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**PROJECT DESCRIPTIONS  
AND UPDATED COST ESTIMATES  
FOR RED BANK PROJECT**

**Prepared by the CALFED Storage and Conveyance Refinement Team  
April 30, 1997**

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## INTRODUCTION

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

This report summarizes the principal features, estimated costs, and environmental considerations of the Red Bank Project. Figure 1 shows the general location of the Red Bank Project. The Red Bank Project would consist of two main reservoirs and two smaller reservoirs. The two main reservoirs include the Dippingvat Reservoir on the South Fork Cottonwood Creek and the Schoenfield Reservoir on Red Bank Creek. These two on-stream reservoirs would develop flows from the Cottonwood and Red Bank Creek basins, which are tributaries to the upper Sacramento River.

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

The cost estimates for the Red Bank Project were primarily developed by applying current unit costs to quantities found in the following reports: the 1993 Department of Water Resources (DWR) *Red Bank Project Pre-Feasibility Design Alternatives Report* and the 1987 DWR *Dippingvat-Schoenfield Report*. The cost estimates in these reports 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 Red Bank 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 used in the evaluation of environmental considerations was gathered from existing literature and databases.

## PROJECT BACKGROUND

The Red Bank Project was originally known as the Dippingvat-Schoenfield portion of the Cottonwood Creek Study for DWR's May 1957 *California Water Plan*. In the late 1960s and 1970s, the U.S. Army Corps of Engineers (COE) conducted studies of two large reservoirs (Tehama and Dutch Gulch) on the lower portion of Cottonwood Creek. The COE's two-reservoir project was authorized by Congress in the Flood Control Act of 1970, but funding for advanced design-engineering and design studies was not appropriated until 1976. Because of inflation, project costs rose to unrealistic levels, and in 1985, the COE terminated its investigation of these reservoirs. The Tehama and Dutch Gulch Reservoirs are, however, the subject of a similar evaluation being prepared by CALFED.

In 1985, DWR renewed its studies of the upper tributaries to the Sacramento River and in 1987 released a report on the Dippingvat-Schoenfield Project. That report indicated a benefit-to-cost ratio greater than one and recommended that an initial feasibility study for development be undertaken. In 1988, the Dippingvat-Schoenfield Project was renamed as the Red Bank Project to avoid confusion between the COE's studies on Cottonwood Creek and DWR's studies. In 1993, DWR published the *Red Bank Project Pre-Feasibility Design Alternatives Report*, which

provided an update of the design and cost estimate of the Red Bank Project. The main purpose of the 1993 report was to determine the least costly alternative based upon new, more detailed topographic and geologic mapping.

## FACILITIES DESCRIPTIONS

This section provides an overview of the major features included in the Red Bank Project. The principal reference used for this synopsis is the DWR 1993 *Red Bank Project Pre-Feasibility Design Alternatives Report*. That report evaluated roller-compacted concrete (RCC), earthfill, and rockfill dams, concluding that the RCC dam was the best alternative primarily because of its substantial cost savings. The preferred alternative dam type, RCC, is constructed with lean (low water content and slump) concrete placed with standard earth-moving equipment. RCC dams typically have fewer impacts on the environment because the footprint of these dams is smaller and they require much less construction materials and earth-moving operations. Further, cost savings over an earthfill alternative result from the inclusion of the spillway into the face of the dam, shorter outlet pipes, and the efficiencies of placement methods. A rockfill alternative was eliminated because of the lack of sufficiently large sources of rock in the area. Therefore, the present evaluation focuses on the RCC alternative for the dams associated with the Red Bank Project.

## PROJECT LOCATION

The Red Bank Project is located in Tehama County approximately 20 miles west of Red Bluff as shown in Figure 2. Specifically, the Schoenfield Reservoir is located about 18 miles west of Red Bluff on Red Bank Creek, and the Dippingvat Reservoir is located on the South Fork of Cottonwood Creek about 20 miles west of Red Bluff. The two main reservoirs would be linked by a 1,800-foot-long tunnel, two small reservoirs, and a series of open channels.

**PROJECT DESCRIPTION**

The Red Bank Project would develop flows from the South Fork Cottonwood Creek and Red Bank Creek. The primary source of water developed by the project would be from the South Fork Cottonwood Creek. The Cottonwood Creek basin represents the largest undeveloped stream system tributary to the upper Sacramento River. A portion of the flows captured at Dippingvat Reservoir on the South Fork Cottonwood Creek would be conveyed to Schoenfield Reservoir on Red Bank Creek for storage. The Schoenfield Reservoir has been sized to accommodate the storage of local inflows and diversions from Dippingvat Reservoir.

Storage in Dippingvat and Schoenfield Reservoirs could be used for several purposes. Stored water could be released down Cottonwood and Red Bank Creeks to supplement flows on the Sacramento River and in the Delta. Alternatively, water stored in Schoenfield Reservoir could be released down Red Bank Creek to the Corning Canal Intertie, where it could be diverted into the Canal. Supplying water to the Corning Canal from the Red Bank Project would reduce the demands for Sacramento River diversions at the Red Bluff Diversion Dam. Similarly, the Red Bank Project could supply water to the Tehama-Colusa Canal via the Corning Canal Intertie and the Corning Canal. Under this final alternative, reverse flow in the upper reaches of the Corning Canal would supply water to the settling basin of the Tehama-Colusa Canal.

The Red Bank Project could provide for fisheries enhancement in the Cottonwood Creek and on the Sacramento River. Specifically, the Red Bank Project has the potential of being beneficial for steelhead and salmon fisheries. By scheduling Dippingvat releases to coincide with temperature and spawning cycle requirements, a fall-run salmon fishery on Cottonwood Creek could be established. Together, the two reservoirs would also reduce turbidity discharges in Cottonwood Creek and the Sacramento River.

## PRINCIPAL FACILITIES

This section provides an overview of the major features associated with the Red Bank Project. The Red Bank Project would consist of (1) the Dippingvat Dam and Reservoir on the South Fork Cottonwood Creek, which would include the Dippingvat-Lanyan Saddle Dams, (2) the Schoenfield Dam and Reservoir on Red Bank Creek, which would include Lewis Flat, Red Bank Road, and Last Chance Creek Saddle Dams, and (3) the conveyance system from Dippingvat to Schoenfield Reservoir, which would include the 1,800-foot-long Dippingvat-Lanyan Tunnel, the Lanyan Dam and Reservoir, the Bluedoor Dam and Reservoir, and three short conveyance canals. The locations of these project facilities are shown in Figure 2. Table 1 provides a summary of the physical characteristics of the above-identified facilities.

### Dippingvat Reservoir

The Dippingvat Dam would be located on South Fork Cottonwood Creek. The proposed RCC dam would be 251 feet high and would create a reservoir with a gross capacity of 104,000 acre-feet, 72,000 acre-feet of which would be allocated for flood control. The average annual inflow to Dippingvat Reservoir is 96,400 acre-feet per year. Figure 3 shows the area-capacity curves for the Dippingvat Reservoir. Figure 4 provides a schematic profile of the Dippingvat Dam and Reservoir.

The Dippingvat Dam would have two outlets: the 15-foot-diameter flood control outlet designed to empty the 72,000 acre-foot flood control pool in six days at an average rate of 6,050 cfs, and a 2-foot-diameter pipe designed to discharge 60 cfs for stream maintenance purposes. The 60 cfs intake would be equipped with seven 20-inch butterfly valves to allow control of water quality. In addition, the Dippingvat Dam would be equipped with a 14-foot-by-14-foot bonneted slide gate, an 11-foot-diameter Howell-Bunger dissipator valve, a 2-foot-diameter Howell-Bunger

dissipator valve, a 2-foot-diameter bonneted slide gate, 15-inch-diameter and 20-inch-diameter bulkhead gates, and eight trashracks.

The spillway for the Dippingvat Dam would be constructed as part of the dam and would have a conventional concrete facing to help dissipate energy. The spillway would have a crest length of 200 feet to correspond to the approximate width of the South Fork Cottonwood Creek stream channel and would be equipped with an uncontrolled ogee weir crest.

The Dippingvat Reservoir would have one 21-foot-high saddle dam located above the Dippingvat-Lanyan conveyance tunnel. The proposed saddle dams would be homogeneous earthfill dams with a crest width of 20 feet and side slopes of 3:1 upstream and 2:5:1 downstream.

