UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

HYDRAULIC MODEL STUDIES OF TRAPEZOIDAL DROP STRUCTURES FOR WYOMING CANAL RIVERTON PROJECT, WYOMING

Hydraulic Laboratory Report No. Hyd-371

ENGINEERING LABORATORIES BRANCH

DESIGN AND CONSTRUCTION DIVISION
DENVER, COLORADO

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CONTENTS

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

Design and Construction Division
Engineering Laboratories Branch
Denver, Colorado
June 18, 1953

Laboratory Report No. Hyd-371
Hydraulic Laboratory Section
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J. W. Bradley

Subject: Hydraulic model studies of trapezoidal drop structures for Wyoming Canal--Riverton Project, Wyoming

SUMMARY

The hydraulic model studies discussed in this report were made to develop a stilling basin, trapezoidal in cross section, which would satisfactorily dissipate the energy of the water falling through the trapezoidal drop. Specifically, the studies included tests to determine the size and location of the control slots upstream from the trapezoidal drop, the shape of the drop chute, and the dimensions of the stilling basin, Figure 6. The effect of baffle piers in the basin was also investigated as was the need for an end sill at the end of the basin. The results and recommendations contained herein are based on tests conducted on a 1:6 scale model of the drop structure, Figures 3 and 4.

As a result of these studies, a design for the drop was evolved which provides a comparatively uniform distribution of flow in the stilling basin and permits the water to enter the downstream canal with a minimum of scour and waves. Eleven stilling basin designs were tested in developing the recommended basin. The length, width, vertical drop, and side slopes of the structure were the same in the 11 test basins, Figure 6. The designs differed in the size and location of the control slots and the number of valleys or shape of the floor of the chute and stilling basin. Figure 26 shows the details of the recommended basin. Table 1, page 8, summarizes the results of the stilling basin studies.

Upon completion of the stilling basin studies, a series of tests were made to determine the effect of various end sills in the transition at the downstream end of the structure, Figures 27 and 29. Results of these tests, which indicated that the different test sills had no appreciable effect on the scour depth in the downstream canal, are shown in Figures 28 and 30 and Table 2. The transition studies are discussed on page 8.

No baffle piers are included in the recommended stilling basin. However, several arrangements of baffle piers were tested in the recommended basin, Figure 31. Although the stilling basin operation was satisfactory without the use of baffle piers, it was found that the wave heights could be reduced from 0.9 to 0.4 foot by installing piers in the recommended basin. At least three baffle piers are needed in each valley of the stilling basin before substantial reduction in wave heights is obtained. Results of the baffle pier studies on the recommended basin are given in Table 3, page 14.

INTRODUCTION

As a part of the Riverton Project, the Wyoming Canal carries water from the Wind River and irrigates land approximately 20 miles to the north and east of Riverton, Wyoming, Figure 1. Several checks, siphons, and drops were required to cross the irregular terrain and deliver the water to laterals irrigating the areas north of Riverton. This report covers the hydraulic model studies made on the trapezoidal drop structure at Station 2241+25, which is one of 17 drop structures, trapezoidal in cross section, located between Stations 2241+25 and 2547+50. Although only one structure was modeled and tested, the studies covered a wide range of flows; and the results may be applied in the design of other trapezoidal drop structures in the project.

Since most canals are trapezoidal in cross section, a stilling basin of the same shape eliminates the need for complicated transition sections or wing walls at the end of the stilling basin. Also, practically all the concrete can be placed with a minimum amount of reinforcing steel and formwork which represents a considerable saving in materials and construction costs over the conventional rectangular basin.

Trapezoidal shapes have the inherent characteristic of producing uneven distribution of flow in a stilling pool. The flow concentrates and shoots through the center of the basin, leaving pronounced eddies on each side of the basin, Figure 8. Model studies of the trapezoidal drop structures for Sand Hollow Wasteway, Boise Project, Idaho,1/ showed that a fairly uniform flow distribution could be obtained in the basin by placing longitudinal ridges along the bottom of the chute and stilling basin. However, the Sand Hollow studies were confined to flow through a single control notch before the water dropped into the trapezoidal basin. Therefore, the model studies of the Wyoming Canal

1/ Hydraulic Model Studies of Trapezoidal Drop Structures for Sand Hollow Wasteway, Boise Project, Idaho, Hydraulic Laboratory Report No. Hyd-250.

trapezoidal drop structures were a continuation of the previous Sand Hollow studies and were concerned primarily with developing satisfactory stilling pool operation when the flow entered the drop structure through two or more notches comprising the control. The control was designed to maintain the water surface in the canal upstream from the drop at normal elevation as shown on Figure 5.

THE 1:6 SCALE MODEL

The hydraulic studies of the trapezoidal drop structure were conducted on a model built to a geometrical scale of 1:6, Figures 3 and 4. The model consisted of a 70-foot (prototype) reach of canal upstream from the drop, the trapezoidal drop structure, and approximately 56 feet of the canal downstream from the drop. The bottom and side slopes of the drop structure and the canal upstream were made of concrete screeded to metal templates. To permit erosion studies in the canal downstream from the drop, the bottom of the canal was filled with pea-gravel (and sand in the later studies) to a depth of 6 inches. The control wall and baffle piers were made from redwood and impregnated with boiled linseed oil to make them more water resistive.

Water was supplied to the model by a vertical turbine pump and metered through a combination Venturi and orifice meter. The tail water in the downstream canal was set according to the tail water curve, Figure 5, by means of a movable tailgate at the downstream end of the model. To facilitate the setting of the tail water and the measurement of wave heights, two white lines representing the tail water elevation for discharges of 410 and 100 second feet were painted on the side walls of the canal.

Both headwater and tail water elevations were measured by hook gages mounted in stilling-wells at the side of the canal. Inlets to the headwater and tail water stilling-wells, respectively, were located 18.5 feet upstream from the control notch (preliminary design) and 28 feet downstream from the transition of the drop structure.

THE INVESTIGATION

General

The model studies of the trapezoidal drop structure were concerned primarily with the size and location of the control slots and the distribution of flow in the stilling basin. The control slots were designed to maintain a depth of water of 5.7 feet in the upstream canal at the maximum discharge of 410 second feet. Studies were made on 11 different designs which varied in the number and location of the control slots and valleys along the floor of the chute and stilling basin. Comparison of the various designs were made by observing the distribution of flow in the stilling basin and measuring the height of waves in the canal 28 feet downstream from the transition at the end of the stilling basin. The wave heights were measured by observing the highest point to which the crest of the waves rose on the sloping canal bank. The height of this point in feet above the normal water surface was recorded as the wave height. Observations were made both with and without basin baffle piers for the maximum discharge of 410 second feet and an intermediate discharge of 100 second feet.

After the recommended basin had been established, a series of tests were made to study several different arrangements of baffle piers and sills at the downstream end of the stilling basin. The effectiveness of these arrangements were determined by scour tests and height of waves. The scour tests were made by operating the model at the maximum discharge of 410 second feet for 1 hour which is equivalent to approximately 2-1/2 hours in the prototype.

Stilling Basin Studies

Design 1. The model was originally built according to the preliminary design, Figures 2 and 3, except that the valleys in the floor of the chute and basin were not placed in the model until later in the studies. The valleys were omitted in the initial tests to obtain data on the stilling pool operation with a level floor for comparison with later studies when ridges and valleys were installed. Figures 3, 4, and 6 show the details of Design 1.

Initially, the model was operated with basin baffle piers installed at the base of the chute. Figure 7 shows the model discharging the maximum flow of 410 second feet. Immediately downstream from the control wall, the jets from the two control slots came together and formed a large fin of water in the center of the chute. This concentration of flow continued into the stilling basin where the flow distribution was very poor. The flow in the center of the basin was very turbulent and rough with pronounced side eddies at the outer edges of the basin.

A discharge of 100 second feet gave results similar to the maximum discharge although the rough water surface in the center of the stilling pool was less severe. Wave heights measured in the canal 28 feet downstream from the stilling basin were 0.90 foot for the maximum discharge of 410 second feet and 0.24 foot for 100 second feet.

Figure 8 shows the operation of Design 1 with the baffle piers removed. The action in the stilling basin was very violent and unstable with the concentrated flow shifting from side to side of the basin. A comparison of Figures 7 and 8 indicates that the baffle piers were wholly responsible for the relatively better performance shown in Figure 7 and that, basically, the arrangement of the structure was very poor. The poor stilling action was reflected in the wave heights which measured 1.94 and 0.76 feet for 410 and 100 second feet, respectively.

Design 2. A single notch, placed at the upstream end of the chute, was used to control the flow in Design 2, Figure 9. It was felt that a single notch would eliminate the large fin of water in the center of the chute and provide a more uniform distribution of flow in the stilling basin. In operation, however, the flow spread to the side slopes of the chute and concentrated along the sides of the basin, Figure 10. The water surface was rough, and waves 0.59 foot high were measured in the canal downstream from the structure. With the baffle piers removed, Figure 11, the concentration of flow at the edges of the basin was more pronounced; and the measured height of waves increased to 1.25 feet.

Design 3. In Design 3, Figure 12, the model was altered to conform to the preliminary design, Figure 2. The two control notches of Design 1 were reinstalled, and a valley 2 feet deep was placed along each side of the chute and basin floor. Although the valleys helped materially in spreading the flow to the outer edges of the chute, there was still a slight concentration of flow in the center of the stilling basin, Figure 13. However, only small eddies formed at the edges of the stilling basin. The wave heights measured 0.62 foot for a discharge of 410 second feet and 0.31 for 100 second feet.

