UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

PRELIMINARY REPORTS OF MODEL STUDIES OF PROPOSED DESIGN OF IMPERIAL DAM AND APPURTENANT WORKS

Denver, Colorado
January 15, 1938

UNITED STATES

DEPARTMENT OF THE INTERIOR

BUREAU OF RECLAMATION

MEMORANDUM TO CHIEF DESIGNING ENGINEER

PRELIMINARY REPORT - MODEL STUDIES OF IMPERIAL DAM SPILLWAY SECTION

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TECHNICAL MEMORANDUM No. 429

Denver, Colorado

January 9, 1935.

(PRICE $1.10)

PRELIMINARY REPORT - MODEL STUDIES OF THE IMERPIAL DAM SPILLWAY SECTION.

SUMMARY.

Model tests of a 1 to 30 model of a section of the proposed Imperial Dam spillway and stilling pool indicated a design of the stilling pool which will minimize erosion below the apron and which, at a discharge of 150,000 c.f.s. will insure the formation of an hydraulic jump on the apron for any tailwater elevation between 159 and 169.

The tests showed some modification of the original stilling pool to be necessary, and also revealed that the proposed crest shape would cause negative pressures on the face of the dam just below the crest, at the higher discharges. A model of a revised crest design has been made, and is to be tested for negative pressures.

ORIGINAL DESIGN.

The original design, Figure 1, provides for a hollow (Ambursen type) round-crested dam, with crest elevation at 180, and having an apron sloping at 6:1 from about elevation 156 down to a 75 ft. long horizontal apron at elevation 152. The river bed was to be paved at elevation 157 for 100 feet downstream from the apron.

HYDRAULIC CONDITIONS.

The maximum expected flood flow is 150,000 c.f.s. to be spilled over a 1400 ft. length of overflow section. With the dam crest at elevation 180, the pond elevation for this flow will be about 189.5. The estimated tailwater level for this discharge is at 168; this figure is, however, very indefinite, because of the uncertainty of the future scour or aggradation of the river bed below

the dam.

The crest of the Laguna Dam, 5 miles downstream, is at elevation 151, and the pond above this dam will be at about elevation 156 for a flow of 150,000 c.f.s. Thus it is conceivable that the river bed might scour to such a point that the tailwater below the Imperial Dam would drop to an elevation of 159 or 160. On the other hand, deposits of silt from the desilting activities at the Imperial intake might choke the river sufficiently to raise the flood tailwater to elevation 170 or thereabouts.

For these reasons, it was necessary to develop an apron design which would not only reduce the dangerous scour immediately below the apron, but which would also accommodate a large range of tailwater depths; with a high tailwater, the jump should not climb up too far on the face of the dam and subject it to unnecessary thumping, and with low tailwater, the jump must still form on the apron.

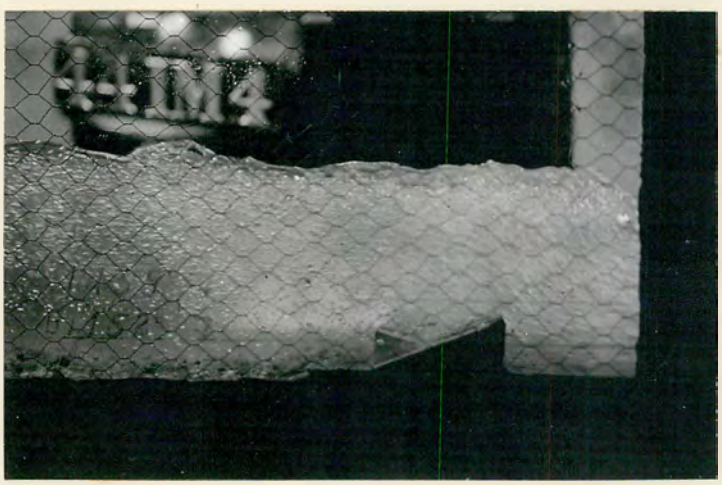
MODEL.

A 1:30 model (Figure 2) of 60 feet of the proposed spillway was constructed of galvanized sheet metal, and tested in the 2 ft. wide flume of the Denver laboratory of the Bureau.

DESIGNS TESTED.

