**	**USBR INDEX OCT. 96**	**UNIT COST OCT. 79**	**UNIT COST OCT. 96**	**TOTAL COST OCT. 96**	**COST REFERENCE**
IX. THOMES CREEK DIVERSION FACILITIES								
Diversion Structure	JOB	LS	121	207	$7,940,000	$13,583,306	$13,583,306	4, page 4-13
Intake Structure	JOB	LS	122	213	$1,150,000	$2,007,787	$2,007,787	4, page 4-13
Canal and Roads	JOB	LS	120	199	$21,740,000	$36,052,167	$36,052,167	4, page 4-13
SUBTOTAL THOMES CREEK DIVERSION FACILITIES							$51,643,260	

Table 2b
ESTIMATED CAPITAL COSTS
THOMES-NEWVILLE RESERVOIR PROJECT - 3.08 MAF ALTERNATIVE

DESCRIPTION	QUANTITY	UNIT[a]	USBR INDEX APR. 80	USBR INDEX OCT. 96	UNIT COST APR. 80	UNIT COST OCT. 96	TOTAL COST OCT. 96	COST REFERENCE
X. CONVEYANCE FACILITIES								
Tehama Colusa Canal Turnout	JOB	LS				$1,543,000	$1,543,000	3
Sour Grass Canal	JOB	LS	127	199	$13,220,222	$20,715,151	$20,715,151	4- page 9-17
Sour Grass Pumping-Generating Plant								
Q=5,000 cfs, TDH = 115 ft. , HP = 86,983	JOB	LS				$97,528,800	$97,528,800	3
Black Butte Canal , factored by $(5,000/10,000)^{3/8}$	JOB	LS	127	199	$15,453,000	$24,213,756	$24,213,756	4- page 9-17
Black Butte Pumping-Generating Plant								
Q=5,000 cfs, TDH = 144 ft. , HP =108,918	JOB	LS				$111,617,600	$111,617,600	3
Tehenn Canal, factored by $(5,000/3,000)^{3/8}$	JOB	LS	127	199	$47,658,000	$74,676,709	$74,676,709	4- page 5-19
Tehenn Reservoir	JOB	LS	127	176	$29,010,000	$40,202,835	$40,202,835	4- page 5-19
Tehenn Pumping-Generating Plant								
Q=5,000 cfs, TDH = 190 ft., HP = 143,711	JOB	LS				$131,816,000	$131,816,000	3
Newville Pumping-Generating Plant								
Q=5,000 cfs, TDH = 380 ft., HP = 287,422	JOB	LS				$199,795,200	$199,795,200	3
SUBTOTAL CONVEYANCE FACILITIES							$702,109,051	
SUBTOTAL COST ITEMS FOR THOMES-NEWVILLE RESERVOIR PROJECT 3.08 MAF ALTERNATIVE							$1,063,400,000	
CONTINGENCIES @ 20%							$212,700,000	
ESTIMATED CONSTRUCTION COST							$1,276,100,000	
ENG., LEGAL, AND ADM. @ 35%							$446,600,000	
ESTIMATED CAPITAL COST FOR THOMES-NEWVILLE							$1,722,700,000	
ESTIMATED CAPITAL COST RANGE FOR THOMES-NEWVILLE								
LOW (-10%)							$1,550,000,000	
HIGH (+15%)							$1,981,000,000	

Footnotes:

[a]CY=cubic yard; LB=pound; EA=each; LS=lump sum; LF=linear foot; SF=square foot; TON=ton; MI=mile; AC=acre

Cost Reference:

1. California Department of Water Resources, *SWP Future Supply Program, Thomes-Newville Plan*, September 1981.
2. California Department of Water Resources, *Los Banos Grandes Facilities Report, Appendix A: Designs and Cost Estimates*, December 1990.
3. Cost developed by Bookman-Edmonston Engineering.
4. California Department of Water Resources, *Thomes-Newville and Glenn Reservoir Plans - Engineering Feasibility*, November 1980.
5. U.S. Bureau of Reclamation, Land Resources Branch, Graham McMullen, February 1997.

Table 3
SUMMARY OF ESTIMATED CAPITAL COSTS
THOMES-NEWVILLE RESERVOIR PROJECT

Cost Item	Estimated Costs ($Millions) 1.84 MAF	3.08 MAF
Land	30.5	36.0
Dam	99.0	150.4
Outlet Works	38.1	38.1
Spillway	19.4	23.9
Reservoir	3.0	3.3
Overlook Access Road	0.8	0.8
Road Relocations	11.7	11.7
Saddle Dams	1.7	45.5
Thomes Creek Diversion Facilities	54.9	51.6
Conveyance Facilities	675.7	702.1
SUBTOTAL	934.7	1,063.4
Contingencies (20%)	186.9	212.7
ESTIMATED CONSTRUCTION COST	1,121.6	1,276.1
Engineering, Legal, and Project Administration (35%)	392.6	446.6
ESTIMATED TOTAL CAPITAL COST	1,514.2	1,722.7
Capital Cost Range (minus 10% - plus 15%)	$1,363 - $1,741	$1,550 - $1,981

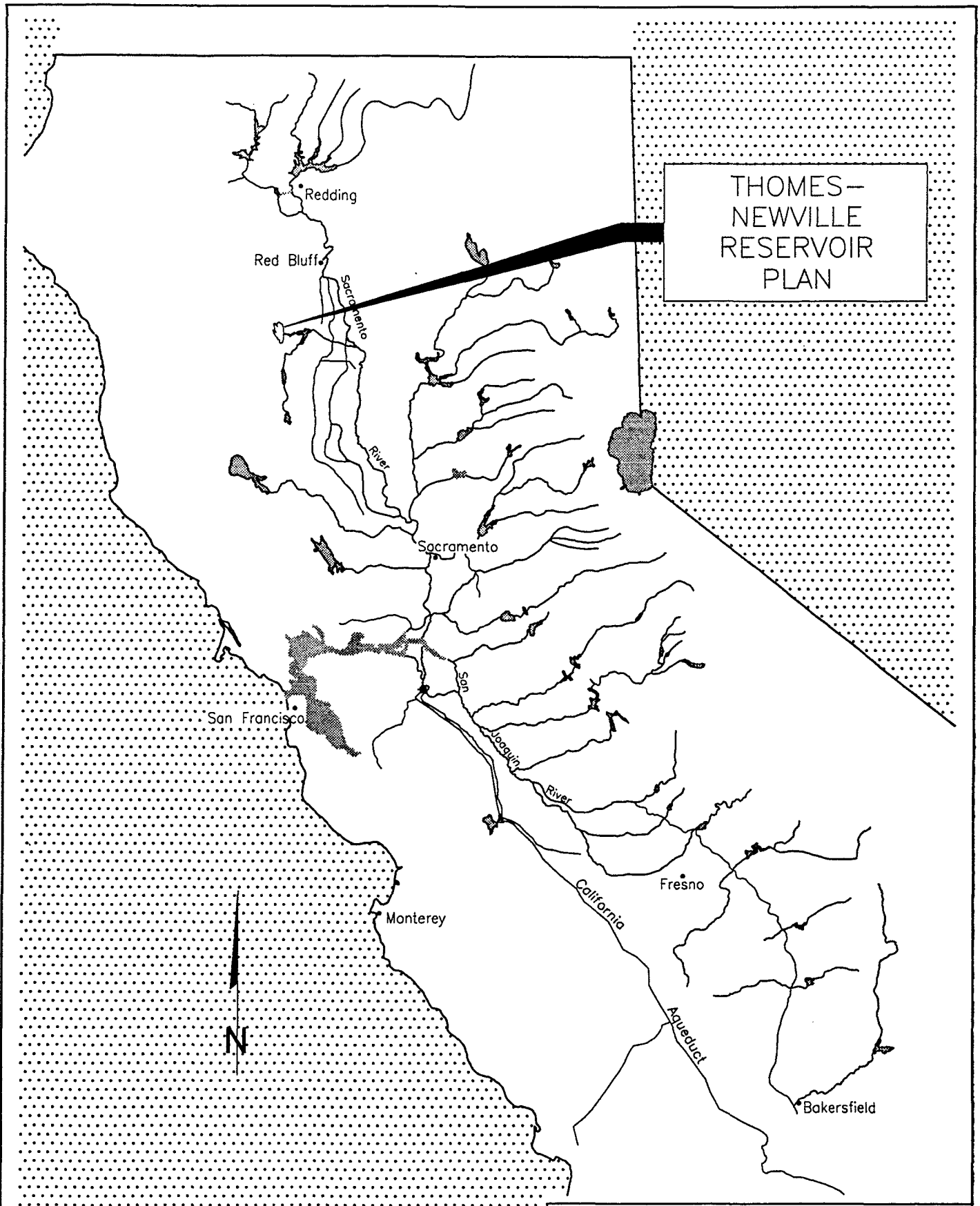

Figure 1

Project Location Map
Thomes–Newville Reservoir Plan

CALFED BAY–DELTA PROGRAM

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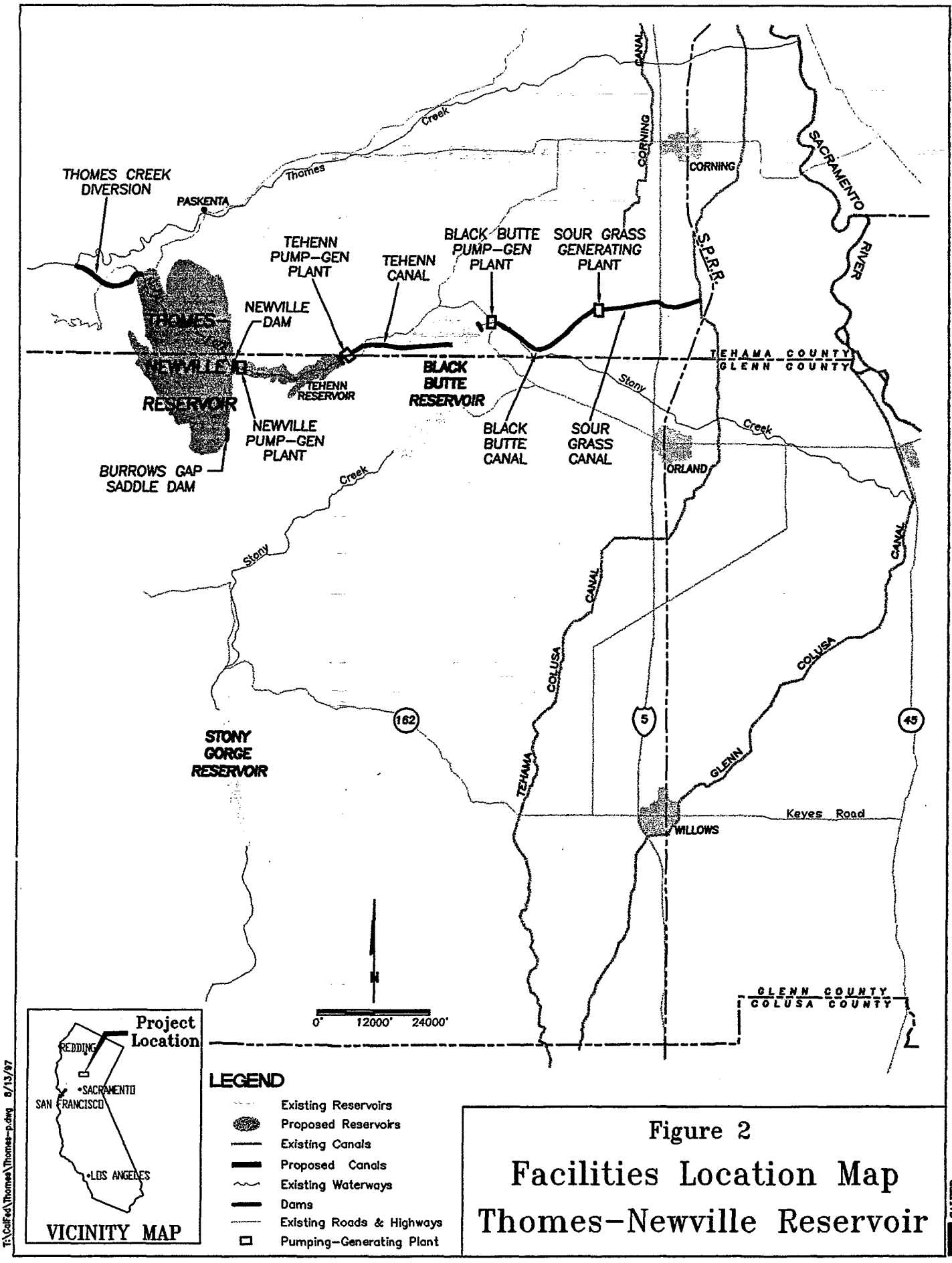

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Figure 2

Facilities Location Map
Thomes–Newville Reservoir

CALFED BAY–DELTA PROGRAM

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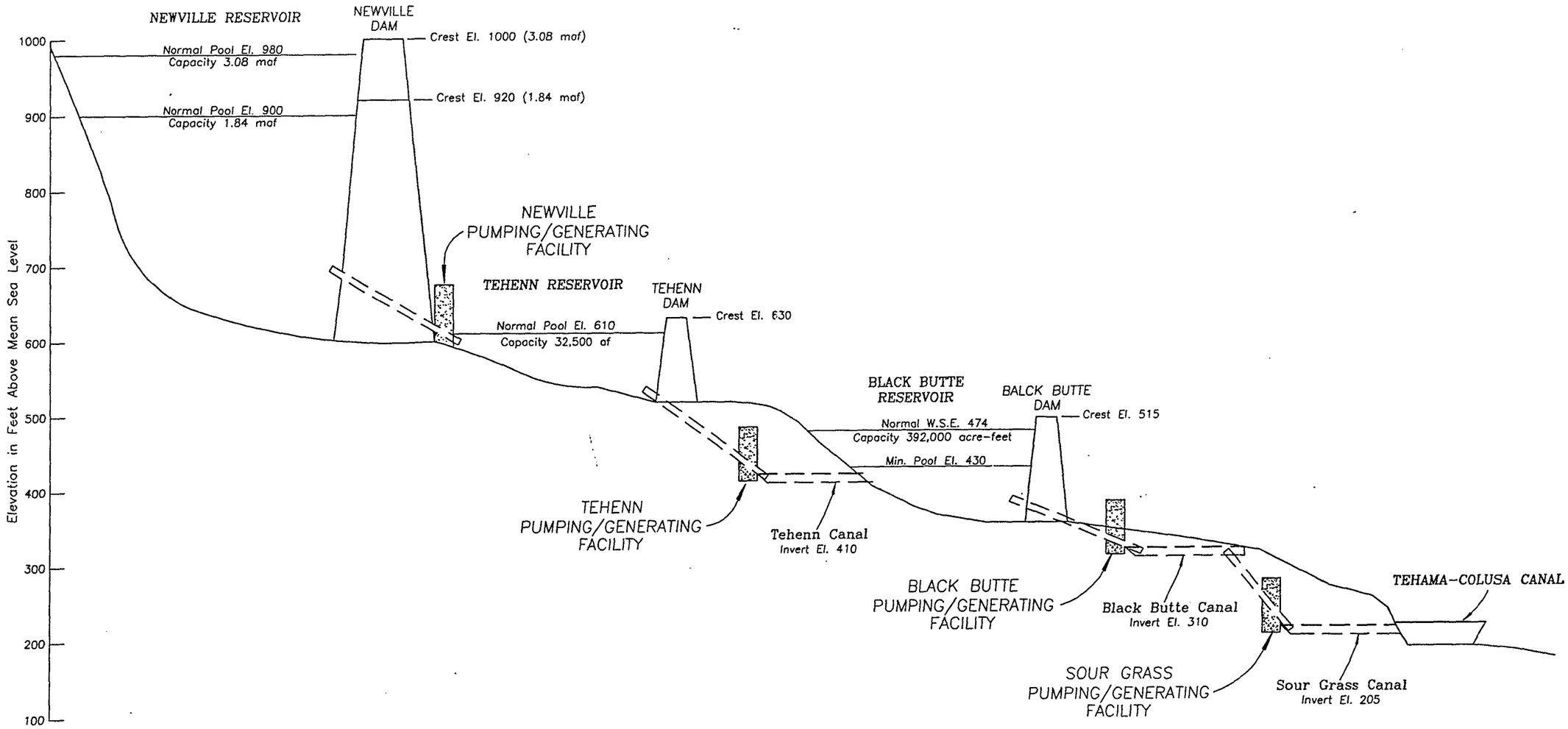
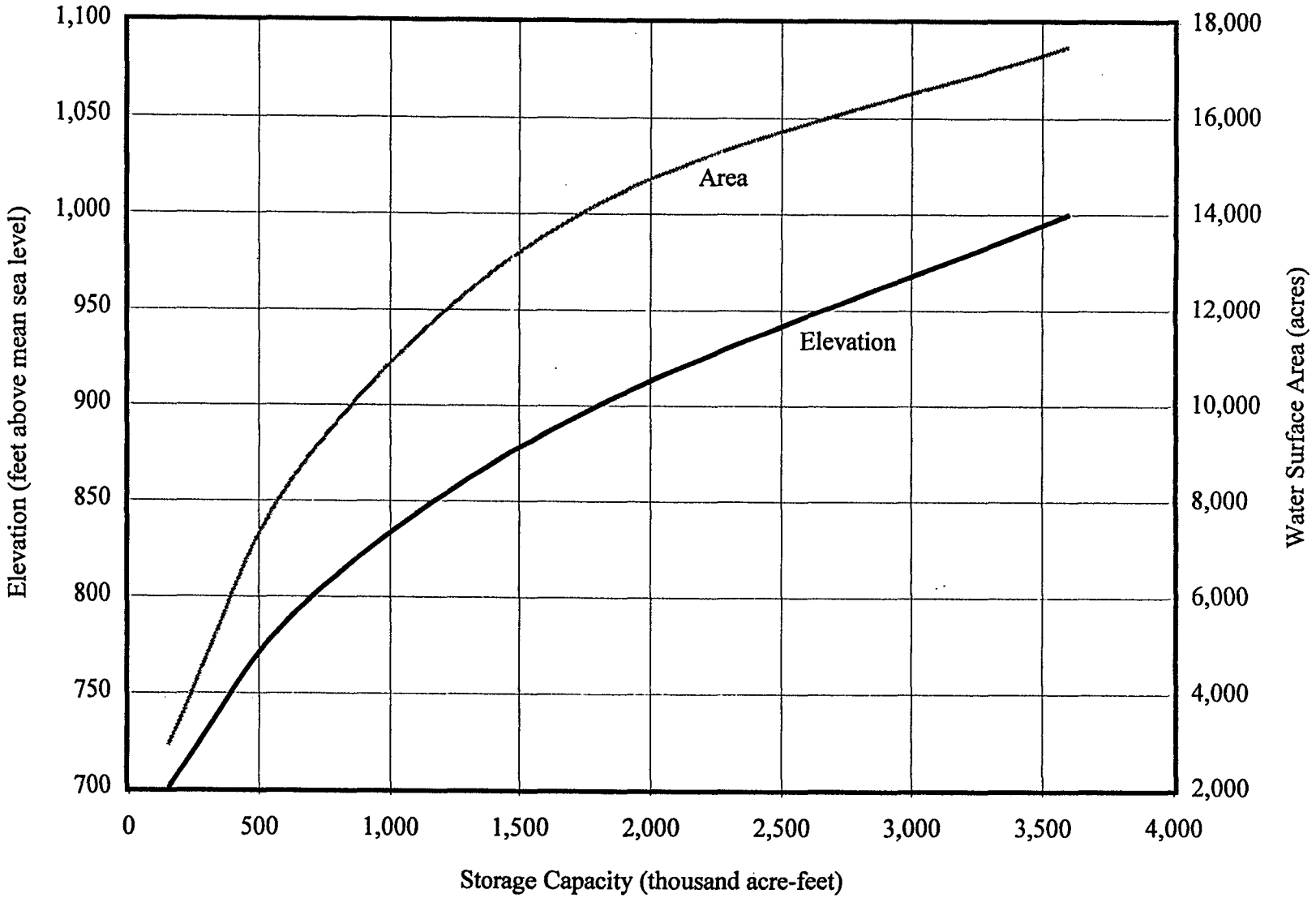


Figure 3
Schematic Profile
Thomes–Newville
Reservoir Project

Figure 4
Area-Elevation-Capacity Curves
Thomes-Newville Reservoir Project



SECTION 2

D-008542

1

D-008543

FACILITY DESCRIPTIONS AND UPDATED COST ESTIMATES FOR LAKE BERRYESSA INTERTIE

Prepared by the CALFED Storage and Conveyance Refinement Team
October 1997

D-008544

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D-008545

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INTRODUCTION

The *Facility Descriptions and Updated Cost Estimates for Lake Berryessa Intertie* 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 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 constructing the Lake Berryessa Intertie. This project would connect Lake Berryessa to the Sacramento River via a two-way conveyance facility. The general location of the Lake Berryessa Intertie is shown in Figure 1. This evaluation and others being performed by CALFED are intended to provide a facility descriptions and updated cost estimates of representative storage and conveyance components. The objectives of the Lake Berryessa Intertie evaluation are to (1) provide an updated cost estimate which represents a cost that is within the range to be expected if the project were to be constructed today and (2) enable CALFED to equally compare this project against other projects that might be considered as part of a long-term CALFED solution strategy.

The cost estimate for the Lake Berryessa Intertie was determined by applying current unit costs to quantities provided in the California Department of Water Resources (DWR), Division of Design and Construction report titled *SWP Future Supply Program: Enlarged Berryessa Reservoir Reconnaissance Study*, 1978. The cost estimates performed by DWR in 1978 were reviewed and adapted for this evaluation; modifications were made to reflect current design and safety standards where appropriate.

A preliminary evaluation of the environmental considerations associated with this proposed project has been 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 the evaluation of environmental considerations was gathered from existing literature and databases.

PROJECT BACKGROUND

The Lake Berryessa Intertie was described as a component of the Lake Berryessa Enlargement project in DWR's report titled *The SWP Future Supply Program: Enlarged Berryessa Reservoir Reconnaissance Study*, 1978 (referred to hereafter as the "Berryessa Report"). This report provides the only detailed description of the Lake Berryessa Intertie project and the Lake Berryessa Enlargement project. While references have been made to enlarging Lake Berryessa in other DWR documents, none provide detailed descriptions; therefore, the Berryessa Report served as the main source of information for this evaluation.

The Berryessa Report considered three possible alignments for connecting Lake Berryessa to the Sacramento River: a northern district route, a Putah Creek route, and a Willow Slough Bypass route. The Willow Slough Bypass route was selected for this CALFED evaluation because it would (1) be the most direct route, (2) traverse 6 miles without disturbing any farmland, and (3) minimize the disturbance of wildlife habitat when compared to the other two alignments.

FACILITIES DESCRIPTION

This section provides an overview of the major features included in the proposed Lake Berryessa Intertie project. The principal source of information used for this synopsis is the DWR Berryessa report.

PROJECT LOCATION

The Lake Berryessa Intertie would be located in the southern Sacramento Valley in Yolo County and would connect an enlarged Lake Berryessa to the Sacramento River. The conveyance facility

would consist of pipelines and canals, pumping-generating plants, and a screened diversion facility on the Sacramento River. The point of diversion from the Sacramento River would be located just north of the existing Sacramento Weir. Figure 2 shows the location of the Lake Berryessa Intertie, the pumping-generating facilities, and the Sacramento River inlet-outlet facility.

PROJECT DESCRIPTION

The Lake Berryessa Intertie would developed used in conjunction with the Lake Berryessa Enlargement project to provide off-stream storage north of the Delta to convey available flows from the Sacramento River to Lake Berryessa for storage. Stored water would then be returned to the Sacramento River to improve the reliability of water supplies for agricultural, municipal, and environmental uses in the Bay-Delta system.

The Lake Berryessa Intertie could have two possible configurations. First, it could be used as a two-way facility capable of diverting water from the Sacramento River, conveying it across southern Yolo County to Lake Berryessa, and alternately returning the water from Lake Berryessa to the Sacramento River. Second, it could be used as a one-way facility to convey water from Lake Berryessa to the Sacramento River. The latter project configuration would require the extension of the Tehama-Colusa Canal to convey water diverted from the upper Sacramento River to Lake Berryessa. The extension of the Tehama-Colusa Canal, along with alternative diversion facilities on the upper Sacramento River that could provide water to the Tehama-Colusa Canal, are also being evaluated by CALFED.

The ability to deliver water from the Sacramento River through the Lake Berryessa Intertie to Lake Berryessa would depend on ongoing activities associated with CALFED, the Central Valley Project Improvement Act, and Water Quality Standards for the Bay-Delta. The outcome of each of these programs will impact the operation of existing water resource projects as well as proposed projects. Because of the undetermined nature of the outcome of these programs, no

attempts were made to describe in detail the potential operating procedures for the Lake Berryessa Intertie.

PRINCIPAL FACILITIES

The primary features of the Berryessa Intertie include three pumping-generating plants, approximately 25 miles of conveyance canals and pipelines, and an inlet-outlet facility on the Sacramento River with fish screens. All of the features of this conveyance project have been designed with a capacity of 5,000 cfs. The facilities described here assume that the Berryessa Intertie would be utilized as a two-way facility. Table 1 summarizes the physical characteristics of the facilities included in this project.

Diversion Facility with Fish Screens

The diversion facility, which would include fish screens, would have a capacity of 5,000 cfs and would be located on the Sacramento River immediately upstream of the Sacramento Weir. The facility has been designed to meet the Department of Fish and Game velocity limits of not more than 0.4 feet per second through the screen. The screen would be comprised of twenty-four 32-foot bays and two 24-foot bays with two 6-foot by 8-foot slide gates per bay. The screening material would be 3/8-inch perforated plates. The screens would be set at a 45° angle. A bridge deck would cross over the top of the structures to carry State Route 16. From the diversion facility, an intake channel with a length of 10,000 feet would convey water to the Yolo Pumping-Generating Plant and then into the Yolo Penstocks.

Yolo Pumping-Generating Plant

The Yolo Pumping-Generating Plant would be located north of the Sacramento Weir and just east of the Yolo Bypass' eastern levee. This pumping-generating plant would connect the Sacramento River diversion facility with the Yolo Penstocks. The pumping-generating plant

would have a maximum static head of 28 feet, an energy requirement of 16 megawatts during pumping operations, and a generating capacity of 12 megawatts during reservoir release operations from Lake Berryessa to the Sacramento River.

Yolo Penstocks

The Yolo Penstocks would be located between the Yolo Pumping-Generating Plant and the Plainfield Canal. The penstocks would consist of four 11.5-foot-diameter, buried pipelines approximately 11,000 feet long that would cross the Yolo Bypass. The combined capacity of the four penstocks would be 5,000 cfs. The Yolo Penstocks would connect with the Plainfield Canal through an inlet-outlet structure located on the western levee of the Yolo Bypass.

Plainfield Canal

The Plainfield Canal would be located between the Yolo Penstocks and the Plainfield Pumping-Generating Plant. The Plainfield Canal would have a total capacity of 5,000 cfs and have a length of approximately 51,000 feet. The proposed canal would have a concrete-lined, trapezoidal cross-section with 2:1 side slopes and bottom width of 22.5 feet. Figures 3a and 3b show representative canal cross-sections for this project. The canal would intercept Dry Slough and utilize the upper portion of Willow Slough Bypass as part of the conveyance canal. The Willow Slough Bypass portion of the canal would be unlined. This alignment would cross Highway 113, the Southern Pacific Railroad, three county roads, and one farm access road.

Plainfield Pumping-Generating Plant

The Plainfield Pumping-Generating Plant would be located at the junction of the Plainfield and Airport Canals. This facility would have a maximum static head of 55 feet, an energy requirement of 30 megawatts during pumping operations, and a generating capacity of

21 megawatts during reservoir release operations. The penstocks for this facility would have a total length of 400 feet.

Airport Canal

The Airport Canal would be located between the Plainfield and Airport Pumping-Generating Plants. The Airport Canal would have a total capacity of 5,000 cfs and an approximate length of 26,500 feet. This alignment would cross three county roads and one farm access road. The canal cross-section would be similar to those of the Plainfield Canal shown in Figures 3a and 3b.

Airport Pumping-Generating Plant

The Airport Pumping-Generating Plant would be located at the junction of the Airport and Winters Canals. This facility would have a maximum static head of 55 feet, an energy requirement of 28 megawatts during pumping operations, and a generating capacity of 19 megawatts during reservoir release operations. The penstocks on this facility would have a total length of 400 feet.

Winters Canal

The Winters Canal would be located between the Airport and Winters Pumping-Generating Plants, which is an element of the Lake Berryessa Enlargement project. The Winters Canal would have a total capacity of 5,000 cfs and an approximate length of 35,000 feet. This alignment would cross Interstate 505, four county roads, and two farm access roads. The typical canal cross-sections for the Winters Canal are similar to those shown in Figures 3a and 3b.

COST ESTIMATE

The cost estimate for the Lake Berryessa Intertie is based on the 1978 Berryessa report. The updated cost estimate provided here includes only those cost items identified in the Berryessa report. Additional project costs not identified in the report, including environmental documentation, environmental mitigation, operation and maintenance, power, and interest during construction, are not included in this estimate.

COST ESTIMATE METHODOLOGY

The cost estimates developed by DWR have been reviewed and adapted for the present cost estimate update. Several items in the previous cost estimates have been modified to ensure that current design standards and safety factors were incorporated.

General

The cost estimate for the Lake Berryessa Intertie was determined by escalating the costs provided in the 1978 Berryessa report to October 1996 dollars using the U.S. Bureau of Reclamation (Reclamation) Construction Cost Trend (CCT) indices. Table 2 provides a detailed breakdown of the estimated costs of the Lake Berryessa Intertie. An updated cost estimate for each cost item identified in the previous cost estimates has been provided, along with the quantities of the cost item or an indication that the estimated cost has been developed through a lump sum approach. The table also includes the Reclamation CCT index for the month and year in which the estimated cost was developed and for October 1966. 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 2 provides the cost reference for each cost item.

Pumping-Generating Plants

The cost estimate for the Lake Berryessa Intertie pumping-generating plant has been based on actual construction costs for the Waddell Pumping-Generating Plant in Arizona, which was completed in 1994 and is similar in size and scope to the Lake Berryessa Intertie pumping-generating plants. To develop a cost for the Lake Berryessa Intertie pumping-generating plants, the actual construction cost of the Waddell Pumping-Generating Plant (escalated to October 1996 dollars) was factored by the following empirical equation:

$$\frac{(Cost)_1}{(Cost)_2} = \frac{HP_1^{6/10}}{HP_2^{6/10}}$$

where HP equals horsepower.

This cost factor formula is typically valid over moderate ranges in horsepower; the validity over larger ranges is undetermined. The impact of any error resulting from utilizing this ratio beyond its valid range is considered to be within the range of the accuracy of the present cost estimate.

Right-of-Way Costs

Right-of-way cost of $5,000 per acre was used based on land use costs developed by Reclamation's Land Resources Branch (Personal Communication, February 1997). The canal right-of-way was assumed to be 350 feet wide for the entire 25-mile length.

Contingencies and Other Costs

All contingencies and engineering, construction management, and administrative factors were selected based on engineering judgment and a review of previous studies with similar levels of cost estimation. Contingencies were chosen to be 20 percent; 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 15 percent to the estimated capital cost for the high-end cost. Costs for the initial filling of the reservoirs, interest during construction, and environmental mitigation are not included in this estimate.

PRELIMINARY COST FINDINGS

Costs of the Lake Berryessa Intertie and its supporting facilities have been updated to an October 1996 basis as described above. Table 3 summarizes estimated costs within selected project categories. The three pumping-generating plants constitute nearly 37 percent of the project construction costs. The cost of the canals and the Yolo Penstocks combine to constitute approximately 16 percent of the total construction cost. The total cost of constructing the Lake Berryessa Intertie is estimated to be about $649 million with a resulting calculated range of costs between $584 and $746 million.

ENVIRONMENTAL CONSIDERATIONS

[NOTE: The Environmental Considerations section of this report needs to be reevaluated by DWR to ensure consistency with the information presented in the previous sections.]

This section of the evaluation provides a summary of environmental considerations related to the Lake Berryessa Intertie. Fish, wildlife, plant, and cultural resources that could be affected by this project have been described and potential impacts identified. In general, the information presented in this section was gathered from existing literature, with limited original research. No field work was conducted for this analysis.

WILDLIFE

Constructing an intertie between the Sacramento River and Lake Berryessa could impact approximately 1,000 acres of terrestrial wildlife habitat. The proposal could also result in fish losses at the Sacramento River diversion facilities.

Fish, Amphibians, Reptiles, and Invertebrates

Diverting water from the Sacramento River near the Sacramento Weir to Lake Berryessa could result in adverse impacts to migrating juvenile and adult anadromous fish. The degree of impacts to fisheries from the Sacramento River diversion would depend on the timing of diversions, the rate of diversions, and the effectiveness of installed fish screens.

General Wildlife

Wildlife habitat along the proposed alignment of the Lake Berryessa Intertie (Figure 2) supports a diverse faunal assemblage. Game species in the area include blacktail deer, California quail, mountain quail, mourning dove, wild turkey, and ring-necked pheasant. Representative furbearers include raccoon, spotted skunk, striped skunk, bobcat, gray fox, coyote, and opossum. Several species of songbirds, birds of prey, and waterfowl are either resident or winter resident or migrate through the area. Birds of prey include red-tailed hawk, prairie falcon, and kestrel.

Sensitive and Listed Fish and Wildlife Species

According to the California Department of Fish and Game's (CDFG) California Natural Diversity Data Base records (CNDDB) Version 8/96, 11 wildlife species that are State or federally listed and 11 wildlife species that are either candidates for listing or species designated by CDFG as species of special concern have been known to occur in or near the area that would be affected by the Lake Berryessa Intertie.

The listed wildlife species that could be affected by the conveyance facility include Swainson's Hawk (State threatened), western snowy plover (federal threatened, CDFG special concern), western yellow billed cuckoo (State endangered), bank swallow (State threatened), California wolverine (federal candidate/State threatened), giant garter snake (federal and State threatened), conservancy fairy shrimp (federal endangered), vernal pool fairy shrimp (federal threatened), vernal pool tadpole shrimp (federal endangered), Delta green ground beetle (federal threatened), and the Valley elderberry longhorn beetle (federal threatened).

Wildlife species that are either candidates for State or federal listing or considered species of special concern by the CDFG that have been known to occur in or near the area affected by the proposed project include California tiger salamander (federal candidate/CDFG species of special concern), white-faced ibis (federal candidate/CDFG species of special concern), 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), northwestern pond turtle (federal candidate/CDFG species of special concern), and Rickseckers water scavenger beetle (federal candidate). Other sensitive wildlife species that have been known to occur in the area of the proposed intertie include the black crowned night heron, snowy egret, great egret, and white-tailed kite.

VEGETATION

Vegetation along the proposed alignment of the Lake Berryessa Intertie consists primarily of 760 acres of agricultural land, 150 acres of grassland, 80 acres of disturbed lands, 10 acres of woodland, and approximately 3 acres of riparian and marsh areas. The riparian and marsh areas occur along the Sacramento River and support several types of riparian forest.

Special-status habitats that may be found along or near the area of the proposed project include valley needlegrass grassland, northern claypan vernal pool, coastal and valley freshwater marsh (see wetlands section), great valley cottonwood forest, elderberry savanna, and oak woodland.

Sensitive and Listed Plant Species

Federal- or State-listed plants that have been known to occur in or around the area that could be affected by the project area include Mason's lilaeopsis (federal candidate/State rare), palmate-bracted bird's beak (federal and State endangered), Boggs Lake hedge-hyssop (State endangered), Colusa grass (State endangered/proposed federal threatened), and Crampton's tuctoria (federal and State endangered).

Candidate plant species for federal listing that may occur in the project area include Suisun Marsh aster, Carquinez goldenbush, Contra Costa goldfields, Heckard's pepper grass, legenere, heartscale, brittlescale, San Joaquin saltbush, Delta tule pea, showy Indian clover, 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 Lake Berryessa Intertie. These plants include dwarf downingia, alkali milk vetch, California hibiscus, and Bakers navarretia.

WETLANDS

From information gathered from the U.S. Fish and Wildlife Services' National Wetland Inventory Map, there are approximately 6 miles of wetlands along an existing levee and 6 miles along an excavated shallow marsh. The conveyance facility would cross eight intermittent streambeds, two levees, two canals (Winters and Tule), one permanently flooded-excavated wetland, two wet meadows, two shallow marshes, four often flooded-excavated wetlands, three forested wetlands (Willow Slough and Dry Slough), and one shrub-scrub shallow marsh.

Two special-status wetland habitats, northern claypan vernal pool and coastal and valley freshwater marsh, could be affected by the proposed Lake Berryessa Intertie.

CULTURAL RESOURCES

One not-significant prehistoric site has been recorded along the proposed alignment of the Lake Berryessa Intertie. Approximately 90 percent of the proposed alignment is thought to have a low archeological sensitivity, while the foothills west of Winters and between Chickahomony Slough and Dry Creek are expected to be moderately sensitive.

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

Table 1
SUMMARY OF PHYSICAL CHARACTERISTICS
LAKE BERRYESSA INTERTIE

Intake Channels and Fish Screens	
Invert Elevation (feet MSL)	-1
Maximum Static Water Level Elevation (feet MSL)	12
Length (feet)	10,000
Capacity (cfs)	5,000
Yolo Pumping/Generating Plan	
Maximum Static Head (feet)	28
Energy Requirement (MW)	16
Generating Capacity (MW)	12
Penstock Length (feet)	11,000
Plainfield Canal	
Invert Elevation (feet MSL)	20
Maximum Water Surface Elevation (feet MSL)	40
Capacity (cfs)	5,000
Length (feet)	51,000
Excavation Volume (cubic yards)	3,000,000
Embankment Volume (cubic yards)	2,900,000
Plainfield Pumping/Generating Plant	
Maximum Static Head (feet)	55
Energy Requirement (MW)	30
Generating Capacity (MW)	21
Penstock Length (feet)	400
Airport Canal	
Invert Elevation (feet MSL)	75
Maximum Water Surface Elevation (feet MSL)	95
Capacity (cfs)	5,000
Length (feet)	26,500
Excavation Volume (cubic yards)	2,200,000
Embankment Volume (cubic yards)	1,100,000
Airport Pumping/Generating Plan	
Maximum Static Head (feet)	55
Energy Requirement (MW)	28
Generating Capacity (MW)	19
Penstock Length (feet)	400
Winters Canal	
Invert Elevation (feet MSL)	130
Maximum Water Surface Elevation (feet MSL)	150
Capacity (cfs)	5,000
Length (feet)	35,000
Excavation Volume (cubic yards)	4,200,000
Embankment Volume (cubic yards)	3,100,000

Table 2
ESTIMATED COSTS
LAKE BERRYESSA INTERTIE

DESCRIPTION	QUANTITY	UNIT	USBR INDEX JUL. 78	USBR INDEX OCT. 96	UNIT COST JUL. 78	UNIT COST OCT. 96	TOTAL COST OCT. 96	COST REFERENCE
I. SCREEN AND INTAKE CHANNELS								
Channel Excavation	2,704,000	CY				$2.00	$5,408,000	1
Embankment	43,000	CY				$0.80	$34,400	1
Levee Removal	78,000	CY				$2.00	$156,000	1
Concrete (Including rebar, excavation and backfill)	21,520	CY				$600.00	$12,912,000	1
Riprap	17,000	CY				$31.64	$537,880	2, item V-c1
Dewatering - Steel Sheet piling	516,000	LB	108	212	$0.55	$1.08	$557,280	3, page A38
Structural Steel	252,000	LB	108	209	$0.70	$1.35	$340,200	3, page A38
Trash Booms (1000 ft.)	JOB	LS	108	212	$200,000.00	$392,593.00	$392,593	3, page A38
6' X 8' Slide Gates	52	EA	108	212	$65,000.00	$127,593.00	$6,634,836	3, page A38
Fish Screens	5,000	CFS				$10,000.00	$50,000,000	1
Lighting	JOB	LS	108	212	$20,000.00	$39,259.00	$39,259	3, page A38
Type 25 Barrier Railing	1,800	LF	108	212	$18.00	$35.33	$63,594	3, page A38
SUBTOTAL SCREEN & INTAKE CHANNELS							$77,076,042	
II. CANAL INLET - OUTLET STRUCTURE (3 TOTAL)								
Structural Concrete	2,400	CY				$600.00	$1,440,000	1
Radial Gates 15' X 15'	9	EA				$90,000.00	$810,000	4
Penstock 12' Dia. X 3 Barrels	1,386,000	LB				$1.65	$2,286,900	2, item VII-c
Concrete for Anchorage	3,000	CY				$256.15	$768,450	2, item VII-d
SUBTOTAL CANNEL INLET - OUTLET STRUCTURE							$5,305,350	
III. YOLO PENSTOCKS								
Pipeline Excavation	594,000	CY				$2.00	$1,188,000	1
Compacted Backfill	228,000	CY				$4.00	$912,000	1
Common Backfill	213,000	CY				$1.00	$213,000	1
Levee Removal	11,000	CY				$2.00	$22,000	1
Levee Replacement	11,000	CY				$3.00	$33,000	1
Steel Pipe-4 bbl.X11.5' Dia.X11,000'	27,587,000	LB				$1.65	$45,518,550	2, item VII-c
Protective Coating	1,590,000	SF				$0.60	$954,000	1
SUBTOTAL YOLO PENSTOCKS							$48,840,550	
IV. WINTERS CANAL								
Clearing and Grubbing	12,250,000	SF	106	198	$0.0137	$0.0256	$313,484	3, page A23
Channel Excavation	4,200,000	CY				$2.00	$8,400,000	1
Compacted Embankment	1,900,000	CY				$0.80	$1,520,000	1
Common Embankment	1,200,000	CY				$0.50	$600,000	1
Concrete Lining	81,000	CY				$80.00	$6,480,000	1

Table 2
ESTIMATED COSTS
LAKE BERRYESSA INTERTIE

DESCRIPTION	QUANTITY	UNIT	USBR INDEX JUL. 78	USBR INDEX OCT. 96	UNIT COST JUL. 78	UNIT COST OCT. 96	TOTAL COST OCT. 96	COST REFERENCE
Operating Roads: Gravel Surfacing	23,000	TON	109	237	$5.15	$11.20	$257,547	3, page A23
Liquid Asphalt	130	TON				$382.95	$49,784	2, item V-h
Drainage Overchute: Concrete	845	CY				$600.00	$507,000	1
Box Culvert -4-10' X10' X 579' - Concrete	3,800	CY				$600.00	$2,280,000	1
Box Culvert -2 - 5' X 6' X 300' - Concrete	390	CY				$600.00	$234,000	1
Ditch Excavation	14,000	CY				$4.00	$56,000	1
BRIDGES:								
Road 29 - 32' X 336'	10,752	SF				$100.00	$1,075,200	1
Road 88 - 32' X 312'	9,984	SF				$100.00	$998,400	1
Road 89 - 32' X 118'	6,016	SF				$100.00	$601,600	1
Farm Access - 20' X 127'	2,540	SF				$100.00	$254,000	1
Hwy. 505 - 40' X 127'	5,080	SF				$100.00	$508,000	1
Road 91B - 32' X 127'	4,060	SF				$100.00	$406,000	1
Farm Access - 20' X 127'	2,540	SF				$100.00	$254,000	1
SUBTOTAL WINTERS CANAL							$24,795,015	
V. AIRPORT CANAL								
Clearing and Grubbing	6,630,000	SF	106	198	$0.0137	$0.0256	$169,665	3, page A29
Channel Excavation	2,200,000	CY				$2.00	$4,400,000	1
Compacted Embankment	600,000	CY				$0.80	$480,000	1
Common Embankment	500,000	CY				$0.50	$250,000	1
Concrete Lining	61,000	CY				$80.00	$4,880,000	1
Operating Road: Gravel Surfacing	17,000	TON	109	237	$5.15	$11.20	$190,361	3, page A29
Liquid Asphalt	100	TON				$382.95	$38,295	2, item V-h
Culvert: 72" RCP	150	LF				$188.53	$28,280	2, itemV-o
Concrete for Headwalls	85	CY				$600.00	$51,000	1
BRIDGES:								
Road 94 - 32' X 136'	4,352	SF				$100.00	$435,200	1
Road 95 - 32' X 127'	4,064	SF				$100.00	$406,400	1
Road 96 - 32' X 127'	4,060	SF				$100.00	$406,000	1
Farm Access - 20' X 127'	2,540	SF				$100.00	$254,000	1
SUBTOTAL AIRPORT CANAL							$11,989,201	
VI. PLAINFIELD CANAL								
Clearing and Grubbing	23,500,000	SF	106	198	$0.0137	$0.0256	$601,378	3, page A32
Channel Excavation	3,000,000	CY				$2.00	$6,000,000	1
Compacted Embankment	600,000	CY				$0.80	$480,000	1
Common Embankment	2,300,000	CY				$0.50	$1,150,000	1
Concrete Lining	42,400	CY				$80.00	$3,392,000	1

