CHERRY CREEK DAM AND RESERVOIR

CHERRY CREEK AND TRIBUTARIES
COLORADO

REPORT OF MODEL STUDIES SPILLWAY AND STILLING BASIN

MADE BY
THE HYDRAULIC LABORATORY
U.S. DEPARTMENT OF INTERIOR
BUREAU OF RECLAMATION
DENVER, COLORADO

U.S. ENGINEER OFFICE
DENVER, COLORADO
JULY 1944

September 11, 1944.

F O R E W O R D

The investigation and the report of model studies of the spillway and the stilling basin for Cherry Creek Dam and Reservoir, Colorado, were conducted and compiled by the Hydraulic Laboratory, Engineering and Geological Control and Research Division, Branch of Design and Construction, Bureau of Reclamation, U. S. Department of the Interior, Denver, Colorado.

These studies were conducted as requested by the U. S. Engineer Department, Denver District Office, and by authority of a directive dated 19 February 1944, from the Office of the Chief of Engineers.

The conduct of the work was under the general supervision of J. E. Warnock. All operations were directed by Fred Locher and C. V. Adkins.

CONTENTS

LIST OF FIGURES

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

REPORT OF MODEL STUDIES OF THE SPILLWAY AND STILLING BASIN FOR CHERRY CREEK DAM AND RESERVOIR, COLORADO

I - INTRODUCTION AND SUMMARY

Introduction

1. Purpose and scope of model studies

The purpose of the model studies of the spillway and stilling basin, Cherry Creek Dam and Reservoir, Colorado, was to verify the design and, by adjustment, develop a satisfactory hydraulic structure.

Two different designs were submitted for tests. For the purpose of this report, the one shown on figure 2 will be designated as the original design and the successive change will be designated as original design A, figure 3. The other design, as shown on figure 4, is designated as the alternate design and the successive changes as alternate design A, B, and C.

In order to expedite the testing and have a direct, visual comparison between the designs, a 1:60 hydraulic model of each was constructed in the laboratory. From the tests it was necessary to establish for each of the designs the correct length and the shape of crest and size of notch required to produce a predetermined head-discharge curve at the weir; to determine a suitable shape for the spillway chute; to design a satisfactory stilling basin for the anticipated variation in tailwater; and to determine the difference, if any, in the scour immediately downstream from the stilling basins.

The tailwater elevations at the stilling basin, the maximum discharge, and the characteristics of the head-discharge curve were established by the U. S. Engineer Office, Denver, Colorado.

2. Authority

This project was authorized by the Flood Control Act approved August 18, 1941 (Public No. 228, 77th Congress, 1st Session), which reads, in part, as follows:

> "SEC. 3. That the following works of improvement for the benefit of navigation and the control of destructive floodwaters and other purposes are hereby adopted and authorized in the interest of national security and the stabilization of employment, and shall be prosecuted as speedily as may be consistent with budgetary requirements, under the direction of the Secretary of War and the supervision of the Chief of Engineers in accordance with the plans in the respective reports hereinafter designated and subject to the conditions set forth therein * * * *."

* * * * * * * * * * * * * * *

> "Missouri River Basin - The comprehensive plan for the improvement of Cherry Creek and tributaries, Colorado, for flood control and other purposes in accordance with the recommendations of the Chief of Engineers in House Document Numbered 426, Seventy-sixth Congress, first session, is approved and there is hereby authorized $3,000,000 for the initiation and partial accomplishment of the project."

3. The definite project plan

The definite project plan (initial development) provides as follows:

(a) Complete flood protection for the City of Denver by the construction of a rolled-earth dam, including an outlet-control structure through the dam near the right abutment; an overflow-spillway canal to pass the spillway-design flood from the Cherry Creek Basin into the Tollgate Creek Basin and thence through Sand Creek into the South Platte River at a location downstream from Denver.

(b) The dam will be constructed in such manner as to provide for multiple-purpose development (ultimate development), making available to irrigation and other water-use interests 85,000 acre-feet of storage capacity.

(c) The definite project plan will include the construction of the dam to multiple-purpose height, but it will include only those features of the outlet conduits and the spillway necessary to accommodate flood control before irrigation or other water uses are developed.

4. General

The proposed multiple-purpose Cherry Creek Dam and Reservoir is located near the site of the existing Kenwood Dam on Cherry Creek in Arapahoe County (figure 1), at river mile 11.4 as measured from the mouth of Cherry Creek at its junction with the South Platte River near the center of the business district of Denver. The Cherry Creek drainage basin is approximately 57 miles in length and contains a total of approximately 414 square miles. The area upstream from the proposed Cherry Creek Dam contains 386 square miles.

The proposed spillway and the stilling basin are located approximately 1.2 miles from the Cherry Creek Reservoir. The floodwaters will flow from the reservoir via a canal to the spillway which will drop the water to a canal discharging into Tollgate Creek. The flow into Tollgate Creek will discharge into Sand Creek and reach the Platte River at a point downstream from Denver.

Summary

5. Undesirable conditions and remedial measures in the original design

In the initial tests of the original design (figure 2), it was discovered that the discharge capacity of both the notch and the crest exceeded that in the design, thus indicating that this part of the structure should be decreased in size.

The flow from the notch spread laterally on the chute and caused a high standing wave that overtopped the walls at the sides of the chute. The flow from the stilling basin caused excessive scour downstream. As a remedy for these conditions, the notch and the spillway capacities were reduced, the training walls downstream from the notch were raised and lengthened, and a sill and dentates were placed in the pool.

When the model was tested under these conditions, the desired flow characteristics were obtained; but there was considerable objection to the standing wave formed in the area between the crest and the side wall. To eliminate the standing wave the warped side walls were replaced by vertical walls which constricted the openings between the longitudinal parts of the crest and the side walls (figure 3). This submerged the standing wave and improved the flow in the chute. There were no serious objections to the flow pattern in this structure, and the arrangement of figure 3 was considered satisfactory from an hydraulic viewpoint.

6. Undesirable flow characteristics and remedial measures in the alternate design

The first tests with alternate design A (figure 5) indicated that in addition to decreasing the capacity, either training walls or some other device was required to keep the notch flow from spreading laterally and overtopping the side walls. The scour of riprap along the side walls due to this overtopping is shown in figure 7D. The discharge capacity of tho structure was reduced by shortening the crest length and varying the notch width until a predetermined discharge curve similar to the one on figure 12 was obtained. Several attempts were made to stop the lateral spread of the notch flow. However, as none of these was entirely satisfactory, the center notch was eliminated and half sections of the original notch were placed at the two ends of the crest (figure 8).

This arrangement caused a high standing wave in the center of the chute which gradually leveled until the flow had spread to the width of the chute at the beginning of the stilling basin (figure 9). There being little flow along the sides, low walls could be used along most of the length of the chute (figure 15). Attempts to decrease the height of the standing wave, such as using three notches, baffles, or a deflecting block were not successful, and in some cases they actually made flow conditions in the pool unstable. The design as shown in figures 6 and 8 was considered satisfactory.

The suggestion was made that the height of standing wave might be reduced by warping the side walls as shown in figures 9 and 10. This did not improve the flow on the apron. However, the entrance conditions to the notches were improved and there was considerable improvement in the appearance of the structure.

This arrangement was selected as the final design. It was superior to the original design A from both economic and hydraulic viewpoints. The difference in energy dissipation in the stilling basins of the two designs is shown clearly in figure 11.

II - MODEL TESTS

7. Preliminary considerations

A thorough study of the original design (figure 2) was made in an attempt to anticipate its hydraulic performance before the model was constructed. Conclusions, based upon previous field and laboratory experience, were that the stilling basin was too short for the existing entrance conditions. Following a computation of the hydraulic characteristics through the spillway chute, the stilling basin was lengthened 28 feet to obtain a desirable hydraulic jump and sufficient energy dissipation in the pool. The crest cross section was also developed in the laboratory from previous experimental data.

In the initial development, although the spillway and the stilling basin will not be constructed, a canal from the reservoir to West Tollgate Creek will be excavated to elevation 5598.00. In the ultimate development the canal will be deepened and widened. The outlet channel below the stilling basin will be excavated to a slope of 0.0015, beginning at elevation 5567. It was planned that any additional depth obtained would result from retrogression. Two tail-water elevation curves were submitted to the hydraulic laboratory, representing conditions both before and after retrogression. The outlet channel in the model was built to represent conditions indicated to exist after retrogression and with a bottom width such that the tailwater in the model could be lowered to the required elevations. Otherwise, the model of the original design was constructed according to plan.

A sketch of the alternate design as submitted to the hydraulic laboratory is shown on figure 4. The same design of stilling basin and outlet channel was used in both models. The crest cross section was developed from previous laboratory data and is shown on figure 9. A comprehensive study of the sketch and computation of the hydraulic characteristics through the chute showed that other changes could be made that would improve the hydraulic action of the chute and also make it more economical. The over-all length of the chute was reduced, and a new floor shape was developed. The bottom width of the approach canal was reduced from 170 to 75 feet. The model as it was first constructed is shown on figures 5 and 7A.

8. Initial tests of original design

The model was operated with flows of from 3,000 to 45,000 second-feet (figure 13). There was a fairly even distribution of flow over the lower part of the apron at all discharges. At the higher discharges, the water passing through the notch spread and climbed the chute walls just above the stilling basin.

The entire head-discharge curve fell below that shown on figure 12, indicating surplus capacity. The flow over the sections of the crest parallel to the longitudinal axis of the chute was considerably less than that over the sections normal to the longitudinal axis. The depth over the crest varied from a minimum of approximately 2.5 feet at the notch to a maximum of approximately 9 feet at the chute walls for a discharge of 45,000 second-feet. This condition was due partly to the drawdown in the water surface through the notch and partly because the flow of the approaching water was not normal to the axis of the crest. The efficiency of the longitudinal sections was reduced thereby.

An imperfect hydraulic jump formed in the stilling pool. The jet of water from the apron was diving under the tailwater and flowing along the bottom. Consequently, there was insufficient energy dissipation and considerable scour immediately downstream from the pool.

A very high standing wave was formed in the side channels just below the crest. The choking action accompanying the wave gave an impression of insufficient channel capacity for the water passing over the crest.

9. Revisions of original design

Several changes were suggested in attempting to improve the hydraulic performance of the structure (figure 3). Since the extensions of the downstream ends of the crest serve as training walls, it was thought that by raising and lengthening them the tendency of water to climb the chute walls could be eliminated. These walls were extended 20.5 feet down the apron and sloped from the crest elevation at the notch to a height of 6.25 feet at a point 105 feet below the notch. This reduced the lateral flow and minimized the tendency of the water to climb the chute walls. The flow pattern on the apron was also improved.

As a means of raising the head-discharge curve, the crest sections were moved toward the center of the chute to obtain a notch bottom width of 12 feet (figure 3). The sections of crest parallel to the longitudinal axis of the chute were shortened 10 feet. This moved the sections normal to the longitudinal axis downstream 10 feet. The resulting head-discharge curve agreed favorably with the required curve. The desired discharge curve having been obtained, the depression in the approach floor was filled with no change in the discharge curve.

