Chapter 5. Engineering Analysis

As summarized in preceding chapters, considerable engineering and related studies of the four north of the Delta offstream storage projects have been previously conducted. This past work has been incorporated into this investigation to the extent possible. However, most of these previous studies were performed at less than feasibility level and under planning guidelines that have changed substantially. Therefore, much additional engineering work remains to be done on each alternative, subject to continuing screening. This chapter summarizes the engineering work completed to date.

In addition to differing years of engineering analysis, studies have been performed at differing levels of detail and precision. Many of the design characteristics shown are for comparative purposes. As studies progress and more site-specific information is developed, some of these characteristics may change.

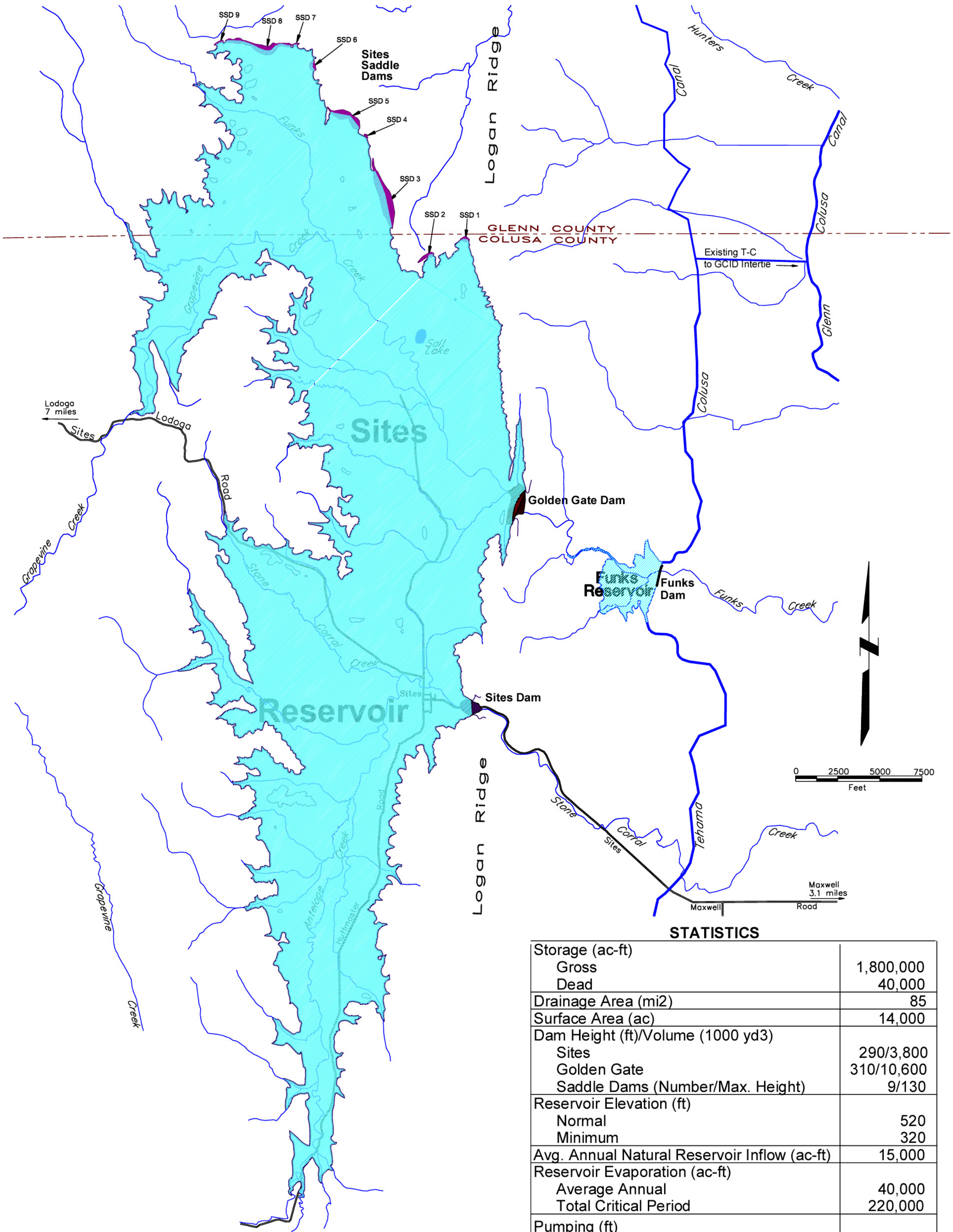
Sites Project

Sites Reservoir would be formed by Golden Gate Dam on Funks Creek, Sites Dam on Stone Corral Creek, and nine saddle dams along the ridge between Funks and Hunters Creeks. Figure 5-1 shows the dams and reservoir for the Sites Project, with dam statistics based on initial designs of the dam embankments. Statistics shown for Golden Gate Dam are for a downstream embankment alternative. An area-capacity curve for Sites Reservoir is shown in Figure 5-2. The normal water surface elevation of the reservoir would be 520 feet, inundating 14,000 acres for a total capacity of 1.8 maf. The minimum operating water surface elevation would be 320 feet. Dead storage at that elevation would be approximately 40 taf.

Much of the Sites Project engineering work is being conducted by DWR’s Division of Engineering in Sacramento, while most of the geology work has been performed by DWR’s Northern District Geology Section. Northern District's Offstream Storage Investigation Branch directed the overall planning effort.

Since the two small watersheds above the reservoir produce only around 15 taf of average annual runoff, Sites Reservoir would serve as offstream storage for other sources of water. The reservoir would be filled almost entirely by diversions from the Sacramento River and local tributaries using existing, new, or enlarged conveyance and diversion facilities. A number of water supply source and conveyance options have been considered for the Sites Project. The source and conveyance options have been packaged in various combinations to create eight unique source and conveyance alternatives and an additional six that are variations. All of the supply and conveyance alternatives being considered include multiple conveyance options; all but one include multiple sources. Decisions related to optional water supply sources and conveyance have not been made.

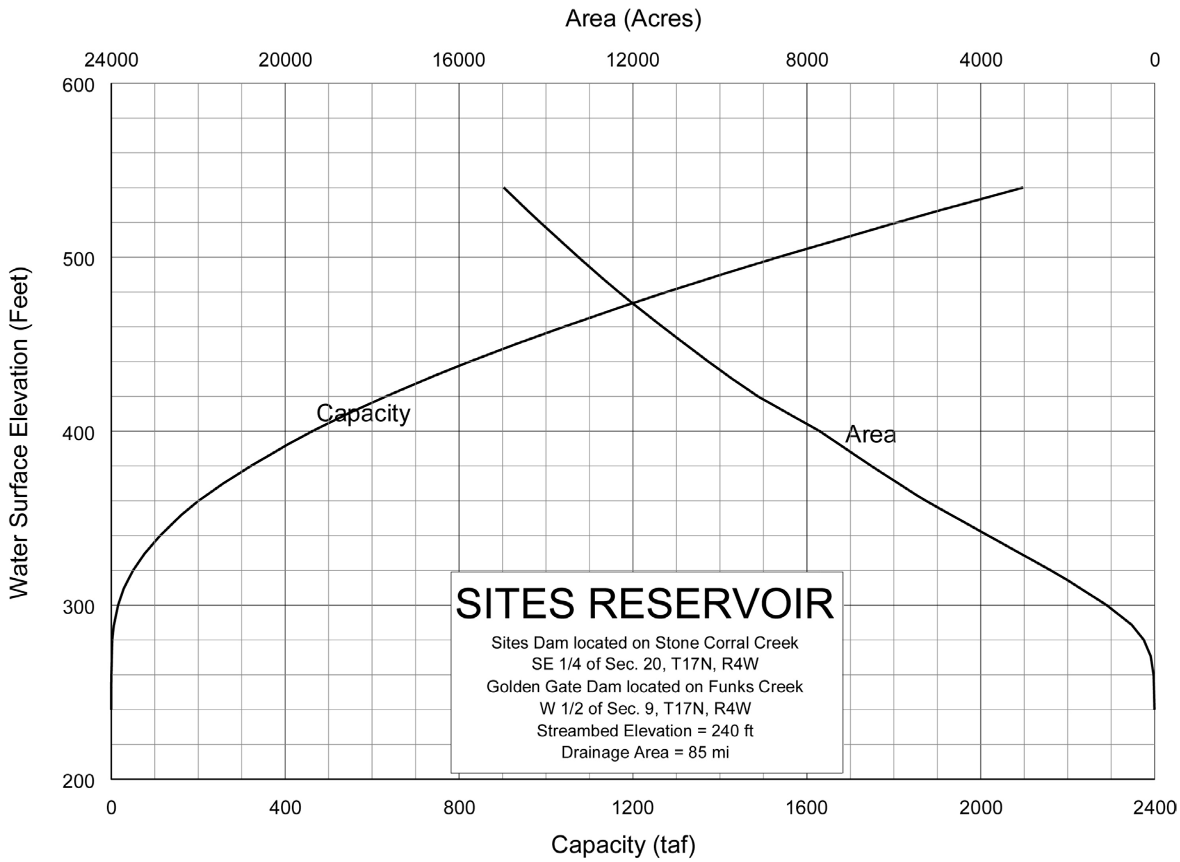
Figure 5-1. Sites Project and Statistics



STATISTICS

Storage (ac-ft)	
Gross	1,800,000
Dead	40,000
Drainage Area (mi2)	85
Surface Area (ac)	14,000
Dam Height (ft)/Volume (1000 yd3)	
Sites	290/3,800
Golden Gate	310/10,600
Saddle Dams (Number/Max. Height)	9/130
Reservoir Elevation (ft)	
Normal	520
Minimum	320
Avg. Annual Natural Reservoir Inflow (ac-ft)	15,000
Reservoir Evaporation (ac-ft)	
Average Annual	40,000
Total Critical Period	220,000
Pumping (ft)	
Static Lift from T-C Canal	
Maximum	320
Minimum	120
Capacity	
Maximum (1000 ft^3/s)	5 to 8

Figure 5-2. Sites Reservoir Area-Capacity Curves



Funks Reservoir, approximately 2 miles downstream from the Golden Gate Dam site, is a convenient forebay/afterbay for the Sites Project. All of the water supply source and conveyance options propose to use Funks Reservoir as a forebay, with the exception of the upper Stony Creek water supply options. The existing 40-foot-high dam that impounds Funks Reservoir might be used as is or might be replaced with a larger dam to regulate the inflow and outflow from Sites Reservoir. For this investigation, it was assumed that no additional forebay or afterbay storage would be required to meet project inflow or outflow regulation needs.

Tehama-Colusa Canal and Glenn-Colusa Canal are existing conduits that could convey water to Sites Reservoir from the Sacramento River. Tehama-Colusa Canal runs through Funks Reservoir, which currently serves as a surge reservoir for canal operations. The Glenn-Colusa Canal runs approximately 3 miles east of and 80 feet below Funks Reservoir. Water from this canal could be pumped into Funks Reservoir through a new connector canal and pumping plant. Another conveyance option is a new canal running west from a new diversion point on the Sacramento River that also could convey water from the Colusa Basin Drain. Water from this new canal would be pumped into Funks Reservoir through the same connector canal mentioned previously.

Reservoir inflow from the alternatives considered ranges from 3,900 up to 8,000 cubic feet per second. A pumping/generating plant located at the base of

Golden Gate Dam would lift water up to 320 feet from Funks Reservoir into Sites Reservoir. During scheduled releases, the plant would be used to generate power. The plant would have maximum pumping and discharge capacities of around 8,000 cfs.

Contour maps of Sites Reservoir were scanned and digitized in 1997 by DWR. USBR prepared the original contour maps from 1:25000 photography BR-SVC-2, dated April 8, 1978. Ten-foot contours were interpolated from 5-meter contours. This digitized information was used for determining the most efficient facilities layout and the area-capacity curve.

Golden Gate Dam

Golden Gate Dam, including its inlet/outlet works and pumping/ generating plant, is the most complex structure necessary to form either Sites or Colusa Reservoirs. The dam site is located on Funks Creek along Logan Ridge approximately 8 miles northwest of Maxwell. For Sites and Colusa Reservoirs, the normal reservoir elevation would be 520 feet.

