TECHNICAL SERVICE CENTER
Denver, Colorado

South Powerhouse Tailrace Bypass Tunnel
Reconnaissance Report

Battle Creek Project, California

Prepared by
Technical Service Center

U.S. Department of the Interior
Bureau of Reclamation

January 1999

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APPROVAL SIGNATURES

This reconnaissance-level report was prepared by the following persons in the Technical Service Center (TSC) of the Bureau of Reclamation:

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ACKNOWLEDGMENTS

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U.S. Bureau of Reclamation

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SOUTH POWERHOUSE TAILRACE BYPASS TUNNEL

A. Introduction

The existing Inskip Diversion Dam and Canal are located in Northern California on the South Fork Battle Creek, about 1 mile south of Manton, California (see Location Map, Appendix A). The Inskip diversion features were constructed around 1905, and are currently owned and operated by the Pacific Gas and Electric Company (PG&E). The masonry dam is about 25 feet high and 100 feet long, with a crest at elevation 1435.0, as shown on Exhibit L-19 (Appendix A). An Alaska Steeppass-type fish ladder is located on the left abutment of the dam within a 100-foot-long concrete steppool structure (crest elevation 1433.6). The existing canal headworks structure is located to the right (north) of the dam, and includes a trashrack and a 10-foot 10-inch-wide by 3-foot-high top-seal radial gate (invert elevation 1430.3). A 100-foot- long, 10-foot by 10-foot unlined rock tunnel passes through the right abutment downstream of the radial gate for releases to the Inskip Canal. A sand settler and a 6- by 15-foot radial sluice gate is provided at the existing tunnel outlet portal to prevent potential sediment loading and overcharging of the Inskip Canal. The Inskip Canal extends 4.5 miles to the Inskip Powerhouse (near the Coleman Diversion Dam) and consists of 5,103 feet of unlined tunnel, 291 feet of metal flume (146 feet of #180 type, and 145 feet of #192 type), and 18,540 feet of excavated channel sections (6,465 feet unlined and 12,075 feet concrete-lined) with a bottom width of 8 feet, a top width of 14 feet, and a maximum flow depth of 5.5 feet.

Water from North Fork Battle Creek is diverted into the Union Canal at about elevation 1920, and is conveyed through the South Powerhouse penstock, through a 7.5 MW turbine-generator, and into a 600-foot-long tailrace channel at about elevation 1440 which joins the South Fork Battle Creek about 700 feet upstream of the Inskip Diversion Dam. The existing South Powerhouse was constructed by PG&E in 1979, and is shown on Exhibit L-8 (Appendix A). See photographs 1 thru 13 for existing project features (Appendix B).

B. Project Objectives

To support a salmon and steelhead restoration plan being developed for Battle Creek, Reclamation's Technical Service Center (TSC) was requested to prepare a reconnaissance-level design and cost estimate for providing water from the South Powerhouse tailrace (which includes flow from North Fork Battle Creek) to the Inskip Canal, without allowing the water to enter South Fork Battle Creek. This option is referred to as the South Powerhouse tailrace bypass tunnel concept. The proposed bypass tunnel would operate in conjunction with the existing Inskip Diversion Dam, which would continue to divert water from South Fork Battle Creek to the Inskip Canal when the stream flow exceeds instream requirements and the canal has capacity to accept the additional water. Limited site topography for this study was provided by the California Department of Water Resources (DWR), included in Appendix A.

C. Site Geology

The bedrock formation in the project area is the Pliocene Tuscan Formation, which is predominantly a volcanic breccia composed of angular sand- to boulder-sized andesite and basalt clasts in a tuff matrix. The predominant size of the clasts is estimated to be about 1 to 3 inches (gravel size), but larger sizes including a basalt block up to 5 feet high were observed in the vicinity of the proposed tunnel inlet. Outcroppings of bedrock at the project site demonstrate that the rock is generally well indurated, competent, and particularly resistant to erosion. In general, the bedrock exposed at the surface is slightly weathered to fresh, and unfractured. The volcanic fragments are generally hard to very hard (i.e. rock hammer rings when rock is struck), and the matrix is generally moderately hard (i.e. hammer pick penetrates about 1/4-inch with strong

hammer blow). Occasional zones may exist within the bedrock where the matrix is slightly softer, causing the overall strength of the rock to be somewhat decreased. Due to the difference in hardness between the clasts and the matrix, the walls of the bypass tunnel will likely be fairly rough and uneven, assuming conventional drill and blast excavation methods are used. Existing unlined tunnels in the area, which were excavated in the bedrock around 1905, appear to be holding up well; however, the tunnels were carrying flow and could not be inspected for this study.

Water springs are located along the footpath above the proposed bypass tunnel alignment, suggesting locally high groundwater levels. The unlined Union Canal, located on the ridge above the proposed tunnel site, may also contribute some water to the ground. Groundwater can be expected to seep into the proposed tunnel during excavation, requiring some special water handling and treatment facilities.

The peninsula separating the tailrace channel from South Fork Battle Creek appears to be composed of an unconsolidated deposit of sand, gravel, cobbles, and small boulders on top of Tuscan bedrock. This deposit is probably fairly permeable. A number of medium-sized trees are growing on the peninsula. The narrow portion of the peninsula was reportedly breached during a flood event in 1997, and was subsequently restored by PG&E.

In the vicinity of the inlet to the proposed bypass tunnel, bedrock is either exposed or very near the ground surface, and appears to be good and competent rock. The slope of the terrain in this area is fairly steep, so the inlet portal excavation will not have to extend very far into the hillside (to the northwest) before gaining the necessary rock cover. However, at the outlet end of the proposed bypass tunnel, the slope of the terrain is gentler, or about 4H:1V (although the available topography is deficient in this area). Depending on the required minimum amount of rock cover (assumed equal to at least one tunnel diameter), the outlet portal would have to be located quite some distance (about 100 to 150 feet) into the hillside, away from the existing Inskip Canal and outside the "project boundary" shown on Exhibit K-8 (Appendix A), on privately-owned land. Additional right-of-way would be required at this location. Based on the assumed inlet and outlet portal locations, the length of the bypass tunnel would be about 1,050 feet. An open channel would carry the water from the outlet portal to the Inskip Canal.

D. Design and Construction Considerations

Some type of light, partial tunnel lining should be anticipated to prevent localized spalling or caving during construction and throughout the life of the bypass tunnel. A nominal 3-inch thickness of shotcrete on the crown and sidewalls, over the full length of the bypass tunnel (or about 270 yd^3), is included in the reconnaissance-level cost estimate. The bedrock is believed to be generally unjointed and well indurated, and rockbolts are not anticipated to be needed. Final designs may include a small quantity of rockbolts in the event some are required.

In order to maintain a dry working area for the bypass tunnel excavation, a temporary upstream cofferdam and a permanent downstream dike would be constructed in the tailrace channel near the inlet portal, and flows from the South Powerhouse would be diverted into South Fork Battle Creek through the existing peninsula near the powerhouse. Due to the permeable nature of the peninsula's alluvial material, and the potential for seepage water from South Fork Battle Creek through the peninsula, some unwatering of the inlet portal area would probably be required during construction. Construction access would be provided along the peninsula to the inlet portal location.

Suitable waste areas for the tunnel muck (estimated at up to 5,000 yd^3 of loose material) would

have to be located, possibly to the east of the powerhouse and along construction access roads. The tunnel muck is assumed to not meet minimum size requirements for slope protection, and alternative sources would be required for riprap. Although the land between the Inskip Diversion Dam and the South Powerhouse, and along the penstock, is owned by PG&E, suitable waste areas would likely have to be found outside these areas for final disposition of a substantial portion of the tunnel muck.

