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UNITED STATES
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HYDRAULIC LABORATORY REPORT NO. 71

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HYDRAULIC MODEL STUDIES FOR RECONSTRUCTION OF THE LAHONTAN DAM SPILLWAY

By

J. H. Douma
R. A. Goodpasture

- - -

Denver, Colorado
January 13, 1940

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MEMORANDUM TO CHIEF DESIGNING ENGINEER
(J. H. Douma and R. A. Goodpasture)

Subject: Hydraulic model studies for reconstruction of the Lahontan Dam spillway.

1. Introduction. The Lahontan Dam was constructed for the Newlands Irrigation District by the Bureau of Reclamation about 30 years ago. Since that time only two small floods have passed over the spillways. Recent field inspection of the structure found the spillways to be in very poor condition; the concrete having been weathered and eroded in numerous places to the extent that vegetation will grow thereon. Obviously, the structure in its present condition is not considered safe for the passage of a flood of any magnitude. The assistance of hydraulic model studies was considered advisable in making recommendations for needed repairs.

2. The models. Three models were tested in connection with the project. One was a 1:60 model of the entire spillway structures (figure 1), including the channels and pool downstream, while the others were 1:4 and 1:5 sectional models of a proposed spillway gate. The 1:60 model was studied to obtain the operating characteristics of the spillways, channels, and stilling pool. The sectional crest models were used to determine the water pressures on the gate for various gate inclinations and reservoir elevations.

3. Spillways. Operation of the model was satisfactory in all respects except on the large level area downstream from the right spillway crest. A hydraulic jump formed near the upper end of this area, producing a 10-foot depth of water at the maximum discharge (figure 2). Since the side walls along this area are 10 feet high, additional height will be needed to provide freeboard. Apparently the original designer did not anticipate the formation of a hydraulic jump in this region. Water surface profiles along the side walls of the channels are shown on figure 2 for discharges of 15,000 and 30,000 second-feet, while photographs of maximum flow are shown on figure 3.

Inasmuch as (1) automatic flash gates are being considered for the spillway crests; (2) the left spillway is in somewhat better structural condition than the right; and (3) the cost of repairs could be considerably reduced by passing flood flows over the left side only, the left spillway crest was calibrated for the original crest with and without the bridge, and then with the bridge for the crest revised to accommodate the flash gates (figure 4). These calibrations showed that for the revised design the reservoir water surface would be 0.6 feet from the top of the earth dam with 30,000 second-feet passing through one spillway. This would seriously encroach on the safety of the structure. In addition the stilling basin at the end of the channel did not operate satisfactorily with one spillway operating and additional wall height would be needed along the spillway channel (figure 2). Accordingly the plan for operating only the left spillway was abandoned.

Two small gates were installed on the left spillway of the 1:60 model. Their operation indicated that the nappe would not be aerated properly at all flows. However, there is some question as to the reliability of the small model in studying the nappe aeration. A larger model of two or more gates would be necessary for reliable results.

4. Flash gates. The flash gate sectional models were constructed in a flume two feet wide. The 1:1 upstream slope was installed on both models while the 10:1 approach slope was only installed for the final tests on the 1:5 model. Piezometers were installed in the gate to determine the pressures on the gate with different angles of inclination and reservoir elevations. Gate pressures without the 10:1 approach slope are shown on figures 5 and 6 and with the 10:1 slope on figure 7. The pressures shown on figure 5, together with supplementary data taken at intermediate heads were used to calculate the moments about the gate pin for various gate positions and reservoir elevations. These moment curves (figure 8) were used in the design of the automatic gate operating mechanism.

5. Recommendations. The model studies demonstrated that the plan for operating only the left spillway was impractical. Consequently it will be necessary to recondition the entire spillway structure. Since the automatic gates were designed for complete aeration of the nappe, it is imperative that sufficient air be supplied under the gates. Gate aeration studies made on the 1:60 model were not reliable indicating that the aeration investigations should be conducted on a larger model.

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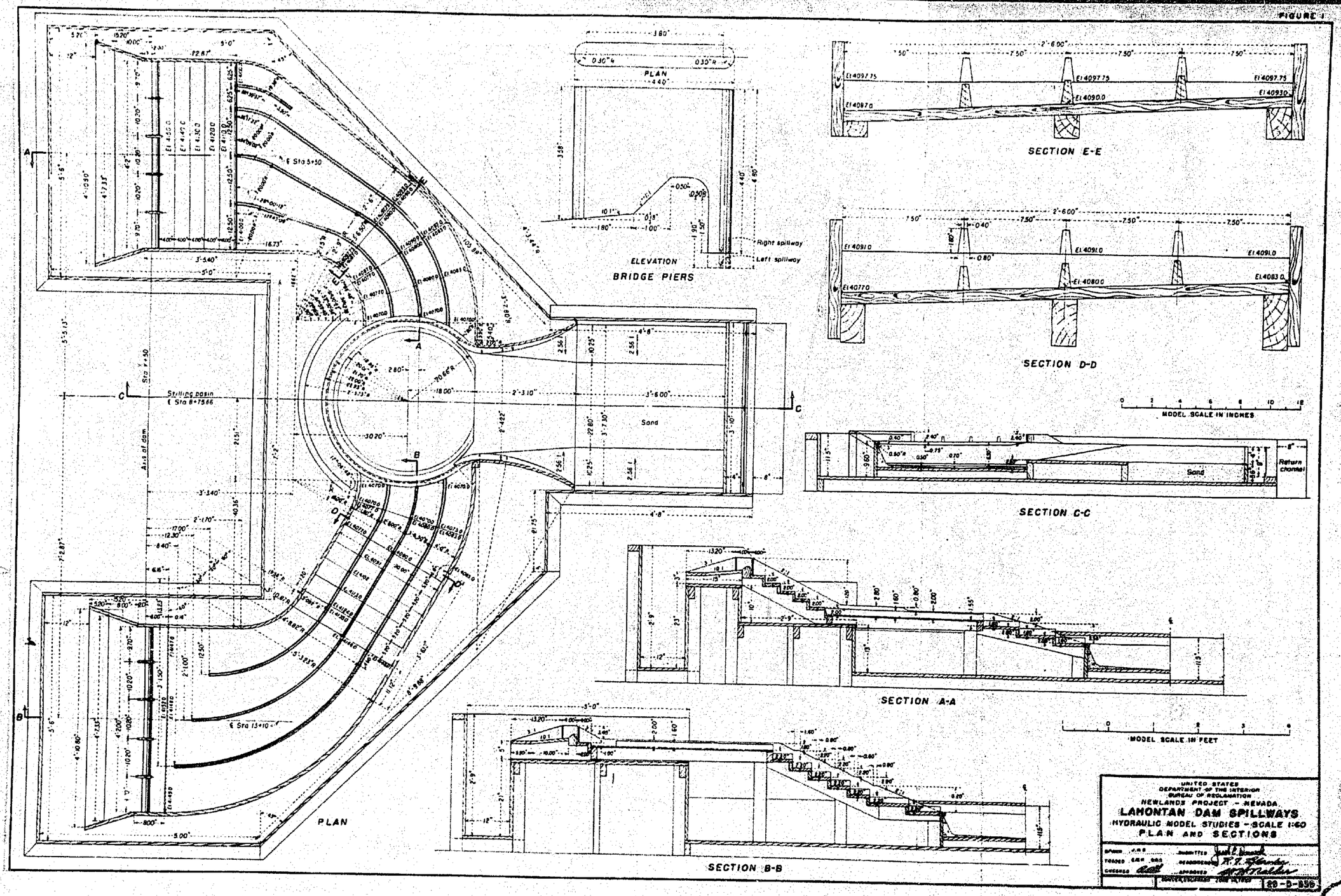
FIGURE 1
PLAN
ELEVATION
BRIDGE PIERS
Right spillway
Left spillway
SECTION E-E
SECTION D-D
SECTION C-C
SECTION A-A
SECTION B-B
PLAN
Stilling basin
Sand
Return channel
Axis of dam
MODEL SCALE IN INCHES
MODEL SCALE IN FEET
UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
NEWLANDS PROJECT - NEVADA
LAHONTAN DAM SPILLWAYS
HYDRAULIC MODEL STUDIES - SCALE 1:60
PLAN AND SECTIONS
29-D-856

