TRIP TO STATE OF CALIFORNIA DEPARTMENT OF WATER RESOURCES OFFICES IN SACRAMENTO AND OROVILLE, CALIFORNIA, RELATIVE TO OROVILLE DAN MODEL STUDIES

J. W. BALL, ENGINEER

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Bureau of Reclamation

INFORMATIONAL ROUTING

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August 10, 1961

Travel Report #2253

To: Assistant Commissioner and Chief Engineer

Through: Chief Research Engineer
Chief, Hydraulic Laboratory Branch

From: J. W. Ball, Engineer

Subject: Trip to State of California Department of Water Resources Offices in Sacramento and Oroville, California, relative to Oroville Dam model studies

Purpose and Extent of Trip

I left Denver, Colorado, 3:45 p.m., Monday, July 10, 1961, by air and arrived in Sacramento at 8:10 p.m., the same evening. I spent Tuesday, July 11, and Wednesday, July 12, with members of the Staff of the State of California Department of Water Resources inspecting Oroville damsite and vicinity and discussing problems concerning the hydraulic features of the dam and related structures. I returned from Sacramento, California, on July 13, by air, leaving there at 7:45 a.m., and arriving in Denver at 12:05 p.m.

Contacts Made

Most of the time spent in the Department offices was with Mr. Gordon W. Dukleth, of the Dam Design Section, and members of his staff.

Contacts made during the two days included:

H. G. Dewey, Jr., Division Engineer
James J. Doody, Dam Section
James V. Williamson, Aqueduct Section
Kenneth Bucker
E. W. Stropini
W. E. Busby
H. C. Hyde
S. J. Linn
C. Lanning
R. W. Ehrhart
R. Rutherford
D. A. Crane
N. Pona
R. Wong
Mark Lyons

Trip to Oroville Damsite

Mr. Gordon W. Dukleth met me at the hotel at 8 a.m., July 11, and took me to the Department Design Offices, where contacts were made briefly with Messrs, Dewey and Doody, and members of Mr. Dukleth's staff, before proceeding to Oroville for an inspection of the Oroville damsite. The proposed entrance structure for Diversion Tunnel No. 1 was discussed briefly, confirming suggestions for extending the upper and side portions of the entrance headwall 15 feet beyond the edges of the rectangular bellmouth entrance, and discussing revisions for minimizing the cavitation tendency of the gate slots and breaks in surface alinement at the tail of the pier in the tunnel entrance.

Mr. Dukleth, Mr. Bucher, who will come to Denver for training in hydraulic laboratory work and assist in the conduct of hydraulic investigations related to Oroville Dam, and myself, left Sacramento for Oroville about 9 a.m. We arrived at Oroville, California, about 10:30 a.m., contacted the project office and proceeded to the site (Drawing No. AD828-1). The three of us, along with Mr. Mark Lyons the project geologist, hiked to the river from the roadway on the right bank of the Feather River opposite the area in which the diversion tunnel entrances will be located. We then hiked about a mile down the river to the highway bridge to the area where the tunnel exits are to be located, and back out of the canyon. Numerous pictures of the river channel and banks in the tunnel inlet and exit areas and intermediate points were taken. Photograph No. P846D28133 shows the area where the entrances to the diversion tunnels are to be located. Photograph No. P846D28134 shows the area near the bridge to be covered by the toe of the dam. Photograph No. P846D28135 shows the area where the diversion tunnel outlet portals will be located. The site for the tailrace control weir is on the rock point shown on the right bank in the center of Photograph No. P846D28135.

After lunch Mr. Lyons took us to the area where the spillway entrance is to be located, Photograph No. P846D28136. We hiked from the entrance, in temperatures near 120° F down the centerline of the spillway for a distance of about 1 mile to a point near the river. Photographs were taken of the area to be traversed by the spillway channel. Photograph No. P846D28137 shows where the spillway channel will empty into the river.

In all, some 40 photographs were taken by me. These will be valuable aids in building and operating the model of the diversion scheme now under construction in the Hydraulic Laboratory.

The return trip from Oroville to Sacramento was made during the evening of July 11.

Discussions

The entire day of July 12, from 8 a.m., to 5 p.m., was spent in the Sacramento Design Offices of the department where numerous hydraulic problems concerning Oroville Dam and related structures were discussed. The subjects considered and conclusions reached are outlined briefly in subsequent sections of this report.

Diversion Tunnels

The alinements of the diversion tunnels have been fixed insofar as possible at this time. Only the discovery of unexpected foundation conditions in the powerplant area would appear to result in any future changes in tunnel alinement.

