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HYD 102

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

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HYDRAULIC MODEL STUDIES OF COACHELLA POWER DROP, STATION 290+00 - ALL-AMERICAN CANAL PROJECT

- - -

By R. R. Pomeroy, Junior Engineer

- - -

Denver, Colorado
January 31, 1942

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MEMORANDUM TO CHIEF DESIGNING ENGINEER

SUBJECT:
HYDRAULIC MODEL STUDIES
of
COACHELLA POWER DROP
Station 290/00 - All American Canal
Project

- - -

By R. R. Pomeroy, Junior Engineer

Under direction of
J. E. Warnock, Engineer
and
R. F. Blanks, Senior Engineer

- - -

Denver, Colorado
January 31, 1942

MEMORANDUM TO CHIEF DESIGNING ENGINEER:
(R. R. Pomeroy through J. E. Warnock)

Subject: Hydraulic Model Studies of Coachella Power Drop - Station 290/00 - Boulder Canyon Project.

1. Introduction. Coachella Canal is a branch of the All-American canal system, the connection occurring at Drop No. 1, about 17 miles west of Yuma, Arizona (figure 1). The canal crosses East Mesa, passes northwest between the Salton Sea and the Chocolate Mountains to a point near Indio, California, where it turns southwest across the Coachella Valley and then south to the Riverside-Imperial county line. The purpose of the canal is to provide water for irrigation in East Mesa and the Coachella Valley.

An abrupt change in ground elevation at station 290/00 on the canal necessitates the construction of a drop structure. Advantage will be taken of this change in elevation to install a power unit, known as the East Mesa Power Plant, to generate electricity for the Imperial Valley.

2. Need for Model Study. The original design called for a structure comparable in length to Drop No. 2 on the All-American Canal. Because of the smaller discharge, 2200 second-feet as against 8500 second-feet, it was felt that a less elaborate and shorter structure might be developed by model tests.

3. Model Tests. A 1 to 24 scale model was constructed from the original design drawings (figure 2). The model was tested for each design using certain flow combinations.

A constant quantity representing a prototype flow of 2200 cubic feet per second was discharged, in turn, through the spillways, through the two units of the powerhouse, and through combinations of powerhouse and spillway.

Flow conditions entering the spillways and powerhouse, down the spillways, and in the stilling pool were observed. Profiles of the water surface in the spillway were taken for design No. 2. Scour downstream from the lower warp was carefully noted for each design.

4. Results from Original Design. Tests on this design disclosed that the perforated piers in the central section at the entrance of the drop structure were not properly located. These piers are built with a series of openings through them as evolved in the All-American Canal Drops, the purpose being to reduce surgingin in the forebay and to equalize the pressures on the two sides of the piers

slopes of the canal downstream from the lower warp. Since operation of the model indicated that the length of the original design was unnecessarily great, the upstream warp was shortened from 105 feet to 70 feet. No detrimental effect was noted. The length of the downstream warp was similarly reduced from 105 feet to 78 feet 6 inches and was moved upstream 76 ft., steepening the slope of the spillway profile. A short concrete section 35 ft. long, at the same cross section as the canal itself, was added downstream from the warp. These changes reduced the total length to 369 ft. 9 in. When tested, a further reduction of length seemed possible. The length of the downstream warp was therefore reduced another 20 ft. This necessitated a change in the slope of the stilling pool floor from 12:1 to 9.87:1.

The width of the channel was decreased from 28 ft. 4 in. to 26 ft. 6 in. at the narrowest point opposite the powerhouse. This change was made for structural considerations only.

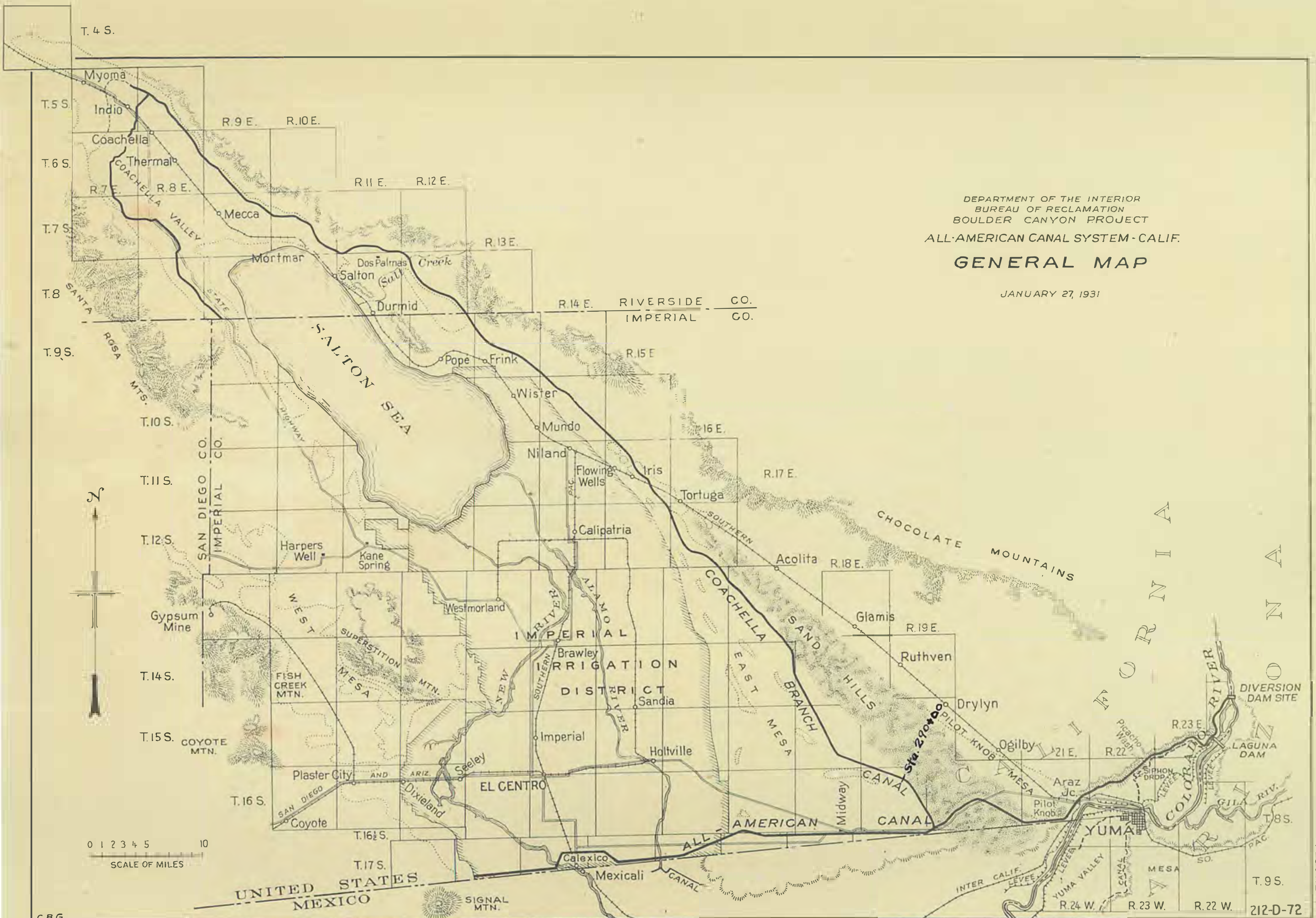
The profile of the spillway was changed in such a way that most of the profile would fall at a higher elevation than the corresponding points on the original profile. In this way a saving in excavation could be accomplished.