As in Designs 1 and 2, the surface of the stilling pool became very rough when the baffle piers were removed, Figure 14, indicating that the shape of the chute and stilling basin was incorrect and that good performance was dependent upon baffle piers which might become damaged or lost altogether. Also, the flow concentrated to a greater extent in the center of the basin and shifted to the left side of the basin after entering the canal. The wave heights more than doubled when the baffle piers were removed, Figure 12.

Designs 4, 5, and 6. Designs 4, 5, and 6 were the same as Design 3 except that the control notches were placed at Stations 0+15, 0+14, and 0+13, respectively, to obtain more uniform flow distribution where the flow entered the trapezoidal basin, Figure 15.

The control notches were moved downstream to Station 0+15 in Design 4. Figures 16 and 17 show the model operating at the maximum discharge of 410 second feet, both with and without baffle piers. With this arrangement, three distinct jets were formed with the larger concentrations of flow along the sides of the basin as shown in Figure 16.

In Design 1, with the same control notches farther upstream, the flow concentration was in the center of the basin, Figures 7 and 8.

The height of waves for Design 4 is shown in Figure 15 and was approximately the same as Design 3, Table 1.

In Design 5, the control notches were moved 1 foot upstream to Station 0+14, Figure 15. Except for possibly more flow in the center of the basin, the distribution of flow and operation of the stilling pool were very similar to that observed in Design 4, Table 1, page 8. The wave heights are shown in Figure 15.

The control notches were moved to Station 0+13 in Design 6, Figure 15; and the distribution of flow in the stilling basin, Figures 18 and 19, was considerably improved. Small side eddies formed at the edges of the pool, but the flow was well distributed across the basin. The maximum wave heights measured 0.62 and 0.31 foot for discharges of 410 and 100 second feet with baffle piers installed in the basin and 1.11 and 0.62 feet with the baffle piers removed. The wave heights, however, were only slightly less than those obtained with Designs 4 and 5, Figure 15.

Design 7. From the preceding tests, it was concluded that the number and location of the control notches materially affected the flow distribution in the stilling basin. Design 6, with two notches at Station 0+13, gave the lowest wave heights and the best stilling basin performance. However, to obtain further refinement in the stilling basin performance, it became apparent that modifications to the cross-sectional shape of the chute and basin floors were necessary.

In Design 7, two peaked ridges 2 feet high and extending the length of the chute and stilling basin were installed in the model, Figure 20. Flow through the drop was controlled by a single notch located 15 feet upstream from the chute. No baffle piers were placed in the stilling basin.

Figure 21 shows the operation of Design 7 at a discharge of 410 second feet. The flow distribution was good with only slightly less flow in the center valley and small eddies at the edges of the basin. However, when the discharge was decreased to 100 second feet, the center valley carried appreciably less flow than the outer valleys. The wave heights for 100 and 410 second feet measured 0.49 and 1.25 feet, respectively, as compared to 0.62 and 1.11 feet for Design 6. Thus, the waves increased in height at maximum flow but decreased for the lower flows when one control notch was used with the additional valley on the chute and basin floor. Testing was continued to reduce the wave heights.

Design 8. Since the chute and basin floor was divided into three distinct valleys in Design 7, it appeared that the flow pattern would be improved if a control notch were placed at the head of each valley. Therefore, in Design 8, three identical control notches were installed at the upstream end of the chute, Figure 22. The valleys in the chute and basin floor remained the same as in Design 7.

Figure 23 shows the operation of Design 8 at a discharge of 410 second feet. The flow from the control slots entered the chute valleys very smoothly with no appreciable turbulence below the slots. However, there was more flow through the center control slot than through either of the side slots which caused a concentration of flow in the center of the basin. This flow concentration, which is evident in Figure 23, caused small eddies at the edges of the basin. However, the height of waves was the lowest observed thus far in the study--0.90 and 0.45 foot for 410 and 100 second feet, respectively.

Designs 9 and 10. In Designs 9 and 10, the control notches were moved upstream from the chute to allow more flow to enter the outer valleys.

In Design 9, the control slots were placed 4 feet upstream from the chute, Figure 22. Thus, the flow from the control slots could spread over the 4-foot horizontal section before dropping into the chute valleys. This spreading of the flow caused two relatively high fins of water to form below the control slots, Figure 24. On entering the chute, the fins of water made a comparatively rough water surface which was very noticeable in the stilling basin. Small side eddies also formed at the edges of the basin. The rough water surface was reflected in the wave heights which measured 1.36 feet in the canal for a discharge of 410 second feet.

In Design 10, the control slots were moved 5 feet farther upstream or 9 feet from the chute. This modification had little effect on the fins of water which formed downstream from the control slots. There was no apparent reduction in their size, Figure 25. However, the water surface in the stilling basin was less rough and the wave heights were approximately the same as those observed in Design 8, Figure 22.

The recommended design. A recapitulation of the studies made on the different model arrangements discussed on the preceding pages is shown in Table 1. Of the different designs tested, the lowest wave heights and the best stilling basin performance were observed in Designs 8 and 10. Although the wave heights in these two designs were approximately the same, the flow in Design 8 entered the chute without fins of water forming downstream from the control notches and passed through the stilling basin with less splash and surface turbulence. Therefore, Design 8, except for the size of control notches, is recommended for construction in the field.

Table 1

HEIGHT OF WAVES FOR DIFFERENT MODEL ARRANGEMENTS

Model arrangement	Discharge cfs	Height of waves, ft*	Remarks
Design 1	410	0.90	Large fin of water between control slots.
	100	0.24	Flow concentrates in center of basin.
Design 1, baffle piers removed	410	1.94	Pronounced side rollers at edges of basin.
	100	0.76	Flow concentration whips from side to side.
Design 2	410	0.59	Stable jump but distinct flow concentrations at
	100	0.28	edges of basin.
Design 2, baffle piers removed	410	1.25	More pronounced flow concentrations at edges.
	100	0.49	
Design 3 (preliminary design)	410	0.62	Good flow distribution in chute. Slight
	100	0.31	concentration in center of basin.
Design 3, baffle piers removed	410	1.32	Unstable jump. Flow whips from side to side at
	100	0.73	downstream end of basin.
Design 4	410	0.69	Insufficient flow in center of basin.
	100	0.35	
Design 4, baffle piers removed	410	1.39	Poor flow distribution. Flow concentrates in
	100	0.76	valleys.
Design 5	410	0.62	Flow pattern similar to Design 4
	100	0.35	
Design 5, baffle piers removed	410	1.18	Flow pattern similar to Design 4
	100	0.80	

Table 1--Continued

Sheet 2 of 2

Model arrangement	Discharge cfs	Height of waves, ft*	Remarks
Design 6	410	0.62	Better flow distribution and stable jump.
	100	0.31	
Design 6, baffle piers removed	410	1.11	Good jump. Slightly greater flow at edges of basin.
	100	0.62	
Design 7	410	1.25	Rough water surface in chute. Less flow in center of basin.
	100	0.49	
Design 8	410	0.90	Slightly more flow in center of basin. Good stilling action with few surges.
	100	0.45	
Design 9	410	1.36	Large fin of water forms between control slots. Rougher water surface.
	100	0.49	
Design 10	410	0.97	Operation similar to Design 9. Slightly smoother water surface.
	100	0.42	
Recommended design	410	0.96	Good stilling action with comparatively uniform flow distribution.
	100	Not observed	

*Maximum height to which crest of waves rises on 1-1/2:1 side slope of canal. Measured vertically in feet above the normal water surface at a point 28 feet downstream from the transition.

Table 2

DEPTH OF SCOUR FOR DIFFERENT TRANSITION DESIGNS

Arrangement	Transition sill	Discharge cfs	Maximum depth of scour, ft	
Design 11	Original	410	0.75	Pea-gravel as erodible material.
Design 11, except the transition at end of basin, was modified as shown in Figures 27 and 29.	A	410	0.75	Pea-gravel as erodible material in canal.
	A	410	2.3	Sand as erodible material in canal.
	B	410	2.5	Sand as erodible material in canal.
	C	410	2.3	Sand as erodible material in canal.
	D	410	2.3	Sand as erodible material in canal.
	E	410	2.0	Sand as erodible material in canal.
	F	410	2.2	Sand as erodible material in canal.
	G	410	2.75	Sand as erodible material in canal.
	H	410	2.3	Sand as erodible material in canal.
	I	410	2.5	Sand as erodible material in canal.
	J	410	2.2	Sand as erodible material in canal.

Since the studies on Design 8 indicated that there was slightly more flow in the center than in the outside valleys, the center control notch was made smaller than the outside notches in the recommended design. The total area of the three control notches in both Design 8 and the recommended design is the same.

Figure 26 shows the dimensions of the control notches for the recommended design which was tested but not photographed since the distribution of flow appeared to be the same as observed in Design 8, Figure 23.

Transition Studies

After the recommended control slots and stilling basin design had been developed, a series of tests were made to determine the effect of different end sills in the transition at the downstream end of the structure. Five different end sills which varied in slope from 1-1/2:1 to 10:1 were tested, Figure 27.

The effectiveness of each sill was determined by measuring the depth of scour in the canal downstream from the structure after the model had been operated at a discharge of 410 second feet for 1 hour, equivalent to approximately 2-1/2 hours in the prototype. Sand was used as the erodible material in the bottom of the downstream canal. The mean diameter of the sand was 0.9 millimeter with approximately 27 percent passing a No. 30 sieve and 10 percent retained by a No. 8 sieve.

Scour patterns for the different sills are shown in Figure 28, and the maximum depth of scour is recorded in Table 2.

From Figure 28 and Table 2, it can be seen that all the scour patterns were practically the same. For Design B (1-1/2:1 end sill) the maximum depth of scour was 2.5 feet while 2.3 feet was observed for the other four sills. From these tests it appears that there is no difference in the depth of scour when end sills with slopes between 2:1 and 10:1 are used.

