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**PROJECT DESCRIPTION  
AND UPDATED COST ESTIMATES  
FOR SITES/COLUSA RESERVOIR PROJECT**

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March 25, 1997**

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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

Various Sites/Colusa Reservoir Projects have been examined over the past four decades. The earliest published reference to a Sites Reservoir Project is found in the DWR Bulletin 3, *The California Water Plan 1957*, which mentions a 48,000 acre-foot off-stream storage reservoir on Stone Corral and Funks Creeks supplied by the Tehama-Colusa Canal. The project was again identified in DWR Bulletin 109, *Colusa Basin Investigation*, 1964, to evaluate potential flood control projects, and considered two separate reservoirs of 5,800 and 7,600 acre-feet on Stone Corral and Funks Creeks, respectively. An update of this report in 1990 found these reservoirs unjustified for flood control alone.

Consideration of larger projects at the Sites location was first documented in December 1964, when the Bureau of Reclamation published its *West Sacramento Canal Unit Report*, which studied the feasibility of extending the Tehama-Colusa Canal (via a new West Sacramento Valley Canal) into Solano County near Fairfield. As part of this canal extension plan, a 1.2 maf Sites Reservoir was proposed. This study did not evaluate the potential of Sites Reservoir as a stand-alone project, only as part of the extended canal system. This was the most detailed study of the Sites Reservoir Project and formed the basis for cursory studies which followed. The Bureau of Reclamation attempted to obtain funds for a full feasibility study of Sites Reservoir in 1977; however, appropriations were never approved. The short concluding report ending the Bureau of Reclamation's efforts stated, "The 1976-77 Drought clearly demonstrated the need for additional surface water development. One means of increasing water supply is conservation of surplus flows by storage in off-stream reservoirs." Sites Reservoir is capable of conserving these surplus flows, thereby increasing water supply availability.

Office Report, September 1983; (3) *Least-Cost CVP Yield Increase Plan - Appendix #6, Surface Storage and Conveyance*, USBR Office Report, September 1995.

In March 1990, the engineering consulting firm, CH2M Hill, Inc., prepared a long-range plan for Glenn-Colusa which included an 870,000 acre-foot Sites Reservoir with normal water surface elevation at 460 feet. This project was based on the Bureau of Reclamation's 1964 report, but was judged unimplementable by Glenn-Colusa because of the financing needed to cover the capital cost of \$152 million. In 1993, CH2M Hill published a small report on *Meeting California's Water Needs in the 21st Century*, which presented a conceptual Westside Storage and Conveyance System. This concept mentioned a Sites/Colusa Reservoir with a feeder pipeline from Lake Oroville. DWR's *California Water Plan Update*, Bulletin 160-93, included a description of the Westside Sacramento Valley Concept when discussing water supply management options.

## FACILITIES DESCRIPTIONS

This section provides details on three alternative sizes of off-stream storage projects at the Sites/Colusa location to be used for this evaluation. These sizes include (1) the Small Sites Reservoir Project, which would have a capacity of 1.2 maf with the crest of the dam at 490 feet above mean sea level (MSL); (2) the Large Sites Reservoir Project, with a capacity of 1.9 maf with the crest of the dam at 541 feet above MSL; and (3) the Colusa Reservoir Project, with a capacity of 3.3 maf with the crest of the dam at 541 feet above MSL. Other intermediate sizes are possible, but these three alternatives encompass the practical range of reservoir sizes for large-scale water conservation purposes. If the storage of Colusa Reservoir was increased above 3.3 maf, the embankment volume and number of saddle dams would increase substantially. Additionally, seepage through Logan Ridge, which forms the eastern boundary of all reservoir options, might become an issue.

capacity curves for Sites Reservoir and Colusa Reservoir are shown on Figures 4 and 5, respectively.

The primary purpose of the Sites/Colusa Reservoir Project would be to provide additional drought-year water supplies for agricultural, environmental, and urban uses in the Bay-Delta. In addition, other potential benefits of a Sites/Colusa Reservoir Project could include:

- Flood control for the lands around the town of Maxwell as well as in the Colusa Basin drain.
- Increased recreational use around the reservoir.
- Increased reliability of local water supplies.
- Potential for conjunctive use and management of local groundwater and surface water supplies to further augment drought period water supplies.
- More reliable and adequate water supplies for refuges in the Colusa Basin.

#### PRINCIPAL FACILITIES

The following section provides a description of the three alternative reservoirs which could be constructed at the Sites/Colusa site. These reservoirs are the Small Sites Reservoir with 1.2 maf of total storage capacity, the Large Sites Reservoir with 1.9 maf of total storage capacity, and the Colusa Reservoir with 3.3 maf of total storage capacity.

Summaries of the physical features of the Small Sites, Large Sites, and Colusa Reservoir alternatives are provided in the following sections. A schematic profile of the Small Sites and

10 percent of the maximum water depth must be released in ten days. Therefore, the Small Sites Reservoir outlet tunnel was cost-estimated at a release capacity of 15,200 cfs. No outlet facility would be required at Sites Dam. Funks Reservoir has a spillway with a capacity of 22,430 cfs and, therefore, no additional emergency release facilities are required at Funks Reservoir to evacuate the emergency release from Small Sites Reservoir.

### Large Sites Reservoir Project

The Large Sites Reservoir Project was described and evaluated in the 1980 Bureau of Reclamation appraisal report on the West Sacramento Canal Unit. Similar in content to the 1964 report, the 1980 report also focused on the West Sacramento Canal Unit components, one of which was Large Sites Reservoir.

The Large Sites Reservoir Project has a maximum operating water surface elevation of 532 feet, which would inundate approximately 14,700 acres. The reservoir would be formed by a 294-foot-high Sites Dam on Stone Corral Creek and a 302-foot-high Golden Gate Dam on Funks Creek (plus 12 saddle dams ranging up to 112 feet high). The total storage capacity of the Large Sites Reservoir would be 1.9 maf.

The existing 40-foot-high dam which forms Funks Reservoir would remain the same for this alternative and would regulate inflow and outflow from Sites Reservoir. A pumping-generating plant would be located at the base of Golden Gate Dam to pump water a maximum of 332 feet from Funks Reservoir into Sites Reservoir (Sites Pumping-Generating Plant). The pumping-generating plant would have a capacity of 5,000 cfs and would serve both inflow and outflow requirements for the Large Sites Reservoir Project.

Twelve saddle dams ranging in height from 27 to 112 feet would be required at the north end of Large Sites Reservoir to close the gaps between the small rolling mounds that form the divide

The Colusa Reservoir, like Small and Large Sites Reservoirs, would be filled by winter and spring Sacramento River surplus flows. This water would be delivered to Colusa Reservoir through an enlarged Tehama-Colusa Canal, but would be pumped from a different location than that of Small and Large Sites Reservoirs. This location is approximately four miles south of Willows and nine miles north of Funks Reservoir.

The conveyance system from the Tehama-Colusa Canal to Colusa Reservoir would include (1) Logan Forebay, a 400 acre-foot impoundment formed by a low earth dam on Logan Creek immediately west of the Tehama-Colusa Canal; (2) a 5,000 cfs, 1.7-mile Logan Canal connecting Logan Forebay to the Logan Pumping-Generating Plant located at the base of Logan Dam; and (3) the Logan Pumping-Generating Plant, which would lift water a maximum of 322 feet into Colusa Reservoir. Logan Pumping-Generating Plant would have a capacity of 5,000 cfs and would serve both inflow and outflow requirements for the Colusa Reservoir Project.