Embankment Design

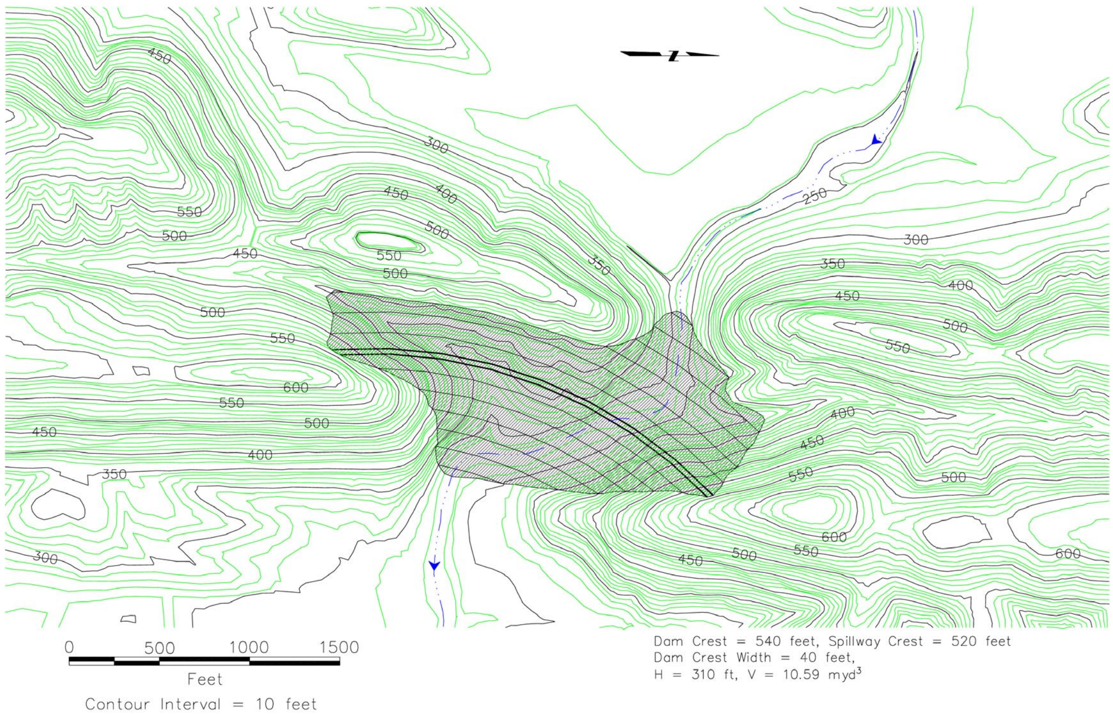
Golden Gate Dam would most likely be constructed as a zoned rockfill embankment dam. A roller-compacted concrete (RCC) dam is being evaluated as an alternative, but appears to be more expensive. The following discussion concentrates on embankment alternatives. Design characteristics shown allow for comparative evaluation. As studies progress and more site-specific information becomes available, some of these characteristics may be adjusted.

Because of complex topographic and geologic conditions at the Golden Gate Dam site, two representative dam axis alignments have been investigated and are shown on Figure 5-3. For the downstream curved alternative, Golden Gate Dam would rise 310 feet above the streambed, with a crest 2,000 feet long and 30 feet wide, and require 10.6 million cubic yards of embankment material. An upstream straight alignment would be 300 feet high, with a crest length of 5,000 feet and crest width of 40 feet, and require 17.3 mcy of embankment material. The crest elevation is the same for all embankment alternatives and would be 540 feet, providing 20 feet of freeboard.

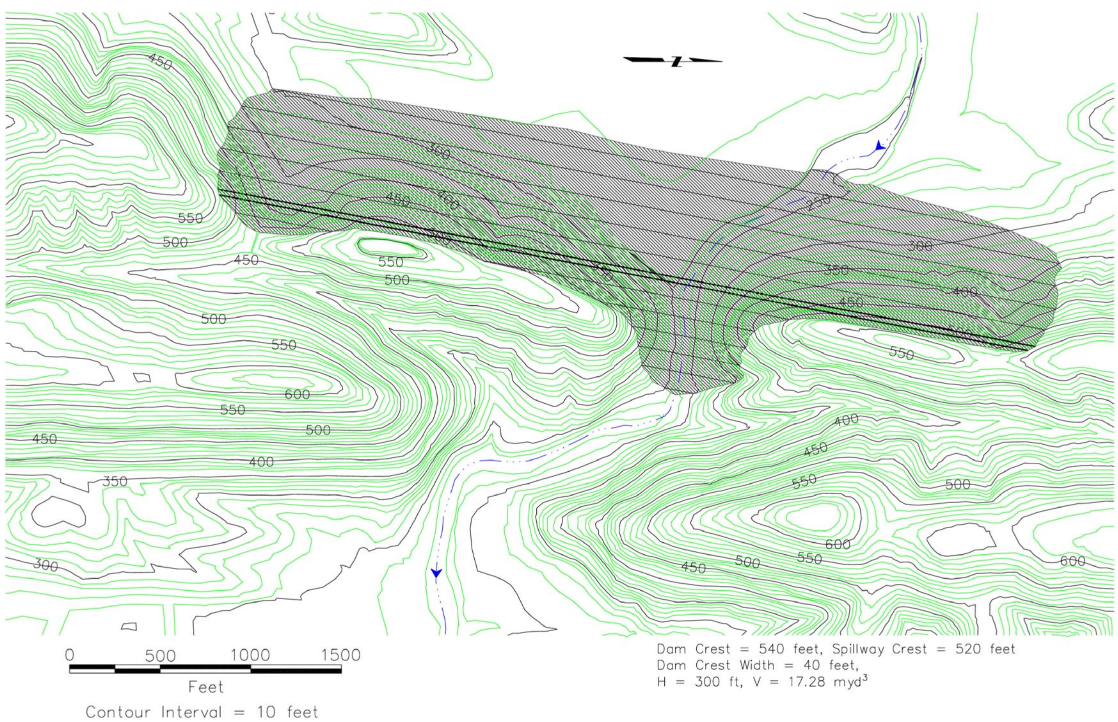
The dam foundation is composed of sandstone and mudstone, which is strong and tight enough to provide an adequate foundation for either an embankment or RCC dam. Stripping will be required to remove softer surface deposits in depths up to 20 feet. Also, extensive grouting in some foundation areas will be required to reduce reservoir seepage.

The zoned embankment alternative would have an impervious clay core with upstream filter and downstream drain zones. Materials testing indicates that adequate clay mixture soils exist in the reservoir area to supply the quantity of material required for the dam's impervious core. Sandstone is available locally for dam rockfill and shell material. Filter, drain, and concrete aggregate material may need to be imported. Additional materials testing work will have to be performed to verify the location and quantity of suitable construction materials.

Figure 5-3. Golden Gate Dam Alternative Alignments



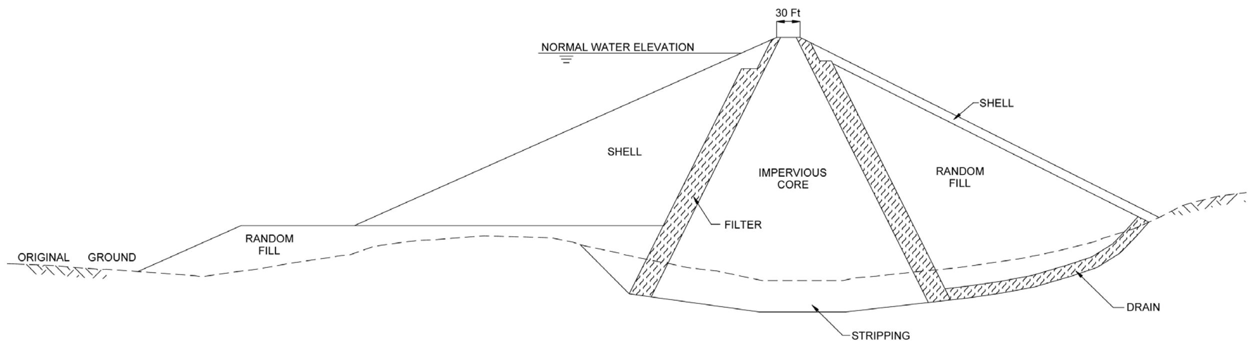
Downstream Curved



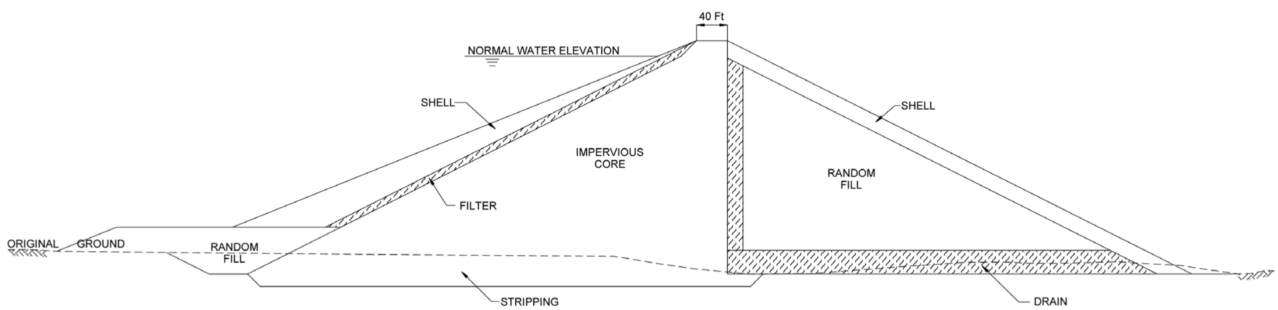
Upstream Straight

The typical cross sections of potential embankment dams at the Golden Gate and Sites locations are shown on Figure 5-4. The results from preliminary stability analyses using assumed strengths are considered adequate for the purpose of developing feasibility-level designs and cost estimates. A significantly different embankment cross section was proposed for the upstream alignment.