A row of dentates and an end sill were built in the stilling basin to break up the jet flowing along the bottom (figures 3 and 13). A good hydraulic jump was created, thus dissipating considerable energy. Scouring was materially reduced; but the scour pattern (figure 11A) shows that the section immediately below the basin requires riprapping. The scour pattern was obtained by replacing the riprap with fine sand and operating the model with the maximum discharge of 45,000 second-feet until the channel had stabilized. This required one hour and fifteen minutes.

The belief was expressed that considerable saving could be effected by making the vertical walls of the stilling basin the same height as the chute walls, the additional height required to be secured by slope paving from the tops of the basin walls on a 2:1 slope. With this arrangement large vortices were formed below and at the sides of the stilling basin. The result was poor energy dissipation and consequently deep scour below and to the sides of the stilling basin. No further consideration was given to this type of design, and the original vertical walls were replaced. The model was considered to indicate satisfactory hydraulic performance except for the high standing wave in the side channels below the crest.

The 10:1 slope at the upper end of the chute floor was extended up through the side channels to the foot of the crest sections lying normal to the longitudinal axis of the chute, to alleviate the high standing wave. As this change was of little value, the level floor was replaced.

The warped walls of the chute were replaced by straight, vertical walls set in such positions that they constricted the side channels (figures 3 and 14). This change resulted in submergence of the standing wave. A smoother and a more even distribution of flow along the apron was also obtained. It could be seen that the chute walls would have to be raised considerably to provide sufficient freeboard. Figure 18 is a water-surface profile along the chute walls for a discharge of 45,000 second-feet. Due to the difficulty and the cost of constructing this design in the field, it was considered best to abandon it in favor of the alternate design shown on figure 9.

10. Initial tests of the alternate design

The model of the so-called alternate design was not constructed according to the original sketch of figure 4 but according to the revised laboratory design of figure 5. The first tests with the design on figure 5 showed that at all flows the discharge from the center notch spread laterally until it impinged on the walls and deflected down the chute (figure 7). At the higher discharges, the lateral component of velocity was sufficient to carry the flow over the walls, thus resulting in scour of the adjoining riprap. This is evident from a close inspection of figure 7.

It was also found that the head-discharge curve was considerably lower than that anticipated in the design. This indicated that the area over the notch passed more water than was originally assumed. As a result, it was necessary to decrease gradually the crest length until the desired conditions were obtained. This was accomplished by moving the side walls toward the center and altering the approach channel to satisfy the new requirements. The shape, the curvature, and the location of the crest remained unchanged.

11. Revisions of the alternate design

To reduce the lateral flow and thus eliminate the undesirable flow over the chute walls, two schemes were tried. In the first one, training walls of various heights were placed at each side of the notch and extended approximately 120 feet downstream. The walls produced the desired results at low flow, but at higher discharges the radial flow from the crest was deflected by the training walls to the chute walls where it formed a high fin and intermittently splashed over onto the riprapped banks.

The second attempt was more successful. It consisted of raising the apron to within five feet of the top of the crest and extending the notch through the apron as shown on figure 18. This produced a fairly even distribution of flow across the lower part of the apron at all discharges. However, there was still a tendency for some of the water passing through the notch to spread laterally and climb the walls near the stilling basin. The apron could have been raised still more and the notch extended to the stilling pool, thus eliminating the side-wall fin entirely. However, in the initial development of the project, the canal from the reservoir will be excavated to elevation 5598.00. With part of the apron at this elevation or higher, a considerable portion of the structure would have to be built on backfill. As there was considerable objection to this feature, the original apron was replaced and no further tests were made in that direction.

12. Tests leading to the final design

From the results of the previous tests, it appeared that the design could be made workable if the notch was divided and half sections placed at the ends of the crest with the channel wall forming one side of each notch. Accordingly, the center opening was plugged, and new notches were cut at each end of the crest. Their combined area was slightly more than that of the original center notch. The tests with this arrangement revealed that at low discharges there was a pronounced concentration of flow in the center of the apron which continued into the stilling basin. As the discharge increased, a standing wave formed in the center of the apron just below the crest and spread gradually as it approached the pool. When the discharge reached the maximum of 45,000 second-feet, the lateral displacement of the flow from the standing wave approximately equalled the chute width as it reached the end of the apron. The result was a sheet of water of uniform depth as it entered the stilling basin. This phenomenon produced a very satisfactory hydraulic jump, with the result that there was little movement of the erodible material downstream from the stilling basin. There was very little depth of flow along the chute walls except in the immediate vicinity of the notch. This was a distinct advantage as it was now possible to use walls of considerably less height than in any of the previous designs.

It was suggested that three notches, one at each end of the crest and one in the center, be tested in an attempt to reduce the height of the standing wave and obtain a better distribution of the flow on the apron at low discharges. With this arrangement a standing wave of the same height as before was formed on each side of the center line, in the area between adjacent notches. As these waves spread on the apron, part of the flow returned to the center line of the structure to form another standing wave and the remainder traveled to the side of the structure and overtopped the walls. With some experimenting and adjusting of the size and the angles of the notches, satisfactory flow conditions could have been obtained. However, it was obvious that in order to accomplish this the center notch would have to be considerably smaller than the side notches. The possibility of clogging by debris caused abandonment of the plan.

At this time it was suggested that there might be an improvement in the flow pattern if the notches were moved away from the channel walls. The sections between the notches and the channel walls would form buttresses, thus affecting favorably the economy of the design. The notches were moved 10 feet toward the center line (figure 17). The standing wave was not affected materially, but another fin of water was formed between the notches and the chute walls which extended well above the top of the wall. The scheme was abandoned, and the notches were returned to their former positions.

At this point the alternate design, with notches at the ends of the crests, was accepted as the final design, and the laboratory proceeded to make refinements to improve the appearance and to curve the chute walls to conform more nearly to the flow pattern (figure 6).

13. Final design

In the arrangement shown on figure 6, the curvature of the chute walls was eased, the entrances to the notches were streamlined, and the transition above the crest consisted of plane surfaces. This change did not affect the flow pattern (figure 8) or the head-discharge curve. Therefore, the design was considered satisfactory. However, two more attempts were made to reduce the height of the standing wave. In the first trial, four rows of half-elliptical baffles were placed on the apron, extending from the foot of the crest to a point 75 feet downstream. Two rows were placed in line with the inside faces of the notches and the others were placed parallel to them and 10 feet nearer the center line of the structure. The major axes of the baffles were placed in the direction of flow through the notches, and companion rows were spaced such that the openings were staggered. This scheme accomplished the purpose to some extent, but the improvement was not sufficient to warrant their use.

In the second trial, a triangular block 12 feet high was placed on the center line of the apron with the apex against the crest to deflect the flow from the crest into that from the notches. This reduced the height of the standing wave considerably. However, the resulting flow into the stilling basin did not produce a stable jump. So the plan was abandoned.

It was suggested that an improvement in the flow pattern could be obtained by warping the walls from a point in the canal to some point downstream from the crest. The model was revised as shown on figure 9. There was no improvement in the flow pattern on the apron (figure 10). However, the entrance conditions to the notches were improved to the extent that their bottom widths were reduced from 10 to 9 feet.

This structure presented a more pleasing appearance than the previous arrangement, and it was selected as the final design. The head-discharge curve is shown on figure 12. The resulting scour pattern, after an equivalent prototype flow of 45,000 second-feet for 1.25 hours in the model, is shown on figure 13A. The scour test was not continued for a greater period of time because the channel bed in the model had stabilized.

III - RESULTS AND CONCLUSIONS

14. Analysis of the results

The hydraulic performance of original design A was satisfactory. However, from an economic viewpoint it did not compare favorably with the final design. The depth of water on the chute at the walls of the first design was considerably deeper than that at the walls of the final design, necessitating higher walls over a greater length (figures 15 and 18).

Original design A also required a greater length of crest than was necessary on the final design, due to the unfavorable entrance. In the longitudinal section of the crest the water flowed diagonally to the crest axis, causing an appreciable reduction in the coefficient of discharge. In addition, the downstream portion suffered a reduction in head due to a drawdown in water surface in the area between the crests which also contributed toward reducing the over-all coefficient. The width of the notch required to pass 10,000 second-feet at elevation 5623.00 was much less for original design A than for the final design. This was due to more favorable approach conditions above the notch, more slope in the downstream apron, and the fact that critical flow occurred downstream from the notch. In the final design the control section of the notch was at the upstream edge of the crest and critical flow occurred before the water reached the apron.

With both designs, a suitable hydraulic jump was formed in the stilling basins and visual observations did not indicate any difference in performance. However, a scour test revealed that original design A scoured much more severely near the pool walls than did the final design (figure 11). This might have been caused by the converging chute walls of the original design which concentrated the flow and reduced the effective width of the pool at maximum discharge.

At the early stages of retrogression in the downstream channel leading into Tollgate Creek, the water surface will be thirty to forty feet above the stilling-pool walls at maximum discharge. This condition will not produce any unfavorable conditions at the structure if sufficient bank protection is provided against wave action in the vicinity of the structure. As retrogression progresses and the tailwater approaches the top of the stilling basin walls, a vortex will form on each side of the pool and there will be considerable return flow into the stilling basin. The velocity of this return flow is sufficient to cause scour and sloughing of the banks. If this is to be prevented, protection must be provided for velocities of approximately 12 feet per second.

15. Conclusions

(a) The stilling pool for the final design, as shown on figure 9, is satisfactory for discharges up to 45,000 second-feet in combination with the corresponding tailwater elevations as shown on figure 19.

(b) The final design (figure 9) is superior to that shown on figure 6, from an aesthetic viewpoint. There is no appreciable difference in their hydraulic properties.

(c) For the final design, the bottom velocities downstream from the pool are less conducive to scour than those of the original design A. Any decrease in the channel area immediately downstream from the pool will have a tendency to increase the scour.

(d) The variation in the alternate design, as shown on figure 16, could be made workable. It was not considered practical for structural reasons.

(e) The three-notch arrangement could have been made satisfactory, and the height of the standing wave could have been reduced; but the narrowness of the center notch would have presented a clogging hazard.