An open-chute type spillway with an uncontrolled crest (ungated) and having a capacity of 2,500 cfs would discharge into Hunters Creek. Like Small and Large Sites Reservoirs, a small spillway is adequate because of the large water surface area in relation to the small, relatively dry tributary drainage area.

The outlet works facilities for Colusa Reservoir would include an outlet at Logan Dam and at Golden Gate Dam. The outlet works facility, located at Logan Dam, would contain the penstock for the Logan Pumping-Generating Plant and would be used to fill Colusa Reservoir and to make releases to Logan Forebay. The outlet facility located at Golden Gate Dam would only be used to help during an emergency evacuation. The DWR, Division of Safety and Dams requires that during an emergency evacuation, 10 percent of the maximum water depth must be released in 10 days. This equates to an estimated release capacity of 44,000 cfs, or 22,000 cfs at each outlet works facility. Alternative methods for evacuating the emergency release flows could include

The 1988 study implied the possibility of large-scale earthquake activity in the area emanating from "hidden" faults along the western Great Valley, other investigations have also examined the west side of the Sacramento Valley and identified several hot spots of micro-seismic activity related to "hidden" or "blind" faults. To date, the extent and potential of these hidden faults have yet to be adequately defined. This undefined potential for large-scale earthquake activity within the Sites/Colusa Reservoir Project region could substantially affect the design of the facilities and deserves considerable additional study.

### COST ESTIMATE

The cost estimates for the facilities described in the previous sections are based on previous estimates performed by the Bureau of Reclamation. The previous estimates have been reviewed and adopted 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. Items not included in this estimate include environmental documentation, operation and maintenance costs, power costs, reservoir filling costs, and interest during construction.

### SMALL AND LARGE SITES RESERVOIRS

The cost estimates for the Small and Large Sites Reservoir alternatives were determined by applying current unit costs to quantities found in the June 1964 Bureau of Reclamation report titled *West Sacramento Canal Unit, Reconnaissance Design Criteria and Cost Estimate Appendix* (Small Sites Report) and in the September 1980 Bureau of Reclamation report titled *West Sacramento Canal Unit, Appraisal Design Criteria and Cost Estimate Appendix* (Large Sites Report). Current unit costs were determined by escalating the unit costs found in the 1990 DWR report titled *Los Banos Grandes Facilities Report, Appendix A: Designs and Cost Estimates* (LBG Report). The costs were escalated to October 1996 dollars using the Bureau of Reclamation's Construction Cost Trends (CCT) indices. Tables 2a and 2b provide a detailed

the outlet works were factored as described below in the Outlet Works Capacity Adjustment section. The cost estimate for the spillway was similarly adjusted.

For the new cost estimates, U.S. Geological Survey (USGS) 1:24,000 scale quad maps were used to locate Hunters Dam, Logan Dam, Logan Forebay Dam, and all nine saddle dams (new dams). Dam embankment quantities were calculated based on the typical Sites Dam cross section used in the 1980 Bureau of Reclamation report and the ground profile generated from the USGS maps. Using the detailed cost estimate for the Large Sites Golden Gate Dam as a basis for determining cost for the new dams, any new dam's cost was estimated by factoring the cost of the Golden Gate Dam by the ratio of the dam embanking volume of the new dam to the dam embankment volume of Golden Gate Dam.

The cost for Logan Canal was developed by applying linear foot unit costs to the 1.7 mile length of canal. The costs for linear foot of canal were developed for the Chico Landing CALFED conveyance component. Table 2c provides a detailed breakdown of the estimated costs of constructing Colusa Reservoir.

### Right-of-Way Costs

Right-of-way cost of \$1,500 per acre was used for the Sites/Colusa Reservoir Project. Right-of-way costs were developed by the Bureau of Reclamation's Land Resources Branch (pers. comm. 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 LBG Report.

### 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 Sites/Colusa Reservoir pumping-generating plants. To develop a cost for the Sites/Colusa Reservoir 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 is equal to horsepower.

As with the cost factor formula used for estimating the new outlet works costs, this formula is also 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.

### 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, and engineering, construction management, and administration were chosen to be 35 percent. A cost range was developed for either of the reservoir alternatives 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.

**Fish, Amphibians, Reptiles, and Invertebrates**

The small streams that run through the Sites/Colusa Reservoir Project area provide habitat for a number of fish species that are classified as nongame. Representative native species include Sacramento sucker, hitch, Sacramento squawfish, and Sacramento blackfish. The area may also support green sunfish, an introduced game fish. Salt Lake, located in Antelope Valley, has no fish, but supports abundant insect fauna.

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**General Wildlife**

The proposed reservoir complex area supports a moderately diverse faunal assemblage. 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.

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The deer population is average for the area and supports considerable hunting by landowners. The open grasslands and areas along the intermittent drainage provide limited yearling and winter deer use. Deer migration corridors are not expected to be impacted by the proposed reservoir, and impacts are projected to be minimal.

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Numerous bird species can be found using the Antelope Valley portion of the proposed reservoir site, especially during spring and fall migrations. Salt Lake also provides habitat for numerous bird species, including curlews and sandpipers. Killdeer can be found nesting in open fields. Some of the common perching birds found nesting in the area include meadowlark, blackbird, jay, flycatcher, swallow, crow, starling, and mockingbird. Birds nesting in the oak woodlands include golden eagles, hawks, and owls. Game birds found in the area include quail, pheasant, dove, and pigeon.

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The San Joaquin pocket mouse, a species of special concern, is known to occur within or adjacent to the project area.

**VEGETATION**

Vegetation at the Sites/Colusa Reservoir Project consists primarily of grasslands (23,065 acres) comprised of wild oat, brome grass, and fescues. About 10 percent of the land is planted in barley (1,300 acres of agriculture). Some valley needlegrass grassland communities may be found in the area. The woodlands (1,345 acres) are comprised mostly of blue oaks and can be found throughout the area, particularly in the western upland areas. Riparian vegetation (220 acres) occurs along Antelope, Stone Corral, Funks, and Grapevine Creeks; however, these areas have been severely degraded as a result of overgrazing and extensive cultivation to the stream edges. The majority of the riparian vegetation found in this area consists of sycamore, willow, and cottonwood. Aquatic plant species found in the drainage areas include bulrush, cattail, rush, and smartweed. Approximately 120 acres of disturbed area exists within the reservoir area.

**Sensitive and Listed Plant Species**

To date, no listed plant species have been recorded in the proposed Sites/Colusa Reservoir Project area.

Candidate species for federal listing that may occur in the project area include tropidocarpum, San Joaquin saltbush, diamond-petaled California poppy, and adobe lily. In the case of the adobe lily, large amounts of potential habitat for this plant exists throughout the project site, particularly north of the community of Sites.

**CULTURAL RESOURCES**

A recent search of the Historic Resources Information System located at Rohnert Park, California, revealed one listing that indicated homesteading and ranching took place in the project area during the historic period. Other sources indicate that there are 18 prehistoric sites and 13 historic sites in the area. Of these 31 sites, five are significant, and at least two others have the potential to be significant, but require additional study. The project site also contains three significant ethnographic sites.

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CH2M Hill, Inc., 1993, *Meeting California's Water Needs in the 21st Century*.

Department of Fish and Game, Bay Delta and Special Water Projects Division, September 28, 1996, *Sites Creek Alternative Environmental Impacts Investigations*, Draft Proposal, State of California.

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

Department of Water Resources, Bulletin 3, *The California Water Plan 1957*, State of California.

Department of Water Resources, 1964, *Colusa Basin Investigation*, Bulletin 109, State of California.

Department of Water Resources, 1965, *Northern Coastal Area Investigation*, Bulletin 136, State of California.