Need for more topographical data for the model studies on the diversion tunnels was pointed out. An immediate request was made of the field forces by the Department Design Office for soundings of the river channel and traverses of the canyon topography to elevation 350 feet for a distance of 1,400 feet downstream from the diversion tunnels exit portals. It was learned that there would be a berm on the toe of the dam to provide parking space and access to the diversion tunnels exits. Detail topography for this area was requested. It was noted that a private powerplant (Kelley Ridge) would be constructed near the river some distance downstream from the exits of the diversion tunnels. It was pointed out that diversion flows might affect the plant. Drawings showing location and other pertinent details were obtained.

Inquiry was made concerning the bed load and suspended sediment that might be expected to flow through the diversion tunnels. No information was available; however, the material on the banks and in the river channel indicates that sand and gravel will be transported through the tunnels during flood periods. Very little material should enter the tunnels once the water upstream has ponded and the tunnels are flowing full with the entrances submerged.

A request was made for photographs showing the river channel and topography in the vicinity of the tunnel inlets and exits. Aerial views and a limited number of other photographs were obtained. Pictures taken on my two hikes of the previous day will provide ample additional photographic information.

The designs of the entrances to the diversion tunnels were discussed in detail. The entrance shapes were considered satisfactory; however, the facing surfaces on the sides and tops of the entrances were not considered adequate to prevent a reentry condition which might introduce objectionable subatmospheric pressures and cavitation. It was recommended that the facing walls on the sides and top of the entrance for Tunnel No. 1 be extended 15 feet or about 1/2 tunnel diameter beyond the edges of the bell entrance. After returning to Denver the problem was considered further.

An examination of recent data from tests made by the Corps of Engineers indicated that the entrance structure might be shortened by 40 feet, or more than 50 percent, without destroying its effectiveness. This information and a proposal to place the tunnel transition downstream from the gates were conveyed to the Department by phone on July 17.

It was suggested that the circular bellmouth entrance of Tunnel No. 2 be treated similarly to the rectangular entrance of Tunnel No. 1, by providing a facing surface outside the bell equal to about half the tunnel diameter. It was pointed out that the suppression of the invert of the circular bell would induce a lowering of pressure at the top and might cause cavitation. It was agreed the Bureau Laboratory would consider the problem further to determine whether or not special treatment would be required. However, it was anticipated that the model study would be needed for this purpose.

Consideration was given to the amount of offset for the downstream corners of the gate slots in Diversion Tunnel No. 1. After a quick check of the hydraulic pressures which are expected to exist in the tunnel during operation, it was concluded that no change would be required. Also, in light of the pressure conditions it was decided that the gate slot could be widened by 3 inches.

The Department designers, because of structural and hydraulic reasons, decided that they would use square instead of rounded bottom corners on the gates. This would require deep slots at the bottom corners. They proposed to install filler blocks in the slots for the diversion period. These would be removed to permit later closure of the square-cornered gate. The new proposed shorter entrance design would eliminate the need for the corner fillets.

A break in alinement of the flow surfaces on each side near the tail of the center pier in the entrance to Tunnel No. 1 was investigated for possible cavitation tendencies. It was determined that the cavitation index would be about 1.6, out of the danger range, and that no change would be needed. The Department designers, however, had made a recent change which would minimize the chances for cavitation even under more severe conditions than could exist.

Outlet Works

Details of the entrance piping, and the arrangement of the valves and energy dissipator of the outlet works, were discussed. A mechanical drawing showing pertinent dimensions was obtained. The possible use of a rounded instead of an elliptical entrance was discussed. The rounded entrance seemed feasible. However, later discussion in this office indicated there would be little, if any, difference in cost and that the elliptical shape was preferable. This opinion was conveyed to the Department Offices July 17.

Powerhouse Penstocks and Draft Tubes

Final arrangement, location, and design of the draft tubes have not yet been established. Data from the Department are expected in approximately 2 weeks. The Department designers expressed concern about the surge chamber passages and their effectiveness during power interruptions and asked that a study of transient pressures be made on the model and that a qualitative evaluation be made of flow within the model draft tubes which contain more than the normal centerline curvature.

The air-operated buoyant dome gate for the penstock intakes was discussed and the following disadvantages of the design enumerated.