**Schoenfield Reservoir**

The Schoenfield Dam would be located on Red Bank Creek. The proposed dam would be 300 feet high. The gross capacity of the reservoir would be 250,000 acre-feet. The average annual inflow would be 16,000 acre-feet per year, including the inflow from the Lanyan and Bluedoor Reservoirs. The Schoenfield Reservoir would have no flood control storage, but would receive most flood control releases from the Dippingvat Reservoir. Figure 4 provides a schematic profile of the Schoenfield Dam and Reservoir. Figure 5 shows the area-capacity curve for the Schoenfield Reservoir.

The Schoenfield Dam would have one 12-foot-diameter pipe outlet that could release the emergency drawdown release requirement of 3,680 cfs. This release capacity would meet DWR, Division of Safety of Dams' requirement of evacuating 10 percent of the maximum dam height in ten days. Thirteen 54-inch butterfly valves would be provided to regulate water quality for

downstream uses. In addition, the Schoenfield Dam would have one 11-foot-by-11-foot bonneted slide gate, one 12-foot-diameter Howell-Bunger dissipator valve, one 54-inch bulkhead gate, and 13 trashracks.

The spillway for the Schoenfield Dam would be constructed as part of the dam and would have a stepped conventional facing to help dissipate energy. The spillway would have a crest length of 200 feet to correspond to the approximate width of the Red Bank stream channel and would be equipped with an uncontrolled ogee weir crest.

The Schoenfield Reservoir would have three saddle dams with heights of 4, 18, and 85 feet located along the boundary of the reservoir at Lewis Flat, Red Bank Road, and Last Chance Creek, respectively. The proposed saddle dams would be homogeneous earthfill dams with crest widths of 20 feet, upstream side slopes of 3:1, and downstream side slopes of 2:5:1.

### **Lanyan Reservoir**

The Lanyan Dam would be located in the headwaters of the north branch of the North Fork Red Bank Creek and is part of the water conveyance system from the Dippingvat Reservoir to the Schoenfield Reservoir. The proposed RCC dam would be 75 feet high and would have a gross capacity of 1,300 acre-feet. Figure 6 provides a schematic profile of the Lanyan Dam and Reservoir.

The outlet for the Lanyan Dam would be sized to meet the Division of Safety of Dams' emergency drawdown discharge requirements of evacuating 10 percent of the normal maximum water depth in seven to ten days. This corresponds to a discharge rate of 40 cfs for the Lanyan Dam, which would be discharged through a 2-foot diameter pipe, complete with a trashrack. A

spillway at the Lanyan Reservoir would not be provided because it would spill to the Bluedoor and Schoenfield Reservoirs through conveyance canals.

### **Bluedoor Reservoir**

The Bluedoor Dam would be located in the headwaters of the North Fork Red Bank Creek as part of the water conveyance system from the Dippingvat Reservoir to the Schoenfield Reservoir. The proposed dam would be 115 feet high and would have a storage capacity of 3,400 acre-feet. Figure 6 provides a schematic profile of the Bluedoor Dam and Reservoir.

The outlet at Bluedoor Dam would be sized to meet the Division of Safety of Dams' emergency drawdown discharge requirements of evacuating 10 percent of the normal maximum water depth in seven to ten days. This corresponds to a discharge rate of 70 cfs for the Bluedoor Reservoir, which would be discharged through a 2.5-foot-diameter pipe complete with a trashrack. A spillway at the Bluedoor Reservoir would not be provided because it would spill to Schoenfield Reservoir through the conveyance canals.

### **Conveyance System**

The purpose of the conveyance system would be to divert up to 800 cfs of available winter water from the Dippingvat Reservoir to the Schoenfield Reservoir. The conveyance system would consist of a tunnel, three canals, and two reservoirs. The three primary conveyance canals would typically have base widths of 10 feet and side slopes of 2:1. However, two reaches in the second and third canal would have side slopes of 5:1 to allow for deer crossings. All canals would be concrete-lined.

An 8-foot-diameter, 1,800-foot-long, steel-lined tunnel would carry water from the Dippingvat Reservoir to the first conveyance canal. The discharge would be controlled by an 8-foot-diameter Howell-Bunger dissipator valve and would also include an 8-foot-diameter bulkhead gate or a 7-foot-by-7-foot bonneted slide gate and one trashrack. The water would then travel through the 3,000-foot-long conveyance canal to the Lanyan Reservoir.

Water would then leave the Lanyan Reservoir by means of the 1,800-foot-long second canal for delivery to the Bluedoor Reservoir.

The 7,500-foot-long third canal (or concrete chute) would convey the water to the Schoenfield Reservoir. The chute drops 300 feet in a distance of 6,000 feet. The chute would have a base width of 10 feet and 10-foot-high vertical walls.

### Road Access

Existing access to the Red Bank Project area is via Red Bank Road, Johnson Road to Balis Bell Road, and Petty John Road. These Tehama County roads are maintained and appear to be in good condition. Several private roads that connect the proposed reservoir areas will need to be upgraded.

### COST ESTIMATES

The cost estimate for the facilities described above is based on previous estimates performed by DWR and have been reviewed and adapted for the present cost estimate. Several items in the previous cost estimates have been modified to incorporate current design standards and safety factors. Items from previous estimates included in the present cost estimate have been escalated to October 1996 dollars. This cost estimate does not include estimated costs of preparing

environmental documentation, operation and maintenance, power, reservoir filling, and interest during construction.

### **COST ESTIMATE METHODOLOGY**

The cost estimates for the Red Bank Project were primarily determined by escalating the costs found in the 1993 DWR report entitled *Red Bank Project Pre-Feasibility Design Alternatives Report*. The costs were escalated to October 1996 dollars by using the Bureau of Reclamation's Construction Cost Trends (CCT) indices. Table 2 provides a detailed breakdown of the estimated costs of the Red Bank Project. This table includes an updated cost estimate for items 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 indicates the CCT index for the month and year in which the estimated cost was developed as well as an index for October 1996. These CCT indices were used to factor the previous cost estimate to October 1996 dollars. The far right-hand column of the table provides 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 the Bureau of Reclamation, Land Resource Branch (Personal Communication, February 1997). The total project lands would include a buffer around the maximum water surface area and could approach approximately 5,400 acres. The ratio of total project land to maximum water surface area used in the cost estimate is 1.32 based on data from the September 1990 *Los Banos Grandes Facility Feasibility Report, Appendix A: Design and Cost Estimates* by DWR.

**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, and engineering, construction management, and administration were chosen to be 35 percent. A cost range was developed for the project by subtracting 10 percent from the estimated capital cost for the low end cost and adding 15 percent to the estimated capital cost for the high end.

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**PRELIMINARY COST FINDINGS**

Costs of constructing the Red Bank Project have been updated to an October 1996 basis as described above. Table 3 summarizes estimated costs within selected project categories. The total estimated capital cost for Dippingvat Reservoir and Schoenfield Reservoir is approximately \$70 million and \$86 million, respectively.

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The total estimated capital cost for the entire Red Bank Project as described above is \$215 million with a resulting calculated range of costs between \$194 and \$247 million. The project would have a total storage capacity of approximately 359,000 acre-feet.

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**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.]*

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This portion of the report provides a summary of environmental considerations related to the proposal for developing the Red Bank Project. Fish, wildlife, plant, and cultural resources that

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could be affected by the proposal are described and the extent of the impacts is 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

Depending on the reservoir configurations selected (Dippingvat, Schoenfield, Lanyan, and Bluedoor), the project could inundate approximately 4,200 acres of terrestrial wildlife habitat and up to 20 miles of intermittent stream habitat.

## Fish, Amphibians, Reptiles, and Invertebrates

Aquatic habitat in the project area include perennial pools and seasonally flowing streams. The streams and tributaries within the potential inundation zone provide habitat for a number of cold- and warmwater 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, 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 game fish are trout and bass.

The project could reduce streamflows which would limit spawning and rearing habitat for a small population of steelhead trout. Flow reductions in creeks downstream of the proposed reservoir sites 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 streamflows 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 warmwater fish species such as striped bass.

### General Wildlife

Lands within the Red Bank Project area support a diverse variety of 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. The project would provide benefits to water-associated birds by increasing available habitat for these birds. Wintering deer may migrate through sections of the project area and use the area as wintering habitat.

### Sensitive and Listed Fish and Wildlife Species

No State or federally listed fish species have been previously recorded within the area of the proposed Red Bank Project.

According to the California Department of Fish and Game's (CDFG) Natural Diversity Data Base (Version 8/96) (NDDDB), two federally listed species and five 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. Listed species that have been known to occur in or near the area affected by the proposed project include California red-legged frog (federal threatened) 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 and that could be affected by the proposed reservoir complex include foothill yellow-legged frog (federal candidate/species of special concern), yellow warbler (species of special concern), chinook salmon spring run (species of special concern), pale big-eared bat (species of special concern), and northwestern pond turtle (federal candidate/species of special concern). Other species of special concern that may be found using the project area include golden eagle, osprey, Coopers hawk, and tricolored blackbird.