Department of Water Resources, 1975, *Major Surface Water Development Opportunities in the Sacramento Valley*, State of California.

Department of Water Resources, November 1981, *State Water Project - Status of Water Conservation and Water Supply Augmentation Plans: Bulletin 76-81*, State of California.

Department of Water Resources, August 1982, *Enlarging Shasta Lake Feasibility Study - Descriptions of Alternative Storage Facilities*, State of California.

Department of Water Resources, 1988, flood flow frequency analysis of the Colusa Basin at the Highway 20 gage west of Williams.

**Table 1**  
**SUMMARY OF PHYSICAL CHARACTERISTICS**  
**SITES/COLUSA RESERVOIR PROJECT**

	Small Sites	Large Sites	Colusa
<b>Storage</b>			
Gross (acre-feet)	1,200,000	1,900,000	3,000,000
Maximum Water Surface Area (acres)	12,300	14,700	28,500
<b>Reservoir Water Surface Elevations</b>			
Maximum Operating (feet MSL)	480	532	520
Minimum Operating (feet MSL)	320	320	530
<b>Dam Crest Elevation (feet MSL)</b>	490	541	529
<b>Dam Height</b>			
Sites (feet)	243	294	280
Golden Gate (feet)	251	302	290
Hunters (feet)	---	---	270
Logan (feet)	---	---	260
<b>Saddle Dams</b>			
Number	5	12	11
Height Range (feet)	10 to 80	27 to 112	35 to 140
<b>Pumping-Generating Plants</b>			
<b>Static Lift from Tehama-Colusa Canal</b>			
Maximum (feet)	280	332	310
Minimum (feet)	155	115	110
<b>Capacity</b>			
Maximum (cfs)	5,000	5,000	5,000
<b>Spillway Capacity (cfs)</b>	250	250	2,500
<b>Outlet Works Capacity (cfs)</b>	15,200	22,000	40,400
<b>Logan Creek Capacity (cfs)</b>	---	---	5,000
<b>Logan Canal Length (mile)</b>	---	---	1.7

**Table 2a**  
**ESTIMATED COSTS**  
**SMALL SITES RESERVOIR (1.2 MAF ALTERNATIVE)**

DESCRIPTION	QUANTITY	UNIT*	USBR INDEX	USBR INDEX	UNIT COST	UNIT COST	TOTAL COST	COST REFERENCE
			OCT. 63	OCT. 96	OCT. 63	OCT. 96	OCT. 96	
Water for seeding	1,000	MGAL	42	176	\$2.50	\$10.48	\$10,476	2, sheet 4
Drilling grout holes 0 to 30 feet	18,180	LF				\$18.70	\$339,966	3, item I-q
Drilling grout holes 30 to 60 feet	9,090	LF				\$18.70	\$169,983	3, item I-q
Drilling grout holes 60 to 110 feet	5,760	LF				\$18.70	\$107,712	3, item I-q
Drilling grout holes 110 to 160 feet	1,720	LF				\$18.70	\$32,164	3, item I-q
Concrete in grout caps	2,000	CY	42	176	\$35.00	\$146.67	\$293,333	2, sheet 4
Furnish and install grout pipe and fittings	17,400	LB	42	176	\$0.95	\$3.98	\$69,269	2, sheet 4
Hookups to grout holes	610	EA	42	176	\$10.00	\$41.90	\$25,562	2, sheet 4
Pressure grouting	52,130	SKS	42	176	\$2.50	\$10.48	\$546,124	2, sheet 4
Cement	16,090	BBL	42	176	\$5.00	\$20.95	\$337,124	2, sheet 4
<b>SUBTOTAL DAMS</b>							\$40,808,484	
<b>VI. SPILLWAY</b>								
Excavation, open cut, all classes	8,557	CY				\$4.03	\$34,485	3, avg items II-a, III-a
Backfill	1,200	CY				\$8.17	\$9,804	3, item III-f
Special compacted backfill	300	CY				\$13.51	\$4,053	1, sheet 5
Structural Concrete in floors and crest	485	CY				\$365.24	\$177,141	3, avg items II-h, III-c, III-d
Structural Concrete in walls	479	CY				\$365.24	\$174,950	3, avg items II-h, III-c, III-d
Drilling and grouting anchors	2,260	LF				\$16.86	\$38,104	1, sheet 5
F&I 4" dia. S.P. drains	180	LF				\$16.86	\$3,035	1, sheet 5
Riprap	200	CY				\$31.64	\$6,328	3, item I-n
Bedding for riprap	100	CY				\$11.79	\$1,179	3, item I-n
F&I 6" dia. S.P. drains	700	LF				\$16.86	\$11,802	1, sheet 5
10% Minor items	JOB	LS					\$46,088	
<b>Subtotal Spillway (1.9 MAF ALT)</b>							\$506,969	
Factor cost by ratio of max. water depths (244.3/295.8)=	0.826							
<b>SUBTOTAL SPILLWAY (1.2 MAF)</b>							\$418,736	
<b>VII. OUTLET WORKS</b>								
Excavation all classes tailrace	36,000	CY				\$7.40	\$266,400	1, sheet 6
Excavation, open cut	6,000	CY				\$3.38	\$20,280	3, item II-a
Excavation, tunnel	9,700	CY				\$128.27	\$1,244,219	3, item VI-s
Excavation, gate chamber and shaft	6,300	CY				\$146.59	\$923,517	3, item II-c
Drilling grout holes	13,400	LF				\$18.70	\$250,580	3, item I-q
F&I grout pipe and fittings	6,700	LB				\$4.59	\$30,753	1, sheet 6
Hookups to grout holes	446	EA				\$91.73	\$40,912	1, sheet 6
Pressure grouting	13,400	SKS				\$91.73	\$1,229,182	1, sheet 6
Concrete in tunnel lining	7,240	CY				\$320.68	\$2,321,723	3, item VI-t
Structural Concrete in intake	3,950	CY				\$339.50	\$1,341,025	3, item VI-k
Structural Concrete in gate chamber and shaft	3,110	CY				\$339.50	\$1,055,845	3, item VI-k

**Table 2a  
ESTIMATED COSTS  
SMALL SITES RESERVOIR (1.2 MAF ALTERNATIVE)**

DESCRIPTION	QUANTITY	UNIT <sup>a</sup>	USBR INDEX OCT. 63	USBR INDEX OCT. 96	UNIT COST OCT. 63	UNIT COST OCT. 96	TOTAL COST OCT. 96	COST REFERENCE
<b>X. SITES-COTTONWOOD ELVERTA #2 LOOP</b>								
Clearing Land	JOB	LS				\$3,841	\$3,841	1, sheet 27
Towers and Fixtures	JOB	LS				\$405,911	\$405,911	1, sheet 27
Conductors and Devices	JOB	LS				\$215,416	\$215,416	1, sheet 27
<b>SUBTOTAL #2 LOOP</b>							\$625,168	
<b>SUBTOTAL</b>							\$349,000,000	
<b>CONTINGENCIES @ 20%</b>							\$69,800,000	
<b>ESTIMATED CONSTRUCTION COST</b>							\$419,000,000	
<b>ENGR, LEGAL, AND ADMIN @ 35%</b>							\$147,000,000	
<b>ESTIMATED CAPITAL COST</b>							\$566,000,000	
<b>ESTIMATED CAPITAL COST RANGE</b>								
LOW (-10%)							\$509,000,000	
HIGH (+15%)							\$651,000,000	
<b>COST ESTIMATE DOES NOT INCLUDE ENLARGING FUNKS RESERVOIR.</b>								

**Footnote:**

<sup>a</sup>AC=acre; LS=lump sum; MI=mile; CY=cubic yard; LF=linear Foot; SY=square yard; MGAL=million gallons; LB=pound; EA=each; BBL=barrel

**Cost References:**

1. U.S. Bureau of Reclamation, *Appraisal Design Criteria and Cost Estimate Appendix, West Sacramento Canal Unit, Sacramento River Division, CVP*, September 1980.
2. U.S. Bureau of Reclamation, *Reconnaissance Design Criteria and Cost Estimate Appendix, West Sacramento Canal Unit, Sacramento River Division, CVP*, June 1964.
3. California Department of Water Resources, *Los Banos Grandes Facilities Report, Appendix A: Designs and Cost Estimates*, December 1990.
4. Cost developed by Bookman-Edmonston Engineering.
5. U.S. Bureau of Reclamation, Land Resources Branch, Graham McMullen, February 1997.