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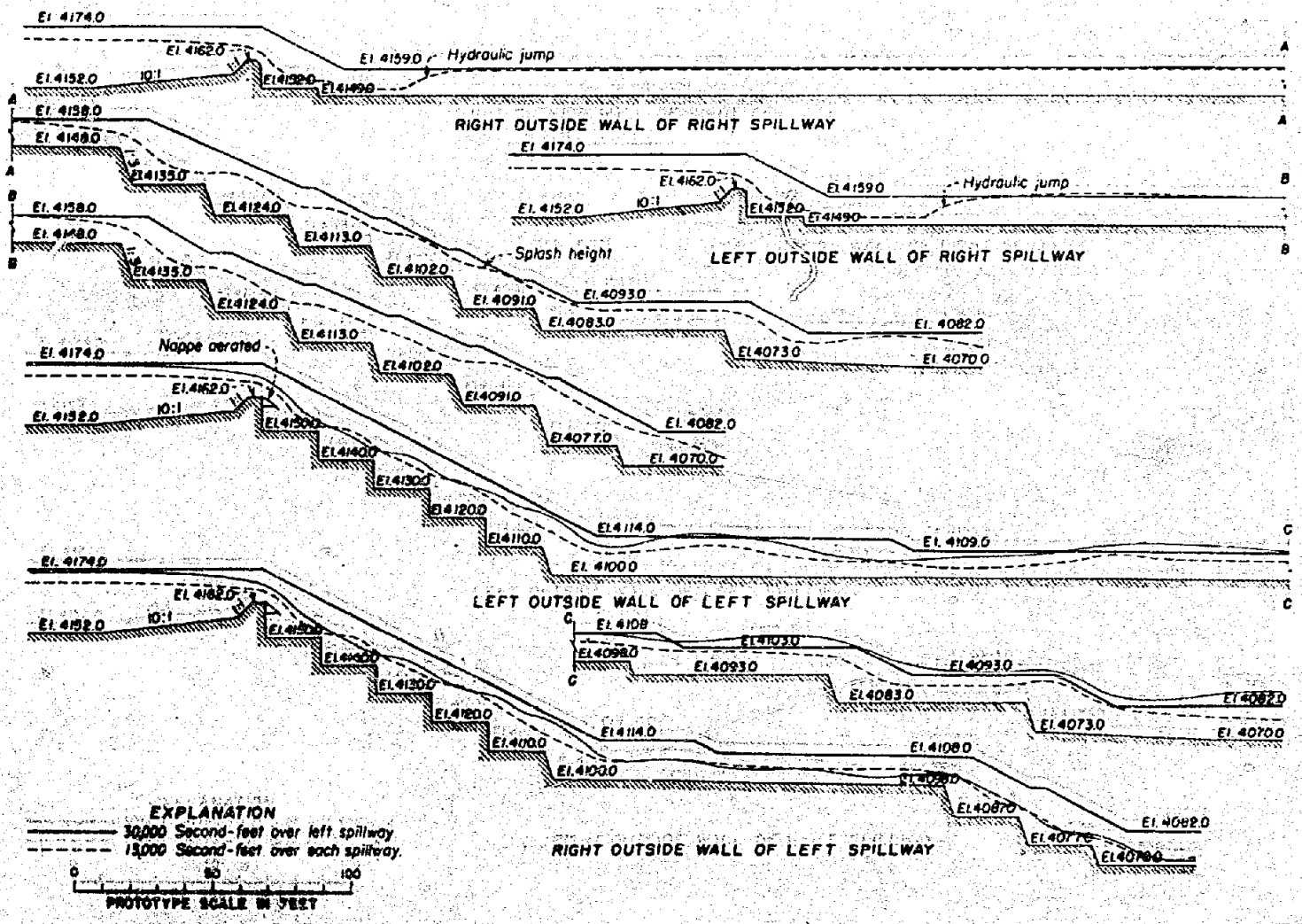