Table 2
ESTIMATED COSTS
LAKE BERRYESSA INTERTIE

DESCRIPTION	QUANTITY	UNIT	USBR INDEX JUL. 78	USBR INDEX OCT. 96	UNIT COST JUL. 78	UNIT COST OCT. 96	TOTAL COST OCT. 96	COST REFERENCE
Operating Road: Gravel Surfacing	26,000	TON	109	237	$5.15	$11.20	$291,140	3, page A32
Liquid Asphalt	115	TON				$382.95	$44,039	2, item V-h
County Road: Aggregate Base	13,600	TON				$19.15	$260,440	2, item V-d
Asphalt Concrete	5,400	TON				$58.92	$318,168	2, item V-e
Liquid Asphalt Prime Coat	131	TON				$412.40	$54,024	2, item V-f
Willow Slough Interception: 48" CMP	224	LF				$94.26	$21,114	2, itemV-m
48" Slide Gate	2	EA	108	212	$14,500.00	$28,463.00	$56,926	3, page A32
Concrete	200	CY				$600.00	$120,000	1
BRIDGES:								
Road 99 - 32' X 168'	5,376	SF				$100.00	$537,600	1
Frontage Road - 32' X 156'	4,992	SF				$100.00	$499,200	1
State Rte. 113 - 2-40' X 156'	12,480	SF				$100.00	$1,248,000	1
Road 102 - 32' X 225'	7,200	SF				$100.00	$720,000	1
Road 105 - 32' X 360'	11,520	SF				$100.00	$1,152,000	1
Farm Access - 20' X 127'	2,540	SF				$100.00	$254,000	1
Remove Existing Bridges	JOB	LS	108	212	$9,500.00	$18,648.00	$18,648	3, page A50
SUBTOTAL PLAINFIELD CANAL							$17,218,679	
VII. BRIDGES - REACH 6 of Reference #3								
Road 124 - 32' x 488'	15,616	SF				$100.00	$1,561,600	1
Sacramento No. Railroad	2,925	SF	109	226	$760.00	$1,576.00	$4,609,800	1
Shoofly	17,000	SF	109	226	$70.00	$145.00	$2,465,000	1
SUBTOTAL BRIDGES - REACH 6							$8,636,400	
VIII. YOLO PUMPING-GENERATING PLANT (Q=5,000cfs, TDH=38FT, eff=75%, 28,740 HP)								
Structure, Equipment and Electrical, Complete	JOB	LS					$50,642,000	1
SUBTOTAL YOLO PUMPING-GENERATING PLANT							$50,642,000	
IX. PLAINFIELD PUMPING-GENERATING PLANT (Q=5,000cfs, TDH=65ft, eff=75%, 49,160 HP)								
Structure, Equipment and Electrical, Complete	JOB	LS					$69,634,000	1
SUBTOTAL PLAINFIELD PUMPING-GENERATING PLANT							$69,634,000	
X. AIRPORT PUMPING-GENERATING PLANT (Q=5,000cfs, TDH=65ft, eff=75%, 49,160 HP)								
Structure, Equipment and Electrical, Complete	JOB	LS					$69,634,000	1
SUBTOTAL AIRPORT PUMPING-GENERATING PLANT							$69,634,000	
XI. ELECTRICAL TRANS. AND INSTRUMENTATION								
Instrumentation:								
Addition to P.O.C.C.	JOB	LS	108	190	$50,000.00	$87,963.00	$87,963	3, page A94

Table 2
ESTIMATED COSTS
LAKE BERRYESSA INTERTIE

DESCRIPTION	QUANTITY	UNIT	USBR INDEX JUL. 78	USBR INDEX OCT. 96	UNIT COST JUL. 78	UNIT COST OCT. 96	TOTAL COST OCT. 96	COST REFERENCE
Area Control Center	JOB	LS	108	190	$100,000.00	$175,926.00	$175,926	3, page A94
Supervisory Equipment	JOB	LS	108	190	$255,000.00	$448,611.00	$448,611	3, page A94
Cable & Microwave Terminal @ Yolo P/G Plant	JOB	LS	108	190	$55,000.00	$96,759.00	$96,759	3, page A94
Cable & Microwave Terminal @ Plainfield P/G Plant	JOB	LS	108	190	$55,000.00	$96,759.00	$96,759	3, page A94
Cable & Microwave Terminal @ Airport P/G Plant	JOB	LS	108	190	$55,000.00	$96,759.00	$96,759	3, page A94
Cable - Area Control Center to Airport P/G Plant	25	MI	108	190	$10,000.00	$17,593.00	$439,825	3, page A94
Electrical Transmission Line:								
230 kV Line	29	MI	111	217	$150,000.00	$293,243.00	$8,504,047	3, page A93
Addition to PG&E's Substation	JOB	LS	108	190	$750,000.00	$1,319,444.00	$1,319,444	3, page A93
SUBTOTAL ELECTRICAL TRANS. AND INSTRUMENTATION							$11,266,093	
XII. RIGHTS-OF-WAY (350FT WIDE)								
Plainfield Canal (51,000 FT Long)	410	AC				$5,000.00	$2,050,000	5
Airport Canal (26,500 FT Long)	213	AC				$5,000.00	$1,065,000	5
Winters Canal (35,000 FT Long)	281	AC				$5,000.00	$1,405,000	5
Yolo Penstocks (34,200 FT Long, 200 Ft Wide)	157	AC				$5,000.00	$785,000	5
SUBTOTAL RIGHTS-OF-WAY							$5,305,000	
SUBTOTAL PROJECT COST							$400,300,000	
CONTINGENCIES @ 20%							$80,100,000	
CONTRACT COST SUBTOTAL							$480,400,000	
ENG., LEGAL, AND ADM. @ 35%							$168,100,000	
TOTAL PROJECT COST							$648,500,000	
TOTAL PROJECT COST RANGE								
LOW (-10%)							$584,000,000	
HIGH (+15%)							$746,000,000	

Footnotes:

[a]CY=cubic yard; LB=pound; EA=each; LS=lump sum; LF=linear foot; SF=square foot; TON=ton; MI=mile; AC=acre

Cost Reference:

1. Cost developed by Bookman-Edmonston Engineering.
2. California Department of Water Resources, *Los Banos Grandes Facilities Report, Appendix A: Designs and Cost Estimates*, Table 4, December 1990.
3. California Department of Water Resources, Division of Design and Construction, *SWP Future Supply Program, Enlarged Berryessa Reservoir Reconnaissance Study*, July 1978.
4. Rodney Hunt Water and Sewage Control Equipment; Orange, Massachusetts.
5. U.S. Bureau of Reclamation, Land Resources Branch, Personal Communication with Graham McMullen, February 1997.

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Table 3
SUMMARY OF ESTIMATED COSTS
LAKE BERRYESSA INTERTIE

Cost Item	Estimated Cost ($ Millions)
Screen and Intake Channels	$77.1
Canal Inlet-Outlet Structure	$5.3
Yolo Penstocks	$48.8
Canals	
Winters Canal	$24.8
Airport Canal	$12.0
Plainfield Canal	$17.2
Subtotal	$54.0
Pumping Plants	
Yolo Pumping-Generating Plant	$50.6
Plainfield Pumping-Generating Plant	$69.6
Airport Pumping-Generating Plant	$69.6
Subtotal	$189.8
Bridges	$8.6
Electrical Transportation and Instrumentation	$11.3
Rights of Way	$5.3
SUBTOTAL	$400.3
Contingencies (20%)	$80.1
ESTIMATED CONSTRUCTION COST	$480.4
Engineering, Legal, and Project Administration (35%)	$168.1
ESTIMATED TOTAL CAPITAL COST	$648.5
Cost Range (minus 10% - plus 15%)	$584 - $746

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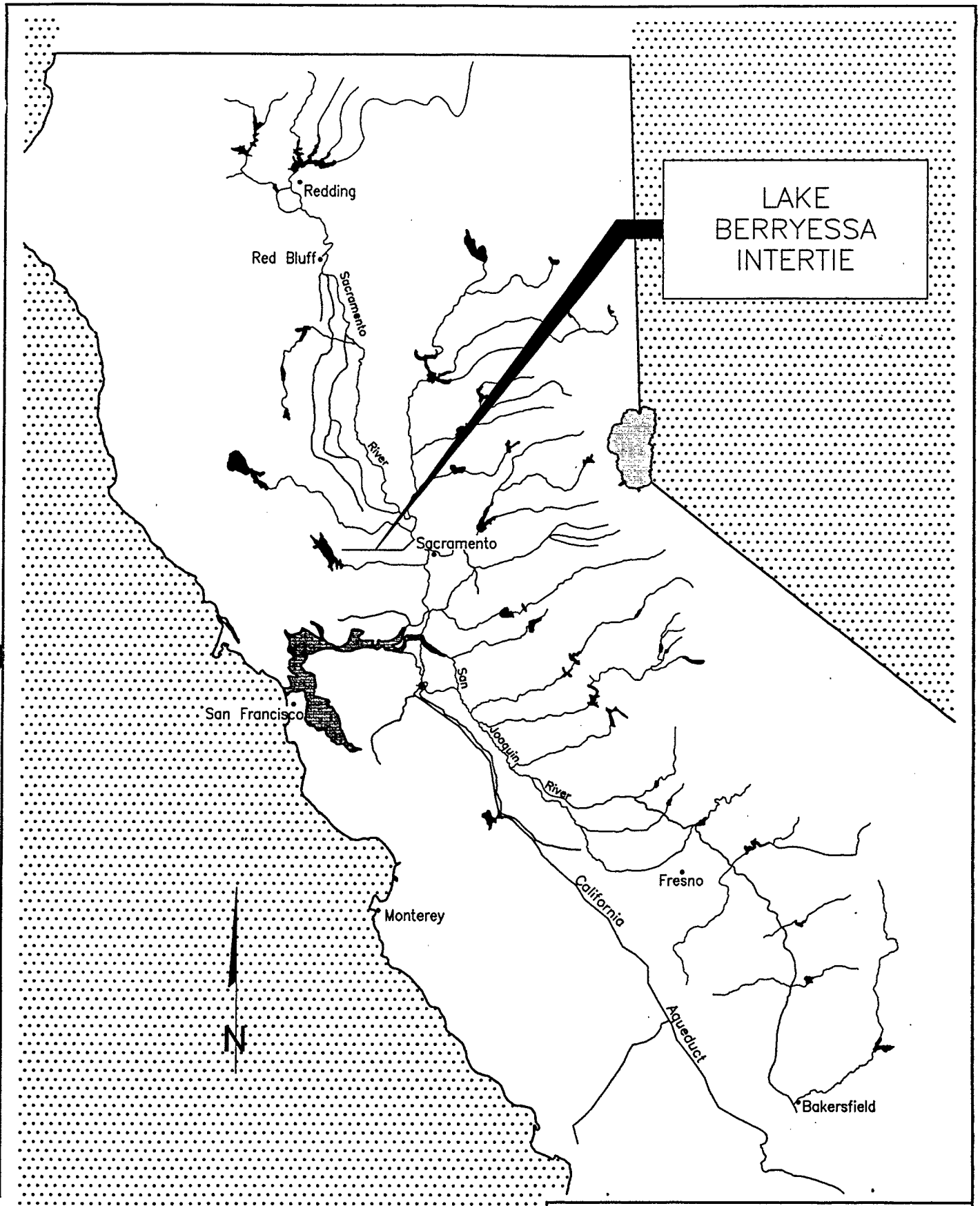

Figure 1
Project Location Map
Lake Berryessa Intertie

CALFED BAY-DELTA PROGRAM

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ESPARTO
STATE HWY 16
INTERSTATE 505
Cottonwood Slough
South Fork Cottonwood Slough
S.P.R.R.
TEHAMA COLUSA CANAL EXTENSION (Q=5000 CFS)
WINTERS PUMPING/ GENERATING PLANT (Q=5000 CFS)
CHAPMAN RANCH CANAL (Q=5000 CFS)
BERRYESSA PUMPING GENERATING PLANT
LAKE BERRYESSA ENLARGEMENT
TUNNEL PORTAL
BERRYESSA TUNNEL (25' DIA)
PROPOSED DAM
EXISTING DAM
State Hwy 128
WINTERS
EL RIO VILLA
YOLO CO.
SOLANO CO.
Putah Creek
Putah South Canal
INLET/OUTLET STRUCTURE
Yolo Central Canal
AIRPORT PUMPING GENERATING PLANT
INLET/OUTLET STRUCTURE
WINTERS CANAL
INLET/OUTLET STRUCTURE
AIRPORT CANAL
Union School Slough
Dry Slough
Yolo County International Airport
WOODLAND
HWY 113
Willow Slough
County Rd 14A
PLAINFIELD PUMPING GENERATING PLANT
PLAINFIELD CANAL
DAVIS
South Fork Putah Creek
DIXON
INTERSTATE 80
S.P.R.R.
YOLO BYPASS
SACRAMENTO RIVER
River Road
YOLO PUMPING GENERATING PLANT
YOLO PENSTOCKS
INLET/OUTLET STRUCTURE
INLET/OUTLET FACILITIES WITH FISH SCREENS
Willow Slough Bypass
Sacramento Bypass
SACRAMENTO WEIR
SACRAMENTO
WEST SACRAMENTO
Port of Sacramento
Barge Canal
Deep Water Ship Channel
Putah Creek Sinks
LAKE GREENHAVEN
SACRAMENTO CO.
YOLO CO.
SOLANO CO.

Project Location
REDDING
SACRAMENTO
SAN FRANCISCO
LOS ANGELES
VICINITY MAP

N
0' 3000' 6000' 12000'

Figure 2
Facilities Location Map
Berryessa Intertie

LEGEND
- Berryessa Intertie
- Berryessa Enlargement Conveyance Facility
- Tehama–Colusa Canal Extension
- Railroad
- Existing Roads and Highways
- Existing Rivers and Creeks
- Canal Inlet–Outlet Structure
- Pumping–Generating Plant

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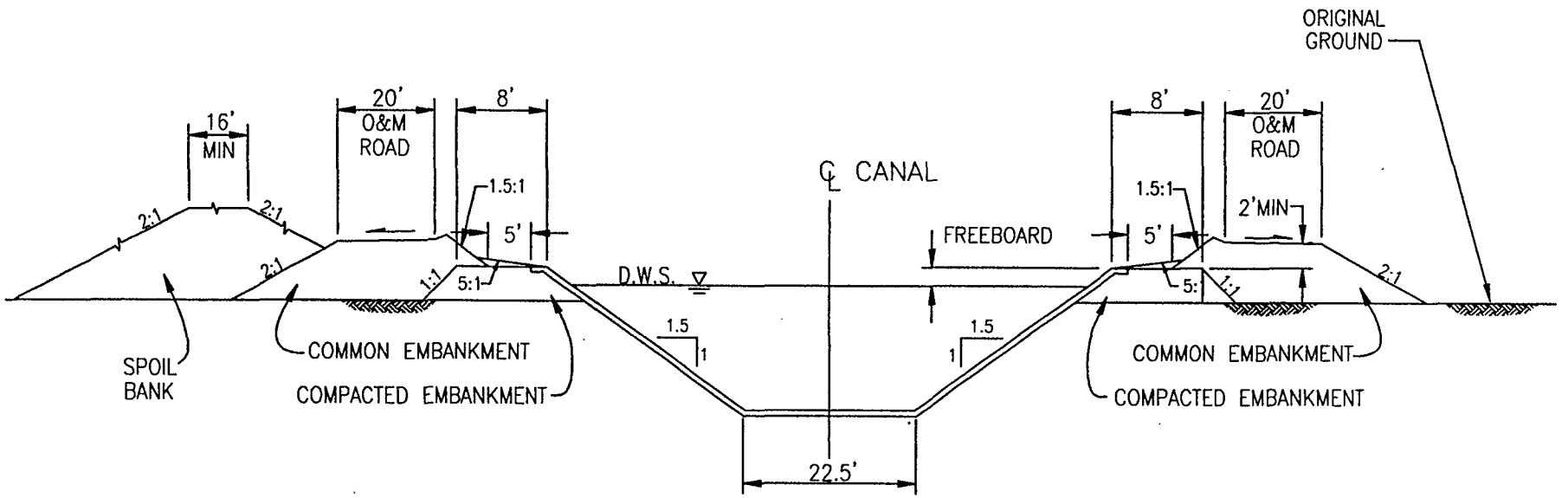
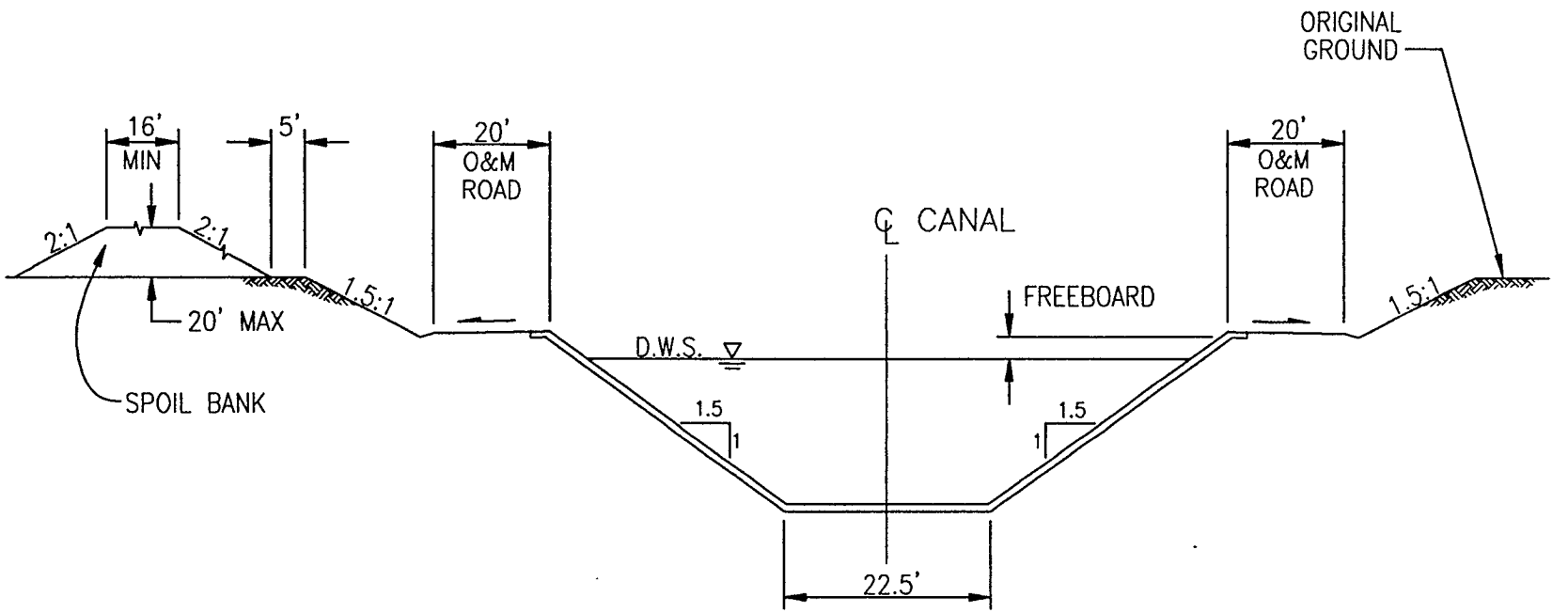


CANAL IN FILL
NOT TO SCALE

Figure 3a

Typical Canal Section

Berryessa Intertie



CANAL IN CUT
NOT TO SCALE

Figure 3b

Typical Canal Section

Berryessa Intertie

CALFED BAY-DELTA PROGRAM

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FACILITY DESCRIPTIONS AND UPDATED COST ESTIMATES FOR CHICO LANDING INTERTIE

Prepared by the CALFED Storage and Conveyance Refinement Team
October 1997

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INTRODUCTION

The *Facility Descriptions and Updated Cost Estimates for Chico Landing Intertie* has been prepared as part of the Storage and Conveyance Component Refinement Task of the CALFED Bay-Delta Program. The mission of the CALFED Bay-Delta Program (CALFED or Program) is to develop a long-term comprehensive plan that will restore 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 Chico Landing Intertie. This project would connect the Sacramento River to the existing Tehama-Colusa Canal as a means of providing Sacramento River flows to new off-stream storage on the west side of the Sacramento Valley. The general location of the Chico Landing Intertie is shown on Figure 1. The Chico Landing Intertie is a new conveyance feature developed by CALFED and, therefore, limited existing information is available on this project.

This evaluation and others that are being performed by CALFED are intended to provide facility descriptions and updated cost estimates of representative storage and conveyance components. The objectives of the Chico Landing Intertie evaluation are to (1) provide an updated cost estimate which represents a cost that is within the range of what would be expected if the project were to be constructed today and (2) enable CALFED to equally compare this project against other projects that might be considered as part of a long-term CALFED solution strategy. The cost estimates for the Chico Landing Intertie were developed from a new conceptual design of the canal and related facilities prepared by Bookman-Edmonston Engineering.

A preliminary evaluation of the environmental considerations associated with this proposed project has also been 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 the evaluation of environmental considerations was gathered from existing information and databases.

PROJECT BACKGROUND

The Chico Landing Intertie has been identified in a CALFED technical memorandum titled *Technical Memorandum on Storage and Conveyance Component Inventories*, February 1997. This conveyance facility has been conceived by CALFED as an alternative means for diverting available flows from the Sacramento River for off-stream storage on the west side of the Sacramento Valley. A review of California Department of Water Resources (DWR) and U.S. Bureau of Reclamation (Reclamation) libraries and publications has revealed no previous investigations of the Chico Landing Intertie or similar facilities.

FACILITIES DESCRIPTION

This section provides an overview of the major features included in the proposed Chico Landing Intertie. The preliminary layout of this facility is original work developed by Bookman-Edmonston Engineering.

PROJECT LOCATION

The Chico Landing Intertie would be located in the northern Sacramento Valley in Glenn County. It would divert flows from the Sacramento River at a point south of Hamilton City and convey these flows to the Tehama-Colusa Canal just south of Greenwood. Figure 2 shows the location of the various facilities that would be included in this proposed conveyance project.

PROJECT DESCRIPTION

The Chico Landing Intertie would be used in conjunction with new off-stream storage along the west side of the Sacramento Valley. Water stored in such off-stream reservoirs would be used to improve the reliability of water supplies for agricultural and municipal uses and for environmental needs on the Sacramento River and in the Delta.

The Chico Landing Intertie would consist of about 10 miles of concrete-lined canals, three pumping plants, and a screened diversion on the Sacramento River. The facility would have a capacity of 5,000 cfs for its entire length. The Intertie would cross the Glenn-Colusa Canal and Southern Pacific Railroad, as well as several smaller irrigation ditches and county roads. To convey water to the proposed Sites/Colusa Reservoir Project, the reach of the Tehama-Colusa Canal between its junction with the Chico Landing Intertie and Funks Reservoir would have to be enlarged to a capacity of 5,000 cfs. To convey water to an enlarged Lake Berryessa, the Tehama-Colusa Canal would also have to be enlarged to a capacity of 5,000 cfs and extended to Lake Berryessa. The Tehama-Colusa Canal enlargement, the proposed Sites/Colusa Reservoir Project, and the Lake Berryessa Enlargement are subjects of similar evaluations performed by CALFED.

The ability to divert water from the Sacramento River through the Chico Landing Intertie would depend on ongoing activities associated with CALFED, the Central Valley Project Improvement Act, and Water Quality Standards for the Bay-Delta. The outcome of each of these programs would impact the operation of existing water resource projects as well as proposed projects. Because of the undetermined nature of the outcome of these programs, no attempts were made to describe in detail the potential operating procedures for this project.

PRINCIPAL FACILITIES

The primary features of the Chico Landing Intertie include three pumping plants, about 10 miles of conveyance canals, and a diversion structure on the Sacramento River with fish screens (Figure 2). The conveyance facility has been designed with a capacity of 5,000 cfs, based on preliminary hydrological evaluations performed by CALFED. Table 1 summarizes some of the physical characteristics of the facilities included in this project.

Diversion Facility with Fish Screens

The diversion facility would be located on the Sacramento River about four miles south of Hamilton City. The fish screens would be designed to meet the Department of Fish and Game velocity limits of not more than 0.4 feet per second through the screen. The design, construction, and operation of the fish screens would incorporate best available technology and would be developed in conjunctions with regulatory agencies.

Canal Reaches

Canal Reach 1 would extend from the Sacramento River to Pumping Plant 1. This reach would be 6,000 feet long and have a design capacity of 5,000 cfs. The proposed canal would be a concrete-lined, trapezoidal section with 1.5:1 side slopes and a bottom width of 60 feet. All of the canal reaches for this project would have the same dimensions. Figures 3a and 3b show typical cross-sections for canals constructed in fill and in cut, respectively. The entire length of Reach 1 would be constructed in cut. Within Reach 1 the Chico Landing Intertie would cross beneath the Glenn-Colusa Canal through an inverted siphon.

Canal Reach 2 would extend from Pumping Plant 1 to Pumping Plant 2 and would have a total length of 22,200 feet. About one-half of this reach would be constructed in cut; the other one-half in fill.

Canal Reach 3 would extend from Pumping Plant 2 to Pumping Plant 3 and would have a total length of 22,000 feet. About 9,000 feet of this reach would be constructed in fill; the other 13,000 feet would be constructed in cut.

Canal Reach 4 would extend from Pumping Plant 3 to the Tehama-Colusa Canal. It would have a total length of 7,400 feet constructed entirely in cut. The terminus of this reach would include six 100-foot-long, 144-inch-diameter pipes to deliver water into the Tehama-Colusa Canal.

Pumping Plants

The proposed Chico Landing Intertie would require three pumping plants to lift water diverted from the Sacramento River to the Tehama-Colusa Canal. The three pumping plants would each have a capacity of 5,000 cfs and a combined total dynamic head of 115 feet. Pumping Plant 1 would have a total dynamic head of 35 feet and a power requirement of 26,470 horsepower. Pumping Plants 2 and 3 would each have a total dynamic head of 40 feet each and a power requirement of 30,250 horsepower each.

Canal Crossings

The proposed canal alignment would cross several existing facilities. The proposed canal alignment would intersect the Glenn-Colusa Canal and the Southern Pacific Railroad. Inverted siphons would be located at both of these locations. This alignment would also include nine irrigation crossings and nine county road crossings.

COST ESTIMATE

The Chico Landing Intertie is a new feature developed by the CALFED Program; thus, there is no previous information describing or estimating the cost of the project. The cost estimate for the Chico Landing Intertie was developed based on previous experience and engineering

judgment. The cost estimate does not include environmental documentation, environmental mitigation, operation and maintenance, power, and interest during construction.

COST ESTIMATE METHODOLOGY

The canal alignment for this analysis was selected based on engineering judgment using U.S. Geological Survey (USGS) 1:24,000 scale quad maps. A profile of the alignment using contours of the USGS maps was developed and a canal profile was prepared and placed on this alignment in order to calculate earthwork quantities. Standard canal unit costs were applied to these quantities to obtain canal costs. Facilities required to complete the Chico Landing Intertie, including the river turnout and outlet structure to the Tehama-Colusa Canal, were designed to a conceptual level. Cost estimates for these facilities were developed by applying standard unit costs to the quantities taken from the conceptual designs.

Right-of-Way Costs

Right-of-way costs of $3,000 per acre were based on land use costs developed by Reclamation's Land Resources Branch (Personal Communication, February 1997). Reclamation provided these cost estimates at a subappraisal level for all the storage and conveyance components being evaluated by CALFED. The Sacramento River diversion facilities were assumed to required about 10 acres of land. The canal right-of-way width was assumed to be 350 feet for the entire 11 mile length.

Pumping Plant Costs

The pumping plant cost estimates are based on actual construction costs for the Waddell Pumping-Generating Plant in Arizona, which was completed in 1994 and is similar in size and scope to the Chico Landing Intertie Pumping Plants. To develop a cost for the Chico Landing

Pumping Plants, the actual construction cost of the Waddell Pumping-Generating Plant (escalated to October 1996 dollars) was factored by the following empirical equation:

$$\frac{(Cost)_1}{(Cost)_2} = \frac{HP_1^{6/10}}{HP_2^{6/10}}$$

where HP is equal to horsepower.

The cost factor formula is typically valid over moderate ranges in capacity; the validity over larger ranges is undetermined. The impact of any error resulting from utilizing this ratio beyond its valid range is considered to be within the range of the accuracy of the estimate.

Contingencies and Other Costs

All contingencies and engineering, construction management, and administrative factors were determined by engineering judgment based on similar levels of cost estimation. Contingencies were chosen to be 20 percent; 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 15 percent to the estimated capital costs for the high-end cost.

PRELIMINARY COST FINDINGS

This analysis provides a prefeasibility level summary of the Chico Landing Intertie. This includes descriptions and cost estimates of the required facilities and a brief summary of the environmental considerations associated with this project.

The Chico Landing Intertie would consist of about 11 miles of conveyance canals that would be utilized in conjunction with either an enlarged Tehama-Colusa Canal and the proposed Sites

Reservoir or an enlarged and expanded Tehama-Colusa Canal and an enlarged Lake Berryessa. The total cost of the project is estimated to be about $409 million and range from $368 to $471 million. A detailed estimate of the costs are provided in Table 2. Table 3 provides a summary of the estimated costs of the principal elements of this project.

ENVIRONMENTAL CONSIDERATIONS

[NOTE: The Environmental Considerations section of this report needs to be reevaluated by DWR to ensure consistency with the information presented in the previous sections.]

This section of the evaluation provides a summary of environmental considerations related to the construction of the proposed Chico Landing Intertie. This section describes the fish, wildlife, plant, and cultural resources that could be affected by the project and identifies the extent of the impacts that could be expected on these resources. In general, the information presented in this section was gathered from existing literature, with limited original research. No field work was conducted for this analysis.

WILDLIFE

The majority of the alignment of the canal would be in agricultural or disturbed lands. Loss of wildlife habitat associated with the canal alignment would not be expected to be significant. The most significant impact resulting from the Chico Landing Intertie would be the potential loss of riparian forest habitat along the Sacramento River.

Fish, Amphibians, Reptiles, and Invertebrates

The Sacramento River at Chico Landing supports important resident and anadromous fish populations. Resident fish species include channel catfish, largemouth bass, white catfish, Sacramento squawfish, and Sacramento sucker. The principal anadromous fish in this portion of

the Sacramento River are chinook salmon, steelhead trout, striped bass, American shad, and white shad. Diversion of water from the river at Chico Landing could adversely affect migrating juvenile and adult anadromous fish. The degree of impacts to fisheries at the Chico Landing river diversion would depend on the timing of diversions, the rate of diversions, and the effectiveness of the fish screens.

General Wildlife

Lands along the Chico Landing Intertie alignment potentially provide limited support for common mammals such as opossum, shrew, raccoon, ring-tailed cat, weasel, badger, skunk, coyote, gray fox, squirrels, gophers, mice, and rabbit.

Common birds that may be found in the area include meadowlark, blackbird, jay, flycatcher, swallow, crow, starling, and mockingbird. Game birds found in the area may include quail, pheasant, dove, and pigeon.

Sensitive and Listed Fish and Wildlife Species

No special-status fish species are known to exist along the proposed alignment of the Chico Landing Intertie.

According to the California Department of Fish and Game's (CDFG) California Natural Diversity Data Base records (Version 8/96), six wildlife species that are State or federally listed and three wildlife species that are either candidates for listing or species designated by CDFG as species of special concern could potentially occur along the proposed alignment. The majority of these species are expected to occur at the river intake.

The listed wildlife species that could be affected by the project include Valley elderberry longhorn beetle (federal threatened), Swainson's hawk (State threatened), western yellow billed

cuckoo (State threatened), bank swallow (State threatened), giant garter snake (federal threatened/State threatened), and vernal pool fairy shrimp (federal threatened).

Wildlife species that are either candidates for State or federal listing or considered species of special concern by the CDFG that could be affected by the project include osprey (CDFG species of special concern), burrowing owl (CDFG species of special concern/Audubon species of special concern), and great blue heron (federal candidate/CDFG species of special concern). One other sensitive species that may be found in the area is the great egret.

VEGETATION

Vegetation along the proposed alignment of the project consists primarily of agricultural and disturbed lands. The intake could affect riparian forest along the Sacramento River.

Sensitive and Listed Plant Species

No federal- or State-listed plant species are known to occur along the Chico Landing Intertie alignment.

Sensitive plant species or plants that are candidates for federal or State listing that could be found along the proposed alignment include caper-fruited tropidocarpum, San Joaquin saltbush, and recurved larkspur. Additional plants like brittlescale, California hibiscus and fox sedge, listed by the California Native Plant Society as being rare, threatened, or endangered in California and elsewhere, could also be affected by the project.

The project could affect sensitive plant communities found along the Sacramento River known as great valley forests. These communities include the cottonwood riparian forest, mixed riparian forest, oak riparian forest, and willow scrub.

WETLANDS

The proposed Chico Landing Intertie would cross three types of wetlands: two artificially flooded, excavated, seasonal wetlands (possibly farm drainage ditches); six seasonally flooded, excavated wetlands; and the Colusa Canal and levee.

CULTURAL RESOURCES

There are no known cultural resources along the alignment of the proposed project. If findings occur, they would probably occur near the Sacramento River.

BIBLIOGRAPHY

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

U.S. Bureau of Reclamation, Land Resource Branch, February 1997, personal communication, Graham McMullen, Department of the Interior.

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. Fish and Wildlife Service, National Wetlands Inventory Program.

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

U.S. Geological Survey Topographic Maps: Fruto Ne; Glenn; Hamilton City; Llano Seco; Ord Ferry; Orland; Stone Valley; and Willows.

Table 1
SUMMARY OF PHYSICAL CHARACTERISTICS
CHICO LANDING INTERTIE

Diversion Facility with Fish Screens	
Capacity (cfs)	5,000
Canals	
Capacity (cfs)	5,000
Reach 1 Length (feet)	6,000
Reach 2 Length (feet)	22,200
Reach 3 Length (feet)	22,000
Reach 4 Length (feet)	7,400
Pumping Plant No. 1	
Total Dynamic Head (feet)	35
Pump Requirements (HP)	26,470
Pumping Plants No. 2 and No. 3	
Total Dynamic Head (feet) each	40
Pump Requirements (HP) "	30,250

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Table 2
ESTIMATED COSTS
CHICO LANDING INTERTIE

DESCRIPTION	QUANTITY	UNIT[a]	UNIT COST[b] OCT. 96	TOTAL COST OCT. 96
I. RIVER TURNOUT				
Structural Concrete				
Intake structure	5,470	CY	$600.00	$3,282,000
Meter vault	1,406	CY	$600.00	$843,600
Outlet structure	769	CY	$600.00	$461,400
120" dia. pipe	1,500	LF	$600.00	$900,000
120" sluice gate with operator	10	EA	$80,000.00	$800,000
120" sonic meter	10	EA	$10,000.00	$100,000
Control building 30'x50'	1,500	SF	$150.00	$225,000
Electrical installation	JOB	LS	$500,000.00	$500,000
Miscellaneous metal works	JOB	LS	$150,000.00	$150,000
Cofferdam and dewatering	JOB	LS	$1,000,000.00	$1,000,000
Fish Screen	5,000	CFS	$10,000.00	$50,000,000
SUBTOTAL RIVER + TURNOUT				$58,262,000
II. PUMPING PLANT NO. 1 (Q=5,000 CFS, TDH=35FT, eff=75%, 26,470 HP)				
Structure, Equipment, and Electrical Complete	JOB	LS		$47,477,600
SUBTOTAL PUMPING PLANT 1				$47,477,600
III. PUMPING PLANTS NO. 2 & NO. 3 (Q=5,000 CFS, TDH=40FT, eff=75%, 30,250 HP)				
Structure, Equipment, and Electrical Complete	JOB	LS		$51,697,600
SUBTOTAL PER PLANT				$51,697,600
SUBTOTAL PUMPING PLANTS 2 & 3				$103,395,200
IV. S.P.R.R. BORED SIPHON				
6-144" dia. pipe	80	LF	$36,000.00	$2,880,000
Structural Concrete (Headwalls)	350	CY	$600.00	$210,000
Concrete transitions	2	EA	$510,000.00	$1,020,000
SUBTOTAL S.P.R.R. BORED SIPHON				$4,110,000
V. GLENN-COLUSA CANAL SIPHON				
Open-cut double 20'x20' box	200	LF	$5,000.00	$1,000,000
Concrete transitions	2	EA	$582,000.00	$1,164,000
Temporary shootfly and				
restoration of Glenn-Colusa				
Canal Siphon	Job	LS	$500,000.00	$500,000
SUBTOTAL GLENN-COLUSA CANAL SIPHON				$2,664,000
VI. BRIDGES (180' x 42')				
County bridges	4	EA	$693,000.00	$2,772,000
County bridge with approach	5	EA	$759,000.00	$3,795,000
SUBTOTAL BRIDGES				$6,567,000

Table 2
ESTIMATED COSTS
CHICO LANDING INTERTIE

DESCRIPTION	QUANTITY	UNIT[a]	UNIT COST[b] OCT. 96	TOTAL COST OCT. 96
VII. IRRIGATION CROSSINGS (9 Crossings @ 350')				
36" dia. RCP	3,150	LF	$108.00	$340,200
Transitions	18	EA	$5,000.00	$90,000
SUBTOTAL IRRIGATION CROSSINGS				$430,200
VIII. OUTLET STRUCTURE TO TEHAMA-COLUSA (T-C) CANAL				
Transition~canal to pipes	Job	LS	$425,000.00	$425,000
144" Dia pipe (6 Barrels @ (100 FT)	600	LF	$864.00	$518,400
Structural concrete	500	CY	$600.00	$300,000
Cofferdam and dewatering	Job	LS	$300,000.00	$300,000
SUBTOTAL OUTLET STRUCTURES				$1,543,400
IX. CANAL (Q=5,000 CFS, Bottom Width=60', Depth=21', Sideslope=1.5:1)				
Reach 1: Sacramento River to P.P. No. 1				
Canal in cut	6,000	LF	$296.00	$1,776,000
Reach 2: P.P. No. 1 to P.P. No. 2				
Canal in fill	12,200	LF	$397.00	$4,843,400
Canal in cut	10,000	LF	$296.00	$2,960,000
Reach 3: P.P. No. 2 to P.P. No. 3				
Canal in fill	9,000	LF	$397.00	$3,573,000
Canal in cut	13,000	LF	$296.00	$3,848,000
Reach 4: P.P. No. 3 to T-C Canal				
Canal in fill	7,400	LF	$397.00	$2,937,800
Concrete Lining	85,630	CY	$80.00	$6,850,400
SUBTOTAL CANAL				$26,788,600
X. RGHTS-OF-WAY				
Rights-of-way - Canals	470	AC	$3,000.00	$1,410,000
Rights-of-way - Sacramento River Diversion	10	AC	$3,000.00	$30,000
SUBTOTAL CANAL				$1,440,000
SUBTOTAL				$252,700,000
CONTINGENCIES @ 20%				$50,500,000
ESTIMATED CONSTRUCTION COST				$303,200,000
ENGR, LEGAL, AND ADMIN @ 35%				$106,100,000
ESTIMATED CAPITAL COST				$409,300,000
ESTIMATED CAPITAL COST RANGE				
LOW (-10%)				$368,000,000
HIGH (+15%)				$471,000,000

Footnotes:

[a]EA=each; LF=linear foot; LS=lump sum; CY=cubic yard; AC=acre; EA=each; SF=square foot; CFS=cubic foot per second

[b]All unit costs were developed by Bookman-Edmonston Engineering, with the exception of righths-of-way costs. Rights-of-way costs were developed by the Bureau of Reclamation. Land Resources Branch, 1997.