A. Inaccessibility of gate

B. Lack of rigid positive control

1. Likely tipping of gate

2. Variable downpull distribution around gate

3. Likely tendency of gate to vibrate

C. Shifting of control on gate bottoms

D. Possible cavitation on gate bottom and seat

E. Possible vibration and pounding at small openings during closing cycle

A new proposal using horizontal bellmouth entrances and slide gates in an intake tower structure was then discussed. The design had many advantages over the buoyant dome-type gate, however, there was some question as to whether or not the trashrack should be placed at 0.6D ahead of the entrance instead of the 0.8D generally recommended by the Bureau. A change in design to provide the 0.8D distance would increase the size of the intake tower. This was considered undesirable as it would increase the cost, which on the present design compared favorably with the cost of the dome type. The need for model studies on this design was discussed and the opinion given that they would not be required. A question was raised as to the influence of the surrounding water on the stability of the structure and if information on this subject in addition to that concerning the Pit River Bridge pier was now available. Inquiry has been made of Bureau designers. They are not aware of any recent development concerning this subject.

Cost Accounting for Model Studies

Because of the accounting system now being used in the Bureau in which separate production orders are required to separate the costs of various features, inquiry was made of the cost distribution desires of the Department. Mr. R. Wong of their finance staff indicated a desire to have the costs separated into three categories as follows:

A. Oroville Dam

B. Oroville Powerplant

C. Oroville miscellaneous which would be divided later between A. and B. in proportions determined by the Department (Studies of Diversion Tunnels is an example)

Work concerning the spillway and outlet works would be chargeable to A. above, and draft tubes, powerplant, and tailrace system would be chargeable to B. Appropriate production orders have been established for distribution of charges in this manner.

Hydraulic Laboratory Trainee

Inquiry was made concerning plans of the Department for sending an engineer to the Bureau for training in Hydraulic Laboratory work as had been discussed in previous meetings. Department representatives stated that plans were being formulated to send Mr. Kenneth Bucher to Denver and that he would be detailed as soon as the arrangements were completed, possibly within a week or two. Department Engineers were informed that Mr. Bucher's services could be used to advantage as soon as he arrived.

Conclusions

The trip to Sacramento was very fruitful and informative. The information obtained will help materially in expediting the model studies and will give those working on the models a better understanding of the project, its purposes, the hydraulic problems involved, and project operating conditions and requirements.

James W. Ball

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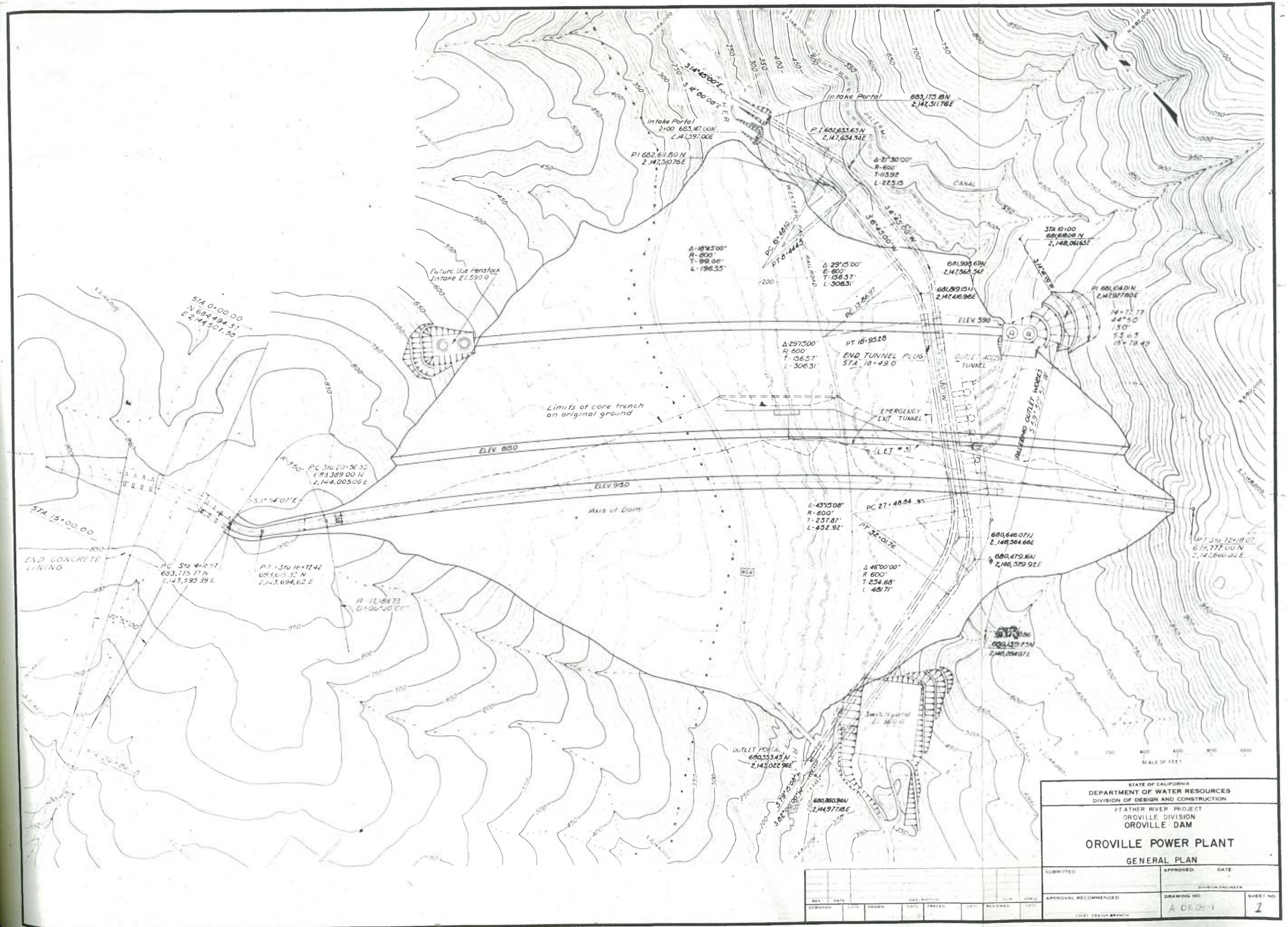
NOTED:.....
(date)