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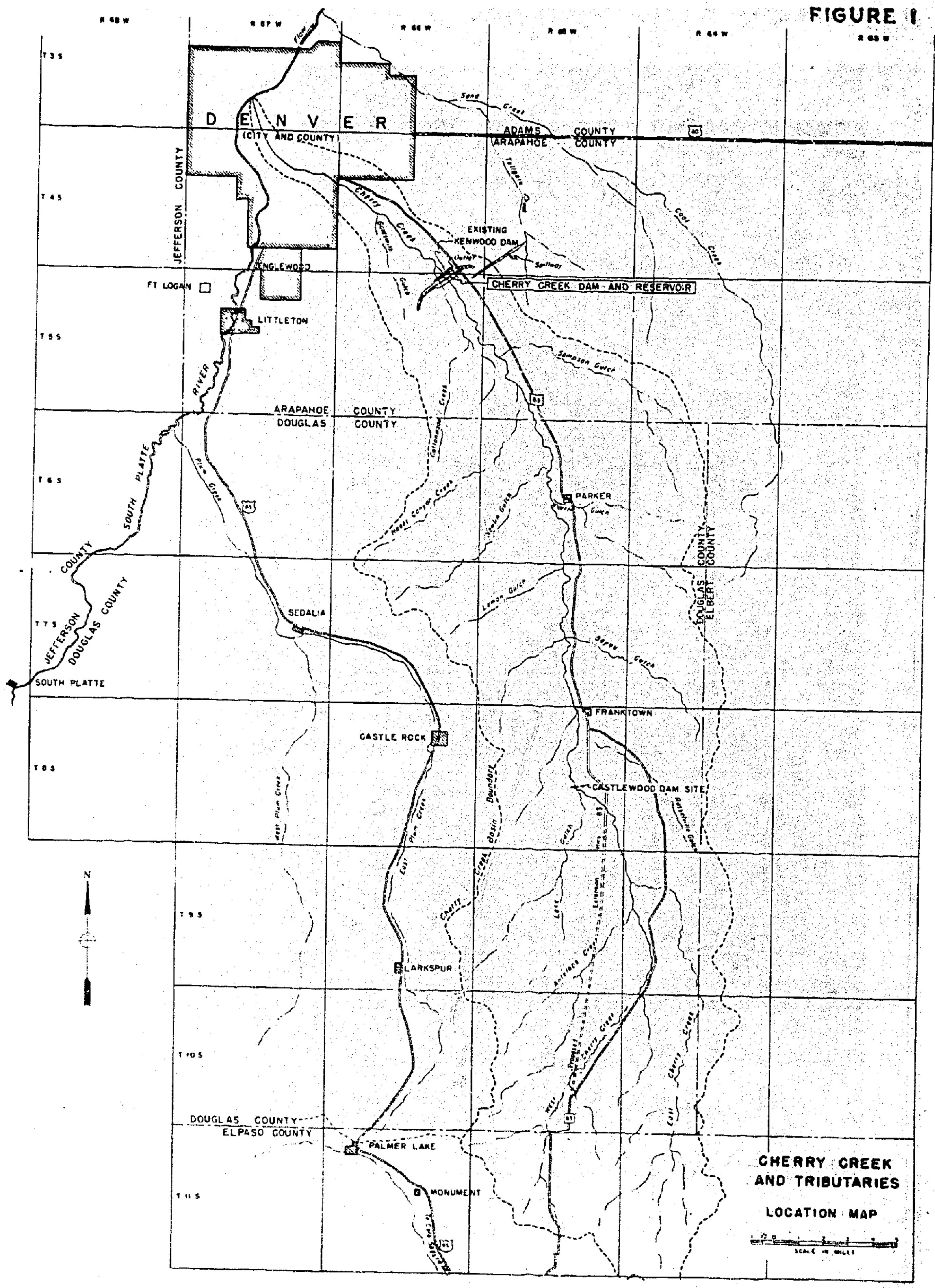
FIGURE 1