Table 3
SUMMARY OF ESTIMATED COSTS
CHICO LANDING INTERTIE

Cost Item	Estimated Cost ($ Millions)
River Turnout	$58.3
Pumping Plants	
Pumping Plant No. 1	$47.5
Pumping Plant No. 2	$51.7
Pumping Plant No. 3	$51.7
Subtotal	$150.9
Siphons	
S.P.R.R. Bored Siphon	$4.1
Glenn-Colusa Canal Siphon	$2.7
Subtotal	$6.8
Bridges	$6.6
Irrigation Crossings	$0.4
Outlet Structure to Tehama-Colusa Canal	$1.5
Canal	$26.8
Rights-of-Way	$1.4
SUBTOTAL	$252.7
Contingencies (20%)	$50.5
ESTIMATED CONSTRUCTION COST	$303.2
Engineering, Legal, and Project Administration (35%)	$106.1
ESTIMATED CAPITAL COST	$409.3
Cost Range (minus 10% - plus 15%)	$368 - $471

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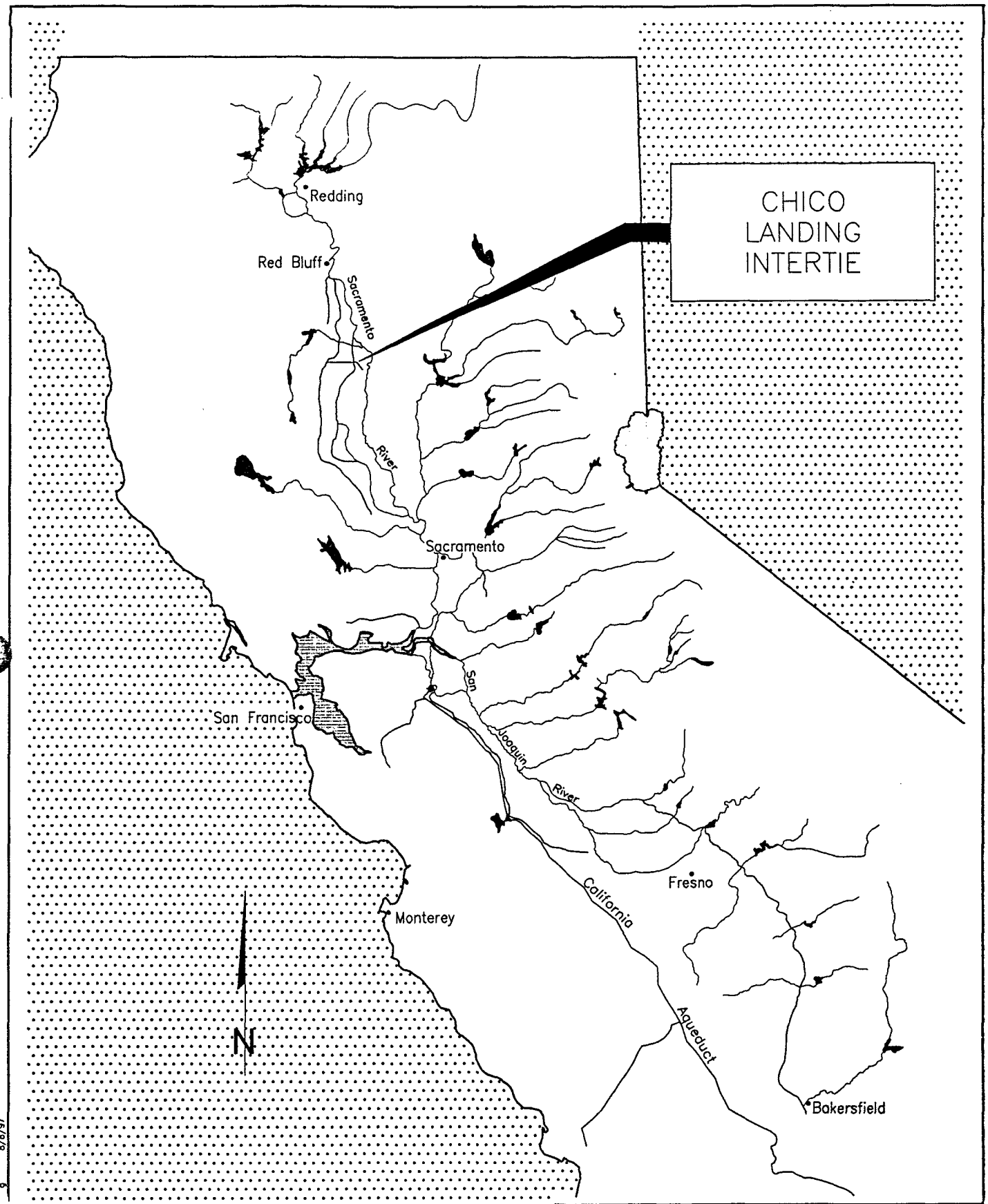

Figure 1
Project Location Map
Chico Landing Intertie

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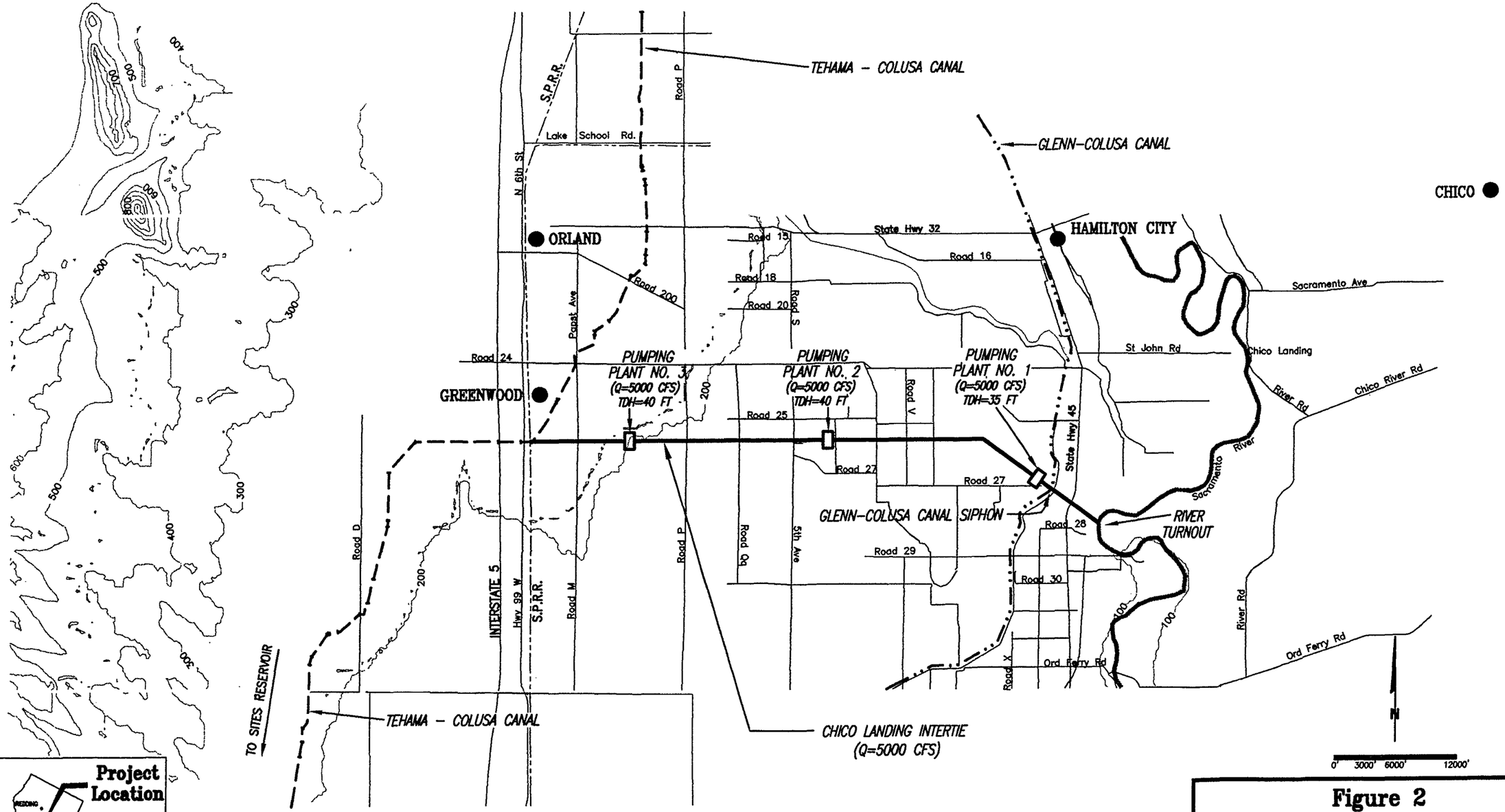

Figure 2
Facilities Location Map
Chico Landing Intertie

LEGEND

- Chico Landing Intertie
- Tehama–Colusa Canal Enlargement
- Glenn–Colusa Canal
- Railroad
- Existing Roads and Highways
- Existing Rivers
- Pumping Plant

CALFED BAY-DELTA PROGRAM

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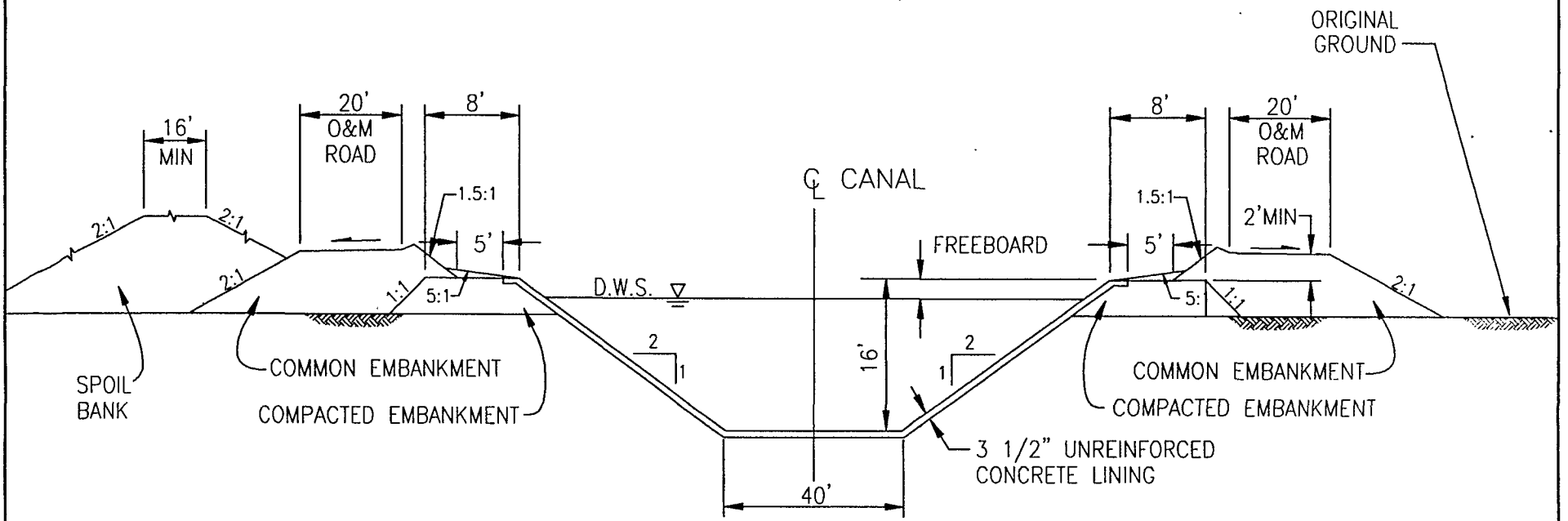

CANAL IN FILL
NOT TO SCALE

Figure 3a

Typical Canal Section Chico Landing Intertie

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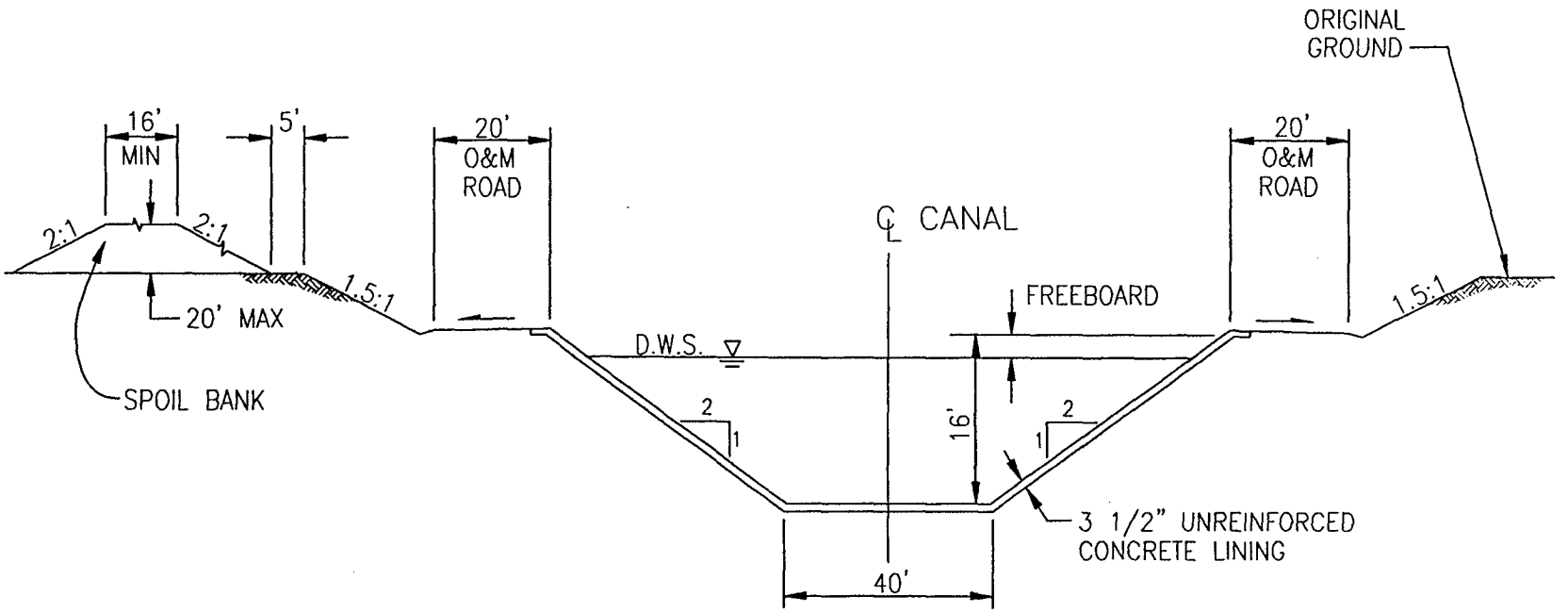

CANAL IN CUT
NOT TO SCALE

Figure 3b

Typical Canal Section
Chico Landing Intertie

CALFED BAY-DELTA PROGRAM

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FACILITY DESCRIPTIONS AND UPDATED COST ESTIMATES FOR THE MID-VALLEY CANAL

Prepared by the CALFED Storage and Conveyance Refinement Team
October 1997

D-008596

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INTRODUCTION

The *Facilities Description and Updated Cost Estimates for the Mid-Valley Canal* 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 a Mid-Valley Canal Project. The general location of the Mid-Valley Canal Project is shown in Figure 1. This project would convey a replacement water supply for a portion of the current groundwater pumping on the east side of the San Joaquin Valley, supplementing existing surface water diversions and groundwater supplies, and facilitating potential conjunctive use operations. The canal could convey water to serve portions of Merced, Madera, Fresno, Kings, and Tulare Counties and, by exchange, furnish a water supply to Kern County. Water could also be provided to three existing national wildlife refuges and two state wildlife management areas.

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

The cost estimates for the Mid-Valley Canal Project were developed by applying current unit costs to quantities found in the following reports: the December 1980 U.S. Bureau of Reclamation (Reclamation) report titled *Mid-Valley Canal Feasibility Design Criteria and Cost Estimate*; the April 1980 Reclamation report titled *Mid-Valley Canal*; the December 1977

Reclamation report titled *Project Cost Estimate, Delta-Mendota Canal Capacity Increase*; and the 1990 Reclamation report titled *The San Joaquin Valley, California Conveyance Investigation*. These cost estimates were reviewed and adapted for this evaluation. Modification to the previous cost estimates have been made, where appropriate, to reflect current design and safety standards.

A preliminary evaluation of the environmental considerations associated with the Mid-Valley Canal has also been 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.

PROJECT BACKGROUND

Planning efforts to alleviate the problem of groundwater overdraft in the San Joaquin Valley began in the 1960s with the Reclamation's *East Side Division Report, Initial Phase,* which recommended direct importation of supplemental water supplies from northern California through an "East Side Canal." A second report, the *Mid-Valley Canal Report* completed in 1980, also recommended imported water supplies to partially relieve the groundwater overdraft of the area through construction of the "Mid-Valley Canal." The canal was strongly supported by local users who recognized that such a facility offered a more immediate and less expensive solution than the East Side Canal. Studies were suspended, however, until 1982 when representatives from Reclamation and the newly formed Mid-Valley Water Agency (MVWA) met to discuss the water supply needs of the MVWA service area. In 1990, a study coordination team comprised of representatives from Reclamation, the California Department of Water Resources (DWR), and the MVWA studied four alternatives for providing supplemental water to the proposed area: an Enlarged Westside Canal with a Mid-Valley Canal (Alternatives 1A, 1B, 1C); an Eastside Canal (Alternative 2); an Eastside Canal to the San Joaquin River with a Mid-Valley Canal

(Alternative 3); and a reduced Eastside Canal with a Mid-Valley Canal (Alternative 4). Alternative 1B of that study was selected for this CALFED evaluation.

FACILITIES DESCRIPTION

This section provides an overview of the major features included in the proposed Mid-Valley Canal Project. The Mid-Valley Canal Project was formulated on the assumption that there would be new water supply opportunities associated with other CALFED storage and conveyance options such as improved through Delta conveyance and additional surface storage facilities.

PROJECT LOCATION

The location of the Mid-Valley Canal is shown in Figure 1. The area encompasses portions of Merced, Madera, Fresno, Kings, and Tulare Counties on the east side of San Joaquin Valley. Principal towns in or near the area include Chowchilla, Madera, Fresno, Selma, Kingsburg, Hanford, Visalia, Exeter, Tulare, Corcoran, and Delano. The area extends from Deadman Creek southward for approximately 107 miles to the Kern County line and from the foothill line of the Sierra Nevada westward for about 45 miles. Figure 2 provides a detailed location map of the Mid-Valley Canal with locations of the major facilities.

PROJECT DESCRIPTION

For purposes of this evaluation, the Mid-Valley Canal Project includes enlargement of the main reaches of the Delta-Mendota Canal to accommodate an additional 2,000 cubic-feet-per-second (cfs) of conveyance capacity; construction of two new concrete-lined canals, the Main and North Branches of the Mid-Valley Canal; and construction of additional pumping plants.

Water would be conveyed to O'Neill Forebay through an enlarged Delta-Mendota Canal. The enlargement of the Delta-Mendota Canal would include a new intake from Clifton Court Forebay to the intake channel of the Delta-Mendota Canal. At O'Neill Forebay, water would be conveyed to the edge of the north and middle subareas of the San Joaquin Valley through an enlarged Delta-Mendota Canal to an enlarged Mendota Pool. The North and Main Branches of the Mid-Valley Canal would be constructed to divert water from the Mendota Pool. The North Branch would convey water from the Mendota Pool to the terminus at the Chowchilla River. The Main Branch would convey water south from the Mendota Pool, down the center of the east side of the valley, and terminate at the White River.

PRINCIPAL FACILITIES

The principal facilities include a new intake facility to the Tracy Pumping Plant from Clifton Court Forebay, two additional pumping units at the Tracy Pumping Plant, 95 miles of enlarged existing canal, 140 miles of new concrete-lined canal, 11 pumping plants; and the rehabilitation of 127 bridges, 19 check structures, 12 siphons, 238 turnouts, 285 drain inlets, 8 overchutes, 33 pipe crossings, 4 wasteways, and 10 culverts. Table 1 provides a summary of the physical characteristics of the major features associated with the Mid-Valley Canal Project.

Intake Facilities

As highlighted in Figure 2, the intake facility of the Mid-Valley Canal Project would include construction of a new 4,200-foot intake canal from Clifton Court Forebay complete with a trashrack, fish screens, and a check structure; enlargement of a portion of the existing intake canal; and construction of a 210-inch-diameter, 775 foot-long, reinforced-concrete pipeline under the Southern Pacific Railroad and Byron-Bethany Road.

Water would flow by gravity through the trashrack and fish screens into the new intake canal. From the intake canal, the water would enter an enlarged intake channel for the Delta-Mendota Canal leading to the Tracy Pumping Plant. The existing intake channel would be enlarged by 2,000 cfs from its current capacity of 4,500. Figures 3a and 3b show representative canal cross-sections for the new intake canal from Clifton Court Forebay and the enlarged portion of the Delta-Mendota Canal intake channel.

Tracy Pumping Plant Addition

The Tracy Pumping Plant addition would be located on the right bank of the Delta-Mendota Canal intake channel about 250 feet upstream of the existing pumping plant. The additional pumping units would be semi-automatic, controlled, and operated from the existing control building and would consist of two vertical, indoor, centrifugal pumps driven by synchronous electric motors. Each pumping unit would have a capacity of 1,000 cfs at 214 feet total pumping head and would be equipped with a 32,000 horsepower motor.

Tracy Pumping Plant Discharge Line

A major feature of the Mid-Valley Canal Project would be a 6,700 foot-long, 228-inch-diameter, reinforced-concrete discharge pipe that would parallel the existing Tracy discharge lines. Water pumped at the Tracy Pumping Plant would discharge directly to the Delta-Mendota Canal.

Enlarged Delta-Mendota Canal

Enlarging the 66.5-mile-long Delta-Mendota Canal from the discharge point of the Tracy Pumping Plant to the O'Neill Forebay (from Milepost (MP) 3.5 to 70.0) would include raising water surface elevations from 3 to 5 feet, raising the canal embankments and the concrete lining approximately 5 feet, and rehabilitating numerous canal structures. The capacity would be

increased in such a manner to keep the canal in operation during construction. Allowable fluctuation in water surface would be the same as at present and the embankment slope would remain at 1.5:1.

Increasing the capacity of the Delta-Mendota Canal between O'Neill Forebay and the Mendota Pool (MP 70.0 to 98.62) would include raising the water surface by 3 feet, raising the canal embankments and the concrete lining approximately 3 feet, constructing a new embankment and a new road, and rehabilitating some canal structures. The lower reach of the canal is earth-lined and a new embankment would be needed to increase the bottom width to 125 feet. The embankment slopes would remain 2.5:1 for the earth-lined section and 1.5:1 for the concrete-lined section.

Figure 3c shows a representative canal cross-section of an enlarged Delta-Mendota Canal for the concrete-lined section of the canal. Figure 3d shows a representative canal cross-section of an enlarged Delta-Mendota Canal for the earth-lined section of the canal. The concrete-lined section of the enlarged Delta-Mendota Canal would have a top width ranging from 111 feet to 120 feet, a bottom width of 48 feet, and a depth of 21 to 24 feet from the normal operating water surface elevation. The earth-lined section of the enlarged Delta-Mendota Canal would have a top width of 205 feet, a bottom width of 125 feet, and a depth of 16 feet from the normal operating water surface elevation. Capacity of the canal would be enlarged by 2,000 cfs.

The canal structures to be rehabilitated as a result of enlarging both reaches of the Delta-Mendota Canal (MP 3.5 to MP 98.62) include 127 bridges, 19 check structures, 12 siphons, 238 turnouts, 285 drain inlets, 8 overchutes, 33 pipe crossings, 4 wasteways, and 10 canal culverts.

Enlarged Mendota Pool

Enlarging the Mendota Pool would require excavation of 2.3 million cubic yards of earth to accommodate the additional 2,000 cfs of increased conveyance capacity from O'Neill Forebay. The excavation would entail deepening, rather than widening, the existing Mendota Pool.

Main Branch and North Branch Canals

After reaching the Mendota Pool, water would be lifted into two canals. The Main Branch of the Mid-Valley Canal would have a capacity of 1,500 cfs and would convey water approximately 107 miles towards the south for use in Fresno, Kings, and Tulare Counties. The North Branch of the Mid-Valley Canal would deliver 500 cfs towards the north for use in Madera and Merced Counties.

Main Branch Canal

The Main Branch of the Mid-Valley Canal would include three concrete-lined reaches (Reaches 2, 3, and 4) and seven pumping plants. Figure 3e provides a representative canal cross-section for Reaches 2, 3 and 4 of the Main Branch Canal. The canal would generally consist of a trapezoidal section with side slopes of 1.5:1. For this evaluation, the Main Branch starts at Reach 2 because Reach 1 has been commonly referred to as an alternative alignment for a new canal to convey water from O'Neill Forebay to the Mendota Pool. This evaluation includes an enlargement of the Delta-Mendota Canal for this reach of a Mid-Valley Canal project. Therefore, Reach 1, or the construction of a new canal from of O'Neill Forebay to the Mendota Pool, is not included in this evaluation.

Reach 2 of the Main Branch would begin at the Mendota Pool near the inlet of the enlarged Delta-Mendota Pool and would progress in a southeasterly direction for 55 miles to Peoples Weir

D-008605

on the Kings River near U.S. Highway 99. Five pumping plants ranging in capacity from 1,200 cfs to 1,500 cfs would provide the hydraulic head necessary for operating this section of the canal. Reach 2 would have a capacity of 1,500 cfs for much of the length of the canal, decreasing in capacity to 1,200 cfs as it approaches Peoples Weir. Reach 2 would have a top width of 61 to 67 feet, a bottom width of 20 to 22 feet, and a depth of 14 to 15 feet from the normal operating water surface elevation.

Reach 3 of the Main Branch Canal would begin at Peoples Weir and would continue in a southeasterly direction for approximately 18 miles along the west side of U.S. Highway 99. Two pumping plants ranging in capacity from 700 to 800 cfs would provide the hydraulic head for operating this section of the canal. Reach 3 would then cross to the east side of the highway to a point 2 miles south of Visalia. With a capacity of 800 cfs, Reach 3 would have a top width of 61 feet, a bottom width of 20 feet, and a depth of 14 feet from the normal operating water surface elevation.

Beginning at the U.S. Highway 99 crossing, Reach 4 would continue south for about 33.5 miles, generally paralleling the highway to White River near Earlimart just north of the Kern County line. With a capacity of 700 cfs, Reach 4 would have a top width of 52 feet, a bottom width of 20 feet, and a depth of 11 feet from the normal operating water surface elevation.

North Branch Canal

The North Branch of the Mid-Valley Canal would extend from the San Joaquin River channel northeast to Deadman Creek just north of Chowchilla, a distance of approximately 33 miles. Four pumping plants ranging in capacity from 240 to 500 cfs would provide the hydraulic head necessary for operating this section of the canal. Water would be conveyed by a 500 cfs capacity, 5-mile-long, dredged channel. An earth intake channel about 2,000 feet long would then divert the water from the deepened Mendota Pool reach to a pumping plant at the head of the concrete-

lined canal. The initial canal capacity of 500 cfs would decrease to 240 cfs before siphoning under Berrenda Slough. Figure 3f provides a representative canal cross-section of the North Branch. The canal would generally consist of a trapezoidal section with side slopes of 1.5:1. In addition, the North Branch would have a top width ranging from 31 to 39 feet, a bottom width of 10 to 12 feet, and a depth of 7 to 9 feet from normal operating water surface elevation.

Pumping Plants

As mentioned above, 11 new pumping plants would be required on the North and Main Branches of the Mid-Valley Canal Project to provide the hydraulic head necessary for operating the canals. Table 1 provides a summary of the physical features and sizes of each pumping plant. Generally, these pumping plants include three to five units ranging from 240 to 1,500 cfs in capacity, from 1,200 to 10,000 horsepower, and from 13 to 36 feet in total dynamic head.

Electrical Transmission Facilities

Electrical transmission facilities would be needed for the 11 pumping plants on the Main and North Branches. This would involve a new substation addition at the Gurnsey Substation, a metering substation, a transmission line from Pumping Plant Number 1 to Pumping Plant Number 4, a transmission line to Pumping Plant Number 5, a transmission line from the Gurnsey Substation to Pumping Plants 6 and 7, as well as a transmission line from Pumping Plant Number 1 to Pumping Plant Number 11.

COST ESTIMATE

The cost estimate for the Mid-Valley Canal is based on the December 1980 Reclamation report titled *Mid-Valley Canal Feasibility Design Criteria and Cost Estimate*, the April 1980 Reclamation report titled *Mid-Valley Canal*, and the December 1977 Reclamation report titled

Project Cost Estimate, Delta-Mendota Canal Capacity Increase. Additional project costs not identified in the reports, including environmental documentation, environmental mitigation, operation and maintenance, power and interest during construction, are not included in this estimate.

COST ESTIMATE METHODOLOGY

The cost estimates developed by Reclamation have been reviewed and adapted for the present cost estimate. Several items in the previous cost estimates have been modified to ensure that current design standards and safety factors were incorporated.

General

The cost estimate for the Mid-Valley Canal was determined by applying current unit costs to the quantities provided in the reports identified above. Some of the costs used were determined by escalating unit costs to October 1996 dollars using Reclamation's Construction Cost Trends (CCT) indices. Additional unit costs were developed by Bookman-Edmonston Engineering based on engineering and construction experience.

Table 2 provides a detailed breakdown of the estimated costs of a Mid-Valley Canal. An updated cost estimate for cost items identified in the previous cost estimates has been provided, along with the quantities of the cost item or an indication that the estimated cost has been developed through a lump sum approach. The table also includes the CCT indices for the month and year in which the estimated cost was developed and for October 1996. These 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 2 provides the cost reference for each cost item.

Pumping Plants

The cost estimate for the 11 pumping plants associated with the Mid-Valley Canal was based on the cost and quantities from the December 1977 Reclamation report titled *Project Cost Estimate, Delta-Mendota Canal Capacity Increase*. These costs were originally priced in July 1974 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 for the Mid-Valley Canal Project. The right-of-way costs were developed by Reclamation's Land Resources Branch (personal communication, February 1997). Reclamation provided land use cost estimates at a subappraisal level for all storage and conveyance components being evaluated by CALFED. A total right-of-way take of 3,616 acres would need to be acquired for this project along the 140 miles of new or expanded canal.

Contingencies and Other Costs

All contingencies and engineering, construction management, and administrative factors were determined by engineering judgment based on similar levels of cost estimation. Contingencies were chosen to be 20 percent; 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 15 percent to the estimated capital cost for the high-end cost.

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PRELIMINARY COST FINDINGS

Costs of the Mid-Valley Canal and supporting facilities have been updated to an October 1996 basis as described above. Table 3 summarizes estimated costs of the major items associated with the Mid-Valley Canal. The total cost of the Mid-Valley Canal is estimated to be about $903 million with a resulting calculated range of costs between $812 and $1,038 million.

ENVIRONMENTAL CONSIDERATIONS

[NOTE: The following "Environmental Considerations" should be reevaluated by DWR to ensure consistency with the information presented in the previous sections.]

This portion of the report provides a summary of environmental considerations related to the proposal for constructing the Mid-Valley Canal and enlarging the Delta-Mendota Canal. Fish, wildlife, plant, and cultural resources that could be affected are described and 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

Food and cover for many of the native wildlife species in this area are limited. Except for a few draws and creek channels, the hot and dry climate of the San Joaquin Valley limits vegetation on the valley floor to mostly sagebrush, tumbleweed, and grasses. The impacts from this proposal are primarily associated with the loss of wildlife habitat value resulting from the construction and maintenance of new canals and conveyance facilities.

Construction of the Main Branch would result in the loss of approximately 25 acres of grassland, 280 acres of riparian habitat, 240 acres of marshlands, 1,640 acres of agricultural lands, and 500 acres of irrigated pasture.

Construction of the North Branch would result in the loss of approximately 110 acres of grassland, 660 acres of agricultural lands, and 25 acres of irrigated pasture.

Construction of the Main Branch Intertie would result in the loss of approximately 270 acres of riparian habitat, 240 acres of marshlands, 1,000 acres of agricultural lands, and 200 acres of irrigated pasture.

Enlargement of the Delta-Mendota Canal would result in the loss of approximately 135 acres of agricultural lands. The impact of enlarging the existing canal is expected to be minimal assuming that the existing right-of-way is used.

Fish, Amphibians, Reptiles, and Invertebrates

The drainages that would be affected by the proposed conveyance components may continue to support native species such as tule perch, Sacramento sucker, riffle sculpin, and endemic minnows. Nonnative game and non-game species may also be found in drainages and channels.

General Wildlife

Historically, large amounts of land within the Tulare Lake Basin portion of the valley were marshlands. Many of the species that once occurred here have been greatly reduced in number because of habitat deterioration and replacement by farming and urban development. General wildlife that may be found throughout the drainage areas within the San Joaquin Valley include species such as California mule deer, mountain lion, golden eagle, coyote, and bobcat. Bird

species found in the drainage areas include valley quail, band-tailed pigeon, dove, osprey, and red-tailed hawk.

Common mammals found in the alkali desert scrub habitats within the lower portions of the San Joaquin Valley include pocket gopher, California ground squirrel, desert cottontail, deer mouse, California vole, Hermann's kangaroo rat, black-tailed hare, striped skunk, badger, and coyote. Reptiles, such as side-blotched lizard, western whiptail, western fence lizard, gopher snake, and western rattlesnake, are commonly observed in alkali desert scrub habitat. Common birds that forage or nest in alkali desert scrub include roadrunner, mourning dove, blue-gray gnatcatcher, common raven, sage sparrow, white-crowned sparrow, house finch, American goldfinch, and lesser goldfinch.

Sensitive and Listed Fish and Wildlife Species

No special-status fish species are known to exist along the alignment of the proposed conveyance.

According to the California Department of Fish and Game's (CDFG) California Natural Diversity Data Base records (Version 8/96), 15 State or federally listed species and 19 species that are either candidates for listing or species designated by CDFG as species of special concern have been known to occur in the area affected by the proposed Mid-Valley Canal and Delta-Mendota Canal Enlargement.

Listed wildlife species that could be affected by the Mid-Valley Canal Main Branch component include Fresno kangaroo rat (federal/State endangered), Tipton kangaroo rat (federal/State endangered), San Joaquin kit fox (federal endangered, State threatened), blunt-nosed leopard lizard (federal/State endangered), giant garter snake (federal/State threatened), and vernal pool fairy shrimp (federal threatened).

Listed wildlife species that could be affected by the Mid-Valley Canal Main Branch Intertie component include Fresno kangaroo rat (federal/State endangered), San Joaquin kit fox (federal endangered, State threatened), giant garter snake (federal/State threatened), and vernal pool fairy shrimp (federal threatened).

Listed wildlife species that could be affected by the Mid-Valley Canal North Branch component include Swainson's hawk (State threatened), western yellow-billed cuckoo (State threatened), bank swallow (State threatened), giant garter snake (federal/State threatened), Fresno kangaroo rat (federal/State endangered), San Joaquin kit fox (federal endangered, State threatened), and blunt-nosed leopard lizard (federal/State endangered).

Listed wildlife species that could be affected by the enlargement of the Delta-Mendota Canal include California red-legged frog (federal threatened), Aleutian Canada goose (federal threatened), Swainson's hawk (State threatened), western yellow-billed cuckoo (State threatened), bank swallow (State threatened), San Joaquin antelope squirrel (State threatened), giant kangaroo rat (federal/State endangered), Fresno kangaroo rat (federal/State endangered), San Joaquin kit fox (federal endangered, State threatened), and blunt-nosed leopard lizard (federal/State endangered).

Wildlife species that are either candidates for State or federal listing or considered species of special concern by the CDFG that could be affected by the proposed Mid-Valley Canal Main Branch component include California tiger salamander, western spade foot, burrowing owl, western pond turtle, Hopping's blister beetle, and Molestan blister beetle.

Wildlife species that are either candidates for State or federal listing or considered species of special concern by the CDFG that could be affected by the proposed Mid-Valley Canal Main Branch Intertie component include tri-colored blackbird, San Joaquin pocket mouse, western pond turtle, Hopping's blister beetle, white-faced ibis, and Molestan blister beetle.

Wildlife species that are either candidates for State or federal listing or considered species of special concern by the CDFG that could be affected by the proposed Mid-Valley Canal North Branch component include California tiger salamander, burrowing owl, western pond turtle, Hopping's blister beetle, Kern shoulderband, Buena Vista Lake shrew, and Morrison's blister beetle.

Wildlife species that are either candidates for State or federal listing or considered species of special concern by the CDFG that could be affected by the proposed enlargement of the Delta-Mendota Canal include California tiger salamander, western spade foot, prairie falcon, yellow-rail, burrowing owl, tri-colored blackbird, white-faced ibis, northern harrier, California mastiff bat, Sacramento splittail, San Joaquin pocket mouse, western pond turtle, California horned lizard, Molestan blister beetle, and curved foot hygrotus diving beetle.

VEGETATION

Much of the native vegetation in the San Joaquin Valley has been replaced by introduced species or has been disturbed by cultivation or grazing. Major natural vegetation classes found within the valley include grassland, sagebrush shrub, coastal shrub, and some hardwood forest-woodland. Willows, western sycamore, cottonwoods, and alder can be found along some of the area's drainages. Typical native plants that might still occur in the undisturbed areas outside the riparian zones in the Tulare Basin include those of the lower Sonoran Grassland Association and the Alkali Sink Association. However, these plants occur only in isolated areas or relatively small remaining natural areas since most of the land is extensively farmed. Some of the common grasses found here include nutgrasses, fescues, bluegrass, wild oats, California needlegrass, and foxtails. Common wildflowers include California poppy, lupine, Mariposa lily, daisy, popcorn flower, fiddleneck, and larkspur.

Sensitive and Listed Plant Species

Federal- or State-listed plant species found in or adjacent to the alignments of the proposed conveyance components and in the area of the existing Delta-Mendota Canal include San Joaquin adobe sunset (proposed federal endangered, State endangered), California jewelflower (federal/State endangered), Hover's eriastrum (federal threatened), palmate-bracted bird's beak (federal/State endangered), San Joaquin woolly threads (federal endangered), Bakersfield small scale (State endangered), Delta button-celery (State threatened), and large-flowered fiddleneck (federal/State endangered).

Candidate plant species for federal listing that may occur along the proposed Mid-Valley Canal and enlarged Delta-Mendota Canal alignment include Mason's lilaeopsis, Mt. Hamilton coreopsis, caper-fruited tropidocarpum, Coulter's goldfields, heart scale, Lost Hills crown scale, San Joaquin saltbush, Ferris's milk-vetch, Mt. Diablo phacelia, diamond-petaled California poppy, recurved larkspur, hispid bird's beak, Sanford's arrowhead, Merced phacelia, spiny-sepaled button-celery, and Mason's neststraw.

Plants listed by the California Native Plant Society as being rare, threatened, or endangered in California and elsewhere that could be affected by the Mid-Valley Canal and Delta-Mendota Enlargement project include big tarweed, slough thistle, Munz's tidy-tips, showy madia, Wright's trichocoronis, brittlescale, lesser saltbush, alkali milk-vetch, California hibiscus, and Mt. Diablo buckwheat.

Several sensitive plant communities may be found along the proposed alignments of the Mid-Valley Canal components or along the existing Delta-Mendota Canal alignment. These communities include valley sink scrub, valley saltbush scrub, valley sacaton grassland, northern claypan vernal pool , alkali meadow, cismontane alkali marsh, coastal and valley freshwater

marsh, Great Valley cottonwood riparian forest, Great Valley oak riparian forest, and sycamore alluvial woodland.

Special-status habitats within the proposed project's area include valley sink scrub, valley saltbush scrub, valley sacaton grassland, Great Valley cottonwood and oak riparian forests, and sycamore alluvial woodland. Also, there are four Significant Natural Areas in the islands: Mendota alkali sink, Fresno slough, east branch of Cross Creek, and Cross Creek vernal pools.

Wetlands

Wetland types that could potentially be affected by the proposed Mid-Valley Canal include emergent wet meadows, shallow and deep marshes, forested wet meadows, shrub-scrub wet meadows, and ponds. The proposed conveyance would cross four intermittent streambeds (Cross, Mill, Packwood, and Inside Creeks), ten lower perennial stream crossings (Fresno, Chowchilla, and Kings Rivers; Elk Bayou; Outside, Deer, and Deep Creeks; and North, Middle, and South Branches of the Tule River), and five slough crossings (Ash, Berenda, Fish, Cole, and Lone Willow Sloughs).

Wetland types that could potentially be affected by the enlargement of the Delta-Mendota Canal include emergent wet meadows, emergent shallow and deep marshes, forested wetlands, and shrub-scrub wetlands. The Delta-Mendota Canal crosses 21 lower perennial streams and 58 intermittent streambeds.

Coastal and valley freshwater marshes, cismontane alkali marsh, and northern claypan vernal pools are special-status habitats that may occur in the areas affected by the proposed Mid-Valley Canal and Delta-Mendota Canal enlargement.

CULTURAL RESOURCES

Two known prehistoric sites within the area would be affected by the Mid-Valley Canal Main Branch; 14 known prehistoric sites and three historic sites within the area would be affected by the Mid-Valley Canal Main Branch Intertie; and four known prehistoric sites within the area would be affected by the Mid-Valley Canal North Branch. The cultural resources that could be potentially affected by enlarging the existing Delta-Mendota Canal are unknown.