**Table 2b**  
**ESTIMATED COSTS**  
**LARGE SITES RESERVOIR (1.9 MAF ALTERNATIVE)**

DESCRIPTION	QUANTITY	UNIT*	USBR INDEX	USBR INDEX	UNIT COST	UNIT COST	TOTAL COST	COST REFERENCE
			JAN. 80	OCT. 96	JAN. 80	OCT. 96	OCT. 96	
<b>VI. SITES DAM - Earthfill and Rockfill Structure; Crest Elevation 541.5</b>								
Diversion and care of river	JOB	LS	125	207	\$144,000	\$238,464	\$238,464	1, sheet 4
Excavation for equalizing channel and fill in coffer dams	183,000	CY	123	176	\$2.50	\$3.58	\$654,634	1, sheet 4
Excavation, all classes for foundation	209,300	CY				\$3.23	\$676,039	2, item I-d
Stripping borrow pits	167,000	CY				\$1.15	\$192,050	2, item I-c
Excavation, impervious and hauling to dam (borrow)	1,666,000	CY				\$3.22	\$5,364,520	2, item I-e
Excavation, rockfines and hauling to dam (borrow)	470,100	CY	123	176	\$5.00	\$7.15	\$3,363,317	1, sheet 4
Excavation, rock and hauling to dam (borrow)	1,133,600	CY	123	176	\$5.00	\$7.15	\$8,110,309	1, sheet 4
Placing impervious	1,424,000	CY				\$0.95	\$1,352,800	2, item I-f
Placing rockfines	587,600	CY				\$0.75	\$440,700	2, item I-h
Placing rock	1,619,400	CY				\$0.75	\$1,214,550	2, item I-h
F&P sand filters and gravel drains	128,600	CY				\$8.54	\$1,098,244	1, items I-i & I-j
Grouting foundation	JOB	LS	123	176	\$166,000	\$237,528	\$237,528	1, sheet 4
Drains	2,350	LF	123	176	\$12.75	\$18.24	\$42,873	1, sheet 4
Gravel on crest	730	CY	123	176	\$9.00	\$12.88	\$9,401	1, sheet 4
10% Minor items	JOB	LS					\$2,299,543	1, sheet 4
<b>SUBTOTAL SITES DAM</b>							<b>\$25,294,973</b>	
<b>VII. DIKES</b>								
Excavation, all classes for foundation	539,000	CY				\$3.23	\$1,740,970	2, item I-d
Excavation, impervious and hauling to dam (borrow)	4,115,500	CY				\$3.22	\$13,251,910	2, item I-e
Excavation, sand, gravel and hauling to dam (borrow)	970,000	CY	123	176	\$6.65	\$9.52	\$9,229,984	1, sheet 5
Excavation, rock and hauling to dam (borrow)	1,671,000	CY	123	176	\$6.65	\$9.52	\$15,900,312	1, sheet 5
Placing impervious	3,517,500	CY				\$0.95	\$3,341,625	2, item I-f
Placing rockfines	1,212,500	CY				\$0.75	\$909,375	2, item I-h
Placing rock	2,387,500	CY				\$0.75	\$1,790,625	2, item I-h
F&P riprap	169,700	CY				\$31.64	\$5,369,308	2, item I-n
F&P filter blanket	504,100	CY				\$8.54	\$4,305,014	2, item I-i
F&P bedding for riprap	84,900	CY				\$11.79	\$1,000,971	2, item I-m
Grouting foundation	JOB	LS	123	176	\$568,000	\$812,748	\$812,748	1, sheet 5
10% Minor items	JOB	LS					\$5,765,284	
<b>SUBTOTAL DIKES</b>							<b>\$57,652,842</b>	
<b>VIII. SPILLWAY</b>								
Excavation, open cut, all classes	8,557	CY				\$4.03	\$34,485	2, avg items II-a, III-a

**Table 2b**  
**ESTIMATED COSTS**  
**LARGE SITES RESERVOIR (1.9 MAF ALTERNATIVE)**

DESCRIPTION	QUANTITY	UNIT <sup>a</sup>	USBR INDEX JAN. 80	USBR INDEX OCT. 96	UNIT COST JAN. 80	UNIT COST OCT. 96	TOTAL COST OCT. 96	COST REFERENCE
Tunnel vent system	JOB	LS	128	206	\$80,500	\$129,555	\$129,555	1, sheet 6
Other misc. metalwork	3,000	LB				\$3.63	\$10,890	2, item VI-ii
Rockbolts	27,900	LF				\$64.14	\$1,789,506	2, item VI-y
Chain link fabric	23,000	SF	128	206	\$8.00	\$12.88	\$296,125	1, sheet 6
10% Minor items	JOB	LS					\$2,162,722	
<b>SUBTOTAL OUTLET WORKS</b>							<b>\$23,789,947</b>	
Upsize Outlet Works for Emergency Evacuation								
Increase Outlet Works capacity from 2,100cfs to 22,000cfs								
Cost Factor = $(22,000/2100)^{3/8} = 2.413$	2.413							
<b>OUTLET WORKS COST</b>							<b>\$57,405,142</b>	
<b>X. SITES PUMPING - GENERATING PLANT (Located at Golden Gate Dam)</b>								
<b>(Q=5,000cfs, TDH=342, eff=75%, 258,680 HP)</b>								
Structures, Equipment and Electrical, Complete	JOB	LS					\$234,750,000	3
<b>SUBTOTAL SITES PUMPING - GENERATING PLANT</b>							<b>\$234,750,000</b>	
<b>XI. SITES PUMPING-GENERATING PLANT SWITCHYARD</b>								
<b>Station Equipment, Electrical</b>								
Transformer, 3 Phase, 65 MVA, 230/6.9 kv	1	EA	123	190	\$665,721	\$1,028,350	\$1,028,350	1, sheet 26
230-kv Line Bay, 10,000 MVA	3	EA	123	190	\$421,000	\$650,325	\$1,950,976	1, sheet 26
230-kv Bus-Tie Bay, 10,000 MVA	1	EA	123	190	\$371,000	\$573,089	\$573,089	1, sheet 26
Coupling Capacitor, (w/potential device)	5	EA	123	190	\$7,800	\$12,049	\$60,244	1, sheet 26
Carrier equipment	2	EA	123	190	\$20,000	\$30,894	\$61,789	1, sheet 26
Telemetry and supervisory control	JOB	LS	123	190	\$118,936	\$183,722	\$183,722	1, sheet 26
<b>SUBTOTAL SWITCHYARD</b>							<b>\$3,858,169</b>	
Increase capacity from 2,100cfs to 5,000cfs								
Cost Factor = $(5,000/2100)^{6/10} = 1.683$	1.683							
<b>OUTLET WORKS COST</b>							<b>\$6,493,299</b>	
<b>XII. SITES-COTTONWOOD ELVERTA #2 LOOP</b>								
Clearing Land	JOB	LS	126	217	\$2,230	\$3,841	\$3,841	1, sheet 27
Towers and Fixtures	JOB	LS	126	217	\$235,690	\$405,911	\$405,911	1, sheet 27
Conductors and Devices	JOB	LS	126	217	\$125,080	\$215,416	\$215,416	1, sheet 27
<b>SUBTOTAL #2 LOOP</b>							<b>\$625,167</b>	