Figure 5-4. Golden Gate and Sites Embankment Dam Cross Sections



Golden Gate Downstream Alignment and Sites Dam



Golden Gate Upstream Alignment

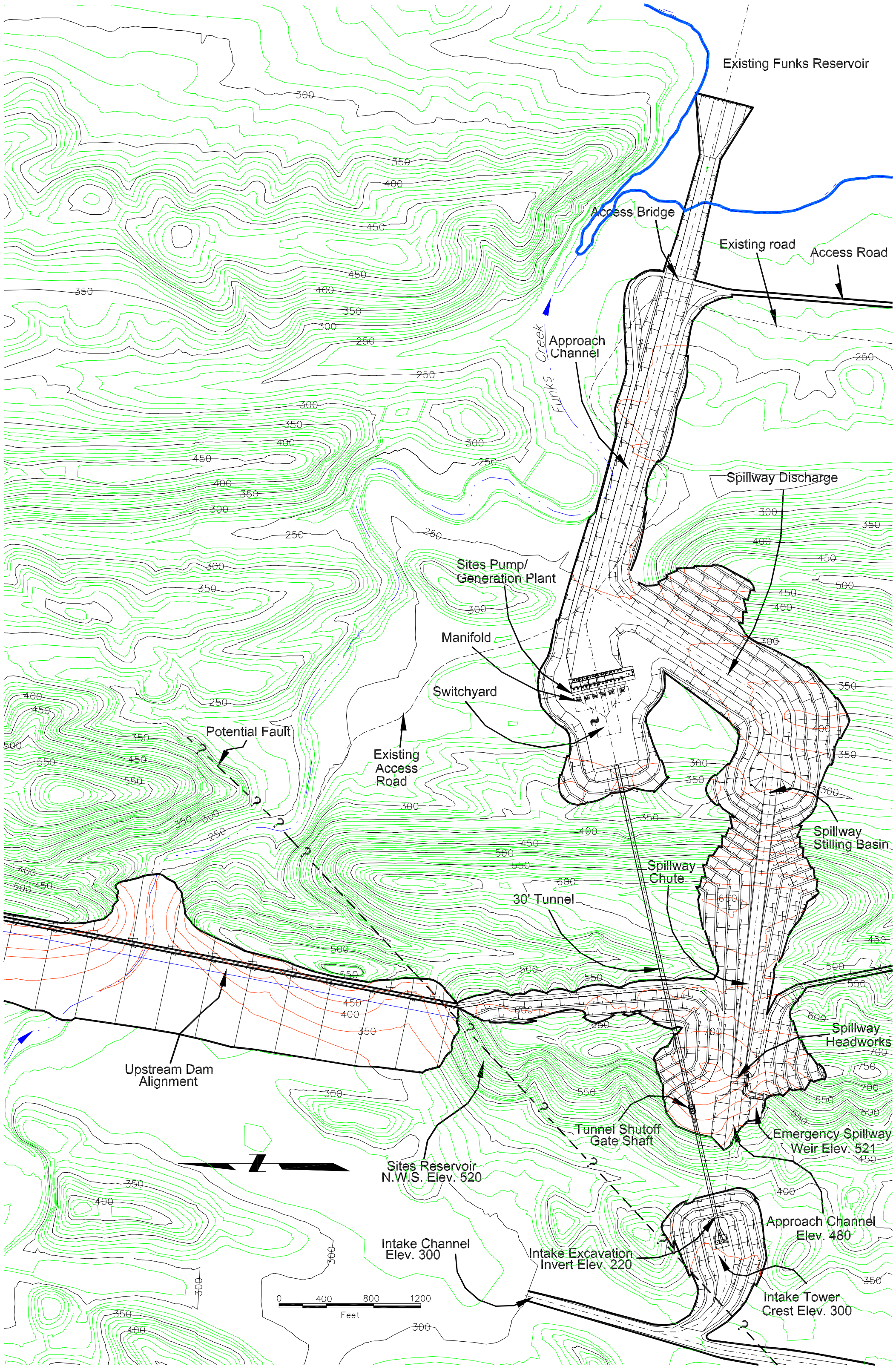
Spillways

Several alternatives are under evaluation for spillway and outlet appurtenant works. A spillway is necessary to convey water around the dam to prevent overtopping from extreme floods. An outlet is necessary to reduce reservoir head in case of an emergency. The emergency spillway is designed to spill the probable maximum flood storm, or 5,000 cfs. The initial alternative considered a high-level outlet consisting of six radial gates that release water into a concrete spillway chute. This spillway can be controlled by a mechanical headgate structure. Other alternatives are being considered.

The emergency spillway is designed as an ungated weir. One option is to have these spillways combined into a single structure as shown in Figure 5-5.

Figure 5-5. Golden Gate Dam Upstream Alignment and Appurtenances

Note: Other alternative dam alignments are still under consideration.



Excavation of this option would produce approximately 6.5 mcy of construction materials that could be incorporated into the Golden Gate Dam embankment. To date, only one of several potential types of outlets has been investigated in this study. Others should be considered and an economical analysis should be completed to determine the ideal size, type, and location of the structure.

Pumping/Generating Plant and Inlet/Outlet Works

Much of the following discussion is applicable for Sites and Colusa Reservoirs. Most of the water entering Sites or Colusa Reservoirs would be diverted from the Sacramento River or its tributaries. The average annual natural inflow from the watersheds upstream of Sites Reservoir is 15 taf; Colusa Reservoir is 20 taf. These natural inflows comprise less than half the water annually evaporated from the respective proposed reservoir. Diverted water would be conveyed to the existing or enlarged Funks Reservoir, in most cases, where it would be pumped into Sites or Colusa Reservoirs. In order to recover much of the power required for pumping, generators would be included for recapturing power when reservoir releases are made.

Initial design and cost estimate studies of the facilities at Golden Gate Dam include facilities to convey water between existing Funks and potential Sites or Colusa Reservoirs. Figure 5-5 shows an alternative location of the pumping/generating plant and other appurtenances. This facility would pump up to 8,000 cfs using from 10-to-15 pumping/generating units. For initial design and cost estimating purposes, ten 680 cfs and three 350 cfs units were used. This facility would be a conventional indoor-type plant with an inline arrangement of 13 vertical pumping/generating units. The total power output would be around 220 MW. Once a dam alignment is selected, the final plant location can be established.

For this initial design, the plant would be located on a relatively low, flat bench immediately south of Funks Creek and less than a mile southeast of the Golden Gate Dam site. If the existing Funks Reservoir were used as a forebay, the maximum excavation depth for the pumping/generating plant would be approximately 130 feet. This compares favorably with pumping plant excavations along the California Aqueduct, which frequently exceeded 140 feet. Much of the large quantity of material excavated to reach the required approach channel and plant depth may be usable in constructing the embankment dam.

The inlet-outlet structure would convey up to 8,000 cfs between Sites Reservoir and the pumping/generating plant. This preliminary design set the reservoir intake tower crest at elevation 300 feet. The intake structure would need to be redesigned to allow water to be drawn from different elevations in the reservoir water column if this feature is required.

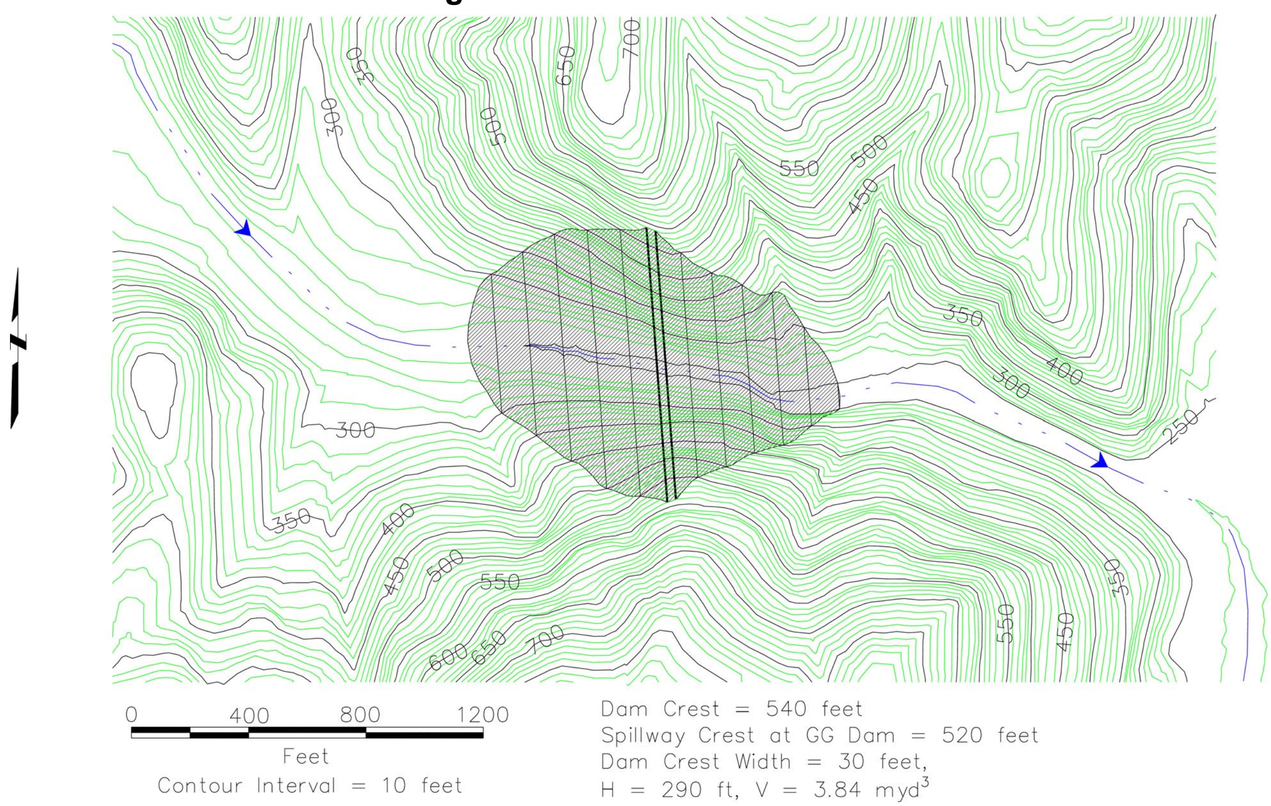
The preliminary design intake structure would connect to a 30-foot inside diameter pressure tunnel that would be 4,000 feet long. This tunnel would be connected to the pumping/generating plant, concrete lined for 3,000 feet and then steel lined for 1,000 feet at the pump/generating plant end. The tunnel is designed to convey water with a maximum velocity not to exceed approximately 10 feet per second. A 30-foot-by 20-foot control gate would be located in the tunnel approximately 1,000 feet from the intake tower and would allow dewatering of the lower tunnel for inspection. Tunnel inspection upstream of the gate shaft could be accomplished by covering the intake openings with bulkhead gates lowered from barges. Other design options are being considered.

A steel penstock would extend approximately 400 feet from the east tunnel portal and connect to a manifold feeding or receiving inflow from the pumping/generating plant. The penstock and manifold would be encased in concrete with anchor blocks to resist thrust forces at bends. The various branch diameters within the manifold were determined by setting maximum water velocity at approximately 10 feet per second. The connecting channel between Funks Reservoir and the pumping/generating plant would be a concrete-lined trapezoidal section with a 100-foot bottom width and 2:1 side slopes.

Sites Dam

The second major dam required to form Sites Reservoir is the 290-foot-high Sites Dam (shown in Figure 5-6) at the Stone Corral Creek water gap through Logan Ridge, approximately 2 miles south of the Golden Gate Dam site. This dam could be constructed either as an RCC or an embankment structure. At this point, it appears that an embankment structure alternative may be less expensive. Further study will be required to allow selection of a preferred alternative. Sites Dam would rise 290 feet above the streambed, with a crest elevation of 540 feet, crest width of 30 feet, and tentatively would require at least 3.8 mcy of embankment material.

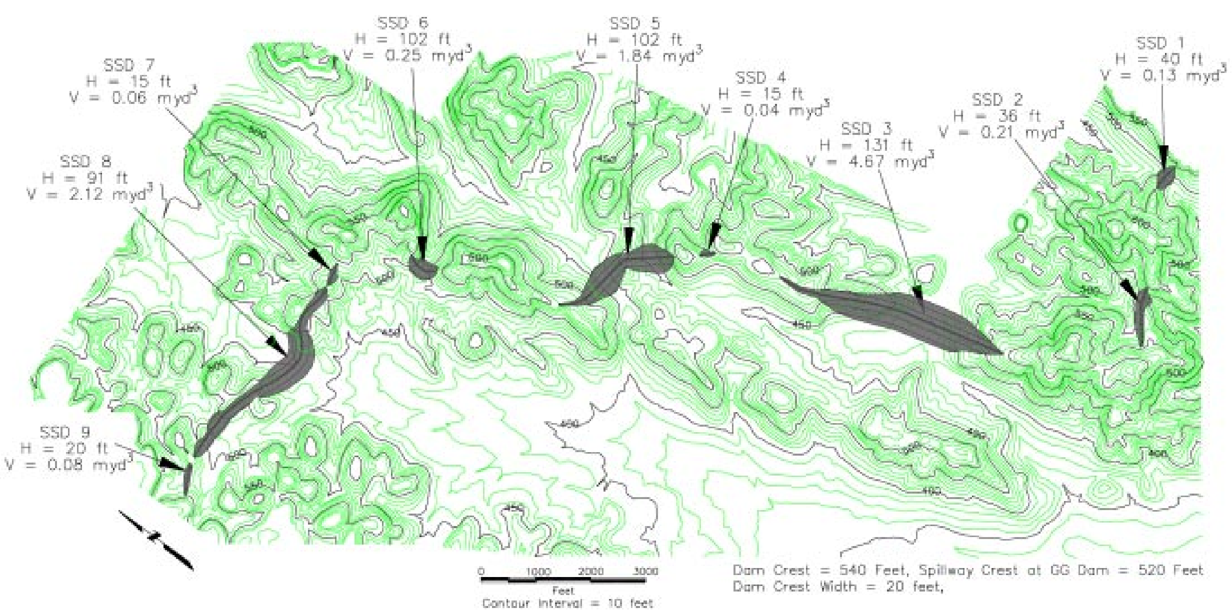
Figure 5-6. Sites Dam Plan View



Saddle Dams

The Sites Project will require the construction of nine saddle dams along the northern ridge dividing the Funks Creek and Hunters Creek drainages, as shown in Figure 5-7. The total embankment volume of these saddle dams is estimated to be about 9.4 mcy; there would be no appurtenances associated with them.