In all cases, the deepest scour occurred at the base of the 1-1/2:1 side slopes of the canal which were formed of concrete in the model. Since the bottom an side slopes of the prototype canal will be formed from the same material, the maximum depth of scour found in the prototype will probably be less than that observed in the model.

Further tests on different arrangements in the transition were made and are shown in Figure 29. These arrangements included extending the end sill up the side slopes of the canal, extending the ridges on the stilling basin floor various distances into the transition, and sloping the downstream end of the ridges. In each case, an end sill with a 2:1 slope on the upstream face was installed at the end of the transition.

Like the preceding transition studies, scour tests were used to evaluate the various arrangements; and, again, there was very little choice between the different arrangements. Figure 30 shows the resulting scour patterns after a discharge of 410 second feet, and the maximum depth of scour is tabulated in Table 2. The maximum depth of scour varied from 2.0 feet for Design E to 2.75 feet for Design G.

The transition studies indicated that the flow at the end of the stilling basin was well distributed with comparatively low velocities. Therefore, any reasonable combination of end sill or length of ridge in the transition may be used without materially affecting the depth of scour in the canal.

Baffle Pier Studies

After the transition studies were completed, several arrangements of baffle piers were tested to determine their effect on the wave heights and depth of scour in the downstream canal. Baffle piers varying from 3 to 11 in number, from 9 to 18 inches wide, and 20 to 30 inches high were tested in the recommended stilling basin with transition Design J, Figure 29.

Figure 31 shows the seven baffle pier arrangements which were tested. Each arrangement was evaluated by measuring the height of waves at the downstream end of the transition at the maximum discharge of 410 second feet. In addition, the depth of scour was recorded for the last two pier arrangements, Plans F and G.

Table 3 is a summary of the results obtained from the seven baffle pier arrangements. In general, the height of waves decreased from 0.9 foot for one baffle pier in each valley to 0.4 foot for three and four baffle piers per valley. The table reveals that at least three piers are needed in each valley before substantial reduction in wave heights is obtained.

Plans C, D, E, F, and G were arrangements using three or four piers in the valleys. The piers were 30 inches high with widths of 9, 12, and 15 inches and spaced 9 and 22-1/2 inches in two rows 3 feet apart. The width of the piers had little effect on the wave heights. The lowest wave heights (0.41 foot) were obtained with Plans F and G which utilized four piers in the outside valleys and three piers in the center valley. Plan F used piers 12 inches wide while the piers in Plan G were 15 inches wide. In both cases, the location and spacing of the piers were the same.

Scour tests obtained with Plans F and G showed a maximum depth of scour of about 1.7 feet, which is 0.5 foot less than the minimum depth of scour obtained in the transition studies without baffle piers installed in the basin, Table 2. Thus, a reduction of both the height of waves and the depth of scour can be expected in the prototype by installing baffle piers in the basin according to Plans F or G, Figure 31.

Specification Design of Structure

Figure 32 shows the details of the drop structure as designed in the specifications. This design includes the recommended basin design, Figure 26, and the original transition, Figure 27, with the tops of the two ridges tapered from a point at the downstream end of the basin to the bottom of the canal at the downstream end of the transition. Although this particular transition design was not tested in the model, the transition studies indicated that minor modifications to the transition could be made without materially affecting the depth of scour, Table 2.

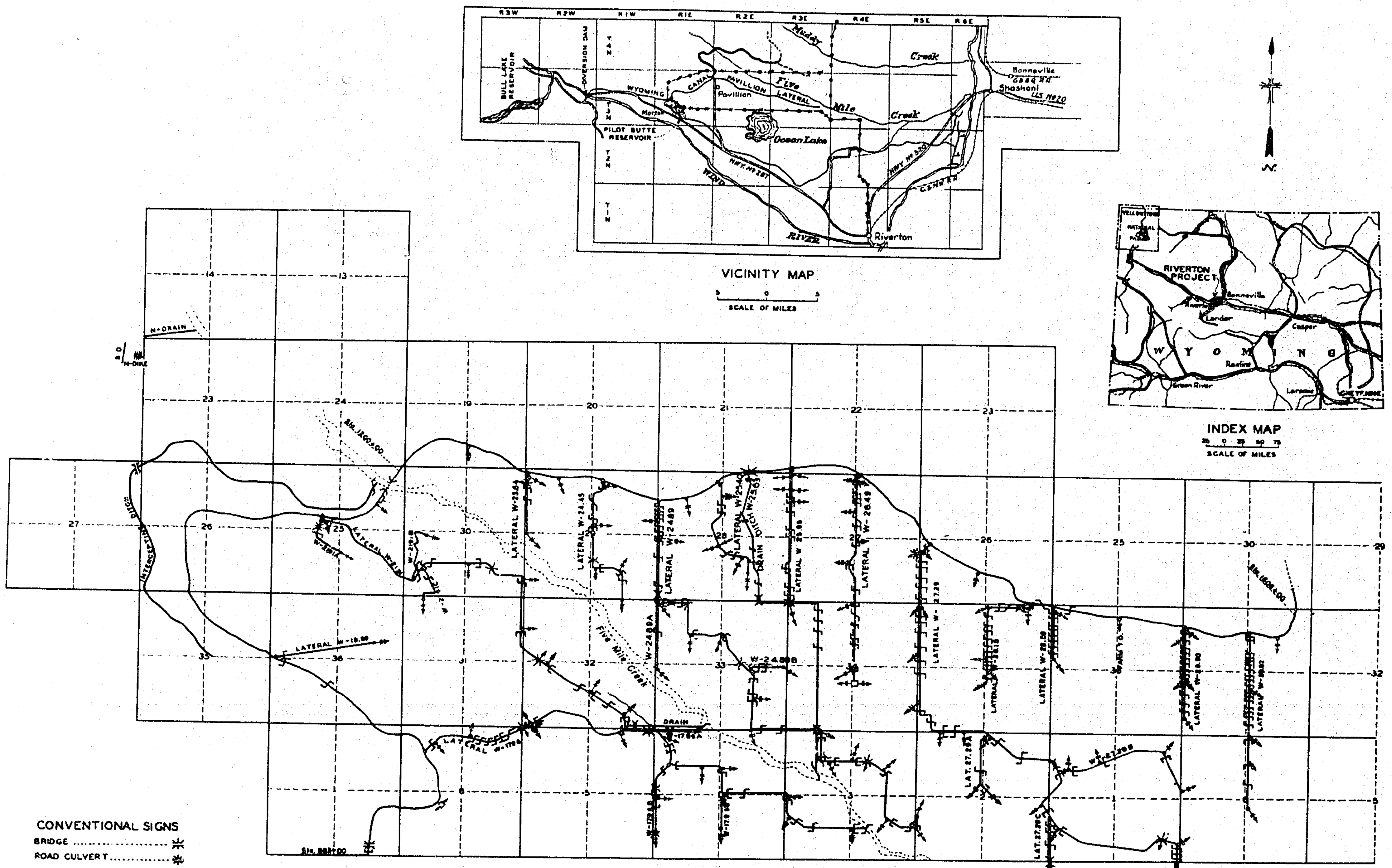
Figure 33 shows the drop structure as constructed in the field at Station 2241+25.

Table 3

COMPARISON OF BAFFLE PIER ARRANGEMENTS
Discharge = 410 Second Feet

Basin baffle pier arrangement	Number of piers in each valley (See Figure 31)	Size of piers, feet: Width	Size of piers, feet: Height	Height of waves, feet*	Maximum depth of scour, feet
Recommended basin	None	-	-	0.96	Not obtained
Plan A	1	1.5	2.0	0.93	Not obtained
Plan B	2	0.75	1.75	0.83	Not obtained
Plan C	3	0.75	2.50	0.49	Not obtained
Plan D	3	0.75	2.50	0.69	Not obtained
Plan E	3 in center and 4 in outside valleys	0.75	2.50	0.54	Not obtained
Plan F	3 in center and 4 in outside valleys	1.00	2.50	0.41	1.75
Plan G	3 in center and 4 in outside valleys	1.25	2.50	0.42	1.65

*Maximum height crest of wave rises on 1-1/2:1 side slope of canal. Measured vertically in feet above the normal water surface at end of transition.



CONVENTIONAL SIGNS

- BRIDGE
- ROAD CULVERT
- DRAINAGE CULVERT
- DROP
- CHECK
- CHUTE
- FARM TO. & WEIR
- WEIR
- WASTEWAY
- SIPHON
- DIVISION BOX

SCHEDULE ARRANGEMENT

Schedule No 1 Wyoming canal-Sta 883+00 to Sta 1200+00, intercepting ditch, N-Dike and N-Drain

Schedule No 2 Wyoming canal-Sta 1200+00 to Sta 1606+00,

Schedule No 3 Laterals W-1796, W-1989, W-2191 and sub-laterals and Drain parallel to W-1796A.

Schedule No 4 Laterals W-2384 to W-2982 and sub-laterals and Drain Ditch W-2563

Note: Schedules No. 3 and No. 4 not included in this contract.