**Table 2c  
ESTIMATED COSTS  
COLUSA RESERVOIR (3.3 MAF ALTERNATIVE)**

DESCRIPTION	QUANTITY	UNIT	USBR INDEX JAN. 80	USBR INDEX OCT. 96	UNIT COST JAN. 80	UNIT COST OCT. 96	TOTAL COST OCT. 96	COST REFERENCE
<b>I. RIGHTS-OF-WAY</b>								
Colusa Reservoir (Includes Buffer Area Factor of 1.32)	39,072	AC				\$1,500	\$58,608,000	1
Logan Canal (1.7 Miles by 350 Feet Wide)	72	AC				\$1,500	\$108,000	1
Logan Forebay (Includes Buffer Area Factor of 1.32)	68	AC				\$1,500	\$102,000	1
<b>SUBTOTAL RIGHTS-OF-WAY</b>							\$59,818,000	
<b>II. RELOCATION OF EXISTING PROPERTY</b>								
Secondary Road Relocation	JOB	LS				\$31,672,000	\$31,672,000	2
12 kV Electrical Line	JOB	LS				\$1,046,000	\$1,046,000	2
<b>SUBTOTAL RELOCATION OF EXISTING PROPERTY</b>							\$32,718,000	
<b>III. CLEARING RESERVOIR</b>								
Reservoir clearing	1,345	AC				\$1,097	\$1,475,721	3, item IV-a
<b>SUBTOTAL CLEARING RESERVOIR</b>							\$1,475,721	
<b>IV. ACCESS ROADS</b>								
Access roads	JOB	LS				\$6,068,000	\$6,068,000	2
<b>SUBTOTAL ACCESS ROADS</b>							\$6,068,000	
<b>V. GOLDEN GATE DAM - Earth and Rockfill Structure; Crest Elevation 541.3</b>								
Total Embankment Volume	8,255,200	CY						
Excavation, all classes for foundation	468,000	CY				\$3.23	\$1,511,640	3, item Id
Stripping borrow pits	319,000	CY				\$1.15	\$366,850	3, item Ic
Excavation, impervious and hauling to dam (borrow)	3,185,000	CY				\$3.22	\$10,255,700	3, item Ic
Excavation, rockfines and hauling to dam (borrow)	1,227,500	CY	123	176	\$5.00	\$7.15	\$8,782,114	4, sheet 3
Excavation, rock and hauling to dam (borrow)	2,799,000	CY	123	176	\$5.00	\$7.15	\$20,025,366	4, sheet 3
Placing impervious	2,722,000	CY				\$0.95	\$2,585,900	3, item If
Placing rockfines	1,534,400	CY				\$0.75	\$1,150,800	3, item Ih
Placing rock	3,998,800	CY				\$0.75	\$2,999,100	3, item Ih
F&P sand filter and gravel drain	145,300	CY				\$8.54	\$1,240,862	3, items Ii & Ij
Grouting foundation	JOB	LS	123	176	\$418,000	\$598,114	\$598,114	4, sheet 4
Drains	2,790	LF	123	176	\$7.75	\$11.09	\$30,940	4, sheet 4
Gravel on crest	2,066	CY	123	176	\$7.75	\$11.09	\$22,911	4, sheet 4
10% minor items	JOB	LS					\$4,957,030	
<b>SUBTOTAL GOLDEN GATE DAM</b>							\$34,527,325	

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**Table 2c**  
**ESTIMATED COSTS**  
**COLUSA RESERVOIR (3.3 MAF ALTERNATIVE)**

DESCRIPTION	QUANTITY	UNIT	USBR INDEX JAN. 80	USBR INDEX OCT. 96	UNIT COST JAN. 80	UNIT COST OCT. 96	TOTAL COST OCT. 96	COST REFERENCE
Stripping borrow pits	252,489	CY				\$1.15	\$290,362	3, item Ic
Excavation, impervious and hauling to dam (borrow)	2,520,931	CY				\$3.22	\$8,117,398	3, item Ic
Excavation, rockfines and hauling to dam (borrow)	971,568	CY	123	176	\$5.00	\$7.15	\$6,951,053	4, sheet 3
Excavation, rock and hauling to dam (borrow)	2,215,412	CY	123	176	\$5.00	\$7.15	\$15,850,099	4, sheet 3
Placing impervious	2,154,466	CY				\$0.95	\$2,046,743	3, item If
Placing rockfines	1,214,479	CY				\$0.75	\$910,859	3, item Ih
Placing rock	3,165,055	CY				\$0.75	\$2,373,791	3, item Ih
F&P sand filter and gravel drain	115,005	CY				\$8.54	\$982,144	3, items Ii & Ij
Grouting foundation	JOB	LS	123	176	330,847	\$473,408	\$473,408	4, sheet 4
Drains	2,208	LF	123	176	\$7.75	\$11.09	\$24,489	4, sheet 4
Gravel on crest	1,635	CY	123	176	\$7.75	\$11.09	\$18,134	4, sheet 4
10% minor items	JOB	LS					\$3,923,494	
<b>SUBTOTAL LOGAN DAM</b>							<b>\$43,158,439</b>	
<b>IX. DIKES</b>								
Total Embankment Volume	23,561,800	CY						
Excavation, all classes for foundation	1,784,308	CY				\$3.23	\$5,763,314	3, item Id
Excavation, impervious and hauling to dam (borrow)	13,623,967	CY				\$3.22	\$43,869,175	3, item Ic
Excavation, sand, gravel and hauling to dam (borrow)	3,211,092	CY	123	176	\$6.65	\$9.52	\$30,554,974	4, sheet 5
Excavation, rock and hauling to dam (borrow)	5,531,685	CY	123	176	\$6.65	\$9.52	\$52,636,456	4, sheet 5
Placing impervious	11,644,346	CY				\$0.95	\$11,062,129	3, item If
Placing rockfines	4,013,865	CY				\$0.75	\$3,010,399	3, item Ih
Placing rock	7,903,589	CY				\$0.75	\$5,927,692	3, item Ih
F&P riprap	561,776	CY				\$31.64	\$17,774,578	3, item In
F&P filter blanket	1,668,775	CY				\$8.54	\$14,251,335	3, item Ii
F&P bedding for riprap	281,053	CY				\$11.79	\$3,313,618	3, item Im
Grouting foundation	JOB	LS	123	176	\$1,880,309	\$2,690,524	\$2,690,524	4, sheet 5
10% Minor items	JOB	LS					\$19,085,419	
<b>SUBTOTAL DIKES</b>							<b>\$190,834,195</b>	
<b>X. SPILLWAY</b>								
Excavation, open cut, all classes	8,557	CY				\$4.03	\$34,485	3, AVG items, IIa, IIIa
Backfill	1,200	CY				\$8.17	\$9,804	3, item IIIf
Special compacted backfill	300	CY	128	186	\$9.30	\$13.51	\$4,054	4, sheet 5
Structural Concrete in floors and crest	485	CY				\$365	\$177,025	3, AVG items IIh, IIIc, IIId
Structural Concrete in walls	479	CY				\$365	\$174,835	3, AVG items IIh, IIIc, IIId
Drilling and grouting anchors	2,260	LF	128	186	\$11.60	\$16.86	\$38,095	4, sheet 5
F&I 4" dia. S.P. drains	180	LF	128	186	\$11.60	\$16.86	\$3,034	4, sheet 5