Figure 5-7. Sites Project – Saddle Dams

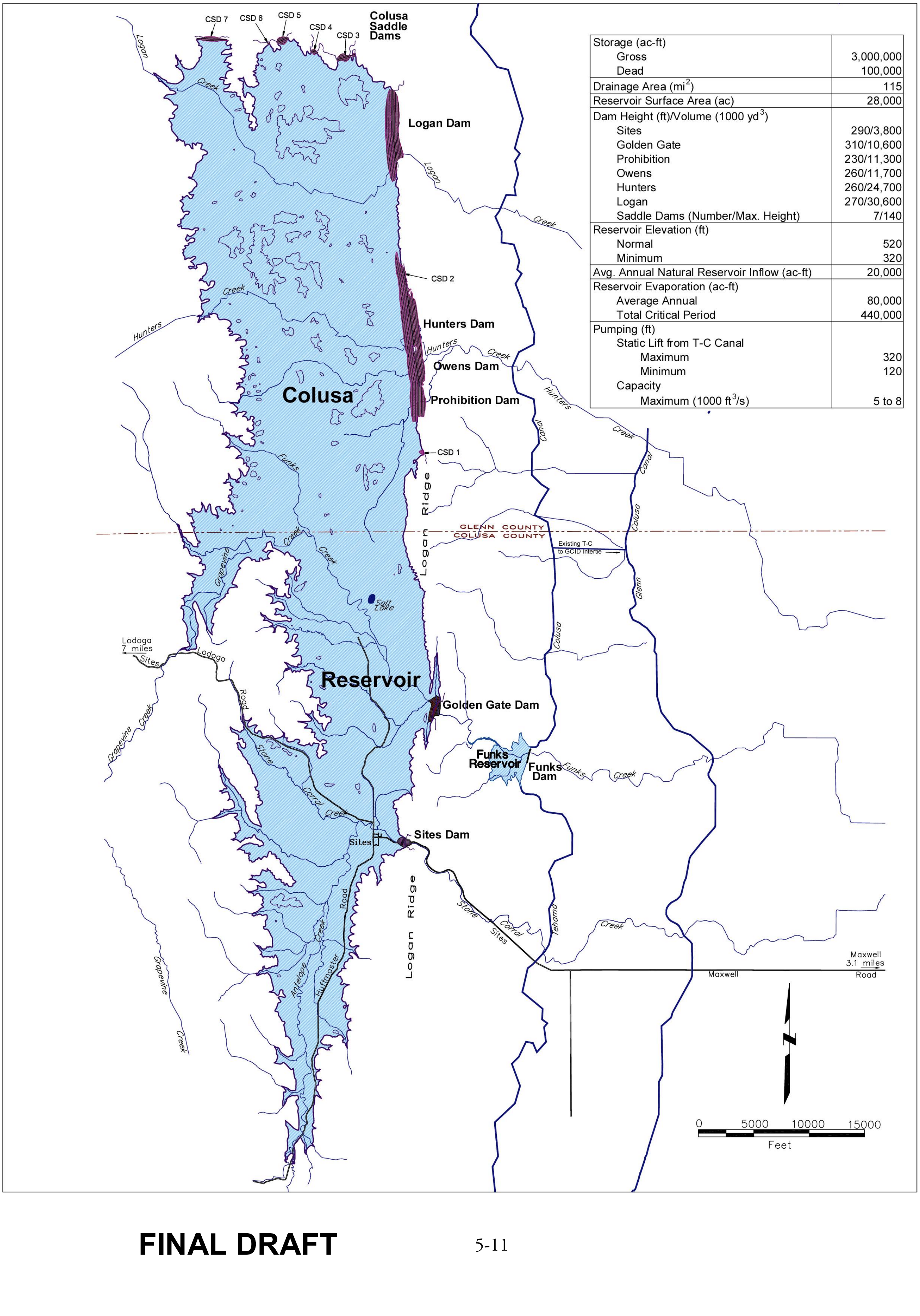


Colusa Project

The Colusa Project (Figure 5-8) would be an expansion of the Sites Project to include the Hunters and Logan Creek drainages to the north. All of the Sites Project facilities, except the saddle dams, would be constructed. Colusa Reservoir requires seven saddle dams along its northern boundary, with total embankment volume estimated to be 7.6 mcy. In addition, large dams would be built along Northern Logan Ridge at the Hunters and Logan Creeks water gaps, forming a 3.0 maf reservoir with a normal water surface elevation of 520 feet.

A large cut or tunnel would be required between Funks and Hunters Creek watersheds, upstream of Logan Ridge, to allow free water transfer between the Sites and Colusa portions of the reservoir at all elevations above dead storage elevation of 320 feet. Colusa Reservoir at a water surface elevation of 520 feet would contain 3.0 maf, or 67 percent more water than the 1.8 maf Sites Reservoir at the same level. However, fill material for Colusa Reservoir is 300 percent greater than Sites Reservoir — 100 mcy versus 24 mcy (for the Golden Gate downstream embankment alternative). This difference in embankment volume required will make the Colusa Project significantly more expensive than the Sites Project.

Figure 5-8. Colusa Project and Statistics



Storage (ac-ft)	
Gross	3,000,000
Dead	100,000
Drainage Area (mi^2)	115
Reservoir Surface Area (ac)	28,000
Dam Height (ft)/Volume (1000 yd^3)	
Sites	290/3,800
Golden Gate	310/10,600
Prohibition	230/11,300
Owens	260/11,700
Hunters	260/24,700
Logan	270/30,600
Saddle Dams (Number/Max. Height)	7/140
Reservoir Elevation (ft)	
Normal	520
Minimum	320
Avg. Annual Natural Reservoir Inflow (ac-ft)	20,000
Reservoir Evaporation (ac-ft)	
Average Annual	80,000
Total Critical Period	440,000
Pumping (ft)	
Static Lift from T-C Canal	
Maximum	320
Minimum	120
Capacity	
Maximum (1000 ft^3/s)	5 to 8

Figure 5-9 is the area-capacity curve for Colusa Reservoir. The plan views of the saddle dams, Hunters Dam, and Logan Dam are shown in Figures 5-10, 5-11, and 5-12 respectively.