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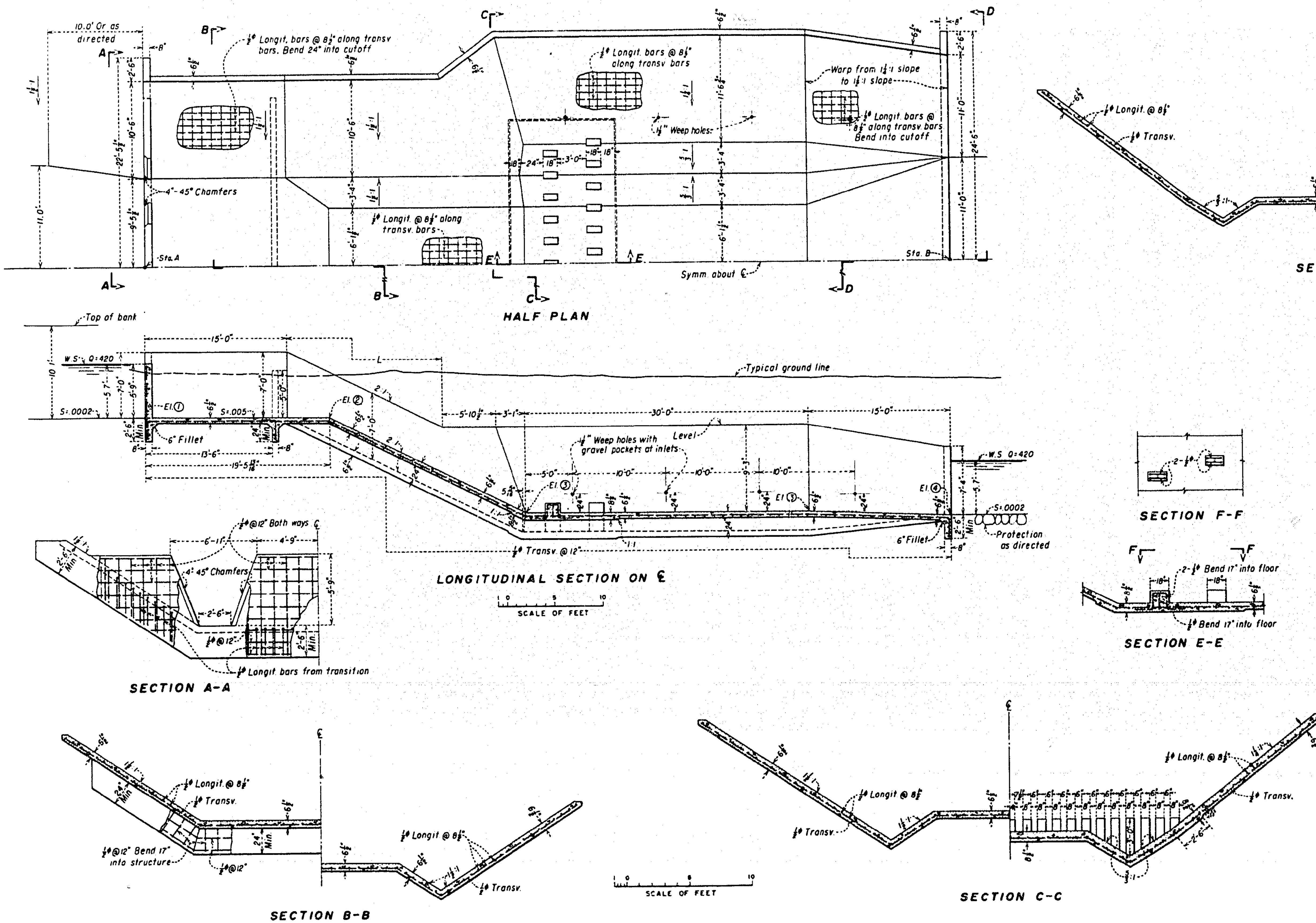
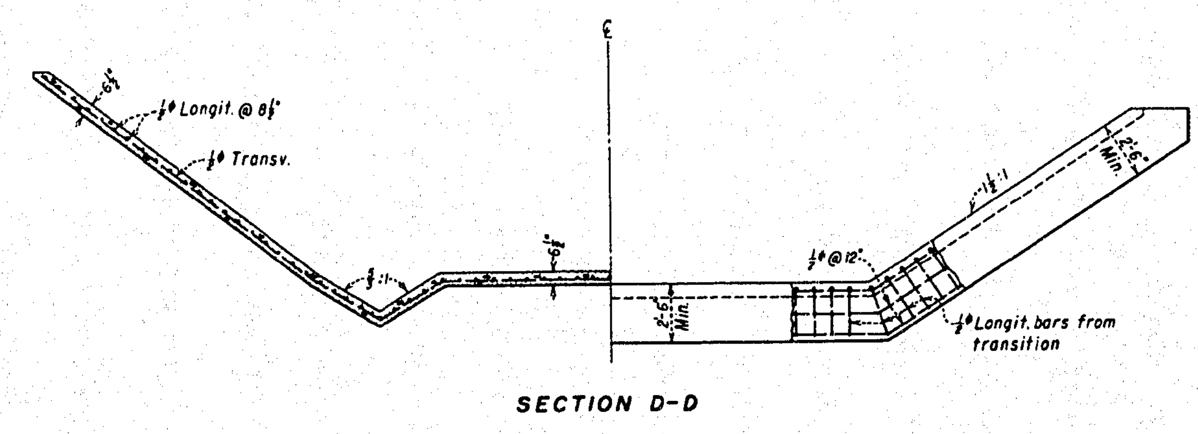
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
RIVERTON PROJECT-WYO.
WYOMING CANAL STA. 883-1607 AND LATERALS
EARTHWORK AND STRUCTURES
LOCATION MAP

DRAWN R.J. SUBMITTED
TRACED J.L. RECOMMENDED
CHECKED J.R.B. APPROVED
CHIEF ENGINEER

RIVERTON, WYO.-APRIL 1946 36-D-1321





STRUCTURE DATA

STA. A	EL. ①	EL. ②	EL. ③	EL. ④	L	STA. B
2262+00	5322.01	5321.91	5312.51	5312.01	14'-4"	2262+83.29
2275+00	5311.77	5311.67	5301.27	5300.77	16'-4"	2275+85.29
2394+00	5277.45	5277.35	5268.95	5268.45	12'-4"	2394+81.29
2427+00	5255.83	5255.73	5247.33	5246.83	12'-4"	2427+81.29
2458+25	5236.24	5236.14	5227.74	5227.24	12'-4"	2459+06.29
2472+00	5226.98	5226.88	5218.48	5217.98	12'-4"	2472+81.29
2504+00	5208.37	5208.27	5199.87	5199.37	12'-4"	2504+81.29

ESTIMATED QUANTITIES

	Ⓘ	Ⓘⅰ	Ⓘⅱ
Concrete	95 Cu. Yds.	97 Cu. Yds.	99 Cu. Yds.
Reinforcement steel	7800 Lbs.	8000 Lbs.	8200 Lbs.

NOTES

All reinforcement shall be placed so that the centers of bars in the outer layer will be 2½" from face of concrete, unless otherwise shown.
Lap all bars 34 diameters at splices. Stagger splices.
Entire structure to be placed on undisturbed earth or thoroughly compacted fill.
(I) Data for drop at Sta's 2394+00, 2427+00, 2458+25, 2472+00, and 2504+00.
(II) Data for drop at Sta. 2262+00.
(III) Data for drop at Sta. 2275+00.

THIS DRAWING IS SUPERSEDED BY DWG. 36-D-1662

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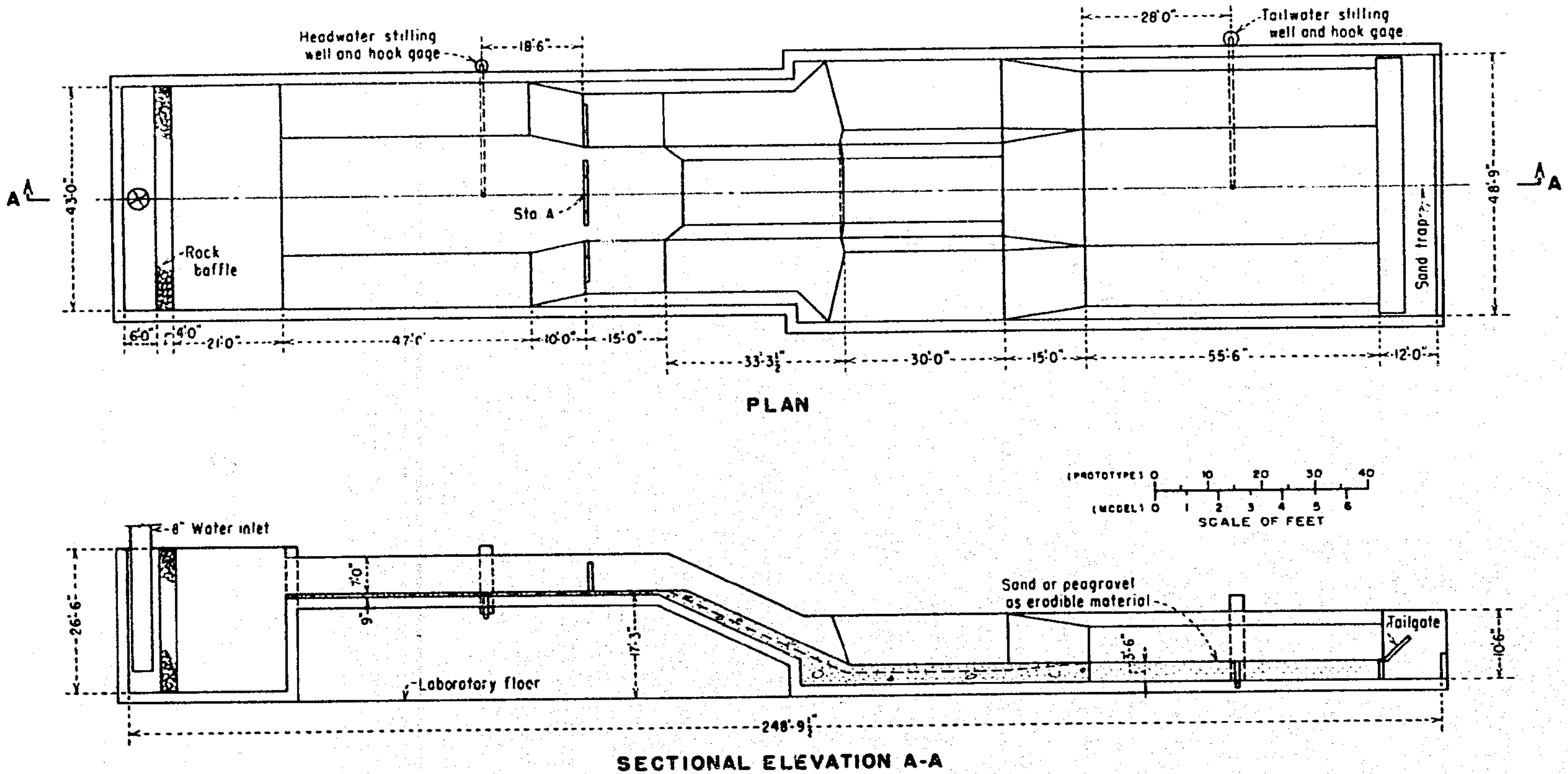
RIVERTON PROJECT—WYOMING
WYOMING CANAL—STA. 2262+00 TO STA. 2504+82