### VEGETATION

Vegetation at the Red Bank Project consists generally of annual grasslands, oak-pine woodlands, and chaparral. Riparian vegetation occurs along the numerous rivers and streams in the area. Vernal pools may be scattered throughout the proposed project area.

Vegetation at the proposed Dippingvat Reservoir site consists of 50 percent annual grasslands, 20 percent woodlands, 10 percent riparian, and 20 percent chaparral.

Vegetation at the proposed Lanyan Reservoir site consists of 85 percent annual grasslands, 5 percent woodlands, 9 percent disturbed land, and 1 percent water.

Vegetation at the proposed Schoenfield Reservoir site consists of 15 percent annual grasslands, 70 percent woodlands, 5 percent disturbed land, 5 percent riparian, and 5 percent water (Sunflower Gulch Reservoir).

Vegetation at the proposed Bluedoor Reservoir site consists of 70 percent annual grasslands, 20 percent woodlands, 5 percent disturbed lands, and 5 percent water.

**Sensitive and Listed Plant Species**

According to CDFG's NDDDB, no listed plant species that have previously recorded occur within the area proposed for the Red Bank Project.

Candidate plant species for federal listing that may occur in the project area include Brandegee's eriastrum, adobe lily, Anthony Peak lupine, Mt. Tedoc linanthus, and Stebbin's lewisia.

Two additional plants, diamorphic snapdragon and Stebbin's madia, listed by the California Native Plant Society as being rare, threatened, or endangered in California and elsewhere could also be found in the proposed project area.

There are no special-status habitats within the area that would be affected by the proposed project.

**Wetlands**

Based on wetland information from the U.S. Fish and Wildlife Service's (USFWS) National Wetlands Inventory Maps, wetlands that would be affected by the proposed project include 20 miles of intermittent streambed, 3.5 miles of upper perennial flat stream, 3 miles of upper perennial open water, 4 acres of shrub-scrub/flat temporarily flooded (wet meadow), and 1 acre of emergent flat wetland semi-saturated (deep marsh).

**CULTURAL RESOURCES**

Approximately 35 non-significant and 10 significant prehistoric sites and an estimated three non-significant historic sites have been found in the proposed project area.

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**Table 1**  
**SUMMARY OF PHYSICAL CHARACTERISTICS**  
**RED BANK PROJECT**

	Dam			
	Dippingvat	Lanyan	Bluedoor	Schoenfield
Dam Crest Elevation (feet)	1,226	1,050	1,050	1,030
Spillway Crest Elevation (feet)	1,205	Spill to Schoenfield	Spill to Schoenfield	1,017
Dam Height (feet)	251	75	115	300
Dam Volume (cubic yards)	367,200	19,000	55,430	467,670
Gross Capacity (acre-feet)	104,000	1,300	3,400	250,000
Flood Control (acre-feet)	72,000	0	0	0
Water Surface Area (acres)	1,270	60	95	2,770
Mean Annual Inflow (acre-feet)	96,400			16,000
Drainage Area (sq. miles)	132	3.1	2.8	39
<b>Saddle Dams</b>				
Number	1			3
Height (feet)	21			4, 15, 85

**Table 2  
ESTIMATED COSTS  
RED BANK PROJECT**

DESCRIPTION	QUANTITY	UNIT <sup>a</sup>	USBR INDEX APR. 91	USBR INDEX OCT. 96	UNIT COST APR. 91	UNIT COST OCT. 96	TOTAL COST OCT. 96	COST REFERENCE
<b>I. SCHOENFIELD RESERVOIR</b>								
Land Acquisition	3,510	AC				\$1,500	\$5,265,000	1
Clearing	2,925	AC				\$1,097	\$3,208,725	2, item IV-a
Access Road	2	MI	215	237	\$230,000	\$253,534.88	\$507,070	3
Construction Facilities	JOB	LS	182	217	\$700,000	\$834,615	\$834,615	3
<b>SUBTOTAL SCHOENFIELD RESERVOIR</b>							<b>\$9,815,410</b>	
<b>II. SCHOENFIELD DAM AND SPILLWAY</b>								
Mobilization	JOB	LS	183	203	\$600,000	\$665,574	\$665,574	3
Excavation								
Foundation Stripping, Rock	97,250	CY	183	203	\$5.00	\$5.54	\$539,115	3
Spillway Channel	76,480	CY	183	203	\$5.00	\$5.55	\$424,192	3
Embankment Structural Backfill	2,000	CY	183	203	\$12.00	\$13.31	\$26,623	3
Construction Galleries and Adits	JOB	LS	183	203	\$500,000	\$554,645	\$554,645	3
Roller Compacted Concrete: Material and Placement	467,670	CY	183	203	\$37.00	\$41.04	\$19,195,148	3
Slipform Face Element Panels	18,000	CY	183	203	\$175	\$194	\$3,494,262	3
Leveling Concrete	14,250	CY	183	203	\$130	\$144	\$2,055,514	3
Spillway Crest	520	CY	183	203	\$370	\$410	\$213,427	3
Spillway Training Walls	720	CY	183	203	\$255	\$283	\$203,666	3
Spillway Basin Walls	3,980	CY	183	203	\$290	\$322	\$1,280,342	3
Spillway Basin Floor	4,350	CY	183	203	\$130	\$144	\$627,858	3
Cement	9,000	TON	183	203	\$95.00	\$105	\$948,443	3
Resteel	3,699,000	LB	183	203	\$0.70	\$0.78	\$2,871,951	3
Foundation Treatment								
Drill and Grout	13,480	LF	183	203	\$19.00	\$21.08	\$284,111	3
Drainage	6,740	LF	183	203	\$6.00	\$6.66	\$44,860	3
Miscellaneous	JOB	LS	183	203	\$1,500,000	\$1,663,934	\$1,663,934	3
<b>SUBTOTAL SCHOENFIELD DAM AND SPILLWAY</b>							<b>\$35,093,664</b>	
<b>III. SCHOENFIELD DAM OUTLET WORKS</b>								
Concrete								
Intake	1,430	CY	183	203	\$290	\$322	\$460,022	3
Substructure	570	CY	183	203	\$375	\$416	\$237,111	3
Steel Liner Blocking	1,270	CY	183	203	\$290	\$322	\$408,551	3
Cement	850	TON	183	203	\$95	\$105	\$89,575	3
Resteel	490,000	LB	183	203	\$0.70	\$0.78	\$380,486	3

**Table 2**  
**ESTIMATED COSTS**  
**RED BANK PROJECT**

DESCRIPTION	QUANTITY	UNIT <sup>a</sup>	USBR INDEX APR. 91	USBR INDEX OCT. 96	UNIT COST APR. 91	UNIT COST OCT. 96	TOTAL COST OCT. 96	COST REFERENCE
12' ID Steel Liner	288,000	LB	183	203	\$2.30	\$3	\$734,793	3
13-54" Butterfly Valves	13	EA	183	203	\$100,000	\$110,929	\$1,442,077	3
11' x 11' Bonnetted Slide Gate	1	EA	183	203	\$730,000	\$809,781	\$809,781	3
12' Diameter Howell Bunger Valve	1	EA	183	203	\$730,000	\$809,781	\$809,781	3
54" Bulkhead Gate	1	EA	183	203	\$100,000	\$110,929	\$110,929	3
13 Trashracks (9,000 lbs each)	117,000	LB				\$3.63	\$424,710	2, item VI-q
<b>SUBTOTAL SCHOENFIELD DAM OUTLET WORKS</b>							<b>\$5,907,818</b>	
<b>IV. BLUEDOOR RESERVOIR</b>								
Land Acquisition	115	AC				\$1,500	\$172,500	1
Clearing	95	AC				\$1,097	\$104,215	2, item IV-a
<b>SUBTOTAL BLUEDOOR RESERVOIR</b>							<b>\$276,715</b>	
<b>V. BLUEDOOR DAM</b>								
Mobilization	JOB	LS	183	203	\$74,000	\$82,087	\$82,087	3
Excavation Foundation Stripping, Rock	18,790	CY	183	203	\$5.00	\$5.55	\$104,218	3
Construction Galleries and Adits	JOB	LS	183	203	\$200,000	\$221,858	\$221,858	3
Roller Compacted Concrete: Material and Placement	55,430	CY	183	203	\$37.00	\$41.04	\$2,275,081	3
Slipform Face Element Panels	2,350	CY	183	203	\$175	\$194	\$456,195	3
Leveling Concrete	3,530	CY	183	203	\$130	\$144	\$509,190	3
Cement	1,140	TON	183	203	\$95.00	\$105	\$120,136	3
Resteel	352,000	LB	183	203	\$0.70	\$0.78	\$273,297	3
Foundation Treatment								
Drill and Grout	6,970	LF	183	203	\$19.00	\$21.08	\$146,903	3
Drainage	3,490	LF	183	203	\$6.00	\$6.66	\$23,229	3
Miscellaneous	JOB	LS	183	203	\$186,000	\$206,328	\$206,328	3
<b>SUBTOTAL BLUEDOOR DAM</b>							<b>\$4,418,523</b>	
<b>VI. BLUEDOOR DAM OUTLET WORKS</b>								
Concrete								
Intake	17	CY	183	203	\$290	\$322	\$5,469	3
Substructure	15	CY	183	203	\$375	\$416	\$6,240	3
Steel Liner Blocking	155	CY	183	203	\$290	\$322	\$49,863	3
Cement	49	TON	183	203	\$95	\$105	\$5,164	3
Resteel	28,050	LB	183	203	\$0.70	\$0.78	\$21,781	3
2.5' ID Steel Liner	2,460	LB	183	203	\$2.30	\$3	\$6,276	3