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**Table 2c**  
**ESTIMATED COSTS**  
**COLUSA RESERVOIR (3.3 MAF ALTERNATIVE)**

DESCRIPTION	QUANTITY	UNIT	USBR INDEX JAN. 80	USBR INDEX OCT. 96	UNIT COST JAN. 80	UNIT COST OCT. 96	TOTAL COST OCT. 96	COST REFERENCE
Upsize Outlet Works for Emergency Evacuation								
Increase Outlet Works capacity from 2,100cfs to 22,000cfs								
Cost Factor = (22,000/2100) <sup>3/8</sup> = 2.413	2.413							
<b>OUTLET WORKS COST AT GOLDEN GATE DAM</b>							\$57,424,480	
<b>XII. OUTLET WORKS AT LOGAN DAM</b>								
Excavation all classes tailrace	36,000	CY	128	206	\$4.60	\$7.40	\$266,513	4, sheet 6
Excavation, open cut	6,000	CY				\$3.38	\$20,280	3, item IIa
Excavation, tunnel	8,440	CY				\$128	\$1,080,320	3, item VIa
Excavation, gate chamber and shaft	6,300	CY				\$147	\$926,100	3, item IIc
Drilling grout holes	11,700	LF				\$18.70	\$218,790	3, item Iq
F&I grout pipe and fittings	5,800	LB	128	206	\$2.85	\$4.59	\$26,603	4, sheet 6
Hookups to grout holes	388	EA	128	206	\$57.00	\$91.73	\$35,593	4, sheet 6
Pressure grouting	11,700	SKS	128	206	\$57.00	\$91.73	\$1,073,292	4, sheet 6
Concrete in tunnel lining	6,300	CY				\$321	\$2,022,300	3, item VII
Structural Concrete in intake	3,950	CY				\$340	\$1,343,000	3, item VIIk
Structural Concrete in gate chamber and shaft	3,110	CY				\$340	\$1,057,400	3, item VIIk
Structural Concrete in stilling basin	3,850	CY				\$340	\$1,309,000	3, item VIIk
Structural Concrete in anchor blocks	3,000	CY				\$256	\$768,000	3, item VIId
Metal control house	JOB	LS	128	206	\$5,700	\$9,173	\$9,173	4, sheet 6
Specially compacted backfill	800	CY	128	206	\$9.70	\$15.61	\$12,489	4, sheet 6
F&I 11x11 fixed wheel gates	116,000	LB	128	206	\$3.45	\$5.55	\$644,072	4, sheet 6
2-42" H.J. valves and controls	32,222	LB	128	206	\$3.90	\$6.28	\$202,243	4, sheet 6
2 guard gates for 42" H.J. valves	32,000	LB	128	206	\$4.30	\$6.92	\$221,450	4, sheet 6
4-6.5'x8.0' H.P. gates	564,000	LB	128	206	\$2.85	\$4.59	\$2,586,909	4, sheet 6
144" dia. penstock & manifold for H.P. gates	1,740,000	LB				\$1.65	\$2,871,000	3, item VIIe
F&I tunnel supports	250,600	LB				\$3.66	\$917,196	3, item IIe
Trashrack metalwork	74,000	LB				\$3.63	\$268,620	3, item VIq
F&I tower bulkhead	100,000	LB				\$3.02	\$302,000	3, item VIh
Tunnel vent system	JOB	LS	128	206	\$70,000	\$112,656	\$112,656	4, sheet 6
Other misc. metalwork	3,000	LB				\$3.63	\$10,890	3, item VIIi
Rockbolts	24,300	LF				\$64.14	\$1,558,602	3, item VIy
Chain link fabric	23,000	SF	128	206	\$8.00	\$12.88	\$296,125	4, sheet 6
10% Minor items	JOB	LS					\$2,016,062	
<b>SUBTOTAL OUTLET WORKS</b>							\$22,176,678	
Upsize Outlet Works for Emergency Evacuation								
Increase Outlet Works capacity from 2,100cfs to 22,000cfs								
Cost Factor = (22,000/2100) <sup>3/8</sup> = 2.413	2.413							
<b>OUTLET WORKS COST AT LOGAN DAM</b>							\$33,312,323	

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**Table 2c**  
**ESTIMATED COSTS**  
**COLUSA RESERVOIR (3.3 MAF ALTERNATIVE)**

DESCRIPTION	QUANTITY	UNIT	USBR INDEX JAN. 80	USBR INDEX OCT. 96	UNIT COST JAN. 80	UNIT COST OCT. 96	TOTAL COST OCT. 96	COST REFERENCE
<b>XVI. SITES-COTTONWOOD ELVERTA #2 LOOP</b>								
Clearing Land	JOB	LS	126	217	\$4,460	\$7,681	\$7,681	4, sheet27
Towers and Fixtures	JOB	LS	126	217	\$471,380	\$811,821	\$811,821	4, sheet27
Conductors and Devices	JOB	LS	126	217	\$250,160	\$430,831	\$430,831	4, sheet27
<b>SUBTOTAL #2 LOOP</b>							\$1,280,333	
<b>SUBTOTAL</b>							\$818,000,000	
<b>CONTINGENCIES @ 20%</b>							\$164,000,000	
<b>ESTIMATED CONSTRUCTION COST</b>							\$982,000,000	
<b>ENGR, LEGAL, AND ADMIN @ 35%</b>							\$344,000,000	
<b>ESTIMATED CAPITAL COST</b>							\$1,310,000,000	
<b>ESTIMATED CAPITAL COST RANGE</b>								
LOW (-10%)							\$1,200,000,000	
HIGH (+15%)							\$1,530,000,000	
<b>COST ESTIMATE DOES NOT INCLUDE FUNKS DAM ENLARGEMENT.</b>								