Current access to the bypass tunnel outlet portal location crosses private land, and consists of a narrow footpath from the South Powerhouse penstock to a point about 850 feet downstream, and then continues another 500 feet along natural ground to the outlet portal. Construction of a suitable equipment access road would be a major undertaking, due to the slope of the terrain and existence of bedrock at or near the existing ground surface, and would require additional right-of-way or easements. A minimum 12-foot width would be required for the access road, with an alignment designed to provide an acceptable grade. Some type of temporary bridge (perhaps consisting of railroad flatcars) would be required for construction equipment to cross the Union Canal overflow channel and the existing power penstock, located near the end of the existing upper access road.

A construction staging area would be required, most likely on the south side of the powerhouse. New access onto the peninsula would have to be provided from the existing roads. Additional contractor access and work areas would probably be cleared on the peninsula and in the unwatered tailrace area near the upstream tunnel portal. During excavation of the tunnel, any seepage water exiting the tunnel would have to be treated before the water enters the existing stream. Settling ponds or holding tanks may meet this requirement, although no capacity estimates were made for this study.

The Union Canal overflow channel, or spillway, has been in use for approximately 90 years and has carried a full discharge on many occasions. The channel is currently considered stable and additional erosion is not expected. In addition, flows entering the overflow channel first pass through a large sand trap area that would catch any significant materials.

E. Proposed Design Features

The following is a summary of the basic design features that have been developed for the reconnaissance-level design. A plan view, profile, and sections of the proposed bypass tunnel and associated features are provided on figures 1 and 2 in Appendix A.

1. The bypass tunnel would consist of a new 1,050-foot-long excavated tunnel located to the right (north) of the existing tunnel at Inskip Diversion Dam. The bypass tunnel discharge capacity is assumed to be 220 ft^3/s for design. The bypass tunnel size and shape is assumed to be the same as those used for the existing tunnels along the Inskip Canal (as shown on Exhibit L-19) and would be unlined, with the exception of shotcrete tunnel support on the crown and sidewalls. The bypass tunnel inlet is located within the existing tailrace channel near the end of the peninsula which separates the tailrace from South Fork Battle Creek. South Powerhouse releases, and any releases from the Union Canal directly to the overflow channel, would be carried from the tailrace, through the bypass tunnel, to the Inskip Canal, without contacting South Fork Battle Creek. This would meet the project objective of separating North Fork and South Fork Battle Creek flows.

2. Tailrace flows from either the South Powerhouse or the Union Canal overflow channel may have to be diverted away from the bypass tunnel in the event either the bypass tunnel or the Inskip Canal must be removed from service. This would require a means of shutting off

tunnel flows and safely discharging up to 220 ft^3/s into South Fork Battle Creek. The cost estimate includes a 10- by 7-foot radial gate within a concrete structure at the bypass tunnel inlet portal to suspend tunnel flows. Stoplog slots may be incorporated in the gate structure for the final designs for gate maintenance purposes. Emergency diversions to the South Fork would be made through a box culvert described below.

3. A precast concrete box culvert containing two 7-foot-wide by 6-foot-high openings (or similar size) would be installed through the peninsula neck between the tailrace and South Fork Battle Creek near the powerhouse (at the site of the recent breach), to allow for the continued passage of powerhouse releases to South Fork during construction. Following construction, stoplogs would be installed at the inlet of the box culvert to the normal tailrace water level, but would be overtopped during higher water levels (due to any cause) to minimize potential overcharging of the downstream tunnel and canal. If powerhouse releases to the bypass tunnel and Inskip Canal must be diverted for repair and/or inspection purposes, the box culvert inlet stoplogs would be removed, and the bypass tunnel inlet portal radial gate would be closed, to allow continued operation of the powerhouse by temporarily routing flows from the tailrace to South Fork Battle Creek through the culvert. This feature would also aid in draining the tailrace for purposes of working in the channel or powerhouse.

4. The bypass tunnel inlet portal area must be unwatered during construction, and bypass tunnel flows must be separated from instream channel flows following construction. This would be achieved by the construction of a permanent downstream dike across the end of the tailrace section separating the tailrace channel from the South Fork Battle Creek. A temporary cofferdam would be constructed upstream of the bypass tunnel inlet portal in the tailrace, just downstream of the Union Canal overflow channel. The area between the dike and cofferdam would be unwatered for bypass tunnel construction. The dike and cofferdam are assumed to be constructed of suitable on-site materials, but may require the installation of a geomembrane material (or purchase of impervious core materials) to provide a water barrier, and the placement of riprap slope protection from a local source. The upstream cofferdam would be removed following completion of the bypass tunnel.

Bypass tunnel and cofferdam seepage waters would have to be treated by suitable settling ponds or holding tanks before being released back into South Fork Battle Creek. The cost estimate includes an allowance for settling ponds, and for small pumps operating an equivalent of about 5 months for unwatering purposes.

5. The bypass tunnel outlet portal would be located downstream of a new fish screen, to be constructed within the prism of Inskip Canal just downstream of the existing tunnel at Inskip Diversion Dam, and upstream of a second tunnel on the Inskip Canal. The new fish screen would prevent fish from entering the bypass tunnel and upstream tailrace area from the stream channel. Reconnaissance-level designs and cost estimates for the fish screen have been prepared by DWR.

6. A concrete-lined stilling basin would be provided at the bypass tunnel outlet portal to provide energy dissipation for tunnel flows. Hydraulic analysis of the tunnel would help determine the energy dissipation requirements due to the head drop between the South Powerhouse tailrace and the Inskip Canal. Exhibit L-8 indicates the normal tailrace water surface at the South Powerhouse is at elevation 1441.7. Assuming the Inskip Canal design water surface to be slightly lower than the diversion dam crest at elevation 1435, a minimum 7-foot head drop should be expected.

7. Potential overcharging of the Inskip Canal downstream of the bypass tunnel outlet portal

would be prevented by construction of a gate structure in the canal and a wasteway channel to South Fork Battle Creek. This would provide protection from excessive flows from either or both of the canal inlets (the bypass tunnel and the diversion dam tunnel). The cost estimate assumes two 6- by 6-foot slide gates (or equivalent) would be provided within the gate structure, and a concrete-lined chute would be required for releases to the stream channel. (An existing "spillway" for Inskip Canal is shown on Exhibit K-8 approximately 1,100 feet downstream from this location, and may serve a similar function. Future studies should confirm the need for an additional gate structure and wasteway at this location.)

8. The South Fork Battle Creek side of the peninsula may have to be stabilized by riprap slope protection to prevent possible erosion damage during high flood flows. The reconnaissance-level design includes riprap slope protection along the peninsula near the box culvert outlet and at the proposed channel dike. Suitable riprap is assumed to be obtained from a local source for this level of study.

F. Construction Sequence

A construction sequence proposed for the bypass tunnel concept is described below:

1. First, construct the precast concrete box culvert through the peninsula between the tailrace and the stream channel. The double box culvert would be about 17 feet wide, 8 feet high, and 70 feet long overall, and would probably be founded on a concrete pad on bedrock across the peninsula, with suitable compacted backfill placed on each side. Alternative culvert dimensions may be required depending upon the bedrock foundation grade, in order to prevent or minimize rock excavation. The precast box culvert would probably be constructed in 10-foot-long sections. Construction of the box culvert may require powerhouse operations to be stopped for a few days, and low flows in South Fork Battle Creek would be desirable. The culvert crown would be designed to accommodate construction equipment loads. Upon completion, powerhouse releases would be diverted through the box culvert.

2. Second, construct a permanent dike downstream of the bypass tunnel inlet portal, and a temporary cofferdam upstream of the bypass tunnel inlet portal, within the tailrace channel, to allow unwatering of the inlet portal area. On-site sand, gravel, and cobble materials would be used to the maximum practicable extent to construct both embankments. Minimum embankment dimensions would include a 12-foot crest width (for construction access) and 1-1/2H:1V side slopes. Establish settling ponds or holding tanks nearby (if possible) for collected seepage water. Special treatment of the seepage water from the tunnel may be required if shotcrete is used.

3. Next, excavate the bypass tunnel inlet portal area and begin excavating the bypass tunnel using drill and blast methods. An assumed tunneling rate of 10 feet per shift would require up to 20 weeks (or about 5 months) to complete the tunnel excavation. Tunnel muck would be removed from the site.