**Table 2**  
**ESTIMATED COSTS**  
**RED BANK PROJECT**

DESCRIPTION	QUANTITY	UNIT <sup>a</sup>	USBR INDEX APR. 91	USBR INDEX OCT. 96	UNIT COST APR. 91	UNIT COST OCT. 96	TOTAL COST OCT. 96	COST REFERENCE
2.5' x 2.5' Bonnetted Slide Gate	1	EA	183	203	\$120,000	\$133,115	\$133,115	3
2.5' Diameter Howell Bungler Valve	1	EA	183	203	\$120,000	\$133,115	\$133,115	3
2.5' X 2.5' Bulkhead Gate	1	EA	183	203	\$25,000	\$27,732	\$27,732	3
1 Trashrack (2500 lbs)	2,500	LB				\$3.63	\$9,075	2, item VI-g
<b>SUBTOTAL BLUEDOOR DAM OUTLET WORKS</b>							<b>\$397,829</b>	
<b>VII. LANYAN RESERVOIR</b>								
Land Acquisition	70	AC				\$1,500	\$105,000	1
Clearing	60	AC				\$1,097	\$65,820	2, item IV-a
<b>SUBTOTAL LANYAN RESERVOIR</b>							<b>\$170,820</b>	
<b>VIII. LANYAN DAM</b>								
Mobilization	JOB	LS	183	203	\$30,000	\$33,279	\$33,279	3
Excavation Foundation Stripping, Rock	8,700	CY	183	203	\$5.00	\$5.54	\$48,229	3
Construction Galleries and Adits	JOB	LS	183	203	\$200,000	\$221,858	\$221,858	3
Roller Compacted Concrete: Material and Placement	19,000	CY	183	203	\$37.00	\$41.04	\$779,840	3
Slipform Face Element Panels	940	CY	183	203	\$175	\$194	\$182,478	3
Leveling Concrete	1,560	CY	183	203	\$130	\$144	\$225,025	3
Cement	480	TON	183	203	\$95.00	\$105	\$50,584	3
Resteel	141,100	LB	183	203	\$0.70	\$0.78	\$109,552	3
Foundation Treatment								
Drill and Grout	1,690	LF	183	203	\$19.00	\$21.08	\$35,619	3
Drainage	840	LF	183	203	\$6.00	\$6.66	\$5,591	3
Miscellaneous	JOB	LS	183	203	\$75,000	\$83,197	\$83,197	3
<b>SUBTOTAL LANYAN DAM</b>							<b>\$1,775,251</b>	
<b>IX. LANYAN DAM OUTLET WORKS</b>								
Concrete								
Intake	15	CY	183	203	\$290	\$322	\$4,825	3
Substructure	13	CY	183	203	\$375	\$416	\$5,408	3
Steel Liner Blocking	92	CY	183	203	\$290	\$322	\$29,596	3
Cement	31	TON	183	203	\$95	\$105	\$3,267	3
Resteel	18,000	LB	183	203	\$0.70	\$0.78	\$13,977	3
2' ID Steel Liner	1,290	LB	183	203	\$2.30	\$3	\$3,291	3
2' x 2' Bonnetted Slide Gate	1	EA	183	203	\$100,000	\$110,929	\$110,929	3
2' Diameter Howell Bungler Valve	1	EA	183	203	\$100,000	\$110,929	\$110,929	3

**Table 2  
ESTIMATED COSTS  
RED BANK PROJECT**

DESCRIPTION	QUANTITY	UNIT <sup>a</sup>	USBR INDEX APR. 91	USBR INDEX OCT. 96	UNIT COST APR. 91	UNIT COST OCT. 96	TOTAL COST OCT. 96	COST REFERENCE
2' x 2' Bulkhead Gate	1	EA	183	203	\$10,000	\$11,093	\$11,093	3
1 Trashracks (1,000 lbs)	1,000	LB				\$3.63	\$3,630	2, item VI-q
<b>SUBTOTAL LANYAN DAM OUTLET WORKS</b>							\$296,945	
<b>X. DIPPINGVAT RESERVOIR</b>								
Land Acquisition	1,704	AC				\$1,500	\$2,556,000	1
Clearing	1,420	AC				\$1,097	\$1,557,740	2, item IV-a
Access Road	4	MI	215	237	\$230,000	\$253,535	\$1,014,140	3
Construction Facilities	JOB	LS	182	217	\$700,000	\$834,615	\$834,615	3
Road Relocation	3	MI	215	237	\$290,000	\$319,674	\$959,023	3
<b>SUBTOTAL DIPPINGVAT RESERVOIR</b>							\$6,921,518	
<b>XI. DIPPINGVAT DAM AND SPILLWAY</b>								
Mobilization	JOB	LS	183	203	\$500,000	\$554,645	\$554,645	3
Excavation								
Foundation Stripping, Rock	119,650	CY	183	203	\$5.00	\$5.54	\$663,291	3
Spillway Channel, Rock	73,730	CY	183	203	\$5.00	\$5.55	\$408,940	3
Embankment Structural Backfill	2,000	CY	183	203	\$12.00	\$13.31	\$26,623	3
Construction Galleries and Adits	JOB	LS	183	203	\$500,000	\$554,645	\$554,645	3
Roller Compacted Concrete: Material and Placement	367,200	CY	183	203	\$37.00	\$41.04	\$15,071,435	3
Slipform Face Element Panels	15,010	CY	183	203	\$175	\$194	\$2,913,827	3
Leveling Concrete	12,100	CY	183	203	\$130	\$144	\$1,745,384	3
Spillway Crest	580	CY	183	203	\$370	\$410	\$238,054	3
Spillway Training Walls	634	CY	183	203	\$255	\$283	\$179,339	3
Spillway Basin Walls	3,960	CY	183	203	\$290	\$322	\$1,273,908	3
Spillway Basin Floor	5,240	CY	183	203	\$130	\$144	\$756,316	3
Cement	8,060	TON	183	203	\$95.00	\$105	\$849,383	3
Resteel	3,290,400	LB	183	203	\$0.70	\$0.78	\$2,554,709	3
Foundation Treatment								
Drill and Grout	13,570	LF	183	203	\$19.00	\$21.08	\$286,008	3
Drainage	6,790	LF	183	203	\$6.00	\$6.66	\$45,192	3
Miscellaneous	JOB	LS	183	203	\$1,200,000	\$1,331,148	\$1,331,148	3
<b>SUBTOTAL DIPPINGVAT DAM AND SPILLWAY</b>							\$29,452,845	

