

HYD 6

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

Branch of Design and Construction
Engineering and Geological Control
and Research Division
Denver, Colorado
April 9, 1936

Laboratory Report No. 6
Hydraulic Laboratory
Compiled by: J. E. Warnock

Subject: Diversion of river through west cofferdam area -
Grand Coulee Dam - Columbia Basin Project.

On October 19, 1935, Construction Engineer F. A. Banks, U. S. Bureau of Reclamation, Coulee Dam, and Engineer C. D. Riddle, Mason-Walsh-Atkinson-Kier Co., visited the hydraulic laboratory at Fort Collins, Colorado, at which time model studies of the proposed diversion through the west cofferdam area were discussed. In a letter of November 11, a set of contractor's drawings were received. Design and construction of a model to a scale ratio of 1:120 was begun immediately based on contractor's drawing D-207 (figure 1) and U.S.B.R. drawings 222-D-914 and 222-D-917 (as revised 9-21-35), which showed the general plan and sections of the diversion conditions.

The model as originally built had the sections 31 to 39, inclusive, as shown in Test 1, table 1. The tops of sections 8 to 30, inclusive, were built to elevation 1010 and 1005 as shown on U.S.B.R. drawing 222-D-914 and 222-D-917 and joints were placed in the model so that the sections could be removed to elevation 950 and 960 if it developed that additional discharge capacity would be required as a result of the model studies.

The model was completed ready for observation on January 31, 1936. The adverse conditions of flow through section 31 and over the powerhouse training wall led to the raising of that section to elevation 1005 and the powerhouse training wall to its ultimate height of elevation 980. While this alteration cut down the effective discharge area of the floodway, the training wall served to prevent the spreading of the stream to the left into the tailrace. That was the status of the model when you inspected it on February 1. Observations (Test 2) were made on this arrangement consisting of water surface profiles through the floodway and point gage and velocity traverses in the narrow portion of the

tailrace channel between the downstream cluster of cellular cofferdams and the riprapped slope shown as section 1 on figure 1. The tailwater rating curve used and the headwater rating curve obtained in Test 2 is shown on figure 2. The point gage traverses of section 1 for Test 2 is shown on figure 3.

On February 24, 25 and 26, Consulting Engineer S. H. Woodward, Mason-Walsh-Atkinson-Kier Co., visited the laboratory accompanied by Engineer J. J. Hammond and myself. In the course of the observations, it was noticed that with a discharge of 500,000 second-feet passing through sections 32 to 39, inclusive, large eddies developed in the tailrace causing some erosion on the riprapped slope. Fifty-foot sections were removed in the powerhouse area to elevation 960 and 955 to provide additional water passages thus establishing a current through the eddies, improving flow conditions and reducing the head differential through the passages. The advisability of omitting either or both sections 30 and 31 above elevation 960 was discussed at some length and the decision was made to construct section 31 to elevation 1010 to provide for the concrete cooling towers and to omit section 30 above elevation 960. A program of further tests was developed based on these decisions.

A telegram was received on February 29, confirmed later by a letter from Construction Engineer Banks, saying that the fifty-foot sections in the powerhouse area could not be used as flood passages on account of the trestle bents and bracing. It was suggested that the 25-foot sections, being free of obstructions, could be used in combination with sections 13 and 30. At the same time, attention was called by Engineer Hammond to the undesirable condition which might prevail should section 30 be omitted above elevation 960 and 955 due to the necessity of having the reinforcing steel around the turbine penstock in that section above these elevations exposed to the action of the flood flow. Contractor's drawing A-55 (figure 1-A) accompanying the letter of February 29 showed the location of the trestle bents in the passageway from section 32 to 39, inclusive, and the model was revamped to incorporate this feature and the program of testing revised accordingly.

On March 16, Engineer C. D. Riddle visited the Fort Collins laboratory, and on March 17, the Denver office, to witness and discuss the model tests. It was decided to incorporate the trestle bents in sections

32 to 39, inclusive, and in section 30, into piers by filling in between the I-beams in a plane normal to the axis of the dam and adding a nose and tail upstream and downstream, respectively. The floor of all water passages were made level at the elevation of the highest blocks in each section. The undesirable condition in section 30 was eliminated by making Blocks A, B, C, and D at elevation 960, Block E at elevation 940, Block F at elevation 925 and Block G at elevation 920. The use of a crib upstream from section 31 was considered as a means of improving the flow conditions.

A final program consisting of 11 tests was developed incorporating all the changes suggested by both the contractor and bureau engineers. To expedite the completion of this program, Tests 3 and 4 were deleted entirely. The condensed program is shown in Table 1 with the arrangement of the blocks and the data that have been or will be obtained from each test. At the time of the preparation of this preliminary report all of the data had been taken except the velocity traverse at sections 2, 3 and 4 for 500,000 second-feet in Test 11. All of the material indicated in the first six data columns of Table 1 is included in this report except the above-mentioned omission. The additional data will be compiled and submitted in the near future. A reel of 16 mm. motion picture films is being prepared and will be ready as soon as the titling is completed.

The headwater and tailwater curves are shown on figure 2. The marked decrease in head differential can be seen in a comparison of Test 2, where only sections 32 to 39 inclusive, were used with any other test where additional sections have been omitted. From the extremely close grouping of the headwater data for Tests 6 to 9, inclusive, there appears to be a limitation beyond which the omission of additional sections produces an extremely small reduction of the head differential. The use of the cribs at the upstream face of section 31 and 39 cause a marked decrease in the head differential; more so in Test 10 than in Test 11.

The traverses at sections 1, 2, 3 and 4 (figure 1) were made at the conclusion of each run as indicated to show the condition of the river bed. The river bed was restored to its original condition (figure 1 and plate 3) at the beginning of each test so that the cross-sections, figures 4, 5, 6 and 7, are comparable. The increase of scour shown in

Tests 10 and 11 was caused by the longer length of time in those tests as compared to Tests 6 to 9, inclusive. It was necessary in Tests 6 to 9, to limit the length of each run due to the necessity of expediting the test program, but in Tests 10 and 11, sufficient time was allowed for the river bed to reach a state of equilibrium. In tests 6 to 9, inclusive, the river bed conditions were obtained by increasing the discharge by increments of 100,000 second-feet until the total discharge was established. The flow at each increment was maintained for fifteen minutes or as in the case of 500,000 second-feet, the total duration was one hour and fifteen minutes. This procedure did not necessarily allow time to establish equilibrium, but it did serve as a basis of comparison.

The velocity distribution at section 1 is shown on figures 8 to 13, inclusive. This section was established as requested by Engineer Riddle in a letter to Construction Engineer Banks on February 7, which said, "It might be useful to us to have such preliminary data ... the velocity at the restricted point between Section C of the cofferdam and the tailrace slope ..."

The velocity distribution at sections 2, 3 and 4 is shown on figures 14 and 15. These sections were established to comply with your request for velocity data to present to the consulting board at their meeting at Coulee Dam on April 13.

The results obtained from Tests 6 to 9, inclusive, indicated that Test 7 or 9 would give the most satisfactory results. Accordingly, Test 10 was made as a repetition of Test 9 to obtain detailed data and incorporate the cribs at the upstream end of sections 31 and 39 and Test 11 was made as a repetition of Test 7 with a crib at the upstream end of section 31.

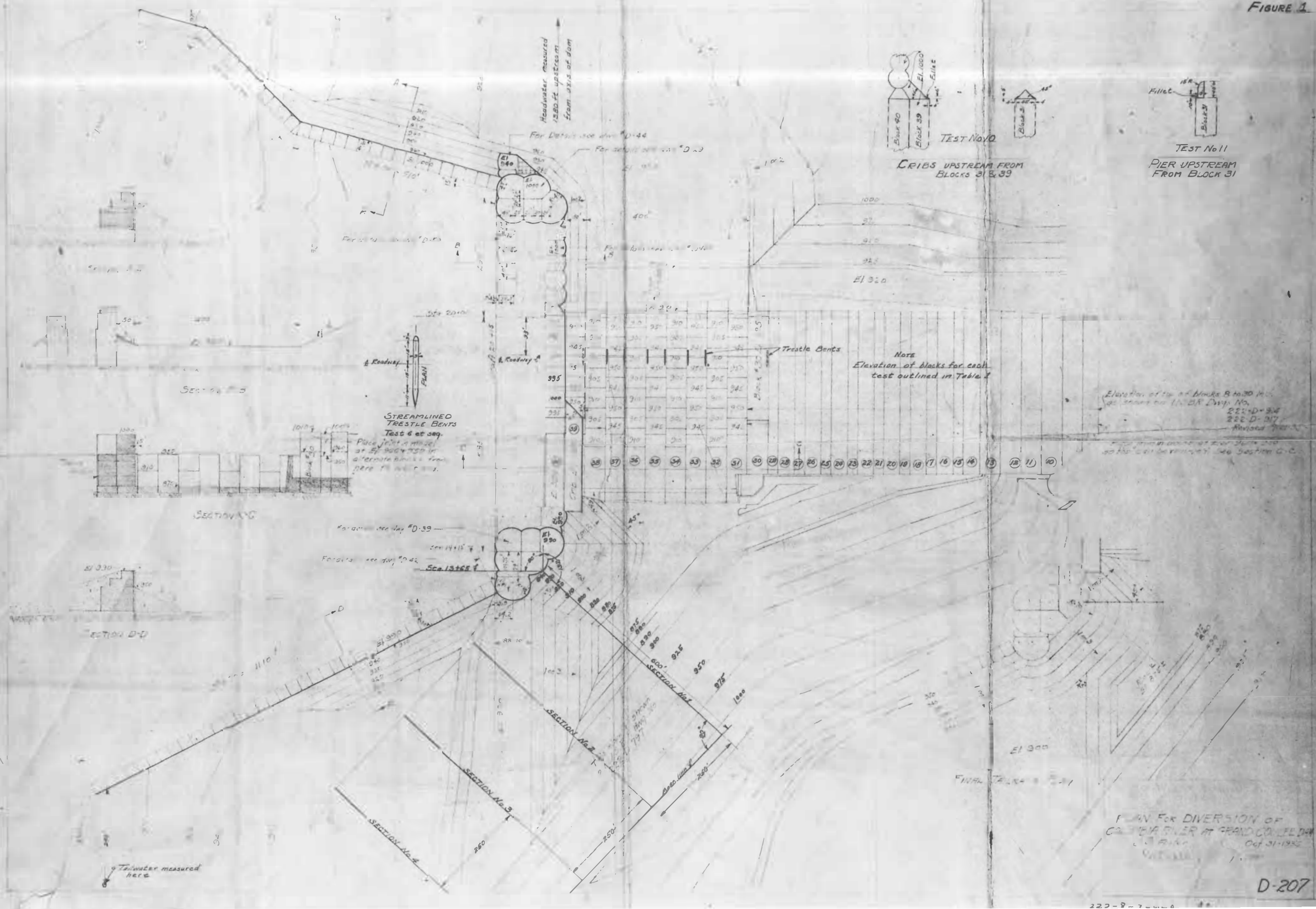
From the results of Tests 10 and 11, it is believed that the former is more satisfactory due (1) to the reduction of the head differential through the passageways and (2) to the lesser scour in the river channel and along the riprapped slope.

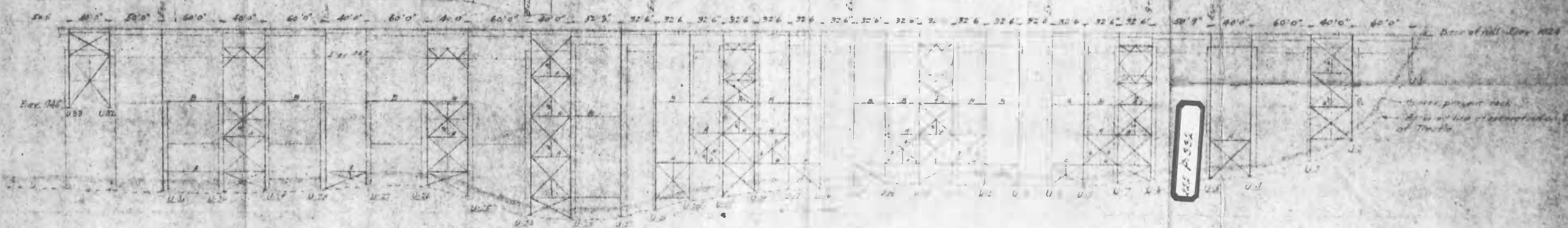
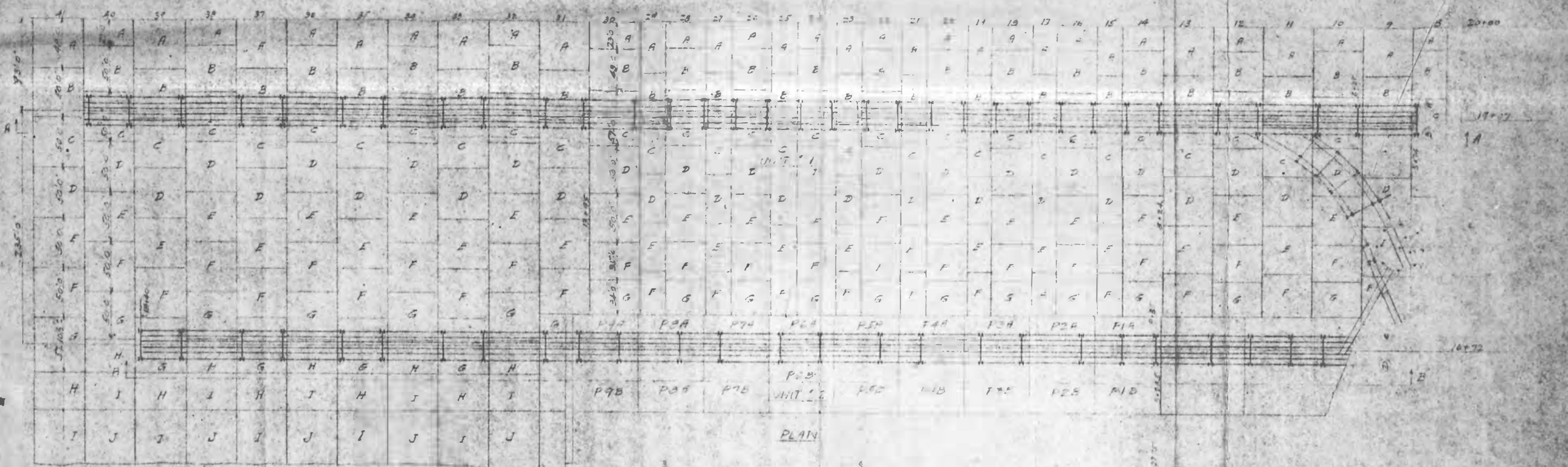
TABLE I

**SUMMARY OF TESTS AND DATA ON 1:120 MODEL OF RIVER DIVERSION
THROUGH WEST COTTREDDAN AREA AT GRAND COULEE DAM**

[illegible]

FIGURE 1





Members marked 2 to be removed when
tariffs has been poured to within 2" or
better of member. The member used again
in Unit 3.