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Table 1
SUMMARY OF PHYSICAL CHARACTERISTICS
MID-VALLEY CANAL

Intake Canal to Tracy Pumping Plant	
Length Enlarged (feet)	6,500
Length New (feet)	4,200
Southern Pacific RR/Bethany Road Crossing (feet)	775
Capacity (cfs)	6,500
Tracy Pumping Plant Addition	
Number of Units Added	2
Total Combined Capacity (cfs)	2,000
Total Combined Horsepower (hp)	64,000
Total Dynamic Head (feet)	214
Discharge Pipeline	
Type	Reinforced Concrete Pipe
Length (feet)	6,700
Diameter (inches)	228
Capacity (cfs)	2,000
Enlargement of Delta-Mendota Canal	
Tracy Pumping Plant to O'Neil Forebay (MP3.5 to MP70)	
Length (miles)	66.5
Type	Concrete-lined
Capacity Increase (cfs)	2,000
Side Slope	1.5:1
Top Width (feet)	111-120
Bottom Width (feet)	48
Depth (feet)	21-24
O'Neil Forebay to Mendota Pool (MP70 to MP98.63)	
Length (miles)	28.6
Type	nation concrete-lined/earth-lined
Capacity Increase (cfs)	2,000
Side Slope	2.5:1 (earth)/1.5:1 (concrete)
Top Width (feet)	205 (earth)/111-120 (concrete)
Bottom Width (feet)	125 (earth/48 (concrete)
Depth (feet)	16 (earth)/21-24 (concrete)
Rehabilitated Canal Structures (MP3.5 to MP98.63)	
Bridges (quantity)	127
Check Structures (quantity)	19
Siphons (quantity)	12
Turnouts (quantity)	238
Drain Inlets (quantity)	285
Overchutes (quantity)	8
Pipe Crossings (quantity)	33
Wasteways (quantity)	4
Culverts (quantity)	10

Table 1
SUMMARY OF PHYSICAL CHARACTERISTICS
MID-VALLEY CANAL

Main Branch - Mid-Valley Canal				
Reach 2 (Mendota Pool to People's Weir)				
Length (miles)				54.9
Type				Concrete-lined
Capacity (cfs)				1,500 and 1,200
Side Slope				1.5:1
Top Width (feet)				61.22-66.55
Bottom Width (feet)				20-22
Depth (feet)				13.74-14.85
Reach 3 (People's Weir to 2 miles South of Visalia)				
Length (miles)				17.9
Type				Concrete-lined
Capacity (cfs)				1,200
Side Slope				1.5:1
Top Width (feet)				61
Bottom Width (feet)				20
Depth (feet)				14
Reach 4 (2 Miles South of Visalia to White River)				
Length (miles)				33.3
Type				Concrete-lined
Capacity (cfs)				700
Side Slope				1.5:1
Top Width (feet)				52
Bottom Width (feet)				20
Depth (feet)				11
Pumping Plants	Units	Capacity (cfs)	Horsepower	TDH (feet)
No. 1	5	1,500	7,500	25
No. 2	5	1,500	8,750	30
No. 3	5	1,500	10,000	36
No. 4	4	1,200	8,000	36
No. 5	4	1,200	7,000	31
No. 6	3	800	1,800	13
No. 7	4	700	2,800	21
North Reach (Mendota Pool to Deadman Creek)				
Length (miles)				33.4
Type				Concrete-lined
Capacity (cfs)				240-500
Side Slope				1.5:1
Top Width (feet)				31-39
Bottom Width (feet)				10-12
Depth (feet)				7-9
Pumping Plants	Units	Capacity (cfs)	**Horsepower**	**TDH (feet)**
No. 8	3	500	2,100	24
No. 9	3	500	2,100	24
No. 10	3	240	1,200	26
No. 11	3	240	1,200	26

Table 2
ESTIMATED COSTS
MID-VALLEY CANAL

DESCRIPTION	QUANTITY	UNIT	USBR INDEX	USBR INDEX OCT. 1996	UNIT COST	UNIT COST OCT. 1996	TOTAL COST OCT. 1996	COST REF.
I. INTAKE CANAL, TRACY PUMPING PLANT AND DISCHARGE LINE			APR. 1976		APR. 1976			
Structures and Improvements								
Construct and Remove Coffer Dam	JOB	LS	93	212	$91,000.00	$207,440.00	$207,440	1
Dewatering	JOB	LS	93	212	$57,000.00	$129,935.00	$129,935	1
Concrete	14,700	CY				$600.00	$8,820,000	2
Steel Superstructure, Lighting, Sanitary Facilities,								
Domestic Water System, etc.	JOB	LS	93	212	$818,222.00	$1,865,194.00	$1,865,194	1
Miscellaneous Metal Work	135,500	LB				$5.00	$677,500	2
Allowance for Unlisted Items (10%)							$1,170,007	
SUBTOTAL STRUCTURES AND IMPROVEMENTS							$12,870,076	
Waterways: Intake Canal, Discharge Line								
Excavation	174,200	CY				$2.00	$348,400	2
Backfill	37,480	CY				$4.00	$149,920	2
Compacted Backfill	18,848	CY	93	212	$7.50	$17.10	$322,301	1
Sand Cradle	5,641	CY	93	212	$20.00	$45.59	$257,173	1
Dewatering	JOB	LS	93	212	$1,800.00	$4,000.00	$4,000	1
228"-B225 RCP	1,200	LF	96	196	$1,100.00	$2,245.83	$2,694,996	1
228"-B200 RCP	1,200	LF	96	196	$1,120.00	$2,286.67	$2,744,004	1
228"-B150 RCP	2,400	LF	96	196	$1,145.00	$2,337.71	$5,610,504	1
228"-B100 RCP	800	LF	96	196	$1,195.00	$2,439.79	$1,951,832	1
228"-B50 RCP	1,100	LF	96	196	$1,225.00	$2,501.04	$2,751,144	1
Steel Pipe Liner	140	LF	93	222	$2,400.00	$5,729.03	$802,064	1
Regrade 80 Feet	JOB	LS	96	237	$1,000.00	$2,468.75	$2,469	1
Outlet Structure	JOB	LS	94	213	$77,650.00	$175,951.60	$175,952	1
Fish Collection Facilities	JOB	LS	93	212	$4,616,850.00	$10,524,432.00	$10,524,432	1
Construct SPRR & Bethany Road 775', 210" Diameter Crossing	JOB	LS	93	212	$4,263,000.00	$9,717,806.00	$9,717,806	1
Enlarge Intake Canal	3,965,128	CY				$2.00	$7,930,256	2
Check Structure	JOB	LS	94	213	$410,000.00	$929,043.00	$929,043	1
Allowance for Unlisted Items (10%)							$4,691,630	
SUBTOTAL WATERWAYS							$51,607,925	
Waterway: Pumping Units, Manifold, etc.								
Concrete	2,404	CY				$600.00	$1,442,400	2
Trashracks and Bulkhead Gates	250,000	LB				$5.00	$1,250,000	2
Steel Discharge Pipe and Manifold	368,000	LB				$4.00	$1,472,000	2
Siphon Breaker Valves - 2 Each	7,880	LB				$5.00	$39,400	2
10 Ft. Butterfly Valves with Operators	JOB	LS	93	212	$412,000.00	$939,183.00	$939,183	1
Compression Couplings	11,000	LB				$5.00	$55,000	2
Allowance for Unlisted Item (10%)							$519,798	

Table 2
ESTIMATED COSTS
MID-VALLEY CANAL

DESCRIPTION	QUANTITY	UNIT	USBR INDEX	USBR INDEX OCT. 1996	UNIT COST	UNIT COST OCT. 1996	TOTAL COST OCT. 1996	COST REF.
SUBTOTAL WATERWAY							$5,717,781	
Miscellaneous Accessories								
Accessory Electrical Equipment	JOB	LS	93	216	$1,000,000.00	$2,322,581.00	$2,322,581	1
Miscellaneous Equipment	JOB	LS	93	216	$1,012,000.00	$2,350,452.00	$2,350,452	1
Road and Road Structures	JOB	LS	96	237	$7,500.00	$18,516.00	$18,516	1
SUBTOTAL MISCELLANEOUS ACCESSORIES							$4,691,549	
Pumps and Prime Movers								
Concrete	2,600	CY				$600.00	$1,560,000	2
Vertical Pumping Units	JOB	LS	92	228	$5,720,000.00	$14,175,652.00	$14,175,652	1
SUBTOTAL PUMPS AND PRIME MOVERS							$15,735,652	
Switchyard and Substation								
Station Equipment	JOB	LS	94	190	$745,000.00	$1,505,851.00	$1,505,851	1
Poles and Fixtures	JOB	LS	94	190	$27,000.00	$54,574.00	$54,574	1
Overhead Conductors and Devises	JOB	LS	94	190	$14,800.00	$29,915.00	$29,915	1
SUBTOTAL SWITCHYARD AND SUBSTATION							$1,590,340	
SUBTOTAL INTAKE CANAL, TRACY PUMPING PLANT AND DISCHARGE LINE							$92,213,323	
II. DELTA-MENDOTA CANAL ENLARGEMENT - CONCRETE LINED (M.P. 3.5 TO M.P. 70.0) INCREASE CAPACITY BY 2,000 CFS			OCT. 1977		OCT. 1977			
Roads and Bridges								
Canal Operation and Maintenance Roads	6,632,800	SF	102	237	$0.14	$0.33	$2,188,824	1
County Roads	JOB	LS	102	219	$45,600.00	$97,906.00	$97,906	1
County Bridges	JOB	LS	102	226	$1,556,500.00	$3,448,716.00	$3,448,716	1
Allowance for Unlisted Items (10%)							$573,545	
SUBTOTAL ROADS AND BRIDGES							$6,308,991	
Waterways								
Excavation	1,768,000	CY				$2.00	$3,536,000	2
Backfill	5,303,800	CY				$1.50	$7,955,700	2
Compacted Backfill	4,243,000	CY				$3.00	$12,729,000	2
Overhaul	12,305,000	MY	102	181	$0.25	$0.44	$5,414,200	1
Concrete Lining	75,200	CY				$80.00	$6,016,000	2
Ladder Extension	773	EA	102	212	$100.00	$207.84	$160,660	1
Allowance for Unlisted Items (5%)							$1,790,578	
SUBTOTAL WATERWAYS							$37,602,138	
Waterway Structures								
Check Structures	12	EA	102	213	$64,882.00	$135,489.00	$1,625,868	1

Table 2
ESTIMATED COSTS
MID-VALLEY CANAL

DESCRIPTION	QUANTITY	UNIT	USBR INDEX	USBR INDEX OCT. 1996	UNIT COST	UNIT COST OCT. 1996	TOTAL COST OCT. 1996	COST REF.
Westley Wasteway	JOB	LS	102	213	$533,209.00	$1,113,466.00	$1,113,466	1
Newman Wasteway	JOB	LS	102	213	$1,467,600.00	$3,064,694.00	$3,064,694	1
Volta Wasteway	JOB	LS	102	213	$1,621,630.00	$3,386,354.00	$3,386,354	1
Mountain House Siphon:								
Earthwork and Concrete	JOB	LS	102	213	$788,250.00	$1,646,051.00	$1,646,051	1
21-Ft. Dia. RCP	2,020	LF	102	213	$1,100.00	$2,297.06	$4,640,061	1
Radial Gate and Hoist	20,000	LB				$5.00	$100,000	2
Allowance for Unlisted Items (5%)							$319,306	
S.P.R.R. Siphon								
Earthwork and Concrete	JOB	LS	102	213	$157,610.00	$329,127.00	$329,127	1
18-Ft. Dia. RCP	180	LF.	102	213	$920.00	$1,921.18	$345,812	1
Remove Concrete	1,450	CY	102	213	$150.00	$313.24	$454,198	1
Temporary R.R. Bridge	JOB	LS	102	226	$550,000.00	$1,148,529.00	$1,148,529	1
Allowance for Unlisted Items (5%)							$113,883	
W.P.R.R. Siphon at Sta. L-774+06:								
Earthwork and Concrete	JOB	LS	102	213	$163,830.00	$342,116.00	$342,116	1
18-Ft. Dia. RCP	210	LF	102	213	$920.00	$1,921.18	$403,448	1
Remove Concrete	1,450	CY	102	213	$150.00	$313.24	$454,198	1
Temporary R.R. Bridge	JOB	LS	102	213	$550,000.00	$1,148,529.00	$1,148,529	1
Allowance for Unlisted Items (5%)							$117,415	
W.P.R.R. & Corral Hollow Creek Siphon:								
Earthwork and Concrete	JOB	LS	102	213	$560,900.00	$1,171,291.00	$1,171,291	1
24-Ft. Dia. RCP	820	LF.	102	213	$1,240.00	$2,589.41	$2,123,316	1
Remove Concrete	4,950	CY	102	213	$100.00	$208.82	$1,033,659	1
Temporary R.R. Bridge	JOB	LS	102	213	$550,000.00	$1,148,529.00	$1,148,529	1
Allowance for Unlisted Items (5%)							$273,840	
Hetch Hetchy Siphon:								
Earthwork and Concrete	JOB	LS	102	213	$369,175.00	$770,924.00	$770,924	1
24-Ft. Dia. RCP	430	LF	102	213	$1,240.00	$2,589.41	$1,113,446	1
Remove Concrete	2,810	CY	102	213	$125.00	$261.03	$733,494	1
Allowance for Unlisted Items (5%)							$130,893	
Puerto Creek Siphon:								
Earthwork and Concrete	JOB	LS	102	213	$408,200.00	$852,418.00	$852,418	1
17.5-Ft. Dia. RCP	690	LF	102	213	$860.00	$1,795.88	$1,239,157	1
Remove Concrete	2,950	CY	102	213	$120.00	$250.59	$739,241	1
Allowance for Unlisted Items (5%)							$141,541	
Oristimba Creek Siphon:								
Earthwork and Concrete	JOB	LS	102	213	$453,840.00	$947,725.00	$947,725	1
24-Ft. Dia. RCP	600	LF	102	213	$1,240.00	$2,589.41	$1,553,646	1
Remove Concrete	3,400	CY	102	213	$100.00	$208.82	$709,988	1
Allowance for Unlisted Items (5%)							$160,568	

Table 2
ESTIMATED COSTS
MID-VALLEY CANAL

DESCRIPTION	QUANTITY	UNIT	USBR INDEX	USBR INDEX OCT. 1996	UNIT COST	UNIT COST OCT. 1996	TOTAL COST OCT. 1996	COST REF.
Garzas Creek Siphon:								
Earthwork and Concrete	JOB	LS	102	213	$410,500.00	$857,221.00	$857,221	1
24-Ft. Dia. RCP	450	LF	102	213	$1,240.00	$2,589.41	$1,165,235	1
Remove Concrete	2,850	CY	102	213	$120.00	$250.59	$714,182	1
Allowance for Unlisted Items (5%)							$136,832	
Pipe Crossings	JOB	LS	102	213	$80,000.00	$167,059.00	$167,059	1
Turnouts	JOB	LS	102	213	$920,000.00	$1,921,176.00	$1,921,176	1
Drain Inlets:								
Concrete	238	CY				$600.00	$142,800	2
Pumps	JOB	LS	102	213	$5,817,611.00	$12,148,518.00	$12,148,518	1
Allowance for Unlisted Items (5%)							$614,566	
SUBTOTAL WATERWAY STRUCTURES							$53,464,319	
SUBTOTAL DELTA-MENDOTA CANAL ENLARGEMENT - M.P. 3.5 TO M.P. 70.0							$97,375,448	
III. DELTA-MENDOTA CANAL ENLARGEMENT - CONCRETE LINED (M.P. 70.0 TO M.P. 98.63) EARTHENED CANAL (M.P. 98.63 TO M.P. 116.61)			**OCT. 1977**		**OCT. 1977**			
Land and Rights	JOB	LS	102	213	$136,500.00	$285,004.00	$285,004	1
Roads and Bridges								
Canal Operation and Maintenance Road	4,416,500	SF	102	237	$0.14	$0.33	$1,457,445	1
County Roads	JOB	LS	102	219	$348,700.00	$748,679.00	$748,679	1
Concrete Bridges	JOB	LS	102	226	$3,593,000.00	$7,960,961.00	$7,960,961	1
SUBTOTAL ROADS AND BRIDGES							$10,167,085	
Waterways								
Excavation	5,857,000	CY				$2.00	$11,714,000	2
Backfill	3,489,000	CY				$1.50	$5,233,500	2
Compacted Backfill	3,000,500	CY				$3.00	$9,001,500	2
Overhaul	1,084,500	MY	102	181	$0.25	$0.44	$477,180	1
Concrete Lining	32,500	CY				$80.00	$2,600,000	2
Ladder Extension	540	EA	102	212	$100.00	$207.84	$112,234	1
Allowance for Unlisted Items (5%)							$1,456,921	
SUBTOTAL WATERWAYS							$30,595,334	
Waterway-Structures								
Check Structures	7	EA	102	213	$55,026.00	$114,908.00	$804,356	1
Firebaugh Wasteway	JOB	LS	102	213	$1,509,291.00	$3,151,755.00	$3,151,755	1
Canal Undercrossings	JOB	LS	102	213	$2,085,160.00	$4,354,305.00	$4,354,305	1
S.P.R.R. and Highway Siphon:								

Table 2
ESTIMATED COSTS
MID-VALLEY CANAL

DESCRIPTION	QUANTITY	UNIT	USBR INDEX	USBR INDEX OCT. 1996	UNIT COST	UNIT COST OCT. 1996	TOTAL COST OCT. 1996	COST REF.
Earthwork and Concrete	JOB	LS	102	213	$931,532.00	$1,945,258.00	$1,945,258	1
18-Ft. Dia. RCP	300	LF	102	213	$920.00	$1,921.18	$576,354	1
Radial Gate and Hoist	20,000	LB				$5.00	$100,000	2
Allowance for Unlisted Items (5%)							$131,081	
Miller and Lux Siphon:								
Earthwork and Concrete	JOB	LS	102	213	$334,896.00	$699,342.00	$699,342	1
18-Ft. Dia. RCP	155	LF	102	213	$920.00	$1,921.18	$297,783	1
Radial Gate and Hoist	45,000	LB				$5.00	$225,000	2
Allowance for Unlisted Items (5%)							$61,106	
Drain Inlets								
Concrete	198	CY				$600.00	$118,800	2
Pumps	JOB	LS	102	213	$519,095.00	$1,083,993.00	$1,083,993	1
Allowance for Unlisted Items (5%)							$60,140	
SUBTOTAL WATERWAY STRUCTURES							$13,609,272	
SUBTOTAL DELTA MENDOTA CANAL ENLARGEMENT - M.P. 70.0 TO M.P. 116.61							$54,371,692	
IV. MENDOTA POOL ENLARGEMENT			**OCT. 1977**		**OCT. 1977**			
Excavation	2,300,000	CY				$2.00	$4,600,000	2
SUBTOTAL MENDOTA POOL ENLARGEMENT							$4,600,000	
V. MAIN BRANCH CANAL - REACH 2 - DESIGN CAPACITY 1,500 CFS FROM MENDOT POOL TO RASIN CITY AND 1,200 CFS FROM RASIN CITY TO PEOPLES' WEIR			**JUL. 1974**		**JUL. 1974**			
Land and Rights	1,330	AC				$3,000.00	$3,990,000	2
Relocation of Existing Property								
Farm Bridges, Concrete (24)	33,600	SF.				$100.00	$3,360,000	2
County Road Bridges, Concrete (41)	198,100	SF				$100.00	$19,810,000	2
State Hwy. 41 Bridge, Concrete (1)	2,940	SF				$150.00	$441,000	2
Railroad Bridge (1)	70	LF	95	226	$900.00	$2,141.05	$149,874	1
SUBTOTAL RELOCATION OF EXISTING PROPERTY							$23,760,874	
Structures and Improvements								
Canal Fencing (Wire Mesh)	369,600	LF				$5.00	$1,848,000	2
Canal Fencing (Chain Link)	97,680	LF				$10.00	$976,800	2
Allowance for Unlisted Items (5%)							$141,240	
SUBTOTAL STRUCTURES AND IMPROVEMENTS							$2,966,040	
Waterways								
Excavation	5,700,000	CY				$2.00	$11,400,000	2
Compacted Embankment	1,700,000	CY				$0.80	$1,360,000	2

Table 2
ESTIMATED COSTS
MID-VALLEY CANAL

DESCRIPTION	QUANTITY	UNIT	USBR INDEX	USBR INDEX OCT. 1996	UNIT COST	UNIT COST OCT. 1996	TOTAL COST OCT. 1996	COST REF.
Preparing Foundation for Concrete Lining	2,000,000	CY				$1.00	$2,000,000	2
Concrete Lining	160,000	CY				$80.00	$12,800,000	2
Road Gravel	59,000	CY				$35.00	$2,065,000	2
Overhaul	240,000	MY	77	181	$0.25	$0.59	$141,600	1
Allowance for Unlisted Items (5%)							$1,488,330	
SUBTOTAL WATERWAYS							$31,254,930	
Canal Structures								
James Bypass Siphon:								
Concrete	5,500	CY				$600.00	$3,300,000	2
Allowance for Unlisted Items (5%)							$165,000	
Turnout to Kings River	JOB	LS	75	213	$162,165.00	$460,549.00	$460,549	1
Kings River Siphon and Check:								
Concrete	1,800	CY				$600.00	$1,080,000	2
Radial Gate with Operator	2	EA	75	213	$40,000.00	$113,600.00	$227,200	1
Electrical Works	JOB	LS	77	212	$16,000.00	$44,052.00	$44,052	1
Allowance for Unlisted Items (5%)							$67,563	
Canal Protective Works Culverts and Overchutes:								
Concrete	5,500	CY				$600.00	$3,300,000	2
Allowance for Unlisted Items (5%)							$165,000	
Operating Road - Asphalt Paved	110	MI	75	237	$35,000.00	$110,600.00	$12,166,000	1
SUBTOTAL CANAL STRUCTURES							$20,975,364	
SUBTOTAL MID-VALLEY REACH 2							$82,947,207	
VI. MAIN BRANCH CANAL REACH 3 - DESIGN CAPACITY 1,200 CFS FROM PEOPLES' WEIR TO 2 MILES SOUTH OF VISALIA			**JUL. 1974**		**JUL. 1974**			
Land and Rights	427	AC				$3,000.00	$1,281,000	2
Relocation of Existing Property								
Farm Bridges, Concrete (15)	31,180	SF				$100.00	$3,118,000	2
County Road Bridges, Concrete (15)	44,975	SF				$100.00	$4,497,500	2
State Highway Bridge (1)	3,066	SF				$150.00	$459,900	2
Railroad Bridge (1)	73	LF	95	226	$900.00	$2,141.05	$156,297	1
Irrigation Crossings	9	EA	75	213	$16,000.00	$45,440.00	$408,960	1
SUBTOTAL RELOCATION OF EXISTING PROPERTY							$8,640,657	
Canal Right of Way Fence								
Weir Mesh Fence	178,000	LF				$5.00	$890,000	2
Chain Link Fence	10,000	LF				$10.00	$100,000	2
SUBTOTAL CANAL RIGHT OF WAY FENCE							$990,000	

Table 2
ESTIMATED COSTS
MID-VALLEY CANAL

DESCRIPTION	QUANTITY	UNIT	USBR INDEX	USBR INDEX OCT. 1996	UNIT COST	UNIT COST OCT. 1996	TOTAL COST OCT. 1996	COST REF.
Waterways								
Excavation	1,916,053	CY				$2.00	$3,832,106	2
Compacted Embankment	940,700	CY				$0.80	$752,560	2
Overhaul	4,014,235	MY	77	181	$0.25	$0.59	$2,368,399	1
Preparing Foundation for Concrete Lining	812,700	CY				$1.00	$812,700	2
Concrete Lining	67,868	CY				$80.00	$5,429,440	2
Safety Ladders	145	EA	75	213	$200.00	$568.00	$82,360	1
Allowance for Unlisted Items (5%)							$663,878	
SUBTOTAL WATERWAYS							$13,941,443	
Canal Structures								
Inlet Structures								
Concrete	553	CY				$600.00	$331,800	2
Radial Gates	675	SF	75	213	$120.00	$340.80	$230,040	1
Miscellaneous Metal Work	2,100	LB				$5.00	$10,500	2
Chain Link Fence	144	LF				$10.00	$1,440	2
Allowance for Unlisted Items (5%)							$28,689	
Siphons:								
Concrete	2,211	CY				$600.00	$1,326,600	2
Borrow	18,270	CY				$3.00	$54,810	2
Riprap	2,366	CY				$30.00	$70,980	2
.Sand and Gravel Bedding	312	CY				$30.00	$9,360	2
174" Dia. Pipe	410	LF	75	213	$325.00	$923.00	$378,430	1
Jacking Pipe	410	LF	75	213	$810.00	$2,300.40	$943,164	1
Allowance for Unlisted Items (5%)							$139,167	
Canal Protective Works-Culverts and Overchutes:								
Concrete	511	CY				$600.00	$306,600	2
Sand and Gravel Bedding	130	CY				$30.00	$3,900	2
Excavation for Bathtub	23,700	CY				$2.00	$47,400	2
30" D25 Pipe	176	LF				$90.00	$15,840	2
42" D25 Pipe	176	LF				$126.00	$22,176	2
54" D25 Pipe	176	LF				$162.00	$28,512	2
57" D25 Pipe	176	LF				$171.00	$30,096	2
66" D25 Pipe	436	LF				$198.00	$86,328	2
69" D25 Pipe	176	LF				$207.00	$36,432	2
72" D25 Pipe	316	LF				$216.00	$68,256	2
Allowance for Unlisted Items (5%)							$32,277	
Operating Road	36	MI	75	237	$15,000.00	$47,400.00	$1,706,400	1
SUBTOTAL CANAL STRUCTURES							$5,909,197	
SUBTOTAL MID-VALLEY CANAL REACH 3							$30,762,297	

Table 2
ESTIMATED COSTS
MID-VALLEY CANAL

DESCRIPTION	QUANTITY	UNIT	USBR INDEX	USBR INDEX OCT. 1996	UNIT COST	UNIT COST OCT. 1996	TOTAL COST OCT. 1996	COST REF.
VII. MAIN BRANCH CANAL REACH 4 - DESIGN CAPACITY 700 CFS			JUL. 1974		JUL. 1974			
TAGUS RANCH PUMPING PLANT TO WHITE RIVER								
Land and Rights	844	AC				$3,000.00	$2,532,000	2
Relocation of Existing Property								
Farm Bridges, Concrete (27)	31,300	SF				$100.00	$3,130,000	2
County Road Bridges, Concrete (37)	75,100	SF				$100.00	$7,510,000	2
State Highway Bridges (3)	7,300	SF				$150.00	$1,095,000	2
Railroad Bridge (1)	58	LF	95	226	$900.00	$2,141.05	$124,181	1
SUBTOTAL RELOCATION OF EXISTING PROPERTY							$11,859,181	
Structures and Improvements								
Canal Fencing (Wire Mesh)	257,664	LF				$5.00	$1,288,320	2
Canal Fencing (Chain Link)	96,096	LF				$10.00	$960,960	2
Allowance for Unlisted Items (5%)							$112,464	
SUBTOTAL STRUCTURES AND IMPROVEMENTS							$2,361,744	
Waterways								
Excavation	3,594,000	CY				$2.00	$7,188,000	2
Compacted Embankment	259,000	CY				$0.80	$207,200	2
Preparing Foundation for Concrete Lining	1,124,000	CY				$1.00	$1,124,000	2
Concrete Lining	93,000	CY				$80.00	$7,440,000	2
Allowance for Unlisted Items (5%)							$797,960	
SUBTOTAL WATERWAYS							$16,757,160	
Canal Structures								
Tule River Siphon								
Concrete	2,400	CY				$600.00	$1,440,000	2
Allowance for Unlisted Items (5%)							$72,000	
Outlet to White River:								
Concrete	85	CY				$600.00	$51,000	2
Radial Gates with Hoists	162	SF	75	213	$120.00	$340.80	$55,210	1
Allowance for Unlisted Items (5%)							$5,310	
Check Structures	2	EA	75	213	$40,000.00	$113,600.00	$227,200	1
Culverts and Overchutes:								
Concrete	26,000	CY				$600.00	$15,600,000	2
Allowance for Unlisted Items (5%)							$780,000	
Operating Roads-Asphalt Paved	67	MI	75	237	$35,000.00	$110,600.00	$7,410,200	1
SUBTOTAL CANAL STRUCTURES							$25,640,920	
SUBTOTAL MID-VALLEY CANAL REACH 4							$59,151,005	

Table 2
ESTIMATED COSTS
MID-VALLEY CANAL

DESCRIPTION	QUANTITY	UNIT	USBR INDEX	USBR INDEX OCT. 1996	UNIT COST	UNIT COST OCT. 1996	TOTAL COST OCT. 1996	COST REF.
VIII. MID-VALLEY PUMPING PLANT NO. 1			**OCT. 1974**		**OCT. 1974**			
Structures and Improvements	JOB	LS	82	209	$1,816,000.00	$4,628,585.00	$4,628,585	1
Waterways	JOB	LS	82	209	$1,508,100.00	$3,843,816.00	$3,843,816	1
Accessory Electrical Equipment	JOB	LS	85	216	$330,000.00	$838,588.00	$838,588	1
Miscellaneous Equipment	JOB	LS	85	216	$139,760.00	$355,155.00	$355,155	1
Roads, Railroads, and Bridges	JOB	LS	81	226	$160,000.00	$446,420.00	$446,420	1
Pumps and Prime Movers	JOB	LS	78	228	$1,175,566.00	$3,436,270.00	$3,436,270	1
Switchyard and Substation	JOB	LS	85	216	$153,000.00	$388,800.00	$388,800	1
SUBTOTAL MID-VALLEY PUMPING PLANT NO. 1							$13,937,634	
IX. MID-VALLEY PUMPING PLANT NO. 2			**OCT. 1974**		**OCT. 1974**			
Structures and Improvements	JOB	LS	82	209	$1,816,000.00	$4,628,585.00	$4,628,585	1
Waterways	JOB	LS	82	209	$1,243,700.00	$3,169,918.00	$3,169,918	1
Accessory Electrical Equipment	JOB	LS	85	216	$340,000.00	$864,000.00	$864,000	1
Miscellaneous Equipment	JOB	LS	85	216	$163,760.00	$416,143.00	$416,143	1
Roads, Railroads, and Bridges	JOB	LS	81	226	$250,000.00	$697,531.00	$697,531	1
Pumps and Prime Movers	JOB	LS	78	228	$1,205,566.00	$3,523,962.00	$3,523,962	1
Switchyard and Substation	JOB	LS	85	216	$153,000.00	$388,800.00	$388,800	1
SUBTOTAL MID-VALLEY PUMPING PLANT NO. 2							$13,688,939	
X. MID-VALLEY PUMPING PLANT NO. 3			**OCT. 1974**		**OCT. 1974**			
Structures and Improvements	JOB	LS	82	209	$1,832,600.00	$4,670,895.00	$4,670,895	1
Waterways	JOB	LS	82	209	$1,280,000.00	$3,262,439.00	$3,262,439	1
Accessory Electrical Equipment	JOB	LS	85	216	$380,000.00	$965,647.00	$965,647	1
Miscellaneous Equipment	JOB	LS	85	216	$163,760.00	$416,143.00	$416,143	1
Roads, Railroads, and Bridges	JOB	LS	81	226	$160,000.00	$446,420.00	$446,420	1
Pumps and Prime Movers	JOB	LS	78	228	$1,250,566.00	$3,655,501.00	$3,655,501	1
Switchyard and Substation	JOB	LS	85	216	$259,000.00	$658,165.00	$658,165	1
SUBTOTAL MID-VALLEY PUMPING PLANT NO. 3							$14,075,210	
XI. MID-VALLEY PUMPING PLANT NO.4			**OCT. 1974**		**OCT. 1974**			
Structures and Improvements	JOB	LS	82	209	$1,583,400.00	$4,035,739.00	$4,035,739	1
Waterways	JOB	LS	82	209	$1,035,000.00	$2,637,988.00	$2,637,988	1
Accessory Electrical Equipment	JOB	LS	85	216	$320,000.00	$813,176.00	$813,176	1
Miscellaneous Equipment	JOB	LS	85	216	$159,820.00	$406,131.00	$406,131	1
Roads, Railroads, and Bridges	JOB	LS	81	226	$100,000.00	$279,012.00	$279,012	1
Pumps and Prime Movers	JOB	LS	78	228	$1,078,444.00	$3,152,375.00	$3,152,375	1
Switchyard and Substation	JOB	LS	85	216	$159,000.00	$404,047.00	$404,047	1
SUBTOTAL MID-VALLEY PUMPING PLANT NO. 4							$11,728,468	

Table 2
ESTIMATED COSTS
MID-VALLEY CANAL

DESCRIPTION	QUANTITY	UNIT	USBR INDEX	USBR INDEX OCT. 1996	UNIT COST	UNIT COST OCT. 1996	TOTAL COST OCT. 1996	COST REF.
XII. MID-VALLEY PUMPING PLANT NO. 5			**OCT. 1974**		**OCT. 1974**			
Structures and Improvements	JOB	LS	82	209	$1,577,700.00	$4,021,211.00	$4,021,211	1
Waterways	JOB	LS	82	209	$1,133,100.00	$2,888,023.00	$2,888,023	1
Accessory Electrical Equipment	JOB	LS	85	216	$280,000.00	$711,529.00	$711,529	1
Miscellaneous Equipment	JOB	LS	85	216	$159,820.00	$406,131.00	$406,131	1
Roads, Railroads, and Bridges	JOB	LS	81	226	$100,000.00	$279,012.00	$279,012	1
Pumps and Prime Movers	JOB	LS	78	228	$1,027,444.00	$3,003,298.00	$3,003,298	1
Switchyard and Substation	JOB	LS	85	216	$170,600.00	$433,525.00	$433,525	1
SUBTOTAL MID-VALLEY PUMPING PLANT NO. 5							$11,742,729	
XIII. MID-VALLEY PUMPING PLANT NO. 6			**OCT. 1974**		**OCT. 1974**			
Structures and Improvements	JOB	LS	82	209	$1,529,200.00	$3,897,595.00	$3,897,595	1
Waterways	JOB	LS	82	209	$904,000.00	$2,304,098.00	$2,304,098	1
Accessory Electrical Equipment	JOB	LS	85	216	$92,500.00	$235,059.00	$235,059	1
Miscellaneous Equipment	JOB	LS	85	216	$159,820.00	$406,131.00	$406,131	1
Roads, Railroads, and Bridges	JOB	LS	81	226	$100,000.00	$279,012.00	$279,012	1
Pumps and Prime Movers	JOB	LS	78	228	$516,563.00	$1,509,953.00	$1,509,953	1
Switchyard and Substation	JOB	LS	85	216	$108,000.00	$274,447.00	$274,447	1
SUBTOTAL MID-VALLEY PUMPING PLANT NO. 6							$8,906,295	
XIV. MID-VALLEY PUMPING PLANT NO. 7			**OCT. 1974**		**OCT. 1974**			
Structures and Improvements	JOB	LS	82	209	$1,354,508.00	$3,452,344.00	$3,452,344	1
Waterways	JOB	LS	82	209	$526,032.00	$1,340,740.00	$1,340,740	1
Accessory Electrical Equipment	JOB	LS	85	216	$122,000.00	$310,024.00	$310,024	1
Miscellaneous Equipment	JOB	LS	85	216	$105,490.00	$268,069.00	$268,069	1
Roads, Railroads, and Bridges	JOB	LS	81	226	$100,000.00	$279,012.00	$279,012	1
Pumps and Prime Movers	JOB	LS	78	228	$459,108.00	$1,342,008.00	$1,342,008	1
Switchyard and Substation	JOB	LS	85	216	$95,600.00	$242,936.00	$242,936	1
SUBTOTAL MID-VALLEY PUMPING PLANT NO. 7							$7,235,133	
XV. NORTH BRANCH CANAL - FROM MENDOTA POOL TO DEADMAN CREEK, DESIGN CAPACITY 240 CFS TO 500 CFS			**JUL. 1974**		**JUL. 1974**			
Land and Rights	880	AC				$3,000.00	$2,640,000	2
Relocation of Existing Property								
Farm Bridges, Concrete (34)	41,000	SF				$100.00	$4,100,000	2
County Road Bridges, Concrete (7)	13,950	SF				$100.00	$1,395,000	2
State Highway Bridges, Concrete (2)	4,780	SF				$150.00	$717,000	2
Replace Road Pavement and Detours	8	EA	75	219	$6,000.00	$17,520.00	$140,160	1
Irrigation Crossings	2	EA	75	213	$2,000.00	$5,680.00	$11,360	1
SUBTOTAL RELOCATION OF EXISTING PROPERTY							$6,363,520	

Table 2
ESTIMATED COSTS
MID-VALLEY CANAL

DESCRIPTION	QUANTITY	UNIT	USBR INDEX	USBR INDEX OCT. 1996	UNIT COST	UNIT COST OCT. 1996	TOTAL COST OCT. 1996	COST REF.
Structures and Improvements:								
Canal Fencing (Wire Mesh)	264,000	LF				$5.00	$1,320,000	2
Canal Fencing (Chain Link)	95,040	LF				$10.00	$950,400	2
Allowance for Unlisted Items (5%)							$113,520	
SUBTOTAL STRUCTURES AND IMPROVEMENTS							$2,383,920	
Waterways								
Dredging	500,000	CY				$2.00	$1,000,000	2
Excavation	1,793,000	CY				$2.00	$3,586,000	2
Compacted Embankment	1,023,000	CY				$0.80	$818,400	2
Preparing Foundation for Concrete Lining	789,000	CY				$1.00	$789,000	2
Overhaul	585,000	MY	77	181	$0.25	$0.59	$345,150	1
Concrete Lining	66,000	CY				$80.00	$5,280,000	2
Safety Ladders	65	EA	75	213	$200.00	$616.00	$40,040	1
Allowance for Unlisted Items (5%)							$592,930	
SUBTOTAL WATERWAYS							$12,451,520	
Canal Structures								
Intake Structure								
Concrete	80	CY				$600.00	$48,000	2
Riprap	100	CY				$30.00	$3,000	2
Sand and Gravel Bedding	30	CY				$30.00	$900	2
Allowance for Unlisted Items (5%)							$2,595	
Siphons								
Concrete	4,000	CY				$600.00	$2,400,000	2
Gates and Hoists	16,000	LB				$5.00	$80,000	2
Jacking 84" Dia. Pipe	4,000	LB				$5.00	$20,000	2
Allowance for Unlisted Items (5%)	330	LF				$1,512.00	$498,960	2
Outlet Structure								
Concrete	60	CY				$600.00	$36,000	2
Riprap	200	CY				$30.00	$6,000	2
Sand and Gravel Bedding	65	CY				$30.00	$1,950	2
Gates and Hoists	4,000	LB				$5.00	$20,000	2
Miscellaneous Metal Work	1,000	LB				$5.00	$5,000	2
Allowance for Unlisted Items (5%)							$3,448	
Culverts and Overchutes								
Concrete	3,900	CY				$600.00	$2,340,000	2
Riprap	1,700	CY				$30.00	$51,000	2
Sand and Gravel Bedding	600	CY				$30.00	$18,000	2
Hauling Spoil	39,000	MY	77	181	$0.25	$0.59	$23,010	1

Table 2
ESTIMATED COSTS
MID-VALLEY CANAL

DESCRIPTION	QUANTITY	UNIT	USBR INDEX	USBR INDEX OCT. 1996	UNIT COST	UNIT COST OCT. 1996	TOTAL COST OCT. 1996	COST REF.
Gates and Hoists	7,600	LB				$5.00	$38,000	2
Miscellaneous Metal Work	2,000	LB				$5.00	$10,000	2
Removing Existing Structure	JOB	LS	75	213	$2,000.00	$5,680.00	$5,680	1
Allowance for Unlisted Items (5%)							$124,285	
Gravel for Operating Road	80,000	CY				$50.00	$4,000,000	
SUBTOTAL CANAL STRUCTURES							$9,735,827	
SUBTOTAL MID-VALLEY CANAL NORTH BRANCH							$33,574,787	
XVI. MID-VALLEY PUMPING PLANT NO. 8			JAN. 1977		JAN. 1977			
Structures and Improvements	JOB	LS	98	209	$1,250,000.00	$2,665,816.00	$2,665,816	1
Waterways	JOB	LS	98	209	$1,200,000.00	$2,559,184.00	$2,559,184	1
Accessory Electrical Equipment	JOB	LS	98	216	$136,000.00	$299,755.00	$299,755	1
Miscellaneous Equipment	JOB	LS	98	216	$121,900.00	$268,678.00	$268,678	1
Roads, Railroads, and Bridges	JOB	LS	98	226	$120,000.00	$276,735.00	$276,735	1
Pumps and Prime Motors	JOB	LS	98	228	$407,935.00	$949,073.00	$949,073	1
Switchyard and Substation	JOB	LS	98	216	$108,000.00	$238,041.00	$238,041	1
SUBTOTAL MID-VALLEY PUMPING PLANT NO. 8							$7,257,282	
XVII. MID-VALLEY PUMPING PLANT NO. 9			JAN. 1977		JAN. 1977			
Structures and Improvements	JOB	LS	98	209	$1,250,000.00	$2,665,816.00	$2,665,816	1
Waterways	JOB	LS	98	209	$460,000.00	$981,020.00	$981,020	1
Accessory Electrical Equipment	JOB	LS	98	216	$105,000.00	$231,429.00	$231,429	1
Miscellaneous Equipment	JOB	LS	98	216	$121,900.00	$268,678.00	$268,678	1
Roads, Railroads, and Bridges	JOB	LS	98	226	$48,000.00	$110,694.00	$110,694	1
Pumps and Prime Motors	JOB	LS	98	228	$396,935.00	$923,481.00	$923,481	1
Switchyard and Substation	JOB	LS	98	216	$108,000.00	$238,041.00	$238,041	1
SUBTOTAL MID-VALLEY PUMPING PLANT NO. 9							$5,419,159	
XVIII MID-VALLEY PUMPING PLANT NO. 10			JAN. 1977		JAN. 1977			
Structures and Improvements	JOB	LS	98	209	$220,000.00	$469,184.00	$469,184	1
Waterways	JOB	LS	98	209	$200,000.00	$426,531.00	$426,531	1
Accessory Electrical Equipment	JOB	LS	98	216	$69,000.00	$152,082.00	$152,082	1
Roads, Railroads, and Bridges	JOB	LS	98	226	$48,000.00	$110,694.00	$110,694	1
Pumps and Prime Motors	JOB	LS	98	228	$170,000.00	$395,510.00	$395,510	1
Switchyard and Substation	JOB	LS	98	216	$95,400.00	$210,270.00	$210,270	1
SUBTOTAL MID-VALLEY PUMPING PLANT NO. 10							$1,764,271	
XIX. MID-VALLEY PUMPING PLANT NO. 11			JAN. 1977		JAN. 1977			
Structures and Improvements	JOB	LS	98	209	$220,000.00	$469,184.00	$469,184	1
Waterways	JOB	LS	98	209	$200,000.00	$426,531.00	$426,531	1
Accessory Electrical Equipment	JOB	LS	98	216	$69,000.00	$152,082.00	$152,082	1

Table 2
ESTIMATED COSTS
MID-VALLEY CANAL

DESCRIPTION	QUANTITY	UNIT	USBR INDEX	USBR INDEX OCT. 1996	UNIT COST	UNIT COST OCT. 1996	TOTAL COST OCT. 1996	COST REF.
Roads, Railroads, and Bridges	JOB	LS	98	226	$67,200.00	$154,971.00	$154,971	1
Pumps and Prime Motors	JOB	LS	98	228	$170,000.00	$395,510.00	$395,510	1
Switchyard and Substation	JOB	LS	98	216	$95,400.00	$210,270.00	$210,270	1
SUBTOTAL MID-VALLEY PUMPING PLANT NO. 11							$1,808,548	
XX. GURNSEK SUBSTATION ADDITION			JAN. 1975		JAN. 1975			
Land and Rights	JOB	LS	85	212	$1,000.00	$2,494.00	$2,494	1
Station Equipment	JOB	LS	86	228	$44,800.00	$118,772.00	$118,772	1
SUBTOTAL GURNSEK SUBSTATION ADDITION							$121,266	
XXI. METERING SUBSTATION			JAN. 1975		JAN. 1975			
Station Equipment	JOB	LS	85	212	$23,600.00	$58,861.00	$58,861	1
SUBTOTAL METERING SUBSTATION							$58,861	
XXII. PUMPING PLANT NO. 1 TO PUMPING PLANT NO. 4 TRANSMISSION LINE			JAN. 1975		JAN. 1975			
Poles and Fixtures	JOB	LS	86	209	$264,000.00	$641,581.00	$641,581	1
Overhead Conductors and Devices	JOB	LS	86	209	$216,000.00	$524,930.00	$524,930	1
SUBTOTAL PUMPING PLANT NO. 1 TO PUMPING PLANT NO. 4 TRANSMISSION LINE							$1,166,511	
XXIII PUMPING PLANT NO. 5 TRANSMISSION LINE			JAN. 1975		JAN. 1975			
Land and Rights	JOB	LS	85	212	$3,000.00	$7,482.00	$7,482	1
Poles and Fixtures	JOB	LS	86	209	$13,000.00	$31,593.00	$31,593	1
Overhead Conductors and Devices	JOB	LS	86	209	$11,000.00	$26,732.00	$26,732	1
SUBTOTAL PUMPING PLANT NO. 5 TRANSMISSION LINE							$65,807	
XXIV GURNSEY TO PUMPING PLANTS NO. 6 AND NO. 7 TRANSMISSION LINE			JAN. 1975		JAN. 1975			
Land and Rights	JOB	LS	85	212	$110,000.00	$274,352.00	$274,352	1
Clearing Land and Right of Way	JOB	LS	85	212	$43,000.00	$107,247.00	$107,247	1
Poles and Fixtures	JOB	LS	86	209	$297,000.00	$721,779.00	$721,779	1
Conductors and Devices	JOB	LS	86	209	$243,000.00	$590,547.00	$590,547	1
SUBTOTAL GURNSEY TO PUMPING PLANTS NO. 6 AND NO. 7 TRANSMISSION LINE							$1,693,925	
XXV. PUMPING PLANT NO. 1 TO PUMPING PLANT NO. 11 TRANSMISSION LINE			JAN. 1975		JAN. 1975			
Poles and Fixtures	JOB	LS	86	212	$363,000.00	$894,837.00	$894,837	1
Overhead Conductors and Devices	JOB	LS	86	209	$297,000.00	$721,779.00	$721,779	1
SUBTOTAL PUMPING PLANT NO. 1 TO PUMPING PLANT NO. 11 TRANSMISSION LINE							$1,616,616	
SUBTOTAL							$557,300,000	
CONTINGENCIES @ 20 %							$111,500,000	
ESTIMATED CONSTRUCTION COST							$668,800,000	

Table 2
ESTIMATED COSTS
MID-VALLEY CANAL

DESCRIPTION	QUANTITY	UNIT	USBR INDEX	USBR INDEX OCT. 1996	UNIT COST	UNIT COST OCT. 1996	TOTAL COST OCT. 1996	COST REF.
ENG., LEGAL, AND ADM. @ 35 %							$234,100,000	
TOTAL CAPITAL COST							$902,900,000	
ESTIMATED CAPITAL COST RANGE								
LOW (-10 %)							$812,600,000	
HIGH (+ 15 %)							$1,038,000,000	

Footnote:

[a]LS=lump sum; CY=cubic yard; LB=pound; LF=linear foot; SF=square foot; MY=mile-yard; EA=each; AC=acre; MI=mile;

Cost References:

1. U.S. Bureau of Reclamation, *Mid-Valley Canal Feasibility Design Criteria and Cost Estimate,* December 1980.
2. Costs Developed by Bookman-Edmonston Engineering.
3. U.S. Bureau of Reclamation, Land Resources Branch, Graham McMullen, February 1997.