The pier located in the center of the upper end of the spillway channel was seen to be too short to straighten the flow before it reached the stilling pool. Several lengths were tried, but it was discovered that no pier was completely satisfactory, there being a marked tendency in all cases toward the formation of a fin of water from the downstream end of the pier to the pool A pier 70 ft. in length was finally settled upon as giving the best results in this respect. The pier shape was streamlined as much as possible in order to create minimum disturbance (figure 12).

A minor change was made in the shape of the piers at the downstream end of the powerhouse. All the piers, with the exception of the one replacing a portion of the spillway wall, were made 6 ft. 3 in. in length, and the downstream faces were made vertical.

The teeth in the spillway were respaced, the spaces between the teeth in the middle being made the smallest. The purpose of this was to produce better distribution of water in the pool by breaking up the fin which formed at the downstream end of the spillway pier.

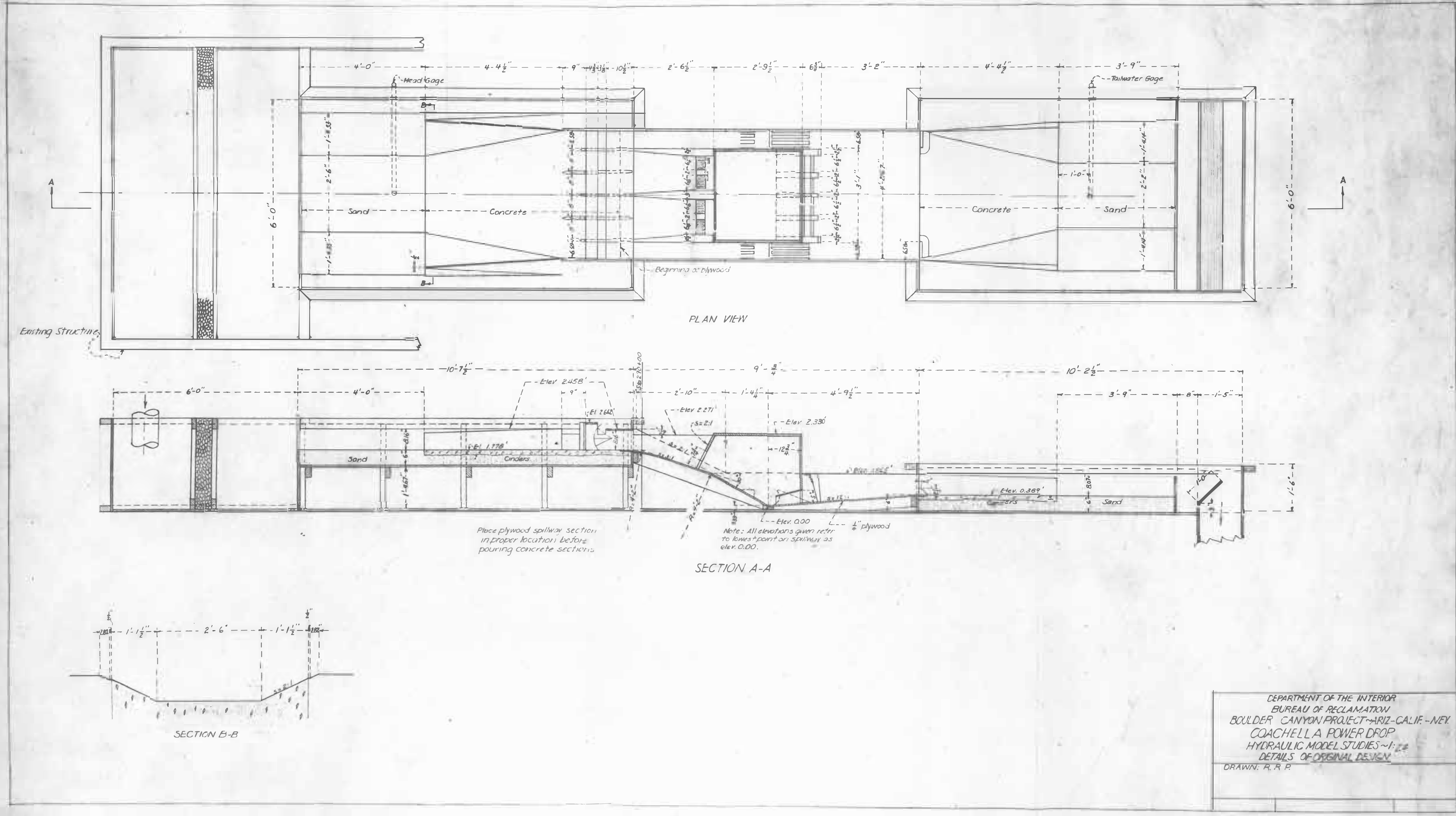
Riprap, of a size equivalent to one- to four-foot rock on the prototype, was placed on the $1\frac{1}{2}$ to 1 side slopes of the canal below the downstream warp. The riprap on the model extended downstream for a distance corresponding to 35 feet on the prototype. Negligible erosion of the sand downstream from the riprapped area indicated this to be sufficient (figure 11). The performance should be satisfactory.