4. Then, construct the bypass tunnel inlet portal and headworks structure. Install mechanical items. Provide a permanent access road from the peninsula to the downstream dike and headworks structure for operation and maintenance purposes.

5. Provide a construction equipment access road to the bypass tunnel outlet portal area, with a turnaround/staging area as required, by providing extensive improvements to the existing footpath and natural terrain. Required excavation from the tunnel and inlet portal

area may provide a suitable roadfill. Assume the access road is at least 12 feet wide and up to 2,000 feet long. Install any necessary bridges for channel and penstock crossings (railroad flatcar bridges assumed for this estimate). Assume any construction equipment needed to excavate the outlet channel and portal area, and for the placement of concrete for the stilling basin and outlet portal structure, may need to use this road. (This road may be retained for future O&M access.)

6. Leave a temporary plug in the outlet channel to allow continued releases in the Inskip Canal during construction of the concrete-lined stilling basin. Completion of the outlet channel and construction of the canal gate structure would probably require suspension of canal releases for a few weeks. The outlet channel and wasteway excavated materials are assumed to be wasted in the area. Concrete for the outlet portal, stilling basin, gate structure, and wasteway would probably have to be delivered over the construction access road.

7. Following completion of the bypass tunnel construction, the upstream cofferdam would be removed and the tailrace bypass box culvert stoplogs would be installed. South Powerhouse releases would then be diverted into the new bypass tunnel and Inskip Canal.

8. An estimated construction contract duration of 9 to 12 months is assumed at this time, for work included in this study.

G. Estimated Costs

A reconnaissance-level construction cost estimate was prepared and is attached to this report (see Appendix C). An allowance of 10 percent for unlisted items and 25 percent for contract contingencies has been included in the estimated field cost of $2,800,000. Mobilization costs of about 10 percent have been assumed for this estimate. Costs for engineering, environmental mitigation, construction management, and contract administration are assumed to add about 43 percent, or $1,200,000, to the field cost, for a total project cost of about $4,000,000.

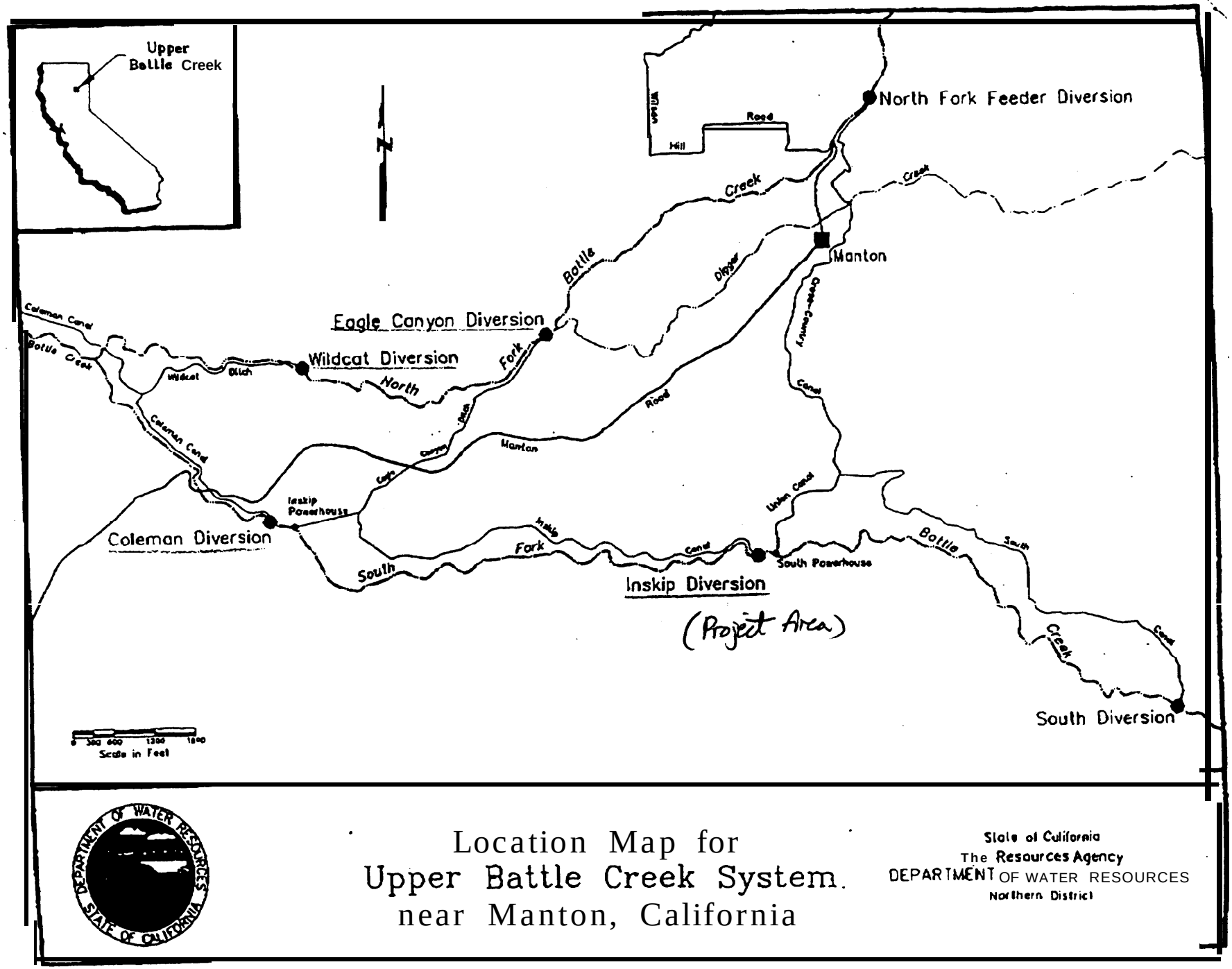
H. Conclusions

The construction of a bypass tunnel to convey South Powerhouse releases directly from the existing tailrace channel to the Inskip Canal, without entering South Fork Battle Creek, is technically feasible. Construction would probably require between 9 and 12 months to complete, with a total project cost of about $4,000,000. The construction of a box culvert through the peninsula near the powerhouse would provide for diversion of South Powerhouse releases to South Fork during construction of the bypass tunnel, allowing continued power generation, and would permit future unwatering of the tailrace channel for maintenance. The addition of a gate structure and wasteway within the Inskip Canal would prevent potential overcharging of the canal due to excessive inflow from any source.

I. Additional Investigations for Future Studies

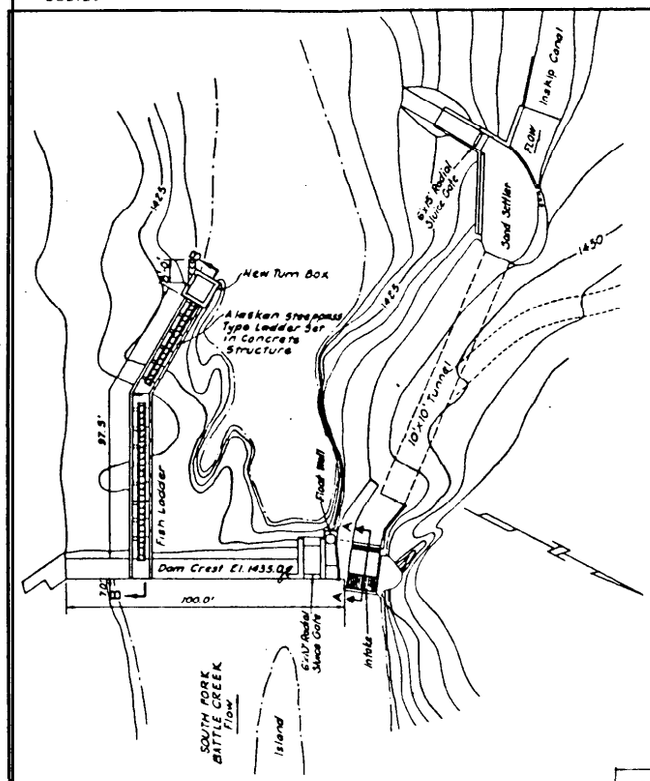
Any future studies would require subsurface investigations along the proposed bypass tunnel alignment and at the portal areas, and additional topography in the vicinity of the outlet portal. Subsurface investigations along the peninsula would be necessary to establish the box culvert size and location, and possibly seepage rates. Suitable riprap material sources and waste disposal areas would also have to be identified.