LAHONTAN DAM

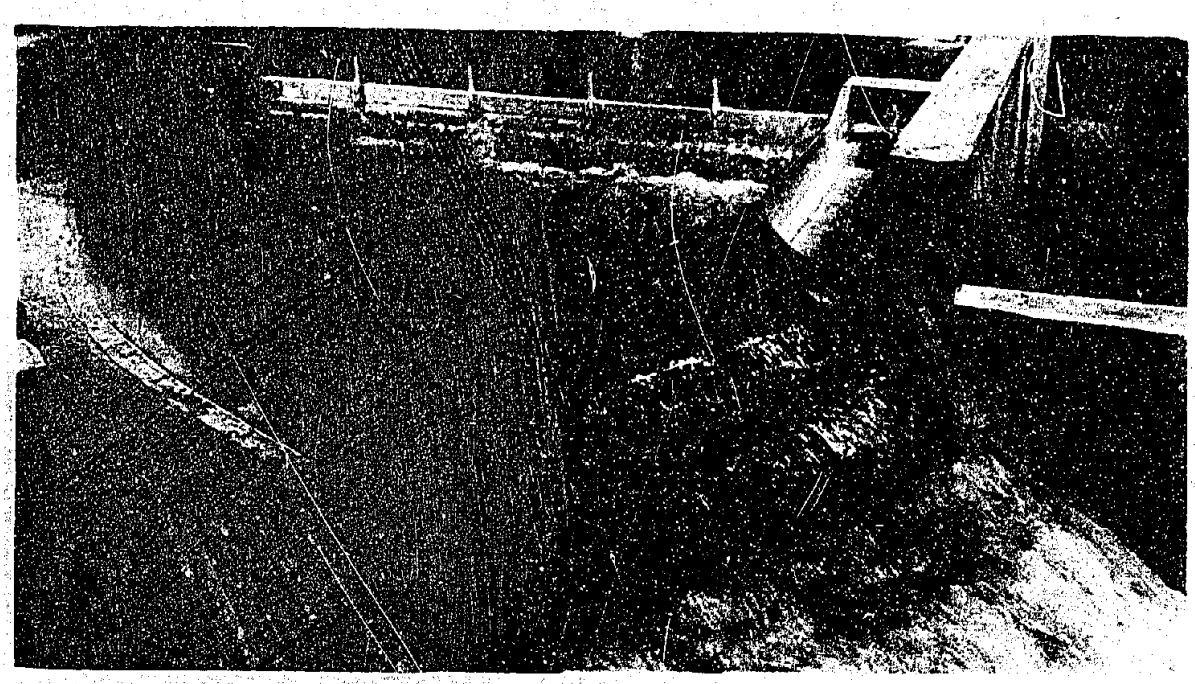
NEWLANDS PROJECT—NEVADA

HYDRAULIC MODEL STUDIES—SCALE 1:60

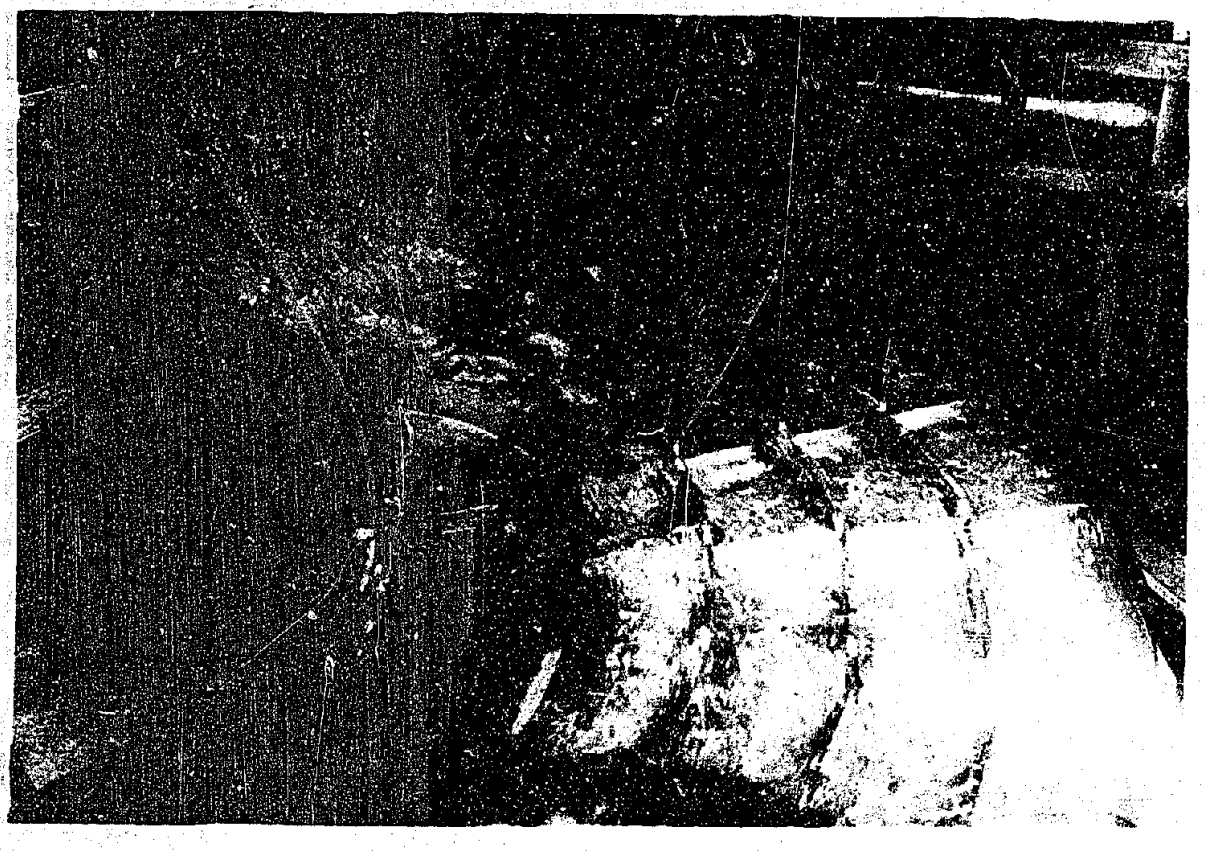
WATER SURFACE ALONG SIDE WALLS OF SPILLWAY