TRAPEZOIDAL CONCRETE DROPS

DRAWN E.B.B. SUBMITTED H.R. McBirney
TRACED J.A.F. RECOMMENDED W.H. Nalder
CHECKED W.A.K. G.R.B. APPROVED L.N. McClellan, CHIEF ENGINEER
DENVER, COLORADO. MARCH 1, 1946 36-D-1622

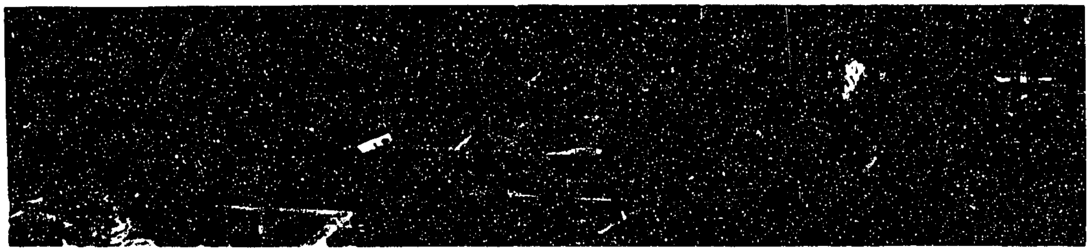


WYOMING CANAL TRAPEZOIDAL DROP

EXTENT AND LAYOUT OF 1:6 SCALE MODEL

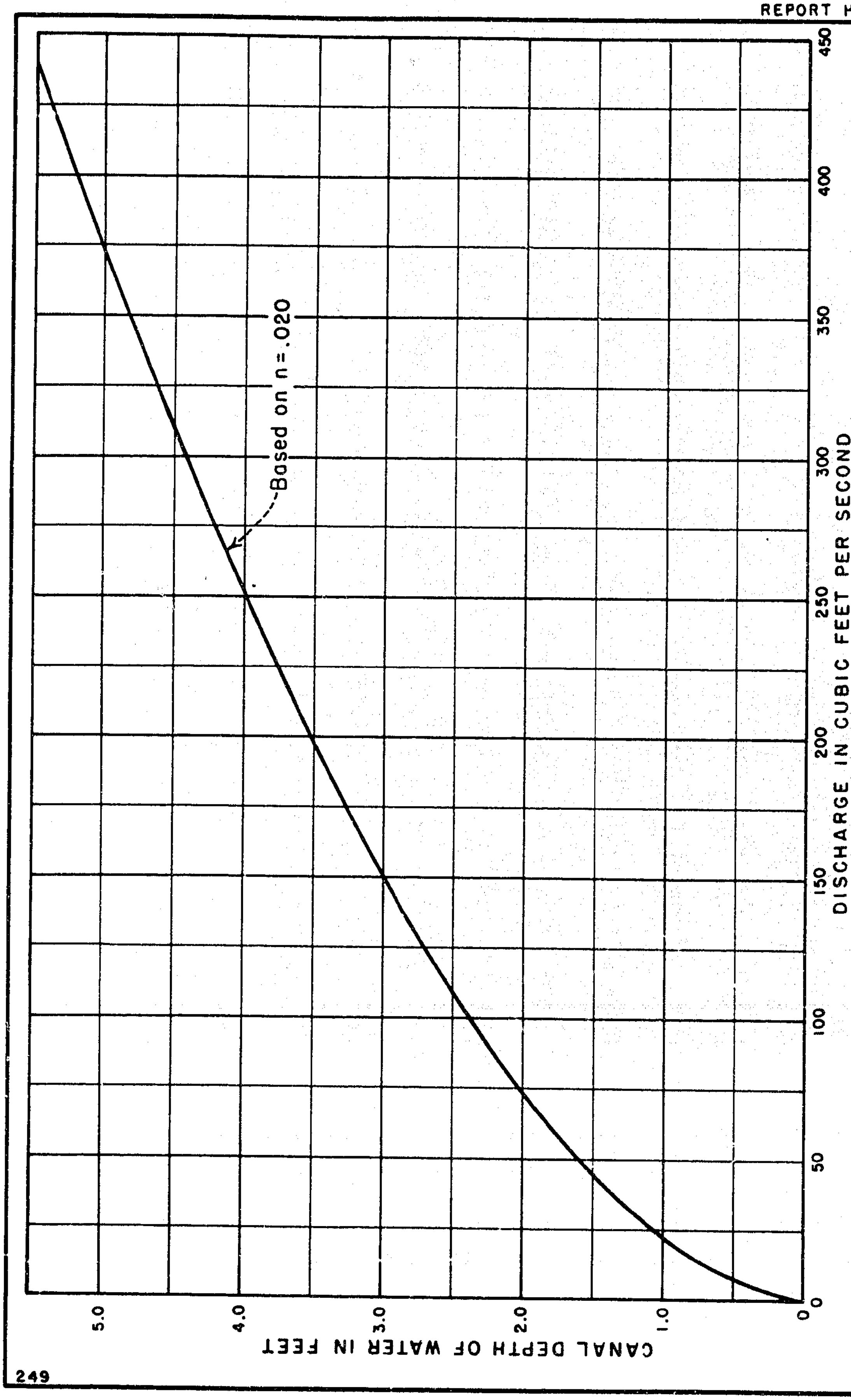
PRELIMINARY DESIGN

FIGURE 3
REPORT HYD. 371



WYOMING CANAL TRAPEZOIDAL DROP
The 1:6 Scale Model

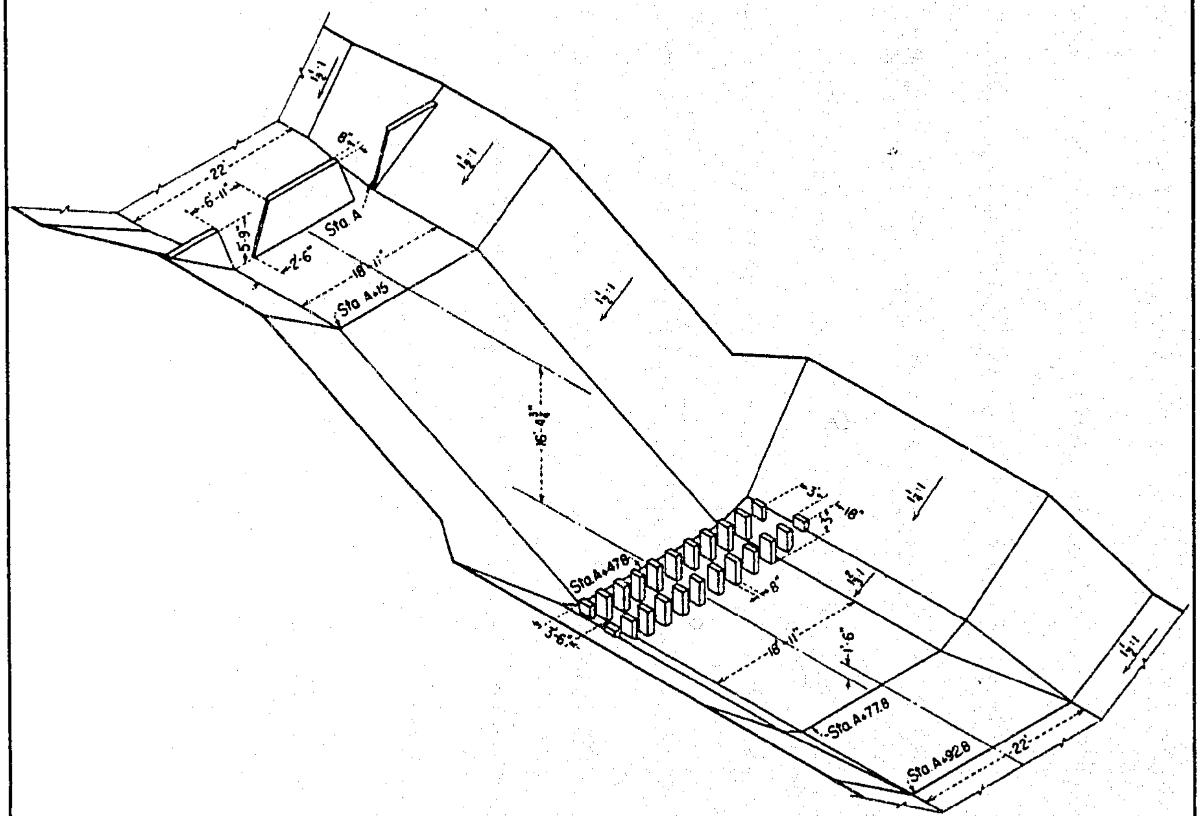
FIGURE 5
REPORT HYD. 371



WYOMING CANAL, STA. 2241 TO STA. 2448
TAILWATER CURVE

249

FIGURE 6
REPORT HYD. 371



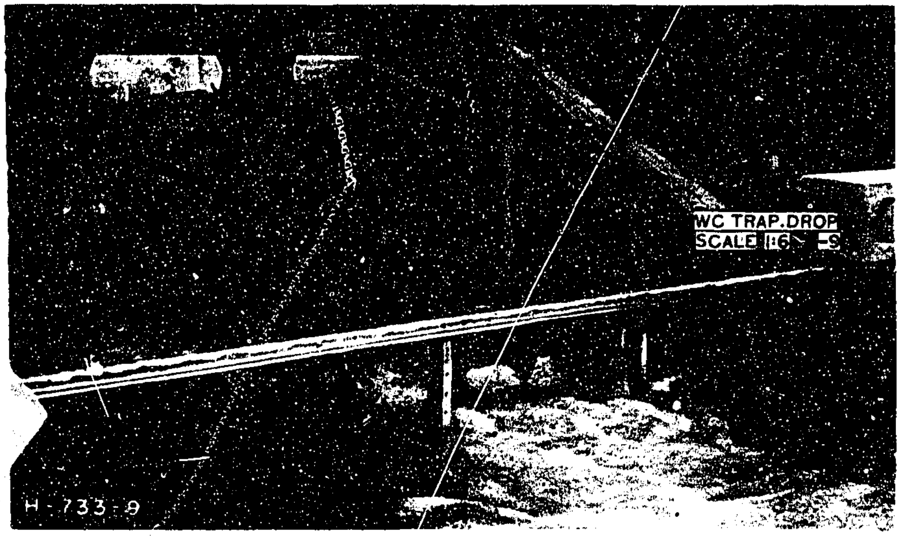
MODEL ARRANGEMENT	DISCHARGE (SEC. FT.)	HEIGHT OF WAVES FEET