**Table 2  
ESTIMATED COSTS  
RED BANK PROJECT**

DESCRIPTION	QUANTITY	UNIT <sup>a</sup>	USBR INDEX APR. 91	USBR INDEX OCT. 96	UNIT COST APR. 91	UNIT COST OCT. 96	TOTAL COST OCT. 96	COST REFERENCE
<b>XII. DIPPINGVAT DAM OUTLET WORKS</b>								
Concrete								
F.C. Intake	650	CY	183	203	\$290	\$322	\$209,101	3
F. C. Substructure	970	CY	183	203	\$375	\$416	\$403,504	3
F. C. Steel Liner Blocking	1,430	CY	183	203	\$290	\$322	\$460,022	3
Cons. Intake	190	CY	183	203	\$290	\$322	\$61,122	3
Conc. Substructure	13	CY	183	203	\$375	\$416	\$5,408	3
Conc. Steel Liner Blocking	260	CY	183	203	\$290	\$322	\$83,640	3
Cement	910	TON	183	203	\$95	\$105	\$95,898	3
Resteel	526,700	LB	183	203	\$0.70	\$0.78	\$408,984	3
15' ID F. C. Steel Liner	315,000	LB	183	203	\$2.30	\$2.55	\$803,680	3
2' ID Cons. Steel Liner	6,300	LB	183	203	\$2.30	\$2.55	\$16,074	3
20" Butterfly Valves	7	EA	183	203	\$20,000	\$22,186	\$155,301	3
14' x 14' Bonnetted Slide Gate	1	EA	183	203	\$1,150,000	\$1,275,683	\$1,275,683	3
2' Diameter Bonnetted Slide Gate	1	EA	183	203	\$100,000	\$110,929	\$110,929	3
11' Diameter Howell Bunger Valve	2	EA	183	203	\$670,000	\$743,224	\$1,486,448	3
2' Diameter Howell Bunger Valve	1	EA	183	203	\$100,000	\$110,929	\$110,929	3
15' Diameter Bulkhead Gate	1	EA	183	203	\$625,000	\$693,306	\$693,306	3
20" Diameter Bulkhead Gate	1	EA	183	203	\$20,000	\$22,186	\$22,186	3
1 Trashrack (40,000 lbs)	40,000	LB				\$3.63	\$145,200	2, item VI-q
7 Trashracks (1,000 lbs)	7,000	LB				\$3.63	\$25,410	2, item VI-q
<b>SUBTOTAL DIPPINGVAT DAM OUTLET WORKS</b>							<b>\$6,572,825</b>	
<b>XIII. SADDLE DAMS</b>								
Dippingvat-Lanyan								
Stripping	5,010	CY	143	159	\$5.00	\$5.56	\$27,853	3
Excavation	8,860	CY	143	159	\$5.00	\$5.56	\$49,257	3
Embankment	8,860	CY	143	159	\$3.00	\$3.34	\$29,554	3
Lewis Flat								
Stripping	1,540	CY	143	159	\$5.00	\$5.56	\$8,562	3
Excavation	3,090	CY	143	159	\$5.00	\$5.56	\$17,179	3
Embankment	3,090	CY	143	159	\$3.00	\$3.34	\$10,307	3
Red Bank Road								
Stripping	340	CY	143	159	\$5.00	\$5.56	\$1,890	3
Excavation	440	CY	143	159	\$5.00	\$5.56	\$2,446	3
Embankment	440	CY	143	159	\$3.00	\$3.34	\$1,468	3

**Table 2**  
**ESTIMATED COSTS**  
**RED BANK PROJECT**

DESCRIPTION	QUANTITY	UNIT <sup>a</sup>	USBR INDEX APR. 91	USBR INDEX OCT. 96	UNIT COST APR. 91	UNIT COST OCT. 96	TOTAL COST OCT. 96	COST REFERENCE
Last Chance Creek								
Stripping	33,300	CY	143	159	\$5.00	\$5.56	\$185,129	3
Excavation	209,700	CY	143	159	\$5.00	\$5.56	\$1,165,815	3
Embankment	209,700	CY	143	159	\$3.00	\$3.34	\$699,489	3
SUBTOTAL SADDLE DAMS							\$2,198,948	
<b>XIV. CONVEYANCE SYSTEM</b>								
<b>DIPPINGVAT-LANYAN</b>								
Channel Excavation	258,100	CY	165	199	\$5.00	\$6.03	\$1,556,421	3
Concrete Lining	2,490	CY	165	199	\$290	\$350	\$870,896	3
Cement	650	TON	165	199	\$95.00	\$115	\$74,474	3
Resteel	249,400	LB	165	199	\$0.70	\$0.84	\$210,554	3
Tunnel								
Mobilization	JOB	LS	192	226	\$69,000	\$81,219	\$81,219	3
Excavation	9,360	CY				\$128	\$1,198,080	2, item VI-s
Steel Supports	174,600	LB				\$1.05	\$183,330	2, item VI-v
Timber Lagging	110	MBM				\$1,930	\$212,300	2, item VI-w
Concrete Lining	3,780	CY				\$321	\$1,213,380	2, item VI-t
Long Rebar	95,400	LB	192	226	\$0.70	\$0.82	\$78,606	3
Grouting	JOB	LS	192	226	\$500,000	\$588,542	\$588,542	3
Cement	980	TON	192	226	\$95.00	\$112	\$109,586	3
Miscellaneous 5%	JOB	LS	192	226	\$171,000	\$201,281	\$201,281	3
8' ID Steel Liner	378,000	LB	183	203	\$2.30	\$2.55	\$964,416	3
8' Diameter Bulkhead Gate	1	EA	183	203	\$300,000	\$332,787	\$332,787	3
7' x 7' Bonnetted Slide Gate	1	EA	183	203	\$430,000	\$476,995	\$476,995	3
8' Diameter Howell Bungler Valve	1	EA	183	203	\$430,000	\$476,995	\$476,995	3
1 Trashrack (20,000 lbs)	20,000	LB				\$3.63	\$72,600	2, item VI-q
<b>LANYAN - BLUEDOOR</b>								
Channel Excavation	63,310	CY	165	199	\$5.00	\$6.03	\$381,778	3
Concrete Lining	1,500	CY	165	199	\$290	\$350	\$524,636	3
Cement	390	TON	165	199	\$95.00	\$115	\$44,685	3
Resteel	150,000	LB	165	199	\$7.00	\$8.44	\$1,266,364	3

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**Table 2**  
**ESTIMATED COSTS**  
**RED BANK PROJECT**

DESCRIPTION	QUANTITY	UNIT <sup>a</sup>	USBR INDEX APR. 91	USBR INDEX OCT. 96	UNIT COST APR. 91	UNIT COST OCT. 96	TOTAL COST OCT. 96	COST REFERENCE
BLUEDOOR - SCHOENFIELD								
Channel Excavation	119,100	CY	165	199	\$5.00	\$6.03	\$718,209	3
Concrete Lining	10,920	CY	165	199	\$290	\$350	\$3,819,353	3
Cement	2,840	TON	165	199	\$95.00	\$115	\$325,395	3
Resteel	1,580,000	LB	165	199	\$7.00	\$8.44	\$13,339,030	3
SUBTOTAL CONVEYANCE SYSTEM							\$29,321,912	
SUBTOTAL FOR RED BANK PROJECT							\$132,600,000	
CONTINGENCIES @ 20%							\$26,500,000	
ESTIMATED CONSTRUCTION COST FOR RED BANK PROJECT							\$159,100,000	
ENG., LEGAL, AND ADM. @ 35%							\$55,700,000	
ESTIMATED CAPITAL COST FOR RED BANK PROJECT							\$214,800,000	
ESTIMATED CAPITAL COST RANGE FOR RED BANK PROJECT								
LOW (-10%)							\$193,000,000	
HIGH (+15%)							\$247,000,000	