FIGURE 2

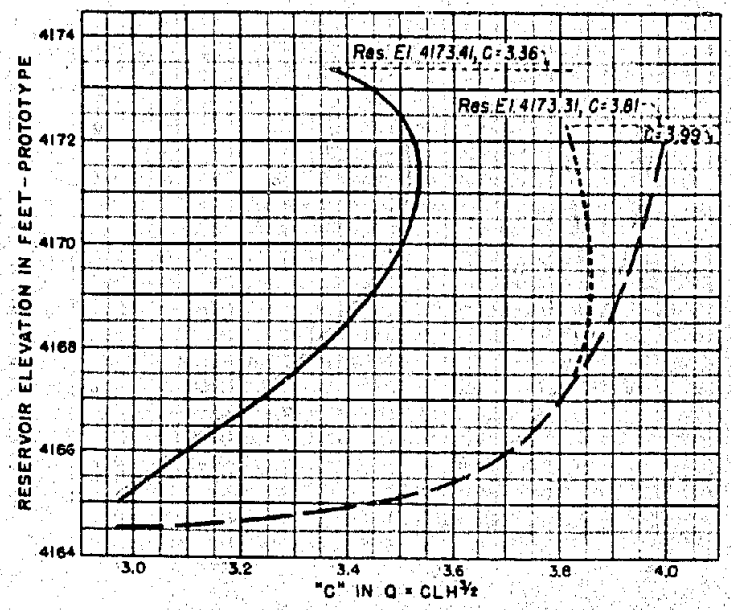
29-D-340



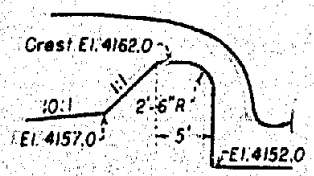
15,000 SECOND-FEET OVER RIGHT SPILLWAY



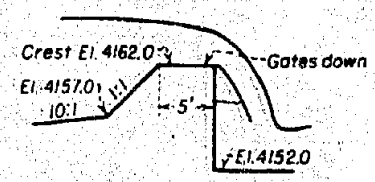
15,000 SECOND-FEET OVER LEFT SPILLWAY



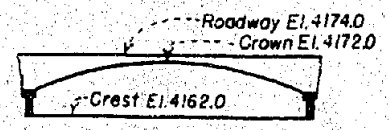
DISCHARGE COEFFICIENTS



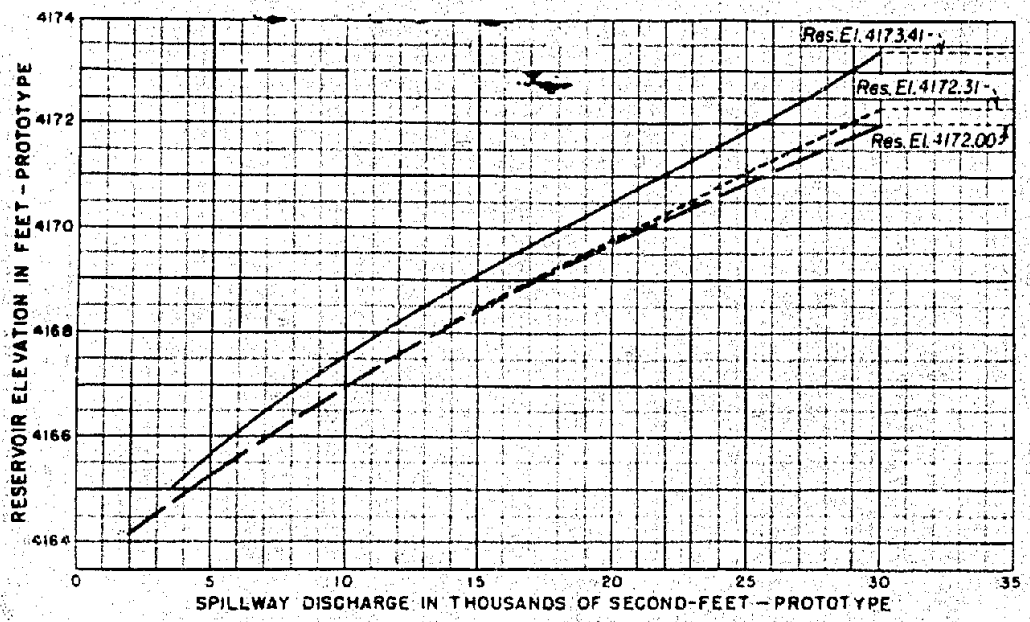
ORIGINAL CREST



REVISED CREST



ELEVATION OF ONE GATE



DISCHARGE CURVES

NOTES

Curves will apply to right spillway.
Top of earth dam is at elevation 4174.00.

EXPLANATION

— — Original crest and no bridge.
- - - - - Original crest with bridge.
——— Revised crest with bridge.

LAHONTAN DAM
NEWLANDS PROJECT - NEVADA
HYDRAULIC MODEL STUDIES - SCALE 1:60
COEFFICIENT AND DISCHARGE CURVES
FOR LEFT SPILLWAY

J.H.D. 9-19-39

29-D-341

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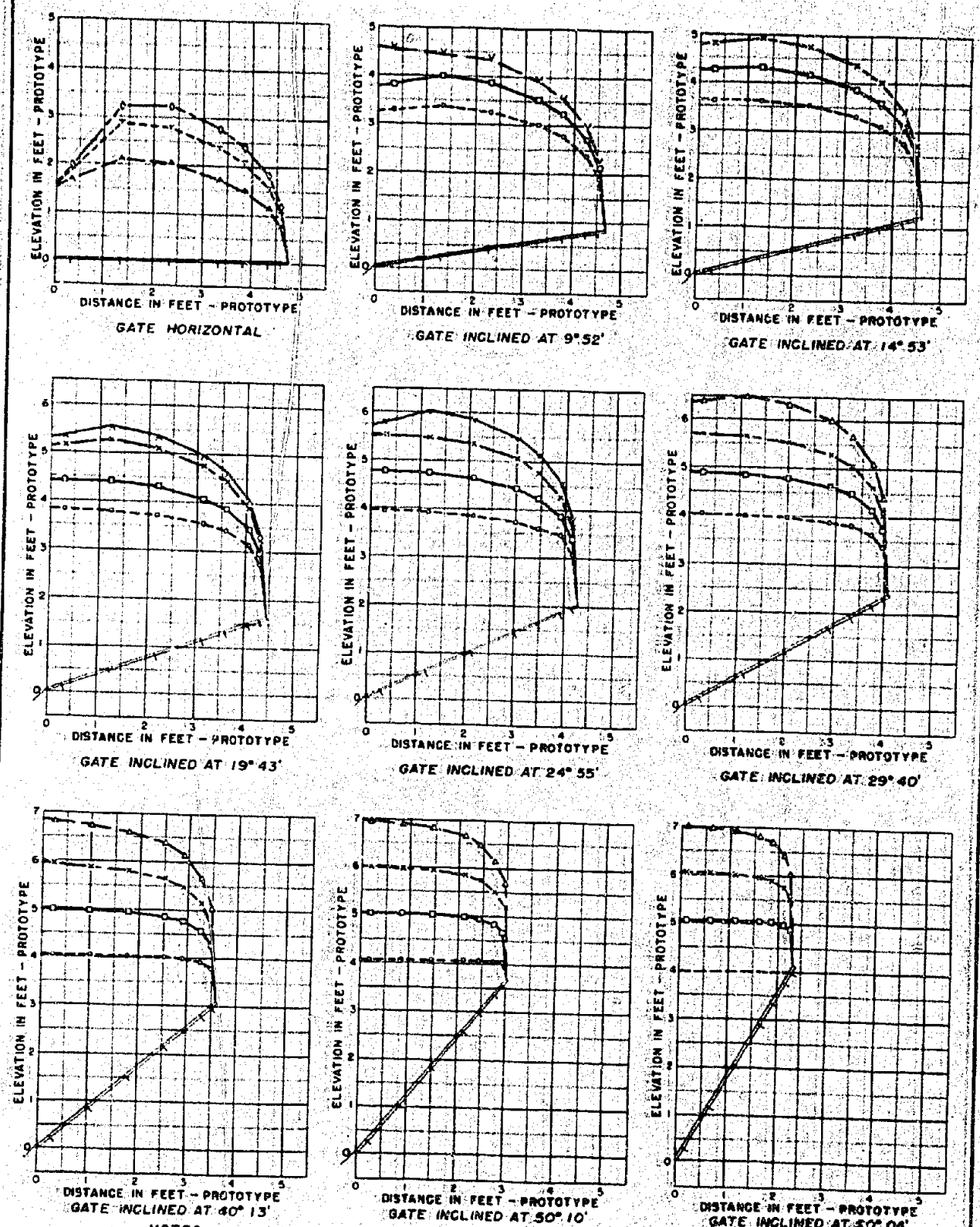