Original - Model tests of the original design showed the apron to be too high, and indicated that the flat sloping apron (6:1) did not start from a point high enough on the downstream face of the dam. A tailwater elevation of about 167 forced the jump up the slope on to the hollow dam section, and at a tailwater elevation of 164, the jump formed at the lower end of the 6:1 slope.

View of original model
looking upstream



Q 150,000 Tailwater at El. 166
Flow right to left

Q 150,000 Tailwater at El. 162.4
Flow right to left

Final set-up after 1-hour
run. Q 150,000

REVISED APRON LAYOUT.

The apron of the model was then altered to the design shown in Figure 3; the 6:1 slope was steepened to a 4:1 slope which started higher on the face of the dam, and the horizontal apron was lowered two feet to elevation 150. Subsequent studies were directed at determining the best length of apron and the most suitable type of sill to use on the apron.

Sills - Numerous types of baffle piers and sills were investigated, such as rectangular and triangular sills, diffuser sills, dentated sills, two rows of staggered baffle piers, etc. Many of these had particular advantages but the design shown in Figure 3 seemed to be the best for the situation. It consists of a modified Rehbock sill at the end of a 41 ft. horizontal apron, and a corrugated, or intermittent, stepped apron at the lower end of the sloping part of the apron. This design gave very little scour below the apron, and insured the formation of an hydraulic jump for all tailwater elevations between 159 and 169. The sill alone was very effective, and the stepped apron greatly increased the permissible range of tailwater.

SPILLWAY CREST.

Tests showed the coefficient of discharge of the dam to vary from about 3.1 for a head of 2.2 ft. to 3.7 for the maximum head of 9.84 feet.

At heads greater than 8 feet, the pressure on the downstream face of the dam, just below the crest, was below atmospheric. A new design was made (Figure 4) to remedy this, and will be tested presently,

also at a scale of 1:30.

RESULTS.

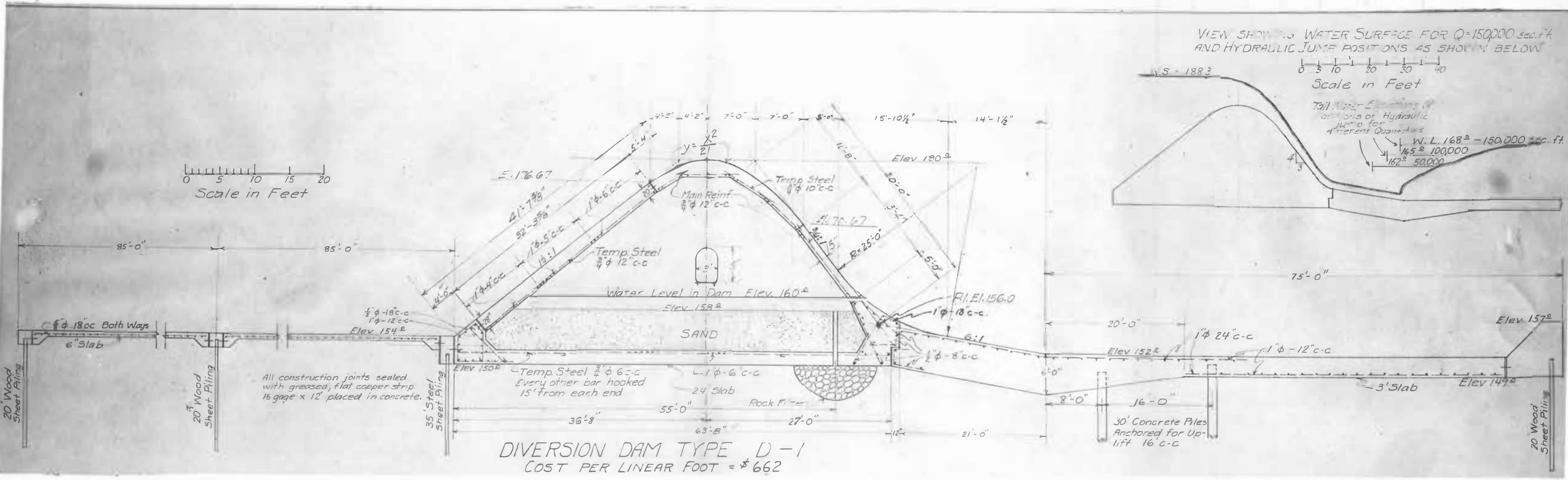
The model tests, when complete, will have accomplished the following things:

1. The satisfactory hydraulic operation of the spillway will be insured.

2. Negative pressures on the downstream face of the dam will be avoided.

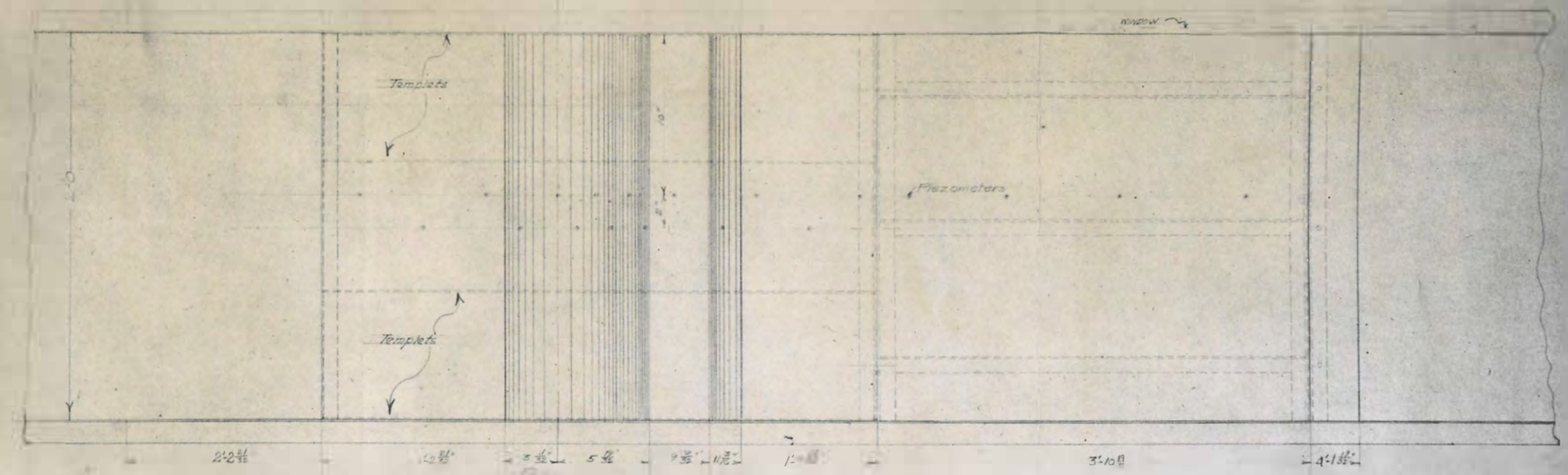
3. The length of the apron will be shortened about 25 feet, with a corresponding saving.