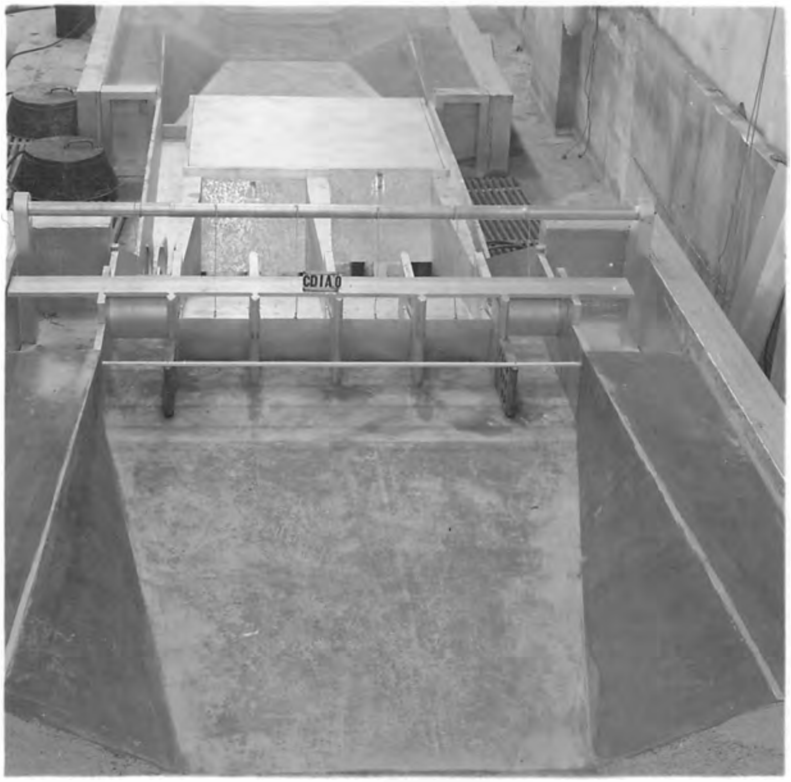


FIGURE

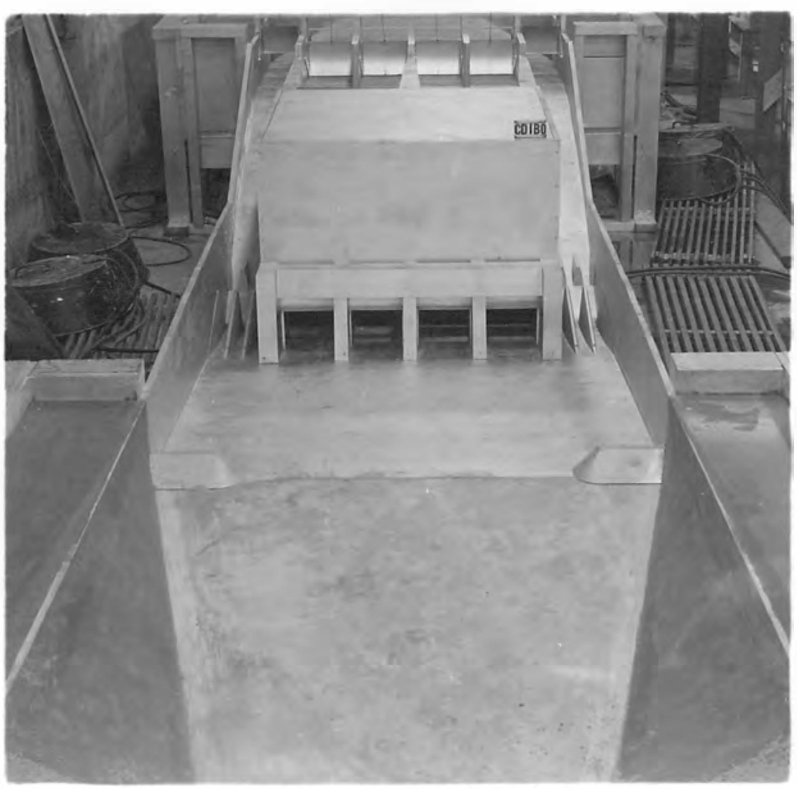
Revised 4-24-30
Revised 3-29-41

FIGURE 2


PLAN VIEW
Head Gage
Tailwater Gage
Sand
Concrete
Concrete
Sand
Beginning of plywood
Existing Structure
SECTION A-A
Elev. 2.458'
El. 2.642'
El. 1.778'
Elev. 2.271
Elev. 2.330
Elev. 0.389'
Elev. 0.00
Sand
Cinders
Cinders
Sand
1/4" plywood
Place plywood spillway section in proper location before pouring concrete sections
Note: All elevations given refer to lowest point on spillway as elev. 0.00.
SECTION B-B
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
BOULDER CANYON PROJECT-ARIZ.-CALIF.-NEV.
COACHELLA POWER DROP
HYDRAULIC MODEL STUDIES~1:24
DETAILS OF ORIGINAL DESIGN
DRAWN: R.R.P.