Grant Bloodgood
Assistant Commissioner
and Chief Engineer



STATE OF CALIFORNIA
DEPARTMENT OF WATER RESOURCES
DIVISION OF DESIGN AND CONSTRUCTION

FEATHER RIVER PROJECT
OROVILLE DIVISION
OROVILLE DAM

OROVILLE POWER PLANT

GENERAL PLAN

REV.	DATE	DESCRIPTION	BY	APP'D

DESIGNED	DATE	DRAWN	DATE	TRACED	DATE	REVIEWED	DATE

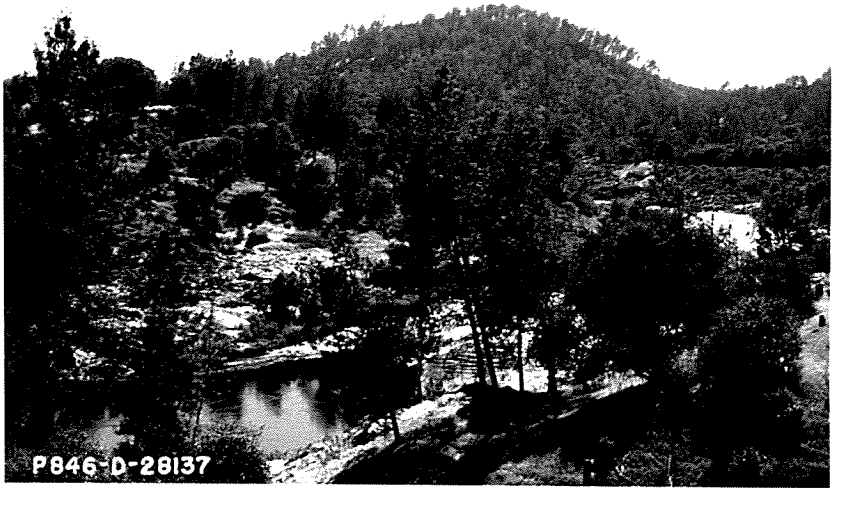
SUBMITTED	APPROVED: DATE DIVISION ENGINEER	
APPROVAL RECOMMENDED CHIEF, DESIGN BRANCH	DRAWING NO. A-OED-1	SHEET NO. 1

Feather River channel where Oroville Dam Diversion tunnel inlets will be located in left bank. View from right bank looking upstream.

Feather River channel upstream from highway bridge. Toe of Oroville Dam will occupy this area. View from right bank looking downstream.

Feather River channel downstream from where Oroville Dam diversion tunnel exits will be located. Tailwater control weir site is at rock point jutting from right bank, center of picture. Kelley Ridge powerplant location is shown in top left corner of picture. View from bridge over centerline of Tunnel No. 1.

Area in which Oroville Dam Spillway entrance structure will be constructed. View from left side.



Feather River channel where Oroville Dam spillway will discharge its flow. View from centerline of spillway channel near Station 30+00.