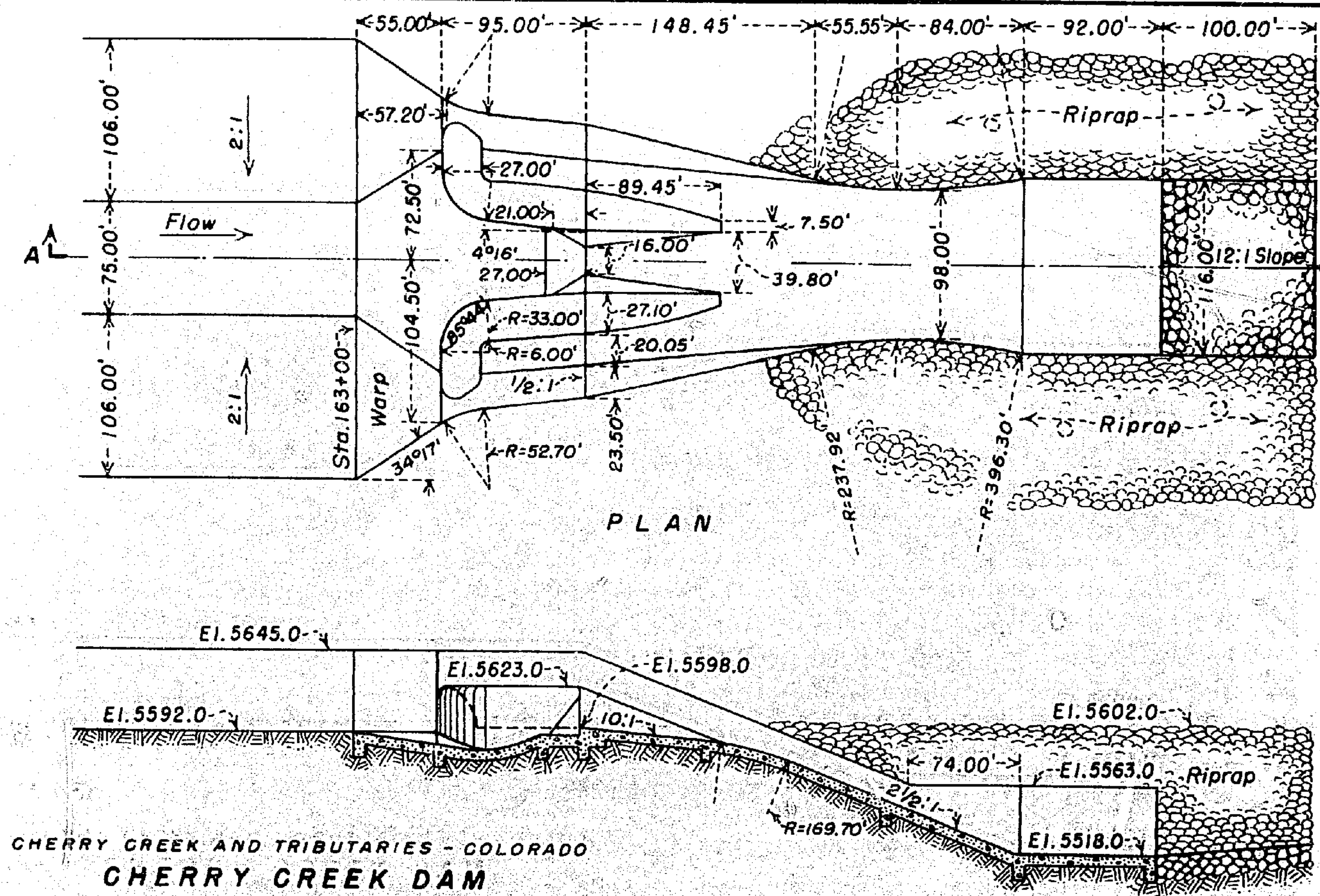


CHERRY CREEK AND TRIBUTARIES

LOCATION MAP

SCALE IN MILES

FIGURE 2



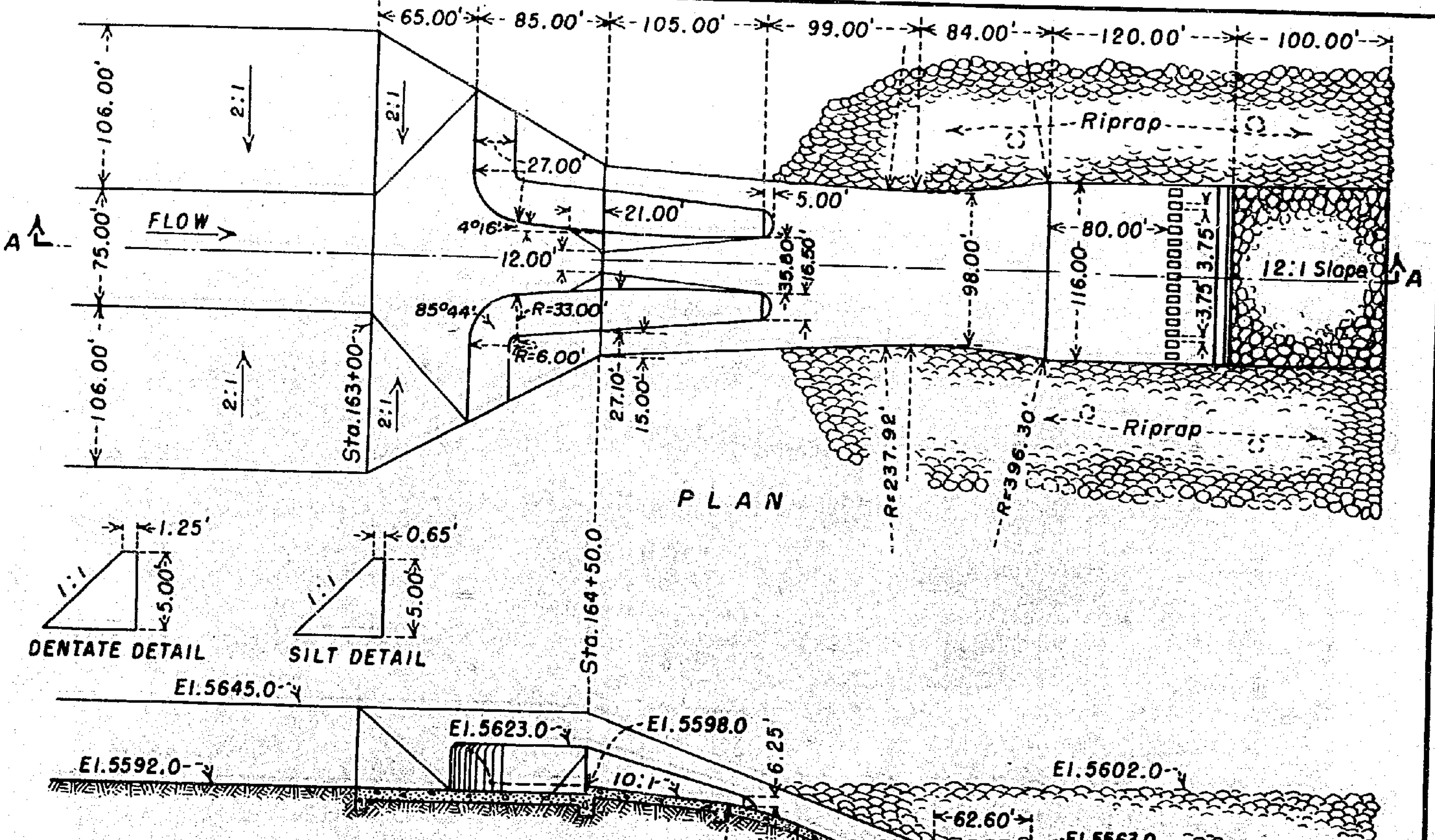
CHERRY CREEK AND TRIBUTARIES - COLORADO

CHERRY CREEK DAM

SPILLWAY - ULTIMATE DEVELOPMENT

NEAT LINES OF WATER PASSAGES

ORIGINAL DESIGN



CHERRY CREEK AND TRIBUTARIES — COLORADO

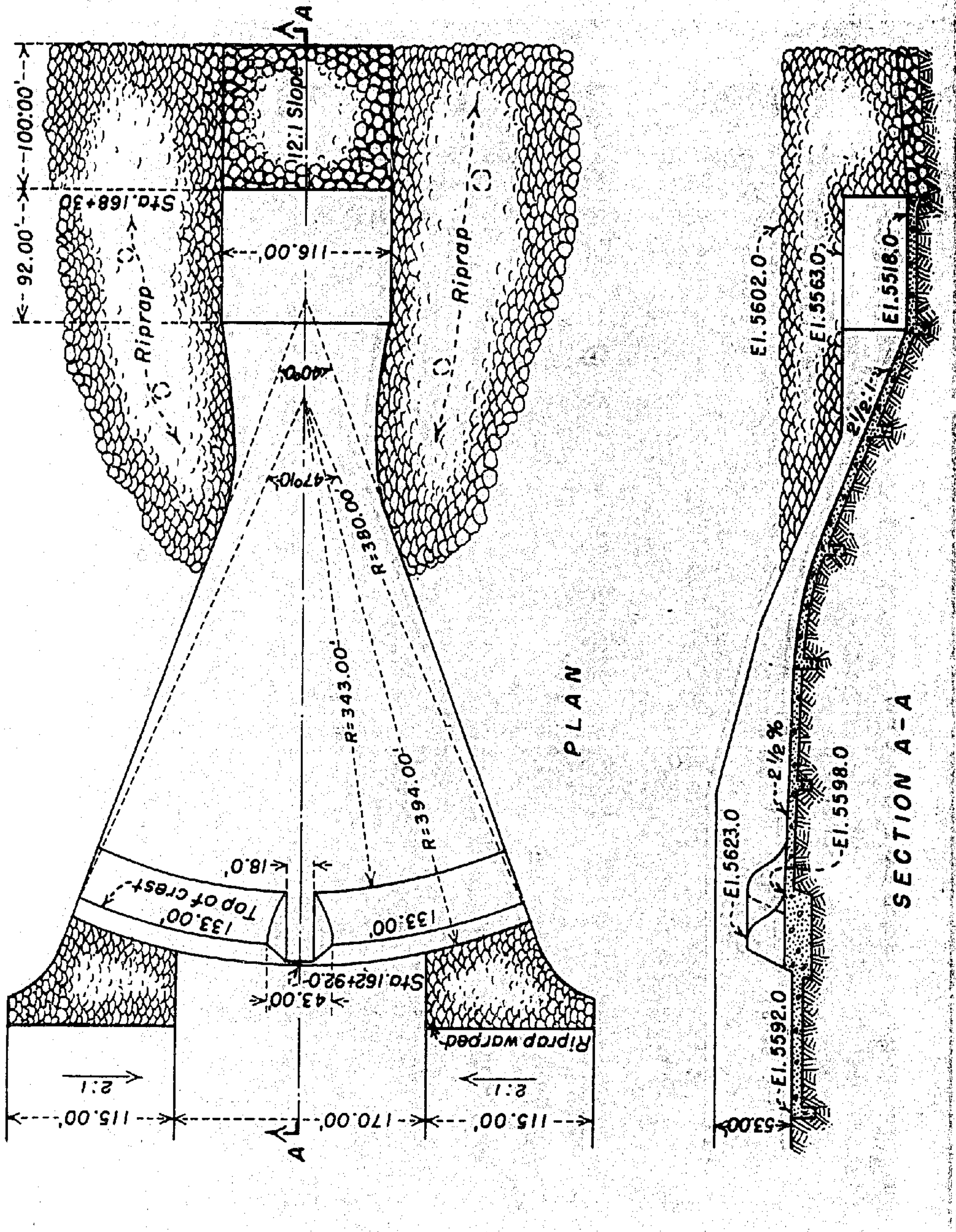
CHERRY CREEK DAM

SPILLWAY - ULTIMATE DEVELOPMENT

NEAT LINES OF WATER PASSAGES

ORIGINAL DESIGN A

FIGURE 3



CHERRY CREEK AND TRIBUTARIES – COLORADO

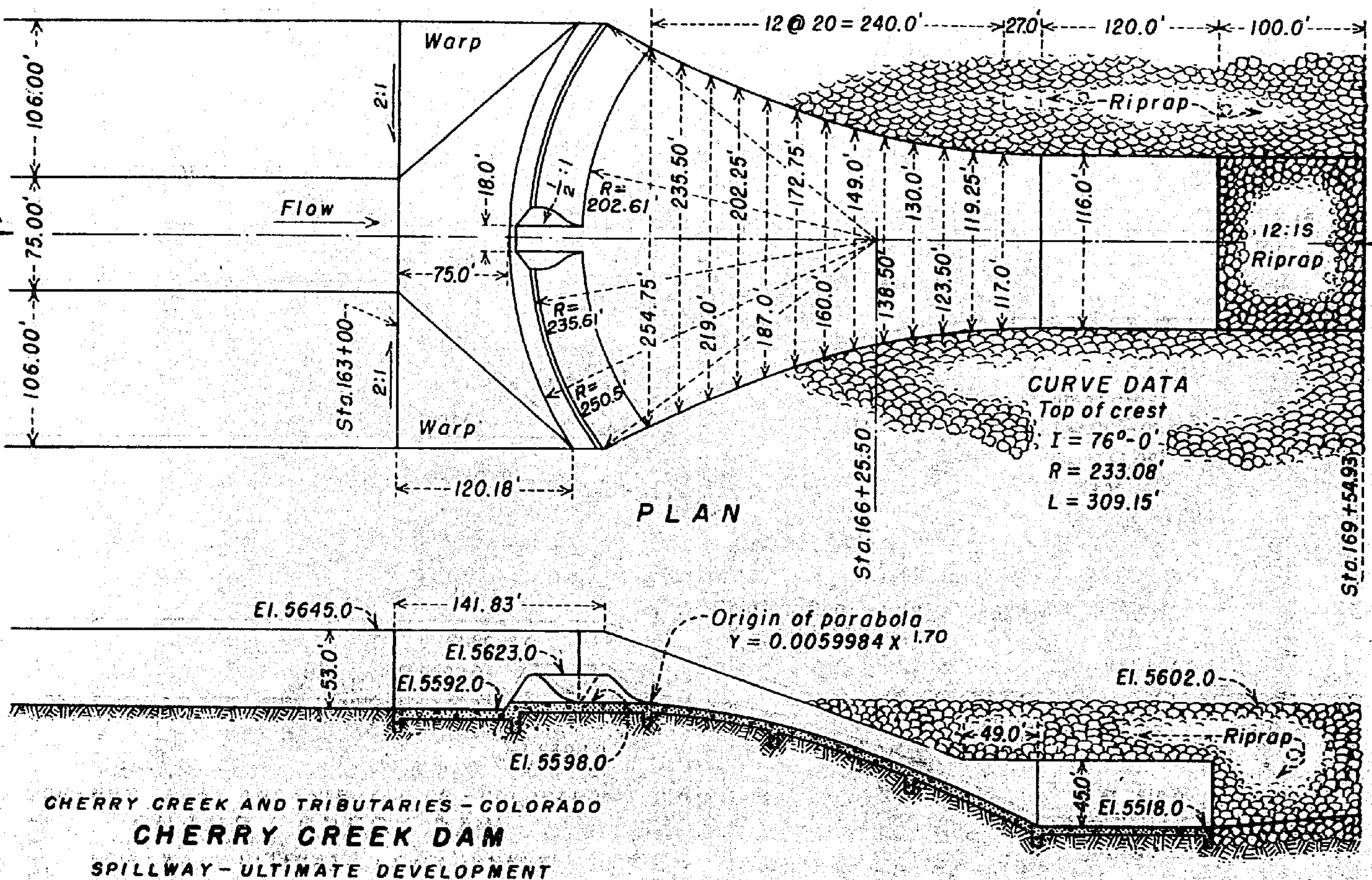
CHERRY CREEK DAM

SPILLWAY – ULTIMATE DEVELOPMENT

NEAT LINES OF WATER PASSAGES

ALTERNATE DESIGN

FIGURE 5



CHERRY CREEK AND TRIBUTARIES – COLORADO