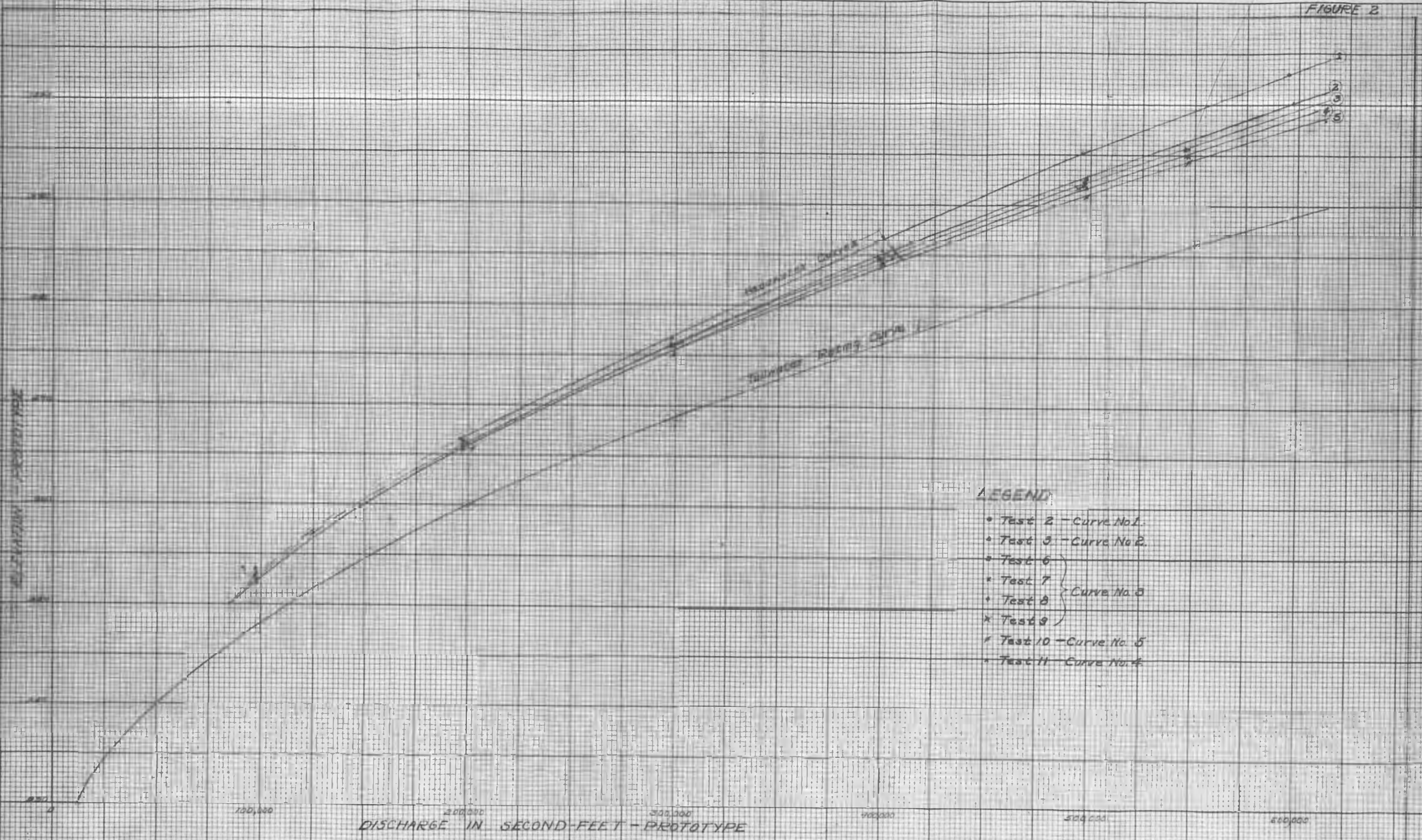
Members marked 2 to be removed when
tariffs has been poured to within 32" of
top of member and used again in Unit 3.



The first of these is the fact that the
 first of the two is a "good" one, and the
 second is a "bad" one. The first is a
 "good" one because it is a "good" one, and
 the second is a "bad" one because it is a
 "bad" one. The first is a "good" one
 because it is a "good" one, and the second
 is a "bad" one because it is a "bad" one.

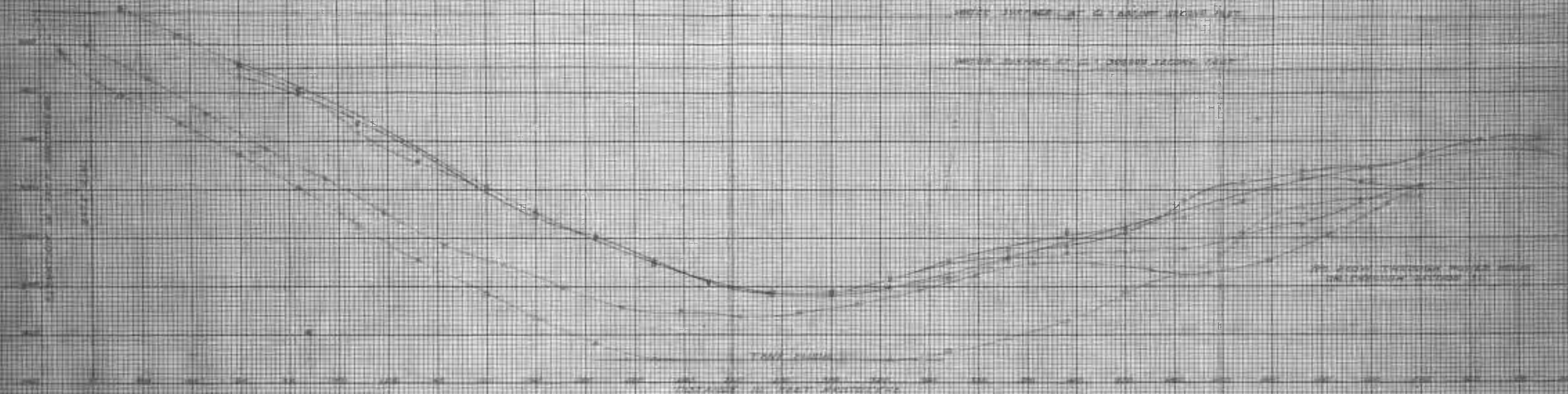
[illegible]

FIGURE 2

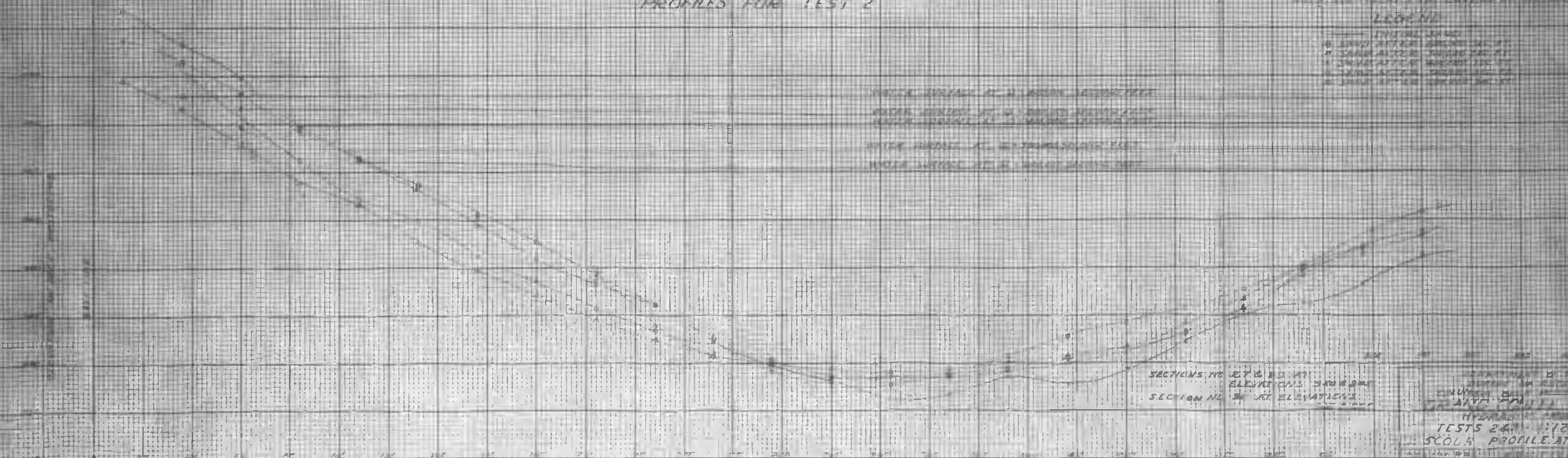


DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
CALIFORNIA, BEAVER PROJECT, WASHINGTON
SECOND COURSE, TURKEY
HYDRAULIC MODEL STUDIES
KOSUMATKA AND TAYLOR, JUN. 1916
CONSTRUCTION - LEFT SIDE - NO. 12, 14, 15, 16
DATE 1916
BY J. H. M. S. J. H. M. S. J. H. M. S.

FIGURE 3



PROFILES FOR TEST 2



PROFILES FOR TEST 3

LEGEND

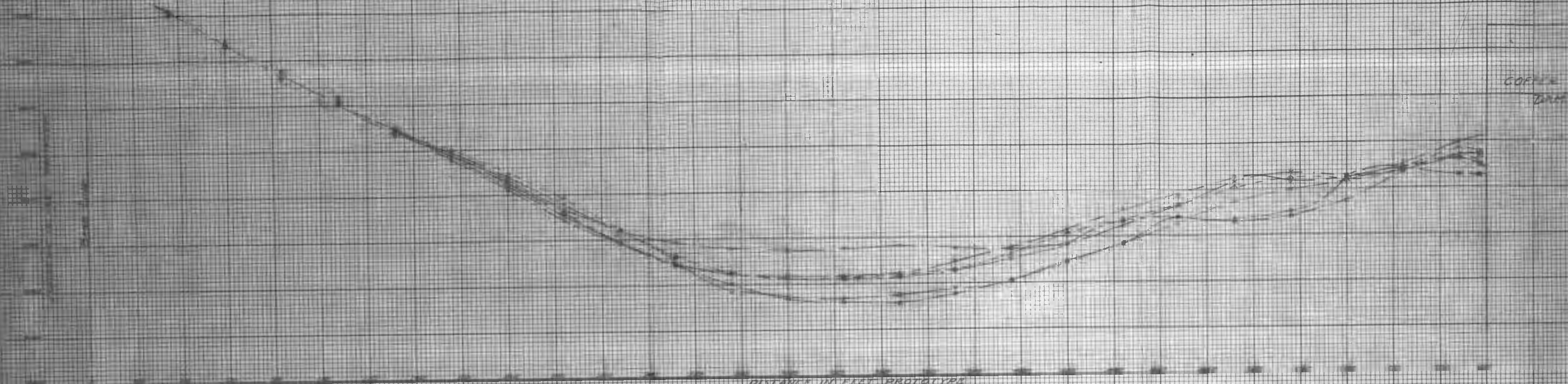
- 1. INITIAL SURFACE
- 2. SURFACE AFTER 10 MIN. AT 1.5
- 3. SURFACE AFTER 20 MIN. AT 1.5
- 4. SURFACE AFTER 30 MIN. AT 1.5
- 5. SURFACE AFTER 40 MIN. AT 1.5

SECTIONS NO. 1, 2, 3, 4, 5
ELEVATIONS 1.5, 2.0, 2.5, 3.0, 3.5
SECTION NO. 1 AT ELEVATION 1.5

TESTS 2, 3, 4, 5
SCOUR PROFILE AT SECTION 1

TRACED
CHECKED
RECOMMENDED
APPROVED

2224 J-WMB-22 FORT COCKING, CALIF. 3/17/54



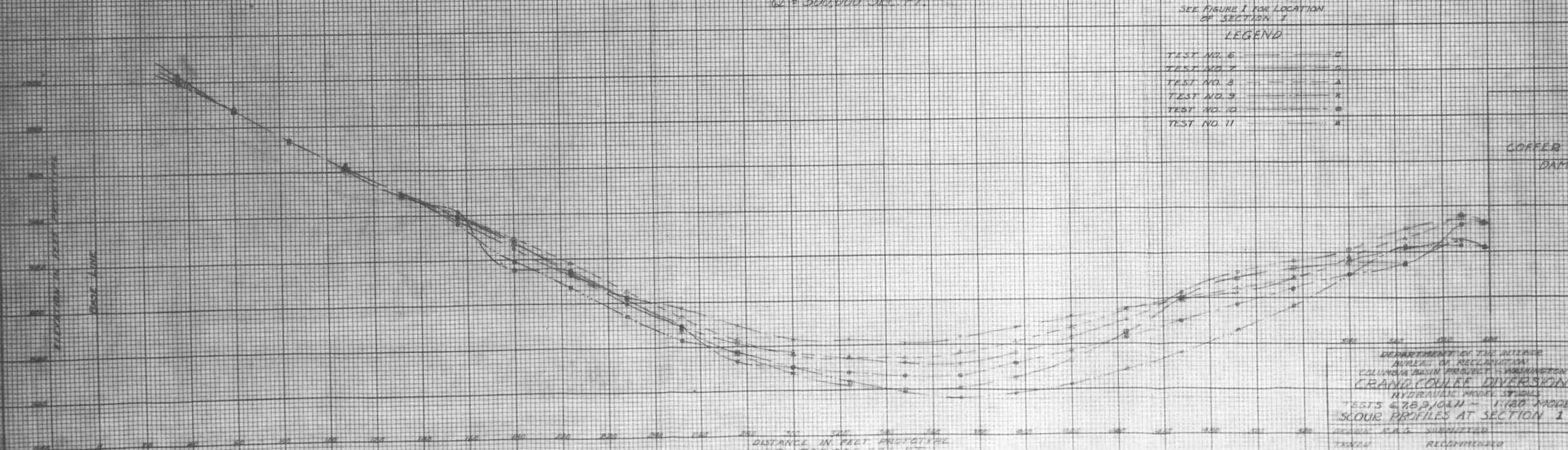
DISTANCE IN FEET, PROTOTYPE
 $Q = 300,000$ SEC. FT.

SEE FIGURE 1 FOR LOCATION
 OF SECTION 1

LEGEND

- TEST NO. 6 ———— D
- TEST NO. 7 ———— D
- TEST NO. 8 ———— A
- TEST NO. 9 ———— X
- TEST NO. 10 ———— O
- TEST NO. 11 ———— B

COFFER
 DAM

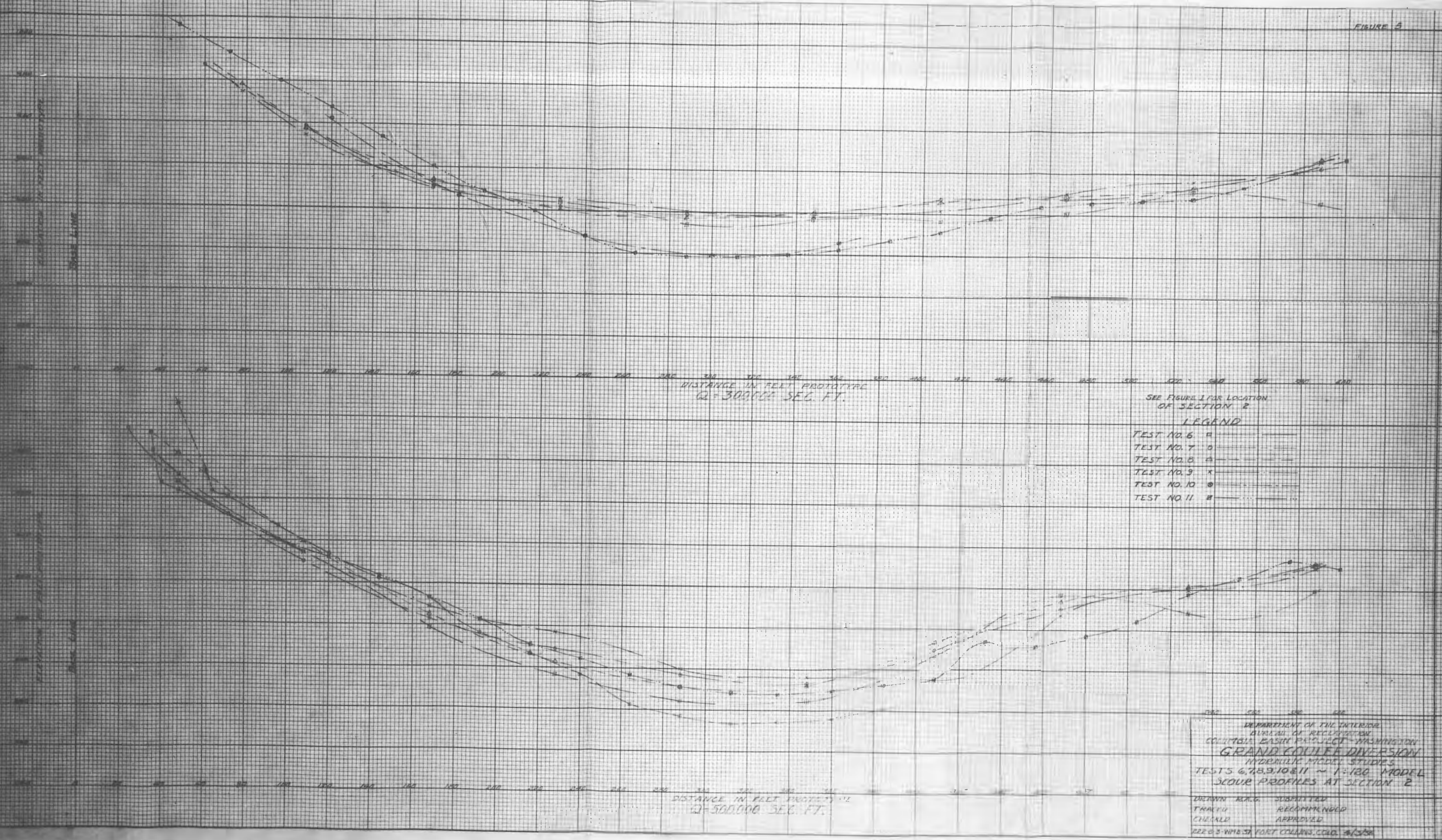


DISTANCE IN FEET, PROTOTYPE
 $Q = 500,000$ SEC. FT.