Table 3
SUMMARY OF ESTIMATED COSTS
MID-VALLEY CANAL

Cost Item	Estimated Costs ($Million)
Delta-Mendota Canal Intake Facilities	
Intake Canal, DMC Intake Canal Enlargement, and Discharge Pipeline	64.5
Tracy Pumping Plant Additons	21.4
Electrical Transmission Facilities and Miscellaneous	6.3
SUBTOTAL:	92.2
Delta-Mendota Canal Enlargement	
Delta-Mendota Canal Enlargement - (MP 3.5 to 70.0)	97.4
Delta-Mendota Canal Enlargement - (MP 7.0 to 116.61)	54.4
Mendota Pool Enlargement	4.6
Mid-Valley Canal--Reach 2	82.9
Mid-Valley Canal--Reach 3	30.8
Mid-Valley Canal--Reach 4	59.2
Mid-Valley Pumping Plant No. 1	13.9
Mid-Valley Pumping Plant No. 2	13.7
Mid-Valley Pumping Plant No. 3	14.1
Mid-Valley Pumping Plant No. 4	11.7
Mid-Valley Pumping Plant No. 5	11.7
Mid-Valley Pumping Plant No. 6	8.9
Mid-Valley Pumping Plant No. 7	7.2
SUBTOTAL:	410.5
Mid-Valley Canal--North Branch	
North Branch Canal	33.6
Mid-Valley Pumping Plant No. 8	7.2
Mid-Valley Pumping Plant No. 9	5.4
Mid-Valley Pumping Plant No. 10	1.8
Mid-Valley Pumping Plant No. 11	1.8
SUBTOTAL:	49.8
Electrical Transmission Facilities	
Gurnsey Substation Addition and Metering Substation	0.2
Pumping Plant No. 1 to No. 4 Transmission Line	1.2
Pumping Plant No. 5 Transmission Line	0.07
Gurnsey to Pumping Plants No. 6 and No. 7 Transmission Line	1.7
Pumping Plant No. 1 to No. 11 Transmission Line	1.6
SUBTOTAL:	4.8
SUBTOTAL	557.3
Contingencies (20%)	111.5
ESTIMATED CONSTRUCTION COST	668.8
Engineering, Legal, and Project Administration (35%)	234.1
ESTIMATED TOTAL CAPITAL COST	902.9
Capital Cost Range (minus 10% - plus 15%)	$812 - $1,038

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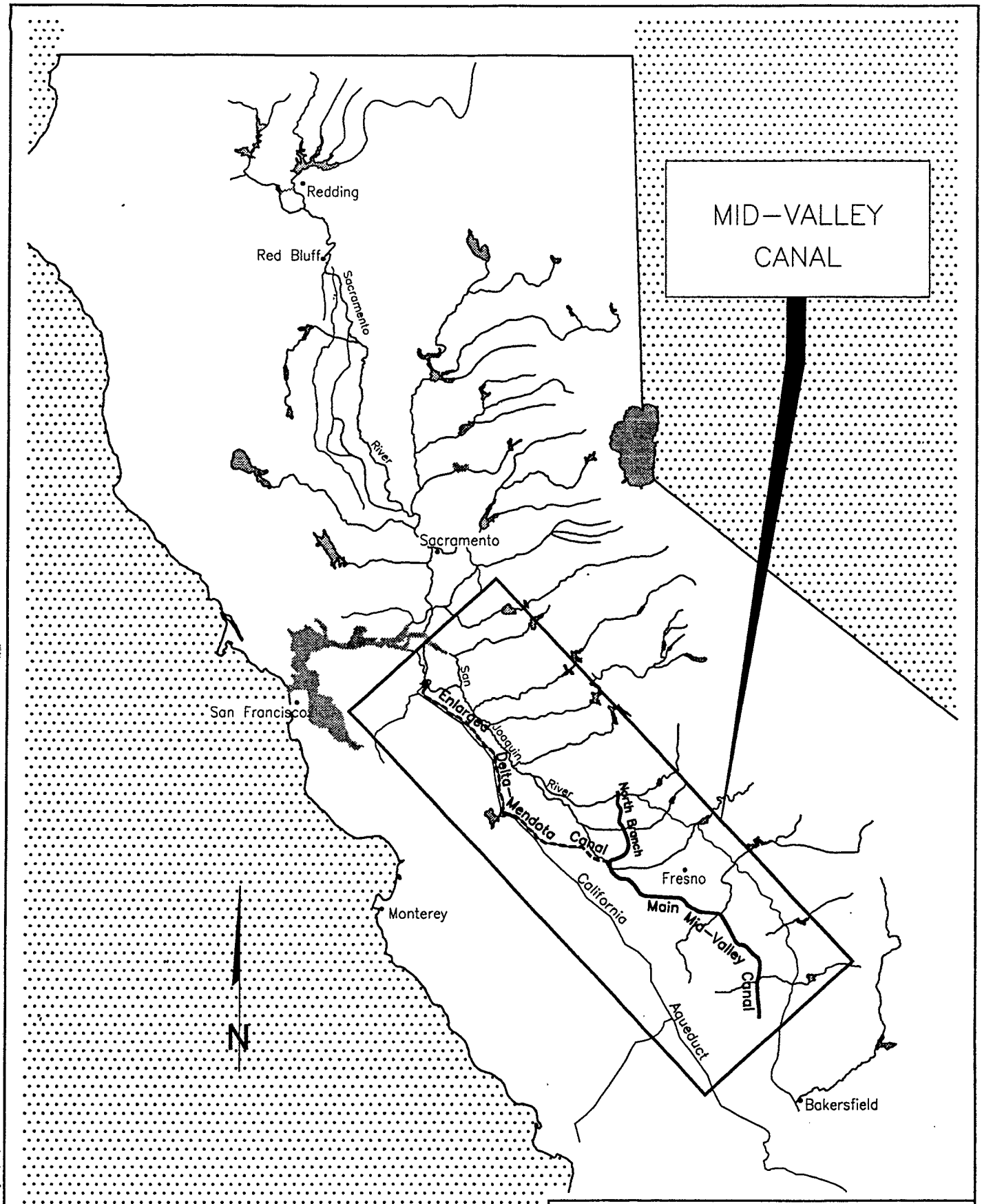

Figure 1

Project Location Map

Mid Valley Canal

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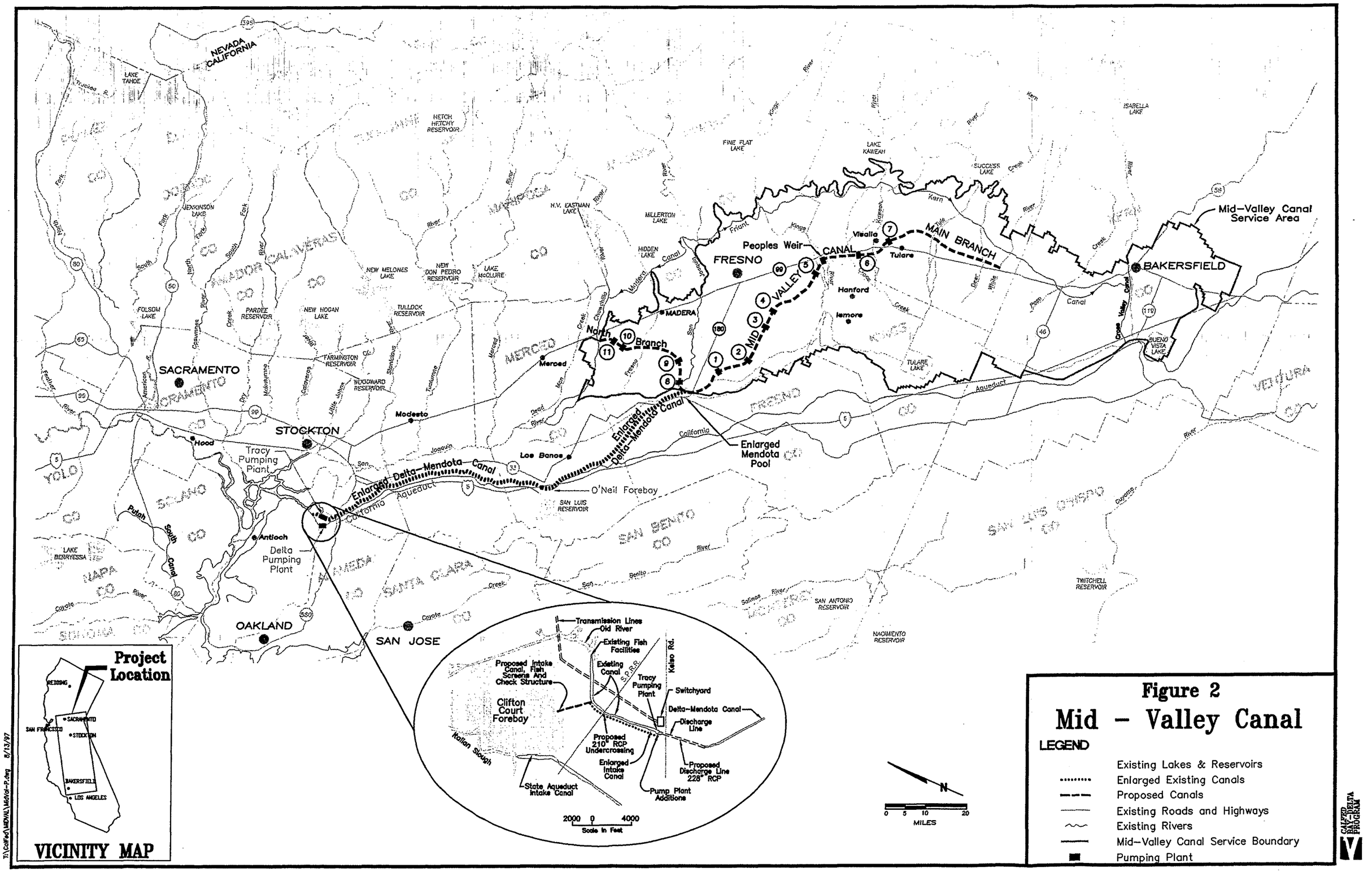

Figure 2
Mid – Valley Canal

LEGEND

- Existing Lakes & Reservoirs
- Enlarged Existing Canals
- Proposed Canals
- Existing Roads and Highways
- Existing Rivers
- Mid–Valley Canal Service Boundary
- Pumping Plant

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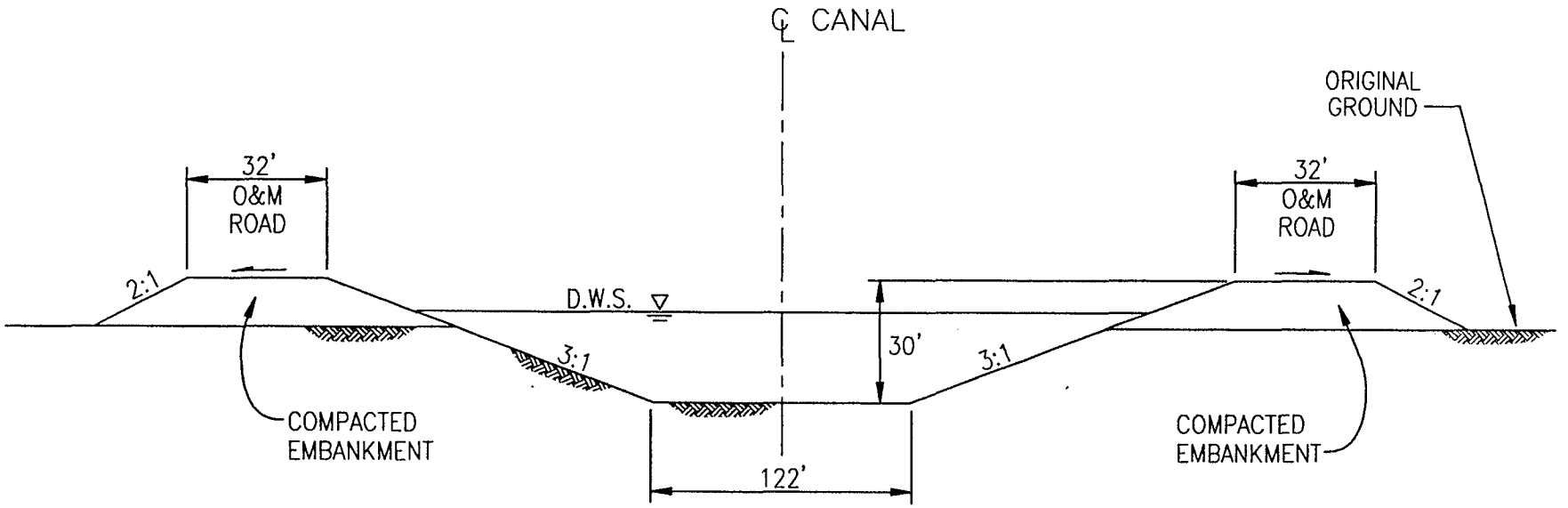

NEW INTAKE CANAL
(From Clifton Court Forebay To
Intersection With Enlarged Existing Canal)
NOT TO SCALE

Figure 3a
Mid-Valley Canal
Typical Canal Section

CALFED BAY-DELTA PROGRAM

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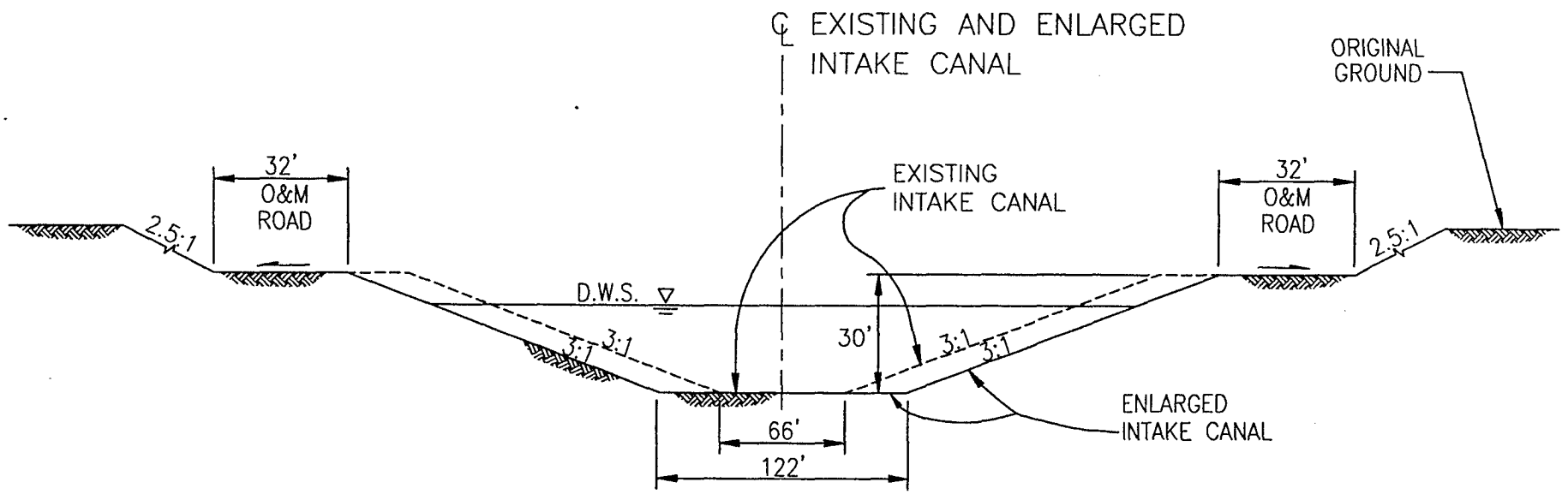

ENLARGEMENT OF A PORTION OF
THE EXISTING INTAKE CANAL
(From Intersection To New Canal
To The Tracy Pumping Plant)
NOT TO SCALE

Figure 3b
Mid-Valley Canal
Typical Canal Section

CALFED BAY-DELTA PROGRAM

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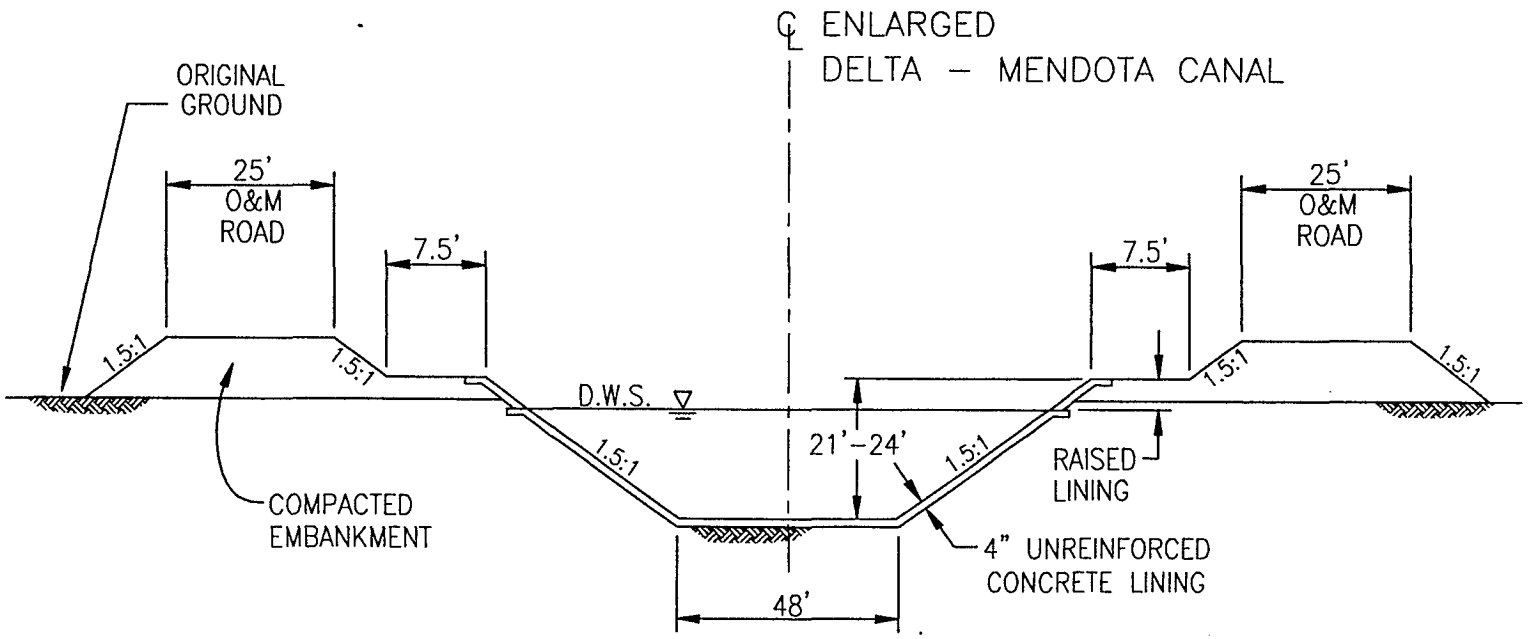

ENLARGED DELTA–MENDOTA CANAL
CONCRETE LINED SECTIONS
NOT TO SCALE

Figure 3c
Mid–Valley Canal
Typical Canal Section

CALFED BAY-DELTA PROGRAM

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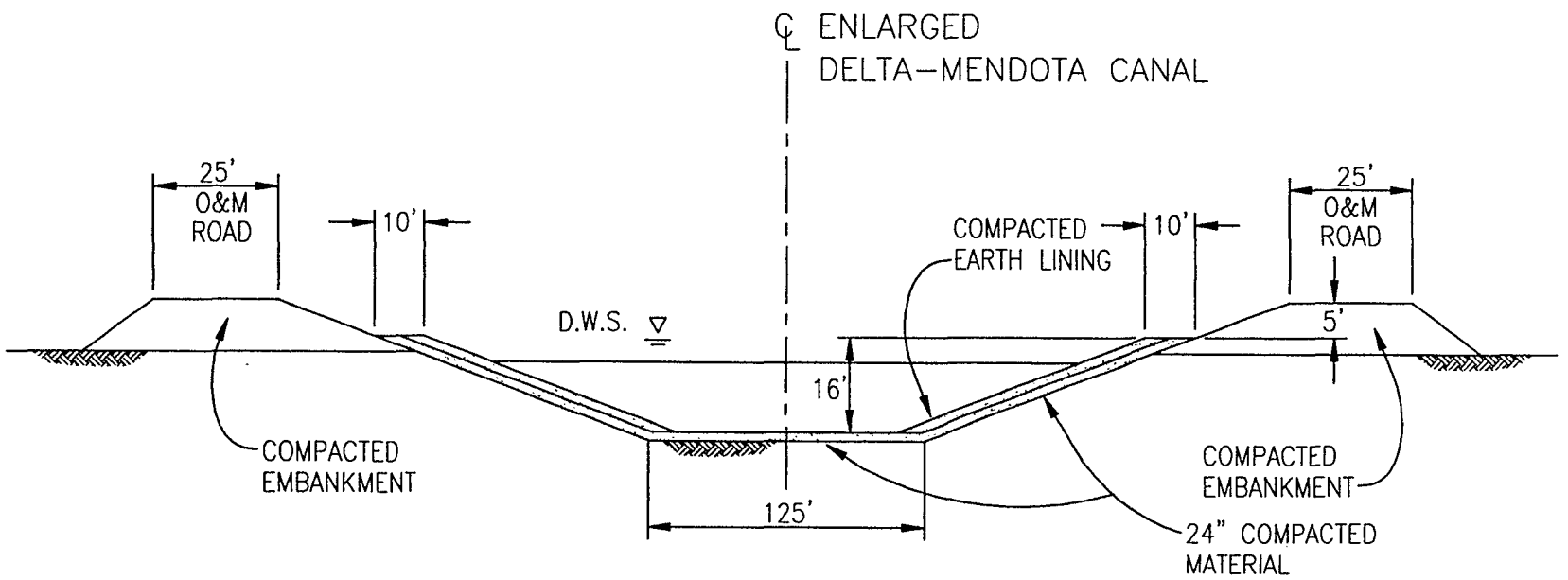


ENLARGED DELTA-MENDOTA CANAL

EARTH LINED SECTIONS

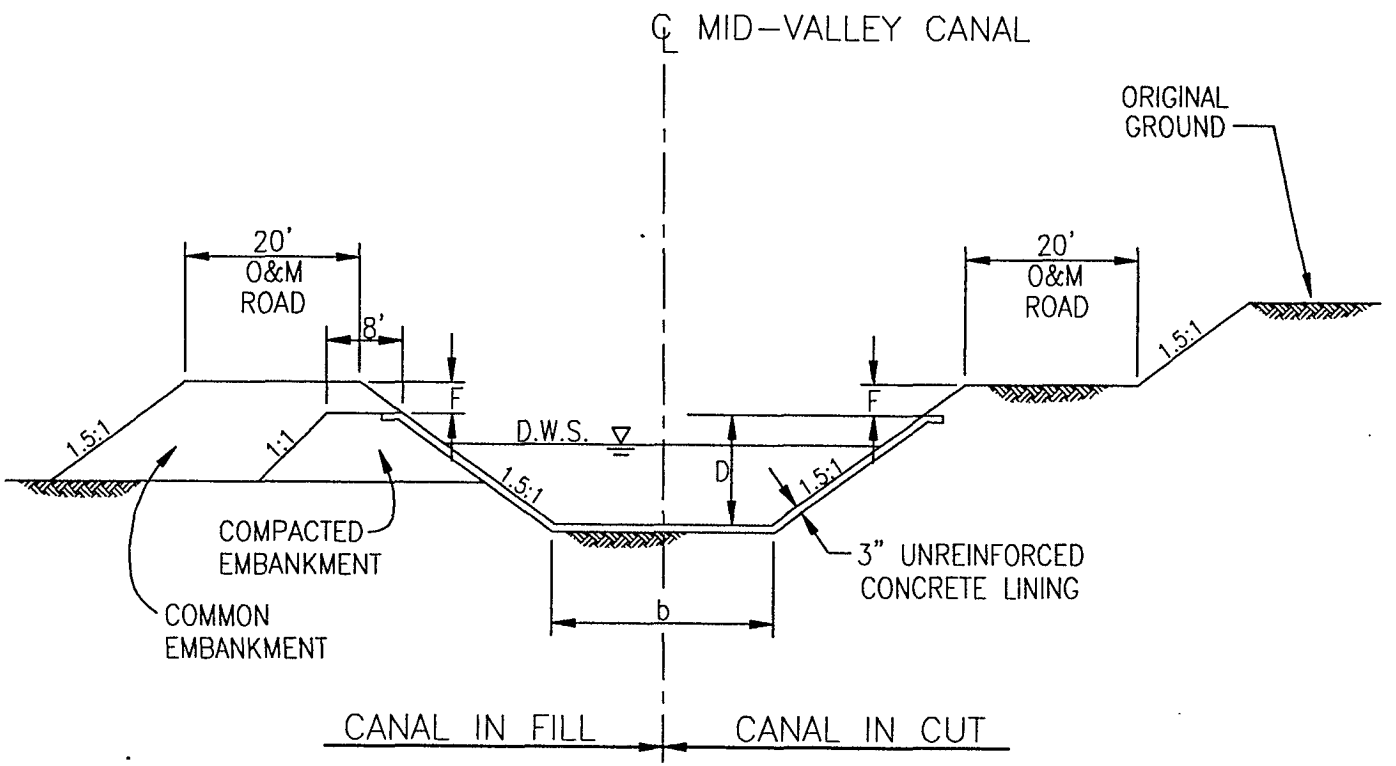
NOT TO SCALE

Figure 3d

Mid-Valley Canal

Typical Canal Section

CALFED BAY-DELTA PROGRAM



MID-VALLEY CANAL MAIN BRANCH
REACHES 2,3,4
NOT TO SCALE

REACH	Q	b	D	F
2	1500 cfs	22'	14.85'	3.9'
	1200 cfs	20'	13.74'	3.7'
3	1200 cfs	20'	13.74'	2.0'
4	700 cfs	20'	10.55'	1.9'

Figure 3e

Mid-Valley Canal
Typical Canal Section

CALFED BAY-DELTA PROGRAM

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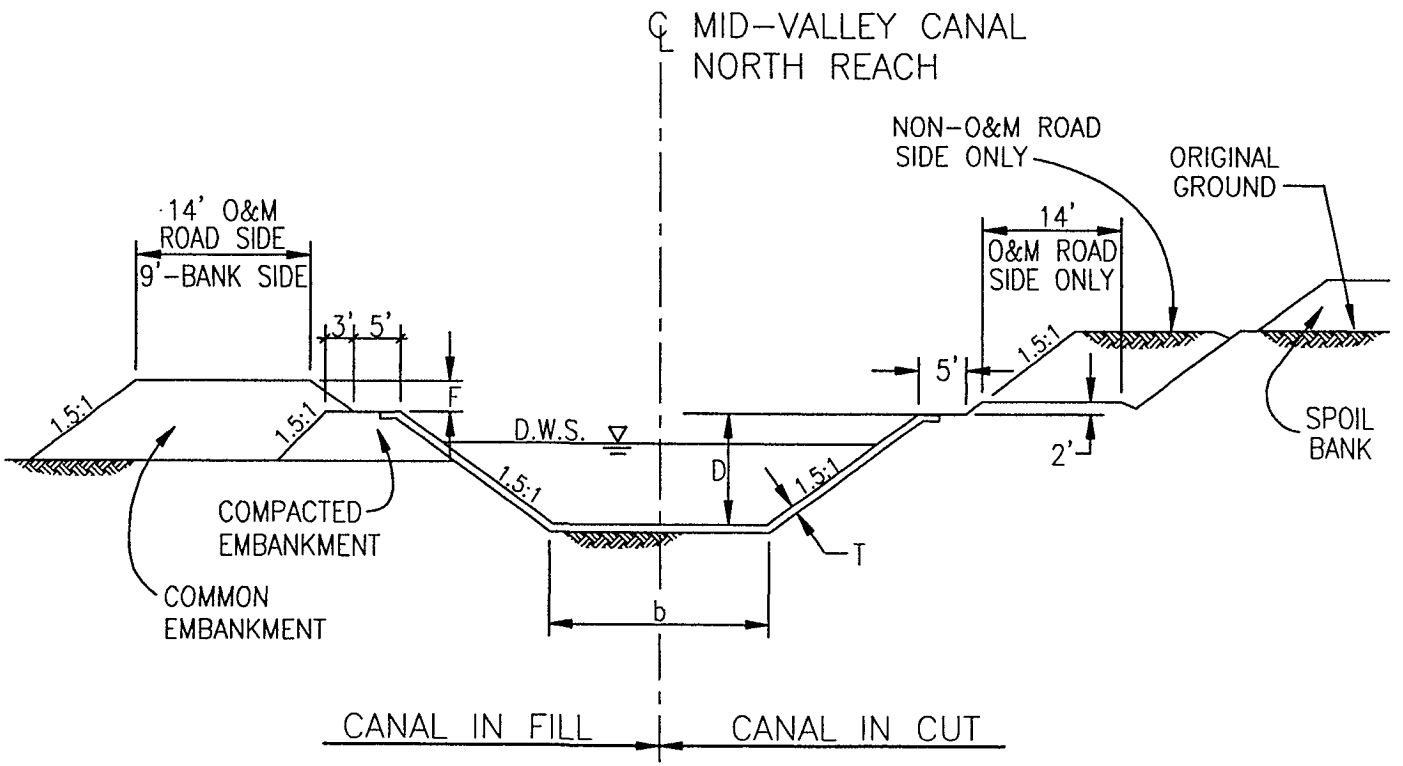

MID-VALLEY CANAL
NORTH BRANCH
NOT TO SCALE

Q	b	D	F	T
500 cfs	12'	9'	–	3"
500 cfs	12'	9'	3.5'	3"
240 cfs	10'	7'	3.5'	2"

Figure 3f
Mid-Valley Canal
Typical Canal Section

CALFED BAY-DELTA PROGRAM

D-008645

FACILITY DESCRIPTIONS AND COST ESTIMATES FOR THE RED BLUFF DIVERSION AND TEHAMA-COLUSA CANAL ENLARGEMENT

Prepared by the CALFED Storage and Conveyance Refinement Team
October 1997

D-008646

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INTRODUCTION

The *Facility Descriptions and Cost Estimates for the Red Bluff Diversion and Tehama-Colusa Canal Enlargement* 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 to restore 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 enlarging the Red Bluff Diversion and the Tehama-Colusa (T-C) Canal. The general location of these existing facilities is shown in Figure 1. This project would increase the diversion capacity of the Red Bluff Diversion from the Sacramento River and the conveyance capacity of the T-C Canal from the diversion to Funks Reservoir to 5,000 cubic-feet-per-second (cfs). This evaluation describes two alternatives for increasing the diversion capacity of the Red Bluff Diversion and two alternatives for increasing the conveyance capacity of the T-C Canal.

This evaluation and others being performed by CALFED are intended to provide facility descriptions and cost estimates of representative storage and conveyance components. The objectives of this evaluation are to (1) provide an updated cost estimate that represents a cost that is within the range to be expected if this project were to be constructed today, and (2) enable CALFED to equally compare this project against other projects that might be considered as part of a long-term CALFED solution strategy.

The cost estimates for increasing the capacity of the Red Bluff Diversion and the T-C Canal were developed from original work prepared by Bookman-Edmonston Engineering and from information provided by the U.S. Bureau of Reclamation (Reclamation). Where previously

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estimated or actual costs were used, current costs were determined by applying Construction Cost Trend (CCT) indices developed by Reclamation.

A preliminary evaluation of the environmental considerations associated with this proposed project has been 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 the evaluation of environmental considerations was gathered from existing literature and databases.

PROJECT BACKGROUND

In 1950, the T-C Canal was authorized as part of the Sacramento Canals Unit of the Central Valley Project (CVP) by Public Law (PL) 81-839. The Red Bluff Diversion Dam, located approximately 2 miles southeast of Red Bluff, was completed in 1964 as a component of the CVP to divert flows from the Sacramento River for the T-C and Corning Canals. The Corning Canal was completed in 1959. From 1950 to 1963, however, there was an insufficient number of water delivery contracts signed to warrant construction of the T-C Canal. In 1964, enough contracts had been signed to defray the annual operating and maintenance costs assigned to the T-C Canal and construction of the T-C Canal began in 1965. In August 1967, PL 90-65 amended PL 81-839 to increase the capacity of the 44-mile section of the T-C Canal from Funks Creek to Bird Creek to enable future water service to Yolo, Solano, Lake, and Napa Counties. The T-C Canal was completed to its present terminus, Bird Creek, in 1984.

The T-C Canal is 111 miles long, extending from the Red Bluff Diversion Dam on the Sacramento River in the north to Bird Creek in Yolo County in the south. The capacity of the canal at the diversion dam is 2,530 cubic feet per second (cfs); it diminishes to 1,700 cfs at the terminus. Funks Reservoir, located at about mile 67 of the canal, is the only regulating facility on the canal.

The T-C and Corning Canal systems are owned by Reclamation, but operated and maintained as part of the CVP by the Tehama-Colusa Canal Authority (TCCA). The TCCA was formed as a Joint Powers Agency of ten water districts in September 1987 and took over operations and maintenance of the T-C and Corning Canal systems pursuant to a cooperative agreement with Reclamation in November 1988.

The T-C Canal has been identified in previous investigations as a component of conveyance facilities which could serve Sacramento River water to proposed off-stream storage reservoirs on the west side of the Sacramento Valley. However, none of the previous investigations formally investigated the enlargement of the existing Red Bluff Diversion or the T-C Canal structures. Previous investigations, particularly those involving the proposed Sites Reservoir, assumed that the entire capacity of the T-C Canal could be used to convey water to off-stream storage reservoirs during non-irrigation periods. Therefore, no previous investigations have been identified which describe the enlargement of the existing T-C Canal facilities.

The Red Bluff Diversion Dam is a principle feature of the Sacramento Canals Unit of the CVP. The dam is composed of concrete overflow weir sections with radial gates. When the gates are in the lowered position, the dam impounds the Sacramento River to form Red Bluff Reservoir, which in turn creates the hydraulic head necessary to divert water through the Red Bluff Diversion and into the T-C and Corning Canals. The weir gates of the dam are typically lowered for diversions from May 15 through September 15 each year. When the weir gates are in the lowered position, two fish ladders on each abutment of the dam provide for fish passage around the dam. During the remaining portion of year, the weir gates are maintained in the raised position to allow unimpeded passage of winter run chinook salmon and other migrating fish on the Sacramento River. When the weir gates are raised, five pumping units pump water from the Sacramento River into the settling basin of T-C Canal intake. The pumps provide a maximum supply of 125 cfs.

The Red Bluff Diversion Dam has been the subject of many investigations regarding fish passage during the period when diversions are taking place. Reclamation and the U.S. Fish and Wildlife Service (USFWS) have been responsible for a majority of the fish passage studies and Reclamation is continuing investigation of alternative diversion methods at the Research Pumping Plant Project located within the Red Bluff Diversion Dam complex. The fish passage investigations performed by Reclamation and the USFWS have focused on improving the fish passage capabilities at the Red Bluff Diversion Dam.

The Red Bluff Diversion Dam Fish Passage Program (Program), a coordinated effort by Reclamation, USFWS, the National Marine Fisheries Service (NWFS), and the California Department of Fish and Game (DFG), was undertaken to develop solutions to identify causes of declines in anadromous fish populations attributable to the Red Bluff Diversion Dam. The identified causes included:

1. Delays to spawning salmonids upon encountering Red Bluff Diversion Dam,
2. Predation of juvenile salmon migrating downstream through Red Bluff Reservoir,
3. Damage to juvenile salmon migrating downstream past the Red Bluff Diversion Dam,
4. Predation on juvenile salmon downstream of Red Bluff Diversion, and
5. Passage of juvenile salmon into the T-C Canal fish facilities.

The Program in its *Appraisal Report: Red Bluff Diversion Dam Fish Passage Program*, released in February 1992, identified a number of alternatives for improving fish passage at the diversion dam. Table 1 lists the alternatives developed by the Program and other alternatives that have been identified by the TCCA and others.

Increasing the diversion capacity of the Red Bluff Diversion, as is examined within this report, in all likelihood would compound the fish passage problems at the Red Bluff Diversion Dam if the current fish passage facilities are not improved. Information gathered

from previous investigations and from meetings with the TCCA and fishery experts were used to develop two alternatives for improving fish passage at the diversion while accommodating both an increase in the diversion capacity and an extended period of diversion.

FACILITIES DESCRIPTION

Increasing the capacity of the Red Bluff Diversion and the T-C Canal would be undertaken in conjunction with the development of new off-stream storage reservoirs on the west side of the Sacramento Valley. Two such reservoirs being evaluated by CALFED are the Sites/Colusa Reservoir and the Lake Berryessa Enlargement (see *Facility Descriptions and Updated Cost Estimates for Sites/Colusa Reservoir Project* and *Facility Descriptions and Updated Cost Estimates for Lake Berryessa Enlargement).*

Increasing the capacity of the Red Bluff Diversion would allow a greater volume of available Sacramento River flows to be diverted into a new off-stream storage reservoir. The present evaluation considers two alternatives that could be implemented to allow increased diversions over a longer diversion period, while also improving the fish passage conditions that presently exist at the Red Bluff Diversion Dam. These two alternatives are:

The Fish Ladder Alternative. Construction of a 3,000 cfs capacity fish ladder on the left abutment of the dam and an increased intake capacity at the headworks of the T-C Canal to 5,000 cfs. This alternative could allow the dam's weir gates to be in the lowered position beyond the May 15 through September 15 period to allow diversions to take place when excess flows are available in the Sacramento River.

The Pumping Plant Alternative. Construction of a 5,000 cfs pumping plant immediately downstream of the dam on its right abutment. This alternative would

allow diversions to take place without lowering the dam's weir gates or impeding fishing passage.

These two alternatives are considered representative of the types of alternatives that could be implemented at the Red Bluff Diversion Dam to allow increased diversions from the Sacramento River. As Table 1 indicates, many more alternatives have been considered, as well as variations of the two alternatives considered here. Before a final solution to the fish passage problems at the Red Bluff Diversion Dam is chosen, more detailed investigations should be undertaken. The two alternatives considered for this evaluation were chosen because they were thought to represent reasonable alternatives that would therefore provide reasonable cost estimates for implementing a solution to the fish passage problem at the Red Bluff Diversion Dam.

Enlarging the T-C Canal could be accomplished by enlarging the existing canal structure, the Enlarged Canal Alternative, or by constructing a parallel canal, the Parallel Canal Alternative. The conveyance capacity of the T-C Canal would be increased, in either alternative, between the Red Bluff Diversion and Funks Reservoir. Funks Reservoir is part of the T-C Canal located at canal mile 67 about 5 miles west of the town of Maxwell in Colusa County. The Sites/Colusa Reservoir would utilize Funks Reservoir as the intake forebay for water conveyed through the T-C Canal. The Lake Berryessa Enlargement would require that the T-C Canal be enlarged from Funks Reservoir to its terminus at Bird Creek in Yolo County and extended to connect to the conveyance facilities associated with the enlargement of Lake Berryessa near Putah Creek in western Yolo County. The enlargement and extension of the T-C Canal, beyond Funks Reservoir, is the subject of an additional evaluation by CALFED titled *Facility Descriptions and Updated Cost Estimates for Tehama-Colusa Canal Extension.*

The following sections describe the existing facilities of the Red Bluff Diversion Dam and T-C Canal and a later section describes the proposed facilities associated with the Red Bluff Diversion and T-C Canal Enlargement. Table 2 provides a comparison of the physical characteristics of the existing and enlarged Red Bluff Diversion and T-C Canal. Figures 2a and 2b show the location of the project features of the Red Bluff Diversion and T-C Canal Enlargement.

EXISTING FACILITIES

The existing T-C Canal and its related facilities extend for over 111 miles from the Red Bluff Diversion Dam in Tehama County to the terminus at Bird Creek in Yolo County. From north to south, some of the major facilities include the Red Bluff Diversion Dam, the T-C Canal Fish Screens and Bypass Facilities, the T-C Canal, and Funks Reservoir.

Red Bluff Diversion Dam

The Red Bluff Diversion Dam was authorized as part of Sacramento Canals Unit in 1950; construction was completed in August 1964. The primary purpose of the diversion dam is to create the necessary hydraulic head to allow gravity diversions from the Sacramento River into the T-C and Corning Canals. The headworks of the T-C Canal have a capacity of 3,030 cfs.

The Red Bluff Diversion Dam consists of 11 concrete overflow weir sections 60 feet wide, a concrete sluiceway 60 feet wide, the headworks to the T-C Canal, fishways at both abutments of the dam, and low earth dikes on each abutment (see Figure 2a). The river control at this facility is created by 11 fixed wheel gates, 60 feet wide by 18 feet tall. When the gates are lowered, water is impounded upstream of the dam to a depth of 17.5 feet, creating Red Bluff Reservoir, which has a storage capacity of about 3,900 acre-feet. Current operating

procedures are to lower the gates from May 15 to September 15 to divert water to meet agricultural water demands on the T-C and Corning Canals.

Tehama-Colusa Canal Fish Screens and Bypass Facilities

The T-C Canal Fish Screens and Bypass Facilities allow water to be diverted from the Sacramento River while minimizing harm to fish that may be present. The fish screens consist of 32 rotating drums covered with a specially designed stainless steel woven wire screen. Fish entering the settling basin are prevented from entering the canal by the slowly rotating drums and are collected in bypass pipes and returned to the center of the Sacramento River downstream of the dam. The drums are set diagonally across the settling basin and are arranged in four groups of eight. The drums are 18 feet, 9 inches in diameter by 12 feet wide. The slots in the wire screen are small enough to keep fish less than 1/4-inch-wide from slipping through. The screens rotate at a rate of one turn each five minutes.

Tehama-Colusa Canal

Sacramento River water diverted into the T-C Canal first enters into a ½-mile-long settling basin through six radial gates at the headworks of the canal. The settling basin allows sediments carried in the river water to settle out before the water is channeled into the intake of the T-C Canal or the Corning Canal Pumping Plant.

There are eight individual reaches along the 111 miles of the T-C Canal from the Red Bluff Diversion Dam to its terminus at Bird Creek. The capacity of the canal decreases from 2,530 cfs at Reach 1 to 1,700 cfs at Reach 8. The reaches are generally identified by major drainage or creek crossings at the ends of each reach. From north to south, the eight reaches include:

- Reach 1 - Red Bluff Diversion Dam to Thomes Creek
- Reach 2 - Thomes Creek to Stony Creek
- Reach 3 - Stony Creek to Wilson Creek
- Reach 4 - Wilson Creek to Logan Creek
- Reach 5 - Logan Creek to Funks Reservoir
- Reach 6 - Funks Reservoir to Freshwater Creek
- Reach 7 - Freshwater Creek to Elk Creek
- Reach 8 - Elk Creek to Bird Creek.

The T-C Canal Enlargement would be located on the northern end of the existing T-C Canal between the Red Bluff Diversion Dam and Funks Reservoir. Therefore, this evaluation is focused only on Reaches 1 through 5. A summary of the physical characteristics is provided for Reaches 1 through 5 on Table 2.

Funks Reservoir

Funks Reservoir was constructed by Reclamation in 1975 and is a major component of the T-C Canal. The dam and reservoir is located in Colusa County at mile 67 of the canal. Funks Reservoir regulates the irrigation flows in the T-C Canal, which would otherwise be spilled due to fluctuations in irrigation demands or would lower the surface water elevation in the canal prism due to delays in flows from the Red Bluff Diversion. The T-C Canal flows into the reservoir near the north end of the dam through a check structure and irrigation flows are released from a check structure into the canal at the south end of the reservoir.

The earth dam that forms Funks Reservoir is 34 feet high and 1,500 feet long. The reservoir has a storage capacity of about 2,200 acre-feet when full or about 2,000 acre-feet at the maximum operating elevation of 205.2 feet above mean sea level (MSL). The reservoir inundates about 220 acres at full capacity. The spillway of the reservoir is controlled by three

hydraulicly operated radial gates, each 25 feet long. The capacity of the spillway is in excess of 25,000 cfs.

PROJECT DESCRIPTION

The evaluation focuses on increasing the diversion and conveyance capacity of the Red Bluff Diversion and the T-C Canal, respectively, to 5,000 cfs. The two alternatives for increasing the diversion capacity are:

The Fish Ladder Alternative. Constructing a 3,000 cfs fish ladder on the dam's left abutment and increasing the intake capacity of the T-C Canal to 5,000 cfs.

The Pumping Plant Alternative. Constructing a 5,000 cfs pumping plant immediately downstream of the dam on its right abutment.

Both of these alternatives would include appropriate fish screening facilities. The two alternatives presented for increasing the conveyance capacity of the T-C Canal are:

The Enlarged Canal Alternative. Enlarging the existing canal structure to accommodate a capacity of 5,000 cfs.

The Parallel Canal Alternative. Constructing a parallel canal with a capacity of 3,500 cfs.

Both alternatives for increasing the conveyance capacity of the T-C Canal would take place between the Red Bluff Diversion and Funks Reservoir.

The facilities descriptions and cost estimates for the Fish Ladder Alternative, the Pumping Plant Alternative, and the Enlarged Canal Alternative are based on original work completed

by Bookman-Edmonston Engineering. The facilities descriptions and cost estimates for the Parallel Canal Alternative are based on original contractor bids received by Reclamation for construction of the T-C Canal.

PRINCIPAL FACILITIES

The following section provides a description of the alternative facilities for increasing the capacity of the Red Bluff Diversion and the T-C Canal. A summary of the physical characteristics of these alternatives is shown in Table 2. Two alternatives for increasing the capacity of the Red Bluff Diversion and the T-C Canal are described. This allows for several combinations for increasing the diversion and conveyance capacity of the T-C Canal system. For example, expansion of the T-C Canal structure to accommodate a capacity of 5,000 cfs could be coupled with a new fish ladder and an enlargement of the headworks to 5,000 cfs or with a 5,000 cfs pumping plant. The appropriate coupling of the alternatives presented in this report will not be determined in this report.

Red Bluff Diversion Dam

The alternatives developed for increasing the diversion capacity of the Red Bluff Diversion were designed to allow a higher rate of diversion (5,000 cfs) over a longer diversion period (beyond May 15 through September 15) and in a manner that could increase the effectiveness of fish passage around Red Bluff Diversion Dam.

Fish Ladder Alternative

The Fish Ladder Alternative is designed to utilize the gravity diversion created by the Red Bluff Diversion Dam. This alternative could allow the weir gates of the dam to remain lowered over a greater period of time, particularly during winter and spring months when

excess flows are available in the Sacramento River. The fish ladder would be designed to effectively allow fish passage around the dam. A summary of the physical characteristics of the Fish Ladder Alternative is provided in Table 2.