Appendix A - Project Drawings

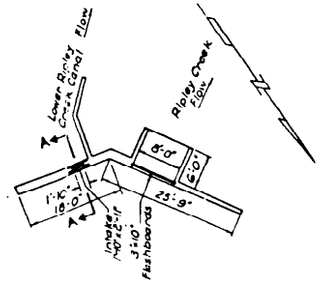


Location Map for Upper Battle Creek System near Manton, California

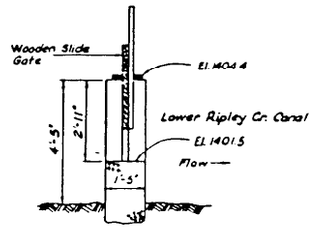
State of California
The Resources Agency
DEPARTMENT OF WATER RESOURCES
Northern District



PLAN OF DIVERSION DAM
1" = 20



PLAN OF DIVERSION DAM
1" = 10'



SECTION A - A
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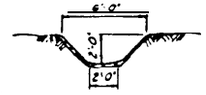
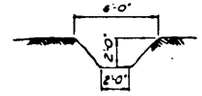
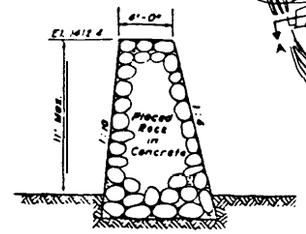


LINED CANAL SECTION
Length 68'
1" = 4'



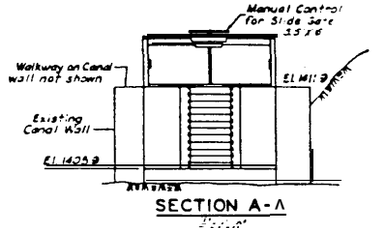
UNLINED CANAL SECTION
Length 316'
1" = 4'

I-OWEN RIPLEY CREEK CANAL

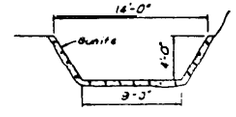


SECTION E - E
1" = 1'-0"

PLAN OF DIVERSION DAM
1" = 20'



SECTION A-A
1" = 1'-0"



LINED CANAL SECTION
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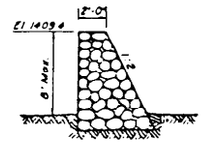
1" = 5'

TUNNEL SECTION
Length 254
1" = 5'



SECTION B-B
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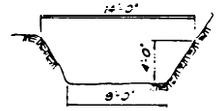

UNLINED CANAL SECTION
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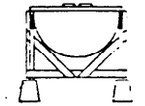
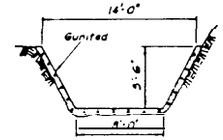


*108 METAL FLUME
Length 324
1" = 5'

EAGLE CANYON CANAL

Elevations are on U.S.G.S. datum



LINED CANAL SECTION
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1" = 5'

TUNNEL SECTION
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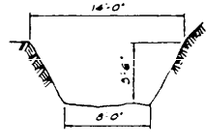
1" = 5'



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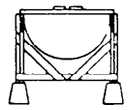
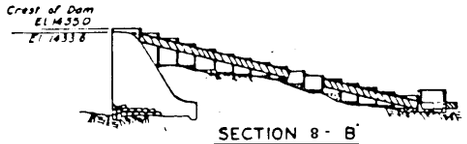


CANAL METAL FLUME
Length 146 of 8'-0" Metal Flume
149 of 6'-8" Metal Flume
1" = 5'

SECTION A-A
1" = 5'



SECTION B - B
1" = 20'

INSKIP CANAL

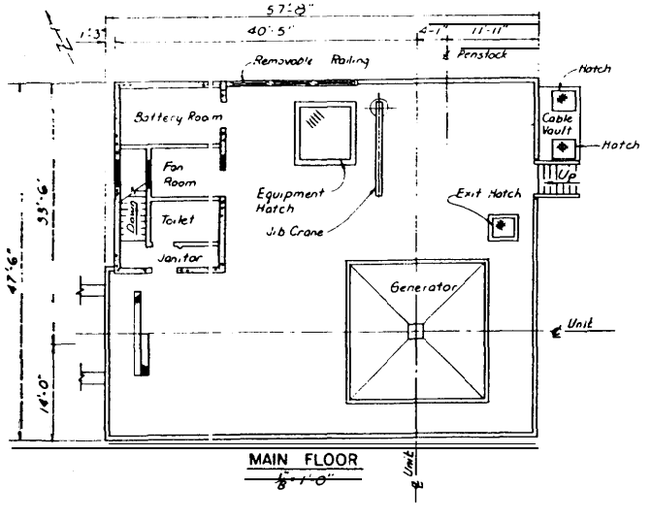
1 Revised October '78 '981' to show change of Est Bill number

2 Revised March, 1982 to Show As-Builts of Sign Loaders At Inskip Canal And Eagle Canal Overs on Dams

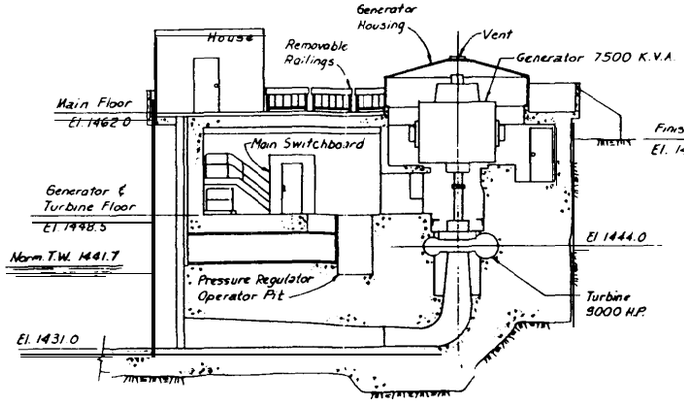
EXHIBIT L-19
DETAILS OF INSKIP CANAL, LOWER RIPLEY CREEK FEEDER, AND EAGLE CANYON CANAL
BATTLE CREEK PROJECT
PACIFIC GAS AND ELECTRIC CO.