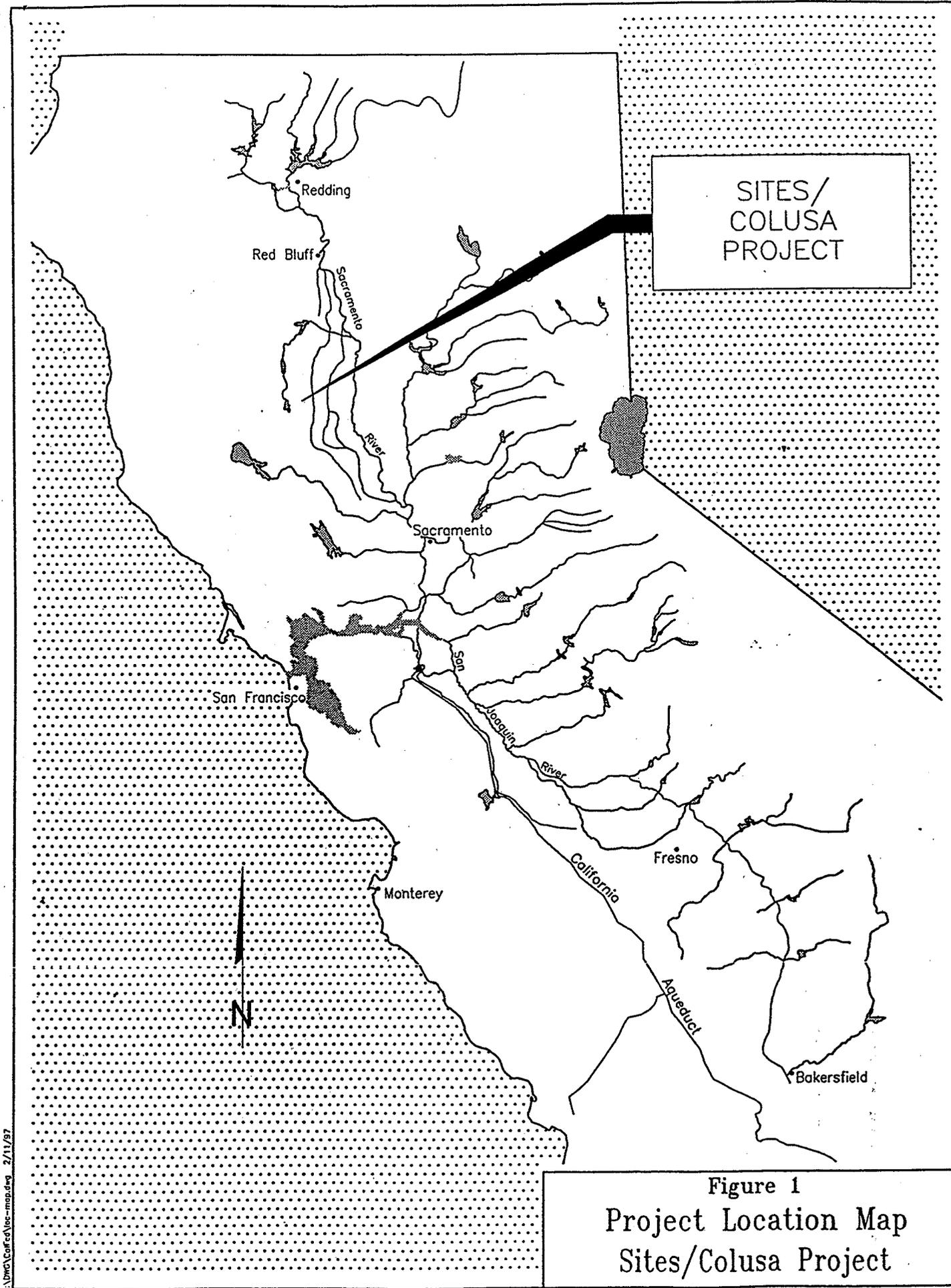
**Footnote:**

\*LS=lump sum; AC=acre; MI=mile; CY=cubic yard; LF=linear foot; LB=pound; SF=square foot; EA=each

**Cost References:**

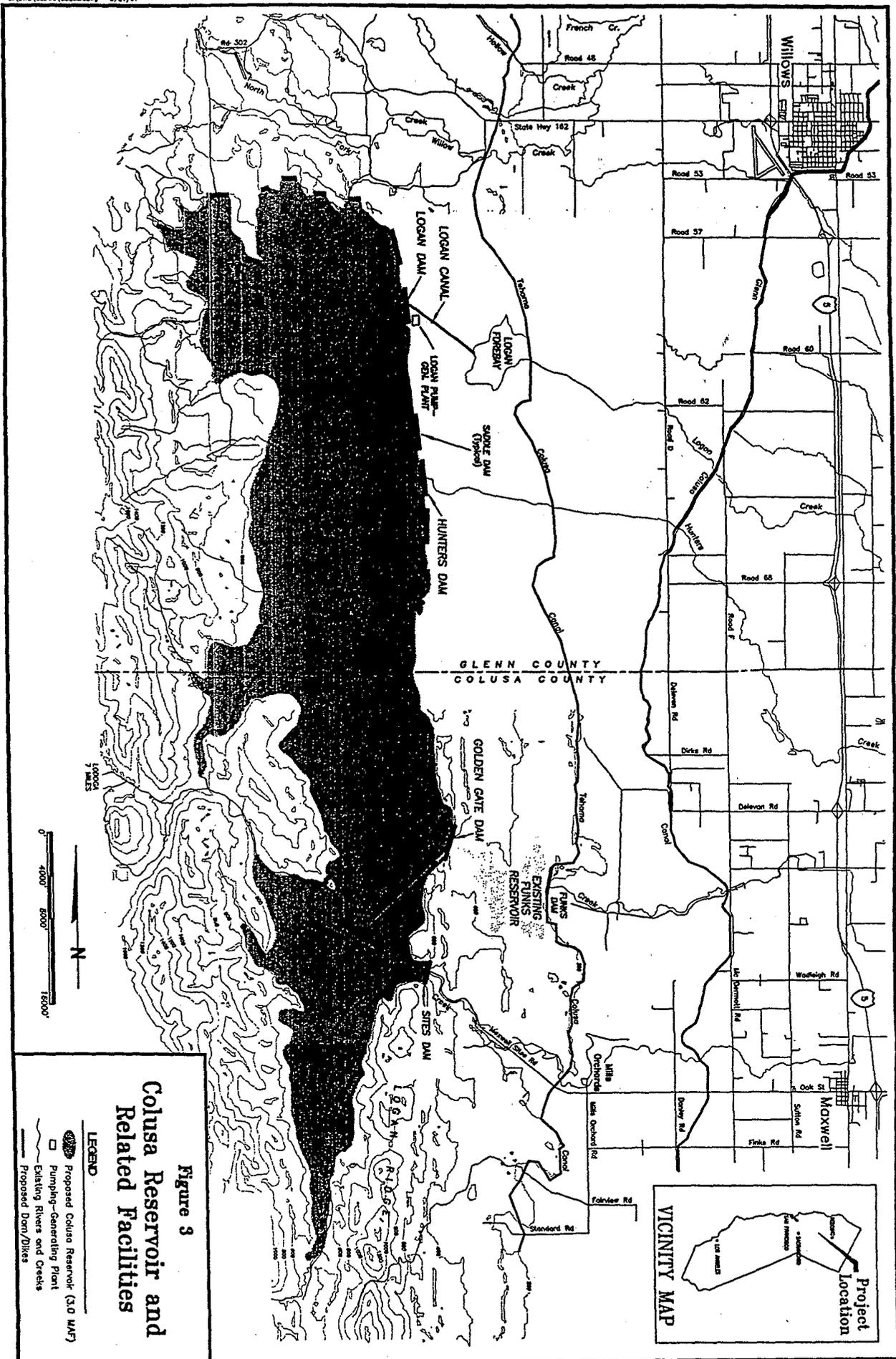
1. U.S. Bureau of Reclamation, Land Resources Branch, Graham McMullen, February 1997.
2. Cost developed by Bookman-Edmonston Engineering.
3. California Department of Water Resources, *Los Banos Grandes Facilities Report, Appendix A: Designs and Cost Estimates*, December 1990.
4. U.S. Bureau of Reclamation, *Appraisal Design Criteria and Cost Estimate Appendix, West Sacramento Canal Unit, Sacramento River Division, CVP*, September 1980.