The Fish Ladder Alternative would require several major modifications to the Red Bluff Diversion Dam. A new 3,000 cfs capacity fish ladder would be constructed on the left abutment of the dam, the headworks of the T-C Canal would be enlarged to a capacity of 5,000 cfs, and the existing fish screening facility would also be enlarged to accommodate a capacity of 5,000 cfs.

The fish ladder on the dam's left abutment would replace the existing ladder in that location (see Figure 3). The new fish ladder would be composed of approximately 15 fishway chambers to accommodate a total rise of about 15 feet. The maximum head difference between each pool would be no greater than 1 foot. The overflow weirs of each pool would be designed to allow only a maximum velocity of 8 feet-per-second (fps). The fish ladder would have a total capacity of 3,000 cfs, but a majority of that capacity would be carried by an auxiliary channel that could feed water into individual fishway chambers to help regulate velocities and to provide attraction flows at the entrance of the fishway. Fisheries experts have indicated that attraction flows at the entrance to fishway can be a significant factor in the effectiveness of a fish ladder. In addition to the attraction flows created by the auxiliary channel, Gate No. 1 of the Red Bluff Diversion Dam, located adjacent to the left abutment, could be manipulated to release water to enhance attraction flows.

The headworks of the T-C Canal would be enlarged in this alternative to allow 5,000 cfs to be diverted by gravity into the T-C Canal. The additional capacity would be accommodated through four new bays adjacent to the six bays that are currently present. Figure 3 shows the location of the new headworks. Each of the new intake bays would include 11.5-foot by

10-foot radial gates similar to those in the existing bays. The new intake bays would increase the total diversion capacity to 5,400 cfs from the existing capacity of 3,030 cfs.

The final modification that would be needed at the Red Bluff Diversion Dam would be the enlargement of the T-C Canal Fish Facility. To accommodate the 5,400 cfs of diversion capacity, the existing fish screens would be doubled from their present configuration. An additional set of 32 rotating drums would be placed diagonally in the new intake channel. Figure 3 shows the general location of the new fish screens. The rotating drums would be covered with the same stainless steel woven wire screen as the existing drums. The fish bypass facilities would also be enlarged to accommodate the additional screens.

Pumping Plant Alternative

The Pumping Plant Alternative has been designed to allow year-round diversions from the Sacramento River to the T-C Canal without the need to lower the weir gates of the Red Bluff Diversion Dam. The existing T-C Canal intake headworks, fish facility, and fishways located on the diversion dam would remain as they are currently. Figure 4 shows the general location of the new pumping plant, immediately downstream of the dam's right abutment. The pumping plant would have a total capacity of 5,000 cfs and would discharge into the stilling basin of the T-C Canal. Table 2 provides a summary of the physical characteristics of the Pumping Plant Alternative.

The Pumping Plant Alternative would be comprised of ten pumping units, each with a capacity of 500 cfs and 2,300 horsepower (HP). The pumping plant would have a lift of approximately 30 feet. The fish screens associated with the pumping plant would be a flat plate type. The pumping units would maintain a velocity of not more than 0.33 fps through the screens. A cross-flow would be provided across the screen face to collect fish through a by-pass system.

The Pumping Plant Alternative would also allow continued operation of the gravity diversion created by Red Bluff Diversion Dam. This alternative would add operational flexibility to the diversion facility. Real-time monitoring could guide the operations of these facilities in accordance with the presence of migrating fish species and hydraulic conditions on the Sacramento River.

T-C Canal Enlargement

The two possible alternatives are described in this section. Some of the pertinent data for both the Enlarged Canal Alternative and the Parallel Canal Alternative facilities are presented in Table 2.

Enlarged Canal Alternative

The Enlarged Canal Alternative would increase the capacity of the canal by enlarging the existing canal structure. All reaches of the canal would be expanded so the entire 67-mile section would consist of a single canal with a constant capacity of 5,000 cfs. Figures 5 and 6 show typical cross-sections of the Enlarged Canal Alternative. Details of the modifications that would be made are identified in Table 5, *Estimated Capital Costs, Tehama-Colusa Canal Enlargement, Enlarged Canal Alternative.*

The conveyance capacity of the five canal reaches between the Red Bluff Diversion Dam to Funks Reservoir would be increased to a total capacity of 5,000 cfs. The capacity of Reach 1 would be increased by about 2,500 cfs. Reach 2 would be increased by 2,800 cfs, and Reaches 3, 4, and 5 would be increased by 2,900 cfs. The expansion of the T-C Canal would require the enlargement of 24 siphons, 58 road crossings, and one check structure with each reach.

Parallel Canal Alternative

The Parallel Canal Alternative would increase the capacity of the canal to at least 5,000 cfs for all reaches. In this alternative, a separate canal would be constructed parallel to the existing canal with a capacity of 3,500 cfs. The Parallel Canal Alternative would require an additional 500 feet of rights-of-way adjacent to the existing canal. The expanded rights-of-way would allow sufficient distance between the two canals for construction and maintenance activities.

The T-C Canal intake facility and fish screens would be enlarged as appropriate for the alternative chosen to increase the Red Bluff Diversion capacity. At the downstream end of the stilling basin, a separate intake structure would be constructed for the Parallel Canal. The intake structure would include radial gates to control the operation of the Parallel Canal. The capacity of the intake structure and the entire Parallel Canal would be 3,000 cfs. The Parallel Canal would have a total length of 67 miles from the stilling basin at the Red Bluff Diversion Dam to Funks Reservoir.

COST ESTIMATE

The Red Bluff Diversion and T-C Canal Enlargement is a concept that has not been extensively investigated in the past. Information on facility descriptions and cost estimates for enlarging the capacity of the Red Bluff Diversion or the T-C Canal was therefore not available. The cost estimates presented in this evaluation are based on original calculations by Bookman-Edmonston Engineering and on original contractor bids received by Reclamation for construction of the existing T-C Canal. These cost estimates are preliminary and are intended to provide an estimated capital cost of construction that can be compared to other conveyance alternatives for providing Sacramento River flows to proposed off-stream storage facilities on the west side of the Sacramento Valley.

COST ESTIMATE METHODOLOGY

The cost estimate for the Fish Ladder, Pumping Plant, and Enlarged Canal Alternatives were developed by Bookman-Edmonston Engineering based on previous experience and engineering judgment. The cost estimate for the Parallel Canal Alternative was based on contractor bids received by Reclamation to construct the original T-C Canal.

The estimated capital costs of the Fish Ladder Alternative is shown in Table 3 and the estimated capital costs of the Pumping Plant Alternatives is shown in Table 4. Both cost estimates were performed by Bookman-Edmonston Engineering. Portions of the Fish Ladder Alternative cost estimate were taken from Reclamation's February, 1992 report titled *Appraisal Report — Red Bluff Diversion Dam Fish Passage Program.*

The cost estimate for the Enlarged Canal Alternative was developed by Bookman-Edmonston Engineering based on available data and engineering judgment. Table 5 provides a detailed breakdown of the estimated costs for the enlargement of canal Reaches 1 through 5. The unit costs for the enlarged canal were developed based on available design drawings for Reach 5 of the T-C Canal. This information was utilized to develop a cost-per-linear-foot of earthwork and concrete lining. Table 6 shows the information used to develop the unit costs of enlarging the canal prism only. It does not include the cost of modifying other major structures (such as check structures or bridge crossings); these costs were developed separately. This cost was applied to the other reaches of canal for the costs of the enlargement. Modification of the major structures required to complete the Enlarged Canal Alternative including the siphons, culverts, farm bridges, county bridges, overchutes, and canal utilities were designed to a conceptual level. Cost estimates for these facilities were developed by applying standard unit cost to the quantities taken from the conceptual designs.

The estimated capital cost of the Parallel Canal Alternative utilized Reclamation's "Abstract of Bids" for each reach as a contract base. For each reach, the average of the three low bids was escalated to October 1996 level using Reclamation's CCT indices. Table 7 provides a summary of the estimated costs for the construction of the Parallel Canal Alternative. This was used as the base for the construction costs. The cost (escalated to October 1996 dollars) of the 3,500 cfs parallel canal was factored by the following empirical equation:

$$\frac{(Cost)_1}{(Cost)_2} = \frac{Q_1^{3/4}}{Q_2^{3/4}}$$

where Q equals flow in cubic-feet-per-second.

This cost factor formula is typically valid over moderate ranges in capacity; the validity over larger ranges is undetermined. The impact of any error resulting from utilizing this ratio beyond its valid range is considered to be within the range of the accuracy of the present cost estimate.

Rights-of-Way Costs

Rights-of-way costs of $3,000 per acre were based on land use costs developed by the Reclamation Land Resource Branch (Personal Communication, February 1997).

Contingencies and Other Costs

All contingencies and engineering, construction management and administrative factors were determined by historical engineering judgment based on similar level of cost estimation. Contingencies were chosen to be 20 percent; 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 total project cost for the low-end cost and adding 15 percent to the project cost for the high-end cost.

PRELIMINARY COST FINDINGS

Costs of the Red Bluff Diversion and T-C Canal Enlargement and its supporting facilities have been presented on an October 1996 basis as described above. Table 8 summarizes estimated capital costs with selected project categories. The estimated capital cost of the Fish Ladder Alternative for increasing the diversion capacity of the Red Bluff Diversion is $63 million, with a calculated cost range of $57 to $73 million. The Pumping Plant Alternative has an estimated capital cost of $145.8 million, with a calculated cost range of $131 to $168 million.

The estimated capital cost of the Enlarged Canal Alternative is $238 million, with a calculated cost range of $214 to $274 million. The estimated capital cost of constructing the Parallel Canal Alternative with a capacity of 3,500 cfs is $364 million, with a calculated cost range of $518 to $662 million.

ENVIRONMENTAL CONSIDERATIONS

[NOTE: The Environmental Considerations section needs to be reevaluated to reflect the canal enlargement from Funks Reservoir only. It also needs to be made consistent with write-up in previous section.]

This portion of the report provides a summary of environmental considerations related to the proposal for enlarging the existing T-C Canal and extending the canal from Dunnigan to Clifton Court Forebay (approximately 95 miles). Fish, wildlife, plant, and cultural resources that could be affected by the proposal are described and the extent of the impacts identified.

For the most part, the information presented in this section was gathered from existing literature, with limited original research. No field work was conducted for this analysis.

WILDLIFE

Enlarging the canal within the existing alignment would result in minimal impacts to wildlife and their associated habitat. Potential impacts to fish could occur as a result of increased diversions at Red Bluff or at any other point of the Sacramento River. Extending the canal from Dunnigan to Clifton Court Forebay could result in significant impacts to wildlife.

Fish, Amphibians, Reptiles, and Invertebrates

Confining the enlargement to the existing right-of-way is expected to have no impact on fish and minimal impact on amphibians, reptiles, and invertebrates. Extending the canal would have short-term impacts on these species.

The Sacramento River supports important resident and anadromous fish populations. Important resident fish species include channel catfish, largemouth bass, white catfish, Sacramento squawfish, and Sacramento sucker. The principal anadromous fish in this portion of the Sacramento River are chinook salmon, steelhead trout, striped bass, American shad, and white shad. Increases in diversions of water from the river could adversely affect migrating juvenile and adult anadromous fish. The degree of increased fish losses at the diversion point would depend on the timing of the diversions and the quality of fish screens.

General Wildlife

Lands along the existing alignment and the proposed enlargement alignment support a moderately diverse wildlife. Mammals which may be found in the area include opossum,

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shrew, bats, black bear, raccoon, ring-tailed cat, weasel, badger, skunk, coyote, gray fox, squirrels, gophers, mice, rabbit, and black-tailed deer.

Numerous bird species are found along the canal alignment and the alignment of the proposed enlargement. Killdeer is found nesting in open fields adjacent to portions of the canal. Some of the common perching birds found nesting in the area include meadowlark, blackbird, jay, flycatcher, swallow, crow, starling, and mockingbird. Gamebirds found in the area include quail, pheasant, dove, and pigeon.

Sensitive and Listed Fish and Wildlife Species

No State or federally listed fish species would be affected directly by the proposed canal enlargement and the proposed enlargement.

According to the California Department of Fish and Game's California Natural Diversity Data Base records (CNDDB - Version 8/96), there are seven wildlife species that are State or federally listed and nine that are either candidates for listing and/or species designated by CDFG as species of special concern known to occur in the area affected by the proposed project.

There are three wildlife species that are State or federally listed and four that are either candidates for listing and/or species designated CDFG as species of special concern known to occur in the alignment of the proposed T-C Canal Enlargement.

The listed wildlife species that could be affected by the proposed enlarged T-C Canal include valley elderberry longhorn beetle (federal threatened), northern spotted owl (federal threatened), Swainson's hawk (State threatened), western yellow billed cuckoo (State

endangered), bank swallow (State threatened), giant garter snake (federal and State threatened), and vernal pool fairy shrimp (federal threatened).

The listed wildlife species that could be affected by the proposed T-C Canal Enlargement include Swainson's hawk (State threatened, western yellow billed cuckoo (State endangered), and bank swallow (State threatened). The valley elderberry longhorn beetle (federal threatened), while not previously recorded along the proposed alignment of the enlargement, could potentially be affected (see below).

Wildlife species that are either candidates for State or federal listing, or considered species of special concern by the CDFG, that could be affected by the proposed enlarged T-C Canal include California tiger salamander (federal candidate/CDFG species of special concern), western spadefoot (federal and CDFG species of special concern), golden eagle (CDFG species of special concern), burrowing owl (CDFG species of special concern), yellow warbler (CDFG species of special concern), yellow breasted chat (CDFG species of special concern), tricolored blackbird (federal and CDFG species of special concern), San Joaquin pocket mouse (CDFG species of special concern), and northwestern pond turtle (federal candidate/CDFG species of special concern).

Wildlife species that are either candidates for State or federal listing or considered species of special concern by the CDFG that could be affected by the proposed T-C Canal Enlargement include California tiger salamander (federal candidate/CDFG species of special concern), burrowing owl (CDFG species of special concern), tricolored blackbird (federal and CDFG species of special concern), and northwestern pond turtle (federal candidate/CDFG species of special concern).

The valley elderberry longhorn beetle, a federally listed threatened species, although not commonly found in the area, could potentially occur in areas adjacent to the canal alignment

and the proposed alignment of the canal enlargement. Limited numbers of elderberry plants occur sporadically along the areas intermittent streams.

Vernal pool habitats, if present, have the potential to support the vernal pool fairy shrimp.

Several sensitive and State or federally listed bird species that have the potential to occur adjacent to the canal's present alignment and the proposed enlargement alignment include Swainson's hawk, golden eagle, burrowing owl, and tricolored blackbird. It is also possible that the area may receive sporadic use by wintering bald eagles.

The Swainson's hawk, a State-listed threatened species, may use the open grassland or cropland habitats adjacent to the T-C Canal alignment and proposed alignment enlargement. Potentially suitable nesting and foraging habitat is available for this species in areas adjacent to the canal.

Limited sporadic use of adjacent lands may also 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.

The San Joaquin pocket mouse, a species of special concern, is known to occur in areas adjacent to the existing canal alignment.

VEGETATION

Vegetation along both sides of the T-C Canal consists of 60 percent agricultural lands and 38 percent grasslands. Approximately 1 percent of the lands along the sides of the canal is riparian and 1 percent is disturbed lands. Vegetation along the proposed alignment of the

T-C Canal Enlargement is similar to that of the existing alignment of the canal and consists primarily of agricultural lands and grassland. Also, approximately 1 percent of the lands along the proposed enlargement alignment is riparian and 5 percent of the lands are disturbed.

Sensitive and Listed Plant Species

No listed plant species have been recorded along the existing alignment of the T-C Canal or the proposed alignment of the T-C Enlargement.

Candidate species or species of concern that may occur along the existing canal alignment include silky cryptantha, caper-fruited tropidocarpum, Ahart's paronychia, San Joaquin saltbush, Ferris's milk-vetch, Bakers navarretia, recurved larkspur, palmate-bracted birds-beak, and adobe lily. One candidate/species of concern, recurved larkspur, may occur along the proposed enlargement of the canal alignment.

Four plants, dwarf dowingia, brittlescale, four-angled spikerush, and Red Bluff dwarf rush, considered by the California Native Plant Society to be either rare, threatened or endangered in California and elsewhere, may occur along the canal alignment.

Several special-status habitats may also be found along the existing canal alignment. These communities include Valley Needlegrass Grassland, Northern Claypan Vernal Pool (see Wetlands section), Great Valley Oak Riparian Forest, Great Valley Mixed Riparian Forest, Great Valley Cottonwood Riparian Forest, and Great Valley Willow Scrub. No special-status habitats are known to occur along the proposed alignment of the canal enlargement. However, field surveys may reveal the presence of one or more of these special-status habitats.

Wetlands

The existing T-C Canal and proposed enlargement crosses 30 intermittent streambeds, one upper perennial stream, 13 emergent seasonally flooded wetlands (shallow marsh), 14 emergent seasonally flooded wetlands (excavated), 28 emergent temporarily flooded wetlands (wet meadow), four emergent temporarily flooded wetland (excavated), one scrub-shrub seasonally flooded shallow marsh, one scrub-shrub/emergent intermittent temporarily flooded wetland (wet meadow), four forested/temporarily-flooded wetlands (wet meadow), one forested/seasonally flooded wetland-excavated shallow marsh, five scrub-shrub temporarily flooded wetland (wet meadow), one drainage canal, and two canal crossings.

One special-status wetland habitat, Northern Claypan Vernal Pool, can be found in the area of the existing T-C Canal.

Cultural Resources

The T-C Canal Enlargement could affect three prehistoric sites, one of which is significant. No other cultural resources of any type are known to exist in the right-of-way on the canal. The majority of the alignment of the canal expansion (approximately 95 percent) is expected to have a low archeological sensitivity, while the major stream crossings along the alignment are expected to have a moderate sensitivity. The extent of cultural resources along the proposed alignment of the canal enlargement is unknown.

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Table 1
List of Alternative Fish Passage Improvement Projects
Red Bluff Diversion Dam (RBDD)

Alternative	Description	Reclamation's Fish Passage Programs Evaluation
Conveyance from Shasta Dam	Pipeline or canal would convey the diversion demand of the T-C Canal from Shasta Dam. Eliminate diversion from Sacramento River.	Not Considered Reasonable
Low Upstream Diversion and Conveyance	Low diversion structure upstream of RBDD, capable of fish passage, would divert T-C Canals demands. Permit permanent opening of RBDD gates.	Not Considered Reasonable
Articial River Channel Through Payne Slough	Artificial channel would convey all Sacramento River flows, except RBDD diversion flows, around the east side of the RBDD through Payne Slough.	Not Considered Reasonable
Terraced Articial Channel on Left Abutment of RBDD	Similar to Payne Slough alternative but would require a shorter articial channel nearer to the RBDD.	Not Considered Reasonable
Iowa Vanes	"Iowa vane" flow deflectors in the river channel downstream of the RBDD would to divert water towards the downstream end of the existing fish ladders to increase attraction flows.	Not Considered Reasonable
Small Capacity Pumping-Plant with Regulatory Storage	A small capacity pumping plant would continuously pump T C Canal diversion requirements into a regulatory storage facility to be released as needed during the irrigation season.	Not Considered Reasonable
Modify Existing Right Abutment Fish Ladder	Increase right ladder capacity to **800 cfs**	Not Considered Reasonable
Install New Fish Ladder to Center of RBDD	Install center ladder with capacity of **1,000 cfs**	Not Considered Reasonable
Modify Existing Right Abutment Fish Ladder & Install New Fish Ladder to Center of RDBB	Increase right ladder capacity to **800 cfs** Install center ladder with capacity of **1,000 cfs**	Not Considered Reasonable
Modify Existing Left Abutment Fish Ladder	Increase left ladder capacity to **800 cfs**	Not Considered Reasonable
Modify Existing Right Abutment Fish Ladder & Modify Existing Left Abutment Fish Ladder	Increase right ladder capacity to **800 cfs** Install left ladder with capacity of **800 cfs**	Not Considered Reasonable
Modify Existing Left Abutment Fish Ladder	Increase left ladder capacity to **2,100 cfs**	Not Considered Reasonable
Modify Existing Right Abutment Fish Ladder & Modify Existing Left Abutment Fish Ladder	Increase right ladder capacity to **800 cfs** Install left ladder with capacity of **2,100 cfs**	Not Considered Reasonable
Modify Existing Left Abutment Fish Ladder	Increase left ladder capacity to **3,000 cfs**	Not Considered Reasonable
Modify Existing Right Abutment Fish Ladder & Modify Existing Left Abutment Fish Ladder	Increase right ladder capacity to **800 cfs** Install left ladder with capacity of **3,000 cfs**	Not Considered Reasonable
Modify Existing Left Abutment Fish Ladder	Increase left ladder capacity to **5,000 cfs**	Not Considered Reasonable
Modify Existing Right Abutment Fish Ladder & Modify Existing Left Abutment Fish Ladder	Increase right ladder capacity to **800 cfs** Install left ladder with capacity of **5,000 cfs**	Not Considered Reasonable

Table 1
List of Alternative Fish Passage Improvement Projects
Red Bluff Diversion Dam (RBDD)

Alternative	Description	Reclamation's Fish Passage Programs Evaluation
Modify Existing Right Abutment Fish Ladder, Install New Fish Ladder in Center of RBDD, & Modify Existing Left Abutment Fish Ladder	Increase right ladder capacity to **800 cfs** Install center ladder with capacity of **1,000 cfs** Install left ladder with capacity of **5,000 cfs**	Not Considered Reasonable
Modify Existing Right Abutment Fish Ladder, Install New Fish Ladder in Center of RBDD, & Modify Existing Left Abutment Fish Ladder	Increase right ladder capacity to **800 cfs** Install center ladder with capacity of **1,000 cfs** Install left ladder with capacity of **800 cfs**	Selected Alternatives
Modify Existing Right Abutment Fish Ladder, Install New Fish Ladder in Center of RBDD, & Modify Existing Left Abutment Fish Ladder	Increase right ladder capacity to **800 cfs** Install center ladder with capacity of **1,000 cfs** Install left ladder with capacity of **2,100 cfs**	Selected Alternatives
Modify Existing Right Abutment Fish Ladder, Install New Fish Ladder in Center of RBDD, & Modify Existing Left Abutment Fish Ladder	Increase right ladder capacity to **800 cfs** Install center ladder with capacity of **1,000 cfs** Install left ladder with capacity of **3,000 cfs**	Selected Alternatives
Peaking Capacity Pumping Plant	Install Archimedes screw design pumping plant with a capacity of **2,720 cfs**, the estimated peak diversion at the RBDD headworks. All diversion would be made though pumping plant.	Selected Alternatives
Pumping Plant and Gravity Diversion Operations	Archimedes screw design pumping plant with a capacity of **2,480 cfs**. The RBDD gates would be lowered to allow gravity diversions during peak summer months. The pumping plant would supply canal demands during remainder of year.	Selected Alternatives
Pumping Plant and Gravity Diversion Operations	Archimedes screw design pumping plant with a capacity of **2,480 cfs**. The RBDD gates would be lowered to allow gravity diversions during peak summer months. The pumping plant would supply canal demands during remainder of year.	Selected Alternatives
Pumping Plant and Gravity Diversion Operations	Archimedes screw design pumping plant with a capacity of **1,360 cfs**. The RBDD gates woul be lowered to allow gravity diversions for a period slightly longer than the peak demand. The pumping plant would supply canal demands during remainder of year.	Selected Alternatives
Modify Existing Right Abutment Fish Ladder, Install New Fish Ladder in Center of RBDD, Modify Existing Left Abutment Fish Ladder, & Install Pumping Plant	Increase right ladder capacity to **800 cfs** Install center ladder with capacity of **1,000 cfs** Install left ladder with capacity of **800 cfs** Archimedes pumping plant with a capacity of **1,360 cfs**	Selected Alternatives
Modify Existing Right Abutment Fish Ladder, Install New Fish Ladder in Center of RBDD, Modify Existing Left Abutment Fish Ladder, & Install Pumping Plant	Increase right ladder capacity to **800 cfs** Install center ladder with capacity of **1,000 cfs** Install left ladder with capacity of **2,100 cfs** Archimedes pumping plant with a capacity of **1,360 cfs**	Selected Alternatives

Table 1
List of Alternative Fish Passage Improvement Projects
Red Bluff Diversion Dam (RBDD)

Alternative	Description	Reclamation's Fish Passage Programs Evaluation
Modified RBDD Gate Operations, Modify Existing Right Abutment Fish Ladder, Install New Fish Ladder in Center of RBDD, & Modify Existing Left Abutment Fish Ladder	The RBDD gates would be lowered from **Apr. 2 - Nov. 31** Increase right ladder capacity to **800 cfs** Install center ladder with capacity of **1,000 cfs** Install left ladder with capacity of **800 cfs**	Selected Alternatives
Modified RBDD Gate Operations, Modify Existing Right Abutment Fish Ladder, Install New Fish Ladder in Center of RBDD, & Modify Existing Left Abutment Fish Ladder	The RBDD gates would be lowered from **Apr. 2 - Nov. 31** Increase right ladder capacity to **800 cfs** Install center ladder with capacity of **1,000 cfs** Install left ladder with capacity of **2,100 cfs**	Selected Alternatives
Modified RBDD Gate Operations, Modify Existing Right Abutment Fish Ladder, Install New Fish Ladder in Center of RBDD, & Modify Existing Left Abutment Fish Ladder	The RBDD gates would be lowered from **Apr. 2 - Nov. 31** Increase right ladder capacity to **800 cfs** Install center ladder with capacity of **1,000 cfs** Install left ladder with capacity of **3,000 cfs**	Selected Alternatives
Wier Gate Slots	On selected RBDD weir gates slots would be made to allow water flow through the gate and may also allow downstream migrating juveniles to pas through the RBDD.	Not Evaluated
Gate Operation Manipulations	Selected RBDD weir gates could be manipulated to allow water passage below the gate by not lowering the gate completely. This operation may allow downstream migrating juveniles to pass beneath the slightly opened gates.	Not Evaluated

Table 2
Summary of Physical Characteristics
Red Bluff Diversion and Tehama-Colusa Canal Enlargement

Red Bluff Diversion Enlargement			
	Existing Red Bluff Diversion Dam	Fish Ladder Alternative	Pumping Plant Alternative
T-C Canal Headworks Intake Facility			
Capacity (cfs)	3,030	5,400	3,030
Fish Ladders			
Left Abutment (Capacity - cfs)	338	-3,000	338
Right Abutment (Capacity - cfs)	338	338	338
Pumping Plant			
Capacity (cfs)	125	125	5,000
Fish Screening Facility			
Capacity at Current Location (cfs)	3,030	5,400	3,030
Capacity at Pumping Plant (cfs)	125	125	5,000
T-C Canal From Red Bluff Diversion to Funks Reservoir			
	Existing T-C Canal	Enlarged T-C Canal Alternative	Parallel T-C Canal Alternative
T-C Canal Reach 1[a]			
Length (miles)	11.4	11.4	11.4
Capacity (cfs)	2,530	5,000	3,500
T-C Canal Reach 2[a]			
Length (miles)	17.3	17.3	17.3
Capacity (cfs)	2,200	5,000	3,500
T-C Canal Reach 3[a]			
Length (miles)	12.9	12.9	12.9
Capacity (cfs)	2,100	5,000	3,500
T-C Canal Reach 4[a]			
Length (miles)	14.3	14.3	14.3
Capacity (cfs)	2,100	5,000	3,500
T-C Canal Reach 5[a]			
Length (miles)	10.8	10.8	10.8
Capacity (cfs)	2,100	5,000	3,500
Funks Reservoir			
Capacity (cfs)	2,200	2,200	2,200
Area (acres)	200	200	200

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Table 3
Estimated Capital Cost
Red Bluff Diversion Dam - Fish Ladder Alternative

DESCRIPTION	QUANTITY	UNIT[a]	UNIT COST OCT. 96	TOTAL COST OCT. 96	COST REFERENCE
I. Land Acquisition	8	AC	$3,500	$28,000	1
II. Tehama-Colusa Canal Headworks Structure					
Concrete Work	916	CY	$600	$549,600	1
Radial Gates (11.5 ft. x 10 ft.)	4	EA	$46,000	$184,000	1
Bridge	JOB	LS	$150,000	$150,000	1
Cofferdam Sheetpiling	15,710	SF	$28.00	$439,880	1
Cofferdam Gravel Fill	2,910	CY	$21.00	$61,110	1
Misc. @ 20%				$276,918	
SUBTOTAL TEHAMA-COLUSA CANAL HEADWORKS STRUCTURE				$1,661,500	
III. Enlarge Intake Canal and Fish Screen Structure					
Evcavation	53,900	CY	$3.00	$161,700	1
Fish Screen Structure	JOB	LS	$558,000	$558,000	1
Fish Screen	1,970	CFS	$10,000	$19,700,000	1
Misc. @ 10%				$2,041,970	
SUBTOTAL ENLARGE INTAKE CANAL AND FISH SCREEN STRUCTURE				$22,461,670	
IV. Construct New Fish Ladder on Left Abutment (3,000 cfs)	JOB	LS	$15,100,000	$15,100,000	1
SUBTOTAL FISH LADDER ALTERNATIVE				**$39,300,000**	
Contingency @ 20%				$7,900,000	
Estimated Construction Costs				$47,200,000	
Engineering, Legal, and Administrative @ 35%				$16,500,000	
TOTAL ESTIMATED COSTS FOR FISH LADDER ALTERNATIVE				**$63,700,000**	
Estimated Project Costs Range:					
Low-End Cost (-10%):				$57,000,000	
High-End Cost (+15%)				$73,000,000	

Footnote:

[a]LS-lump sum; LF=linear foot; EA=each; SF=square foot; LOC=location

Cost Reference:

1. Cost developed by Bookman-Edmonston Engineering.

D—008680

Table 4
Estimated Capital Cost
Red Bluff Diversion Dam - Pumping Plant Alternative
(Q = 5,000 CFS)

DESCRIPTION	QUANTITY	UNIT[a]	UNIT COST OCT. 96	TOTAL COST OCT. 96	COST REFERENCE
I. Land Acquisition	17	AC	$3,500	$59,500	1
II. Concrete Work					
Pumping Facility	17,300	CY	$600	$10,380,000	1
Discharge Channel	3,470	CY	$600	$2,082,000	1
SUBTOTAL CONCRETE WORK				$12,462,000	1
III. Pumps and Motors (2,300 HP)	10	EA	$1,150,000	$11,500,000	1
IV. Control House	5,000	SF	$150	$750,000	1
V. Fish Screens	5,000	CFS	$10,000	$50,000,000	1
VI. Discharge Piping	154,500	LBS	$5.00	$772,500	1
VII. Electrical Work	JOB	LS	$750,000	$750,000	1
VIII. Cofferdam Sheetpiling	172,800	SF	$28.00	$4,838,400	1
IX. Cofferdam Gravel Fill	32,000	CY	$21.00	$672,000	1
X. Misc. @ 10% (Trash racks, Grating, etc.)				$8,180,440	
SUBTOTAL COSTS FOR PUMPING PLANT ALTERNATIVE				**$89,984,800**	
Contingency @ 20%				$18,000,000	
Estimated Construction Costs				$108,000,000	
Engineering, Legal, and Administrative @ 35%				$37,800,000	
TOTAL ESTIMATED COSTS FOR FISH LADDER ALTERNATIVE				**$145,800,000**	
Estimated Project Costs Range:					
Low-End Cost (-10%):				$131,000,000	
High-End Cost (+15%)				$168,000,000	

Footnote:

[a]LS-lump sum; LF=linear foot; EA=each; SF=square foot; LOC=location

Cost Reference:

1. Cost developed by Bookman-Edmonston Engineering.

D—008681

Table 5
Estimated Capital Cost
Tehama-Colusa Canal Enlargement - Enlarged Canal Alternative

DESCRIPTION	QUANTITY	UNIT[a]	UNIT COST OCT. 96	TOTAL COST OCT. 96	COST REFERENCE
I. RED BLUFF TO THOMES CREEK					
REACH 1: 11.4 MILES					
Intake Works and Fish Screen	2,500	LS	$5,000	$12,500,000	1
Enlargement of Canal	54,000	LF	$184	$9,936,000	1
Modification of Coyote Creek Siphon with Check Structure	JOB	LS	$2,500,000	$2,500,000	1
Modification of Oat Creek Siphon	JOB	LS	$1,500,000	$1,500,000	1
Modification of San Benito Ave. and S.P.R.R. Siphon	JOB	LS	$2,000,000	$2,000,000	1
Modification of Elder Creek Siphon w/Check Structure	JOB	LS	$2,500,000	$2,500,000	1
Modification of McClure Creek Siphon	JOB	LS	$1,500,000	$1,500,000	1
Modification of Woodland Ave. and S.P.R.R. Siphon	JOB	LS		$2,000,000	1
Modification of Thomes Creek Siphon (Approx. 1,200' Long)	JOB	LS		$4,600,000	1
Modification of County Road Bridges	5	EA	$485,000	$2,425,000	1
Modification of Farm Road Bridges	4	EA	$285,000	$1,140,000	1
Modification of Utilities at Canal Structures	9	EA	$10,000	$90,000	1
SUBTOTAL REACH 1				$42,691,000	
II. THOMES CREEK TO STONY CREEK					
REACH 2 : 17.3 MILES					
Enlargement of Canal	87,350	LF	$184	$16,072,400	1
Modification of Jewett Creek Siphon	JOB	LS	$1,500,000	$1,500,000	1
Modification of Rice Creek Siphon (with S.P.R.R. Crossing)	JOB	LS	$2,000,000	$2,000,000	1
Modification of Loleta Road Siphon	JOB	LS	$1,500,000	$1,500,000	1
Modification of Moore Creek Siphon (with S.P.R.R. Crossing)	JOB	LS	$2,000,000	$2,000,000	1
Modification of County Road and Railroad Siphon	JOB	LS	$1,500,000	$1,500,000	1
Modification of Check Structure (Sta. 1331+00)	JOB	LS	$1,100,000	$1,100,000	1
Modification of County Road Bridges	12	EA	$485,000	$5,820,000	1
Modification of Farm Bridges	3	EA	$285,000	$855,000	1
Modification of Utilities at Canal Structures	8	EA	$10,000	$80,000	1
SUBTOTAL REACH 2				$32,427,400	

Table 5
Estimated Capital Cost
Tehama-Colusa Canal Enlargement - Enlarged Canal Alternative

DESCRIPTION	QUANTITY	UNIT[a]	UNIT COST OCT. 96	TOTAL COST OCT. 96	COST REFERENCE
III. STONY CREEK TO WILSON CREEK					
REACH 3 : 12.9 MILES					
Enlargement of Canal	63,960	LF	$184	$11,768,640	1
Modification of Stony Creek Siphon (Approx. 800' Long)	JOB	LS	$3,500,000	$3,500,000	1
Modification of Walker Creek Siphon	JOB	LS	$1,500,000	$1,500,000	1
Modification of Wilson Creek Siphon	JOB	LS	$1,500,000	$1,500,000	1
Modification of Hwy. I-5 Bridge - Northbound	3,000	SF	$150	$450,000	1
Modification of Hwy. I-5 Bridge -Southbound	3,000	SF	$150	$450,000	1
Modification of Check Structure (Sta. 1706+50)	JOB	LS	$1,100,000	$1,100,000	1
Modification of State Hwy. Bridge (Sta. 1661+78)	JOB	LS	$600,000	$600,000	1
Modification of County Road Bridges	12	EA	$485,000	$5,820,000	1
Modification of Farm Road Bridges	1	EA	$285,000	$285,000	1
Modification of Trapezoidal Wash Siphon	2	EA	$300,000	$600,000	1
Modification of Utilities at Canal Structures	10	EA	$10,000	$100,000	1
SUBTOTAL REACH 3				$27,673,640	
IV. WILSON CREEK TO LOGAN CREEK					
REACH 4 : 14.3 MILES					
Enlargement of Canal	72,932	LF	$184	$13,419,488	1
Modification of French Creek Siphon	JOB	LS	$1,500,000	$1,500,000	1
Modification of South Fork Wilson Creek Siphon	JOB	LS	$1,500,000	$1,500,000	1
Modification of Logan Creek Siphon	JOB	LS	$1,500,000	$1,500,000	1
Modification of Check Structures	2		$1,100,000	$2,200,000	1
Modification of State Hwy. 261 Bridge	JOB	LS	$600,000	$600,000	1
Modification of County road Bridges	2		$485,000	$970,000	1
Modification of Farm Road Bridges	6		$285,000	$1,710,000	1
Modification of White Cobin Creek Undercrossing	JOB	LS	$100,000	$100,000	1
Modification of Corral Creek Undercrossing	JOB	LS	$100,000	$100,000	1
Modification of Hayes Hollow Creek Undercrossing	JOB	LS	$100,000	$100,000	1
Modification of North Fork Wilson Creek Undercrossing	JOB	LS	$100,000	$100,000	1
Modification of North Fork Logan Creek Undercrossing	JOB	LS	$100,000	$100,000	1
Modification of Utilities at Canal Structures	12	LOC	$10,000	$120,000	1
SUBTOTAL REACH 4				$24,019,488	

Table 5
Estimated Capital Cost
Tehama-Colusa Canal Enlargement - Enlarged Canal Alternative

DESCRIPTION	QUANTITY	UNIT[a]	UNIT COST OCT. 96	TOTAL COST OCT. 96	COST REFERENCE
V. LOGAN CREEK TO FUNKS RESERVOIR					
REACH 5 : 10.8 MILES					
Enlargement of Canal	56,250	LF	$184	$10,350,000	1
Modification of Hunters Creek Siphon	JOB	LS	$1,500,000	$1,500,000	1
Modification of Check Structure	JOB	LS	$1,100,000	$1,100,000	1
Modification of Dual Purpose Wasteway and Stilling Basin	JOB	LS	$1,500,000	$1,500,000	1
Modification of County Road Bridge	1	EA	$485,000	$485,000	1
Modification of Farm Bridges	8	EA	$285,000	$2,280,000	1
Modification of Utilities ast Canal Structures	12	EA	$10,000	$120,000	1
SUBTOTAL REACH 5				$17,335,000	
VI. LANDS					
Rights-of-way	920	AC	$3,000	$2,760,000	2
SUBTOTAL LANDS				$2,760,000	
SUBTOTAL TEHAMA-COLUSA CANAL ENLARGEMENT				**$146,900,000**	
CONTINGENCIES @ 20%				$29,400,000	
ESTIMATED CONSTRUCTION COST FOR TEHAMA-COLUSA CANAL ENLARGEMENT				$176,300,000	
ENGR, LEGAL, AND ADMIN @35%				$61,700,000	
ESTIMATED CAPITAL COST FOR TEHAMA-COLUSA CANAL ENLARGEMENT				**$238,000,000**	
ESTIMATED CAPITAL COST RANGE FOR TEHAMA-COLUSA CANAL ENLARGEMENT					
LOW (-10%)				$214,000,000	
HIGH (+15%)				$274,000,000	

Footnote:

[a]LS-lump sum; LF=linear foot; EA=each; SF=square foot; LOC=location

Cost Reference:

1. Cost developed by Bookman-Edmonston Engineering.
2. U.S. Bureau of Reclamation, Land Resources Branch, Personal Communications with Graham McMullen, February 1997.

Table 6
Estimated Cost Per Linear Foot of Canal
Tehama-Colusa Canal Enlargement
Reach 5 - From Logan Creek to Funks Reservoir

DESCRIPTION	QUANTITY	UNIT[a]	UNIT COST OCT. 96	TOTAL COST OCT. 96
I. EARTHWORKS AND CONCRETE LINING				
Earthworks and concrete lining	JOB	LS	$8,466,900	$8,466,900
Plus 15%				$1,270,035
SUBTOTAL EARTHWORKS AND CONCRETE LINING				$9,736,935
II. MODIFICATION OF PIPE OVERCHUTES				
24" Pipe Overchutes	7	EA	$20,000	$140,000
30" Pipe Overchutes	3	EA	$22,000	$66,000
39" Pipe Overchutes	1	EA	$25,000	$25,000
42" Pipe Overchutes	2	EA	$26,000	$52,000
SUBTOTAL MODIFICATION OF PIPE OVERCHUTES				$283,000
III. MODIFICATION OF PIPE CULVERTS				
24" Single Pipe Culverts	5	EA	$7,500	$37,500
27" Single Pipe Culverts	1	EA	$8,000	$8,000
33" Single Pipe Culverts	1	EA	$9,000	$9,000
36" Single Pipe Culverts	2	EA	$10,000	$20,000
48" Single Pipe Culverts	1	EA	$13,000	$13,000
51" Single Pipe Culverts	1	EA	$14,000	$14,000
54" Single Pipe Culverts	1	EA	$15,000	$15,000
60" Single Pipe Culverts	1	EA	$16,000	$16,000
51" Double Barrel Pipe Culverts	1	EA	$24,000	$24,000
60" Double Barrel Pipe Culverts	1	EA	$30,000	$30,000
66" Double Barrel Pipe Culverts	1	EA	$34,000	$34,000
SUBTOTAL MODIFICATION OF PIPE CULVERTS				$220 500
CALCULATION OF AVERAGE COST				
Earthworks and Concrete Lining	JOB	LS		$9,736,935
Modification of Pipe Overchutes	JOB	LS		$283,000
Modification of Pipe Culverts	JOB	LS		$220,500
Average cost per liniear foot of canal excluding major structures	55,818	LF	$183.46	$10,240,435
UNIT COST OF ENLARGEMENT EXCLUDING MAJOR STRUCTURES			**$184**	

Footnotes:

[a] EA=each; LS=lump sum; LF=linear foot

All costs developed by Bookman-Edmonston Engineering.

Table 7
Estimated Capital Cost
Tehama-Colusa Canal Enlargement - Parallel Canal Alternative

DESCRIPTION	QUANTITY	UNIT[a]	BID DATE	AVERAGE OF THREE LOW BIDS	USBR INDEX BID DATE	USBR INDEX OCT. 96	UNIT COST OCT. 96	"3/8 POWER" FACTOR	TOTAL COST OCT. 96	COST REFERENCE
MODIFICATION OF INTAKE FACILITIES										
Modification of Intake Facilities with Fish Screen	JOB	LS							$25,000,000	1
SUBTOTAL MODIFICATION OF INTAKE FACILITIES									$25,000,000	
PARALLEL CANAL REACHES										
Reach 1 : 2,300 cfs canal capacity	JOB	LS	Jul. 1967	$5,721,436	47	199	$24,224,803	1.17	$28,343,020	2
Reach 1a : 2,300 /2,200 cfs canal capacity siphon expansion	JOB	LS	Jan. 1972	$1,930,000	60	199	$6,401,167	1.19	$7,617,388	2
Reach 2 : 2,200 cfs canal capacity	JOB	LS	Jun. 1965	$8,340,400	45	199	$36,883,102	1.19	$43,890,892	2
Reach 3 : 2,200 / 2,100 cfs canal capacity	JOB	LS	Apr. 1972	$8,896,100	62	199	$28,553,611	1.21	$34,549,870	2
Reach 4 : 2,100 cfs canal capacity	JOB	LS	Jul. 1972	$8,101,600	63	199	$25,590,768	1.21	$30,964,830	2
Reach 5 : 2,100 cfs canal capacity	JOB	LS	Jul. 1975	$16,154,200	91	199	$35,326,218	1.21	$42,744,723	2
SUBTOTAL REACHES									$188,110,723	
LANDS										
Right-of-Way	4,100	AC					$3,000		$12,300,000	3
SUBTOTAL LANDS									$12,300,000	
SUBTOTAL FOR TEHAMA-COLUSA PARALLEL CANAL									$225,400,000	
CONTINGENCIES @20%									$45,100,000	
ESTIMATED CONSTRUCTION COST									$270,500,000	
ENG., LEGAL, AND ADMIN @ 35%									$94,700,000	
ESTIMATED CAPITAL COST FOR TEHAMA-COLUSA PARALLEL CANAL									$365,200,000	
ESTIMATED CAPITAL COST RANGE										
LOW (-10%)									$329,000,000	
HIGH (+15%)									$420,000,000	

Footnote:

[a]LS-lump sum; AC=acre

Cost Reference:

1. Cost developed by Bookman-Edmonston Engineering.
2. U.S. Bureau of Reclamation Abstract of Bids.
3. U.S. Bureau of Reclamation, Land Resources Branch, Personal Communication with Graham McMullen, February 1997.