**Footnotes:**

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

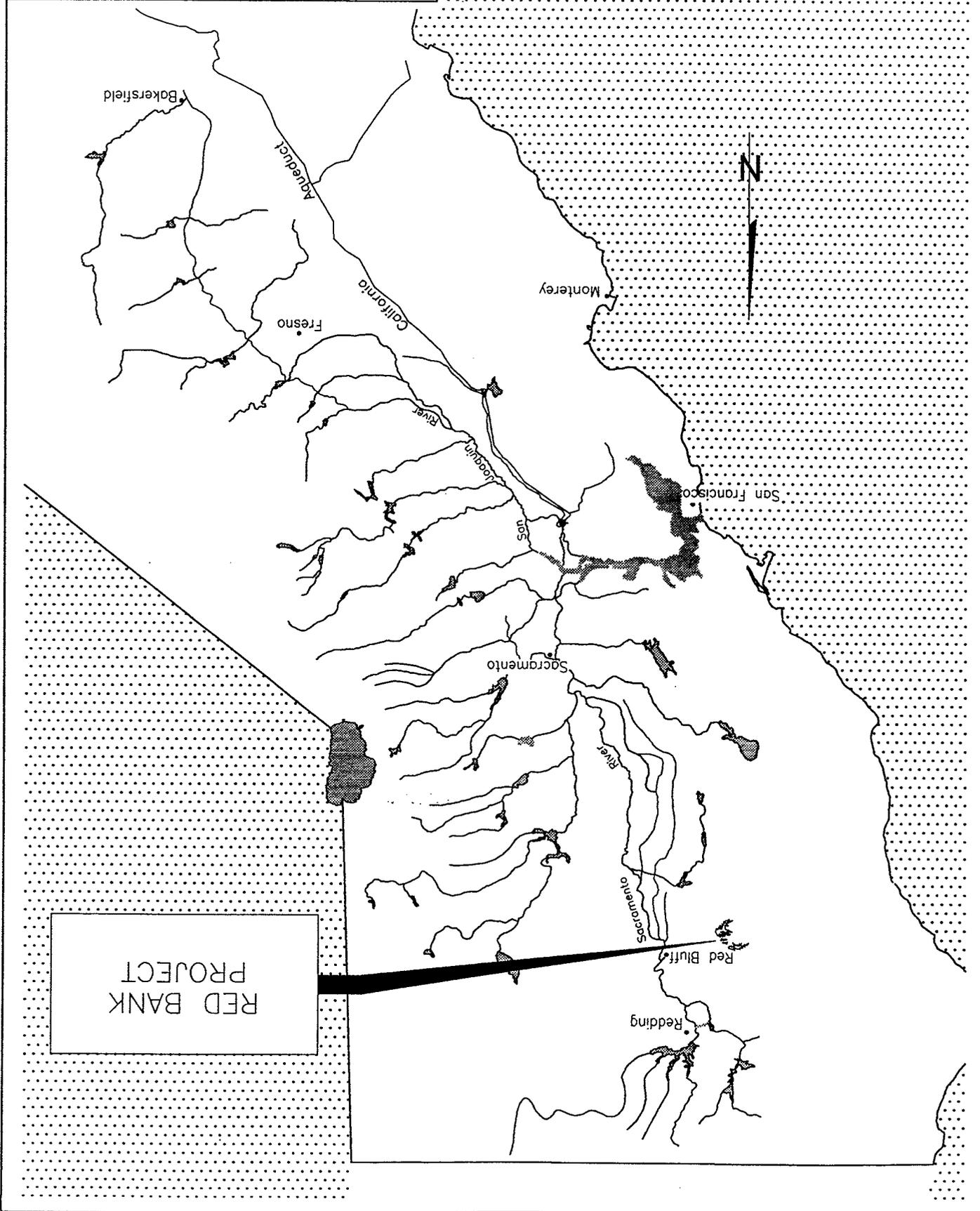
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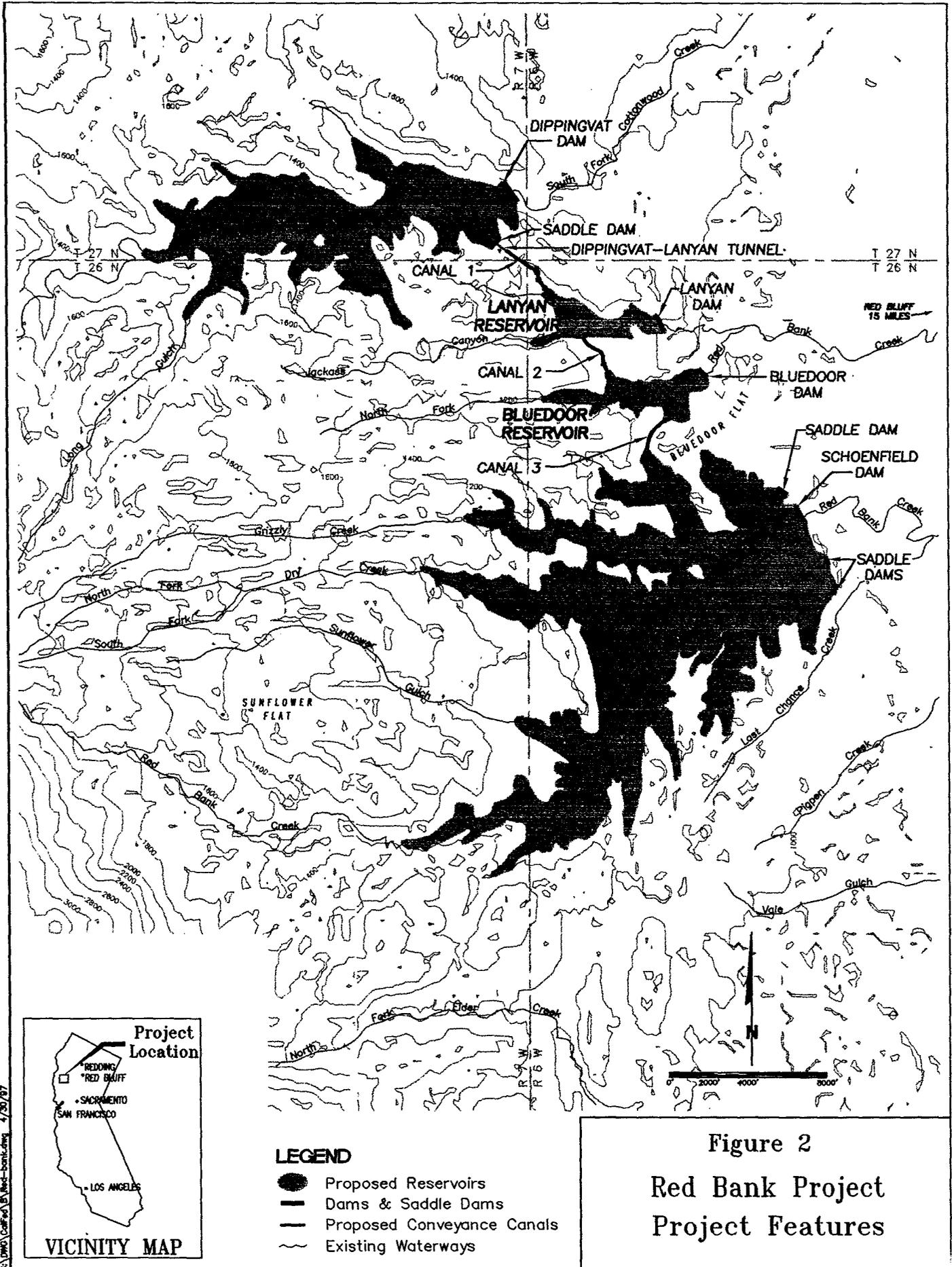
- Costs were developed by U.S. Bureau of Reclamation, Land Resources Branch, February 1997
- California Department of Water Resources, *Los Banos Grandes Facilities Report, Appendix A: Designs and Cost Estimates*, December 1990
- California Department of Water Resources, *Red Bank Project Pre-Feasibility Design Alternatives Report*, June 1993

**Table 3**  
**SUMMARY OF ESTIMATED COSTS**  
**RED BANK PROJECT**

Cost Item	Estimated Costs (\$Million)
Schoenfield Reservoir	9.8
Schoenfield Dam and Spillway	35.1
Schoenfield Dam Outlet Works	5.9
Bluedoor Reservoir	0.3
Bluedoor Dam	4.4
Bluedoor Dam Outlet Works	0.4
Lanyan Reservoir	0.2
Lanyan Dam and Spillway	1.8
Lanyan Dam Outlet Works	0.3
Dippingvat Reservoir	7.0
Dippingvat Dam and Spillway	29.5
Dippingvat Dam Outlet Works	6.6
Saddle Dams	2.2
Conveyance System	29.3
<b>SUBTOTAL</b>	<b>132.8</b>
Contingencies (20%)	26.0
<b>ESTIMATED CONSTRUCTION COST</b>	<b>158.8</b>
Engineering, Legal, and Project Administration (35%)	56.0
<b>ESTIMATED TOTAL CAPITAL COST</b>	<b>214.8</b>
Capital Cost Range (minus 10% - plus 15%)	<b>\$194 - \$247</b>