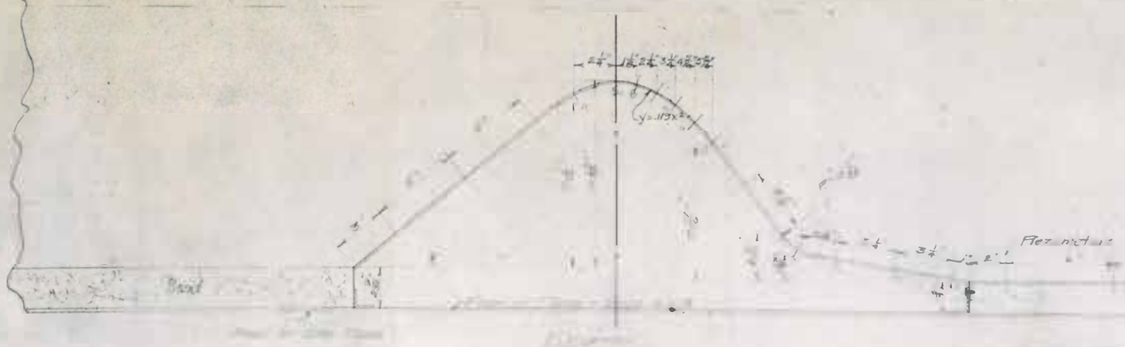
FIGURE I



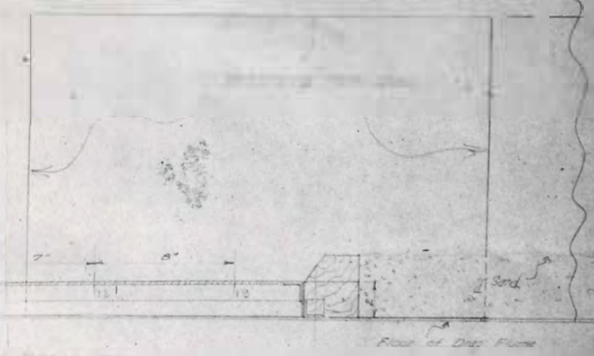
DIVERSION DAM TYPE D-1
COST PER LINEAR FOOT = $662

FIGURE 2





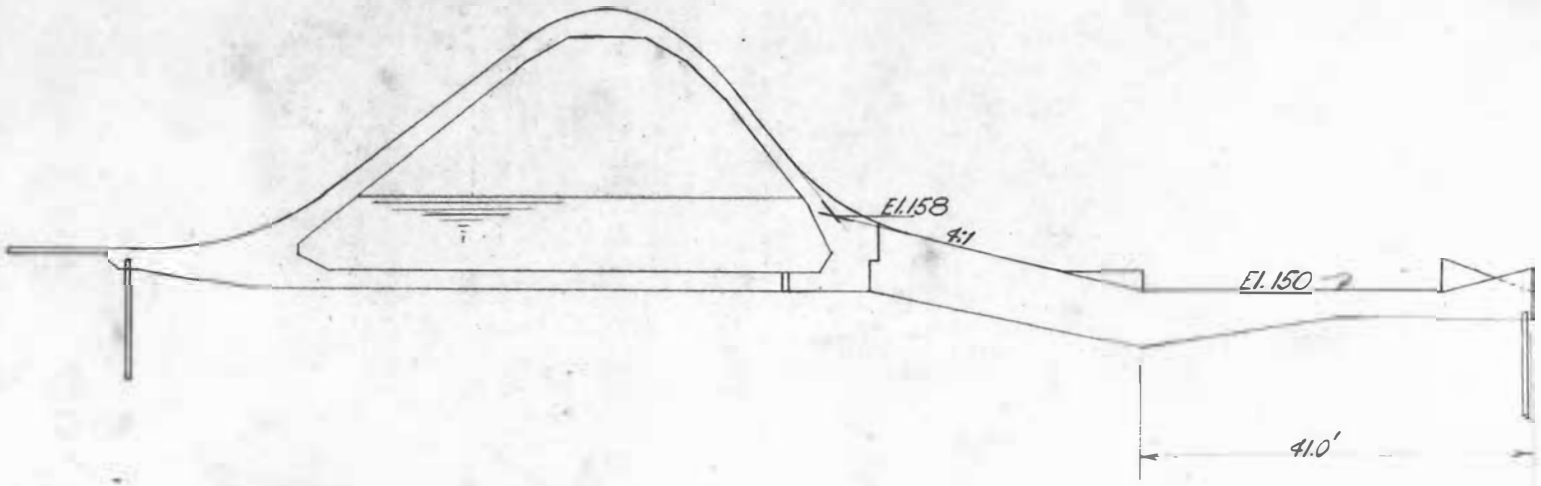
Section along Center line

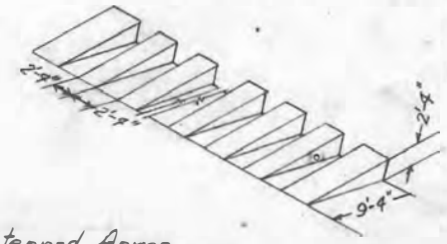


DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
BOULDER CANYON PROJECT-CALIF.
HYDRAULIC MODEL STUDIES
IMPERIAL DAM TYPE D-1
GENERAL PLANS OF MODEL
SCALE 1:30

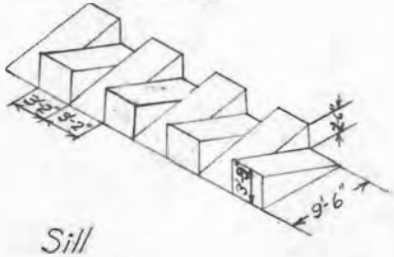
DRAWN: C.H.M.-E.C.P.