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Table 8
Summary of Estimated Capital Cost
Red Bluff Diversion and Tehama-Colusa Canal Enlargement

Cost Item For Red Bluff Diversion - Fish Ladder Alternative	Cost in $Millions
Land Acquisition	0.03
Tehama-Colusa Canal Headworks Structure	1.66
Enlarged Intake Canal and Fish Screens	22.46
New Fish Ladder on Left Abutment (3,000 cfs)	15.10
SUBTOTAL	39.30
ESTIMATED TOTAL CAPITAL COST	-
(w/ 20% Cont. & 35% Eng, Leg, Adm)	63.70
ESTIMATED CAPITAL COST RANGE (-10% - +15%)	57 - 73
Cost Item For Red Bluff Diversion Dam - Pumping Plant Alternative	
Land Acquisition	0.06
Concrete Work	12.46
Pumps and Motors	11.50
Control House	0.75
Fish Screens	50.00
Discharge Piping	0.77
Electrical Work	0.75
Cofferdam	5.51
Trash Racks, Grating, & Misc.	8.18
SUBTOTAL	89.98
ESTIMATED TOTAL CAPITAL COST	
(w/ 20% Cont. & 35% Eng, Leg, Adm)	145.80
ESTIMATED CAPITAL COST RANGE (-10% - +15%)	131 - 168

Cost Item For T-C Enlargement	Enlarged Canal Alternatives	Parallel Canal Alternatives
Modified T-C Canal Intake Structure	12.5	25.0
T-C Canal Reach 1	30.2	36.0
T-C Canal Reach 2	32.4	43.9
T-C Canal Reach 3	27.7	34.6
T-C Canal Reach 4	24.0	31.0
T-C Canal Reach 5	17.3	42.7
Land Acquisition	2.8	12.3
SUBTOTAL	146.9	225.4
ESTIMATED TOTAL CAPITAL COST		
(w/ 20% Cont. & 35% Eng, Leg, Adm)	238.0	365.2
ESTIMATED CAPITAL COST RANGE (-10% - +15%)	214 - 274	518 - 662

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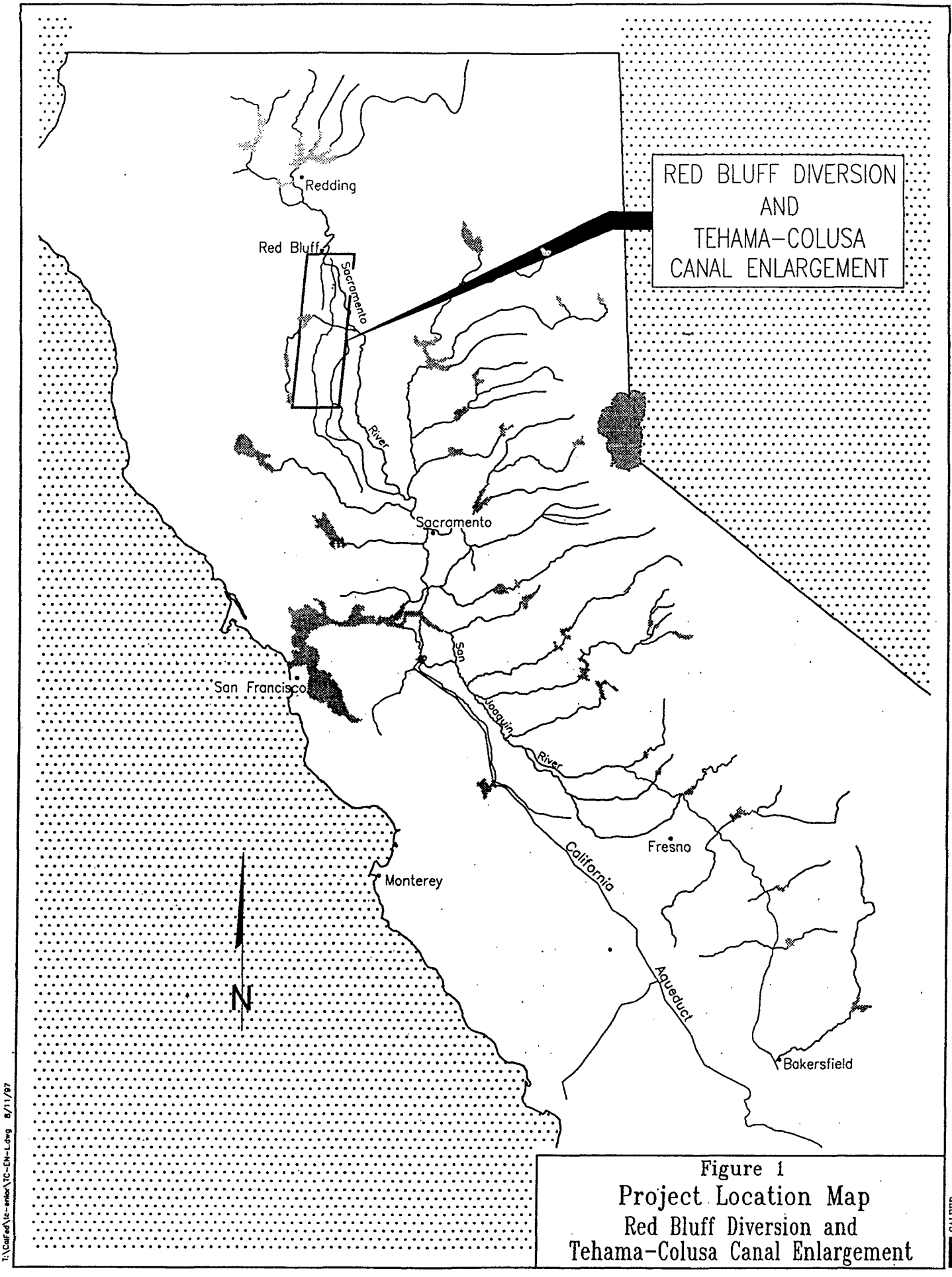

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Figure 1
Project Location Map
Red Bluff Diversion and
Tehama-Colusa Canal Enlargement

CALFED BAY-DELTA PROGRAM

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REACH 1

$Q_{EXISTING}$ = 2,300 CFS
$Q_{ENLARGEMENT}$ = 5,000 CFS
$Q_{PARALLEL}$ = 3,500 CFS

REACH 2

$Q_{EXISTING}$ = 2,200 CFS
$Q_{ENLARGEMENT}$ = 5,000 CFS
$Q_{PARALLEL}$ = 3,500 CFS

TEHAMA – COLUSA CANAL

RED BLUFF DIVERSION DAM

CORNING CANAL

RED BLUFF

CORNING

INTERSTATE 5

S.P.R.R.

Hwy 99 West

State Hwy 99

Sacramento River

Main St.

Road P

Old Corning Rd

Christian Rd

Lake School Rd.

Creek

Thomes

Elder

McClure

Jewett

Coyote

Oat

Rice

Moore

TEHAMA COUNTY
GLENN COUNTY

MATCH LINE – SEE SHEET 2

N

0 3000' 6000' 12000'

SACRAMENTO RIVER FLOW

LEFT BANK FISH LADDER

RED BLUFF DIVERSION DAM

RIGHT BANK FISH LADDER

SLUICEWAY

GATE 10

RESEARCH PUMPING PLANT PROJECT

FISH SCREENS (DRUM TYPE)

Project Location

REDDING

SACRAMENTO

SAN FRANCISCO

LOS ANGELES

VICINITY MAP

Figure 2a
Tehama–Colusa Canal Enlargement

LEGEND

- Tehama–Colusa Canal Enlargement/ Parallel Canal
- Corning Canal
- Railroad
- Existing Roads and Highways
- Existing Rivers

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MATCH LINE – SEE SHEET 1

REACH 3
$Q_{EXISTING}$ = 2,100 CFS
$Q_{PROPOSED}$ = 5,000 CFS
$Q_{PARALLEL}$ = 3,500 CFS

REACH 4
$Q_{EXISTING}$ = 2,100 CFS
$Q_{PROPOSED}$ = 5,000 CFS
$Q_{PARALLEL}$ = 3,500 CFS

REACH 5
$Q_{EXISTING}$ = 2,100 CFS
$Q_{PROPOSED}$ = 5,000 CFS
$Q_{PARALLEL}$ = 3,500 CFS

CHICO LANDING INTERTIE

GREENWOOD
ORLAND
WILLOWS
LOGANDALE
DELEVAN
MAXWELL

Road P
Papst Ave
Road M
S.P.R.R.
Hwy 99 W
Hwy 99 West
Road D
Delevan Rd
Mc Dermont Rd
Sutton Rd
Danley Rd
INTERSTATE 5
GLENN COUNTY
COLUSA COUNTY

Road 200
Road 24
Road 35
Road 39
Road 45
Road 48
Road 57
Road 60
Road 68
Lamoron Rd
Maxwell Colusa Rd
Fairview Rd

Stony Creek
Walker Creek
Wilson Creek
Logan Creek
Hunters Creek
Funks Creek
Hoppes Hollow Creek
Willow Creek
North Fork
French Creek
Nye Creek
Stone Corral Creek
Antelope Creek

TEHAMA – COLUSA CANAL
GLENN – COLUSA CANAL
LOSAN FOREBAY
FUNKS RESERVOIR
SITES
PROPOSED SITES RESERVOIR

N
0 3000' 6000' 12000'

Project Location
REDDING
SACRAMENTO
SAN FRANCISCO
LOS ANGELES
VICINITY MAP

Figure 2b
Tehama–Colusa Canal Enlargement

LEGEND
- Tehama–Colusa Canal Enlargement/ Parallel Canal
- Tehama–Colusa Canal (Not Enlarged)
- Chico Landing Intertie
- Glenn–Colusa Canals
- Railroad
- Existing Roads and Highways
- Pumping–Generating Plant

CALFED BAY-DELTA PROGRAM

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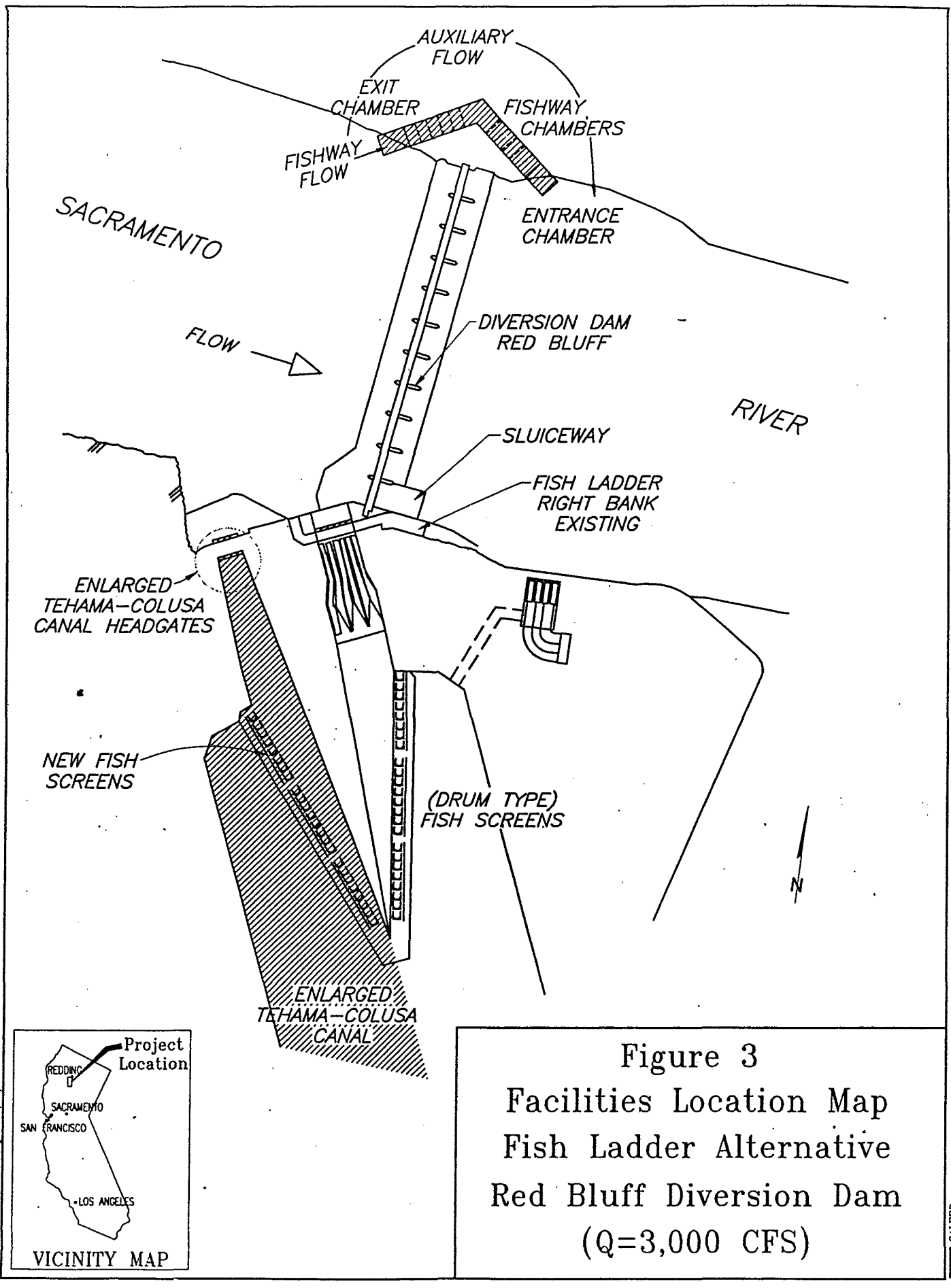

Figure 3
Facilities Location Map
Fish Ladder Alternative
Red Bluff Diversion Dam
(Q=3,000 CFS)

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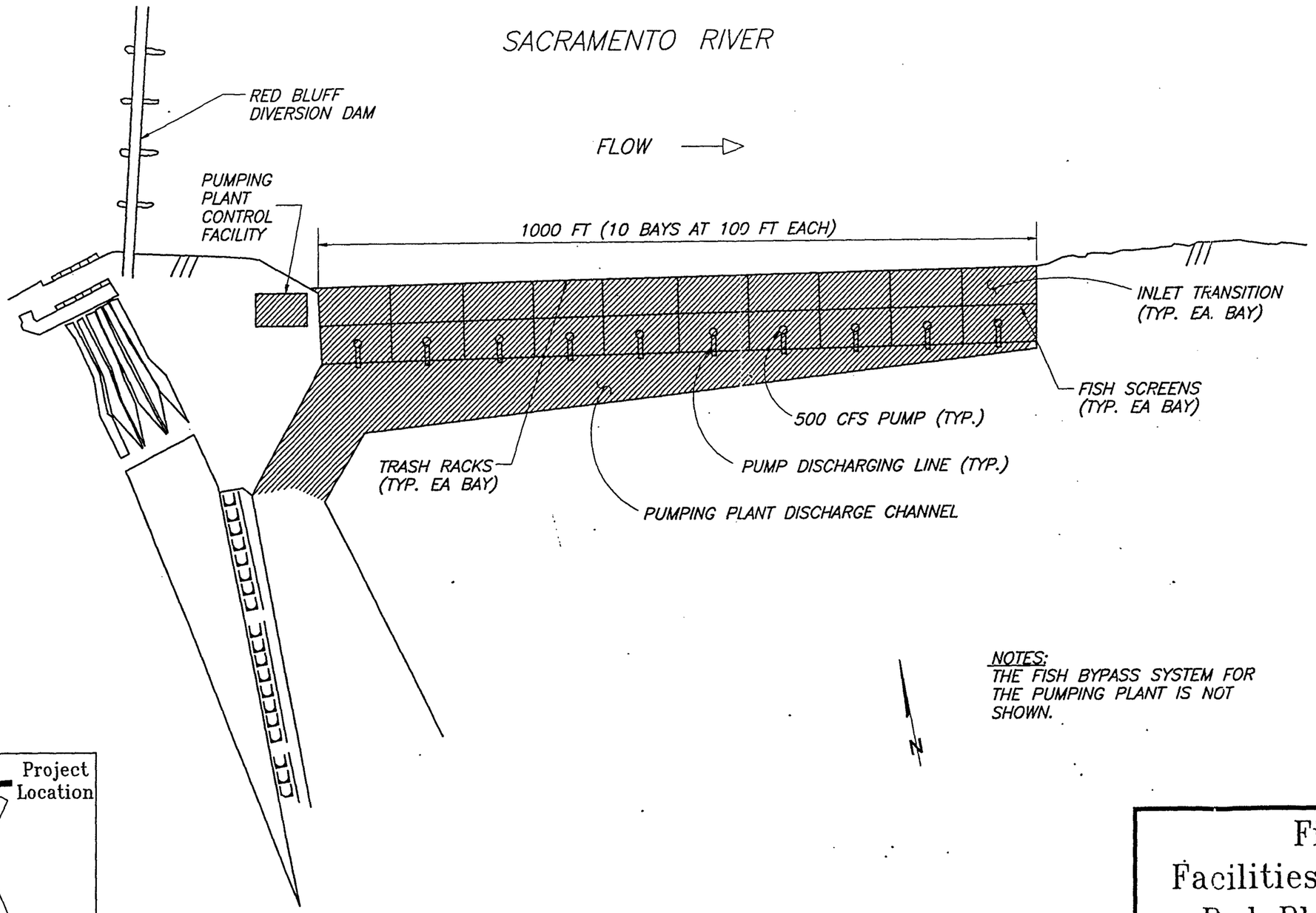

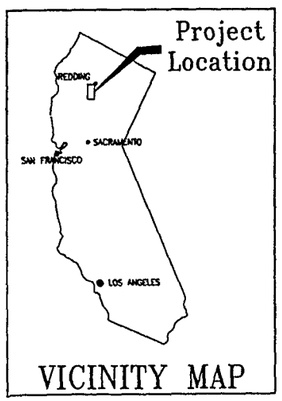

Figure 4
Facilities Location Map
Red Bluff Diversion
Pumping Plant Alternative
(Q= 5,000 cfs)

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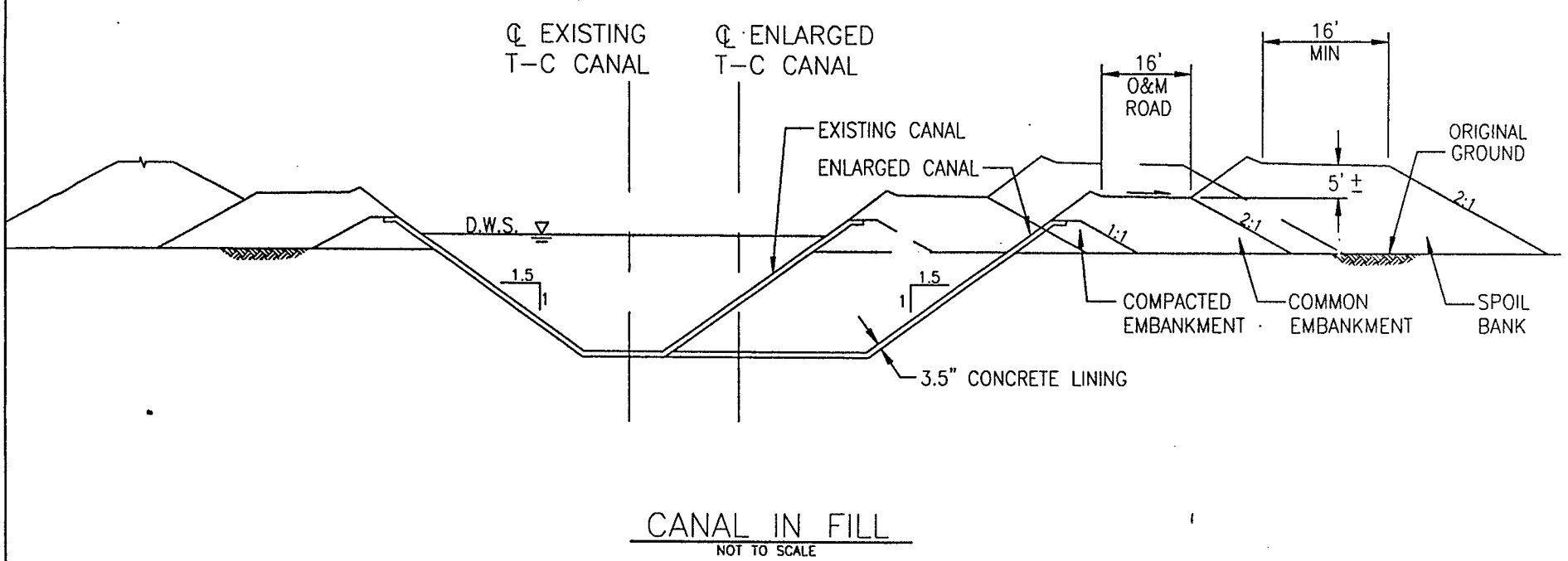

CANAL IN FILL
NOT TO SCALE

Figure 5

Typical Elarged Canal Section In Fill
Tehama–Colusa Canal Enlargement

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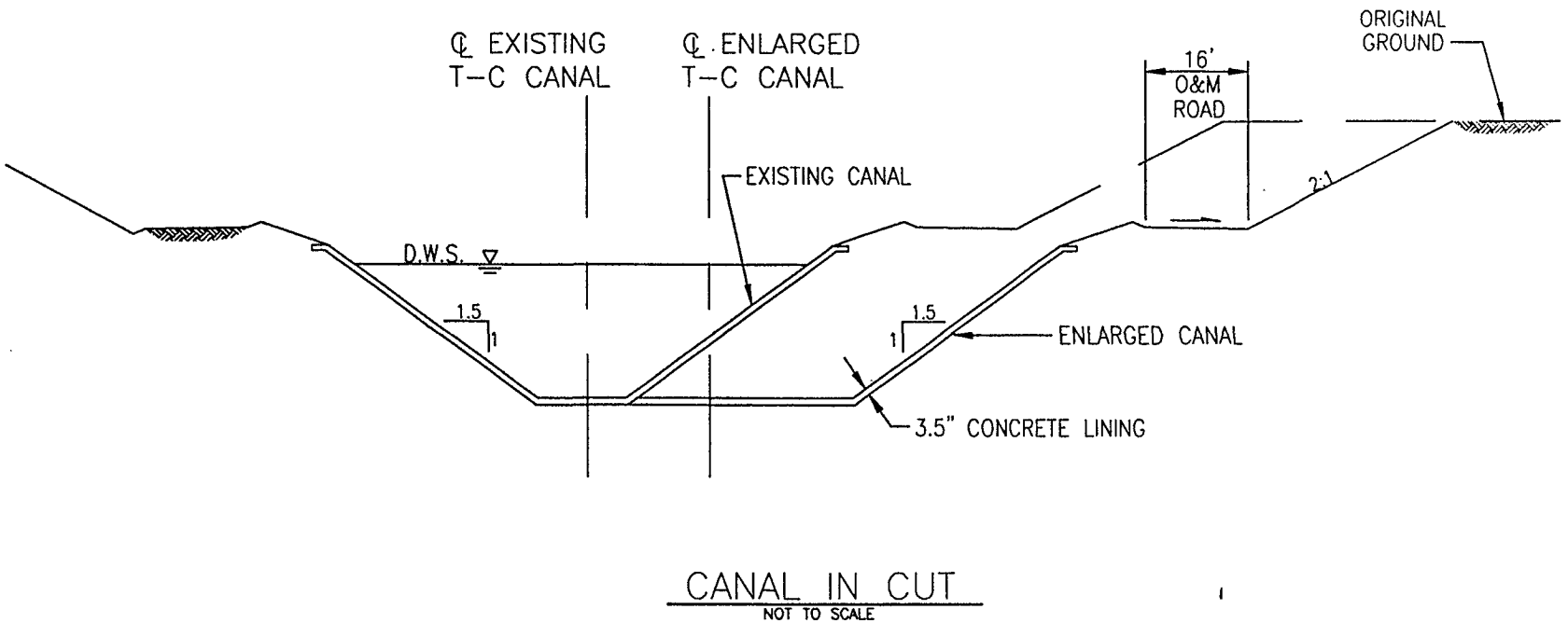

CANAL IN CUT
NOT TO SCALE

Figure 6

Typical Enlarged Canal Section In Cut
Tehama-Colusa Canal Enlargement

CALFED BAY-DELTA PROGRAM

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FACILITY DESCRIPTIONS AND UPDATED COST ESTIMATES FOR TEHAMA-COLUSA CANAL EXTENSION

Prepared by the CALFED Storage and Conveyance Refinement Team
October 1997

TABLE OF CONTENTS

LIST OF TABLES

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INTRODUCTION

The *Facility Descriptions and Updated Cost Estimates for Tehama-Colusa Canal Extension* 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 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 constructing the Tehama-Colusa (T-C) Canal Extension. The general location of the T-C Canal Extension is shown in Figure 1. This project would increase the capacity of the existing T-C Canal structure from Funks Reservoir to the canal's terminus and extend the canal into southern Yolo County. Two potential alternatives for increasing the capacity of the existing structure have been evaluated for this report: (1) increasing the capacity of the existing canal structure, or (2) constructing a parallel canal adjacent to the existing canal.

The cost estimate for enlarging the existing canal structure was developed from new conceptual designs for the canal and its related facilities prepared by Bookman-Edmonston Engineering. The cost estimate for the construction of the parallel canal was determined by applying current cost indices to costs provided by the U.S. Bureau of Reclamation (Reclamation). The cost estimates for the canal extension and related facilities were developed by Bookman-Edmonston Engineering.

This evaluation and others being performed by CALFED are intended to provide facility descriptions and updated cost estimates for representative storage and conveyance components. The objectives of the T-C Canal Extension evaluation are to: (1) provide an updated cost estimate which represents a cost that is within the range to be expected if the project were to be

constructed today, and (2) enable CALFED to equally compare this project against other projects that might be considered as part of a long-term CALFED solution strategy.

A preliminary evaluation of the environmental considerations associated with the T-C Canal Extension has been 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 the evaluation of environmental considerations was gathered from existing literature and databases.

PROJECT BACKGROUND

The T-C Canal was authorized as part of the Sacramento Canal Unit of the Central Valley Project (CVP) by Public Law (PL) 81-839 in 1950. From 1950 to 1963, however, the number of water delivery contracts signed was not sufficient to warrant construction of the canal. In 1964, a sufficient number of contracts had been signed to support the annual operating and maintenance costs assigned to the irrigation portion of the canal; construction began in 1965. In August 1967, PL 90-65 amended PL 81-839 to increase the capacity of the 44-mile section of canal from Funks Creek to Bird Creek to enable future water service to Yolo, Solano, Lake, and Napa Counties.

Construction of the existing canal and its related facilities was completed in May of 1980. The T-C Canal is 111 miles long, extending from the Red Bluff Diversion Dam on the Sacramento River in the north to Bird Creek in Yolo County in the south. The capacity of the T-C Canal at the Red Bluff Diversion Dam is 2,530 cubic-feet-per-second (cfs); the capacity is 1,700 cfs at the terminus. Funks Reservoir, located at about mile 67 of the canal, is the only regulating facility on the canal.

The T-C Canal is owned by Reclamation, but is operated and maintained as part of the CVP by the Tehama-Colusa Canal Authority (TCCA). The TCCA was formed as a Joint Powers Agency

of ten water districts in September 1987 and took over operations and maintenance of the T-C Canal and the Corning Canal pursuant to a cooperative agreement with Reclamation in November 1988.

Extension of the T-C Canal into Yolo and Solano Counties has been investigated since the early 1960s. Reclamation released a reconnaissance appraisal report on the West Sacramento Valley Canal in November 1962. The appraisal report proposed enlarging the canal from Funks Reservoir to Bird Creek and extending the canal into Solano County to Canyon Reservoir, located 4 miles southeast of Vacaville. Reclamation's plan for the West Sacramento Canal included the development of Sites Reservoir and several small regulating reservoirs along the canal alignment, including Oat Reservoir located near the canal's present terminus. The canal extension was proposed to serve 354,900 acre-feet per year between Funks Reservoir and Canyon Reservoir.

FACILITIES DESCRIPTION

This section provides an overview of the major features of the T-C Canal Extension Project, as well as a description of the existing facilities of the T-C Canal which would be either utilized or modified under the proposed extension project. The canal extension would include two components: (1) increasing the conveyance capacity of the existing canal from Funks Reservoir to the canal's present terminus at Bird Creek in Yolo County, and (2) extending the canal to the proposed conveyance facilities of an enlarged Lake Berryessa located near Winters in southern Yolo County. The extension of the T-C Canal would provide additional surface water supplies to Yolo and Solano Counties and would enable storage of available Sacramento River flows in an enlarged Lake Berryessa.

PROJECT DESCRIPTION

The T-C Canal Extension would involve increasing the capacity of the existing canal from Funks Reservoir to the canal's terminus and extending the canal from its terminus to the proposed Winters Pumping-Generating Plant in southern Yolo County. The total capacity of the T-C Canal would be 5,000 cfs from Funks Reservoir to the proposed Winters Pumping-Generating Plant. Figures 2a and 2b show the alignment of the T-C Canal Extension. Figure 2a shows the alignment of the existing canal between Funks Reservoir and its terminus at Bird Creek. This section of the canal would be enlarged or a new parallel canal would be constructed immediately adjacent to the existing canal. Figure 2b shows the proposed alignment of the canal extension from Bird Creek to the proposed Winters Pumping-Generating Plant.

The T-C Canal Extension would be developed in conjunction with two additional projects: the T-C Canal Enlargement and the Lake Berryessa Enlargement. The T-C Canal Enlargement would increase the capacity of the T-C Canal from the Red Bluff Diversion Dam to Funks Reservoir to match the capacity of the T-C Canal Extension Project. The Lake Berryessa Enlargement would include construction of the proposed Winters Pumping-Generating Plant which would be a component of the conveyance system to move water into or out of Lake Berryessa. The capacity of the conveyance system for Lake Berryessa would also match the 5,000 cfs capacity of the T-C Canal Extension.

The T-C Canal Enlargement from Red Bluff to Funks Reservoir and the Lake Berryessa Enlargement are the subject of two separate evaluations being performed by CALFED in August 1997: the *Facility Descriptions and Updated Cost Estimates for Tehama-Colusa Canal Enlargement* and the *Facility Descriptions and Updated Cost Estimates for Lake Berryessa Enlargement.* An additional evaluation is being performed by CALFED of the Lake Berryessa Intertie, which would consist of a two-way conveyance facility from the Sacramento River near the Sacramento Weir in Yolo County to the proposed Winters Pumping-Generating Plant located

4.5 miles north of the town of Winters. This facility would facilitate diversions from the lower Sacramento River, as well as releases from Lake Berryessa to the Sacramento River. The Lake Berryessa Intertie is presented in a CALFED evaluation titled *Facility Descriptions and Updated Cost Estimates for Berryessa Intertie*.

The ability to deliver water from the Sacramento River through the T-C Canal to Lake Berryessa would depend on ongoing activities associated with CALFED, the Central Valley Improvement Act (CVPIA), and Water Quality Standards for the Bay-Delta. Another significant issue which would bear on the ability to divert water from the upper Sacramento River would be the operation of the Red Bluff Diversion Dam.

EXISTING FACILITIES

The existing T-C Canal and its related facilities extend for 111 miles from the Red Bluff Diversion Dam in Tehama County to the terminus at Bird Creek in Yolo County. From north to south, some of the major facilities of the T-C Canal are the Red Bluff Diversion Dam, the Tehama-Colusa Canal Fish Screens and Bypass Facilities, and Funks Reservoir. Only Funks Reservoir and the T-C Canal south of Funks Reservoir are within the study area of this evaluation. A brief description of these facilities is included below.

Tehama-Colusa Canal

There are eight individual reaches identified along the T-C Canal from the Red Bluff Diversion Dam to its terminus. The capacity of the canal decreases from 2,530 cfs in Reach 1 to 1,700 cfs in Reach 8. Each canal reach is named by the creek crossed at the end of the reach. From north to south, the eight reaches include:

Reach 1 - Red Bluff Diversion Dam to Thomes Creek

Reach 2 - Thomes Creek to Stony Creek

Reach 3 - Stony Creek to Wilson Creek

Reach 4 - Wilson Creek to Logan Creek

Reach 5 - Logan Creek to Funks Reservoir

Reach 6 - Funks Reservoir to Freshwater Creek

Reach 7 - Freshwater Creek to Elk Creek

Reach 8 - Elk Creek to Bird Creek.

The T-C Canal Extension project is focused on the existing facilities south of Funks Reservoir which include Reaches 6, 7, and 8. Table 1 provides a summary of the physical characteristics of Reaches 6, 7, and 8.

Funks Reservoir

Funks Reservoir, constructed by Reclamation in 1975, is used to reregulate flow in the T-C Canal. The reservoir is located on Funks Creek at mile 67 of the canal, about 5 miles west of the town of Maxwell in Colusa County. The earth dam that forms Funks Reservior is 34 feet high with a crest length of 1,500 feet. The reservoir has a storage capacity of about 2,000 acre-feet at its maximum operating elevation of 205 feet above mean sea level (MSL). Table 1 provides a summary of the physical characteristics of Funks Reservoir.

PRINCIPAL FACILITIES

The primary features of the T-C Canal Extension include increasing the capacity of the three lower reaches of the existing T-C Canal and constructing a new canal through Yolo County. The conveyance capacity of each of the three reaches of the existing canal would be increased so the entire 44 miles of canal between Funks Creek and the terminus would have a capacity of at least

5,000 cfs. There are two possible configurations for increasing the capacity of the existing canal structure: an enlarged canal configuration and a parallel canal configuration. Both configurations are described in the following sections. Also described in the following sections is the extension of the T-C Canal from its present terminus to the proposed Winters Pump-Generating Plant. Table 1 provides a summary of the physical characteristics of increasing the capacity of the existing canal and the canal extension.

Enlarged Canal Configuration

The enlarged canal configuration would increase the capacity of Reaches 6, 7, and 8 of the T-C Canal by enlarging the existing canal structure. Under this configuration, 44 miles of existing canal would be enlarged to a capacity of 5,000 cfs. The capacity of the existing canal ranges from 2,100 cfs at the outlet of Funks Reservoir to 1,700 cfs at the terminus of the existing canal. Figures 3a and 3b show typical cross-sections of enlarging the canal in fill and in cut, respectively.

Enlargement of the canal would require excavation and relining of portions of the existing canal and modification of numerous siphons, check structures, culverts, overchutes, bridges, and canal utilities. Table 2a provides a summary of the facilities that would be modified for the canal expansion for reaches 6, 7, and 8, as well as a detailed cost estimate.

Parallel Canal Configuration

The parallel canal configuration would require a separate, parallel canal constructed with a capacity of 3,500 cfs for the entire 44-mile length of Reaches 6, 7, and 8. This would increase the capacity of the canal to 5,600 cfs for Reaches 6 and 7, and 5,200 cfs for Reach 8. In this configuration, construction of a parallel canal would require excavation and lining of the canal and construction of siphons, check structures, culverts, overchutes, bridges, and canal utilities

similar in location and design to those of the existing canal. It was assumed that the parallel canal would require a 500-foot wide right-of-way adjacent to the existing canal.

Canal Extension

The canal extension from Bird Creek to the proposed Winters Pumping-Generating Plant would add about 21 miles to the total length of the T-C Canal. The extension would be concrete-lined, trapezoidal section with a capacity of 5,000 cfs. Figures 4a and 4b show typical canal sections for a canal in fill and a canal in cut, respectively. It was assumed that the canal extension would require a 350-foot right-of-way. The construction of the canal extension would require excavation and lining of the canal and construction of siphons, check structures, bridges, overchutes, and culverts. Some of the larger canal crossings include Oat Creek, Cache Creek, and Highway 16.

COST ESTIMATE

The cost estimate for the T-C Canal Extension was developed based on available information, previous experience, and engineering judgment. No existing cost estimates where identified that described the enlargement or extension of the T-C Canal. The cost estimate does not include environmental documentation, environmental mitigation, operation and maintenance, power, and interest during construction.

COST ESTIMATE METHODOLOGY

General

The cost estimate for the T-C Canal Extension — Enlarged Canal Configuration was developed by Bookman-Edmonston Engineering based on previous experience and engineering judgment.

The cost estimate for the T-C Canal Extension — Parallel Canal Configuration was based on contractor bids received by Reclamation to construct the original T-C Canal. The cost estimate for the T-C Canal Extension — Extension from Bird Creek to the proposed Winters Pumping-Generating Plant was developed by Bookman-Edmonston Engineering based on previous experience and engineering judgement. The methodologies used to develop the cost estimates for specific components of the facility are discussed below.

Enlarged Canal Configuration

The estimated capital cost for the enlarged canal configuration was developed by Bookman-Edmonston Engineering based on available data and engineering judgment. Table 2a provides a detailed breakdown of estimated capital cost for the enlargement of Reaches 6, 7, and 8. The unit costs for the enlargement of the canal were developed based on available design drawings for Reach 5 of the T-C Canal. This information was utilized to develop a cost-per-linear-foot of earthwork and concrete lining. Table 2b shows the information used to develop the unit costs for the enlargement, excluding modifications to major structures. Conceptual designs were prepared for modifications to the major structures required to complete the enlarged canal configuration including siphons, culverts, farm bridges, county bridges, and overchutes. Costs estimates for these facilities were developed by applying standard unit cost to the quantities taken from these conceptual designs.

Parallel Canal Configuration

The cost estimate for the parallel canal configuration utilized Reclamation's "Abstract of Bids" for each reach of the T-C Canal. For each reach the average of the three low bids was escalated to October 1996 level using the Reclamation's Construction Cost Trend (CCT) indices. Table 2c provides a detailed breakdown of the estimated costs for the construction of the parallel canal.

The cost (escalated to October 1996 dollars) of the 3,500 cfs parallel canal was factored by the empirical equation:

$$\frac{(Cost)_1}{(Cost)_2} = \frac{Q_1^{3/4}}{Q_2^{3/4}}$$

where Q is equal to capacity.

This cost factor formula is typically valid over moderate ranges of capacity; the validity over larger ranges is undetermined. The impact of any error resulting from utilizing this ratio beyond its valid range is considered to be within the range of the accuracy of the present cost estimate.

Canal Extension

The canal alignment for the canal extension was selected based on engineering judgment using the U.S. Geological Survey (USGS) 1:24,000 scale quad maps. A profile of the alignment was developed using contours of the USGS maps. Facilities required to complete the canal extension including the siphons under Bird, Oat, Cache Creeks, Highway 16, and the Southern Pacific Railroad were designed to a conceptual level. Cost estimates for these facilities were developed by applying standard unit cost to the quantities taken from the conceptual designs. Table 2d provides a detailed breakdown of the estimated costs of extending the T-C Canal from Bird Creek to the proposed Winters Pumping-Generating Plant.

Rights-of-Way Costs

Rights-of-way costs of $3,000 per acre were based on land use costs developed by Reclamation's Land Resource Branch (Personal Communication, February 1997). Reclamation provided land

use cost estimates at a subappraisal level for all storage and conveyance components reviewed by CALFED.

Contingencies and Other Costs

All contingencies and engineering, construction management and administrative factors were determined by historical engineering judgment based on similar level of cost estimation. Contingencies were chosen to be 20 percent; engineering, construction management, and administration were chosen to be 35 percent. A cost range was developed for the project by subtracting 10 percent off the total project cost for the low-end cost and adding 15 percent to the project cost for the high-end cost.

PRELIMINARY COSTS FINDINGS

Costs of the T-C Canal Extension and its supporting facilities have been updated to an October 1996 basis as described above. Table 3 summarizes estimated costs with selected project categories. The cost of enlarging Reaches 6, 7, and 8 of the existing T-C Canal to a total capacity of 5,000 cfs is estimated to be $147 million with a calculated cost range from $132 to $169 million. The cost of constructing a new canal with 3,500 cfs capacity, parallel to the existing T-C Canal, is estimated to be $222 million with a calculated cost range from $200 to $255 million. The estimated cost of constructing a new canal extension through Yolo County is estimated to be $216 million with a calculated cost range from $194 to $248 million. If the T-C Canal Extension was to be developed by enlarging the capacity of the existing canal structure, the estimated cost of constructing the project would be $363 million with a calculated cost range from $326 to $417 million. To develop the project by constructing a new parallel canal would result in an estimated cost of $438 million with a calculated cost range from $394 to $503 million.

ENVIRONMENTAL CONSIDERATIONS

[NOTE: The Environmental Considerations section needs to be reevaluated to reflect the canal extension from Funks Reservoir only. It also needs to be made consistent with write-up in previous section.]

This portion of the report provides a summary of environmental considerations related to the proposal for enlarging the existing T-C Canal and extending the canal from Dunnigan to Clifton Court Forebay (approximately 95 miles). Fish, wildlife, plant, and cultural resources that could be affected by the proposal are described and the extent of the impacts identified. For the most part, the information presented in this section was gathered from existing literature, with limited original research. No field work was conducted for this analysis.

WILDLIFE

Enlarging the canal within the existing alignment would result in minimal impacts to wildlife and their associated habitat. Potential impacts to fish could occur as a result of increased diversions at Red Bluff or at any other point of the Sacramento River. Extending the canal from Dunnigan to Clifton Court Forebay could result in significant impacts to wildlife.

Fish, Amphibians, Reptiles, and Invertebrates

Confining the enlargement to the existing right-of-way is expected to have no impact on fish and minimal impact on amphibians, reptiles, and invertebrates. Extending the canal would have short-term impacts on these species.

The Sacramento River supports important resident and anadromous fish populations. Important resident fish species include channel catfish, largemouth bass, white catfish, Sacramento

squawfish, and Sacramento sucker. The principal anadromous fish in this portion of the Sacramento River are chinook salmon, steelhead trout, striped bass, American shad, and white shad. Increases in diversions of water from the river could adversely affect migrating juvenile and adult anadromous fish. The degree of increased fish losses at the diversion point would depend on the timing of the diversions and the quality of fish screens.

General Wildlife

Lands along the existing alignment and the proposed extension alignment support a moderately diverse wildlife. Mammals which may be found in the area include opossum, shrew, bats, black bear, raccoon, ring-tailed cat, weasel, badger, skunk, coyote, gray fox, squirrels, gophers, mice, rabbit, and black-tailed deer.

Numerous bird species are found along the canal alignment and the alignment of the proposed extension. Killdeer is found nesting in open fields adjacent to portions of the canal. Some of the common perching birds found nesting in the area include meadowlark, blackbird, jay, flycatcher, swallow, crow, starling, and mockingbird. Gamebirds found in the area include quail, pheasant, dove, and pigeon.

Sensitive and Listed Fish and Wildlife Species

No State or federally listed fish species would be affected directly by the proposed canal enlargement and the proposed extension.

According to the California Department of Fish and Game's California Natural Diversity Data Base records (CNDDB - Version 8/96), there are seven wildlife species that are State or federally listed and nine that are either candidates for listing and/or species designated by CDFG as species of special concern known to occur in the area affected by the proposed project.

There are three wildlife species that are State or federally listed and four that are either candidates for listing and/or species designated CDFG as species of special concern known to occur in the alignment of the proposed T-C Canal Extension.

The listed wildlife species that could be affected by the proposed enlarged T-C Canal include Valley Elderberry Longhorn Beetle (federal threatened), Northern Spotted Owl (federal threatened), Swainsons Hawk (State threatened), Western Yellow Billed Cuckoo (State endangered), Bank Swallow (State threatened), Giant Garter Snake (federal and State threatened), and Vernal Pool Fairy Shrimp (federal threatened).

The listed wildlife species that could be affected by the proposed T-C Canal extension include Swainson's Hawk (State threatened, Western Yellow Billed Cuckoo (State endangered), and Bank Swallow (State threatened). The Valley Elderberry Longhorn Beetle (federal threatened), while not previously recorded along the proposed alignment of the extension, could potentially be affected (see below).

Wildlife species that are either candidates for State or federal listing, or considered species of special concern by the CDFG, that could be affected by the proposed enlarged T-C Canal include California Tiger Salamander (federal candidate/CDFG species of special concern), Western Spadefoot (federal and CDFG species of special concern), Golden Eagle (CDFG species of special concern), Burrowing Owl (CDFG species of special concern), Yellow Warbler (CDFG species of special concern), Yellow Breasted Chat (CDFG species of special concern), Tricolored Blackbird (federal and CDFG species of special concern), San Joaquin Pocket Mouse (CDFG species of special concern), and Northwestern Pond Turtle (federal candidate/CDFG species of special concern).