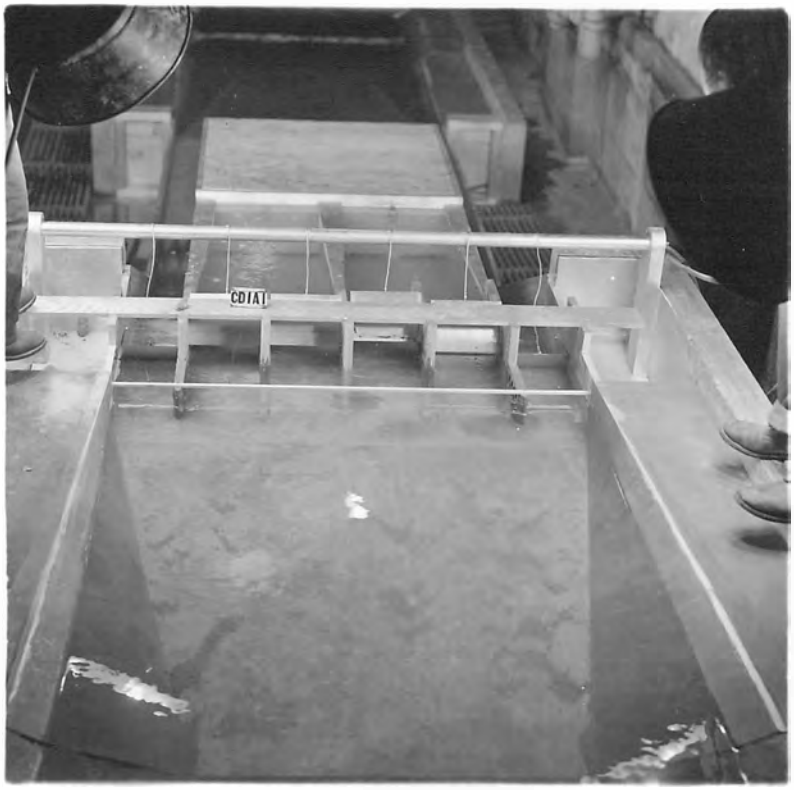
VIEW OF MODEL LOOKING DOWNSTREAM



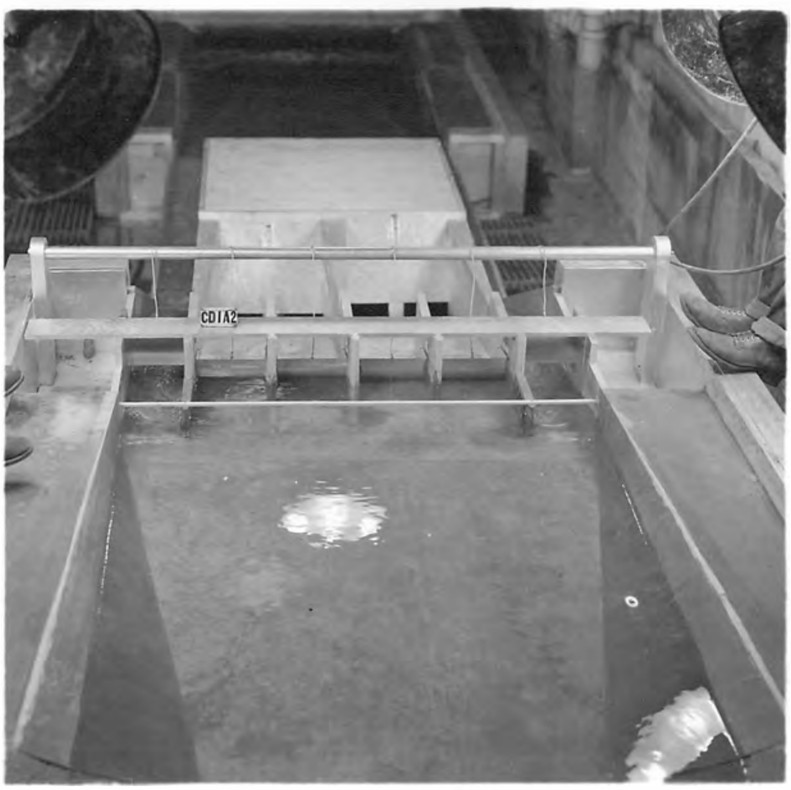
VIEW OF MODEL LOOKING UPSTREAM

ORIGINAL DESIGN

FIGURE 4

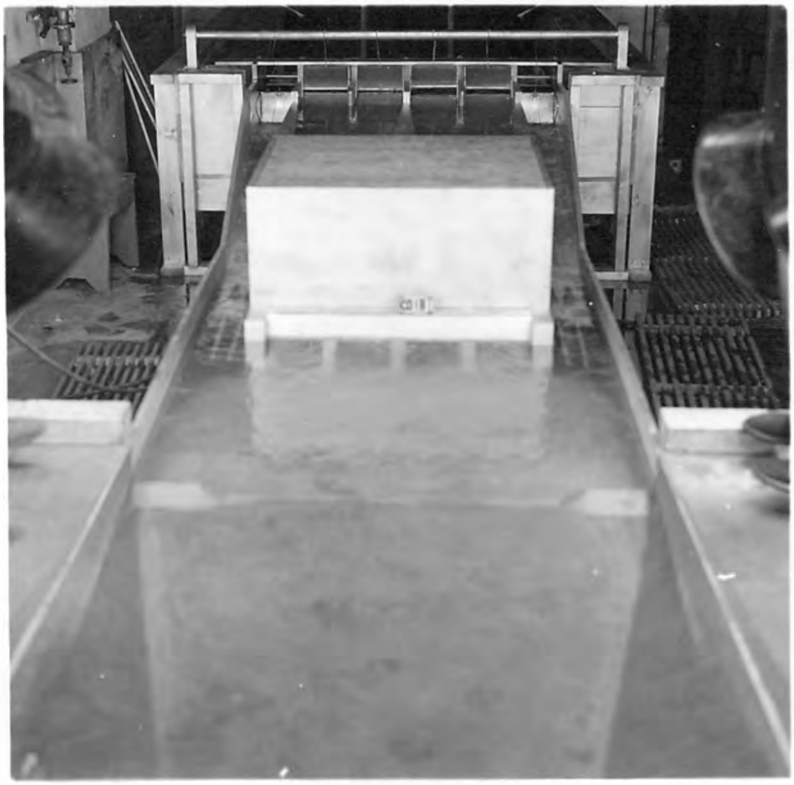


FLOW OF 2200 SECOND-FEET ENTERING POWERHOUSE

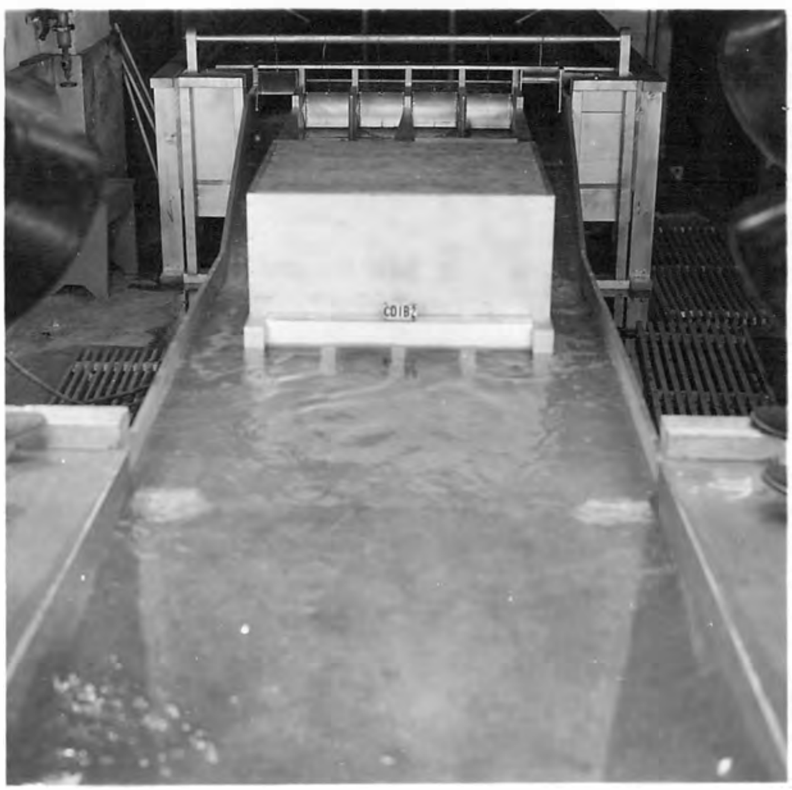


FLOW OF 2200 SECOND-FEET ENTERING SPILLWAYS