Design I (as shown)	410 100	0.30 0.24
Design I (with basin baffle piers removed)	410 100	1.94 0.76

WYOMING CANAL TRAPEZOIDAL DROP

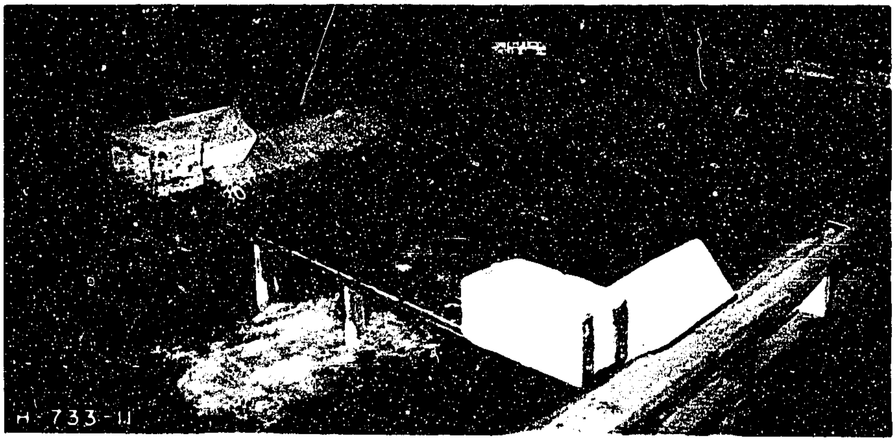
DESIGN 1

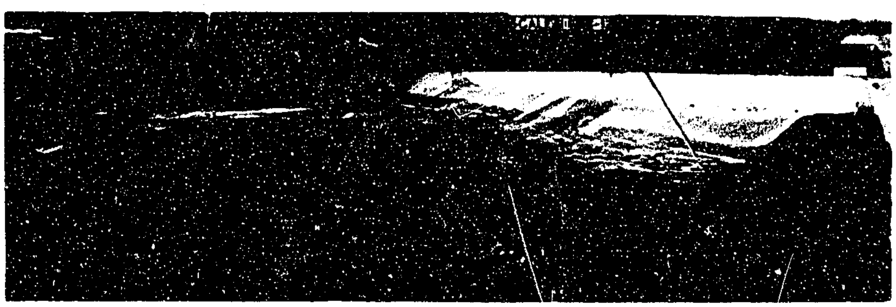
1:6 SCALE MODEL

249

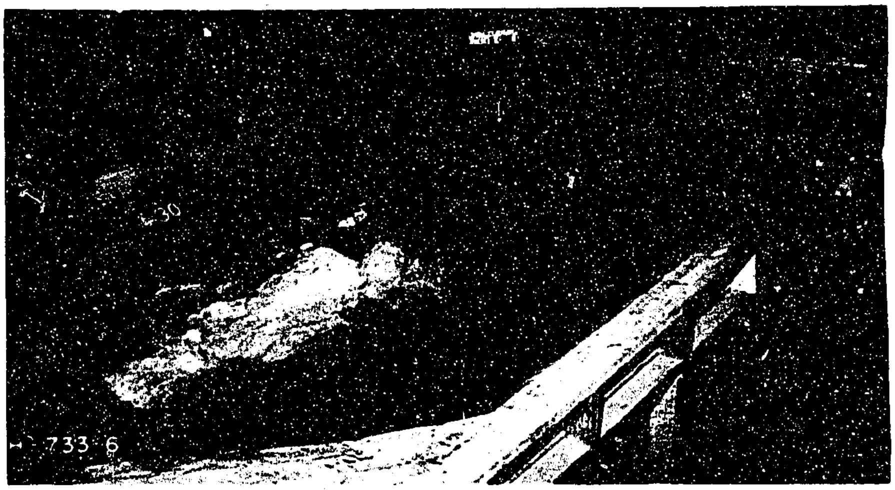


The struts extending into the water were used to hold removable baffle piers in place.



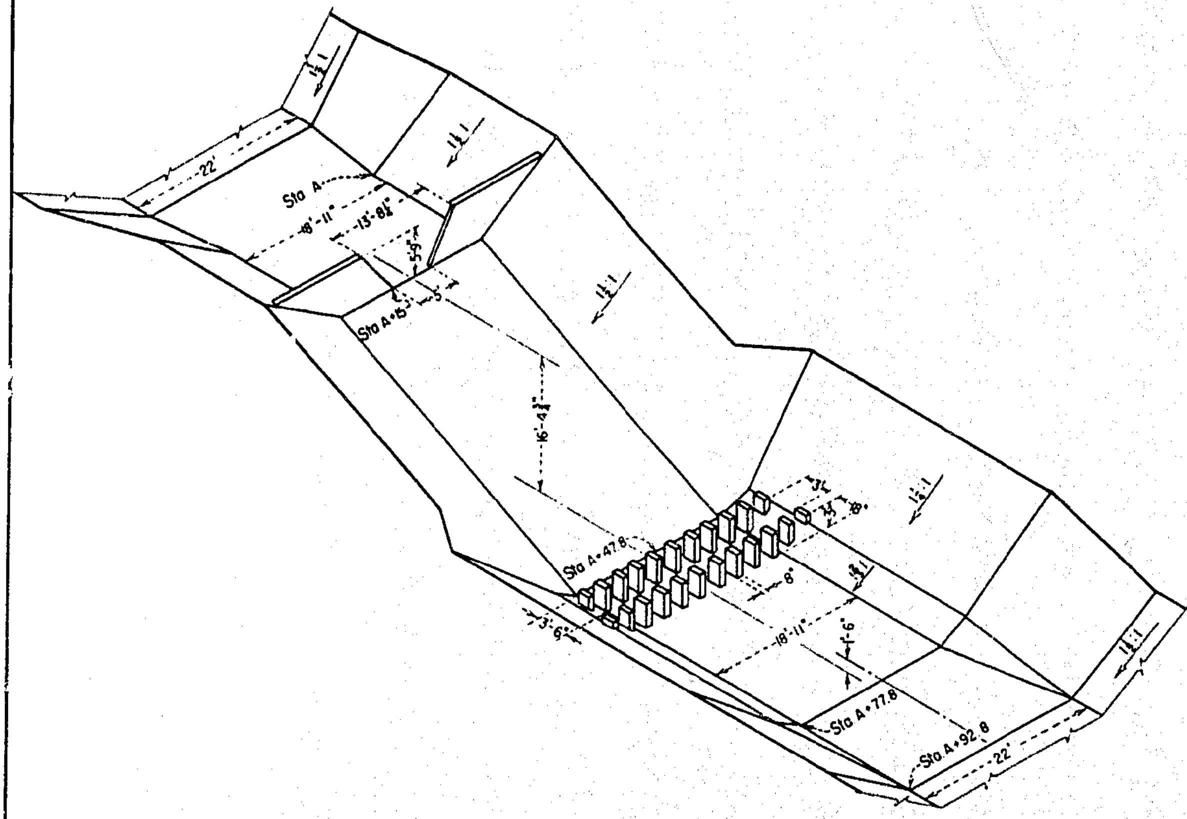


WYOMING CANAL TRAPEZOIDAL DROP
OPERATION OF DESIGN 1
(with basin baffle piers installed)
Discharge = 410 second-feet
1:6 Scale Model



WYOMING CANAL TRAPEZOIDAL DROP
OPERATION OF DESIGN 1
(with baffle piers removed)
Discharge = 410 second-feet
1:6 Scale Model