Figure 5-9. Colusa Reservoir Area-Capacity Curves

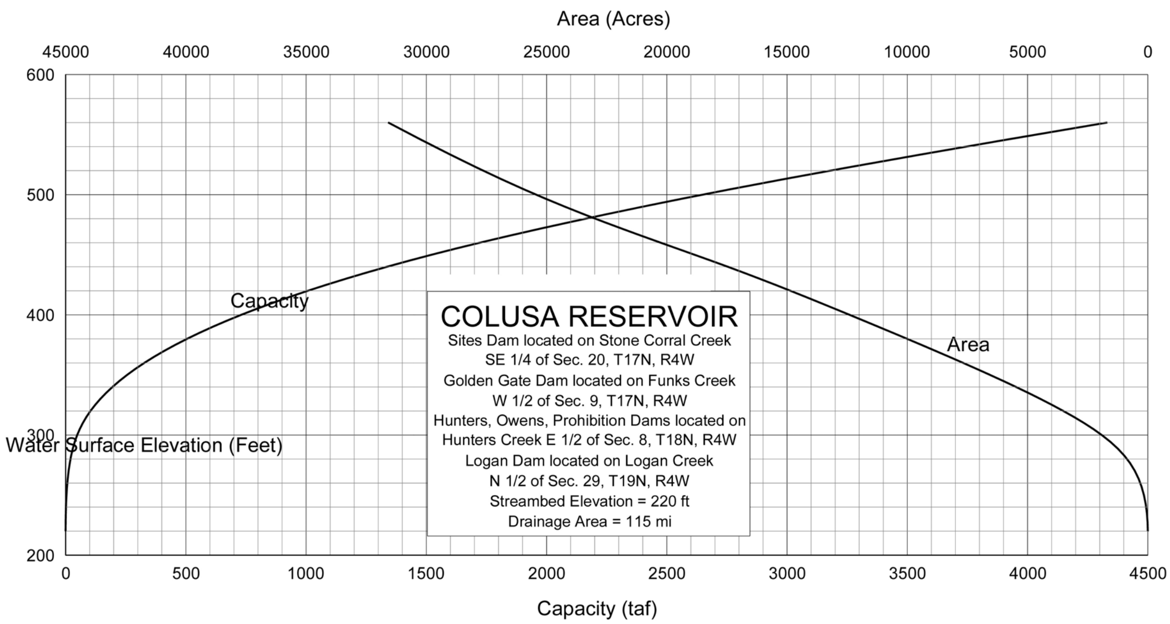


Figure 5-10. Colusa Reservoir – North Saddle Dams

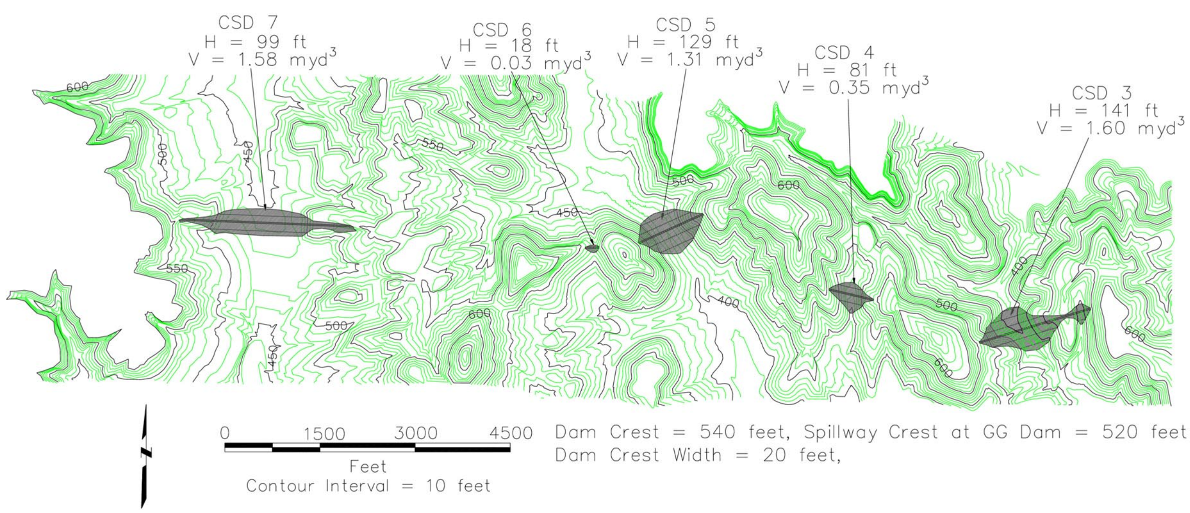


Figure 5-11. Colusa Reservoir – Hunters, Owens, and Prohibition Dams

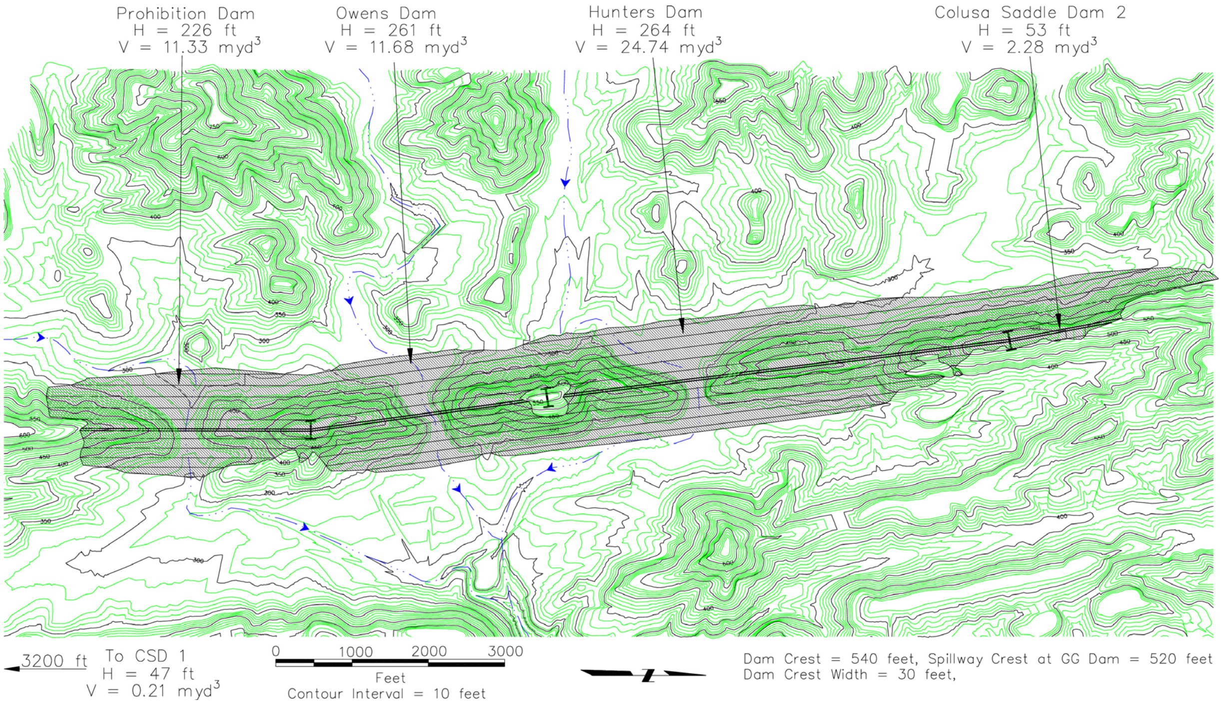
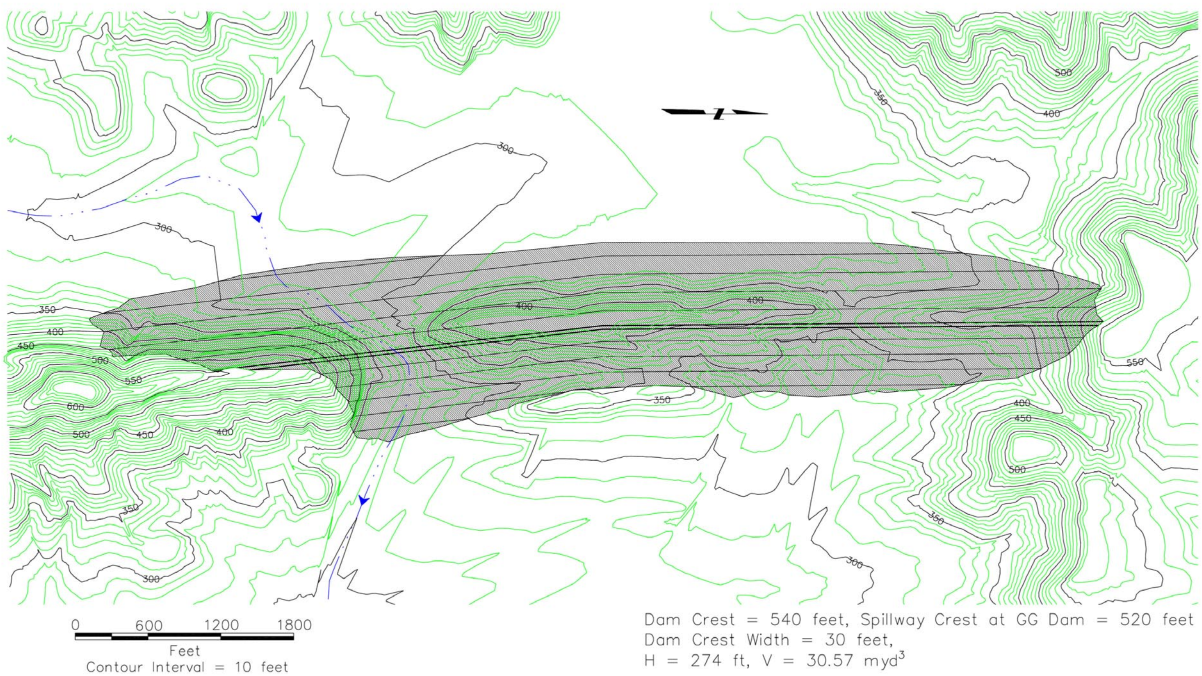


Figure 5-12. Colusa Reservoir – Logan Dam



Investigations conducted for the Colusa Project under the Offstream Storage Investigation have focused on geotechnical studies. Additional analysis of embankment design and materials will be needed if the Colusa Project is retained for continued study. As presently configured, there would be no major appurtenances located at the Colusa Cell dams. The dams at Hunters and Logan Creeks would require low-level outlet works to allow release of stream maintenance flows. This project characteristic and the fact that the Sites Project dams and appurtenances would be significantly similar will simplify the engineering evaluations required for this project. The water supply conveyance options are essentially the same as for Sites, although larger conveyance capacity would likely be required to support Colusa's larger storage capacity.

Road and Utilities Relocations

Sites and Colusa Reservoirs would inundate a portion of the Maxwell to Lodoga Road, which must be relocated. Alternative potential relocation routes under consideration are shown in Figure 5-13. Basically, the relocated road must go either north or south of the reservoir. A north route around Sites and a south route around Colusa appear most practicable, but considerably more investigation and public input is required before a preferred alternative can be identified.

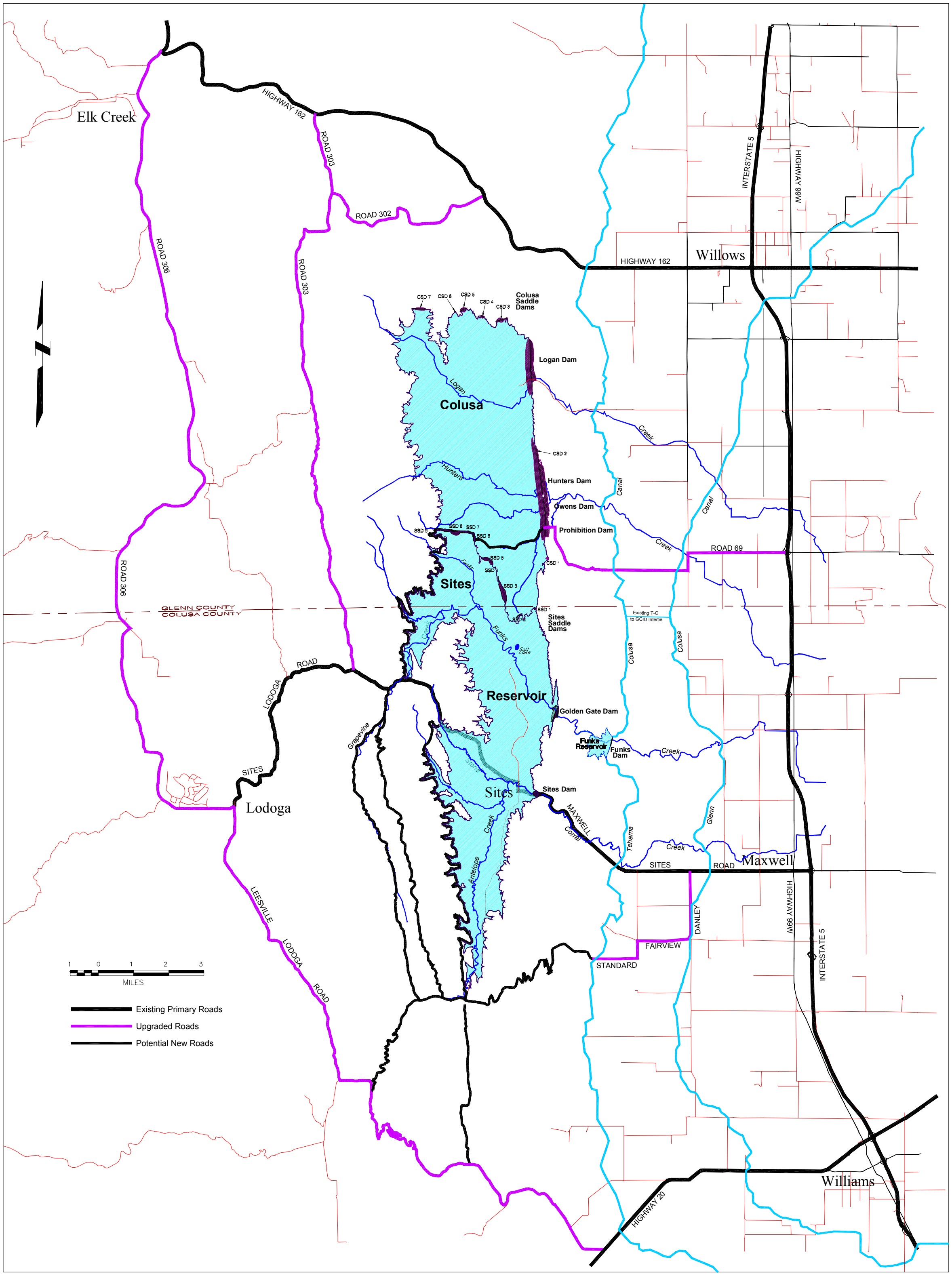
Thomes-Newville Project

A feasibility-level evaluation of the Thomes-Newville Project was conducted by DWR in the late 1970s and reported in November 1980. This work was based on earlier studies conducted in the mid-1960s. Because of the extensive level of past studies, compared to the Sites and Colusa Projects, the Thomes-Newville engineering reevaluation was judged to be of a lower priority for this initial study effort. One of the goals of this study is to bring all the alternative projects up to an equivalent level of knowledge for screening purposes. Therefore, few recent engineering studies have been conducted for the Thomes-Newville Project and most of what is known about it is derived from the historic studies. However, this project will probably receive extensive additional study during the next couple of years.

The Thomes-Newville Project map and area-capacity curve are shown on Figures 5-14 and 5-15, respectively. Reservoir sizes under consideration are 1.9 and 3.0 maf. Newville Dam and at least one saddle dam at Burrows Gap 3 miles south would create Newville Reservoir on North Fork Stony Creek. However, North Fork Stony Creek has a limited drainage area and little surplus water. Therefore, most of the water supply for Newville Reservoir is proposed to be diverted from the mainstem of Stony Creek, Thomes Creek, or the Sacramento River.