ORIGINAL DESIGN

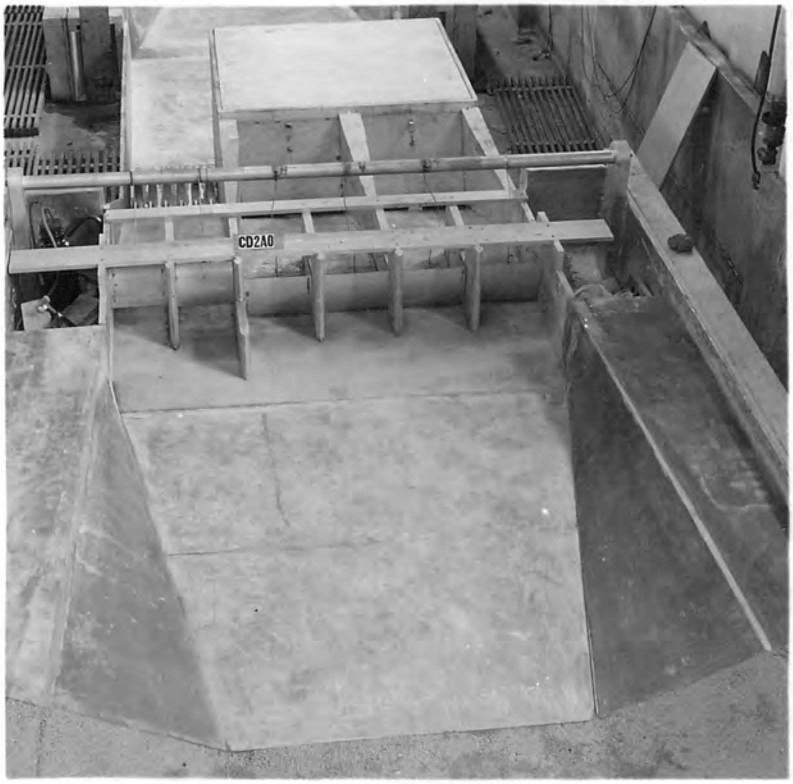


FLOW OF 2200 SECOND-FEET THROUGH POWERHOUSE



FLOW OF 2200 SECOND-FEET THROUGH SPILLWAYS

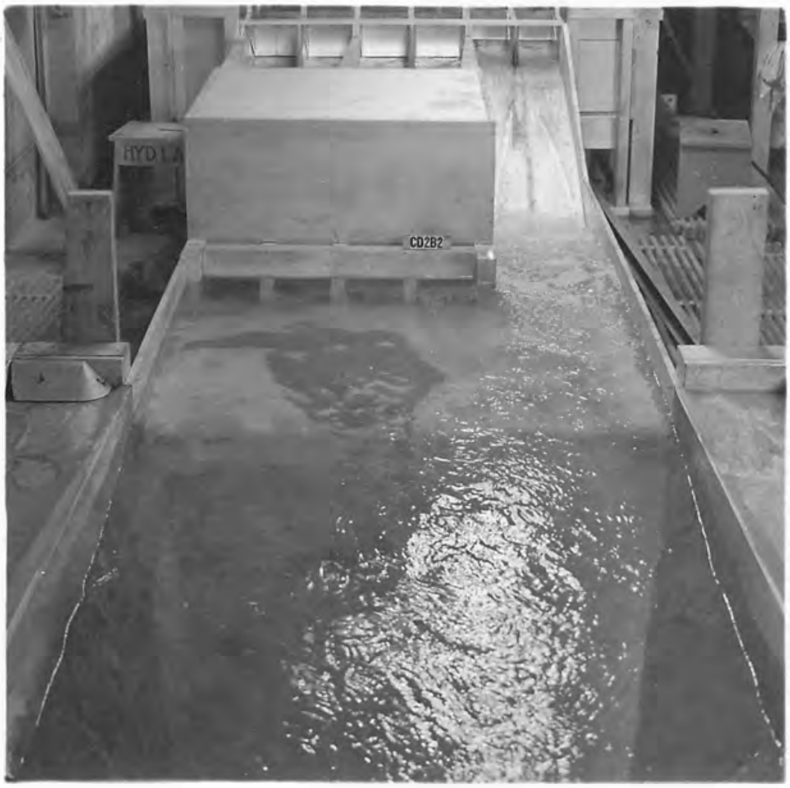
ORIGINAL DESIGN



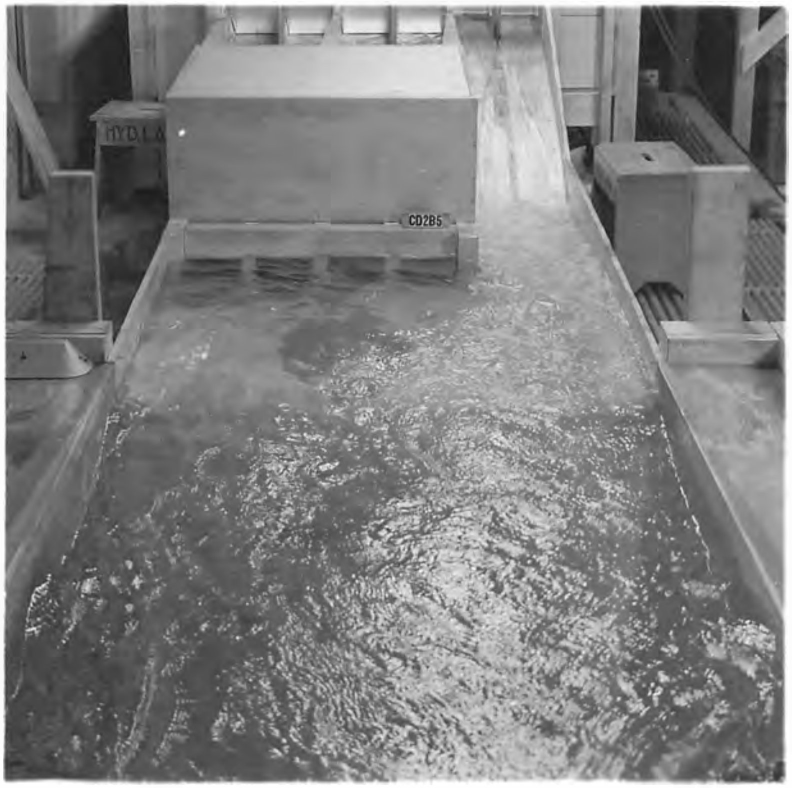
VIEW OF MODEL LOOKING DOWNSTREAM

VIEW OF MODEL LOOKING UPSTREAM

DESIGN NO. 2