SUPERSEDES 440931-2

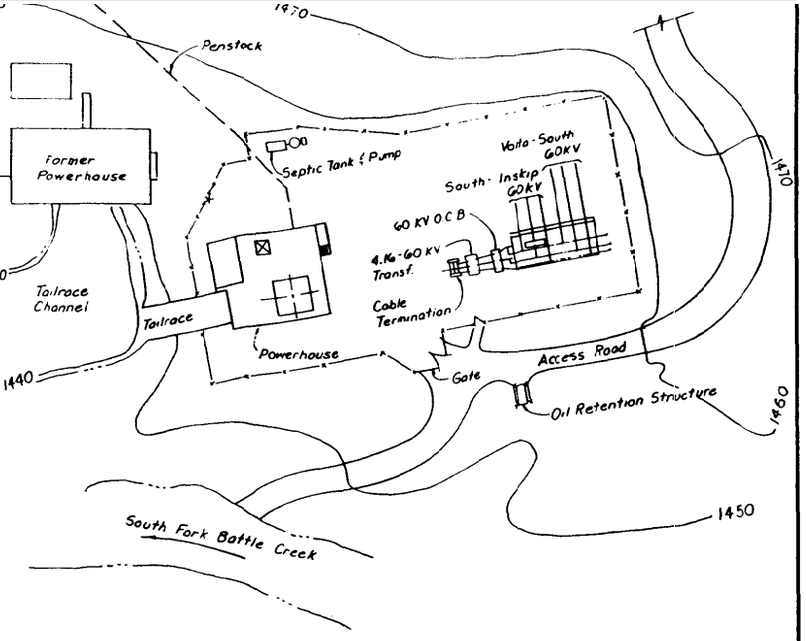
451555-1



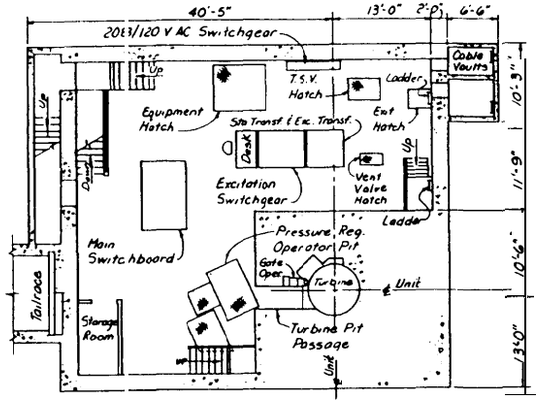
MAIN FLOOR
1/8" = 1'-0"



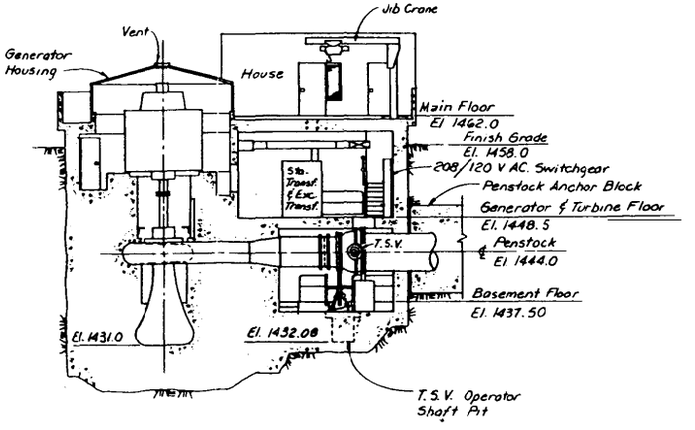
LONGITUDINAL SECTION
1/8" = 1'-0"



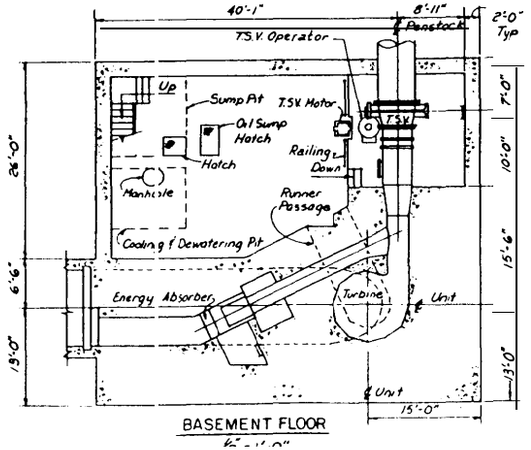
GENERAL ARRANGEMENT OUTDOORS
1" = 30'-0"



GENERATOR & TURBINE FLOOR
1/8" = 1'-0"



TRANSVERSE SECTION
1/8" = 1'-0"



BASEMENT FLOOR
1/8" = 1'-0"

Elevation Are On U.S.G.S. Datum.

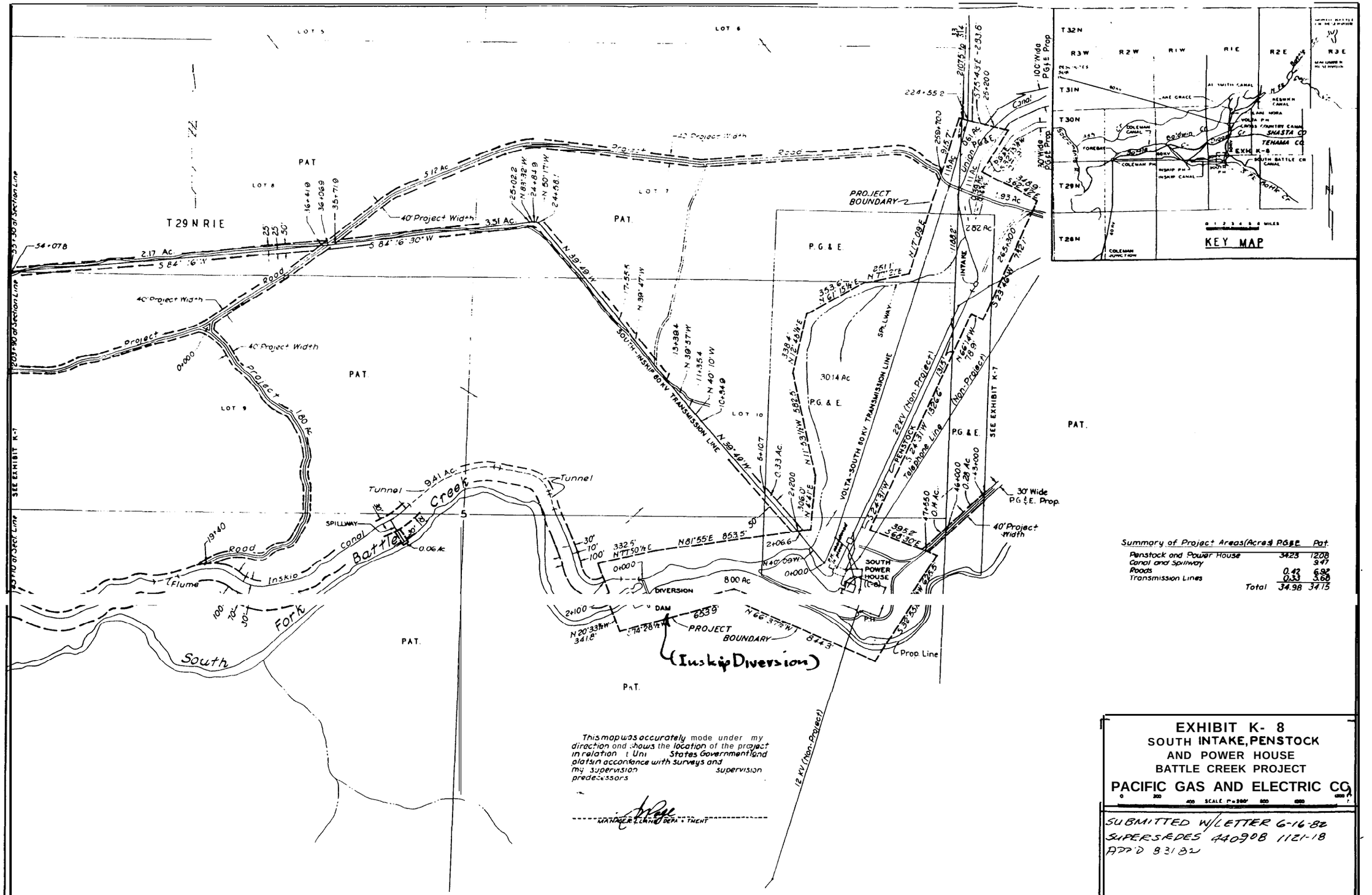
1. Revised and Redrawin December 18, 1981 To Show Powerhouse and Arrangement.