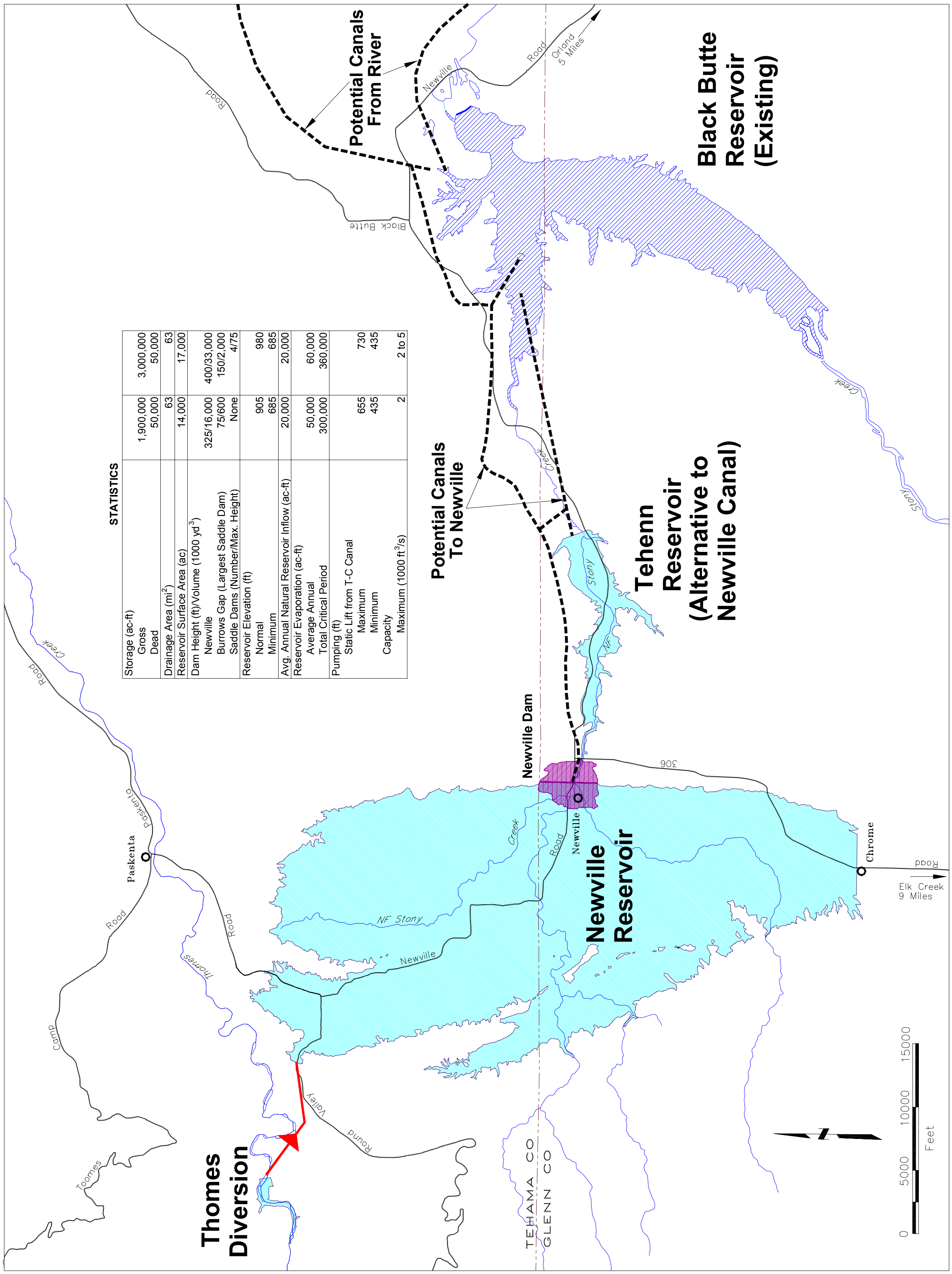
Diversion of surplus flows from the mainstem of Stony Creek would involve pumping from the existing Black Butte Lake to either a proposed Tehenn Reservoir forebay/afterbay on North Fork Stony Creek or a canal that would convey water to the toe of Newville Dam. Since Tehenn would flood a locally-important cemetery, dating from the mid-1880s, future studies will emphasize the canal over the reservoir as a conveyance facility. Two pump lifts would be required with either the Tehenn Reservoir or canal conveyance alternative to transport water from Black Butte to Newville Reservoir. During reservoir releases, generators would recapture most of the energy required for

Figure 5-13. Potential Road Relocations for Sites and Colusa Reservoirs



FINAL DRAFT

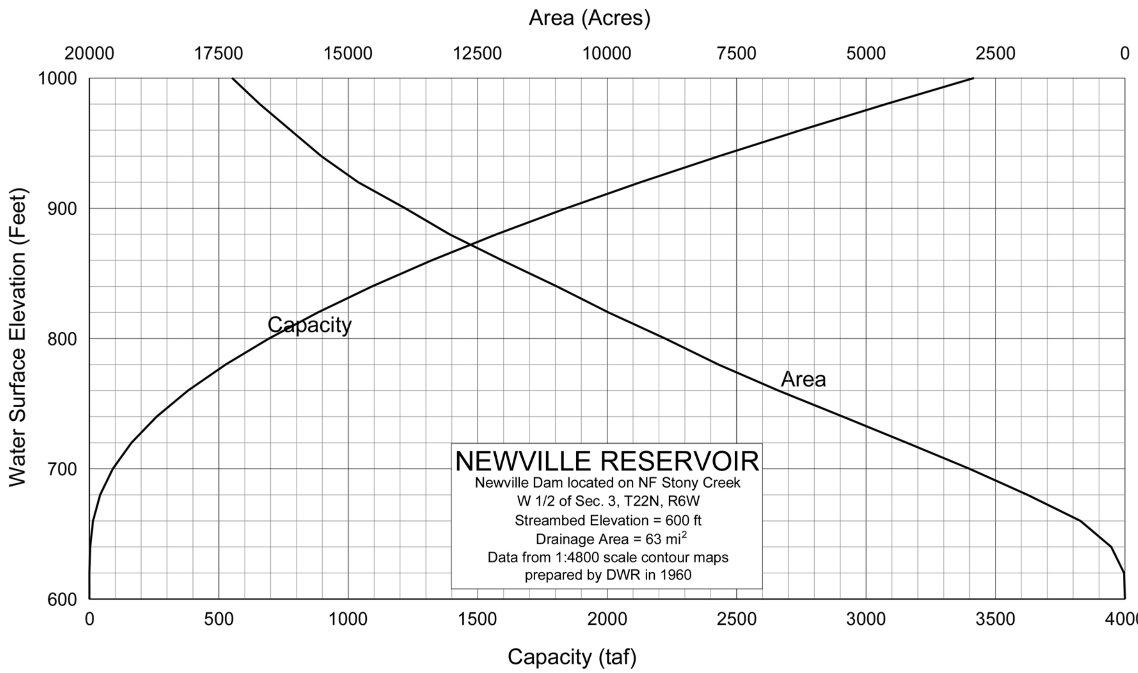
Figure 5-14. Thomes-Newville Project and Statistics



STATISTICS

Storage (ac-ft)		
Gross	1,900,000	3,000,000
Dead	50,000	50,000
Drainage Area (mi^2)	63	63
Reservoir Surface Area (ac)	14,000	17,000
Dam Height (ft)/Volume (1000 yd^3)		
Newville	325/16,000	400/33,000
Burrows Gap (Largest Saddle Dam)	75/600	150/2,000
Saddle Dams (Number/Max. Height)	None	4/75
Reservoir Elevation (ft)		
Normal	905	980
Minimum	685	685
Avg. Annual Natural Reservoir Inflow (ac-ft)	20,000	20,000
Reservoir Evaporation (ac-ft)		
Average Annual	50,000	60,000
Total Critical Period	300,000	360,000
Pumping (ft)		
Static Lift from T-C Canal		
Maximum	655	730
Minimum	435	435
Capacity		
Maximum (1000 ft^3/s)	2	2 to 5

Figure 5-15. Newville Reservoir Area-Capacity Curves



pumping. Reservoir releases would either flow down Stony Creek or the proposed conveyance from Tehama-Colusa Canal and be diverted, under an exchange agreement, to the Glenn-Colusa and Tehama-Colusa Canals. Because of water temperature concerns, no water would be released directly to the Sacramento River.

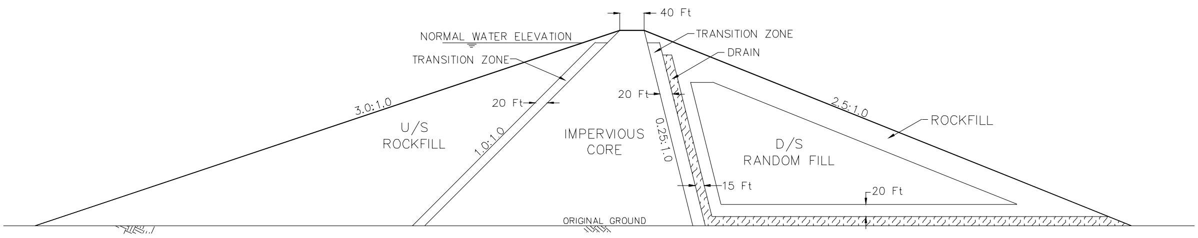
Surplus winter flows from Thomes Creek could be conveyed by gravity from a low diversion dam. A short diversion canal would pass through a saddle on the drainage divide and discharge to the northwest corner of Newville Reservoir. When investigated in the 1970s, this appeared to be a rather conventional diversion, but current requirements to pass fish around diversion dams and screen fish away from the diversion facilities will greatly complicate this structure. Another challenging design issue is Thomes Creek's extremely large sediment load. It is possible that further investigation may reveal that this diversion is no longer practicable. Under those circumstances, a Sacramento River source may be required for all Thomes-Newville Project alternatives.

An investigation to identify Sacramento River diversion and conveyance options for the Thomes-Newville Project is continuing. Likely options would use conveyance in the existing Tehama-Colusa and/or Glenn-Colusa Canals.

Newville Dam

Newville Dam would most likely be a conventional zoned earth-rock embankment dam with a cross section as shown on Figure 5-16. For the reservoir capacities of 1.9 and 3.0 maf under consideration, the dam heights above the streambed are 325 and 400 feet, respectively, and the dam volumes are 16 and 33 mcy, respectively. The dam would have conservative upstream and downstream slopes of 3 to 1 and 2.5 to 1, respectively, a crest width of 40 feet, and a freeboard of 20 feet. Newville Dam would fill the gap in the north-south trending Rocky Ridge through which North Fork Stony Creek flows.

Figure 5-16. Newville Reservoir – Earthfill Dam Section



Embankment Design

The dam would be composed of four major material zones as shown on Figure 5-16 and listed below:

- Impervious core using Tehama Formation clay mixture soils;
- Transition and drain material composed of processed sands and gravels (transition zones prevent mixing of material in different zones);
- Compacted processed rockfill; and
- Random fill.

The material for the impervious zone would come from the Tehama Formation soils located in the reservoir area. Stream gravels for concrete and filter zones are available from streambed sources. Sandstone for rockfill is available from nearby Rocky Ridge. Most of the sand and gravel may have to be obtained from sources up to 50 miles from the dam site. This is because sand and gravel availability near the dam site is limited and crushed sandstone from Rocky Ridge may not meet concrete and drain material specifications.

The relative volume of each type of material composing the dam is approximately 25 percent impervious, 10 percent transition and drain, 55 percent rockfill, and 10 percent random fill. The embankment section was checked for stability under a range of static and seismic loading conditions and the resulting safety factors meet the relevant criteria for large dams.

When the dam height is increased beyond 325 feet (corresponding with a 1.9 maf reservoir capacity), some additional design problems are encountered because of the limited thickness of Rocky Ridge. Since the Newville Dam abutments would be founded on Rocky Ridge, a dam axis must be selected that protects the upstream face of the abutments without excess embankment spillover on the downstream side. Also, as the normal water surface elevation increases, additional saddle dams are required along Rocky Ridge. These issues will need to be addressed during feasibility-level studies. The previous dam design will be modified using current design criteria as the study continues.

Inlet/Outlet Structure

A single structure can convey water into the reservoir from the pumping plant and out of the reservoir to meet water supply demands. The outlet structure must also provide adequate capacity to meet emergency drawdown requirements. The outlet works should be able to selectively withdraw water from different reservoir levels to ensure high quality releases into Black Butte Lake. This structure would serve to divert creek flows around the dam site during construction.

Additional studies will be required to refine plans for this structure and modifications will have to be made depending on the reservoir size ultimately selected. However, this preliminary design revealed no unusual design or construction problems with this structure.

Spillway

A conventional, gated spillway with a concrete-lined chute and a stilling basin on the right abutment was selected for planning purposes. Deep gates were incorporated to let the spillway help meet the emergency reservoir evacuation flow of around 33,000 cfs. This flow estimate is for the 1.9 maf reservoir and would increase substantially if the capacity of the reservoir were increased to 3.0 maf.

Stony Creek Diversion Facilities

One-third to one-half of the inflow to Newville Reservoir could be derived from the mainstem of Stony Creek. Two plans are under consideration for conveying this water from Black Butte Lake to Newville Reservoir. The 32,500 af Tehenn Reservoir would be formed by a 112-foot-high earthfill dam that is 2,500 feet long. A gravity canal would convey water from Black Butte Lake to the base of Tehenn Dam, where the water would be pumped into Tehenn Reservoir, whose upper end terminates at the Newville Dam Pumping Plant. The total pumping lift from Black Butte Lake to Newville Reservoir would range from 210-to-470 feet, depending on the levels of the reservoirs. The possibility of stabilizing the operation of Black Butte Lake so that the water surface elevation varied within a narrow range to facilitate pumping will also be investigated.