NOTES

Elevations are above gate hinge point.
Pressure elevations are in feet of water prototype.
Model was fitted with a 1:1 slope upstream. The 10:1 approach channel was not installed for these tests.

EXPLANATION

- Reservoir elevation 2.97
- Reservoir elevation 4.00
- Reservoir elevation 4.24
- Reservoir elevation 5.00
- Reservoir elevation 5.14
- Reservoir elevation 5.73
- Reservoir elevation 6.00
- Reservoir elevation 6.42
- Reservoir elevation 6.77
- Reservoir elevation 7.00

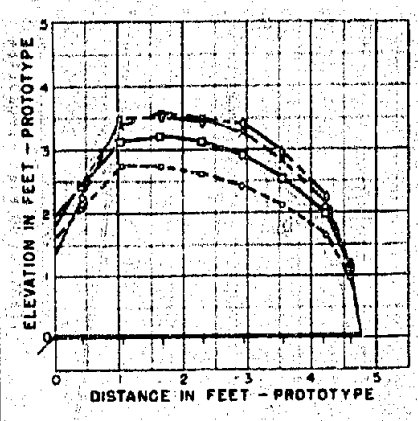
LAHONTAN DAM
NEWLANDS PROJECT — NEVADA
HYDRAULIC MODEL STUDIES — SCALE 1:4

R.A.B. 11-2-39

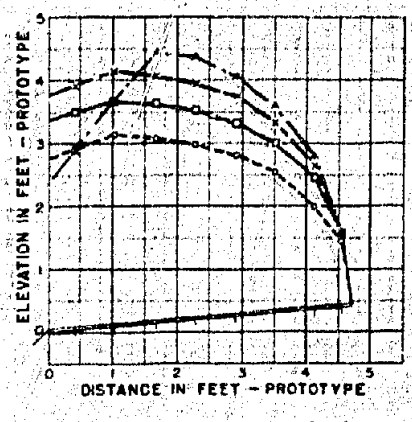
PIEZOMETRIC PRESSURES ON SPILLWAY GATE

29-D-342

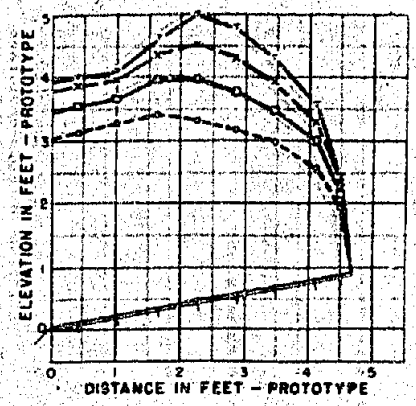
HYD-71



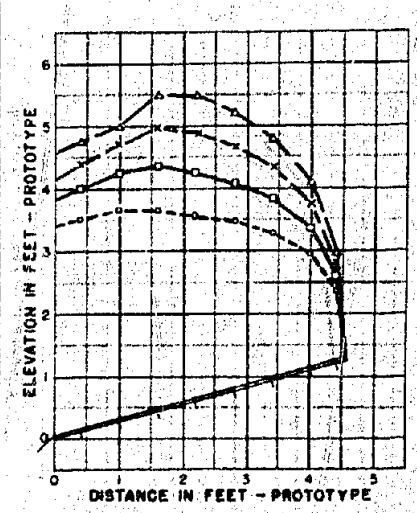
GATE INCLINED AT 0° 12'



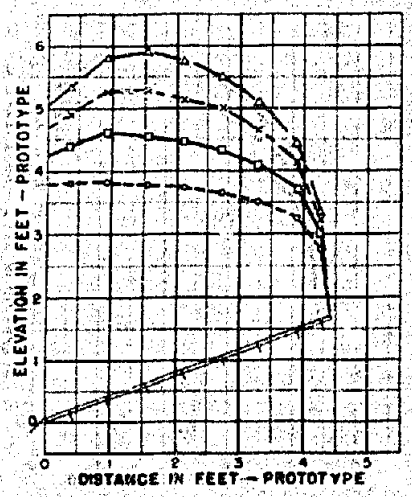
GATE INCLINED AT 4° 56'



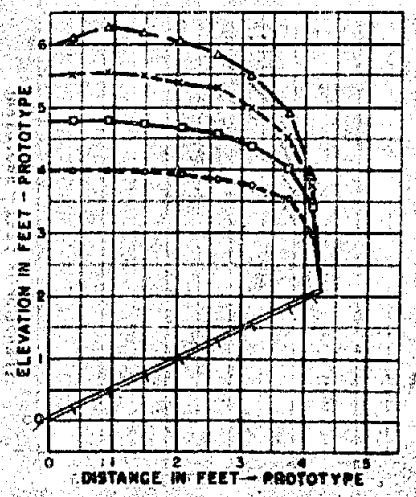
GATE INCLINED AT 10° 12'



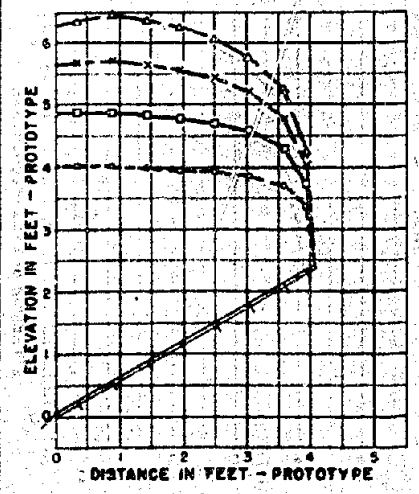
GATE INCLINED AT 15° 12'



GATE INCLINED AT 20° 5'



GATE INCLINED AT 25° 31'



GATE INCLINED AT 30° 8'

NOTES

Elevations are above the gate hinge point.