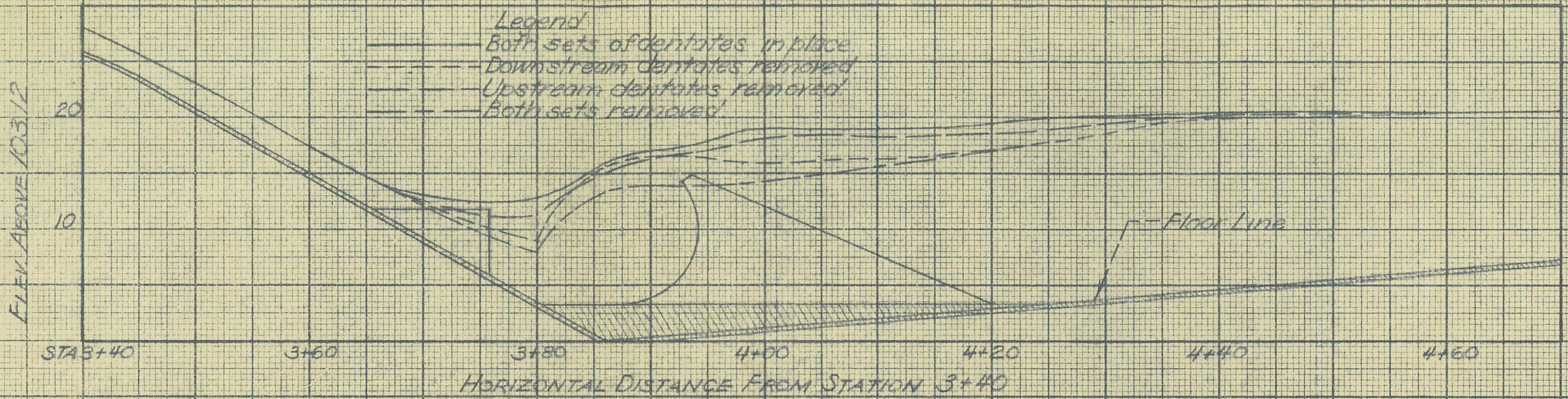


FLOW OF 2200 SECOND-FEET THROUGH SPILLWAY
BOTH SETS OF BUCKET TEETH IN PLACE

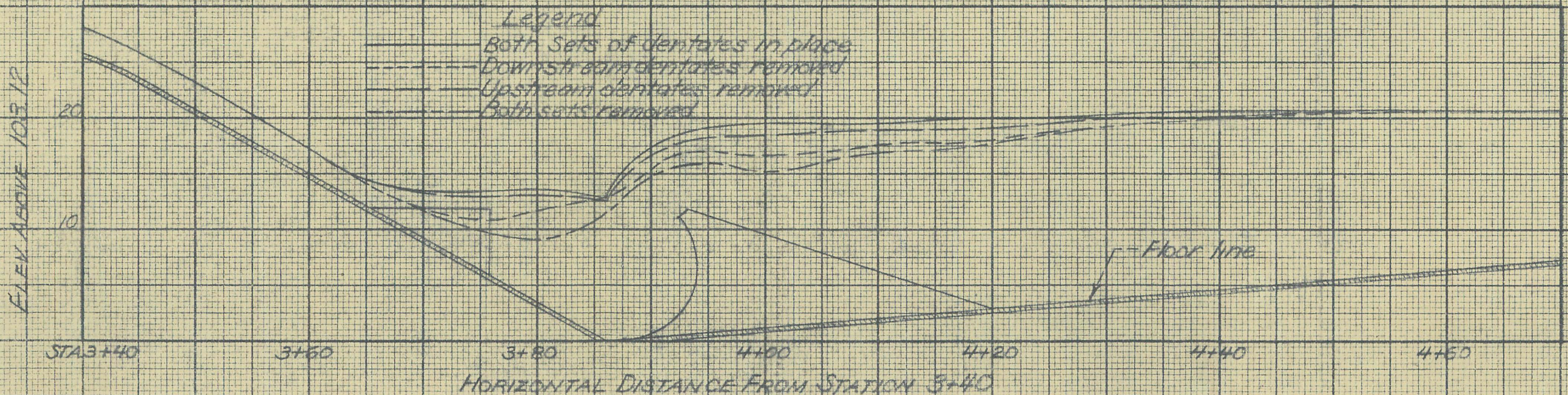


FLOW OF 2200 SECOND-FEET THROUGH SPILLWAY
BOTH SETS OF TEETH REMOVED - RAISED FLOOR

DESIGN NO. 2

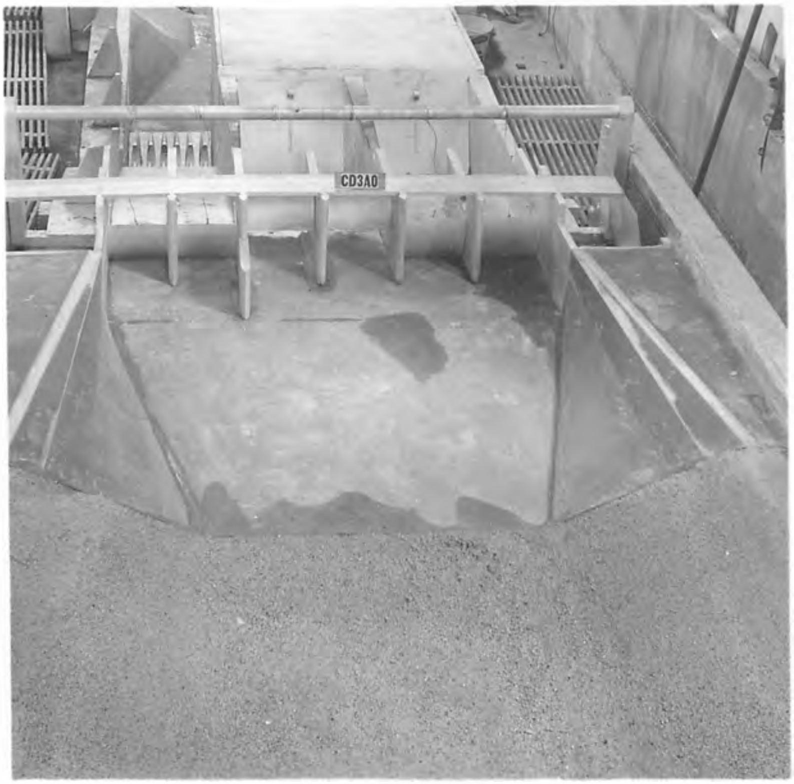


MAXIMUM WATER SURFACE ~ RAISED FLOOR ~ Q = 2200 c.f.s.