A second alternative was developed in response to local concerns that Tehenn Reservoir would flood a historically significant cemetery. This alternative proposes a canal and pumping plants to convey water directly from Black Butte Lake to the Newville Pumping Plant. This alternative is only conceptual at present and design and cost-estimating work will be performed later. The 1980 Thomes-Newville Feasibility Report contains an extensive discussion of the Tehenn alternative.

Tehenn and Newville Pumping/Generating Facilities

The Tehenn plant would have to operate under variable level extremes of between 430 and 474-foot elevation for incoming water from Black Butte Lake. Water elevation in Tehenn Reservoir would normally be held at the spillway crest elevation of 610 feet. The plant would be located 2,000 feet downstream of

Tehenn Dam in a 120-foot deep bowl on the north side of the creek. The plant would connect to the reservoir through a 16-foot diameter welded-steel penstock.

The Newville pumping/generating plant at the toe of Newville Dam would lift water up to 370 feet from Tehenn to Newville Reservoir. The plant would be an 80 x 200-foot indoor facility with two pumping units, one pumping/ generating unit, and a service bay.

Thomes-Creek Diversion Facilities

The nearly 200-square mile Thomes Creek watershed produces an average annual runoff of around 200 taf. West of Paskenta, Thomes Creek passes within a half mile of a low saddle ridge separating its watershed from the Newville Reservoir drainage area. At this point, it would be relatively easy to divert the floodflows of Thomes Creek to Newville Reservoir. However, under today's stringent environmental requirements, there are several major obstacles associated with such a diversion: (1) preventing the diversion of fish; (2) allowing the free passage of fish around a diversion dam; (3) passing the creek's extremely large sediment load; and (4) minimizing interference with the migration of the large deer herd that winters in this area. Any one of these problems in isolation would probably be manageable, but combined, they present a formidable design challenge. Therefore, considerable future work remains to be completed. These obstacles may make this diversion option unfeasible and an alternative source of water would need to be developed.

Saddle Dams and Dikes

For a Newville Reservoir of less than 2 maf capacity, only one saddle dam at Burrows Gap would be required. This saddle dam would be located approximately 3 miles south of Newville Dam and would fill a saddle along Rocky Ridge. A 75-foot-high earth-rockfill embankment dam containing approximately 600,000 cubic yards of material and patterned after the Newville Dam section would likely be used. No unusual problems are anticipated in the design and construction of this relatively low dam.

If the capacity of Newville Reservoir were increased to 3 maf, Burrows Gap Saddle Dam would increase to a height of 150 feet and would require approximately 2.0 mcy of embankment material. Also, as the maximum reservoir capacity increases, within the range of 2.5 to 3.0 maf, two to five additional small saddle dams are required along Rocky Ridge. The total volume of these additional saddle dams would be less than 1 mcy. No appurtenances are proposed at any of the saddle dam locations. Similarly, as the maximum reservoir capacity varies between about 2.5 and 3.0 maf, a 30 to 70-foot-high Chrome Dike would be required at the southern end of the reservoir. This dike would require from 0.25 up to 1.7 mcy of fill material.

Potential Diversions from the Sacramento River

Earlier work on the Thomes-Newville Project, with reservoir capacities less than 2 maf, concentrated entirely on diversions from Stony and Thomes Creeks. However, as larger reservoir sizes up to 3 maf are considered, or if diversion problems are encountered on Thomes Creek, a diversion from the Sacramento River may be required.

Initial investigation of potential diversions from the Sacramento River using existing canals has been conducted, but much work remains to be done before specific design and cost estimates can be developed. Several potential alignments have been identified and initial reconnaissance-level evaluations have been made. More exact estimates will be completed after environmental analysis of comparative alignments has progressed.

Road and Utilities Relocations

There are about 8 miles of public roads within the prospective Newville Reservoir. The Paskenta-Round Valley route, a paved two-lane county road, passes through the north end of the reservoir for a distance of about 2 miles; another county road crosses northwest through the reservoir footprint from the dam site to connect with the Paskenta-Round Valley Road. The Glenn County portion of the road within the reservoir is about 2 miles long and is paved; the 4-mile portion within Tehama County is unpaved.

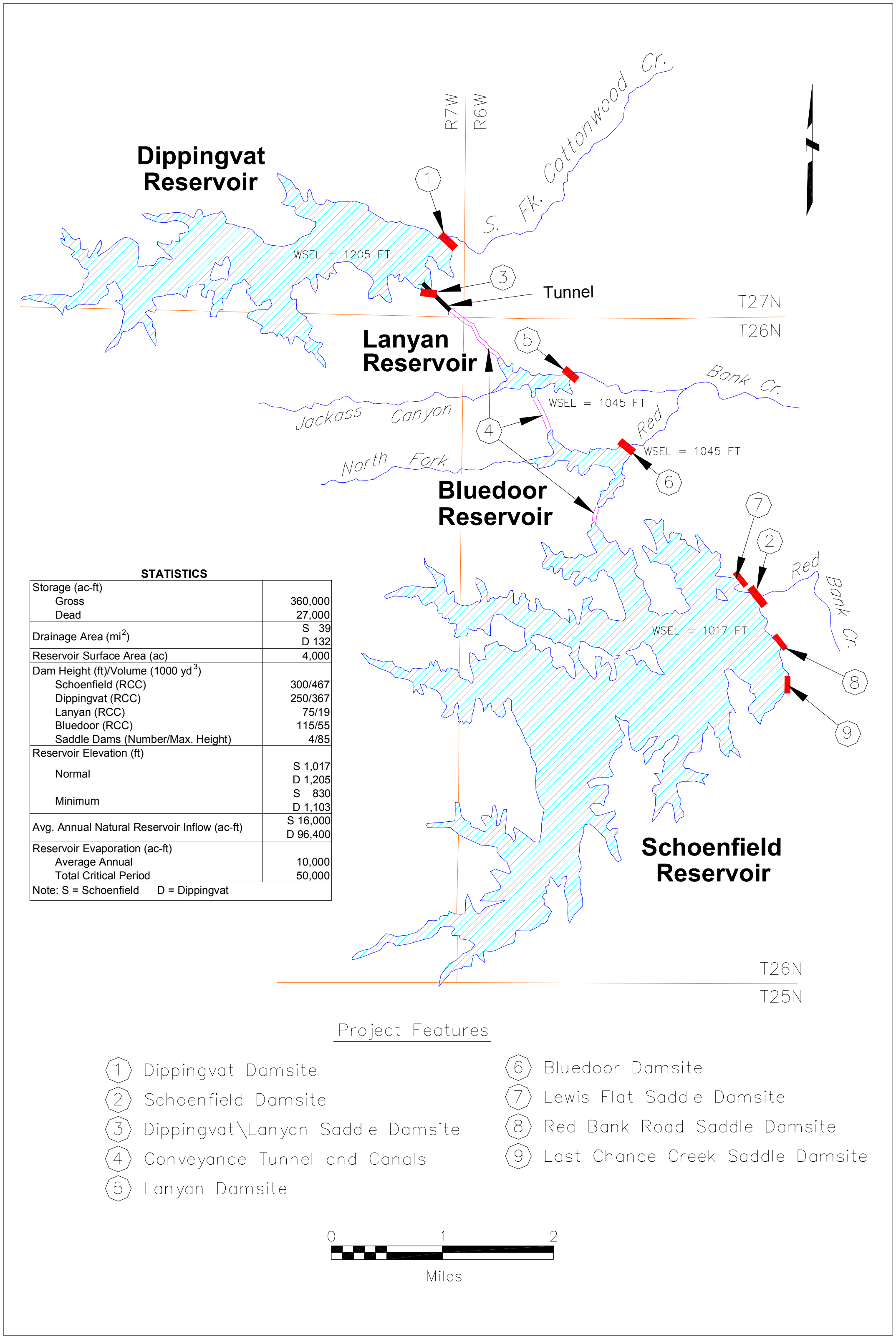
These roads would be relocated and upgraded to current county paved-road standards. The Paskenta-Round Valley Road would be realigned around the north end of the reservoir and the other road would be routed along the east side of Rocky Ridge to link Newville Dam site to the town of Paskenta. The length of new road construction would be about 10 miles. Any power lines or other utilities requiring relocation would follow the new road alignment whenever possible.

Red Bank Project

The Cottonwood Creek basin has been the subject of water development planning studies for more than 50 years. Located within the 927-square-mile watershed are two lower basin sites for large reservoirs, Tehama and Dutch Gulch, which were extensively investigated by the Corps in the late 1970s and early 1980s for flood control and water supply. Higher in the watershed are four smaller potential projects—Hulen, Fiddlers, Rosewood, and Dippingvat—that have been extensively investigated. Of these numerous potential projects, only Dippingvat appeared economically feasible in studies conducted in the late 1980s. It received continued low-level investigation until 1993, when study was suspended because of escalating project cost estimates.

Interest in Dippingvat Reservoir in combination with Schoenfield Reservoir on Red Bank Creek, known as the Red Bank Project (Figure 5-17), was renewed by CALFED around 1996. This renewed interest was motivated by the project's ability to supply water to the entrance of the Tehama-Colusa Canal. This would allow the Red Bluff Diversion Dam gates to remain raised for a longer period. As a result, the Red Bank Project was included as one of the four projects evaluated under the present Offstream Storage Investigation even though it is significantly smaller than the alternative projects. The pre-feasibility design alternatives report completed on the Red Bank Project in 1993 determined that RCC dams would be less expensive than equivalent earthfill dams at this location. Therefore, this progress report discusses only the RCC alternative. Additional future geologic

Figure 5-17. Red Bank Project Features and Statistics



STATISTICS

Storage (ac-ft)	
Gross	360,000
Dead	27,000
Drainage Area (mi^2)	S 39 D 132
Reservoir Surface Area (ac)	4,000
Dam Height (ft)/Volume (1000 yd^3)	
Schoenfield (RCC)	300/467
Dippingvat (RCC)	250/367
Lanyan (RCC)	75/19
Bluedoor (RCC)	115/55
Saddle Dams (Number/Max. Height)	4/85
Reservoir Elevation (ft)	
Normal	S 1,017 D 1,205
Minimum	S 830 D 1,103
Avg. Annual Natural Reservoir Inflow (ac-ft)	S 16,000 D 96,400
Reservoir Evaporation (ac-ft)	
Average Annual	10,000
Total Critical Period	50,000
Note: S = Schoenfield D = Dippingvat	

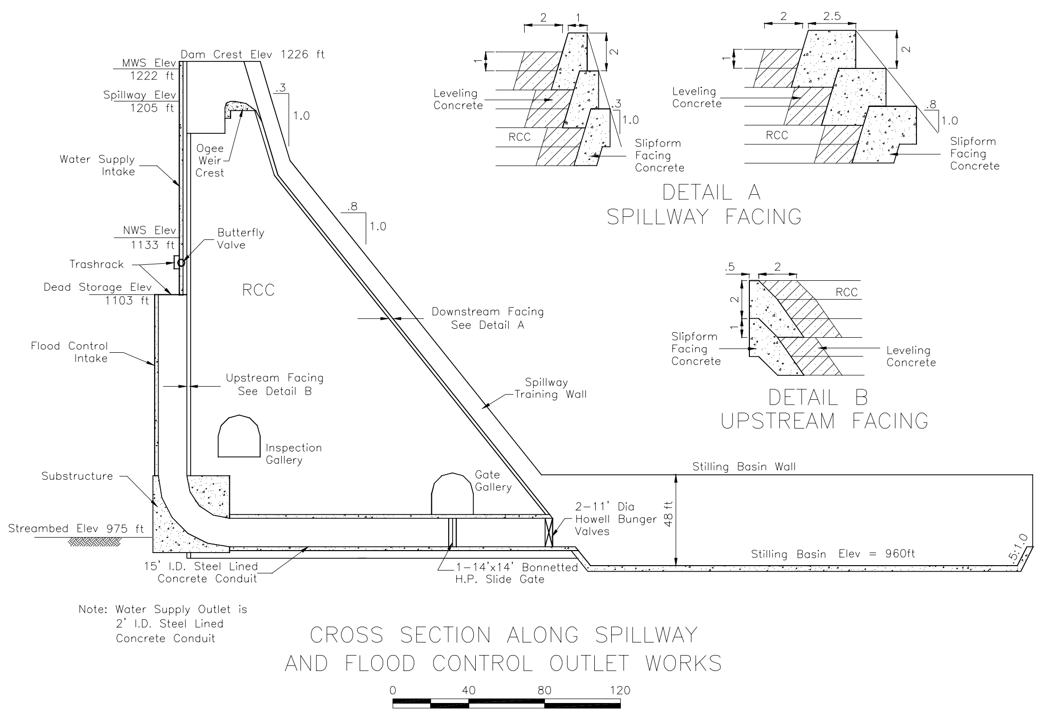
investigations will be required to determine the ultimate suitability of this type of dam at the project location.