FIGURE 9
REPORT HYD. 371

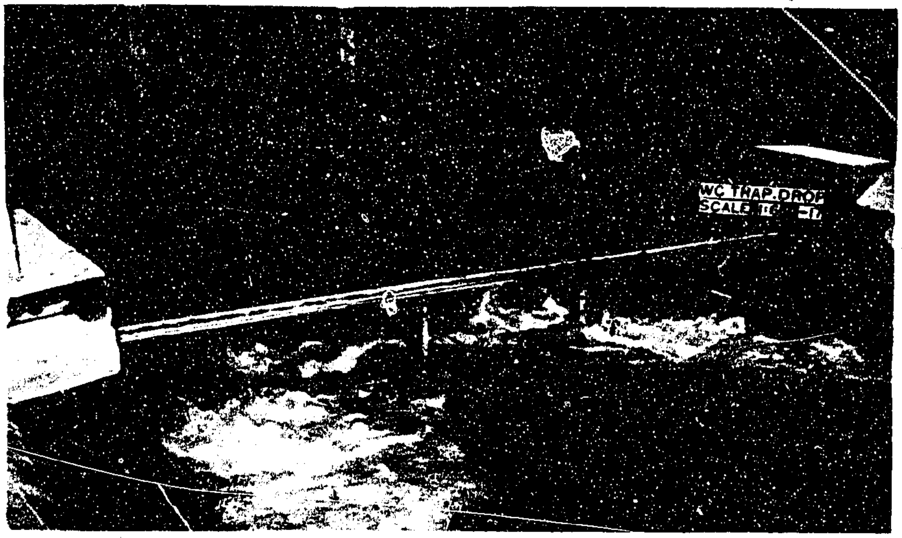


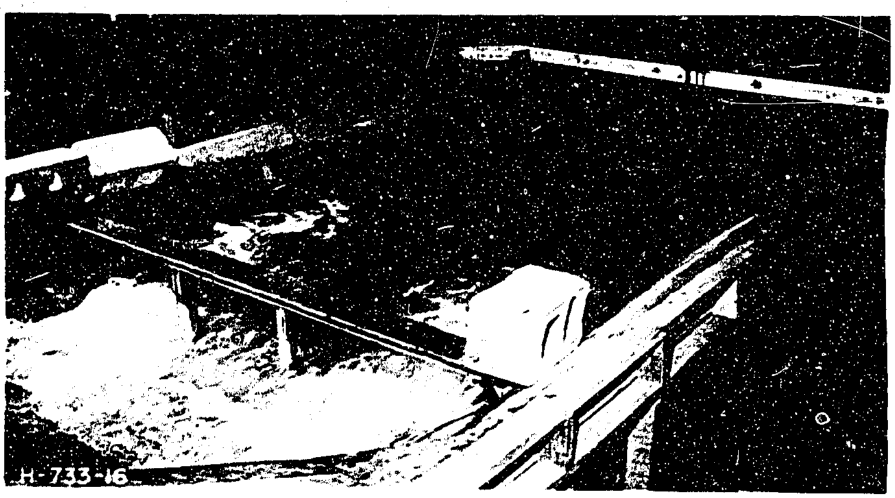
MODEL ARRANGEMENT	DISCHARGE (SEC. FT.)	HEIGHT OF WAVES, FEET
Design 2 (as shown)	410	0.59
	100	0.28
Design 2 (with basin baffle piers removed)	410	1.25
	100	0.49

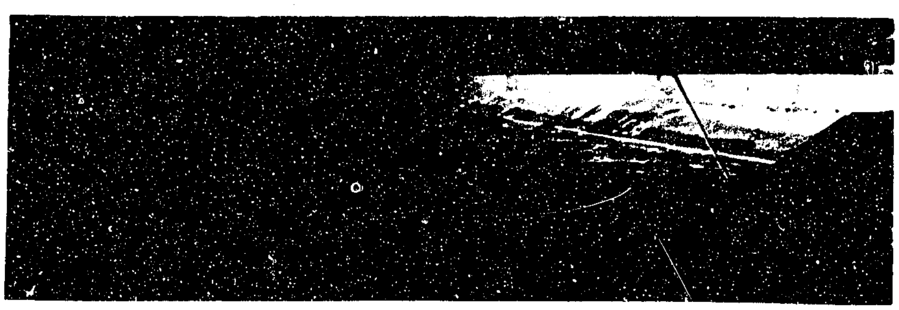
WYOMING CANAL TRAPEZOIDAL DROP

DESIGN 2

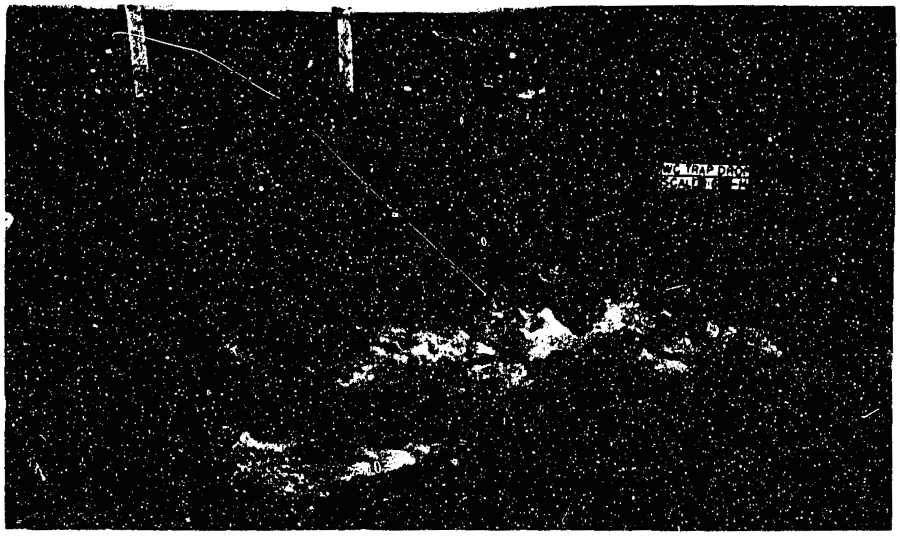
1:6 SCALE MODEL

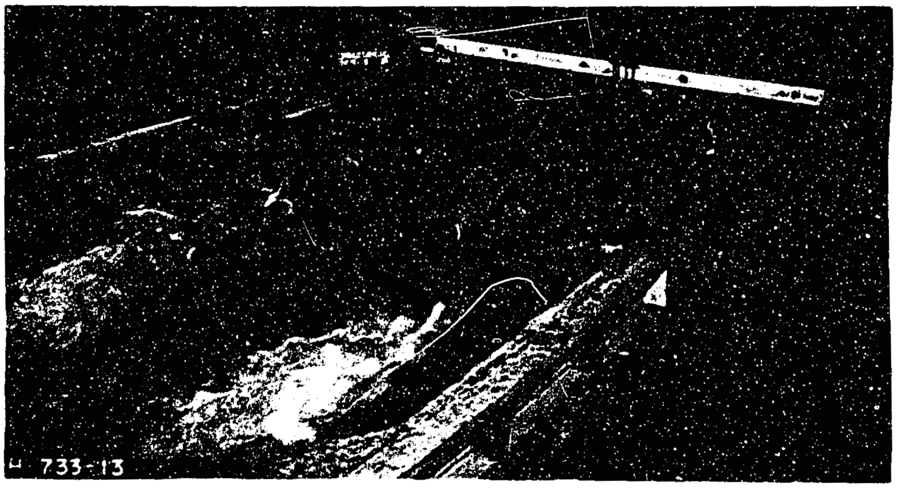


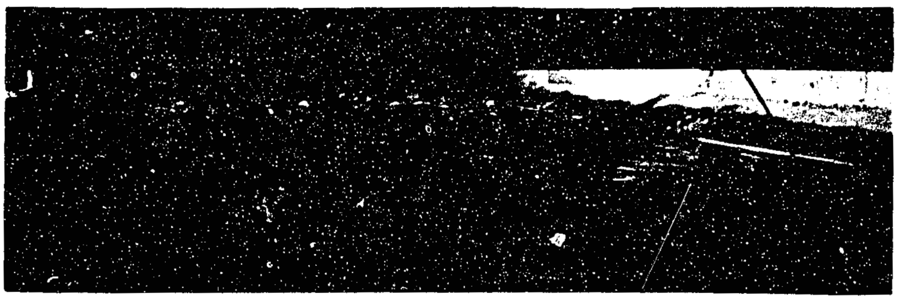




WYOMING CANAL TRAPEZOIDAL DROP
OPERATION OF DESIGN 2
(with basin baffle piers installed)
Discharge = 410 second-feet
1:6 Scale Model