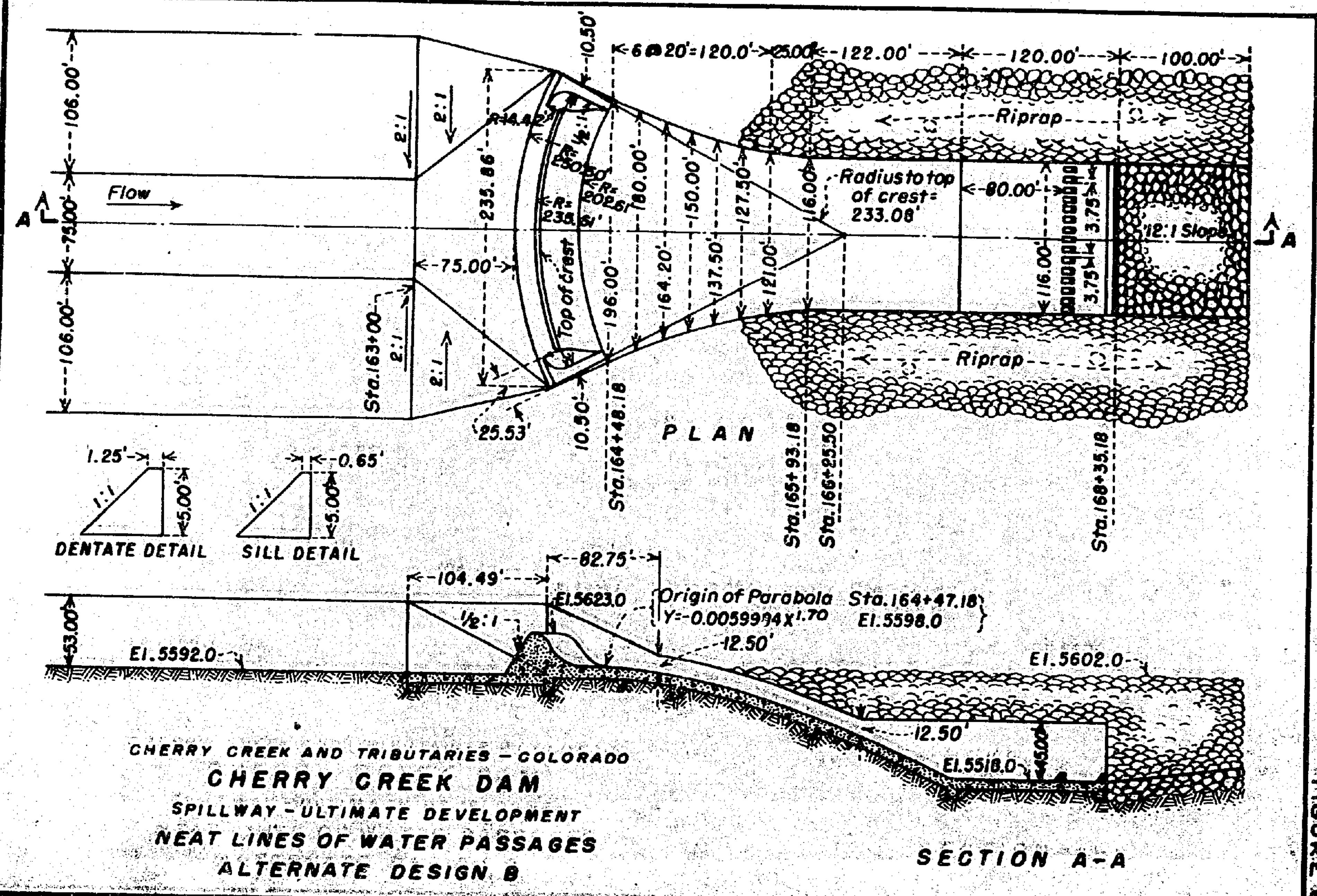
CHERRY CREEK DAM

SPILLWAY – ULTIMATE DEVELOPMENT

NEAT LINES OF WATER PASSAGES

ALTERNATE DESIGN A

FIGURE 6



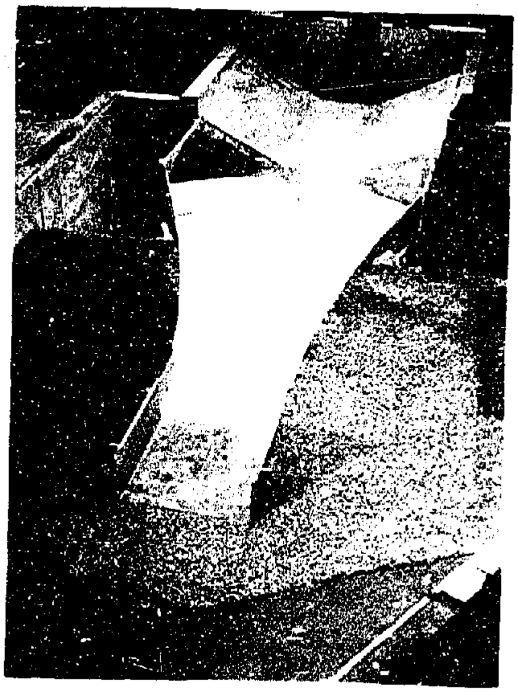
CHERRY CREEK AND TRIBUTARIES — COLORADO

CHERRY CREEK DAM

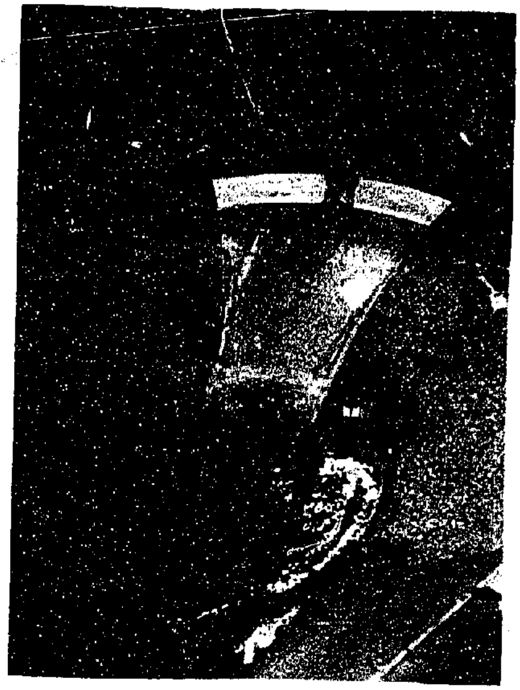
SPILLWAY — ULTIMATE DEVELOPMENT

NEAT LINES OF WATER PASSAGES

ALTERNATE DESIGN B



A. Model arrangement



B. Discharge 10,000 C.F.S.

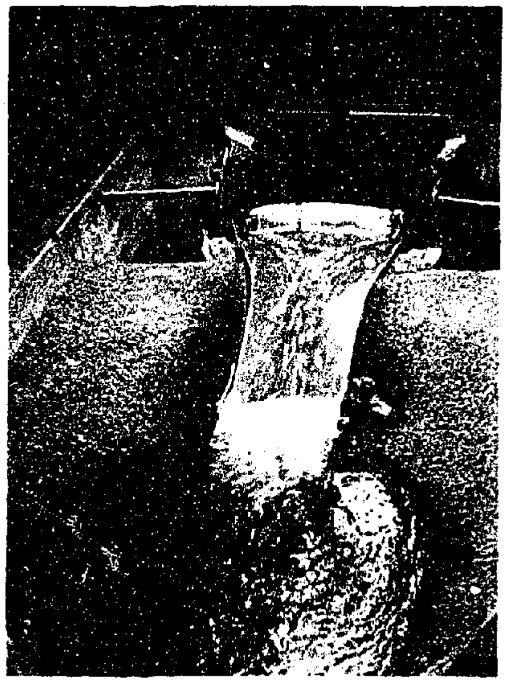
C. Discharge 25,000 C.F.S.

D. Discharge 45,000 C.F.S.

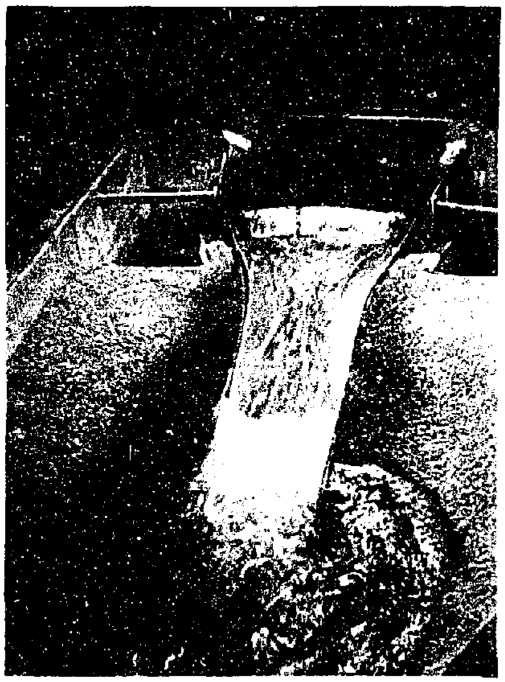
ALTERNATE DESIGN A

A. Model arrangement.

B. Discharge 10,000 C.F.S.

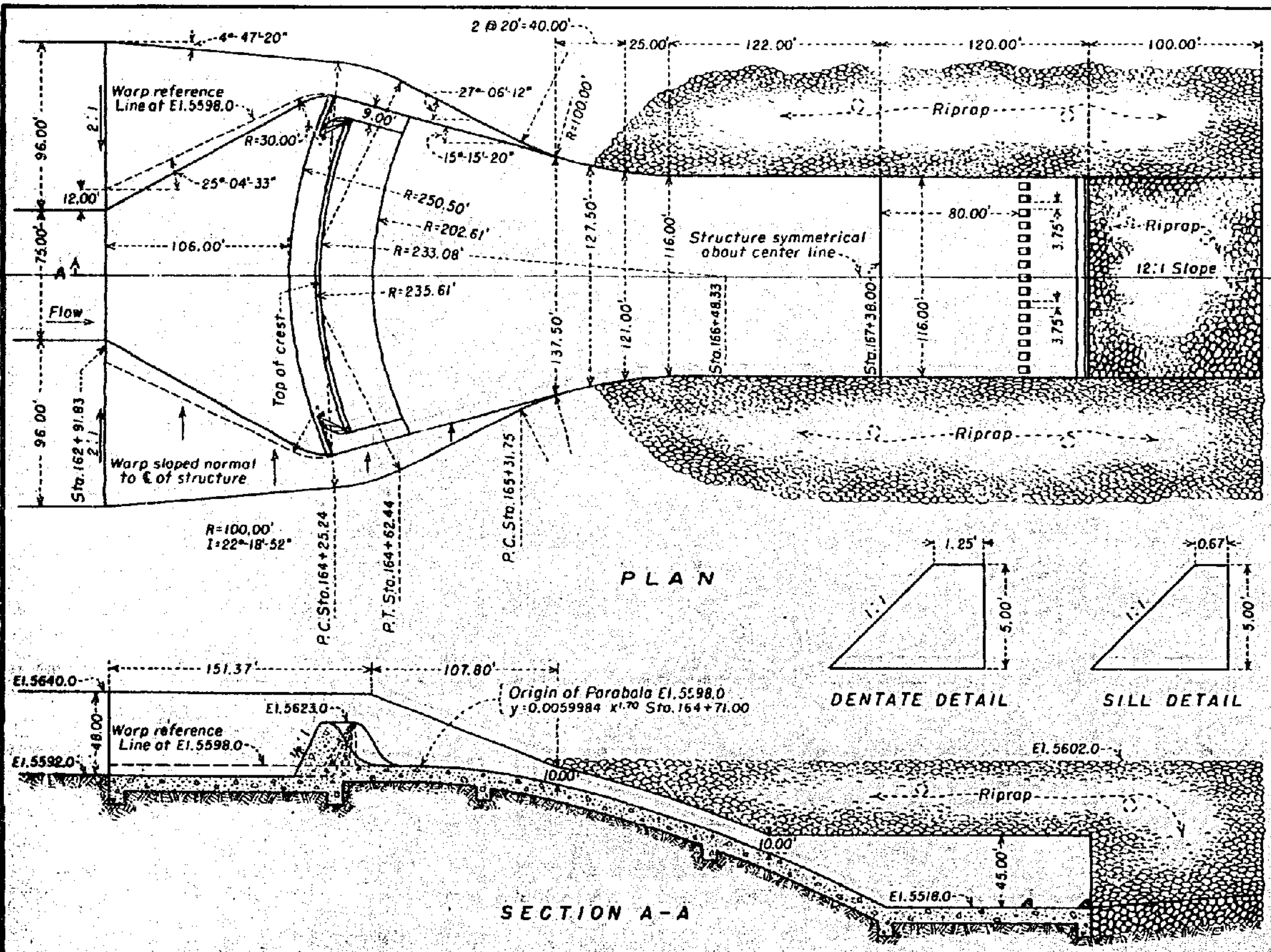


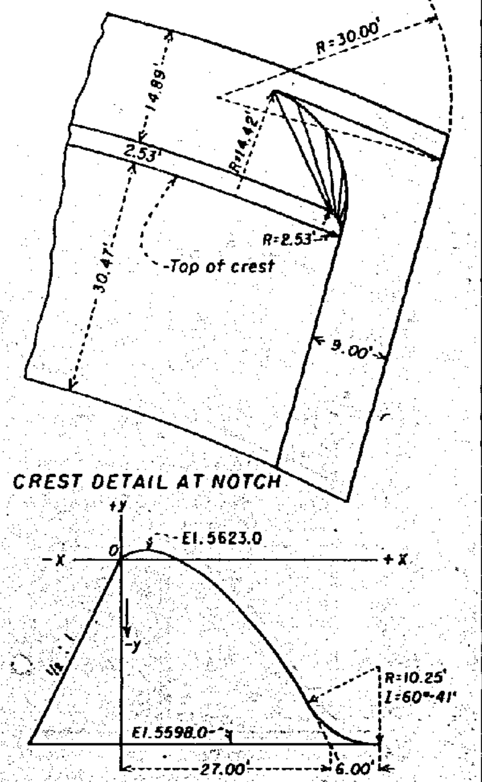
C. Discharge 25,000 C.F.S.