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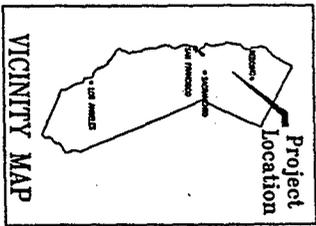
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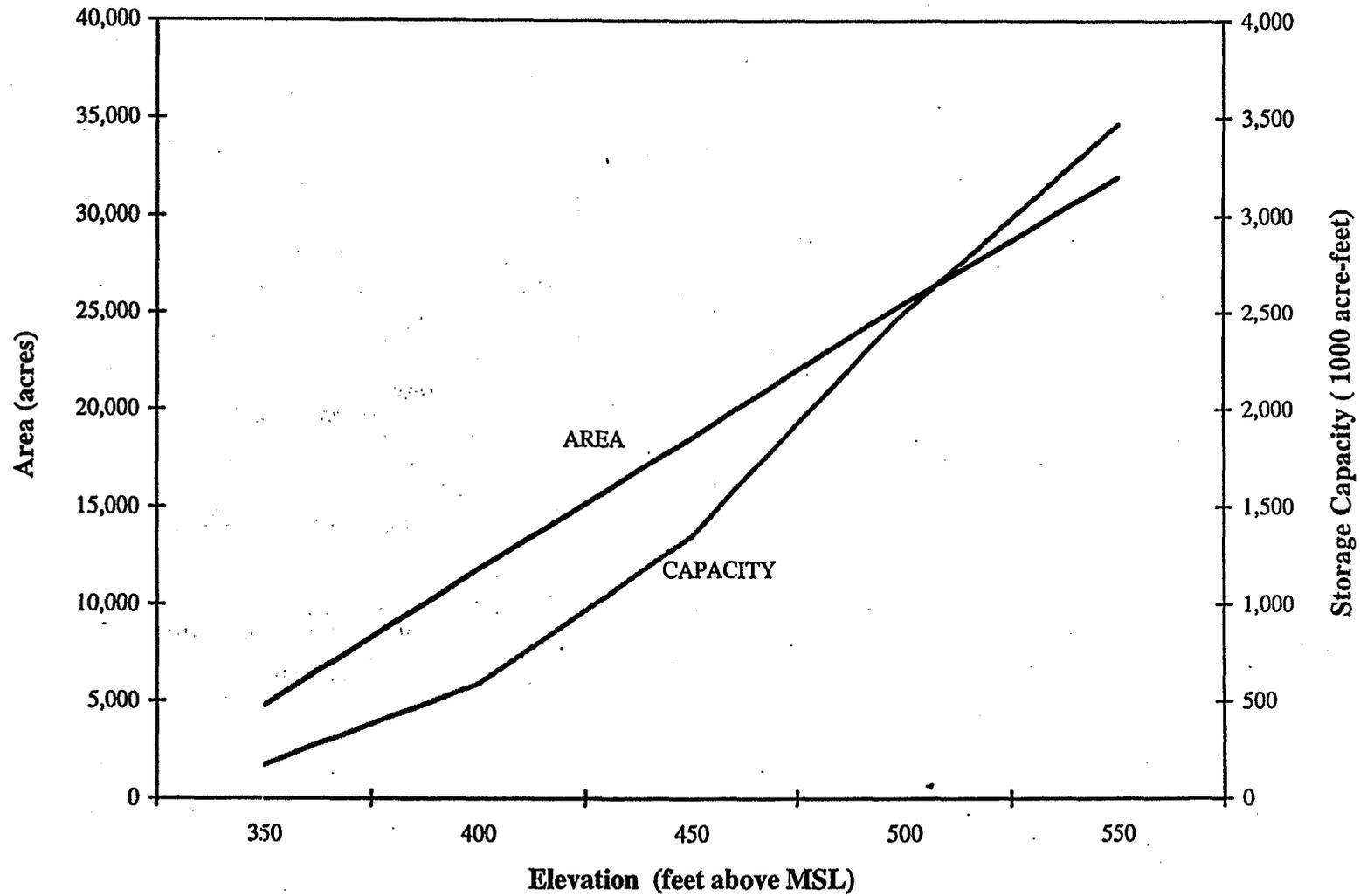


**Figure 3**  
**Colusa Reservoir and**  
**Related Facilities**

- LEGEND**
- Proposed Colusa Reservoir (110 MAF)
  - Pumping-Generating Plant
  - Existing Rivers and Creeks
  - Proposed Dam/Dikes



**Figure 5**  
**AREA-CAPACITY CURVES**  
**COLUSA RESERVOIR**



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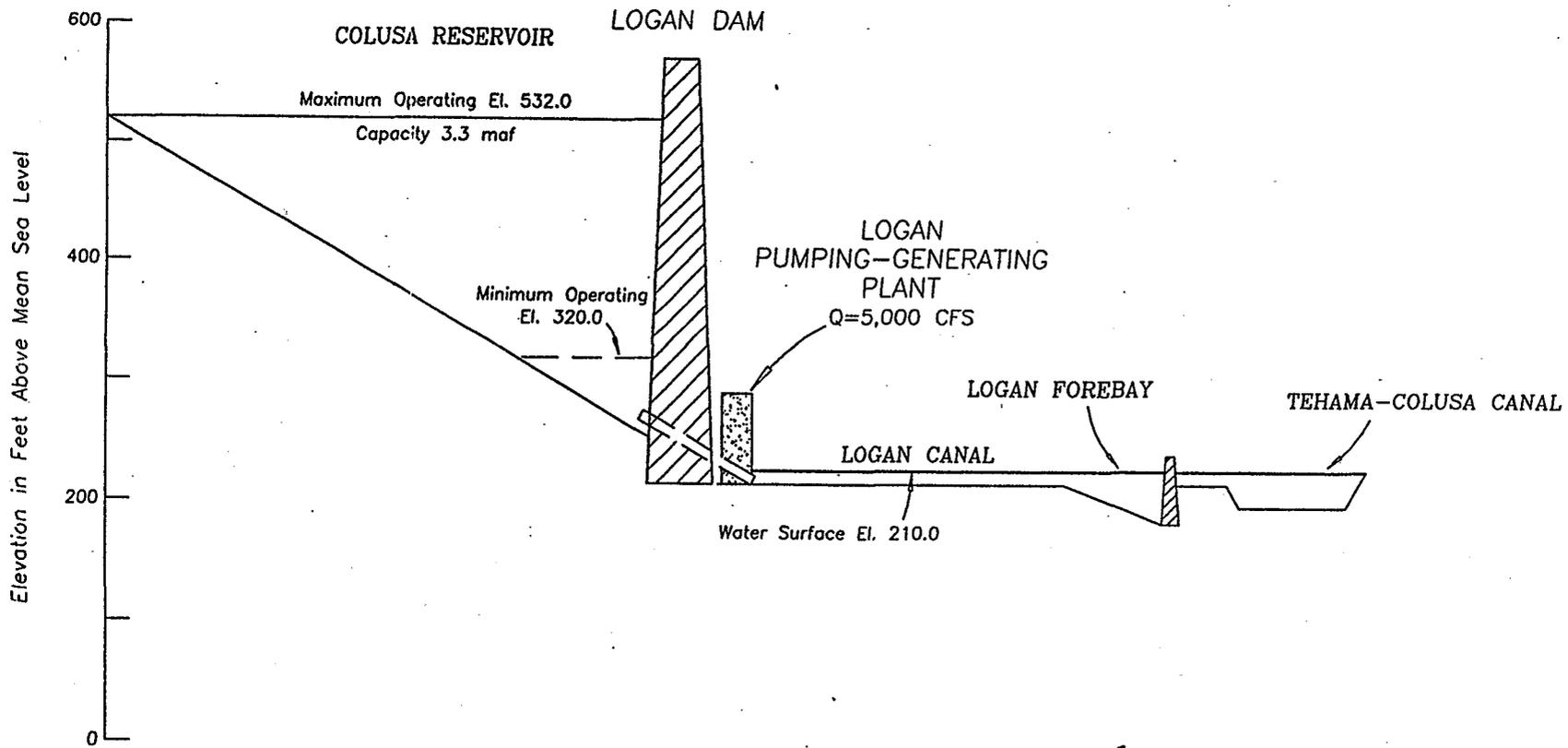


Figure 7  
Colusa Reservoir  
and Related Facilities  
Schematic Profile