EXHIBIT L-8
PLAN AND SECTIONS
SOUTH POWERHOUSE
BATTLE CREEK PROJECT
PACIFIC GAS AND ELECTRIC CO.
SCALE AS NOTED

SUBMITTED W/6-16-82 LETTER
SUPERSEDES "440921 1121-31
OUTDOOR ARRANGEMENTS OF SOUTH
INSKIP & COLEMAN POWERHOUSES"
FPC 1121-13

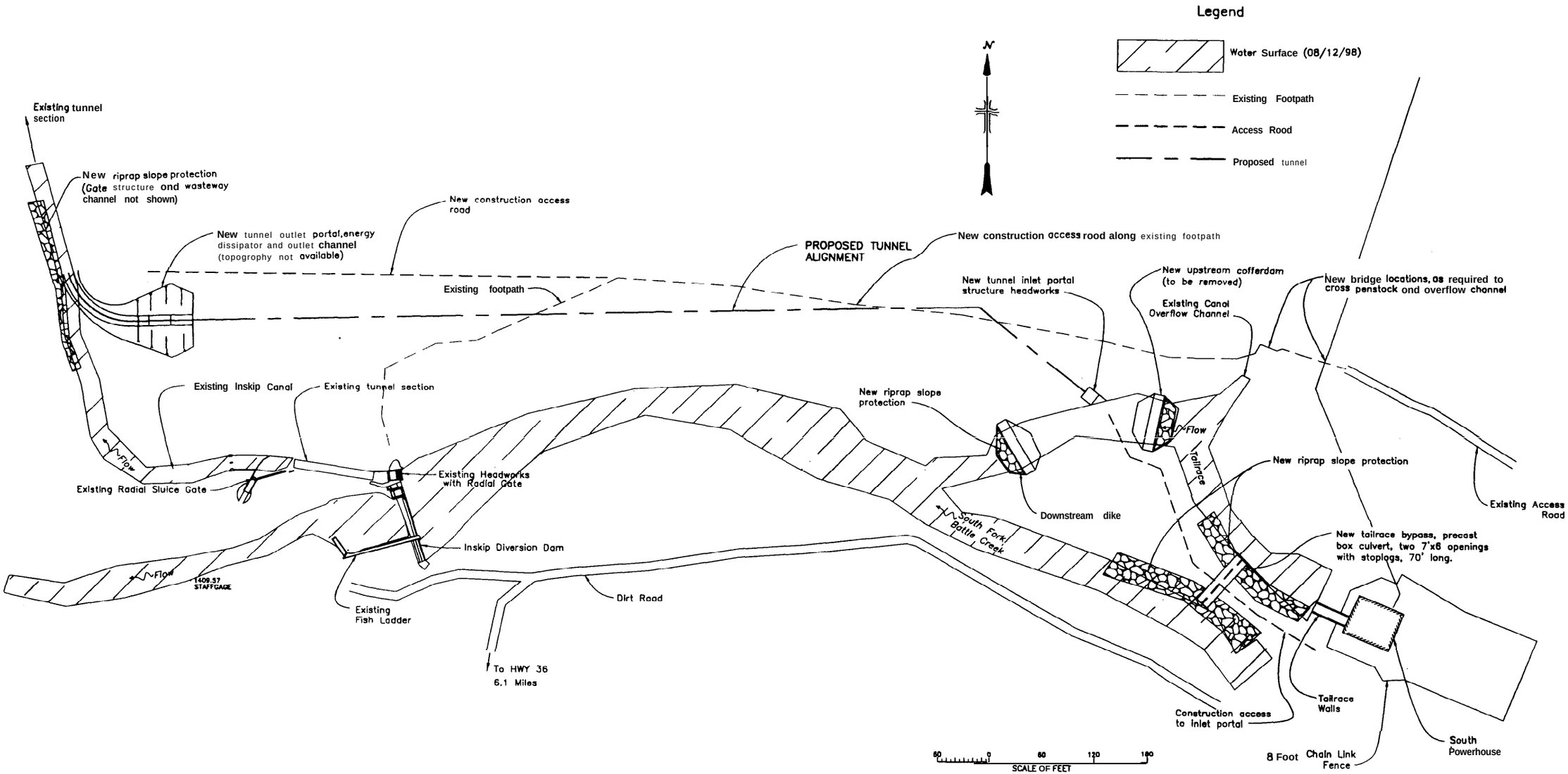
440921-1

SITE
TOPOGRAPHY
FIGURE
UNAVAILABLE
FOR THIS
(ELECTRONIC/cdrom)
VERSION OF THIS REPORT.



This map was accurately made under my direction and shows the location of the project in relation to United States Government land plats in accordance with surveys and my supervision and supervision predecessors

MANAGER LAND DEPARTMENT



NOTE

Drawing base was from Stote of Colifornio, The Resour Agency, Deportment of Woter Resources, Northern Distr revision dote of October 6, 1996.

ALWAYS THINK SAFETY

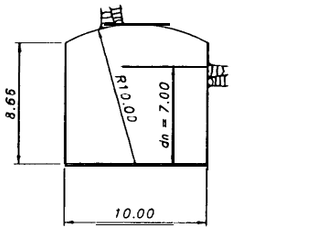
UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
DEPARTMENT OF WATER RESOURCES – CALIFORNIA

SOUTH POWERHOUSE TAILRACE BYPASS

TUNNEL AND ASSOCIATED FEATURES

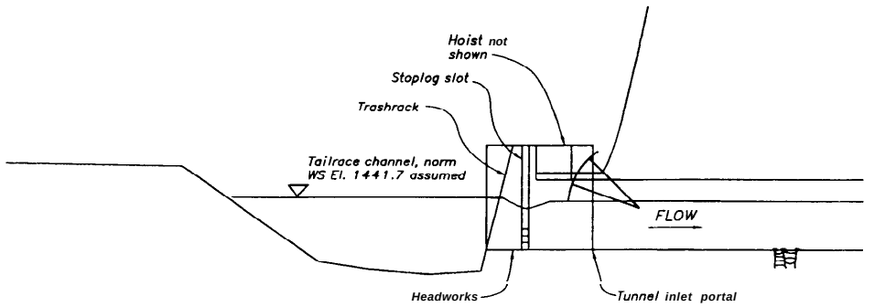
RECONNAISSANCE PLAN

DESIGNED STEVE ROBERTSON CHECKED



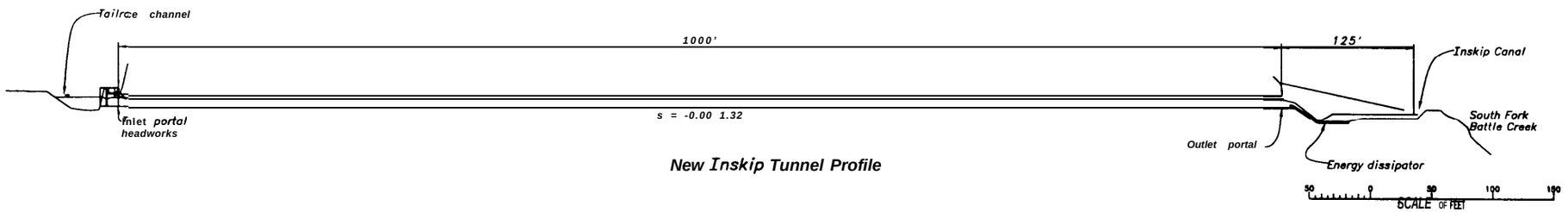
TUNNEL SECTION

SCALE OF FEET



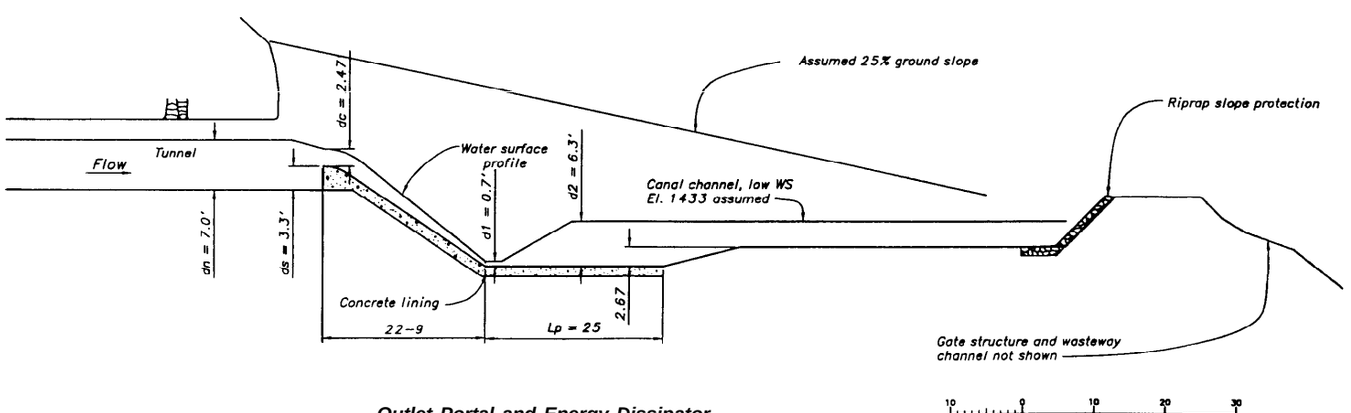
Inlet Portal and Headworks

SCALE OF FEET



New Inskip Tunnel Profile

SCALE OF FEET



Outlet Portal and Energy Dissipator

SCALE OF FEET

NOTE

Design discharge = 220 cfs.