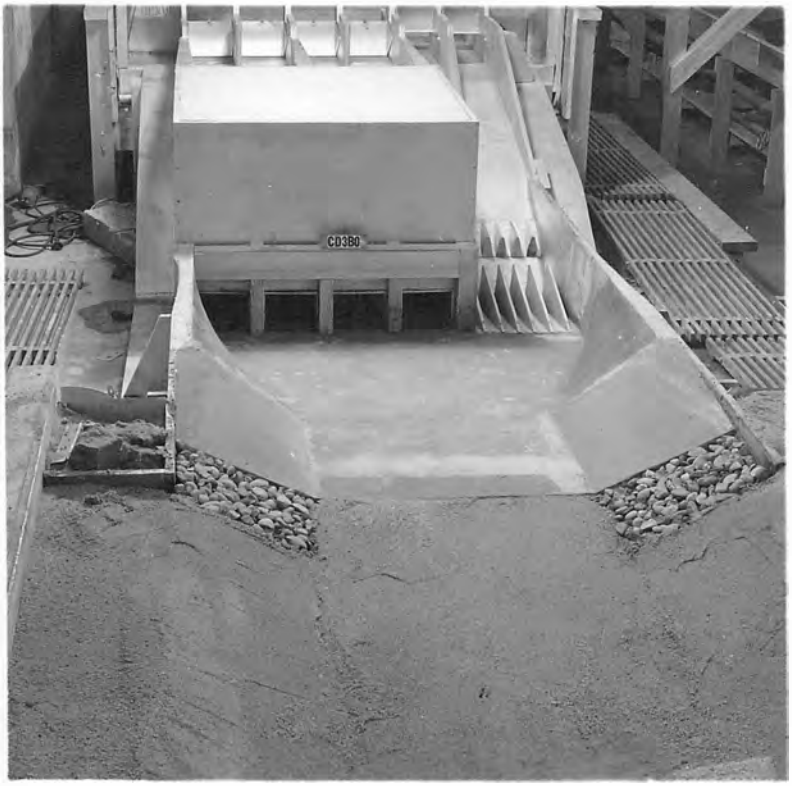


MAXIMUM WATER SURFACE ~ ORIGINAL FLOOR ELEVATION ~ Q = 2200 c.f.s.

WATER SURFACE PROFILES ~ SPILLWAY CHANNEL ~ TEST 2
COACHELLA POWER DROP
1:24 MODEL
5/16/41 R.P.P.