COFFER
 DAM

DEPARTMENT OF THE INTERIOR
 BUREAU OF RECLAMATION
 COLUMBIA BASIN PROJECT - WASHINGTON
 GRAND COULEE DIVERSION
 HYDRAULIC MODEL STUDIES
 TESTS 6, 7, 8, 9, 10, 11 - 1:120 MODEL
 SCOUR PROFILES AT SECTION 1
 DRAWN P.A.G. SUBMITTED
 TRACED RECOMMENDED
 CHECKED APPROVED
 BOE-3-3 WPS-34 PORT COLLINS, COLO. 3-10-36

FIGURE 5



SEE FIGURE 1 FOR LOCATION OF SECTION 2

LEGEND

- TEST NO. 6 $\square$
- TEST NO. 7 $\circ$
- TEST NO. 8 $\triangle$
- TEST NO. 9 $\times$
- TEST NO. 10 $\diamond$
- TEST NO. 11 $\ast$

DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
COLUMBIA BASIN PROJECT - WASHINGTON
GRAND COULE DIVERSION
HYDRAULIC MODEL STUDIES
TESTS 6, 7, 8, 9, 10 & 11 ~ 1:120 MODEL
SCOUR PROFILES AT SECTION 2

DRAWN R.A.G. SUBMITTED
TRACED RECOMMENDED
CHECKED APPROVED

REG-5-WH-37 FORT COLLINS, COLO. 4/3/58

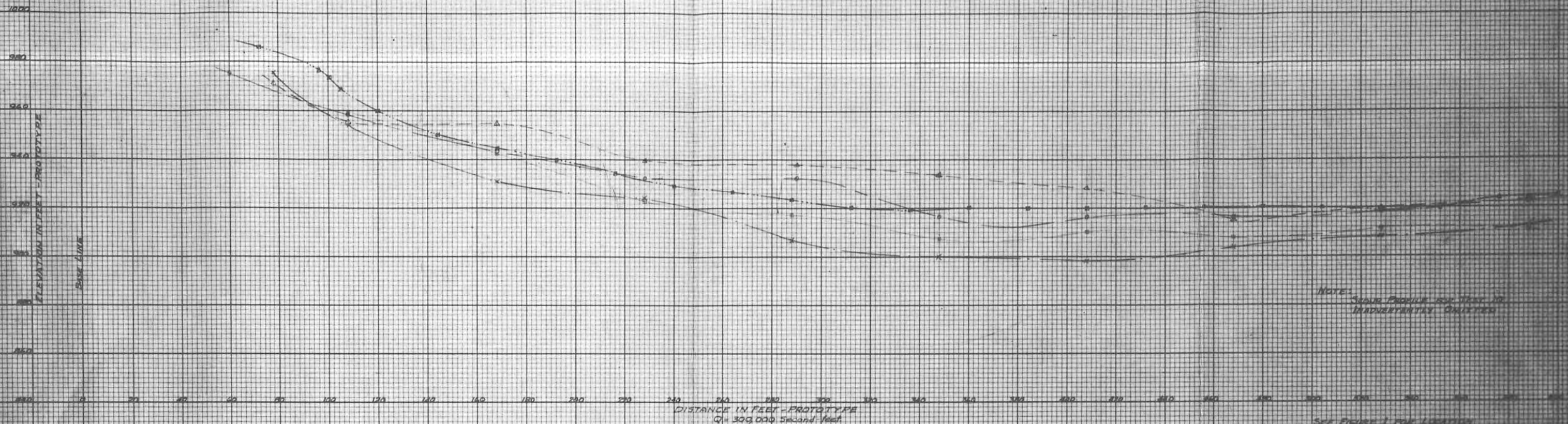
DISTANCE IN FEET PROTOTYPE
Q = 500,000 cfs

SEE DRAWING FOR LOCATION
OF SECTION 3

- TEST NO. 6
- TEST NO. 7
- TEST NO. 8
- TEST NO. 9
- TEST NO. 10
- TEST NO. 11

DISTANCE IN FEET PROTOTYPE
Q = 500,000 cfs

HYDRAULIC MODEL STUDIES
TESTS 6, 7, 8, 9, 10, 11
SCOUR PROFILES SECTION 3
APPROVED
RECEIVED
RECEIVED

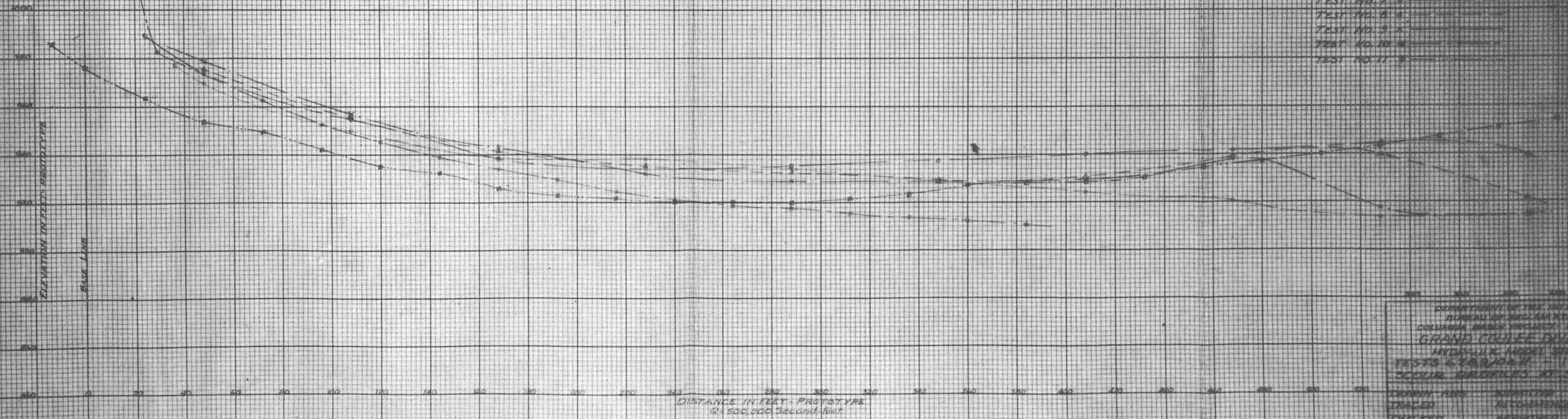


NOTE:
Scour Profile for Test 10
Individually Only

SEE FIGURE 1 FOR LOCATION
OF SECTION A

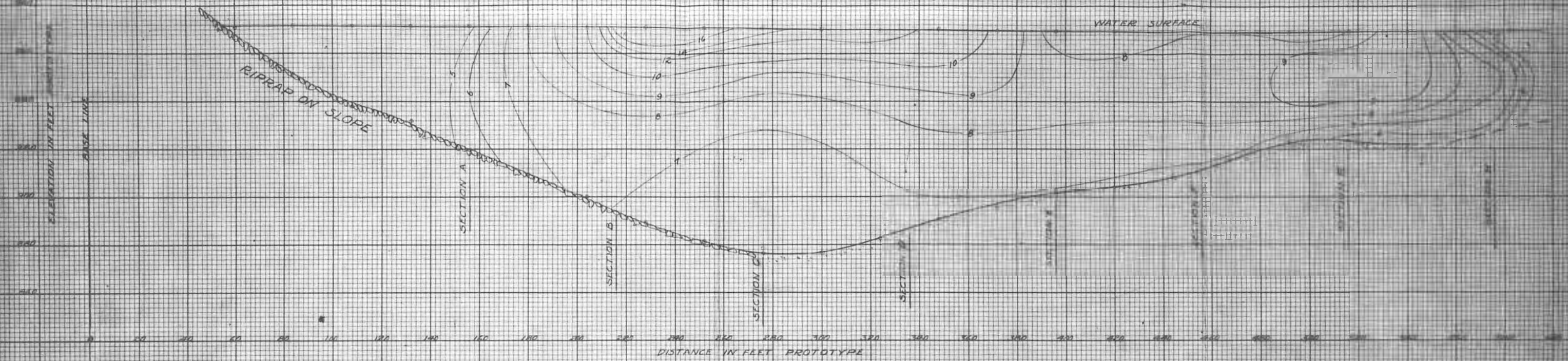
LEGEND

- TEST NO. 6
- TEST NO. 7
- TEST NO. 8
- TEST NO. 9
- TEST NO. 10
- TEST NO. 11



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BUREAU OF RECLAMATION
COLUMBIA RIVER PROJECT - WASHINGTON
GRAND COULEE DIVERSION
HYDRAULIC MODEL STUDIES
TESTS 6-11, 1934 - 1/200 MODEL
SCOUR PROFILES AT SECTION A

DESIGNED BY	REVIEWED BY
TRACED	RE-DESIGNED
CHECKED	APPROVED
SEE 6-3 FOR SCOUR PROFILES	



PROTOTYPE ISOVELS AT SECTION 1

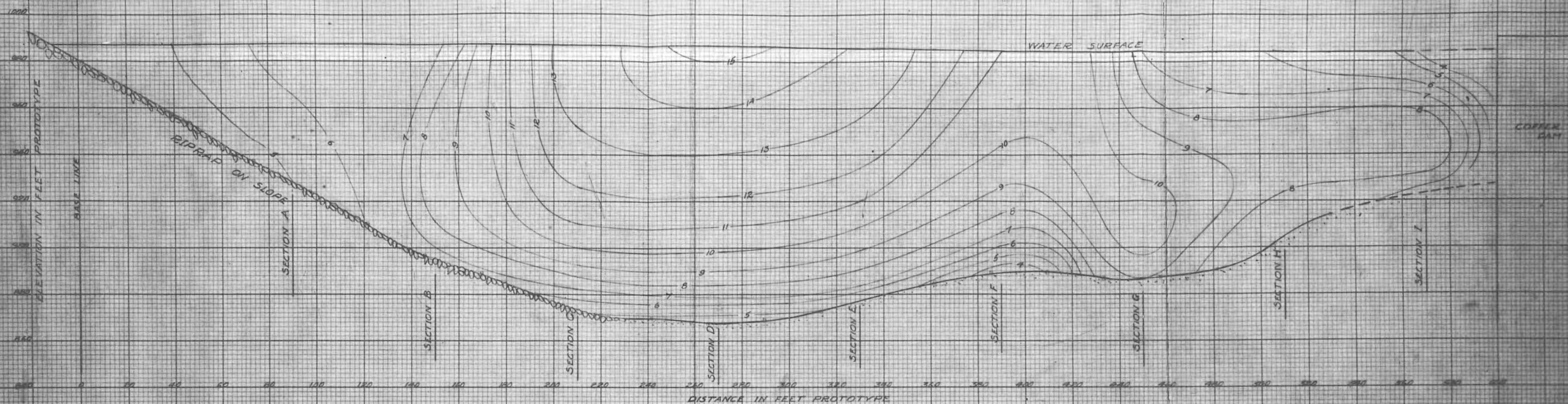
NOTE: ELEVATION IS IN FEET
 ALL MEASUREMENTS ARE IN FEET
 SECOND PROTOTYPE
 SEE FIGURE 1 FOR LOCATION OF SECTION 1



PROTOTYPE VELOCITIES AT VARIOUS VERTICALS

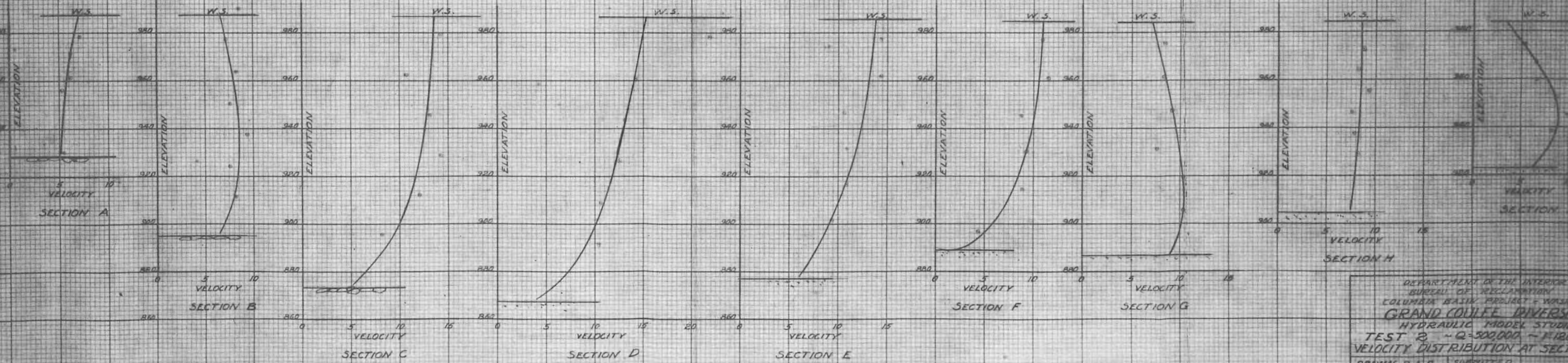
DEPARTMENT OF THE INTERIOR
 BUREAU OF RECLAMATION
 COLUMBIA BASIN PROJECT - WASHINGTON
 GRAND COULEE DIVERSION
 HYDRAULIC MODEL STUDIES
 TEST 2 - Q = 300,000 - 1:120 MODEL
 VELOCITY DISTRIBUTION AT SECTION 1
 DRAWN BY G. SUBMITTED
 TRACED RECOMMENDED
 CHECKED APPROVED
 JUNE 5, 1968 R. E. COLLINS, COLD, 3446

FIGURE 9



PROTOTYPE ISOVELS AT SECTION 1

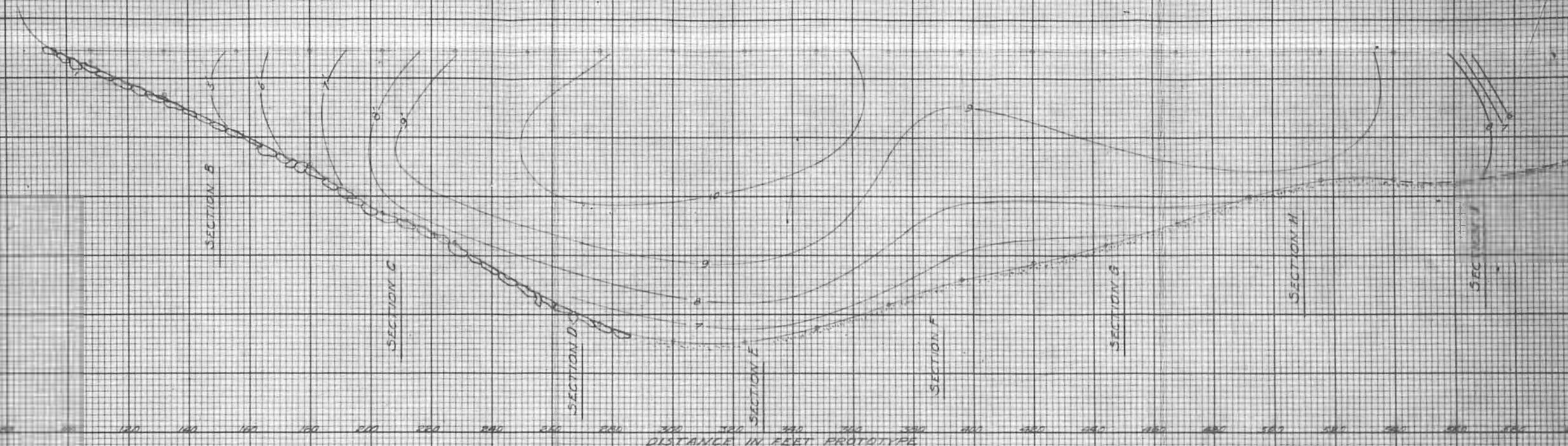
NOTE: BLOCKS NO. 8 TO 31 POURED TO FINAL POSITION.
SEE FIGURE 1 FOR LOCATION OF SECTION 1.
ALL VELOCITIES ARE IN FEET PER SECOND PROTOTYPE.