Dippingvat Dam

Dippingvat Dam site is located on South Fork Cottonwood Creek, in a deep narrow canyon one-half mile downstream of Dippingvat Flat, Section 36, T27N, R7W. The proposed dam would be 250-feet high and would create a 104 taf reservoir. The average annual inflow to Dippingvat Reservoir is 96 taf captured by the 132 square mile upstream watershed. Dippingvat is an excellent dam site and Cottonwood Creek produces a substantial water supply. However, the reservoir's capacity is too small to capture the majority of the available runoff and also provide downstream flood control benefits. Therefore, a larger reservoir on nearby Red Bank Creek to help store excess Cottonwood Creek flows was thought desirable as part of the project.

Dippingvat Dam would be a 250-foot high RCC structure with a crest length of about 1,000 feet. The upstream face of the dam would be vertical and the downstream face would be sloped as shown in Figure 5-18. An earthfill dam was also evaluated at this location, but appears to be much more expensive than the RCC alternative. However, seismic investigations may determine that this site is not suitable for a RCC dam.

Figure 5-18. Dippingvat RCC Dam, Cross Section



Outlet and Spillway

The outlet works at Dippingvat Dam would be located through the dam near the center, at approximately streambed elevation. The outlet would be used to pass creek flows during construction. Discharge would be controlled by a dissipater valve at the end of each outlet as it transitions into a stilling basin. Maximum design velocity in the outlet pipe would be 35 feet per second.

Dippingvat Dam would have two outlets, a 15-foot diameter flood control outlet and a 2-foot diameter pipe to carry 60 feet per second for stream maintenance purposes. This stream maintenance outlet would draw from any of seven butterfly valves located along the upstream face of the dam to control outlet water temperatures.

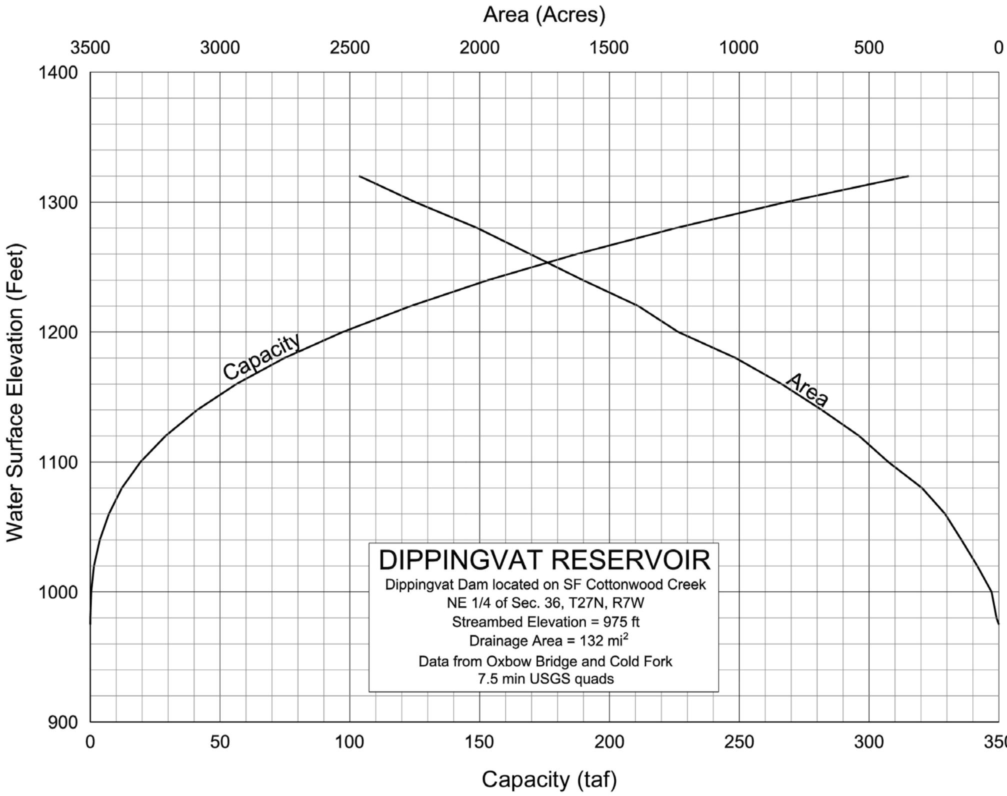
The spillway (Figure 5-19) at Dippingvat would be constructed as an integral part of the RCC dam face. Stepped concrete facing would line the spillway and help dissipate energy. The spillway would have a crest length of 200 feet and would be controlled by an uncontrolled ogee-type weir.

Figure 5-19. Dippingvat RCC Dam

Dippingvat Reservoir

At the spillway crest level, Dippingvat Reservoir would have a total storage of 104 taf and cover 1,270 acres. The area-capacity curves for Dippingvat Reservoir are shown in Figure 5-20. As planned in 1993, the reservoir would reach the spillway level only during major floods. Normally, the reservoir storage would be held at around 32 taf to maintain a 72 taf flood control reservation. These operating criteria could easily be modified in future studies if the level of flood control was changed.

Figure 5-20. Dippingvat Reservoir Area-Capacity Curves



Schoenfield Dam

Schoenfield Dam site is located on Red Bank Creek in a deep, narrow canyon known as the Narrows. This dam would form a 250 taf reservoir to store runoff primarily diverted from South Fork Cottonwood Creek. Water would be conveyed from Dippingvat to Schoenfield Reservoir through three short canals and two low dam reservoirs, Lanyan and Bluedoor.

Schoenfield Dam would be a 300-foot high RCC structure approximately 900 feet long. About 540,000 cubic yards of concrete would be required to build the dam and the cross section would be similar to that for Dippingvat Dam. An earthfill dam at this location is still a potential alternative if seismic investigations determine that the less expensive RCC dam is unsuitable.

Outlet Structure and Spillway

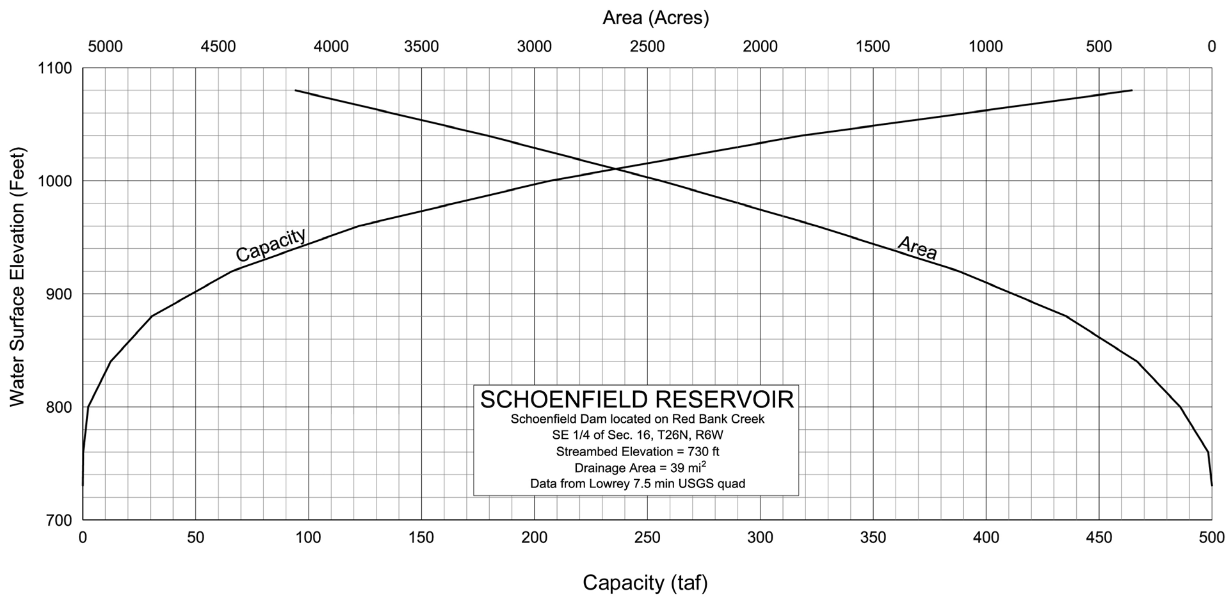
Schoenfield Dam would have a central overflow spillway constructed as part of the dam. The spillway crest length is limited to about 200 feet because of the narrow canyon floor at the downstream toe of the dam, which limits the width of the stilling basin. The maximum flow down the spillway resulting from the probable maximum flood is estimated at around 25,000 cfs.

Schoenfield Reservoir

At the spillway crest, Schoenfield Reservoir would store 250 taf of water and have a surface area of 2,770 acres. . The area-capacity curves Schoenfield

Reservoir are shown in Figure 5-21. The natural average inflow into the reservoir is around 16,000 af per year and the releases would be made down Red Bank Creek to the Tehama-Colusa Canal. Only low-level creek fishery maintenance releases would flow into the Sacramento River.

Figure 5-21. Schoenfield Reservoir Area-Capacity Curves



Conveyance System

Much of the Cottonwood Creek water captured by Dippingvat Reservoir would be conveyed to the larger Schoenfield Reservoir for long-term storage and ultimate release down Red Bank Creek. This water would be transported approximately 4 miles through three low ridges that separate the reservoirs. The conveyance system to accomplish this would consist of two small earthfill dams, a short linked tunnel/canal, and two other short canals. No fish screen is planned for placement at the entrance of the conveyance system because anadromous fish could not pass Dippingvat Dam.

Water would be diverted from Dippingvat Reservoir into an 8-foot diameter, one-half-mile long concrete-lined tunnel, capable of carrying 800 cfs. A one-mile unlined canal would carry the water to 1,200 af Lanyan Reservoir, formed by a 70-foot-high dam on Lanyan Creek. The water would then flow by gravity through a one-half mile canal from Lanyan Reservoir to 3,500 af Bluedoor Reservoir, formed by 90-foot-high Bluedoor Dam on the upper North Fork Red Bank Creek. From Bluedoor, a short canal would convey water to Schoenfield Reservoir. Lanyan and Bluedoor Reservoirs would normally be held at their maximum storage level to facilitate conveyance by gravity. Due to the gravity conveyance, water could only flow south through this system. The Lanyan and Bluedoor Dams were originally designed as conventional earthfill structures, but they could also be built as RCC structures.

Potential Future Studies

If study of the Red Bank Project continues, a canal-only conveyance alternative between the two major dams should be investigated. This would eliminate the need for Lanyan and Bluedoor Dams.

Also, a high dam on Cottonwood Creek would block salmon migration to suitable habitat on areas upstream of the dam. This has raised recent interest in investigating a low dam on Cottonwood Creek, which could divert surplus flows to Schoenfield Reservoir while still allowing fish passage. While the low dam alternative may be feasible, there would be significant impacts to the project's water supply yield and flood control and recreation benefits that would require considerable additional investigation to evaluate.

If interest in the Red Bank Project continues, the effect of potentially large flow reductions along Red Bank Creek should also be investigated. The amount of water diminished by percolation to groundwater and consumptive use by adjacent vegetation in the approximately 30 stream miles between Schoenfield Dam and the Tehama-Colusa Canal entrance would need to be determined. This flow reduction could be considerable, particularly during the summer months.