D. Discharge 45,000 C.F.S.

ALTERNATE DESIGN B





CHERRY CREEK AND TRIBUTARIES - COLORADO

CHERRY CREEK DAM

SPILLWAY - ULTIMATE DEVELOPMENT
NEAT LINES OF WATER PASSAGES
ALTERNATE DESIGN C
[FINAL DESIGN]

TABLE OF COORDINATES FOR OGEE SECTION

X IN FEET	Y IN FEET
0.000	0.000
+0.115	+0.165
0.230	0.310
0.344	0.439
0.459	0.539
0.574	0.633
0.689	0.712
0.918	0.844
1.150	0.950
1.607	1.102
2.066	1.185
2.527	1.213
3.214	1.210
3.910	1.160
4.590	1.036
5.740	0.735
6.890	+0.299
8.040	-0.276
9.180	0.918
10.340	1.676
11.480	2.526
17.230	8.380
+22.960	-16.740

A. Model arrangement

B. Discharge 10,000 C.F.S.

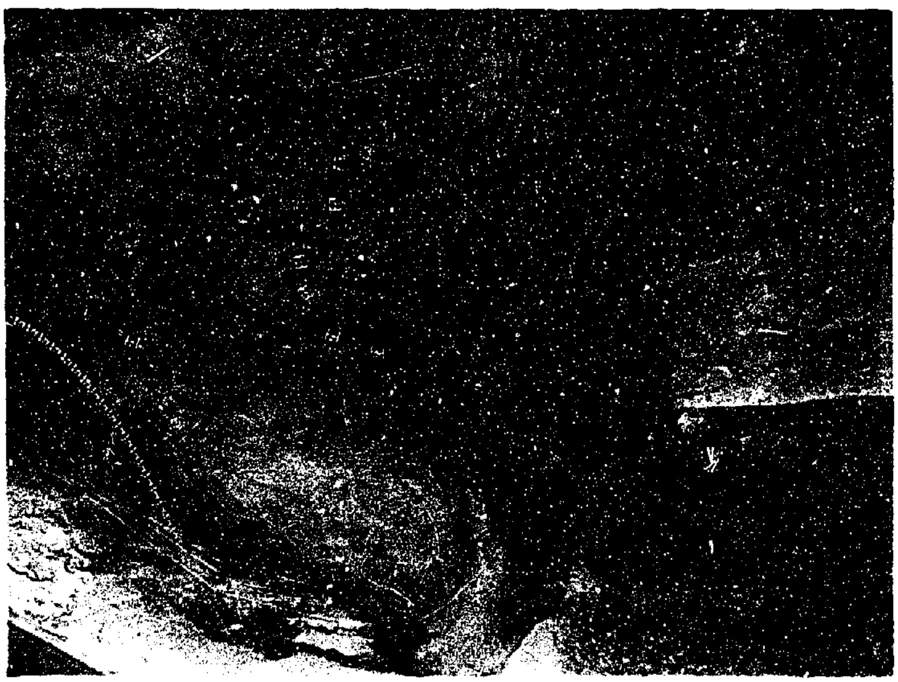
C. Discharge 25,000 C.F.S.

D. Discharge 45,000 C.F.S.

ALTERNATE DESIGN C

FIGURE 11

A. Scour after flow 45,000 C.F.S. Original Design A.



B. Scour after flow 45,000 C.F.S. Alternate Design C.

SCOUR PATTERNS.

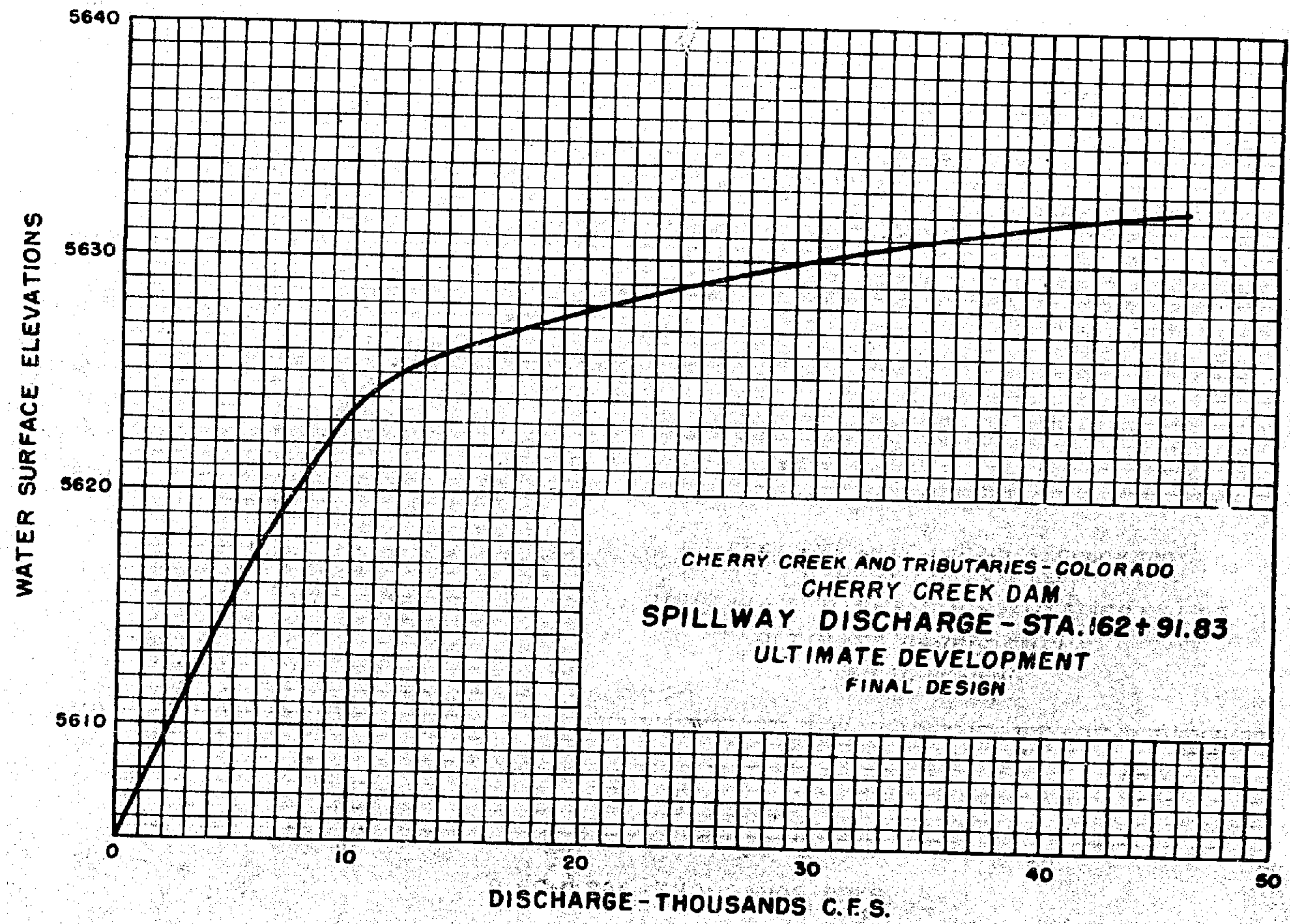
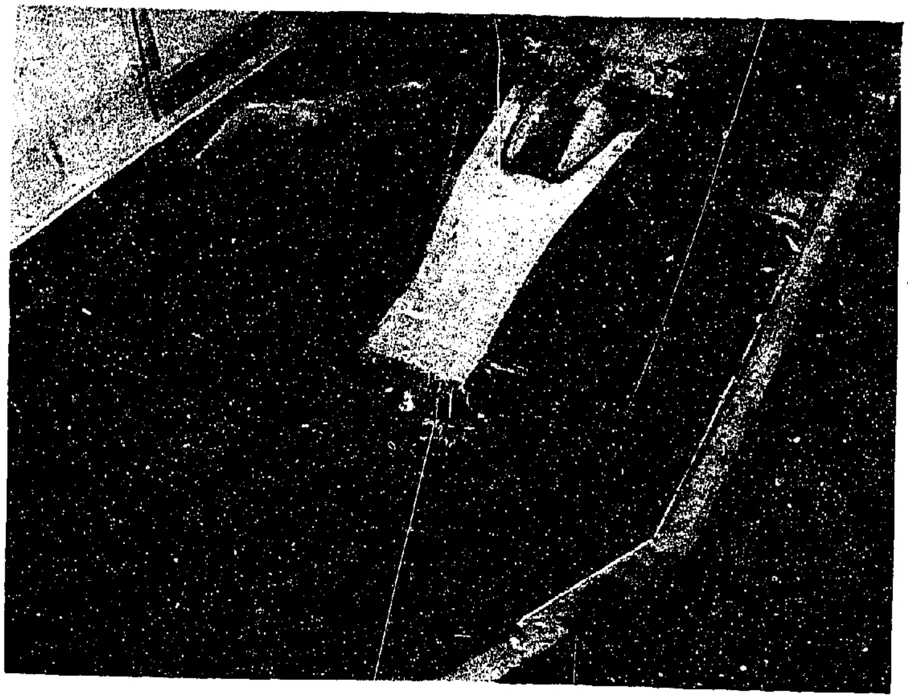

CHERRY CREEK AND TRIBUTARIES - COLORADO
CHERRY CREEK DAM
SPILLWAY DISCHARGE - STA. 162+91.83
ULTIMATE DEVELOPMENT
FINAL DESIGN
WATER SURFACE ELEVATIONS
5640
5630
5620
5610
0
10
20
30
40
50
DISCHARGE - THOUSANDS C.F.S.