PROTOTYPE VELOCITIES AT VARIOUS VERTICALS

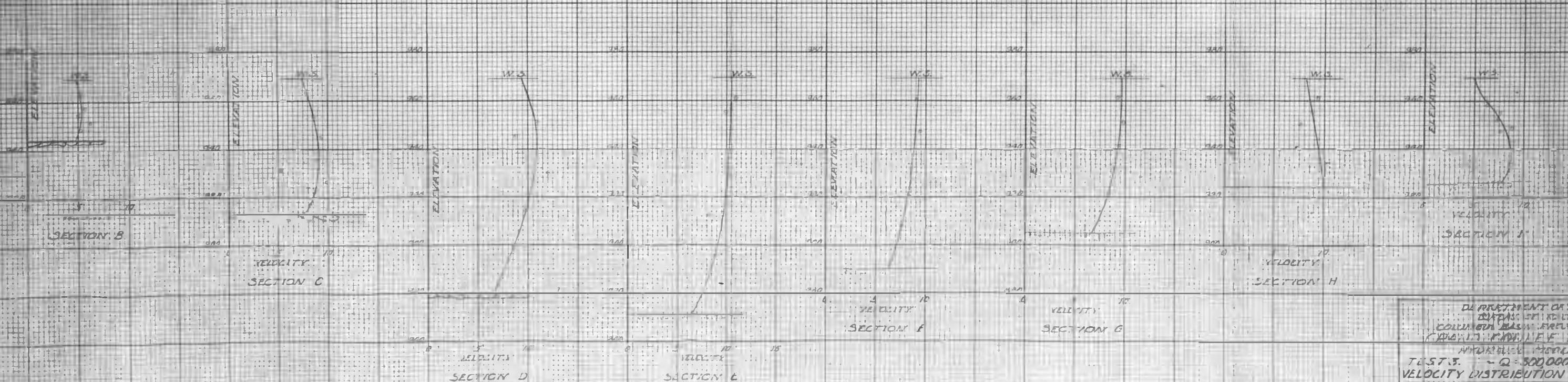
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
COLUMBIA BASIN PROJECT - WASHINGTON
GRAND COULE DIVERSION
HYDRAULIC MODEL STUDIES
TEST 2 - Q-500000 - F180 MODEL
VELOCITY DISTRIBUTION AT SECTION 1
DRAWN R.A.G. SUBMITTED
TRACED RECOMMENDED
CHECKED APPROVED
R22-B-3-WINDYFT COLLINS, COLO. 3/6/54

FIGURE 10



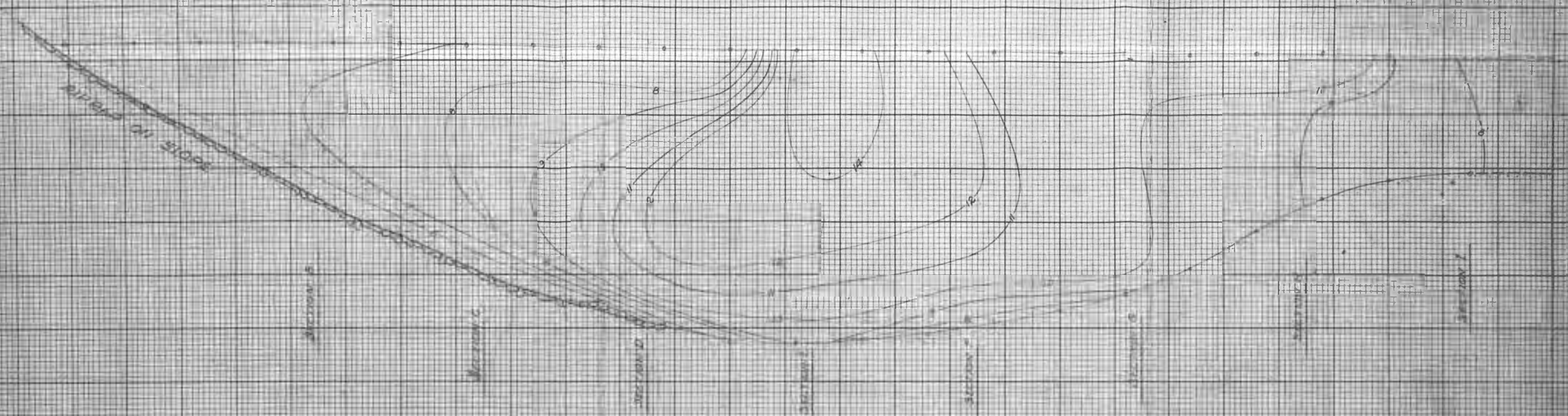
150VELS ACROSS TAIL RACE

NOTE
BLOCKS NO. 27 & 29 AT ELEVATION 950 & 965
BLOCK NO. 30 AT ELEVATION 960 & 955
BLOCK NO. 31 AT ELEVATION 1005 & 1000
SEE FIGURE 1 FOR LOCATION OF SECTION NO. 1.
ALL VELOCITIES ARE FEET PER SECOND PROTOTYPE



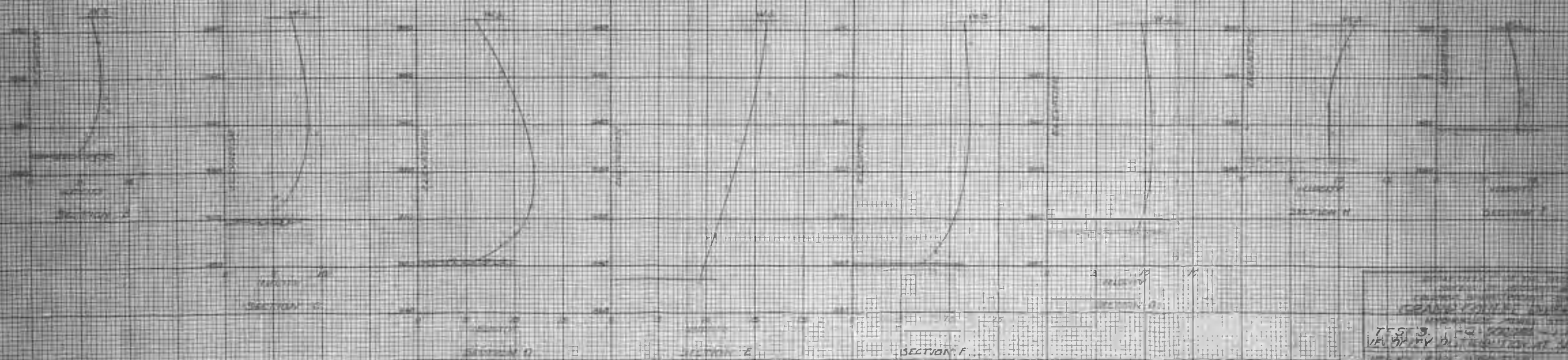
PROTOTYPE VELOCITIES AT VARIOUS VERTICAL

DEPARTMENT OF THE ARMY
DISTRICT ENGINEERING OFFICE
COLUMBIA BASIN PROJECT
COLUMBIA RIVER DIVISION
HYDROLOGIC WORKS STATION
TEST S. - Q. 300,000 - T. 120' H.P.
VELOCITY DISTRIBUTION AT SECTION 1.
SECTION B - E. VIEW
DATE: 11/1/54
BY: [Signature]
CHECKED: [Signature]
APPROVED: [Signature]
E. J. [Signature] COL. U.S. ARMY



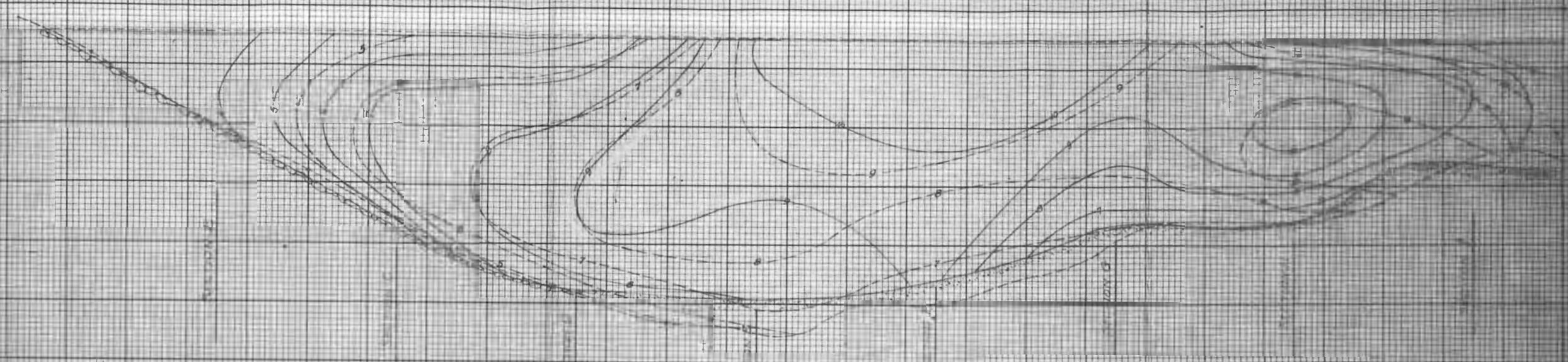
MOVELS ACROSS TAIL FACE WITH
WATER SURFACE 5.50 IN

NOTE: BLOCK NO 27 IS AT ELEVATION 1000.0 AND
BLOCK NO 31 AT ELEVATION 1000.0 AND
BLOCK NO 37 AT ELEVATION 1000.0 AND
SEE MAPS FOR THE LOCATION OF THE
AND LOCATIONS FOR THE OTHER BLOCKS.



PROTOTYPE VELOCITIES AT VARIOUS VERTICALS

7559



SECTIONS ACROSS REACH WITH WATER SURFACE & SOUND

TEST 10
TEST 11

NOTES

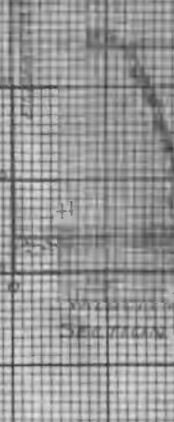
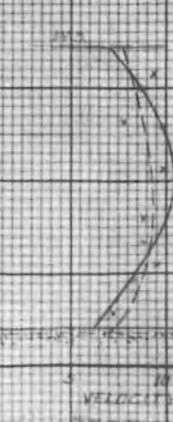
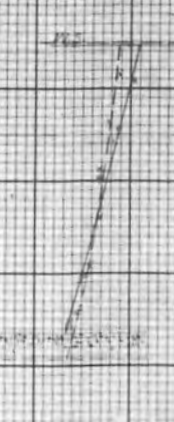
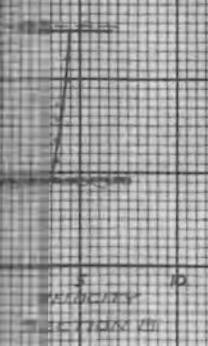
TEST 11

SECTIONS 12, 23, 25, 27, 29, 31, 33 AND 35 ARE
LEVEL AT EL. 950
IN SECTIONS 12, 17, 19 AND 31 BLOCKS B, C AND D
AT EL. 1000 AND BLOCKS B AND D AT EL. 1000
SECTION 20 BLOCKS B, C AND D AT EL. 1000
AND BLOCKS B AND D AT EL. 1000
SECTIONS 32, 34, 36, 37 AND 38 ARE LEVEL
AT EL. 910
STRAIGHT LINES DRAWN FROM EL. 910
TO EL. 950

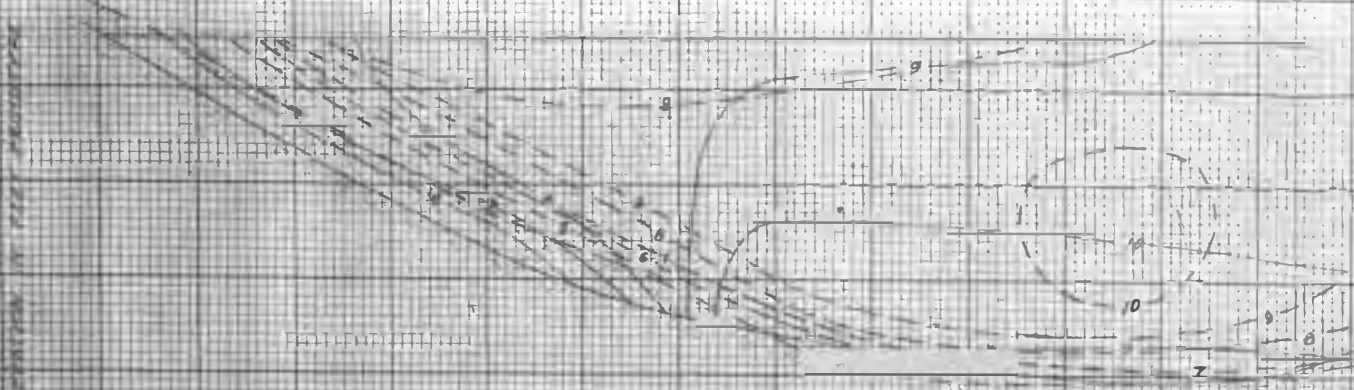
NOTES

TEST 10

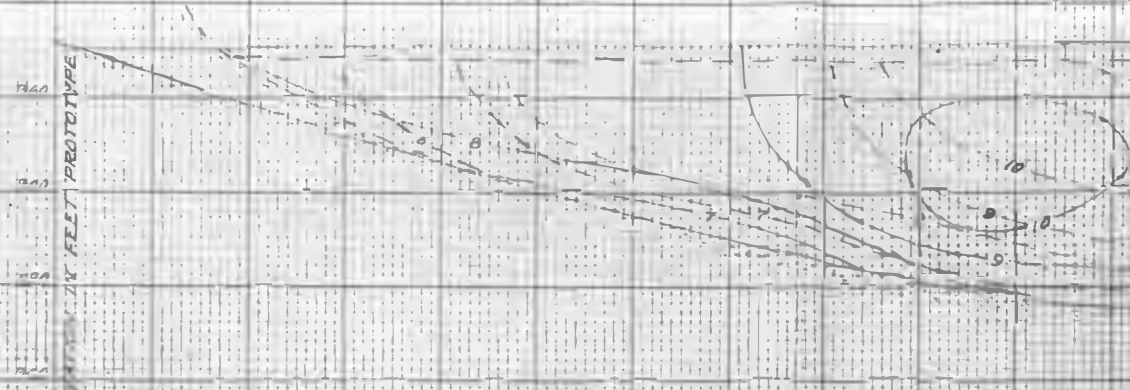
SECTION 11 AT EL. 910 AND 950
SECTION 11 AT EL. 910 AND 950
SECTION 11 AT EL. 910 AND 950
SECTION 11 AT EL. 910 AND 950
SECTION 11 AT EL. 910 AND 950
SECTION 11 AT EL. 910 AND 950
SECTION 11 AT EL. 910 AND 950
SECTION 11 AT EL. 910 AND 950



SECTION	EL. 910	EL. 950
11	0.0	0.0
12	0.0	0.0
13	0.0	0.0
14	0.0	0.0
15	0.0	0.0
16	0.0	0.0
17	0.0	0.0
18	0.0	0.0
19	0.0	0.0
20	0.0	0.0
21	0.0	0.0
22	0.0	0.0
23	0.0	0.0
24	0.0	0.0
25	0.0	0.0
26	0.0	0.0
27	0.0	0.0
28	0.0	0.0
29	0.0	0.0
30	0.0	0.0
31	0.0	0.0
32	0.0	0.0
33	0.0	0.0
34	0.0	0.0
35	0.0	0.0
36	0.0	0.0
37	0.0	0.0
38	0.0	0.0