ALWAYS THINK SAFETY

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
DEPARTMENT OF WATER RESOURCES - CALIFORNIA

SOUTH POWERHOUSE TAILRACE BYPASS

TUNNEL AND ASSOCIATED FEATURES

RECONNAISSANCE PROFILE AND SECTIONS

DESIGNED STEVE ROBERTSON CHECKED

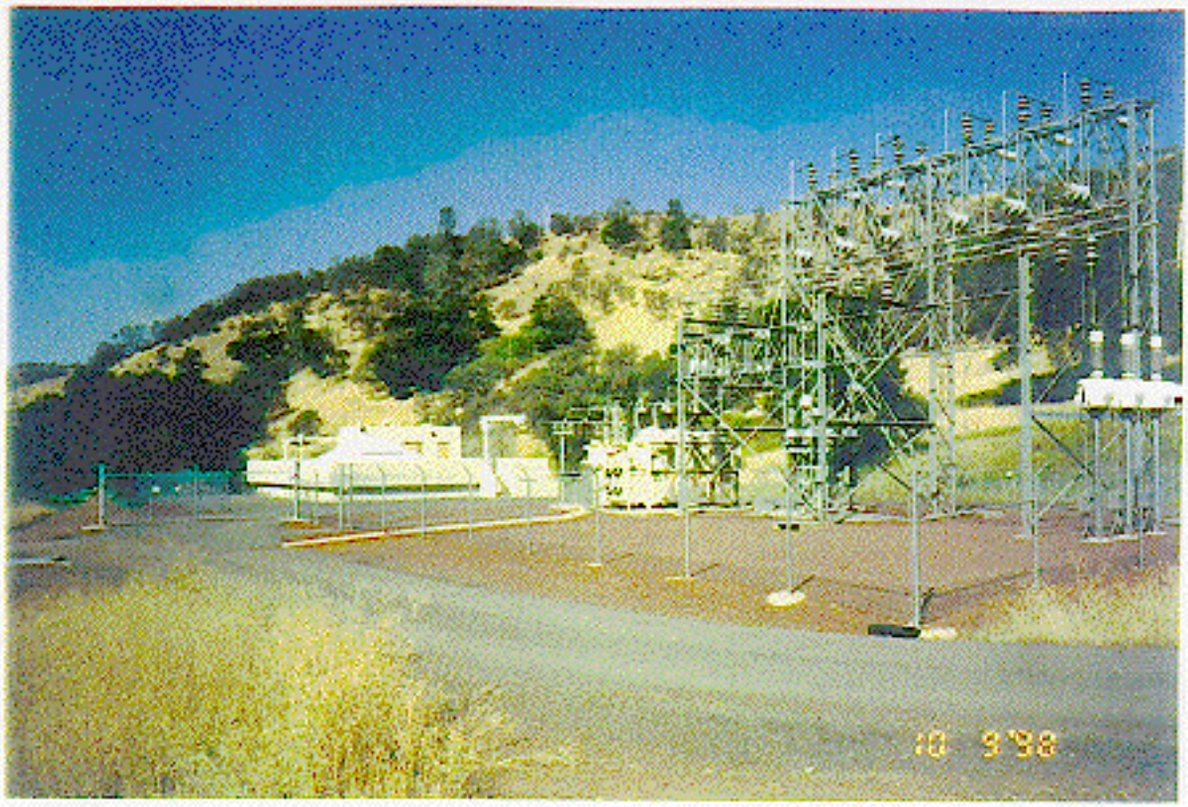
DRAWN TECH. APPR.

APPROVED

CADD SYSTEM | CADD FILENAME | DATE AND TIME PLOTTED

Appendix B - Project Photographs

(All photographs by Bureau of Reclamation)



Photograph 1. - South Powerhouse switchyard and plant structure.

Photograph 2. - South Powerhouse and tailrace channel, looking upstream.

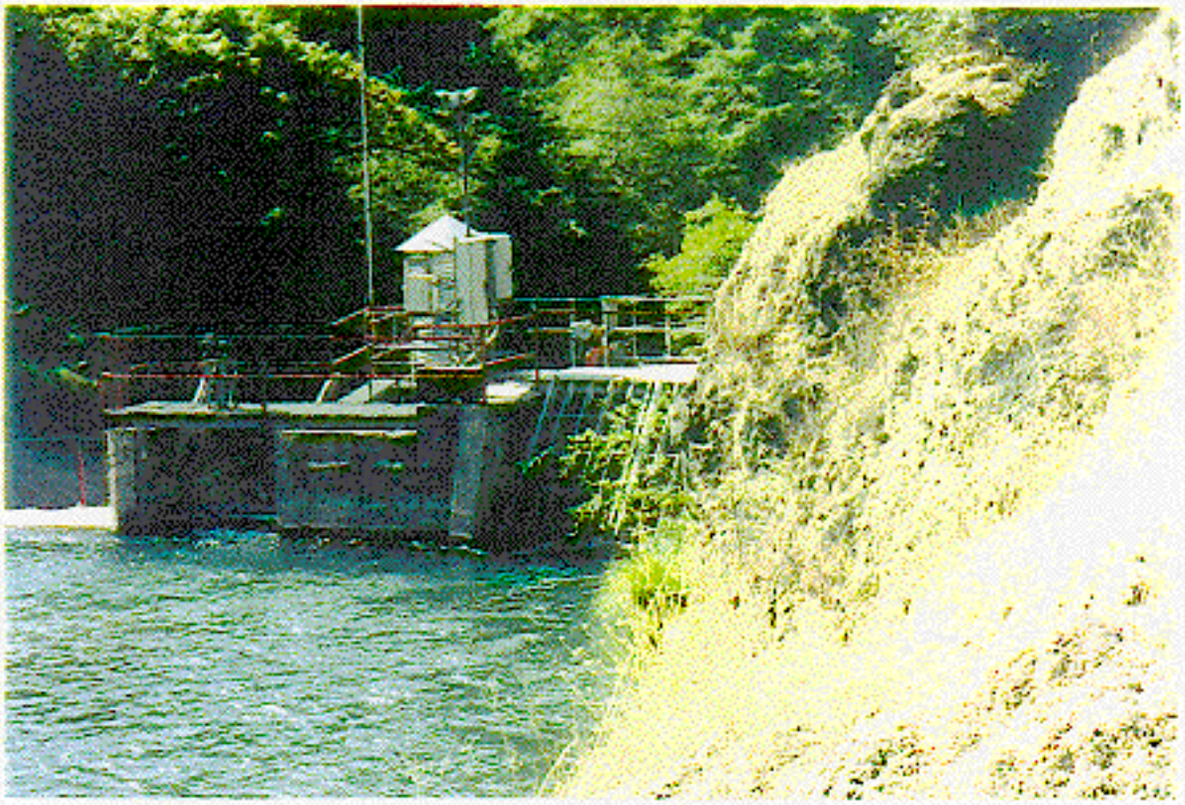
Photograph 3. - Union Canal overflow channel outfall to tailrace channel.