FIGURE 12

FIGURE 13

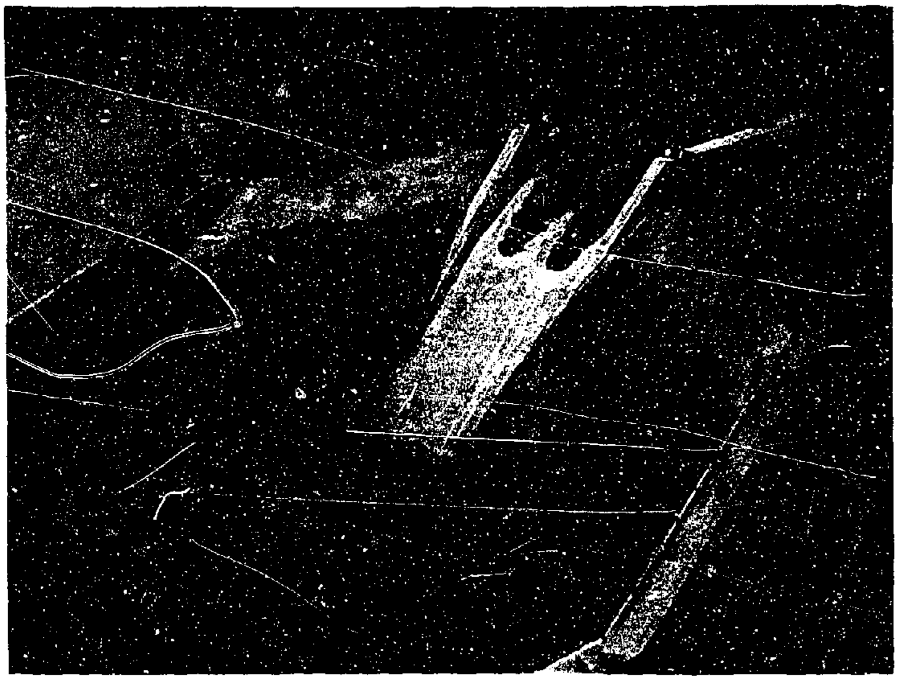


A. Model arrangement

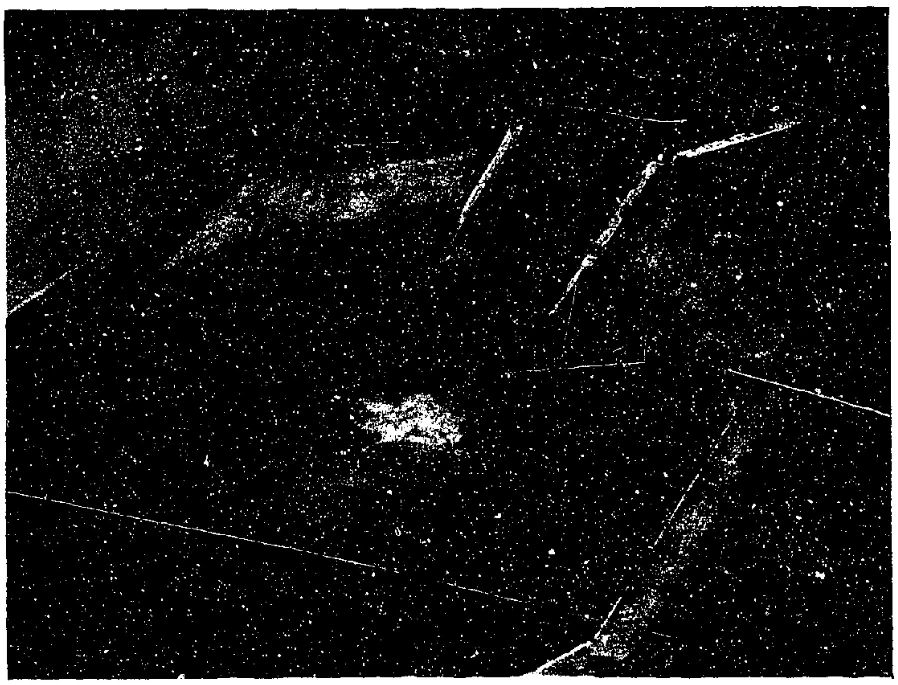
B. Discharge 45,000 C.F.S.

ORIGINAL DESIGN

FIGURE 14



A. Model arrangement



B. **Flow conditions with discharge of 45,000 C.F.S.**

ORIGINAL DESIGN A

FIGURE 15

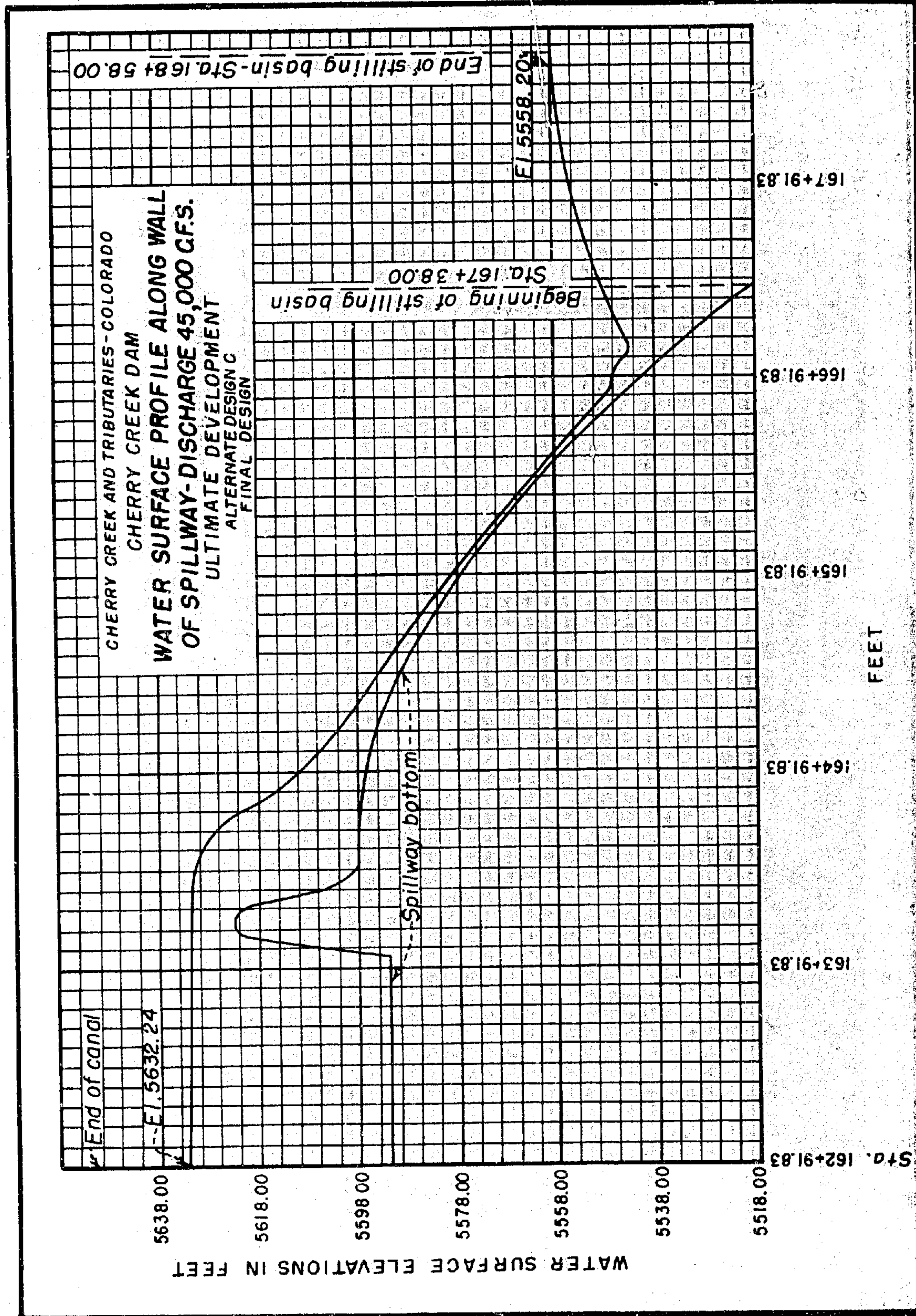

CHERRY CREEK AND TRIBUTARIES-COLORADO
CHERRY CREEK DAM
WATER SURFACE PROFILE ALONG WALL
OF SPILLWAY-DISCHARGE 45,000 C.F.S.
ULTIMATE DEVELOPMENT
ALTERNATE DESIGN C
FINAL DESIGN
End of stilling basin-Sta.168+58.00
El.5558.20
Beginning of stilling basin
Sta.167+38.00
Spillway bottom
End of canal
El.5632.24
5638.00
5618.00
5598.00
5578.00
5558.00
5538.00
5518.00
WATER SURFACE ELEVATIONS IN FEET
Sta. 162+91.83
163+91.83
164+91.83
165+91.83
166+91.83
167+91.83
FEET