DISTANCE IN FEET PROTOTYPE
PROTOTYPE VELOCITY AT SECTION 2

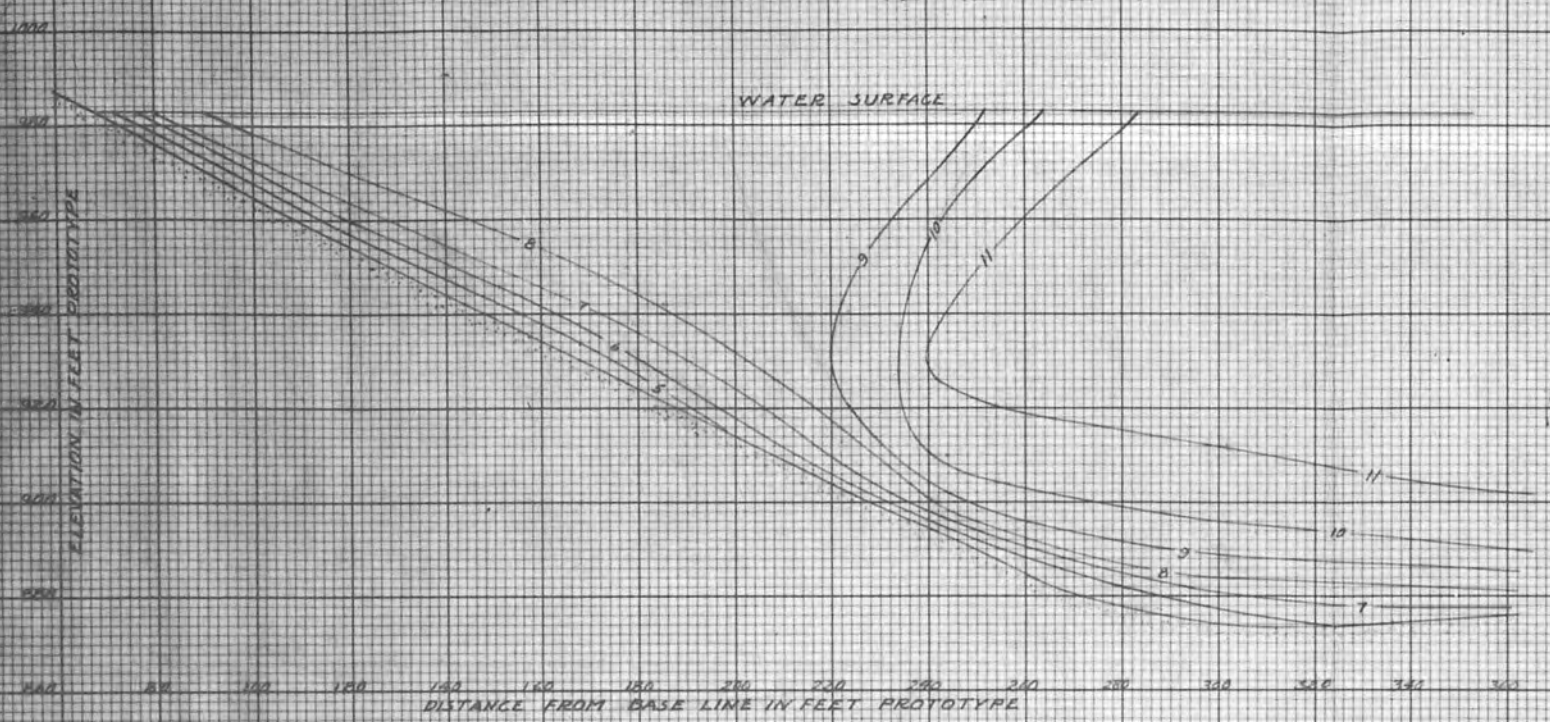


DISTANCE IN FEET PROTOTYPE
PROTOTYPE VELOCITY AT SECTION 2

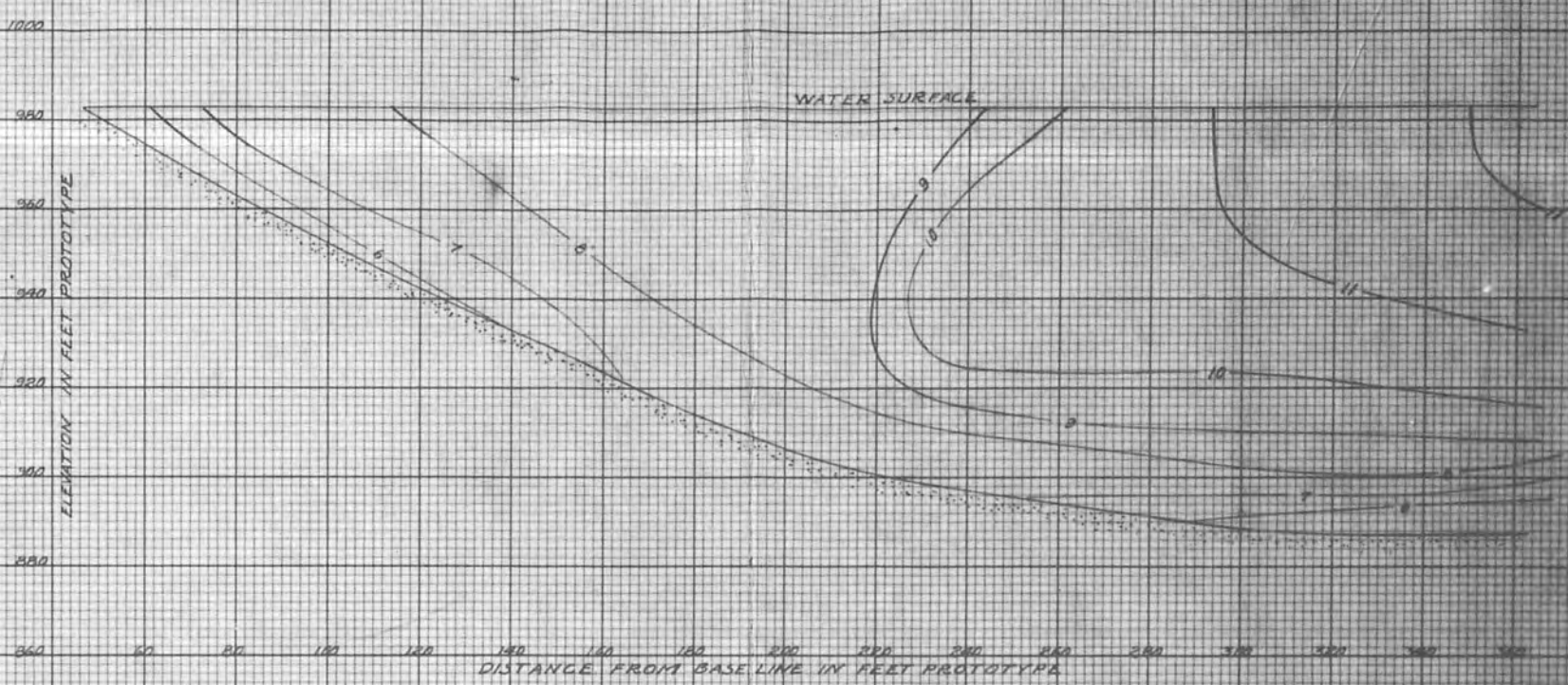
TEST 10
TEST 11

TEST 12

BLOCK NO. 13, 15, 17, 23, 25, 27, 29, 31, 33, 35, 37, 39, 41, 43, 45, 47, 49, 51, 53, 55, 57, 59, 61, 63, 65, 67, 69, 71, 73, 75, 77, 79, 81, 83, 85, 87, 89, 91, 93, 95, 97, 99, 101, 103, 105, 107, 109, 111, 113, 115, 117, 119, 121, 123, 125, 127, 129, 131, 133, 135, 137, 139, 141, 143, 145, 147, 149, 151, 153, 155, 157, 159, 161, 163, 165, 167, 169, 171, 173, 175, 177, 179, 181, 183, 185, 187, 189, 191, 193, 195, 197, 199, 201, 203, 205, 207, 209, 211, 213, 215, 217, 219, 221, 223, 225, 227, 229, 231, 233, 235, 237, 239, 241, 243, 245, 247, 249, 251, 253, 255, 257, 259, 261, 263, 265, 267, 269, 271, 273, 275, 277, 279, 281, 283, 285, 287, 289, 291, 293, 295, 297, 299, 301, 303, 305, 307, 309, 311, 313, 315, 317, 319, 321, 323, 325, 327, 329, 331, 333, 335, 337, 339, 341, 343, 345, 347, 349, 351, 353, 355, 357, 359, 361, 363, 365, 367, 369, 371, 373, 375, 377, 379, 381, 383, 385, 387, 389, 391, 393, 395, 397, 399, 401, 403, 405, 407, 409, 411, 413, 415, 417, 419, 421, 423, 425, 427, 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PROTOTYPE ISOVELS AT SECTION 2



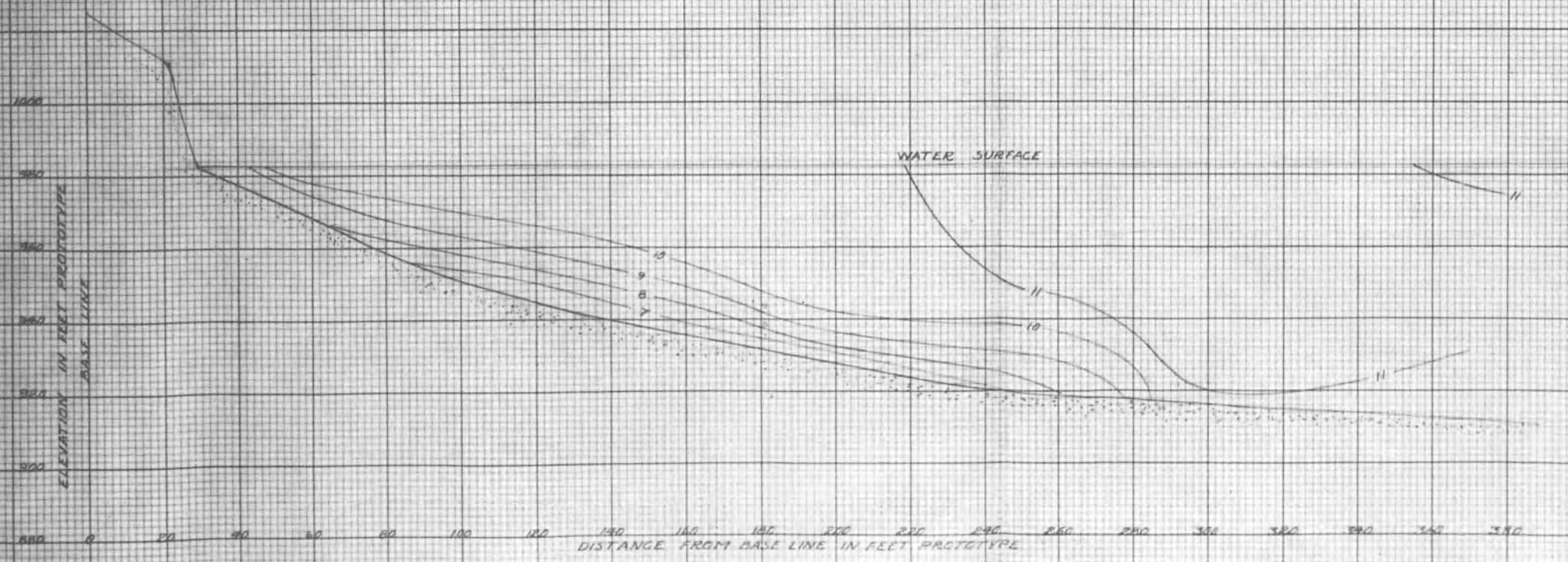
PROTOTYPE ISOVELS AT SECTION 3

NOTE

BLOCK NO. 39 AT ELEVATION 1005 AND 1000
 BLOCKS NO. 13, 15, 17, 23, 25 AND 29 LEVEL AT ELEVATION 980
 BLOCK 30 A, B, C AND D AT ELEVATION 960
 BLOCK 30 E AT ELEVATION 940
 BLOCK 30 F AT ELEVATION 925
 BLOCK 30 G AT ELEVATION 900

SEE FIGURE 1 FOR LOCATION OF SECTIONS 2, 3 AND 4

ALL VELOCITIES ARE IN FEET PER SECOND PROTOTYPE



PROTOTYPE ISOVELS AT SECTION 4

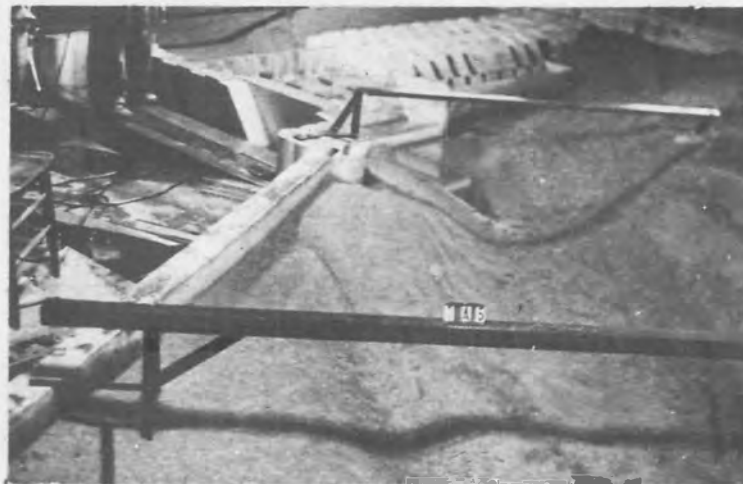
DEPARTMENT OF THE INTERIOR
 BUREAU OF RECLAMATION
 COLUMBIA BASIN PROJECT - WASHINGTON
GRAND COULEE DIVERSION
 HYDRAULIC MODEL STUDIES
 TESTS Q 500000 ~ 1120 MODEL
 VELOCITY DISTRIBUTION ALONG LEFT BANK
 DRAWN R.A.G. SUBMITTED
 TRACED RECOMMENDED
 CHECKED APPROVED
 REE-B.3 WRIGHT COLLINS, C.E.D. 4-7-56

GRAND COULÉE DIVERSION MODEL
Scale Ratio 1:120

PLATE I



Test 6



Test 7



Test 8



Test 9

Erosion below Dam after a Discharge of 500,000 Second-feet.



Test 6



Test 7



Test 8



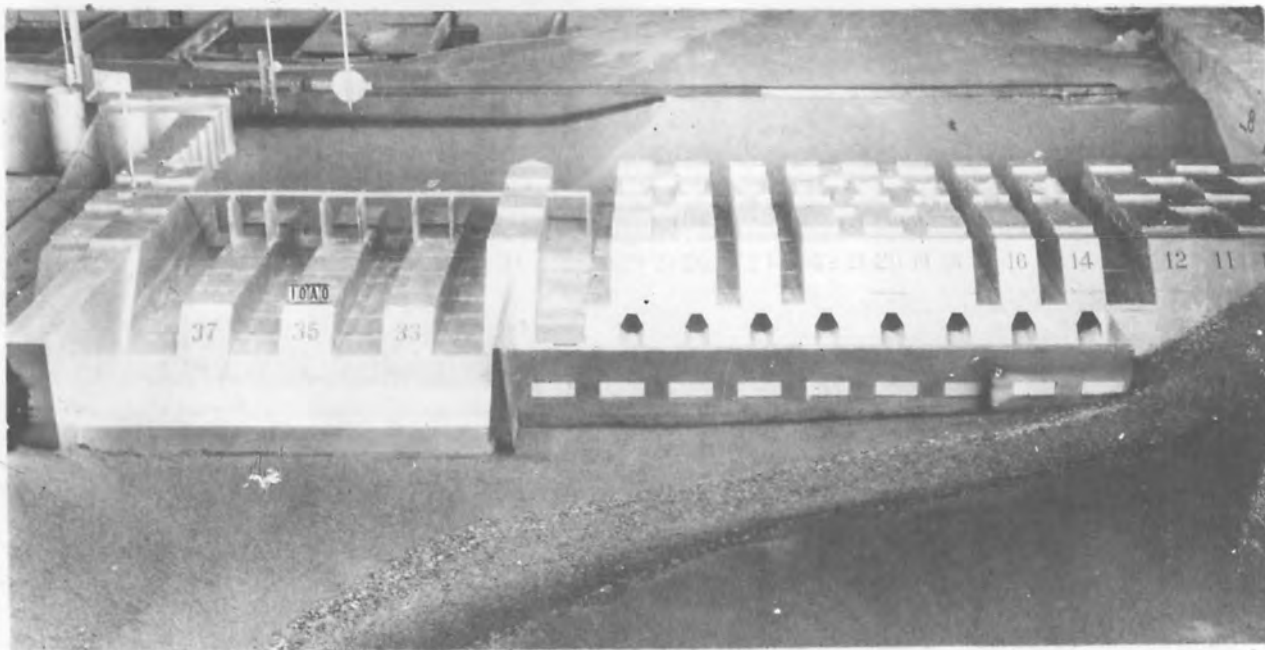
Test 9

Erosion below Dam after a Discharge of 500,000 Second-feet.

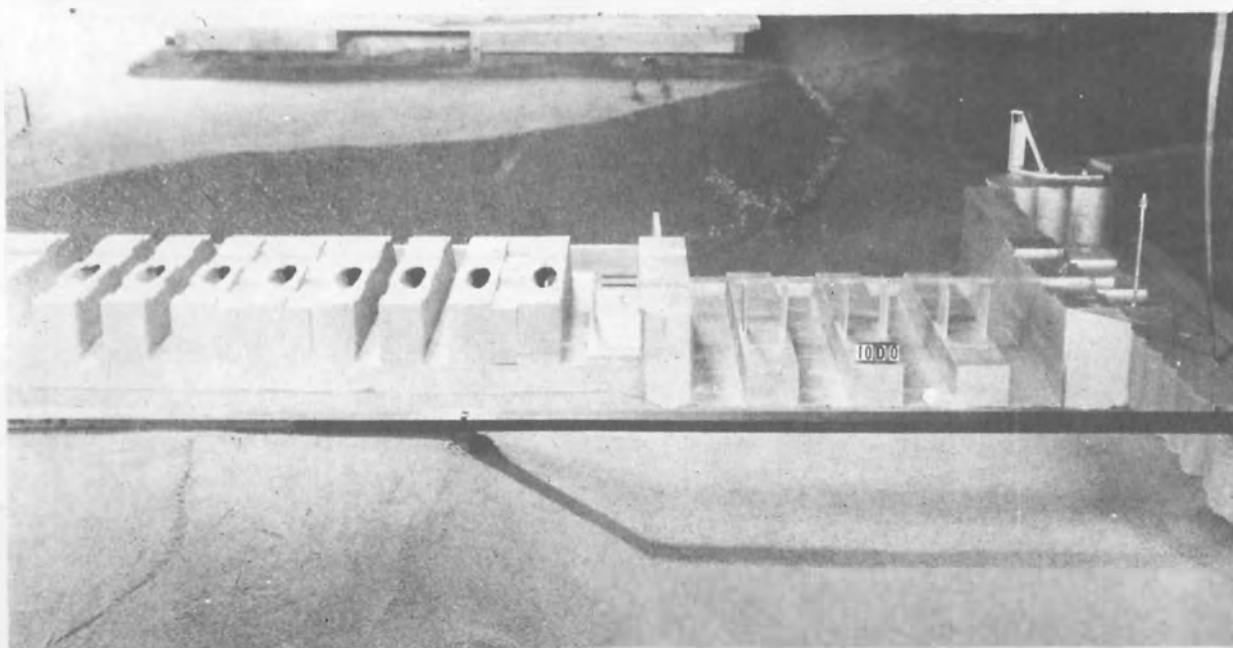
GRAND COULEE DIVERSION MODEL
Scale Ratio 1:120 Test 10.