Photograph 4. - South Fork Battle Creek, looking downstream along tailrace peninsula.

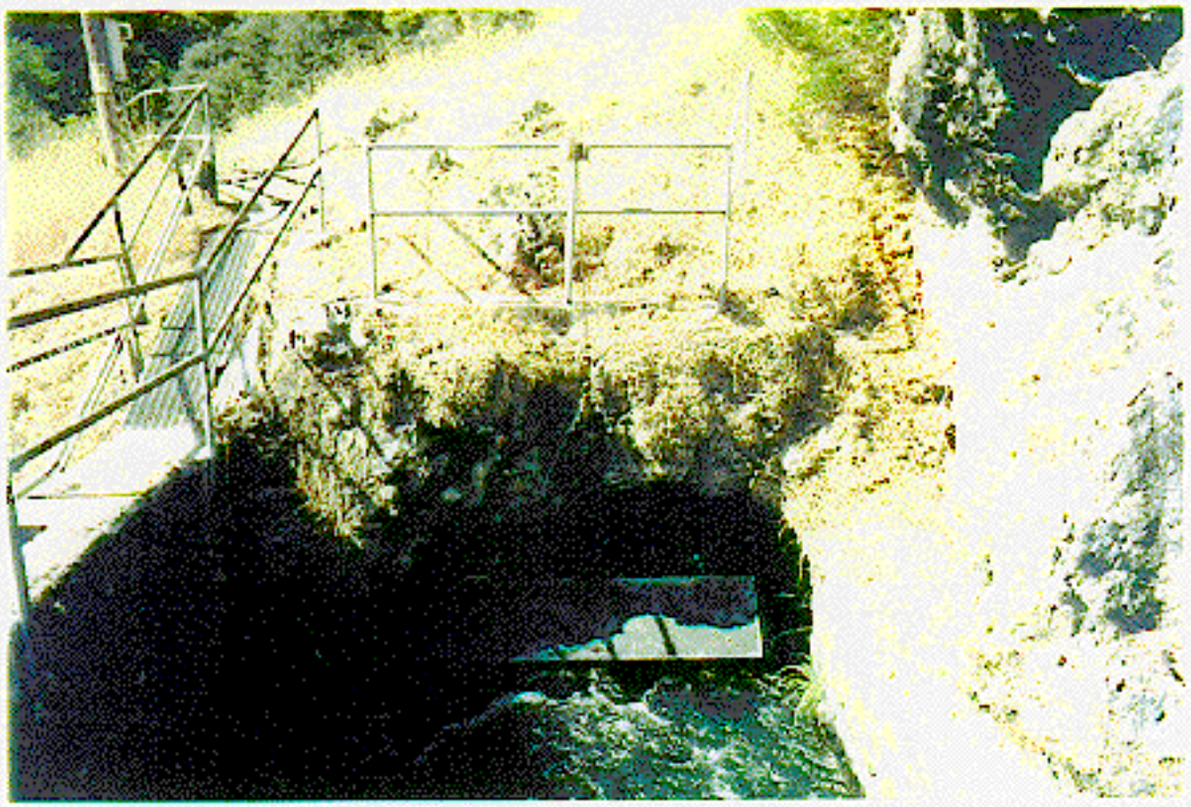
Photograph 5. - Proposed bypass tunnel inlet portal area along tailrace channel

Photograph 6. - Bedrock at South Fork Battle Creek and tailrace channel confluence.

Photograph 7. - Upstream view of Inskip Diversion Dam (canal headworks at right).



Photograph 8. - Inskip Canal headworks at Inskip Diversion Dam.



Photograph 9. - Inskip Canal tunnel inlet portal downstream of headworks structure.

Photograph 10. - Downstream face of Inskip Diversion Dam.

Photograph 11. - Inskip Canal tunnel outlet portal (footbridge shown over wasteway).

Photograph 12. - Proposed bypass tunnel outlet channel area along Inskip Canal (looking across canal to the southeast).

Photograph 13. - Proposed bypass tunnel outlet portal area, looking northwest.

Appendix C - Cost Estimate

CODE:

ESTIMATE WORKSHEET

FEATURE:

RECONNAISSANCE ESTIMATE
TAILRACE BYPASS TUNNEL

PROJECT:

DIVISION:

UNIT:

PLANT ACCT.	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
	1	Mobilization and preparatory work, Site Access	D8130	1	LS	$200,000.00	$200,000.00
	2	Construct site access road (12' wide, 2000' long, incl. access bridge consisting of four steel flatcars)	D8130	1	LS	$133,000.00	$133,000.00
	3	Excavation, common, open-cut for structures	D8130	1,000	yd3	$8.00	$8,000.00
	4	Excavation, rock, open-cut for structures	D8140	2,500	yd3	$20.00	$50,000.00
	5	Tunnel excavation, drill and blast (10' by 9.5'), 1050 ft	D8140	3,700	yd3	$300.00	$1,110,000.00
	6	Water treatment for tunnel construction	D8140	1	LS	$1 oo,ooo.oo	$100,000.00
	7	Shotcrete for tunnel support (3" crown and sidewalls)	D8130	270	yd3	$400.00	$108,000.00
	8	Construct dike and temporary cofferdam in tailrace (incl. geomembrane water barrier; site materials)	D8140	2,000	yd3	$20.00	$40,000.00
	9	Backfill for structures (site materials)	D8130	300	yd3	$10.00	$3,000.00
	10	Riprap for channel slope protection (from quarry)	D8130	600	yd3	$40.00	$24,000.00
	11	Concrete in double-box culvert (2-7' by 6'), 70 ft (with upstream stoplog slots) for diversion to creek	D8130	140	yd3	$600.00	$84,000.00
	12	Concrete in tunnel headworks structure (with upstream stoplog slots and provision for radial gate and hoist)	D8130	40	yd3	$600.00	$24,000.00
	13	Concrete in tunnel outlet portal structure	D8140	150	yd3	$600.00	$90,000.00
	14	Concrete in canal wasteway structure, to creek	D8130	20	yd3	$600.00	$12,000.00
	15	Radial gate (10' by 7') and hoist, for tunnel headwork	D8130	3,000	lbs	$6.00	$18,000.00
	16	Slide gates (2-6' by 6') and hoists, for canal wasteway	D8130	3,000	lbs	$4.00	$12,000.00

QUANTITIES		PRICES	
BY	APPROVED	**BY**	CHECKED
T. Hepler		**DLMaag**	FILE: RKC 10/20/98
DATE PREPARED	**DATE**	DATE	PRICE LEVEL
11/20/98		**11/20/98**	

CODE:D-3521

ESTIMATE WORKSHEET

FEATURE:
BATTLE CREEK DAMS
SOUTH POWERHOUSE

RECONNAISSANCE ESTIMATE
TAILRACE BYPASS TUNNEL

PROJECT:
BATTLE CREEK RESTORATION

DIVISION:

UNIT:

PLANT ACCT.	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
	17	Stoplogs, seats, and guides (for box culvert, headworks	D8 140	5,000	lbs	$5.00	$25,000.00
	18	Trashracks (for box culvert, headworks)	D8140	5,000	Ibs	$5.00	$25,000.00
		Subtotal - South Powerhouse Tailrace Bypass Tunne.					$2,066,000.00
		Unlisted items @ 10 percent					$234,000.00
		Contract cost					$2,300,000.00
		Contingencies @ 25 percent					$500,000.0( )
		Field Cost - South Powerhouse Tailrace Bypass Tunnel					$2,800,000.0()

QUANTITIES		PRICES	
BY T. Hepler	APPROVED	**BY** **DLMaag**	CHECKED RICC 10/20/98 FILE:
DATE PREPARED 1 **1/20/98**	DATE	DATE 20-Nov-98	PRICE LEVEL