Wildlife species that are either candidates for State or federal listing or considered species of special concern by the CDFG that could be affected by the proposed T-C Canal extension include

California Tiger Salamander (federal candidate/CDFG species of special concern), Burrowing Owl (CDFG species of special concern), Tricolored Blackbird (federal and CDFG species of special concern), and Northwestern Pond Turtle (federal candidate/CDFG species of special concern).

The Valley elderberry longhorn beetle, a federally listed threatened species, although not commonly found in the area, could potentially occur in areas adjacent to the canal alignment and the proposed alignment of the canal extension. Limited numbers of elderberry plants occur sporadically along the area's intermittent streams.

Vernal pool habitats, if present, have the potential to support the vernal pool fairy shrimp. Several sensitive and State or federally listed bird species that have the potential to occur adjacent to the canal's present alignment and the proposed extension alignment include Swainson' hawk, golden eagle, burrowing owl, and tricolored blackbird. It is also possible that the area may receive sporadic use by wintering bald eagles.

The Swainsons hawk, a State listed threatened species, may use the open grassland or cropland habitats adjacent to the T-C Canal alignment and proposed alignment extension. Potentially suitable nesting and foraging habitat is available for this species in areas adjacent to the canal.

Limited sporadic use of adjacent lands may also occur for wintering greater sandhill cranes. This species (State 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.

The San Joaquin pocket mouse, a species of special concern, is known to occur in areas adjacent to the existing canal alignment.

VEGETATION

Vegetation along both sides of the T-C Canal consists of 60 percent agricultural lands and 38 percent grasslands. Approximately 1 percent of the lands along the sides of the canal are riparian and 1 percent are disturbed lands. Vegetation along the proposed alignment of the T-C Canal Extension is similar to that of the existing alignment of the canal and consisting primarily of agricultural lands and grassland. Also, approximately 1 percent of the lands along the proposed extension alignment are riparian and 5 percent of the lands are disturbed.

Sensitive and Listed Plant Species

No listed plant species have been recorded along the existing alignment of the T-C Canal or the proposed alignment of the T-C Canal Extension.

Candidate species or species of concern that may occur along the existing canal alignment include: Silky Cryptantha, Caper-fruited Tropidocarpum, Ahart's Paronychia, San Joaquin Saltbush, Ferris's Milk-vetch, Bakers Navarretia, Recurved Larkspur, Palmate-bracted Birds-beak, and Adobe Lily. One candidate/species of concern, Recurved Larkspur, may occur along the proposed extension of the canal alignment.

Four plants, Dwarf Dowingia, Brittlescale, Four-angled Spikerush, and Red Bluff Dwarf Rush, considered by the California Native Plant Society to be either rare, threatened or endangered in California and elsewhere, may occur along the canal alignment.

Several special status habitats may also be found along the existing canal alignment. These communities include Valley Needlegrass Grassland, Northern Claypan Vernal Pool (see Wetlands section), Great Valley Oak Riparian Forest, Great Valley Mixed Riparian Forest, Great Valley Cottonwood Riparian Forest, and Great Valley Willow Scrub. No special status habitats

are known to occur along the proposed alignment of the canal extension. However, field surveys may reveal the presence of one or more of these special status habitats.

Wetlands

The existing T-C Canal and proposed extension crosses 30 intermittent streambeds, one upper perennial stream, 13 emergent seasonally flooded wetlands (shallow marsh), 14 emergent seasonally flooded wetlands (excavated), 28 emergent temporarily flooded wetlands (wet meadow), four emergent temporarily flooded wetland (excavated), one scrub-shrub seasonally flooded shallow marsh, one scrub-shrub/emergent intermittent temporarily flooded wetland (wet meadow), four forested/temporarily-flooded wetlands (wet meadow), one forested/seasonally flooded wetland-excavated shallow marsh, five scrub-shrub temporarily flooded wetland (wet meadow), one drainage canal, and two canal crossings.

One special status wetland habitat, Northern Claypan Vernal Pool, can be found in the area of the existing T-C Canal.

CULTURAL RESOURCES

The T-C Canal Enlargement could affect three prehistoric sites, one of which is significant. No other cultural resources of any type are known to exist in the right-of-way on the canal. The majority of the alignment of the canal expansion (approximately 95%) is expected to have a low archeological sensitivity; the major stream crossings along the alignment are expected to have a moderate sensitivity. The extent of cultural resources along the proposed alignment of the canal extension is unknown.

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Table 1
SUMMARY OF PHYSICAL CHARACTERISTICS
TEHAMA-COLUSA CANAL EXTENSION

DESCRIPTION	Existing Facilities	Enlarged Canal Configuration	Parallel Canal Configuration	Canal Extension
Funks Reservoir				
Normal Pool Elevation (feet above MSL)	205			
Storage at Normal Pool (acre-feet)	2,000			
Inundation Area (acres)	220			
Dam Type	Earthfill			
Dam Height Above Streambed (feet)	34			
Dam Crest Length (feet)	1,500			
Reach 6				
Length (miles)	16.4	16.4	16.4	
Capacity (cfs)	2,100	5,000	3,500	
Reach 7				
Length (miles)	13.5	13.5	13.5	
Capacity (cfs)	2,100	5,000	3,500	
Reach 8				
Length (miles)	14.5	14.5	14.5	
Capacity (cfs)	1,700	5,000	3,500	
Canal Extension				
Length (miles)	-	-		21.2
Capacity (cfs)	-	-		5,000

Table 2a
ESTIMATED CAPITAL COSTS
TEHAMA-COLUSA CANAL EXTENSION - ENLARGED CANAL CONFIGURATION

DESCRIPTION	QUANTITY	UNIT[a]	UNIT COST OCT. 96	TOTAL COST OCT. 96	COST REFERENCE
I. FUNKS RESERVOIR TO FRESHWATER CREEK REACH 6 : 16.4 MILES					
Modification of Outlet Work at Funks Reservoir	JOB	LS	$500,000	$500,000	1
Enlargement of Canal	86,740	LF	$184	$15,960,160	1
Modification of Check Structure (Sta. 3583+23)	JOB	LS	$1,100,000	$1,100,000	1
Modification of Stone Corral Creek Siphon	JOB	LS	$5,600,000	$5,600,000	1
Modification of Check Structure (Sta. 4064+50)	JOB	LS	$1,100,000	$1,100,000	1
Modification of Freshwater Creek Siphon	JOB	LS	$1,500,000	$1,500,000	1
Modification of County Road Bridges	4	EA	$485,000	$1,940,000	1
Modification of Farm Bridges	5	EA	$285,000	$1,425,000	1
Modification of Overchutes	JOB	LS	$1,200,000	$1,200,000	1
Modification of Culverts	JOB	LS	$500,000	$500,000	1
Modification of Utilities at Canal Structures	13	EA	$10,000	$130,000	1
SUBTOTAL REACH 6				$30,955,160	
II. FRESHWATER CREEK TO ELK CREEK REACH 7 : 13.5 MILES					
Enlargement of Canal	71,410	LF	$184	$13,139,440	1
Modification of Salt Creek Siphon	JOB	LS	$1,500,000	$1,500,000	1
Modification of Spring-Walters Creek Siphon with Check Structure	JOB	LS	$2,500,000	$2,500,000	1
Modification of Cortina Creek Siphon	JOB	LS	$1,500,000	$1,500,000	1
Modification of Sand Creek Siphon	JOB	LS	$1,500,000	$1,500,000	1
Modification of Elk Creek Siphon with Check Structure	JOB	LS	$2,500,000	$2,500,000	1
Modification of County Road Bridges	5	EA	$485,000	$2,425,000	1
Modification of Farm Bridges	2	EA	$285,000	$570,000	1
Modification of Utilities at Canal Structures	12	EA	$10,000	$120,000	1
SUBTOTAL REACH 7				$25,754,440	
III. ELK CREEK TO END OF CANAL REACH 8 : 14.5 MILES					
Enlargement of Canal	76,460	LF	$230	$17,585,800	1
Modification of Salt Creek Siphon	JOB	LS	$1,650,000	$1,650,000	1

Table 2a
ESTIMATED CAPITAL COSTS
TEHAMA-COLUSA CANAL EXTENSION - ENLARGED CANAL CONFIGURATION

DESCRIPTION	QUANTITY	UNIT[a]	UNIT COST OCT. 96	TOTAL COST OCT. 96	COST REFERENCE
Modification of Check Structure (Sta. 5398+50)	JOB	LS	$1,210,000	$1,210,000	1
Modification of Petroleum Creek Siphon	JOB	LS	$1,650,000	$1,650,000	1
Modification of Buckeye Creek Siphon	JOB	LS	$1,650,000	$1,650,000	1
Modification of County Road Bridges	11	EA	$490,000	$5,390,000	1
Modification of Farm Bridges	7	EA	$280,000	$1,960,000	1
Modification of Culverts	JOB	LS	$500,000	$500,000	1
Modification of Utilities at Canal Structures	22	EA	$10,000	$220,000	1
Modification of Terminal Structure	JOB	LS	$200,000	$200,000	1
SUBTOTAL REACH 7				$32,015,800	
IV. LANDS					
Rights-of-ways	650	AC	$3,000	$1,950,000	2
SUBTOTAL LANDS				$1,950,000	
SUBTOTAL FOR ENLARGEMENT OF TEHAMA-COLUSA CANAL				$90,700,000	
CONTINGENCIES @ 20%				$18,100,000	
ESTIMATED CONSTRUCTION COST				$108,800,000	
ENG., LEGAL, AND ADM. @ 35%				$38,100,000	
ESTIMATED CAPITAL COST FOR ENLARGEMENT OF TEHAMA-COLUSA CANAL				$146,900,000	
ESTIMATED CAPITAL COST RANGE					
LOW (-10%)				$132,000,000	
HIGH (+15%)				$169,000,000	

Footnotes:

[a]CY=cubic yard; LB=pound; EA=each; LS=lump sum; LF=linear foot; SF=square foot; TON=ton; MI=mile; AC=acre

Cost Reference:

1. Cost developed by Bookman-Edmonston Engineering.
2. U.S. Bureau of Reclamation, Land Resources Branch, Personal Communication with Graham McMullen, February 1997.

Table 2b

ESTIMATED CAPITAL COST PER LINEAR FOOT OF ENLARGED CANAL
TEHAMA-COLUSA CANAL EXTENSION - REACH 5 - LOGAN CREEK TO FUNKS RESERVOIR

DESCRIPTION	QUANTITY	UNIT[a]	UNIT COST OCT. 96	TOTAL COST OCT. 96
I. EARTHWORKS AND CONCRETE LINING				
Earthworks and concrete lining	JOB	LS	$8,466,900	$8,466,900
Miscellaneous @ 15%				$1,270,035
SUBTOTAL EARTHWORKS AND CONCRETE LINING				$9,736,935
II. MODIFICATION OF PIPE OVERCHUTES				
24" Pipe Overchutes	7	EA	$20,000	$140,000
30" Pipe Overchutes	3	EA	$22,000	$66,000
39" Pipe Overchutes	1	EA	$25,000	$25,000
42" Pipe Overchutes	2	EA	$26,000	$52,000
SUBTOTAL MODIFICATION OF PIPE OVERCHUTES				$283,000
III. MODIFICATION OF PIPE CULVERTS				
24" Single Pipe Culverts	5	EA	$7,500	$37,500
27" Single Pipe Culverts	1	EA	$8,000	$8,000
33" Single Pipe Culverts	1	EA	$9,000	$9,000
36" Single Pipe Culverts	2	EA	$10,000	$20,000
48" Single Pipe Culverts	1	EA	$13,000	$13,000
51" Single Pipe Culverts	1	EA	$14,000	$14,000
54" Single Pipe Culverts	1	EA	$15,000	$15,000
60" Single Pipe Culverts	1	EA	$16,000	$16,000
51" Double Barrel Pipe Culverts	1	EA	$24,000	$24,000
60" Double Barrel Pipe Culverts	1	EA	$30,000	$30,000
66" Double Barrel Pipe Culverts	1	EA	$34,000	$34,000
SUBTOTAL MODIFICATION OF PIPE CULVERTS				$220,500
TOTAL COST OF CANAL STRUCTURE FOR REACH 5				$10,240,435
AVERAGE COST PER LINEAR FOOT OF CANAL	55,818	LF		**$183**

Footnotes:

[a] EA=each; LS=lump sum; LF=linear foot

All costs developed by Bookman-Edmonston Engineering.

Table 2c
ESTIMATED CAPITAL COSTS
TEHAMA-COLUSA CANAL EXTENSION - PARALLEL CANAL CONFIGURATION

DESCRIPTION	QUANTITY	UNIT*	BID DATE	AVERAGE OF THREE LOW BIDS	USBR INDEX BID DATE	USBR INDEX OCT. 96	UNIT COST OCT. 96	"3/8 POWER" FACTOR	TOTAL COST OCT. 96	COST REFERENCE
PARALLEL CANAL REACHES										
Reach 6: 2,100 cfs canal capacity	JOB	LS	Apr. 1977	$21,933,300	99	199	$44,088,148	1.21	$53,346,660	1
Reach 7: 2,100 cfs canal capacity	JOB	LS	Nov. 1977	$14,476,900	102	199	$28,244,148	1.21	$34,175,419	1
Reach 8: 1,700 cfs canal capacity	JOB	LS	Dec. 1978	$17,538,200	108	199	$32,315,757	1.31	$42,333,642	1
SUBTOTAL REACHES									$129,855,721	
LANDS										
Right-of-Way	2,430	AC					$3,000		$7,290,000	2
SUBTOTAL LANDS									$7,290,000	
SUBTOTAL FOR TEHAMA-COLUSA PARALLEL CANAL									$137,100,000	
CONTINGENCIES @20%									$27,400,000	
ESTIMATED CONSTRUCTION COST									$164,500,000	
ENG., LEGAL, AND ADMIN @ 35%									$57,600,000	
ESTIMATED CAPITAL COST FOR TEHAMA-COLUSA PARALLEL CANAL									$222,100,000	
ESTIMATED CAPITAL COST RANGE										
LOW (-10%)									$200,000,000	
HIGH (+15%)									$255,000,000	

Footnote:

*LS-lump sum; AC=acre

Cost Reference:

1. Bureau of Reclamation Abstract of Bids.
2. U.S. Bureau of Reclamation, Land Resources Branch, Personal Communication with Graham McMullen, February 1997.

Table 2d
ESTIMATED CAPITAL COSTS
TEHEMA-COLUSA CANAL EXTENSION
CONSTRUCTION OF NEW CANAL FROM BIRD CREEK TO PROPOSED WINTERS PUMPING-GENERATING PLANT

DESCRIPTION	QUANTITY	UNIT[a]	UNIT COST OCT. 1996	TOTAL COST OCT. 1996	COST REFERENCE
I. CONCRETE LINED CANAL					
Clearing and Grubbing	900	AC	$200.00	$180,000	1
Excavation	10,136,000	CY	$2.00	$20,272,000	1
Compacted Embankment	3,046,000	CY	$0.80	$2,436,800	1
Common Embankment	1,980,000	CY	$0.50	$990,000	1
Borrow (Beginning of Canal to Oat Creek)	2,500,000	CY	$2.00	$5,000,000	1
Concrete Lining	138,000	CY	$80.00	$11,040,000	1
Fencing	224,000	LF	$5.00	$1,120,000	1
SUBTOTAL CONCRETE LINED CANAL				$41,038,800	
II. SIPHONS					
Bird Creek Siphon (1,800 feet)					
Siphon Barrel Concrete	31,680	CY	$600.00	$19,008,000	1
Inlet/Outlet Transition Concrete	1,400	CY	$600.00	$840,000	1
Oat Creek Siphon (1,500 feet)					
Siphon Barrel Concrete	26,400	CY	$600.00	$15,840,000	1
Inlet/Outlet Transition Concrete	1,400	CY	$600.00	$840,000	1
Drainage Siphon (800 feet)					
Siphon Barrel Concrete	14,080	CY	$600.00	$8,448,000	1
Inlet/Outlet Transition Concrete	1,400	CY	$600.00	$840,000	1
County Road and Drainage Siphon (300 feet)					
Siphon Barrel Concrete	5,280	CY	$600.00	$3,168,000	1
Inlet/Outlet Transition Concrete	1,400	CY	$600.00	$840,000	1
County Road and Drainage Siphon (300 feet)					
Siphon Barrel Concrete	5,280	CY	$600.00	$3,168,000	1
Inlet/Outlet Transition Concrete	1,400	CY	$600.00	$840,000	1
Cache Creek Siphon (1,800 feet)					
Siphon Barrel Concrete	31,680	CY	$600.00	$19,008,000	1
Inlet/Outlet Transition Concrete	1,400	CY	$600.00	$840,000	1
Highway 16 and R.R. Siphon (300 feet)					
Siphon Barrel Concrete	5,280	CY	$600.00	$3,168,000	1
Inlet/Outlet Transition Concrete	1,400	CY	$600.00	$840,000	1

Table 2d
ESTIMATED CAPITAL COSTS
TEHEMA-COLUSA CANAL EXTENSION
CONSTRUCTION OF NEW CANAL FROM BIRD CREEK TO PROPOSED WINTERS PUMPING-GENERATING PLANT

DESCRIPTION	QUANTITY	UNIT*	UNIT COST OCT. 1996	TOTAL COST OCT. 1996	COST REFERENCE
Railroad Shootfly	JOB	LS		$200,000	1
County Road and Drainage Siphon (300 feet)					
Siphon Barrel Concrete	5,280	CY	$600.00	$3,168,000	1
Inlet/Outlet Transition Concrete	1,400	CY	$600.00	$840,000	1
SUBTOTAL SIPHONS				$81,896,000	
III. CHECK STRUCTURES					
3 Check Structures	3	EA	$1,100,000.00	$3,300,000	1
SUBTOTAL CHECK STRUCTURES				$3,300,000	
IV. COUNTY ROAD BRIDGES					
5 County Road Bridges	5	EA	$420,000.00	$2,100,000	1
SUBTOTAL COUNTY ROAD BRIDGES				$2,100,000	
V. FARM ROAD BRIDGES					
4 Farm Road Bridges	4	EA	$240,000.00	$960,000	1
SUBTOTAL FARM ROAD BRIDGES				$960,000	
VI. DRAINAGE OVERCHUTES					
3 Drainage Overchutes	3	EA	$66,000.00	$198,000	1
Winters Canal Overchute	JOB	LS		$200,000	1
SUBTOTAL DRAINAGE OVERCHUTES				$398,000	
VII. DRAINAGE CULVERTS					
13 Drainage Culverts	13	EA	$54,000.00	$702,000	1
SUBTOTAL DRAINAGE CULVERTS				$702,000	
VIII LAND COST					
350-Foot Canal Right of Way, Width 21.2 miles	900	AC	$3,000.00	$2,700,000	2
SUBTOTAL LAND COST				$2,700,000	

Table 2d
ESTIMATED CAPITAL COSTS
TEHEMA-COLUSA CANAL EXTENSION
CONSTRUCTION OF NEW CANAL FROM BIRD CREEK TO PROPOSED WINTERS PUMPING-GENERATING PLANT

DESCRIPTION	QUANTITY	UNIT[a]	UNIT COST OCT. 1996	TOTAL COST OCT. 1996	COST REFERENCE
SUBTOTAL FOR TEHAMA-COLUSA CANAL EXTENSION				$133,100,000	
CONTINGENCIES 20%				$26,600,000	
ESTIMATED CONSTRUCTION COST FOR TEHAMA-COLUSA CANAL EXTENSION				$159,700,000	
ENGR., LEGAL, AND ADMIN. @35%				$55,900,000	
ESTIMATED CAPITAL COST FOR TEHAMA-COLUSA CANAL EXTENSION				$215,600,000	
ESTIMATED CAPITAL COST RANGE FOR TEHAMA-COLUSA CANAL EXTENSION					
LOW (-10%)				$194,000,000	
HIGH (+15%)				$248,000,000	

Footnotes:

[a]CY=cubic yard; EA=each; LS=lump sum; LF=linear foot; AC=acre

Cost Reference:

1. Cost developed by Bookman-Edmonston Engineering.
2. U.S. Bureau of Reclamation, Land Resources Branch, Personal Communication with Graham McMullen, February 1997.

Table 3
SUMMARY OF ESTIMATED CAPITAL COST
TEHAMA-COLUSA CANAL EXTENSION

DESCRIPTION	Estimated Cost ($Millions)	
	Canal Enlargement Plus Canal Extension	Parallel Canal Plus Canal Extension
Canal Enlargement		
Reach 6	31.0	53.3
Reach 7	25.7	34.2
Reach 8	32.0	42.3
Lands	2.0	7.3
SUBTOTAL	90.7	137.1
Canal Extension		
Concrete-Lined Canal	41.0	41.0
Siphons	81.9	81.9
Check Structures	3.3	3.3
County Road Bridges	2.1	2.1
Farm Road Bridges	1.0	1.0
Drainage Overchutes	0.4	0.4
Drainage Culverts	0.7	0.7
Land Costs	2.7	2.7
SUBTOTAL	133.1	133.1
TOTAL ESTIMATED PROJECT COSTS	223.8	270.2
Contingencies @ 20 %	44.8	54.0
ESTIMATED CAPITAL CONSTRUCTION COSTS	268.6	324.2
Eng., Legal, Admin. @ 35%	94.0	113.5
ESTIMATED PROJECT DEVELOPMENT COSTS	362.6	437.7
Capital Cost Range (minus 10% - plus 15%)	$326 - $417	$394 - $503

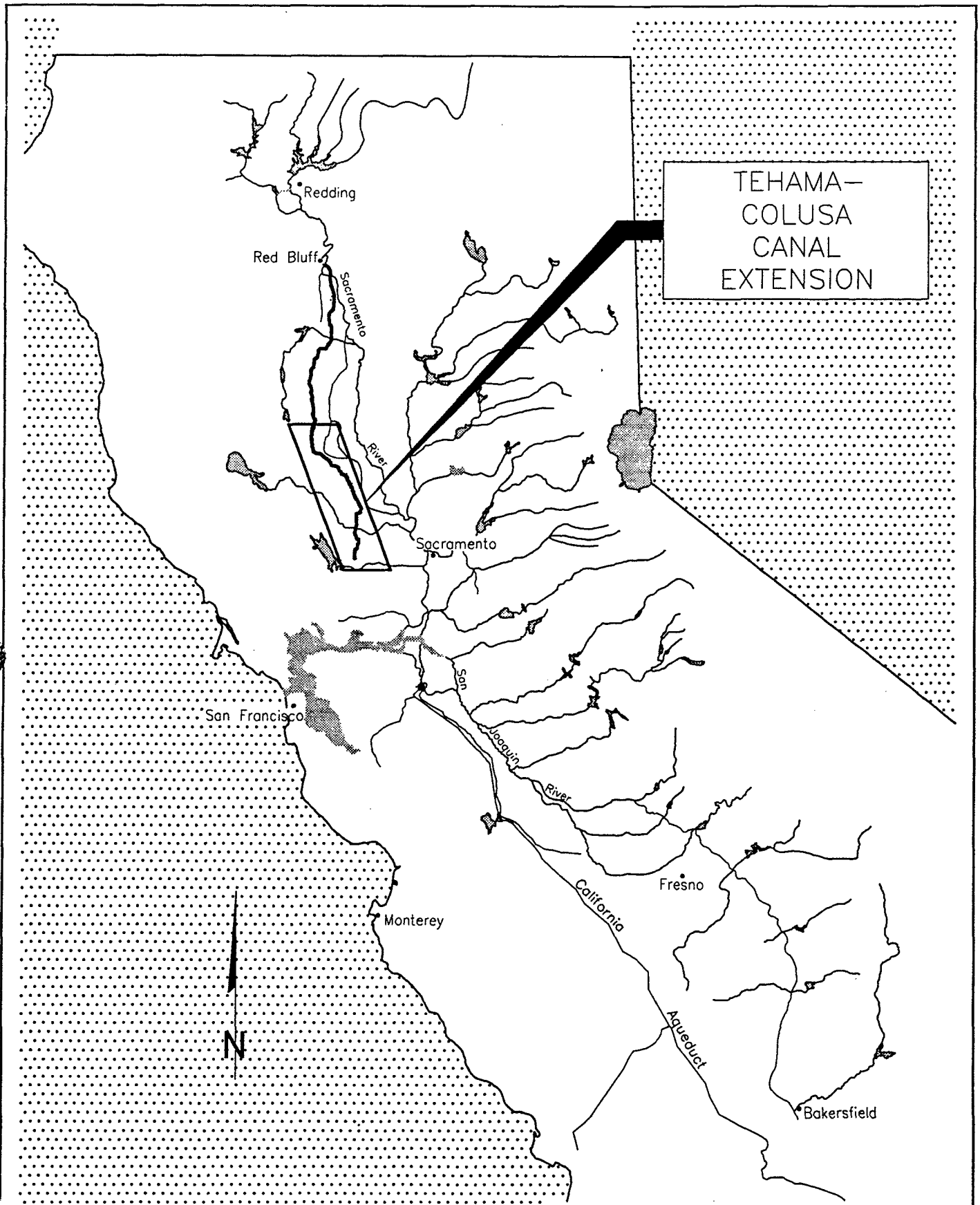

Figure 1

Project Location Map
Tehama-Colusa Canal Extension

CALFED BAY-DELTA PROGRAM

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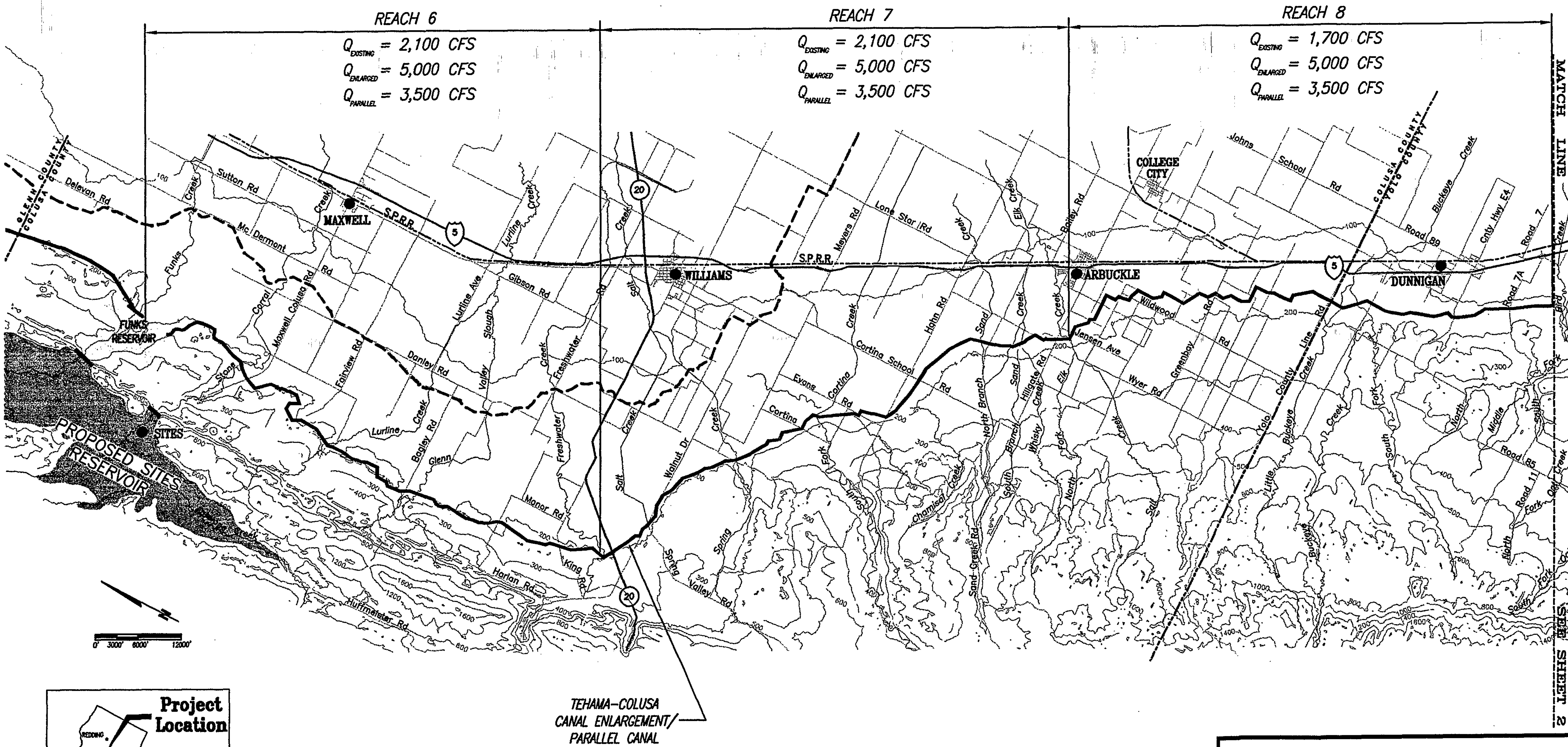

LEGEND

- Existing Funks Reservoir
- Proposed Sites Reservoir
- Existing Tehama–Colusa Canal
- Tehama–Colusa Canal Enlargement / Parallel Canal
- Glenn–Colusa Canal
- Railroad
- Existing Roads and Highways
- Existing Rivers

Figure 2a

Facilities Location Map Tehama–Colusa Canal Extension

Sheet 1 OF 2

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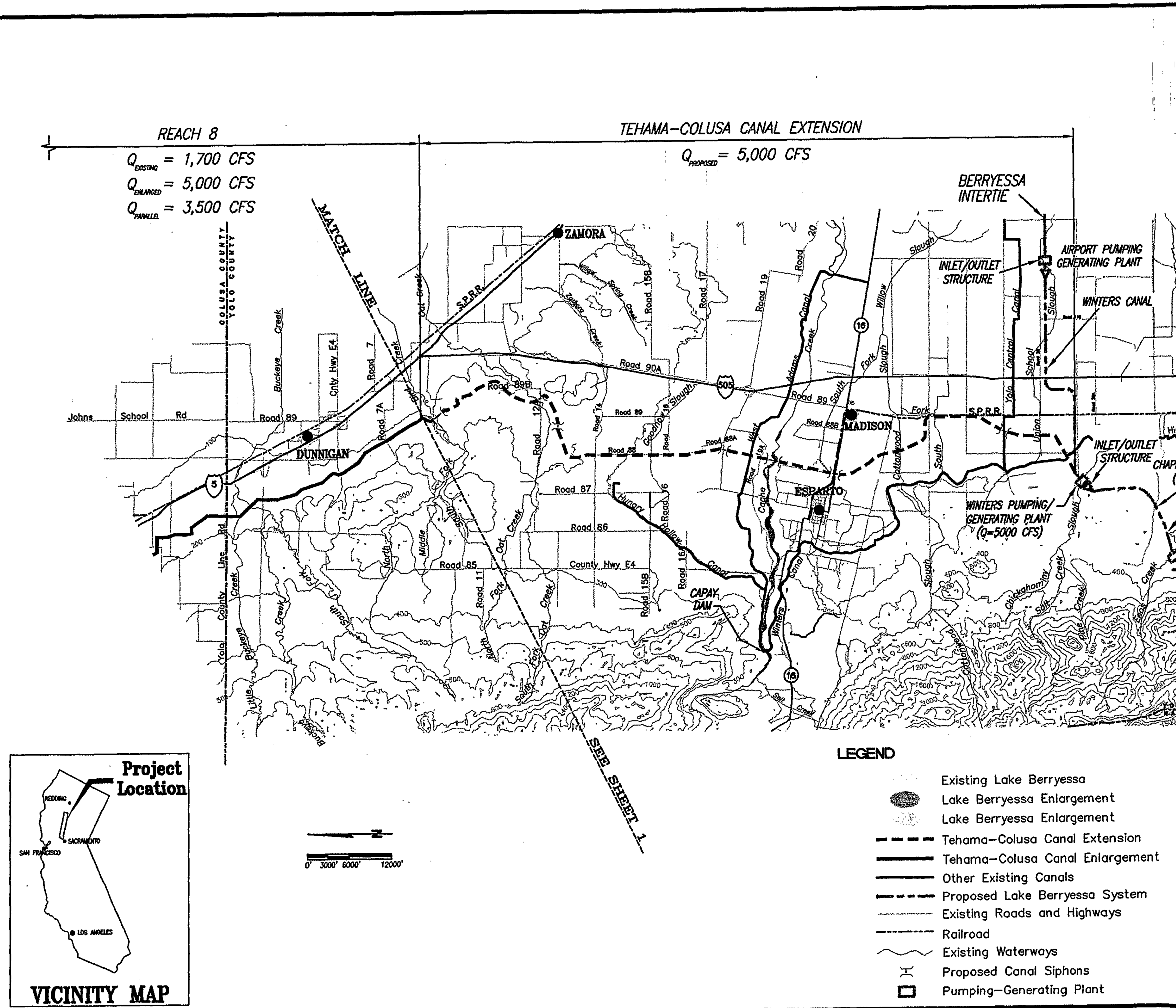

Figure 2b

Facilities Location Map
Tehama-Colusa Canal Extension

Sheet 2 OF 2

CALFED BAY-DELTA PROGRAM

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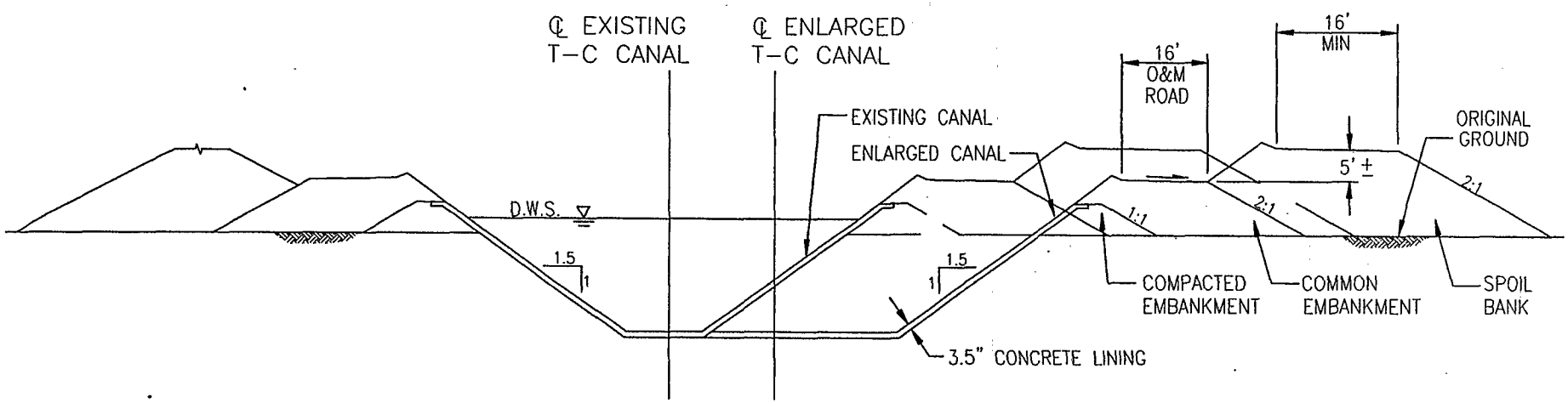


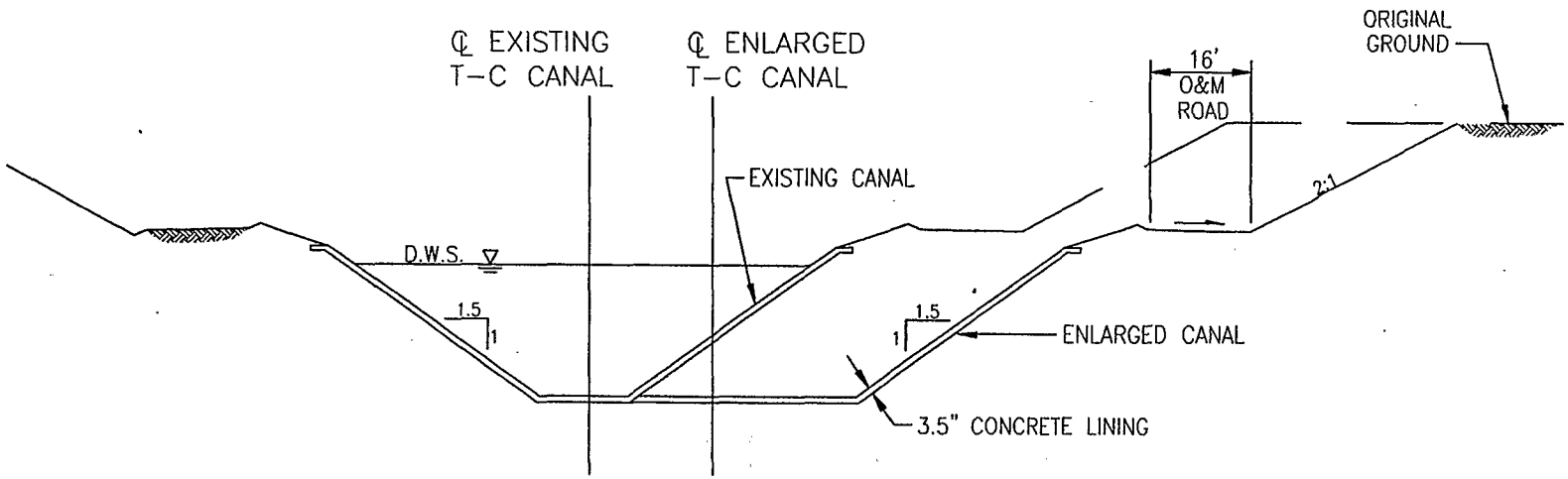
ENLARGED CANAL IN FILL
(Reaches 6, 7, and 8 of
Existing Tehama–Colusa Canal)

NOT TO SCALE

Figure 3a

Typical Canal Section
Tehama-Colusa Canal Extension

CALFED BAY-DELTA PROGRAM



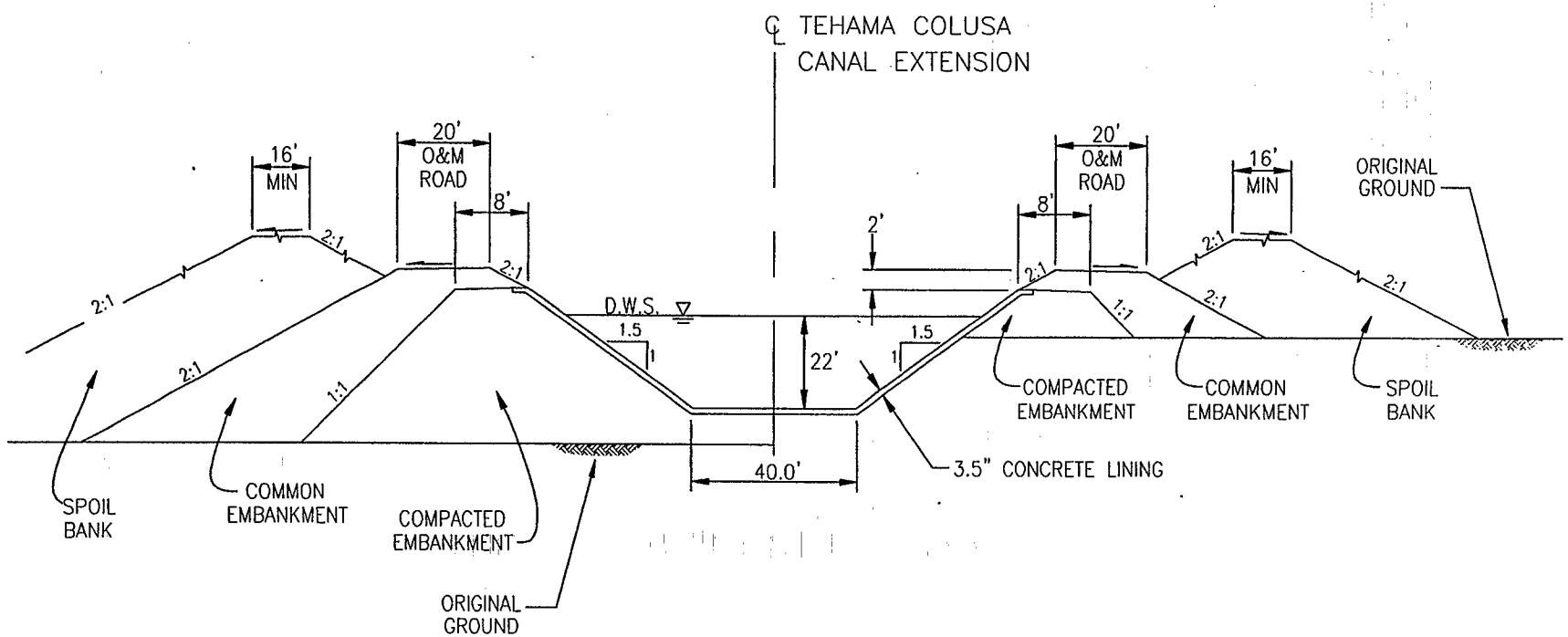
ENLARGED CANAL IN CUT
(Reaches 6, 7, and 8 of
Existing Tehama-Colusa Canal)
NOT TO SCALE

Figure 3b

Typical Canal Section

Tehama-Colusa Canal Extension

CALFED BAY-DELTA PROGRAM



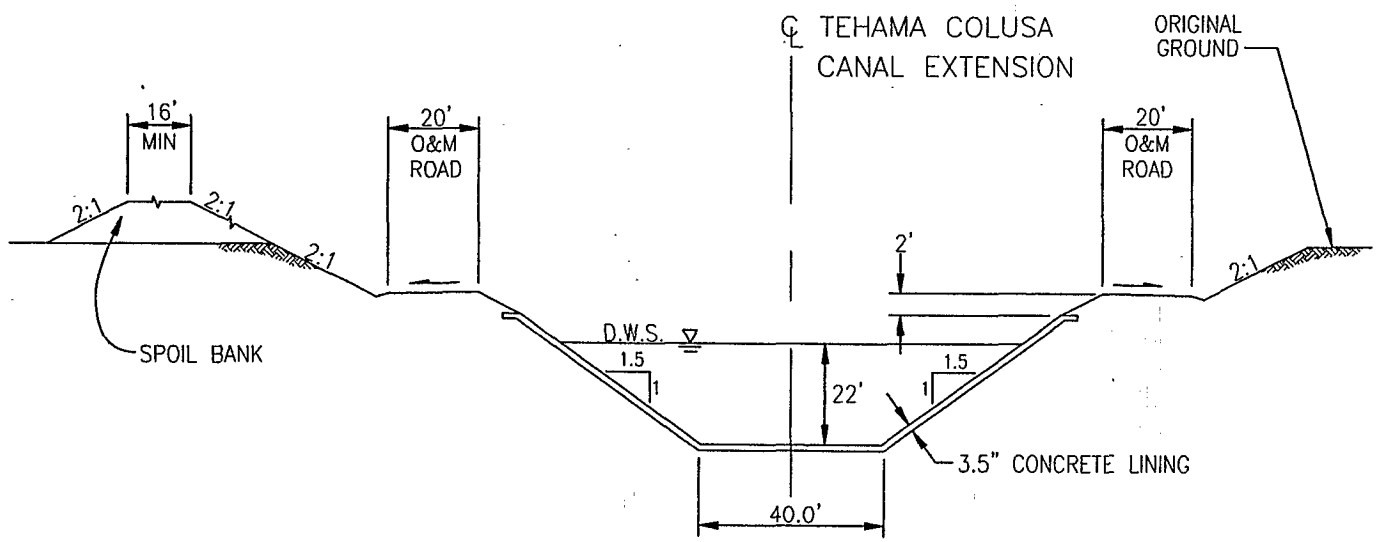
NEW CANAL IN FILL
NOT TO SCALE

Figure 4a

Typical Canal Section

Tehama-Colusa Canal Extension

CALFED BAY-DELTA PROGRAM



NEW CANAL IN CUT
NOT TO SCALE

Figure 4b

Typical Canal Section

Tehama-Colusa Canal Extension

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