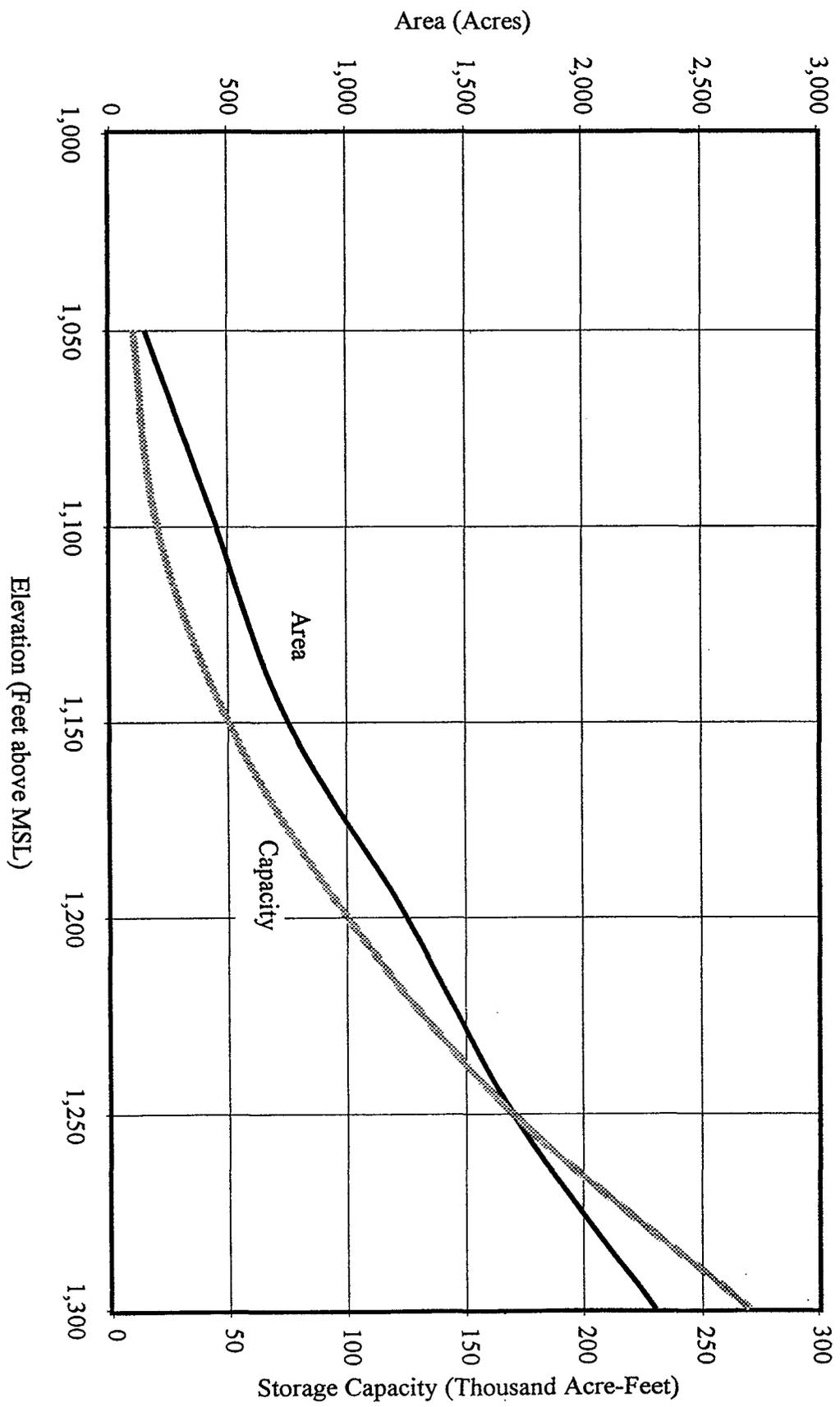
Figure 1  
Project Location Map  
Red Bank Project





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FIGURE 3  
 AREA-CAPACITY CURVES  
 RED BANK PROJECT - DIPPINGVAT RESERVOIR



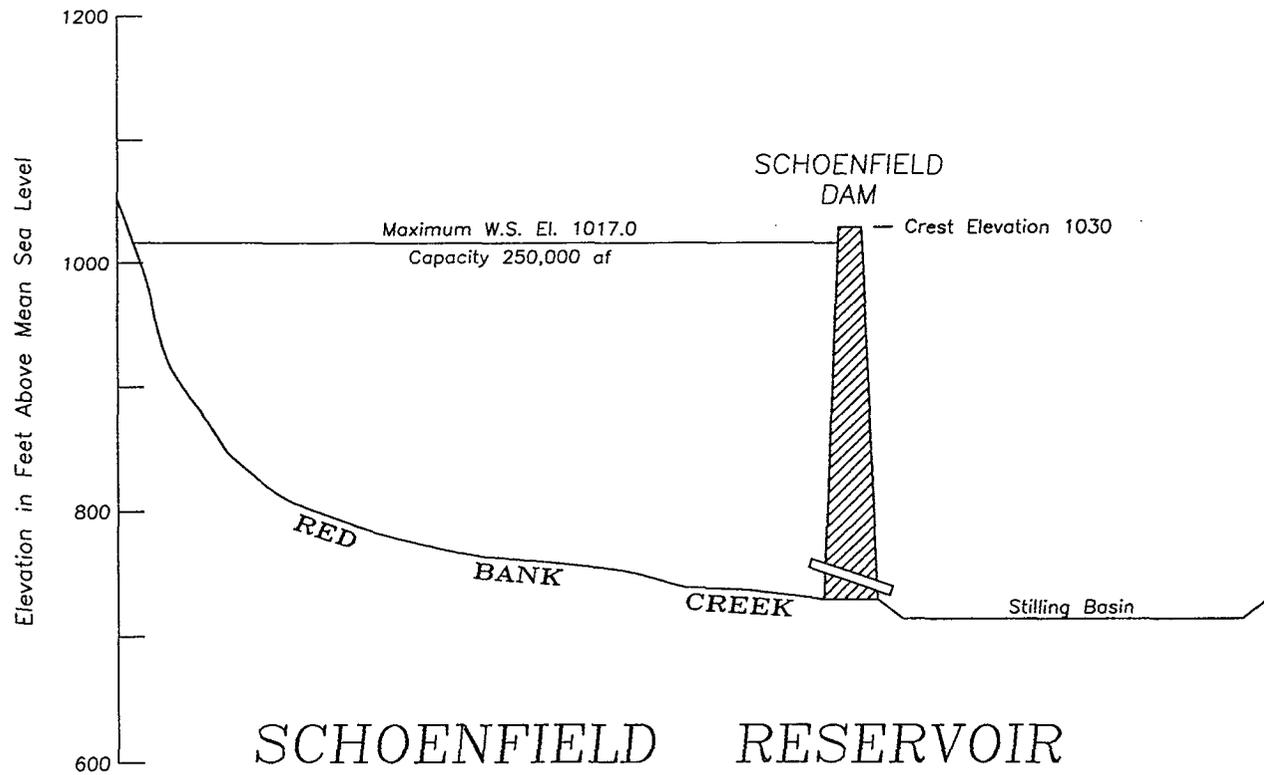
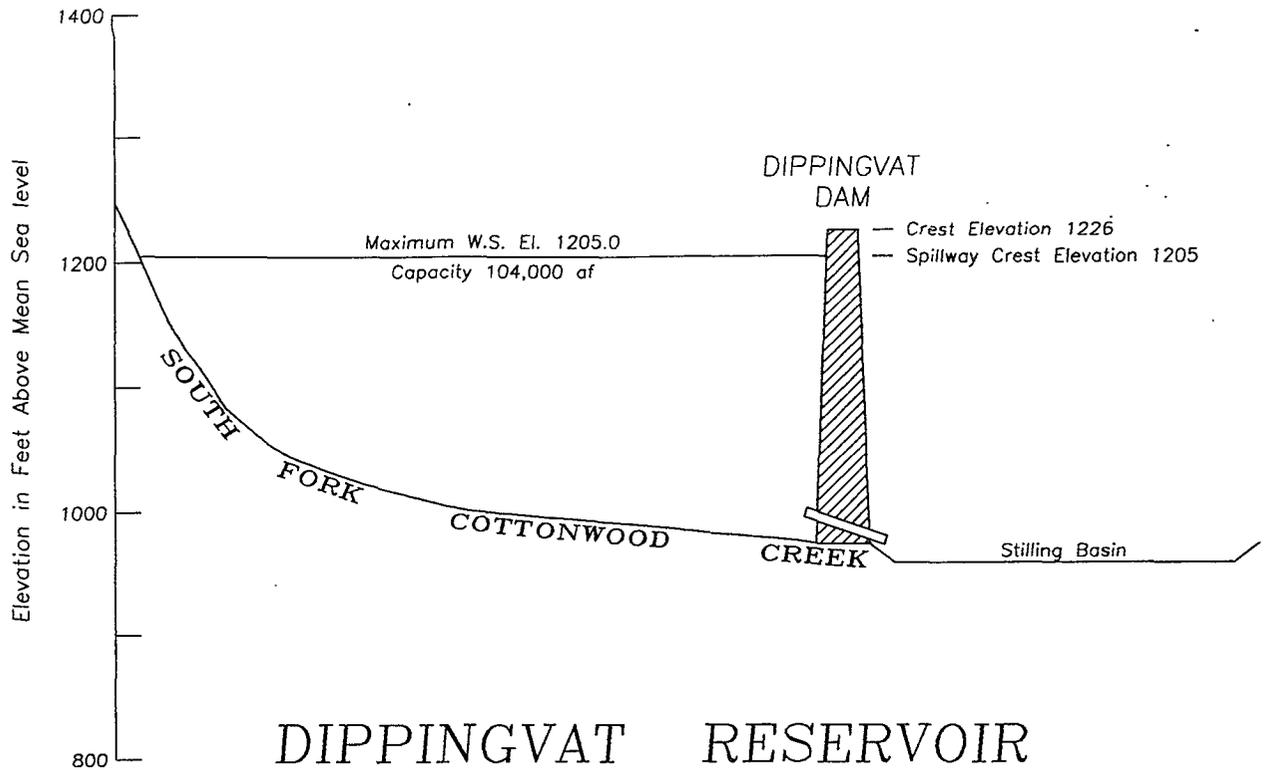
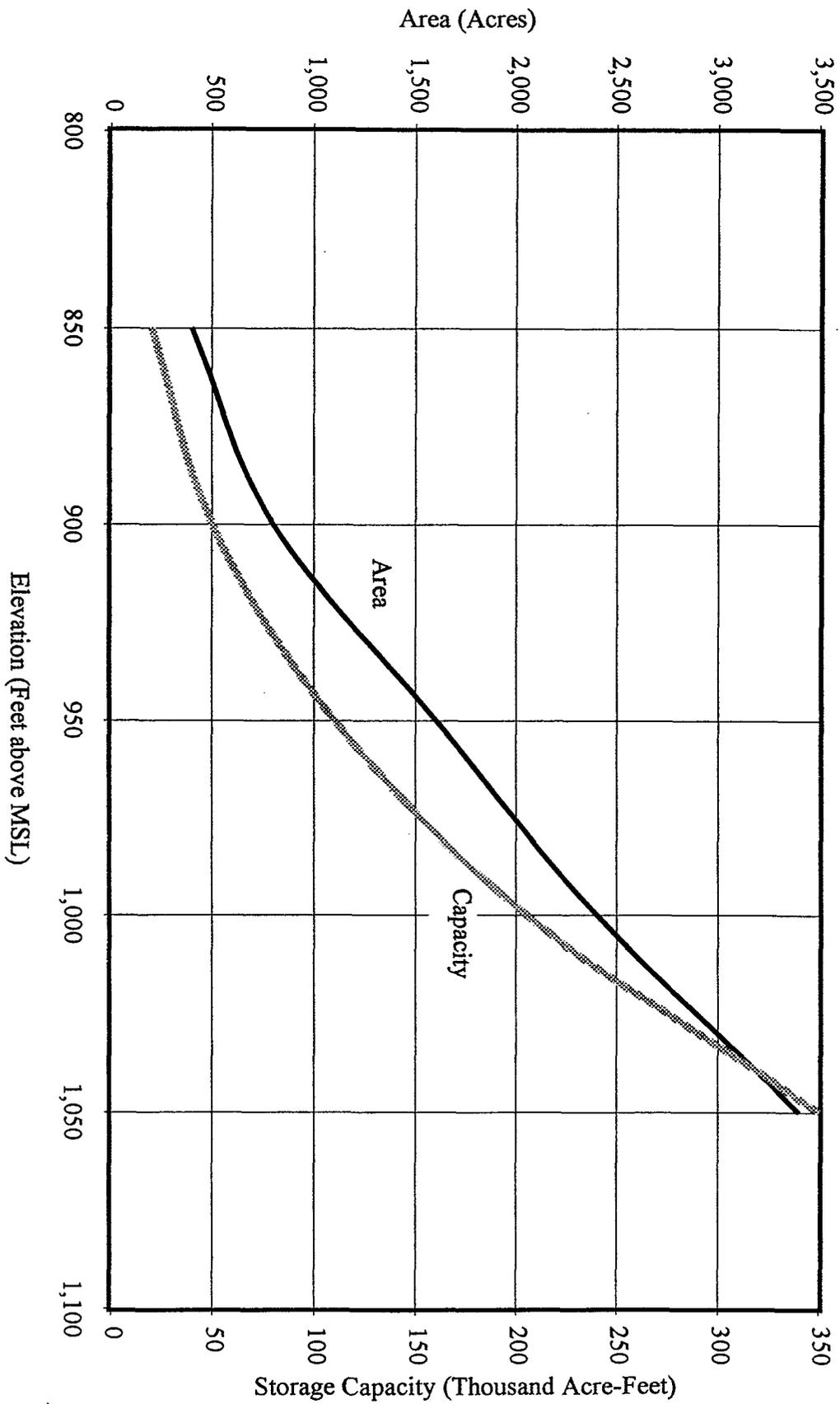