Plate III

Flow through openings over blocks 13, 15, 17, 23, 25, 29, 30 and 32 to 38 inclusive. Each of these blocks except No. 30 level on top. Cribs upstream from blocks 31 and 39. Streamlined trestle bents in place.



Tailrace and Downstream Side of Dam



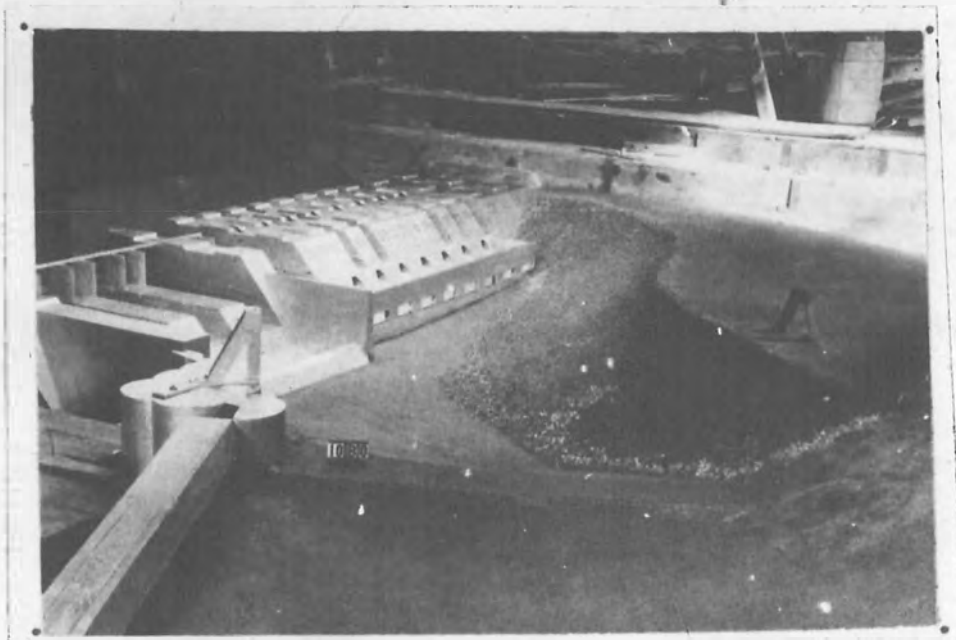
Upstream Side of Dam

Condition of River Bed before Test

GRAND COULEE DIVERSION MODEL
Scale Ratio 1:120 Test 10

PLATE IV

Flow through openings over blocks 13, 15, 17, 23, 25, 29, 30 and 32 to 38 inclusive. Each of these blocks except No. 30 level on top. Cribs upstream from blocks 31 and 39. Streamlined trestle bents in place.



Looking Upstream from Right Bank



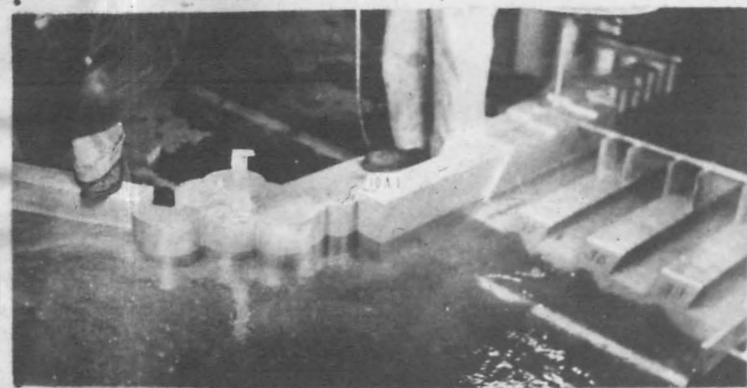
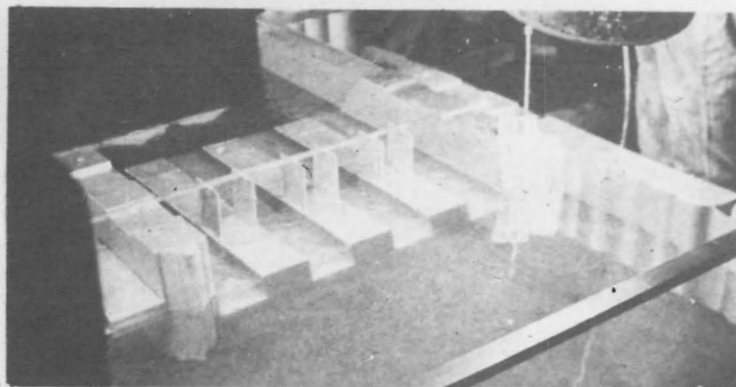
Close up of Spillway Section
Showing Trestle Bents.

Condition of River Bed before Test.

GRAND COULÉE DIVERSION MODEL
Scale Ratio 1:120 Test 10

PLATE V

Flow through openings over blocks 13, 15, 17, 23, 25, 29, 30 and 32 to 38 inclusive. Each of these blocks except No. 30 level on top. Cribs upstream from blocks 31 and 39. Streamlined trestle bents in place.



Discharge 100,000 Second-feet.



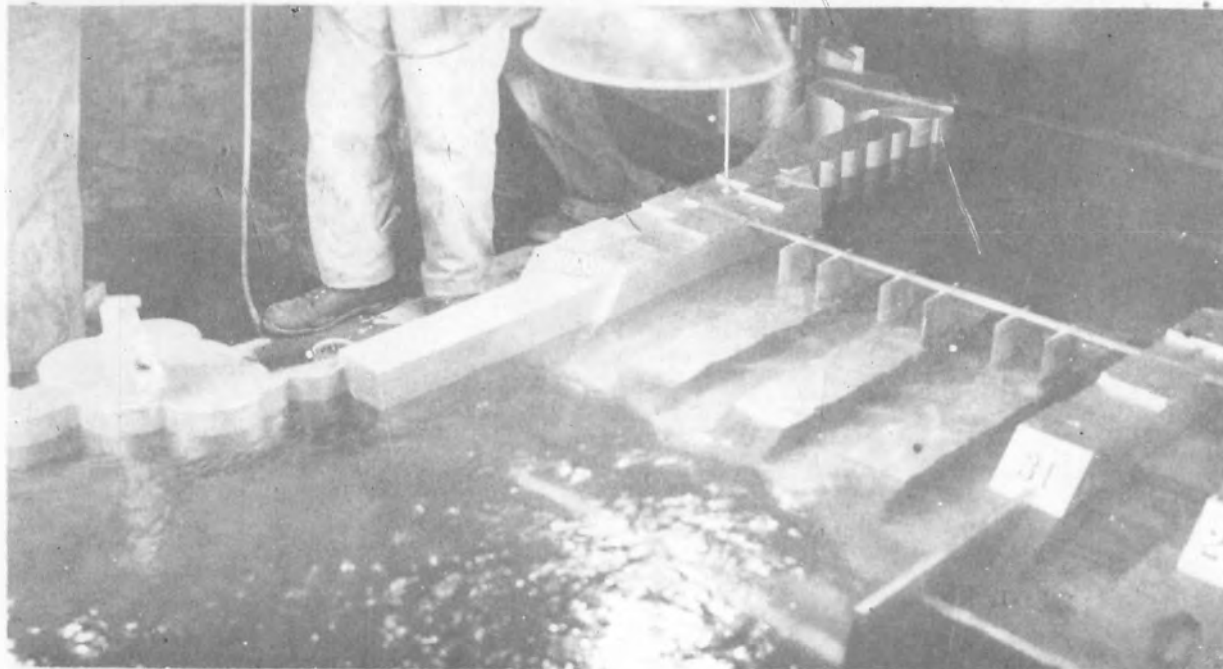
Discharge 200,000 Second-feet.

Flow Conditions during Diversion of the River
through Left Powerhouse and Spillway Sections.

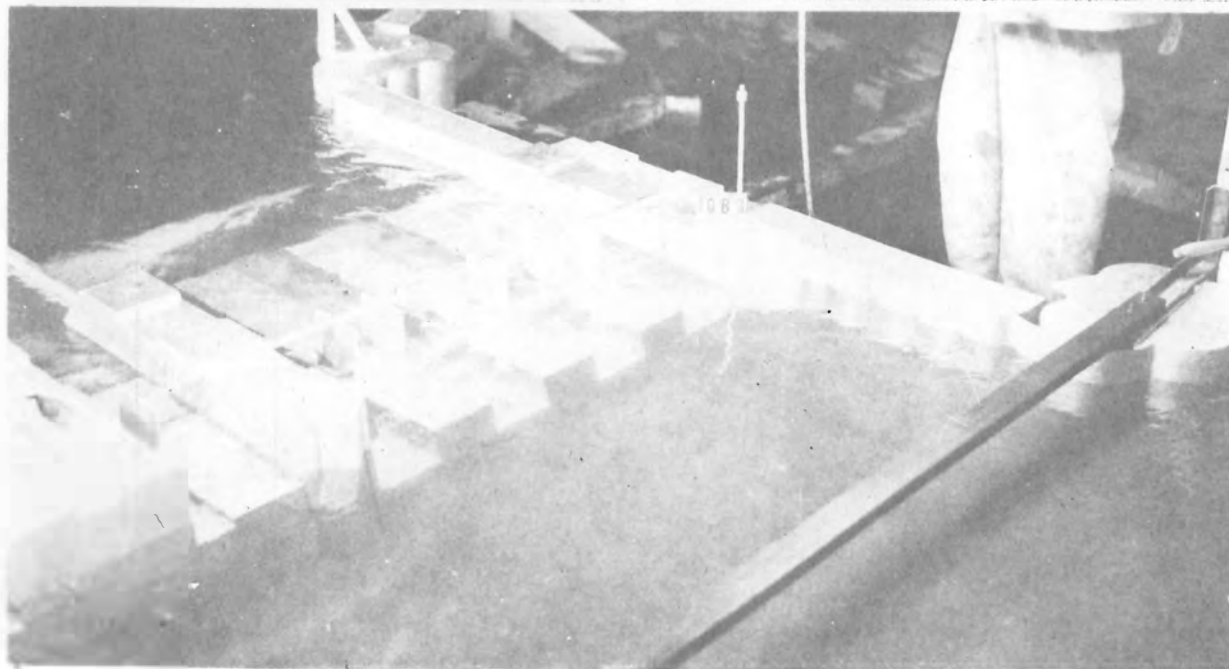
GRAND COULEE DIVERSION MODEL
Scale Ratio 1:120 Test 10

PLATE VI

Flow through openings over blocks 13, 15, 17, 23, 25, 29, 30 and 32 to 38 inclusive. Each of these blocks except No. 30 level on top. Cribs upstream from blocks 31 and 39. Streamlined trestle bents in place.



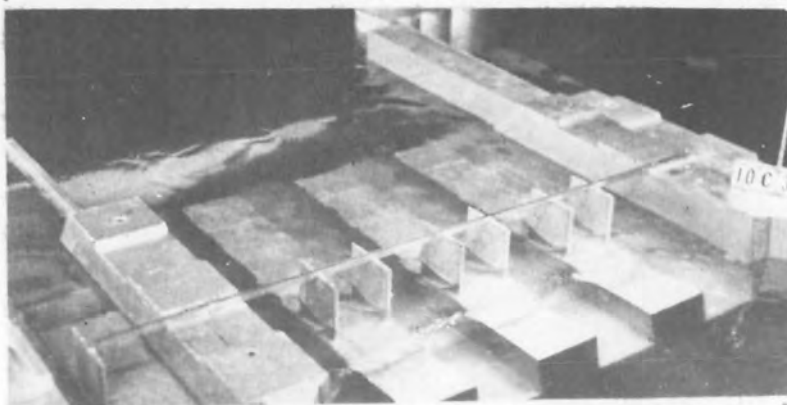
Looking Upstream from Left Bank.



Looking Downstream from Left Bank.

Flow Conditions with Discharge of 300,000 Second-feet.

Flow through openings over blocks 13, 15, 17, 23, 25, 29, 30 and 32 to 38 inclusive. Each of these blocks except No. 30 level on top. Cribs upstream from blocks 31 and 39. Streamlined trestle bents in place.



Discharge 300,000 Second-feet.

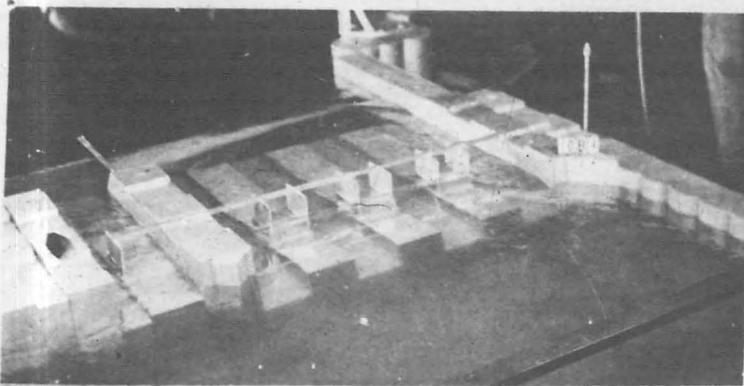


Below Bucket of Spillway Section

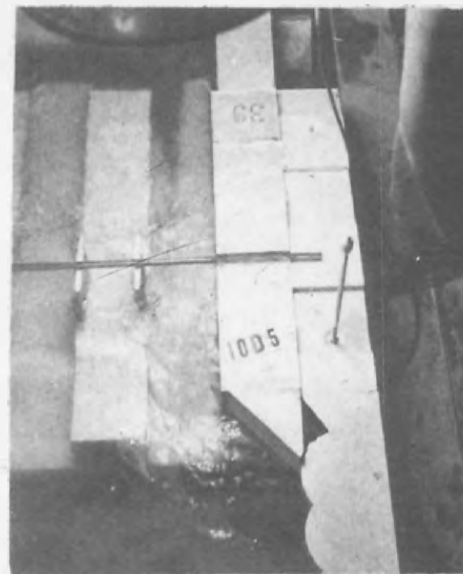


Downstream from Tailrace Riprap Section

Erosion below Dam after a Discharge of 300,000 Second-feet.



Discharge of 400,000 Second-feet.



Wooden Crib at Upstream End of Block 39 - Discharge 500,000 Second-feet.