Pressure elevations are in feet of water prototype.

Model was fitted with 1:1 slope upstream.

EXPLANATION

- Reservoir elevation 4.00
- Reservoir elevation 5.00
- Reservoir elevation 6.00
- Reservoir elevation 6.44
- Reservoir elevation 6.82
- Reservoir elevation 6.95
- Reservoir elevation 7.00

LAHONTAN DAM

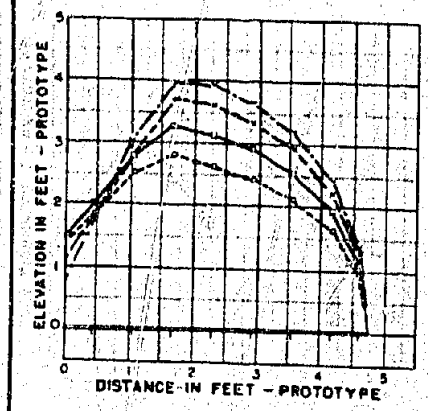
NEWLANDS PROJECT – NEVADA

HYDRAULIC MODEL STUDIES – SCALE 1:8

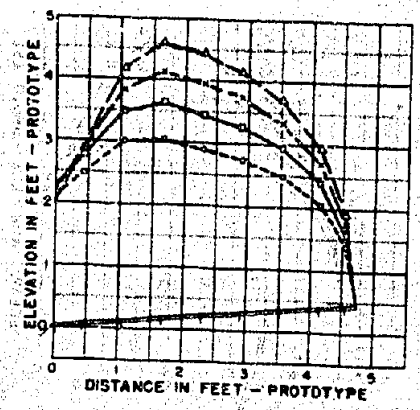
PIEZOMETRIC PRESSURES ON SPILLWAY GATE WITHOUT 10:1 APPROACH CHANNEL

H.A.G. 11-1-39

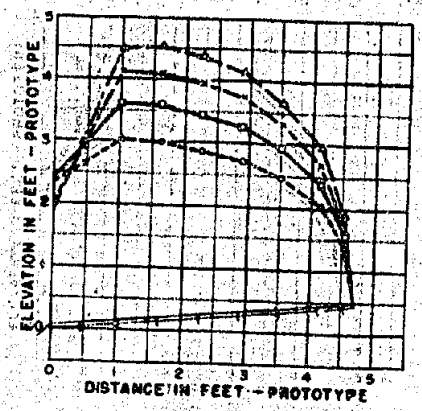
FIGURE 7



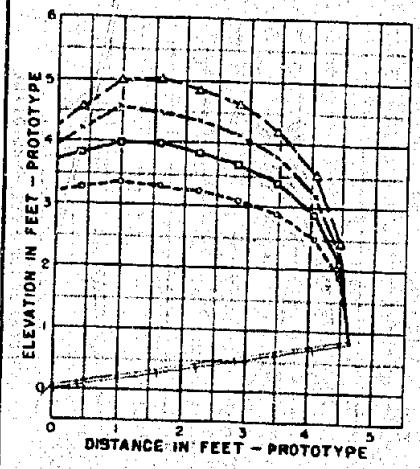
GATE HORIZONTAL



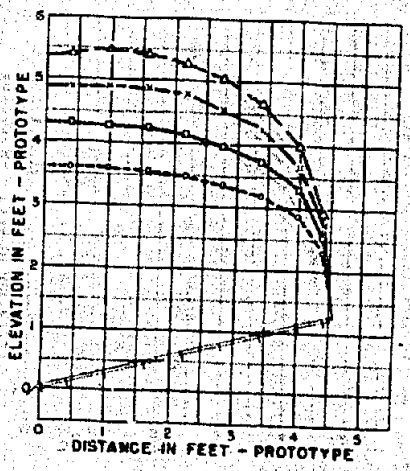
GATE INCLINED AT 4° 54'



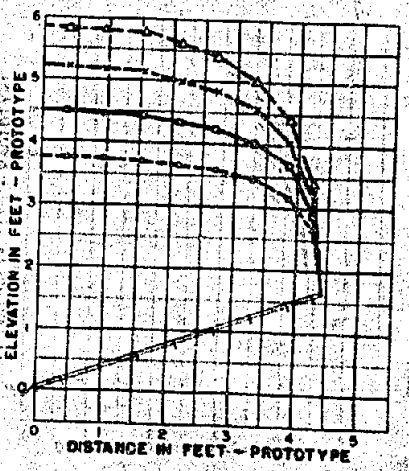
GATE INCLINED AT 5° 2'



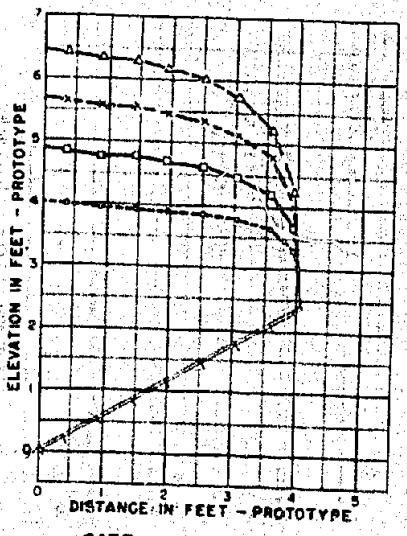
GATE INCLINED AT 9° 52'



GATE INCLINED AT 15° 10'



GATE INCLINED AT 20° 4'