FIGURE 16

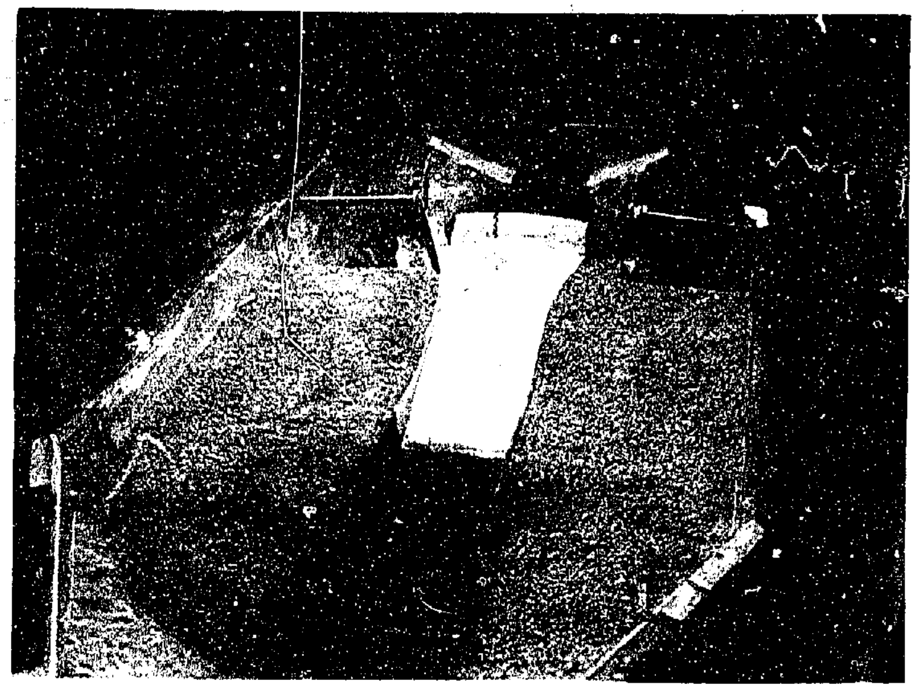
A. Model arrangement

B. Discharge 10,000 C.F.S.

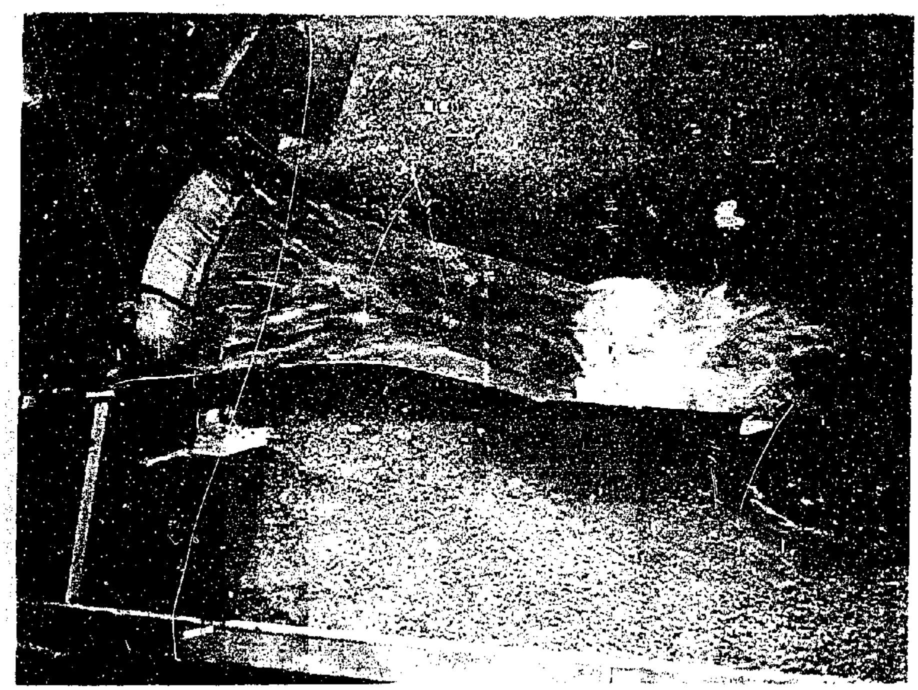
C. Discharge 25,000 C.F.S.

D. Discharge 45,000 C.F.S.

SECOND VARIATION OF ALTERNATE DESIGN A.



A. Model arrangement



B. Discharge 45,000 C.F.S.

VARIATION OF ALTERNATE DESIGN B.

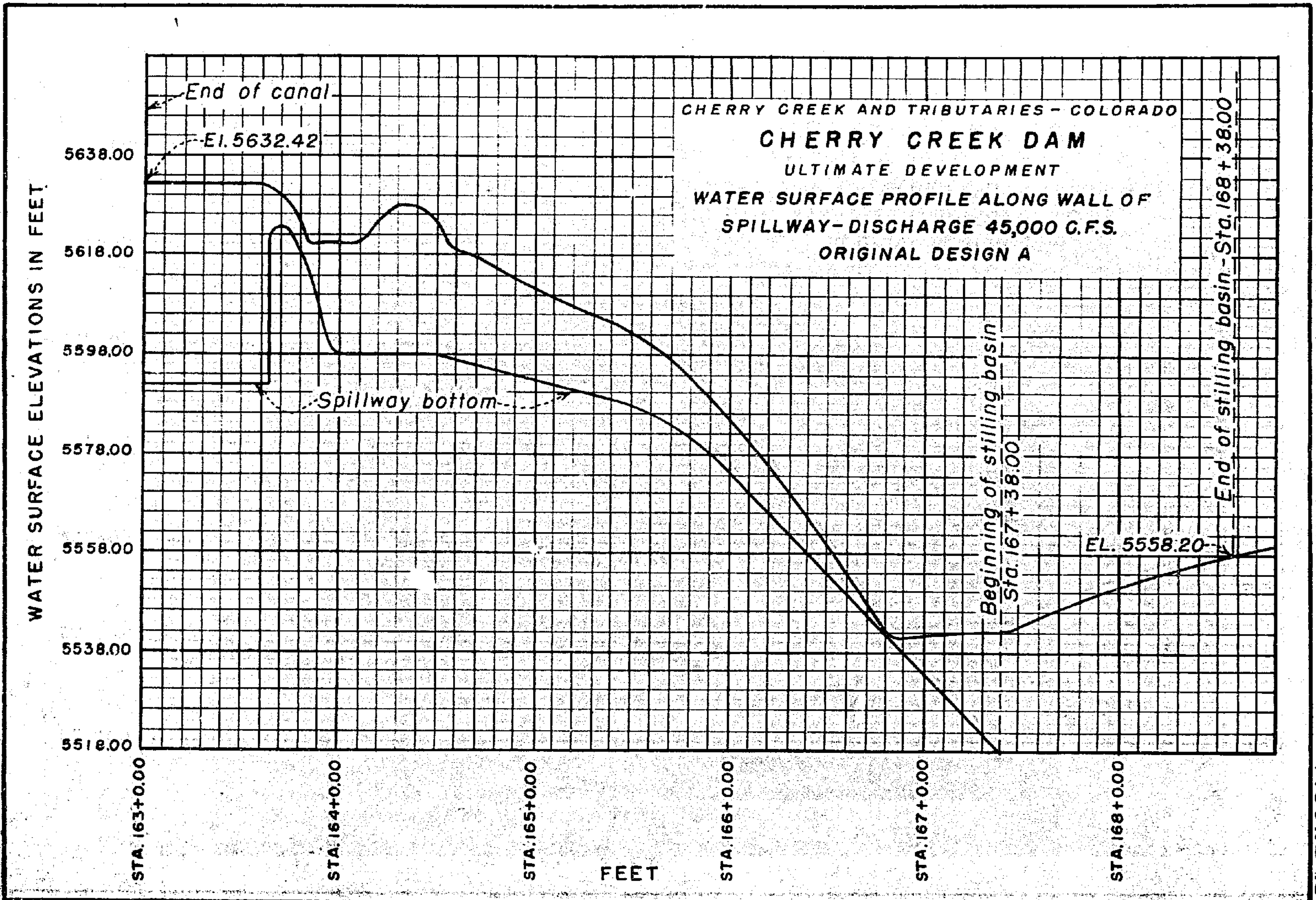
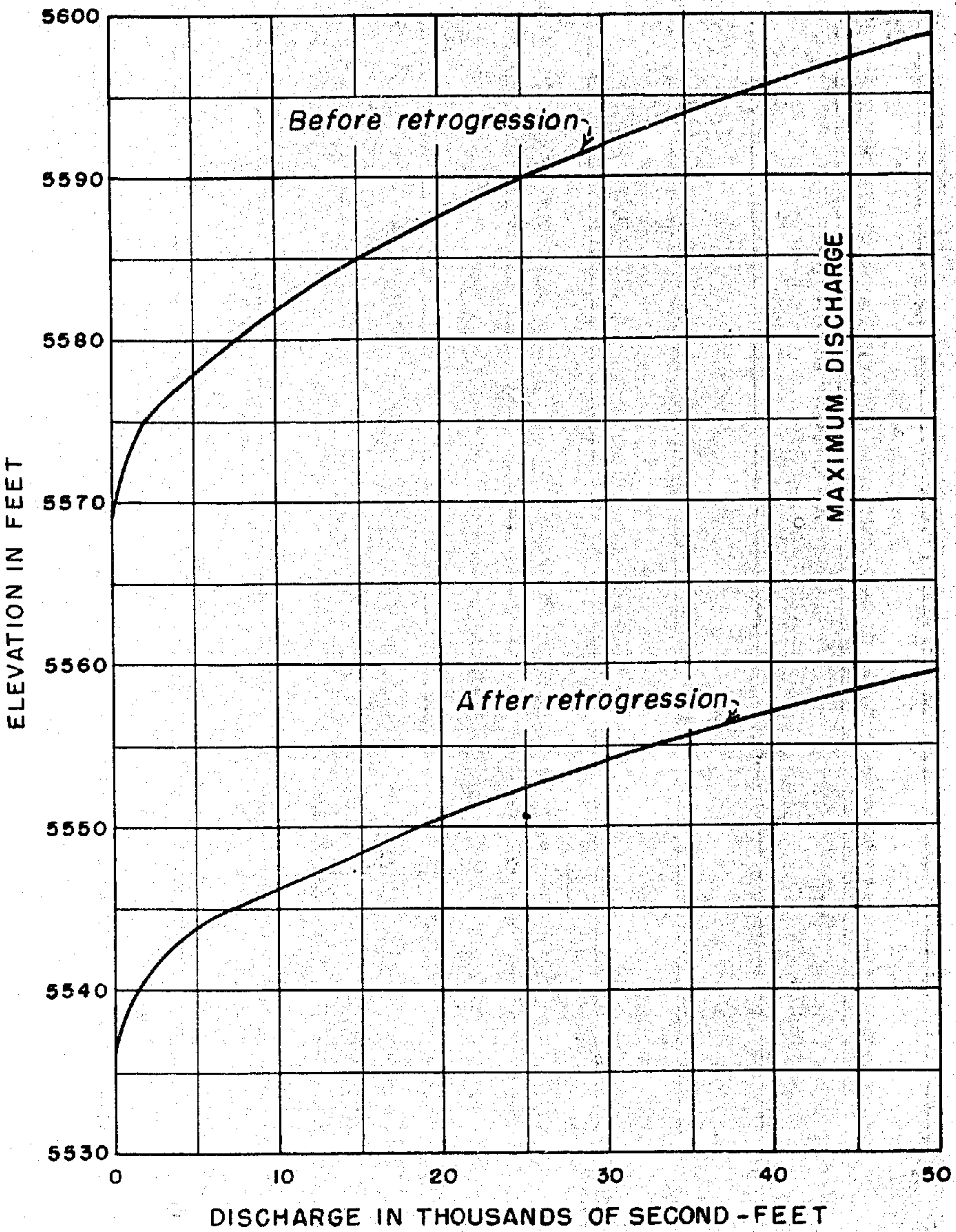

CHERRY CREEK AND TRIBUTARIES - COLORADO
CHERRY CREEK DAM
ULTIMATE DEVELOPMENT
WATER SURFACE PROFILE ALONG WALL OF
SPILLWAY-DISCHARGE 45,000 C.F.S.
ORIGINAL DESIGN A
End of canal
El. 5632.42
Spillway bottom
Beginning of stilling basin
Sta. 167 + 38.00
End of stilling basin - Sta. 168 + 38.00
EL. 5558.20
WATER SURFACE ELEVATIONS IN FEET
5638.00
5618.00
5598.00
5578.00
5558.00
5538.00
5518.00
STA. 163+0.00
STA. 164+0.00
STA. 165+0.00
STA. 166+0.00
STA. 167+0.00
STA. 168+0.00
FEET

FIGURE 16



CHERRY CREEK, COLO.

CHERRY CREEK DAM

ULTIMATE DEVELOPMENT

SPILLWAY TAILWATER

CURVES

FOR STATION 171+90

S.A.M. 2-5-44