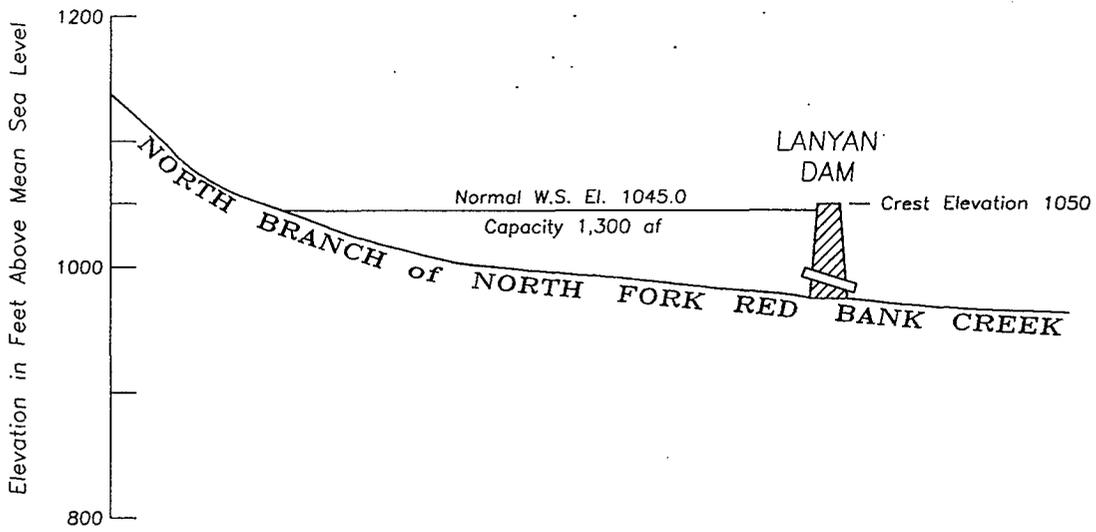
Figure 4  
Schematic Profile  
Red Bank Project  
Dippingvat & Schoenfield Reservoirs

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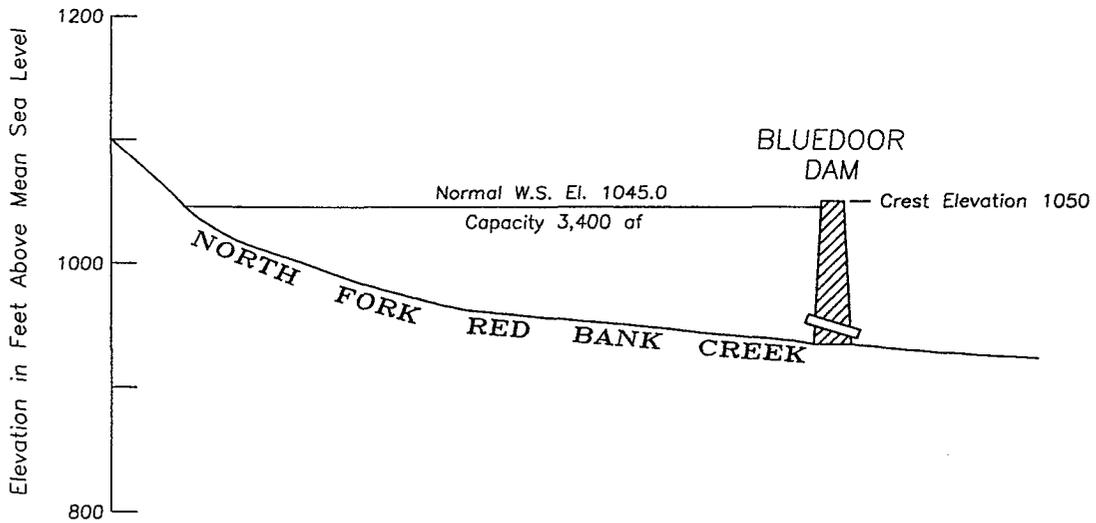
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PROGRAM

FIGURE 5  
 AREA-CAPACITY CURVES  
 RED BANK PROJECT - SCHOENFELD RESERVOIR





## LANYAN RESERVOIR



## BLUEDOOR RESERVOIR

Figure 6  
 Schematic Profile  
 Red Bank Project  
 Lanyan & Bluedoor Reservoirs

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