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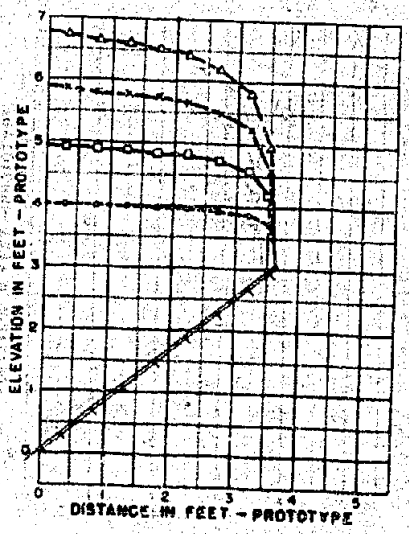
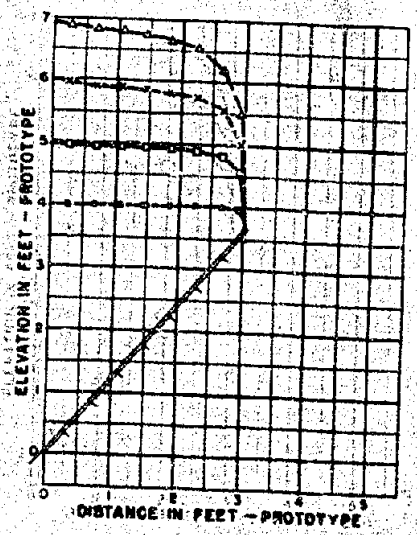


GATE INCLINED AT 39° 50'



GATE INCLINED AT 49° 39'

NOTES

Elevations are above gate hinge point.
Pressure elevations are in feet of water prototype.
Model was fitted with 1:1 slope upstream.

LAHONTAN DAM
NEWLANDS PROJECT – NEVADA
HYDRAULIC MODEL STUDIES – SCALE 1:5
PIEZOMETRIC PRESSURES ON SPILLWAY GATE WITH 10:1 APPROACH CHANNEL

EXPLANATION

- ○ Reservoir elevation 4.00
- □ Reservoir elevation 5.00
- × Reservoir elevation 6.00
- △ Reservoir elevation 7.00
- ▽ Reservoir elevation 6.90

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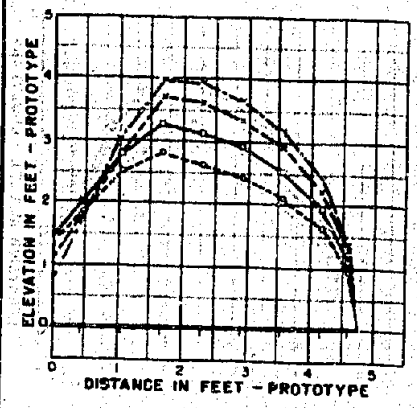
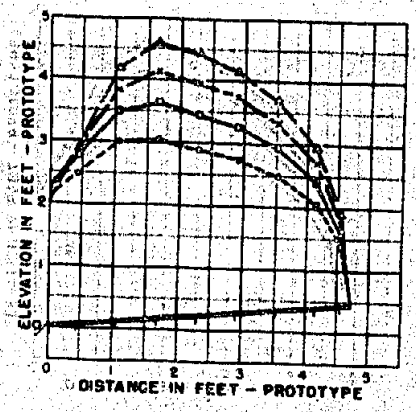
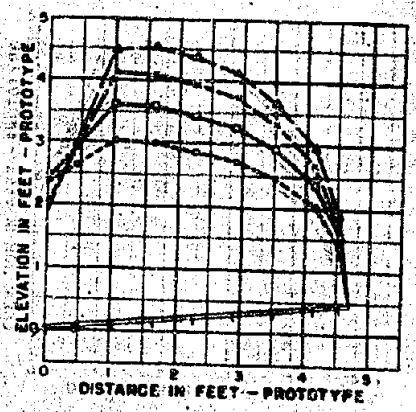


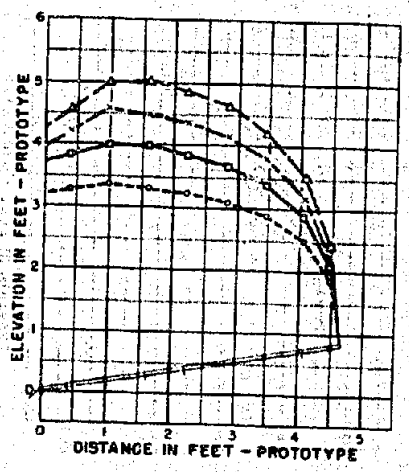
GATE HORIZONTAL



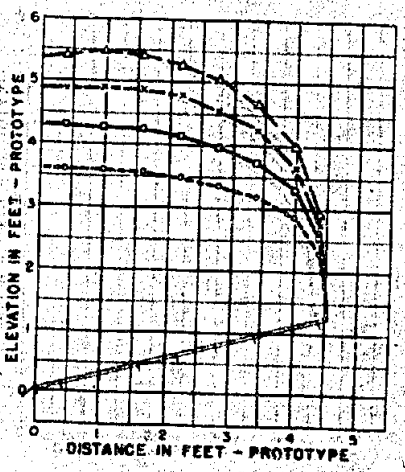
GATE INCLINED AT 4° 54'



GATE INCLINED AT 5° 2'



GATE INCLINED AT 9° 52'



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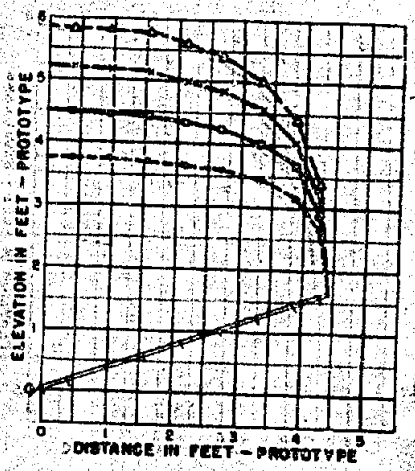
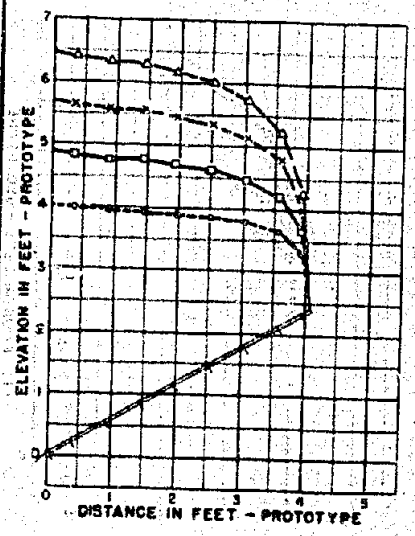
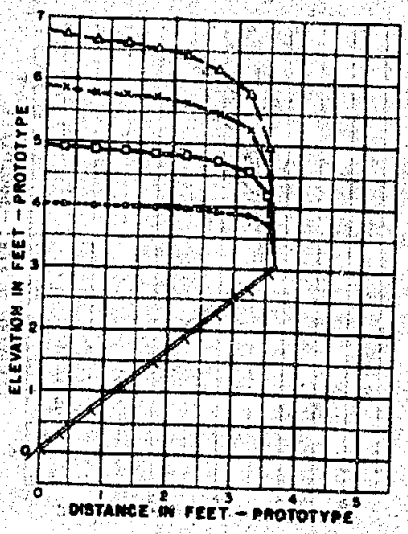