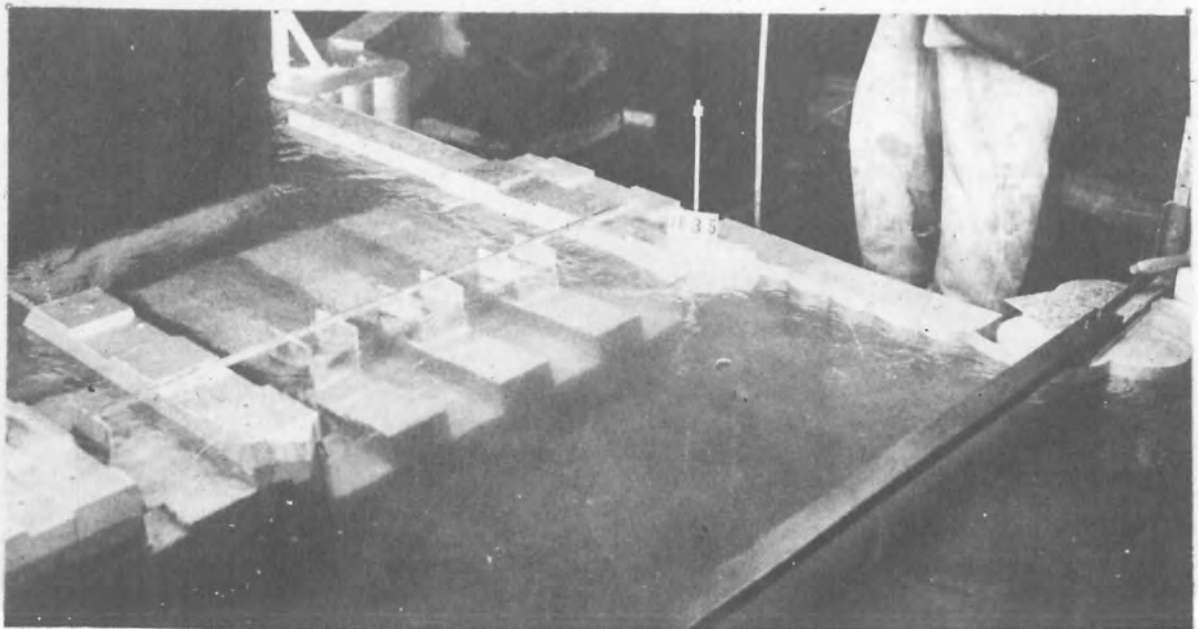
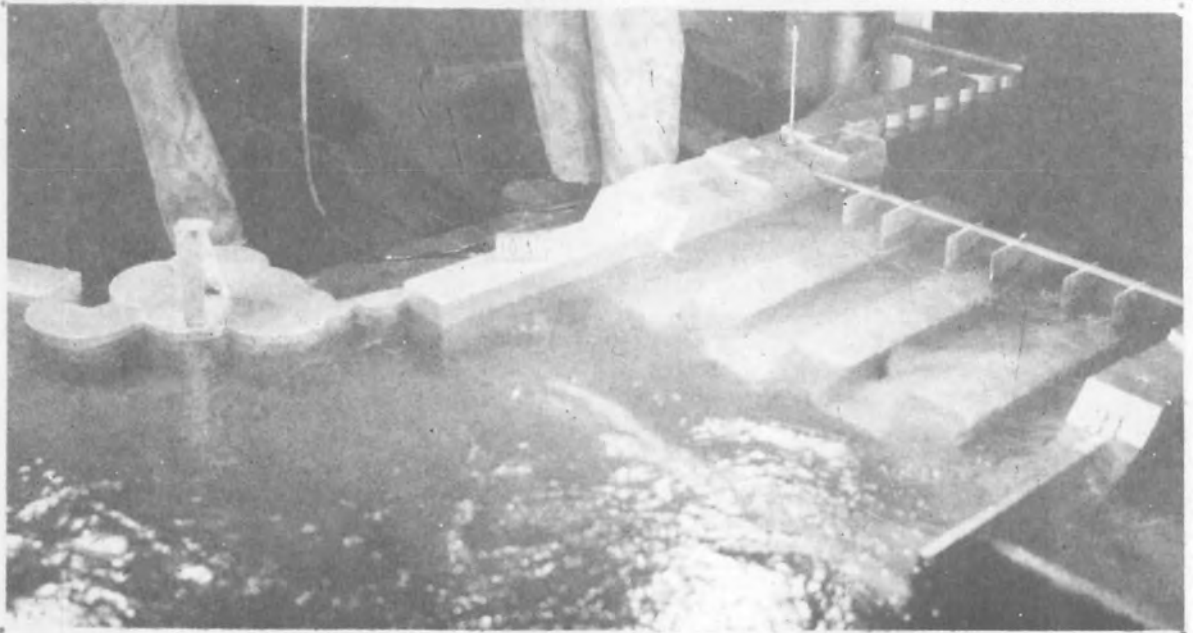
Flow Conditions during Diversion through Left Powerhouse and Spillway Sections.

GRAND COTLEE DIVERSION MODEL
Scale Ratio 1:120
Flow through openings over blocks 13, 15, 17, 23, 25, 29, 30 and 32 to 38 inclusive. Each of these blocks except No. 30 level on top. Cribbs upstream from blocks 31 and 39. Streamlined trestle bents in place.

GRAND COULEE DIVERSION MODEL
Scale Ratio 1:120 Test 10

PLATE IX

Flow through openings over blocks 13, 15, 17, 23, 25, 29, 30 and 32 to 38 inclusive. Each of these blocks except No. 30 level on top. Cribs upstream from blocks 31 and 39. Streamlined trestle bents in place.



Flow Conditions through Spillway
Section with Discharge of 500,000
Second-feet.

GRAND COULEE DIVERSION MODEL
Scale Ratio 1:120 Test 10

PLATE X

Flow through openings over blocks 13, 15, 17, 23, 25, 29, 30 and 32 to 38 inclusive. Each of these blocks except No. 30 level on top. Cribs upstream from blocks 31 and 39. Streamlined trestle bents in place.



Upstream Side of Dam.



River Channel below Dam and Left Bank below Riprap.

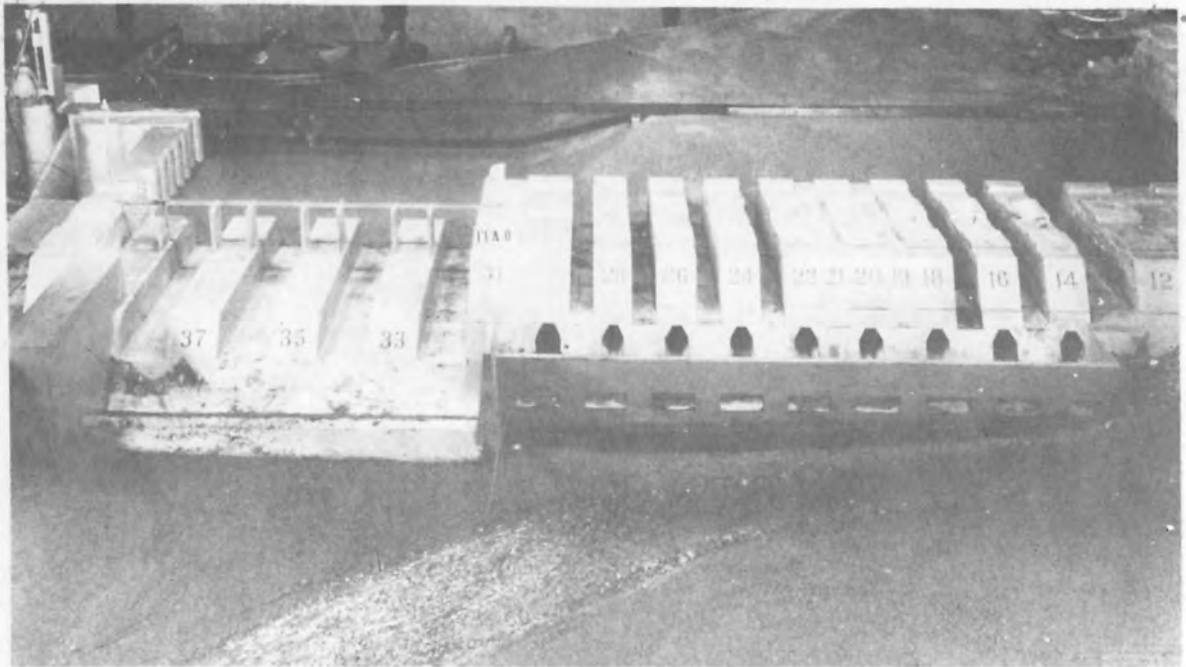


Downstream from Overflow Section
Erosion after a Discharge of 500,000 Second-feet.

GRAND COULEE DIVERSION MODEL
Scale Ratio 1:120 Test 11

PLATE II

Flow through Openings over blocks 13, 15, 17, 23, 25, 27, 29 and 32 to 39 inclusive. Each of these blocks level on top. Pier upstream from block 31. Streamlined trestle bents in place.



Tailrace and Downstream Side of Dam.



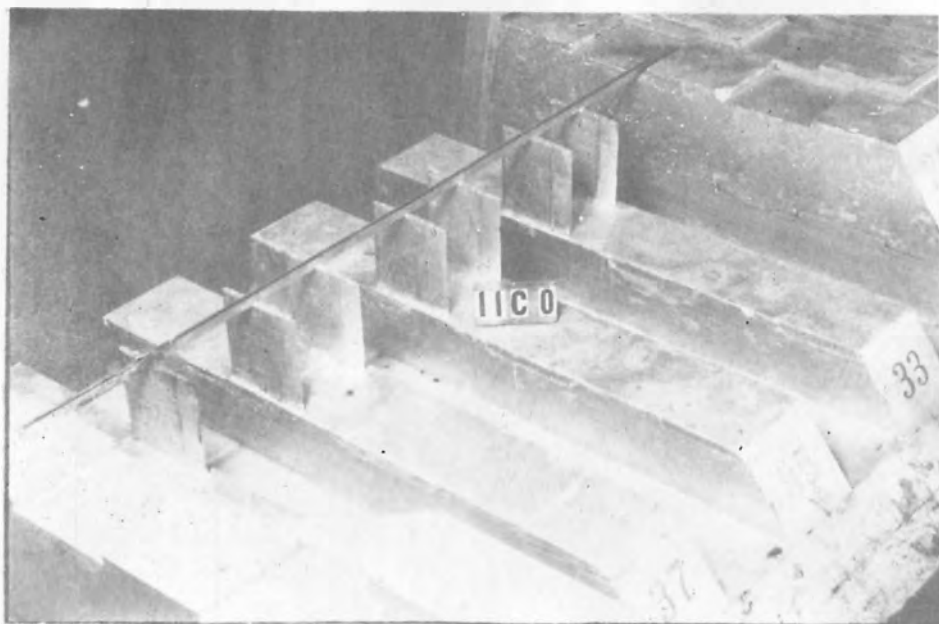
Upstream Side of Dam.

Condition of River Bed before Test.

Flow through openings over blocks 13, 15, 17, 23, 25, 27, 29 and 32 to 39 inclusive. Each of these blocks level on top. Pier upstream from block 31. Streamlined trestle bents in place.

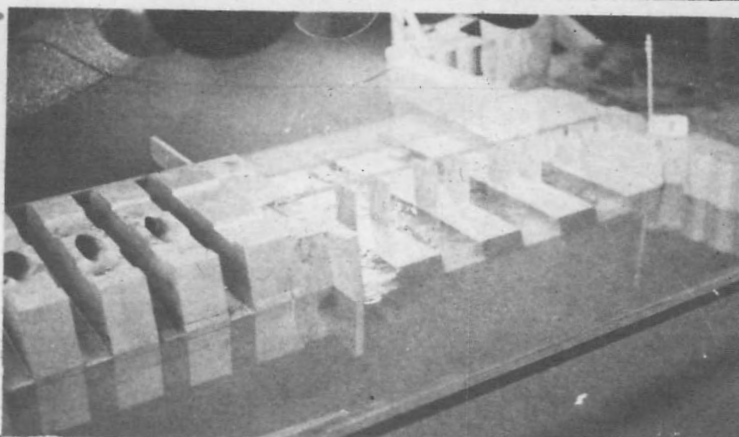
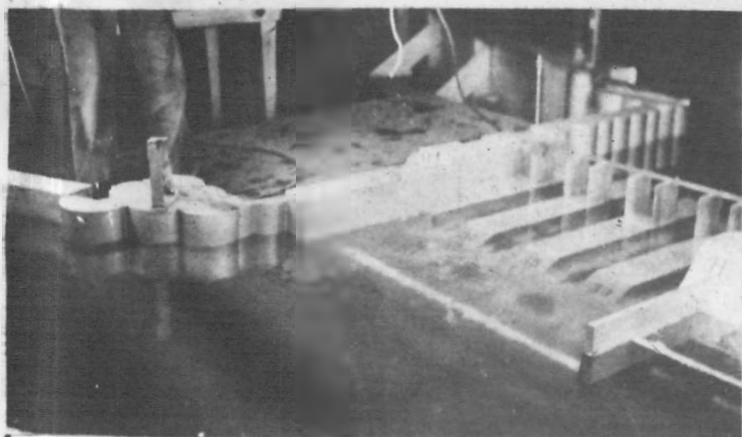


Looking Upstream from Right Bank.

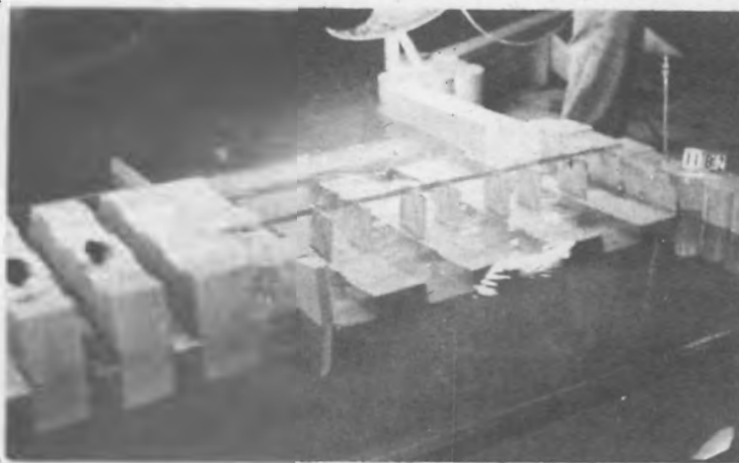


Close up of Spillway Section
Showing Trestle Bents.

Condition of River Bed before Test.



Discharge 100,000 Second-feet.



Discharge 200,000 Second-feet.

Flow Conditions during Diversion of the River
through Left Powerhouse and Spillway Sections.

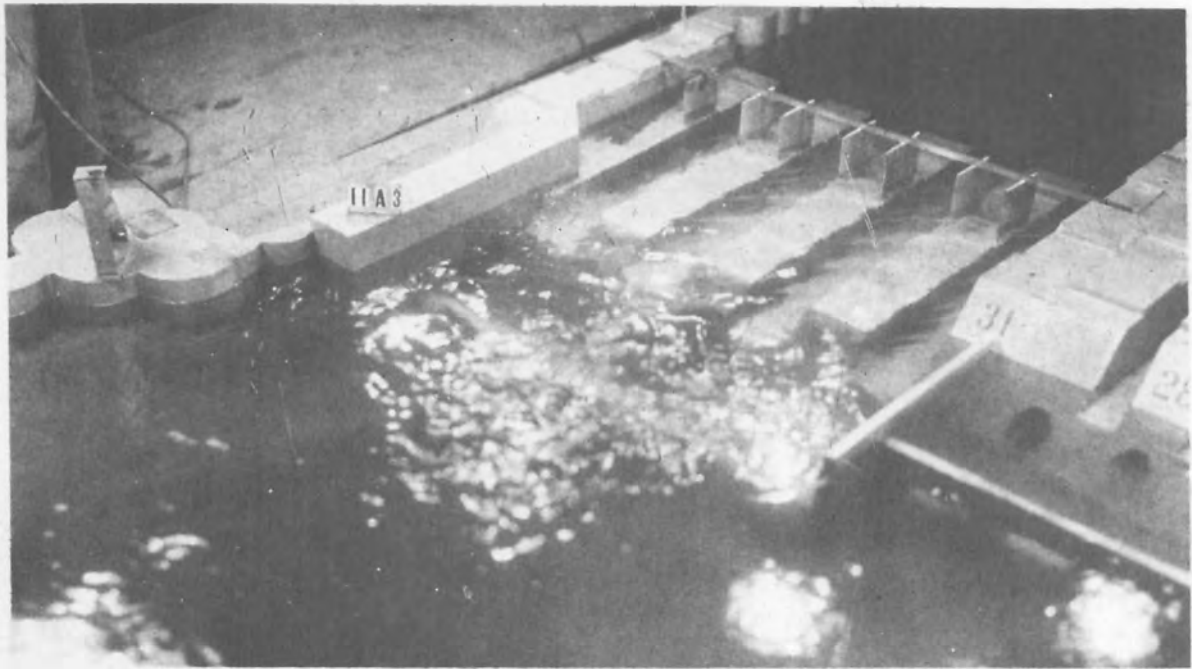
GRAND COULEE DIVERSION MODEL
Scale Ratio 1:120 Test 11
Flow through openings over blocks 13, 15, 17, 23, 25, 27,
29 and 32 to 39 inclusive. Each of these blocks level on
top. Pier upstream from block 31. Streamlined trestle
bents in place.