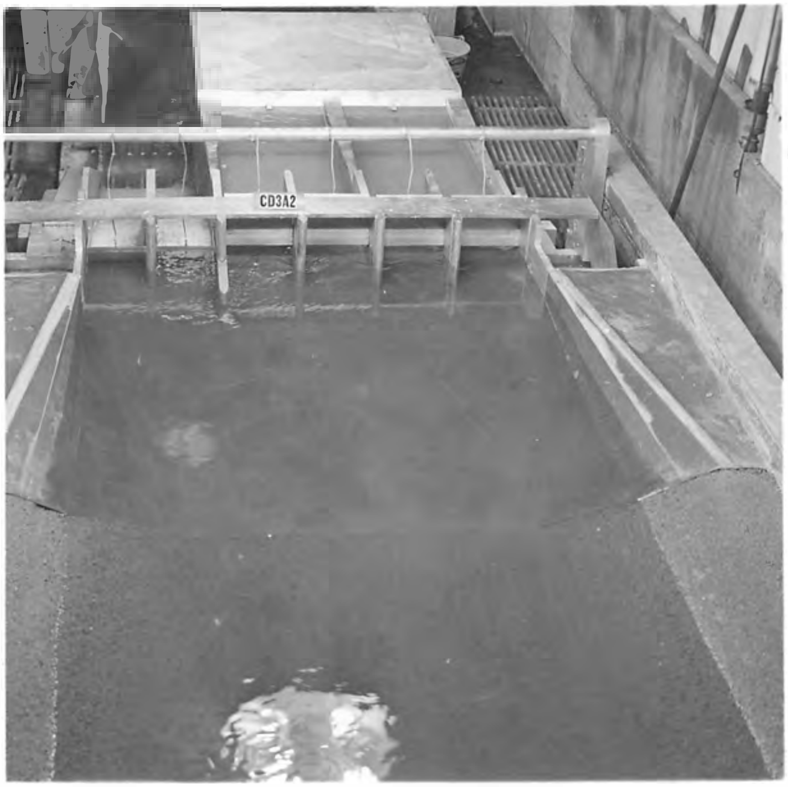


VIEW OF MODEL LOOKING DOWNSTREAM

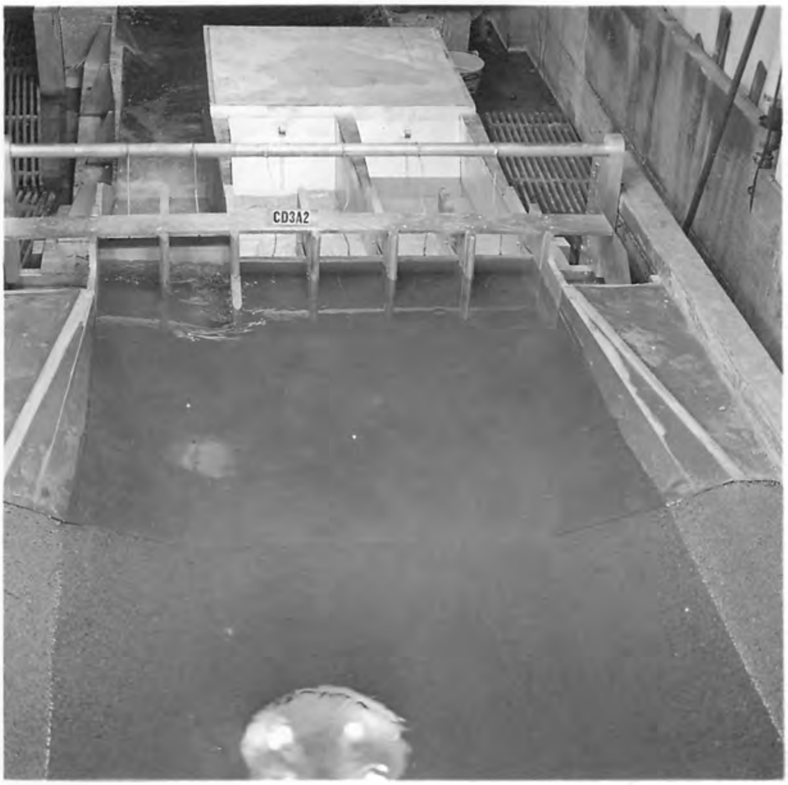


VIEW OF MODEL LOOKING UPSTREAM

FINAL DESIGN



FLOW OF 2200 SECOND-FEET ENTERING POWERHOUSE



FLOW OF 2200 SECOND-FEET ENTERING SPILLWAYS

FINAL DESIGN

FLOW OF 2200 SECOND-FEET THROUGH POWERHOUSE

FLOW OF 2200 SECOND-FEET THROUGH SPILLWAY

FINAL DESIGN

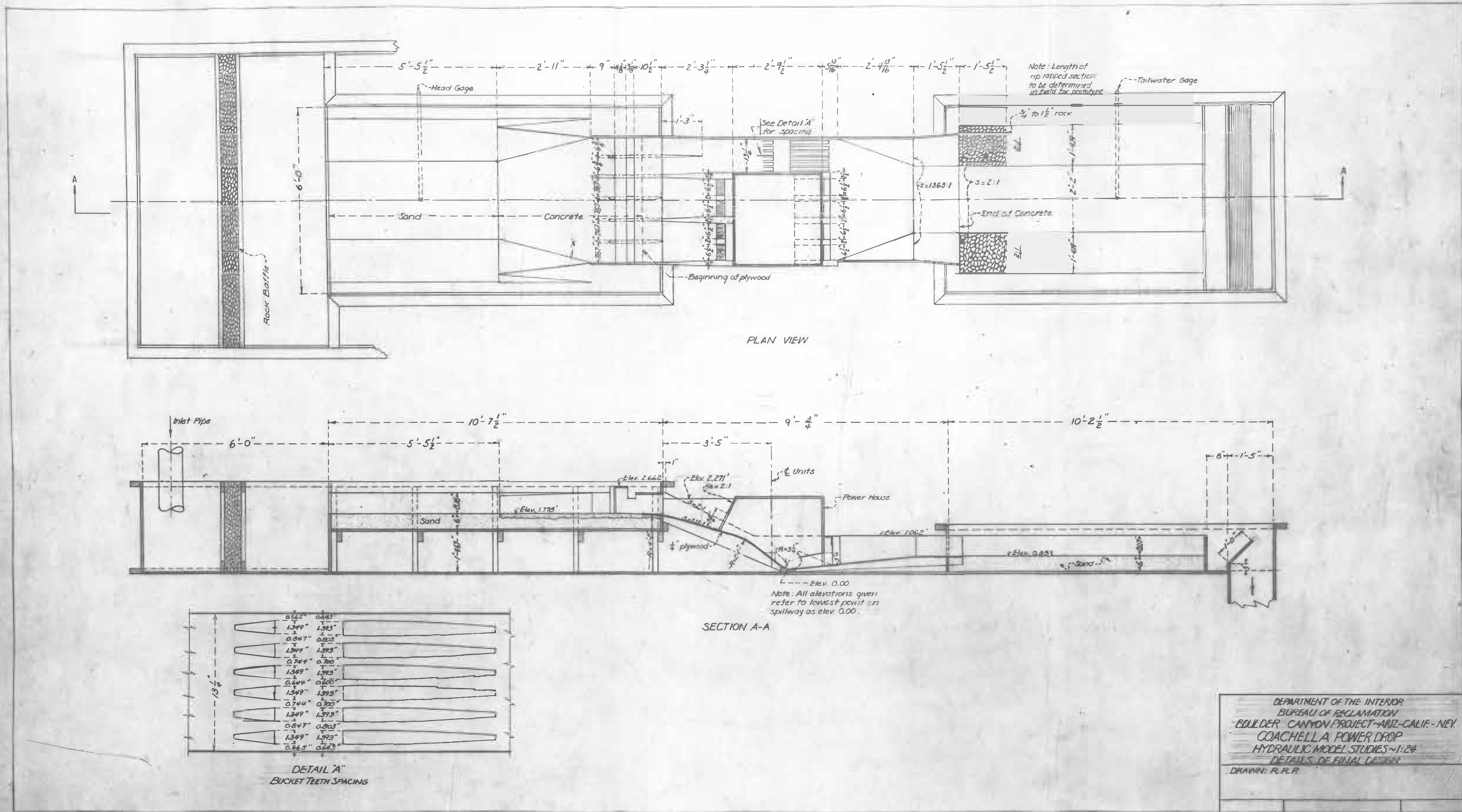
FLOW OF 2200 SECOND-FEET THRU
SPILLWAY WITH BOTH GATES OPEN

FLOW OF 2200 SECOND-FEET DIVIDED
BETWEEN ONE UNIT OF POWERHOUSE
AND ADJACENT SPILLWAY

FLOW OF 2200 SECOND-FEET DIVIDED
BETWEEN ONE UNIT OF POWERHOUSE
AND OPPOSITE SPILLWAY

FINAL DESIGN

FIGURE 13


PLAN VIEW
Head Gage
Tailwater Gage
Note: Length of rip rapped section to be determined in field for prototype
See Detail "A" for spacing
Sand
Concrete
Rock Baffle
Beginning of plywood
End of Concrete
SECTION A-A
Inlet Pipe
Elev. 2.662
Elev. 1.778'
Power House
℄ Units
¼" plywood
Elev. 0.00
Note: All elevations given refer to lowest point on spillway as elev. 0.00.
DETAIL "A"
BUCKET TEETH SPACING
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
BOULDER CANYON PROJECT - ARIZ.-CALIF.-NEV.
COACHELLA POWER DROP
HYDRAULIC MODEL STUDIES ~ 1:24
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