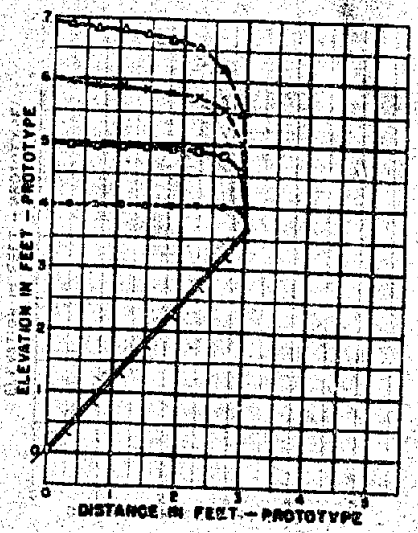
GATE INCLINED AT 20° 4'



GATE INCLINED AT 30° 10'



GATE INCLINED AT 39° 50'



GATE INCLINED AT 49° 48'

NOTES

Elevations are above gate hinge point.
Pressure elevations are in feet of water prototype.
Model was fitted with 1:1 slope upstream.

LAHONTAN DAM
NEWLANDS PROJECT – NEVADA
HYDRAULIC MODEL STUDIES – SCALE 1:8
PIEZOMETRIC PRESSURES ON SPILLWAY GATE WITH 10:1 APPROACH CHANNEL

EXPLANATION

- O —— Reservoir elevation 4.00
- □ —— Reservoir elevation 5.00
- X —— Reservoir elevation 6.00
- △ —— Reservoir elevation 7.00
- V —— Reservoir elevation 6.90

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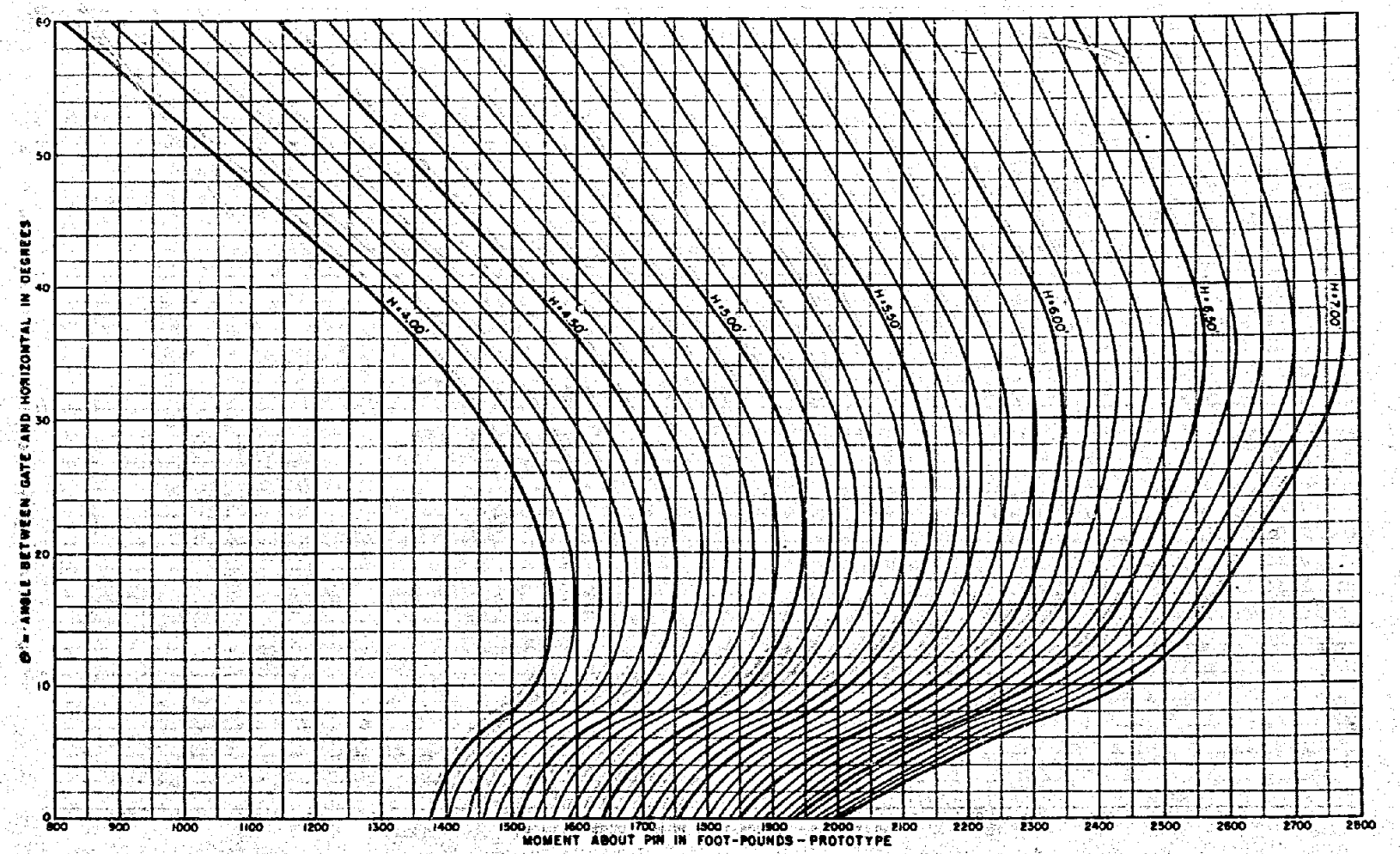

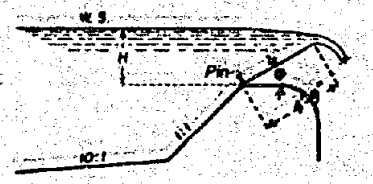

NOTES

Moments are per foot of length prototype due to water pressure.

LAHONTAN DAM

NEWLANDS PROJECT – NEVADA

HYDRAULIC MODEL STUDIES – SCALE 1:5

OPERATING MOMENTS FOR AUTOMATIC FLASHBOARD

29-D-345

FIGURE 8