GRAND COULEE DIVERSION MODEL

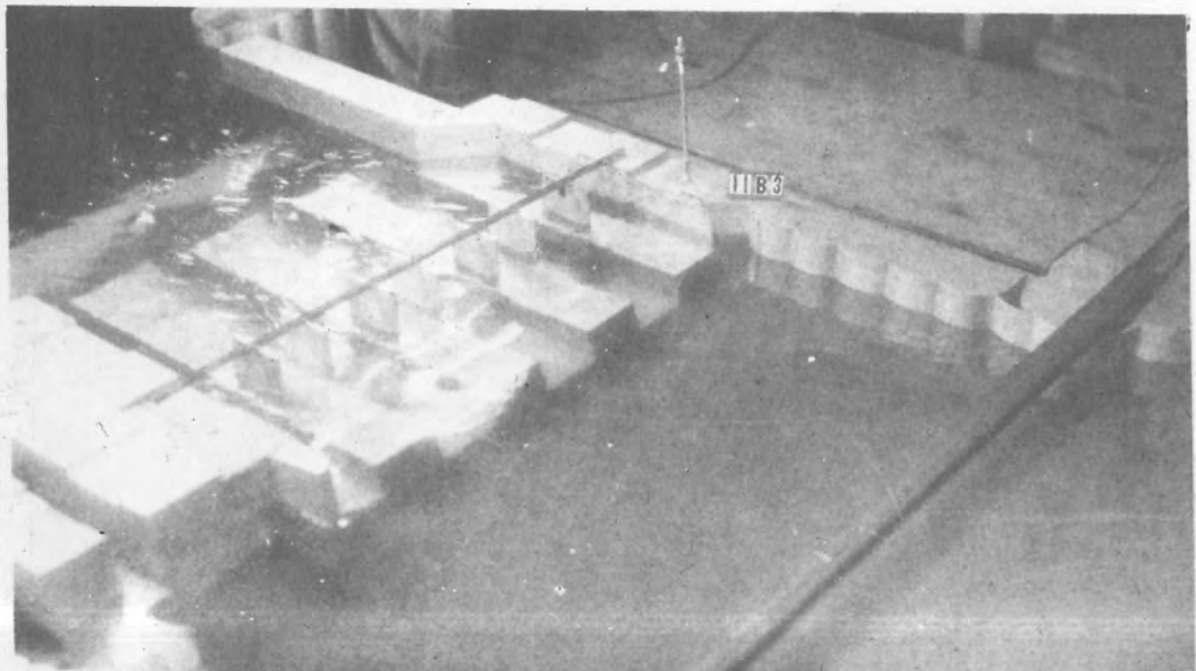
PLATE XIV

Scale Ratio 1:120 Test 11

Flow through openings over blocks 13, 15, 17, 23, 25, 27, 29 and 32 to 39 inclusive. Each of these blocks level on top. Pier upstream from block 31. Streamlined trestle bents in place.



Looking Upstream from Left Bank.



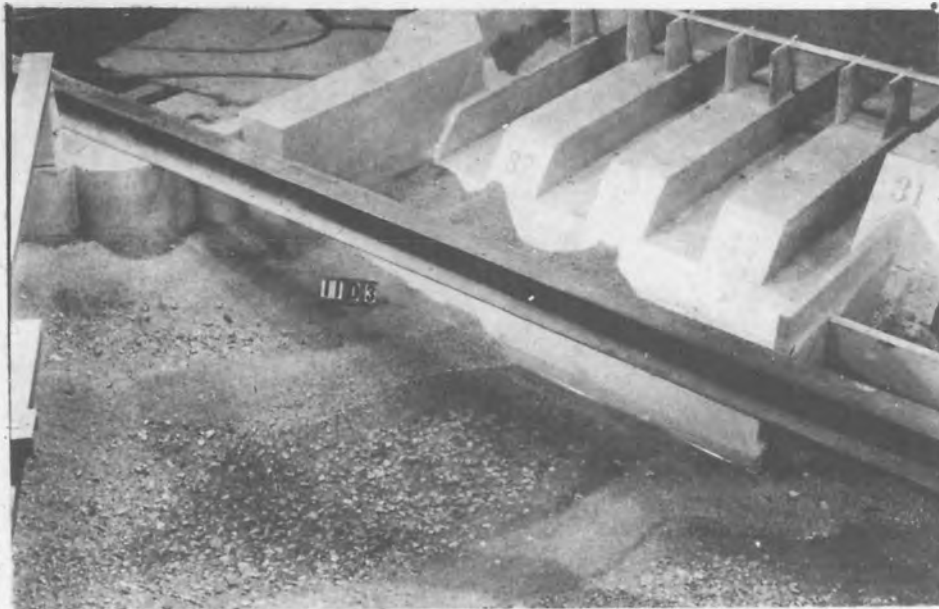
Flow Conditions with a Discharge of 300,000 Second-feet.

GRAND COULEE DIVERSION MODEL

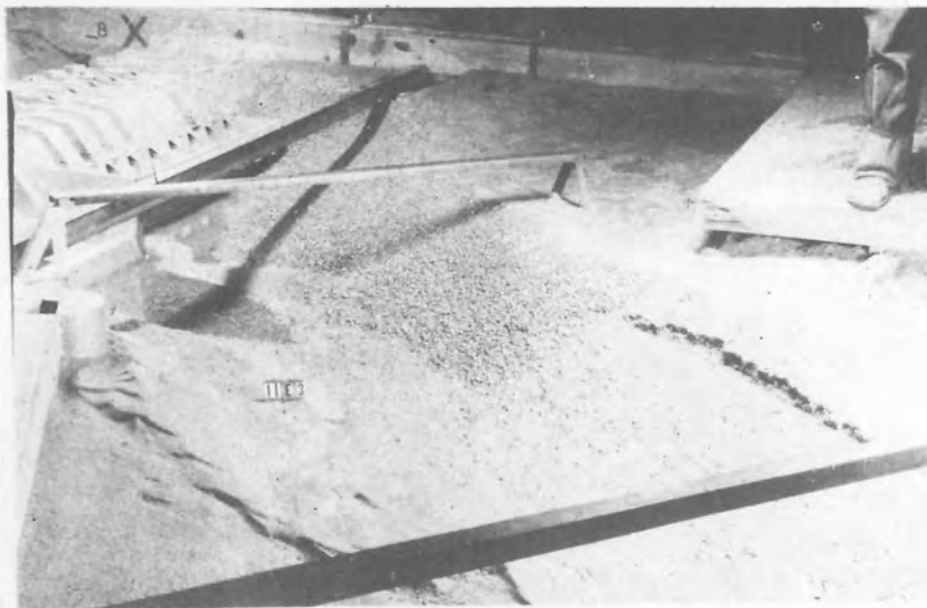
PLATE XV

Scale Ratio 1:120 Test 11

Flow through openings over blocks 13, 15, 17, 23, 25, 27, 29 and 32 to 29 inclusive. Each of these blocks level on top. Pier upstream from block 31. Streamlined trestle bents in place.



Below Bucket of Spillway Section



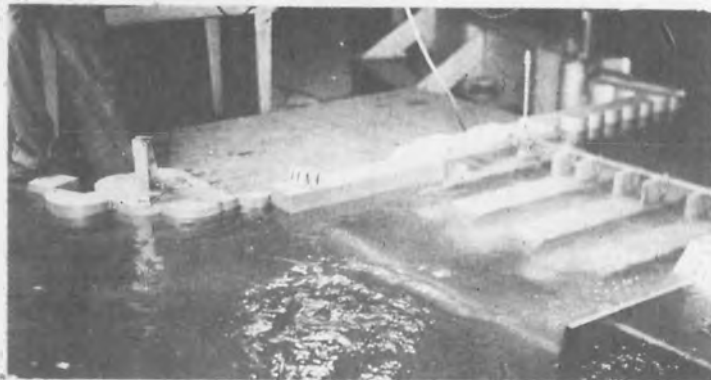
Downstream from Tailrace Riprap Section.

Erosion below Dam after a Discharge of 300,000 Second-feet.

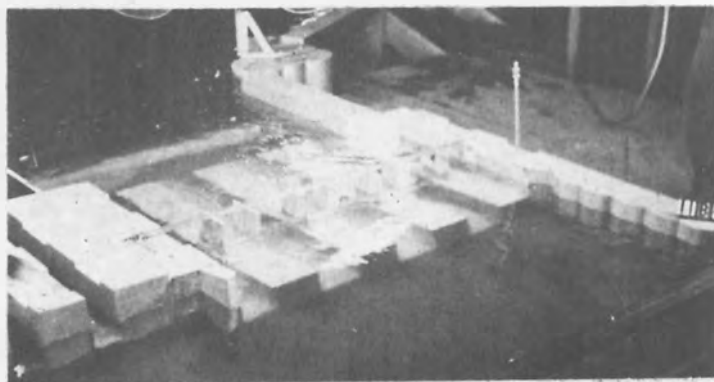
GRAND COULEE DIVERSION MODEL
Scale Ratio 1:120 Test 11

PLATE XVI

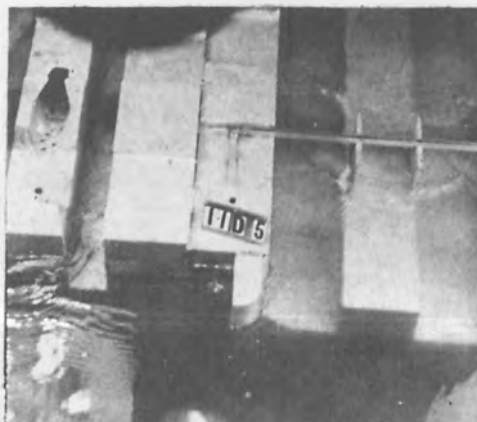
Flow through openings over blocks 13, 15, 17, 23, 25, 27, 29 and 32 to 39 inclusive. Each of these blocks level on top. Pier upstream from block 31. Streamlined trestle bents in place.



Discharge of 400,000 Second-feet.



Discharge of 400,000 Second-feet.

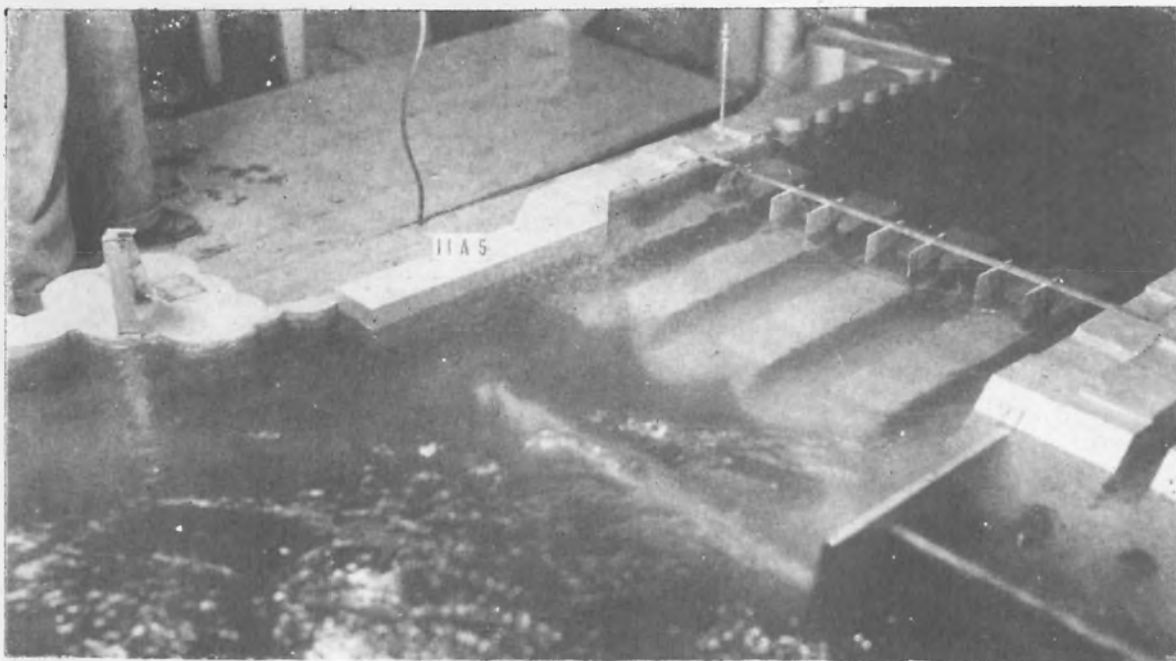


Flow Conditions at Crib Upstream
from block 31.

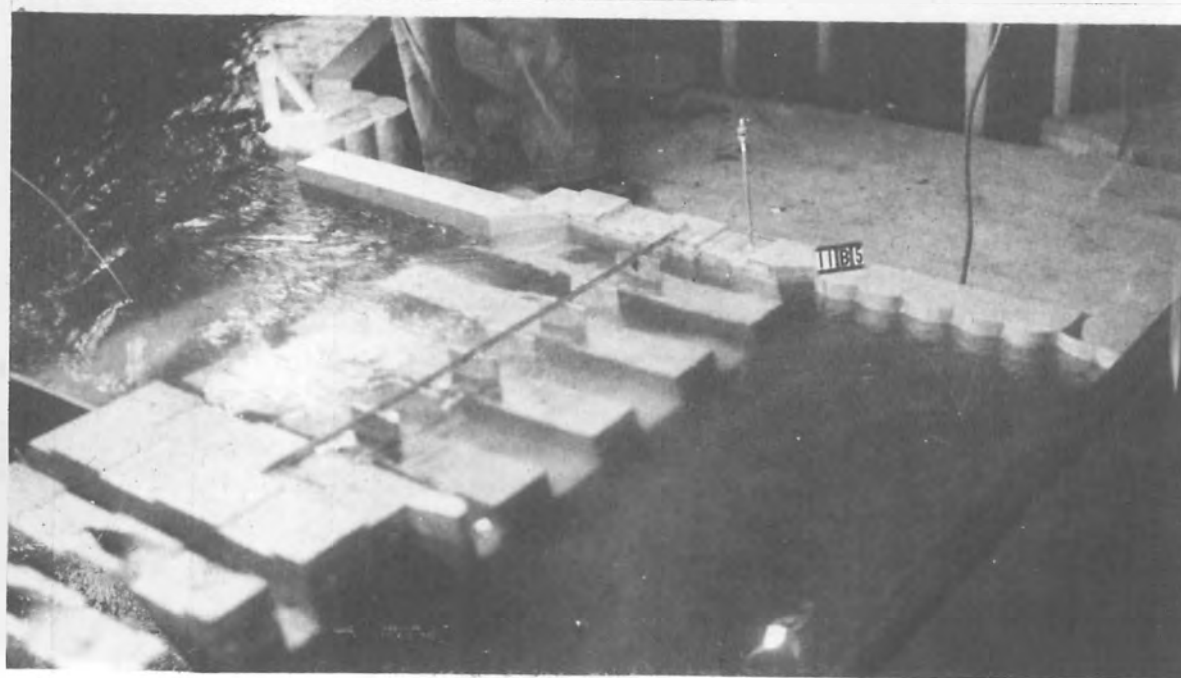
GRAND COULEE DIVERSION MODEL
Scale Ratio 1:120 Test 11

PLATE XVII

Flow through openings over blocks 13, 15, 17, 23, 25, 27, 29 and 32 to 39 inclusive. Each of these blocks level on top. Pier upstream from block 31. Streamlined trestle bents in place.



Looking Upstream from Left Bank.



Looking Downstream from Left Bank.

Flow Conditions with a Discharge of 500,000 Second-feet.

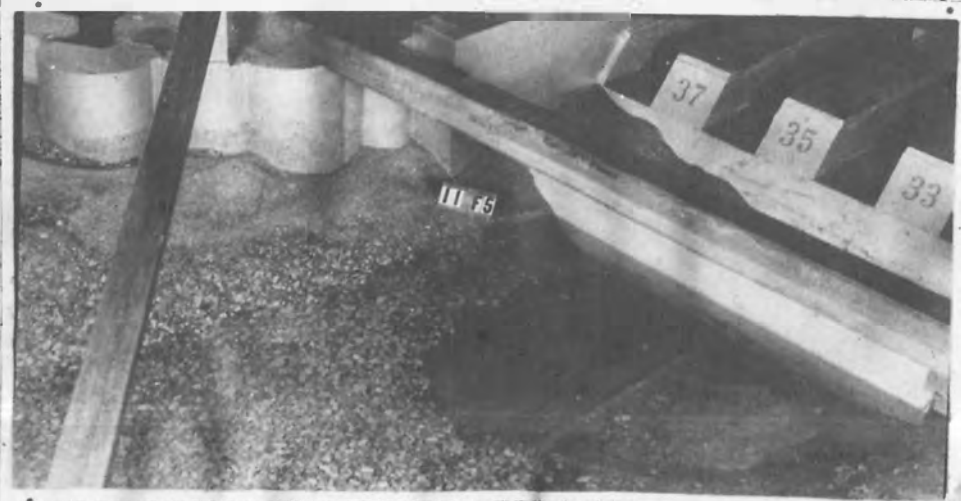
Flow through openings over blocks 13, 15, 17, 23, 25, 27, 29 and 32 to 39 inclusive. Each of these blocks level on top. Pier upstream from block 31. Streamlined trestle bents in place.



Upstream Side of Dam.



Left Bank below Riprap and River Channel below Dam.



Downstream from Overflow Section.
Erosion after a Discharge of 500,000 Second-feet.