DENVER, COLO. AUGUST 15, 1934





Stepped Apron



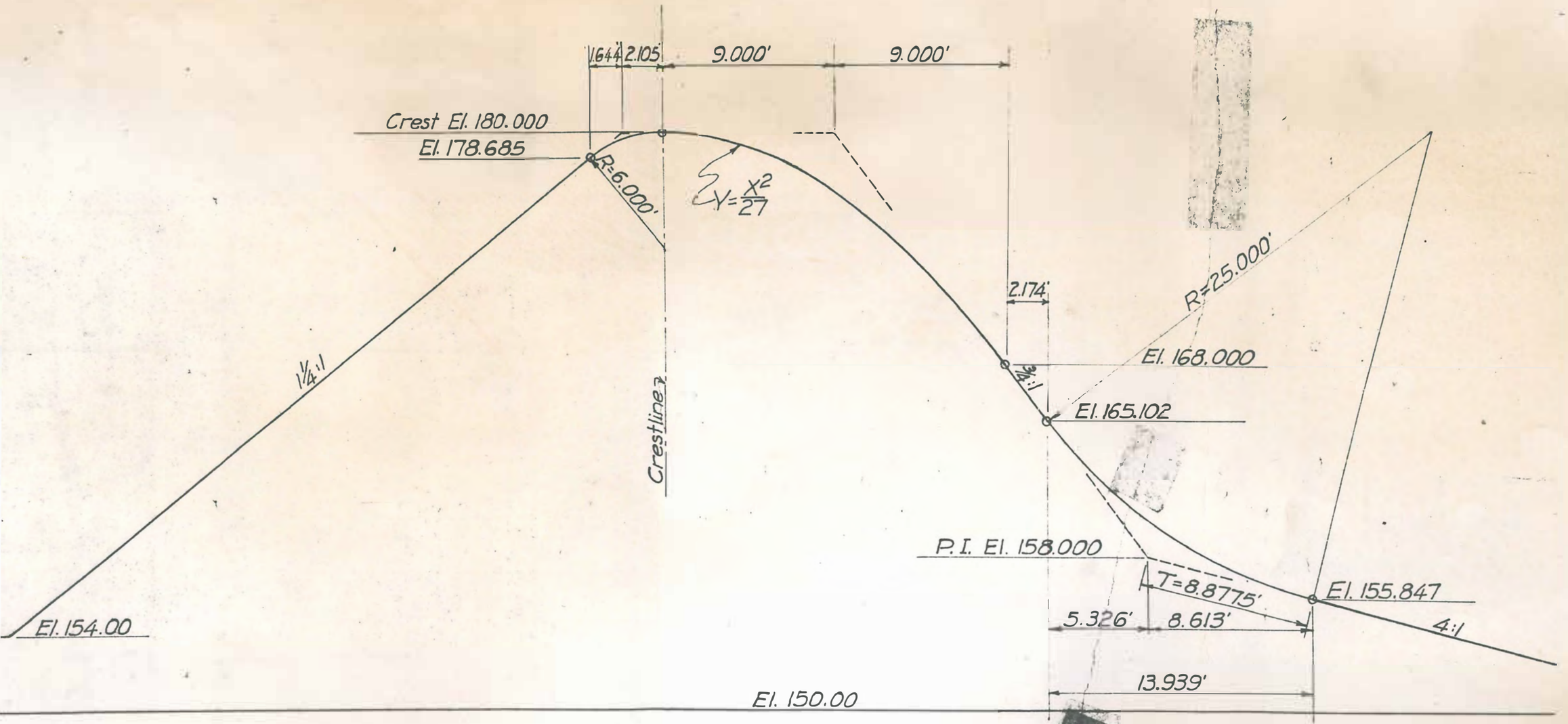
Sill

IMPERIAL DAM

REVISED APRON DESIGN

JAN 10 1935

FIGURE 3



IMPERIAL DAM

REVISED PROFILE

Scale: 1"=5'-0"

Nov. 16, 1934

A^2L