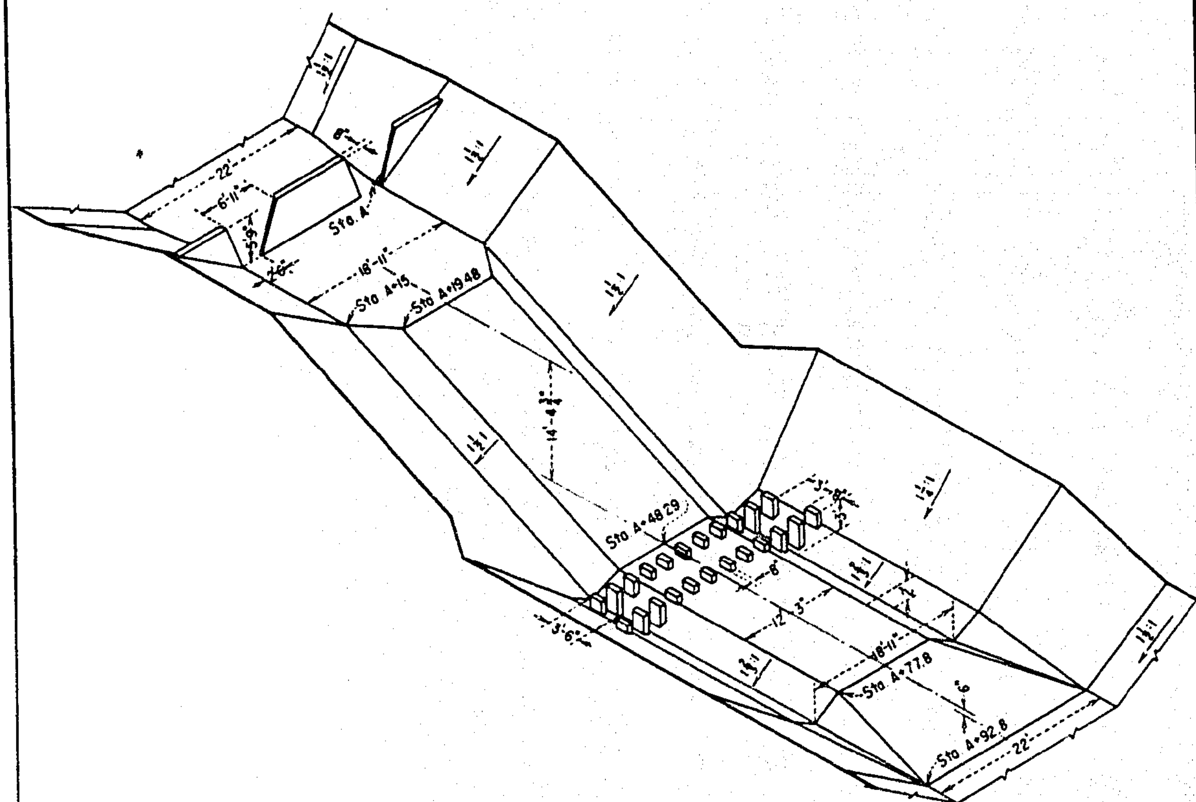






WYOMING CANAL TRAPEZOIDAL DROP
OPERATION OF DESIGN 2
(with basin baffle piers removed)
Discharge = 410 second-feet
1:6 Scale Model

FIGURE 12
REPORT HYD 371

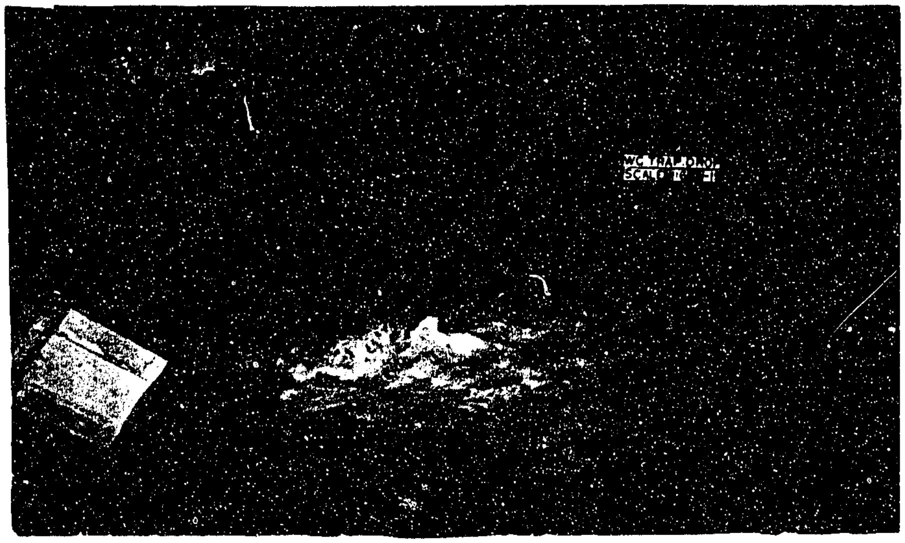


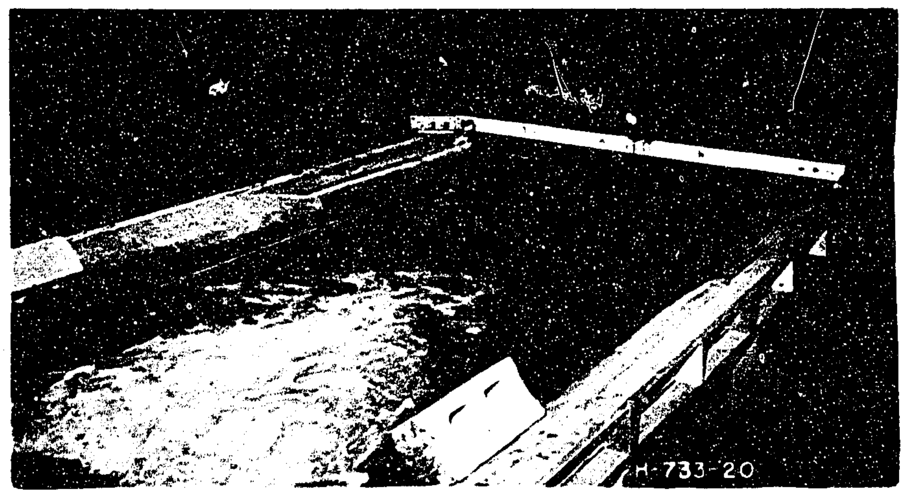
MODEL ARRANGEMENT	DISCHARGE (SEC. FT.)	HEIGHT OF WAVES, FEET
Design 3 (as shown)	410	0.62
	100	0.31
Design 3 (with basin baffle piers removed)	410	1.32
	100	0.73

WYOMING CANAL TRAPEZOIDAL DROP

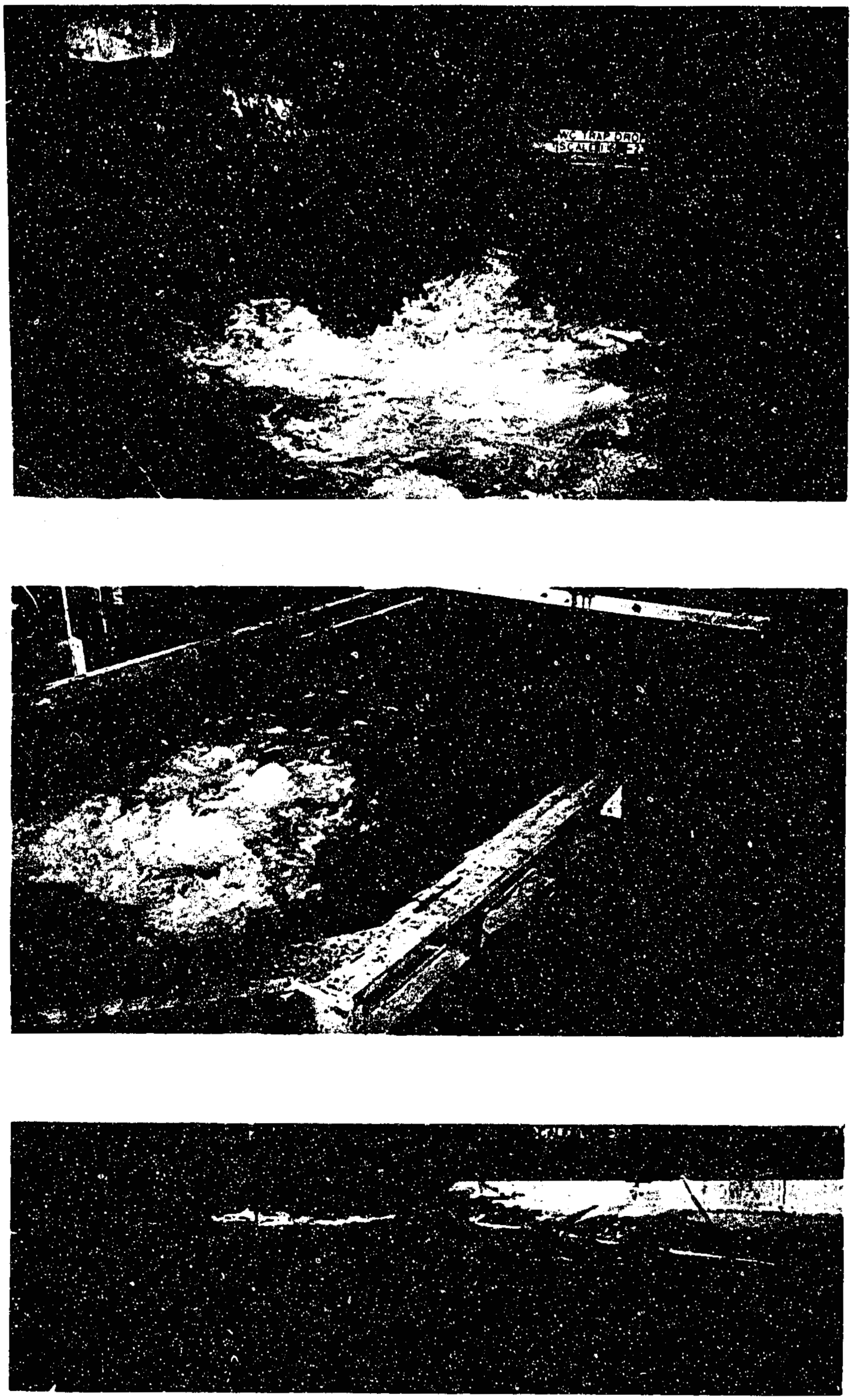
DESIGN 3 (PRELIMINARY)

1:6 SCALE MODEL

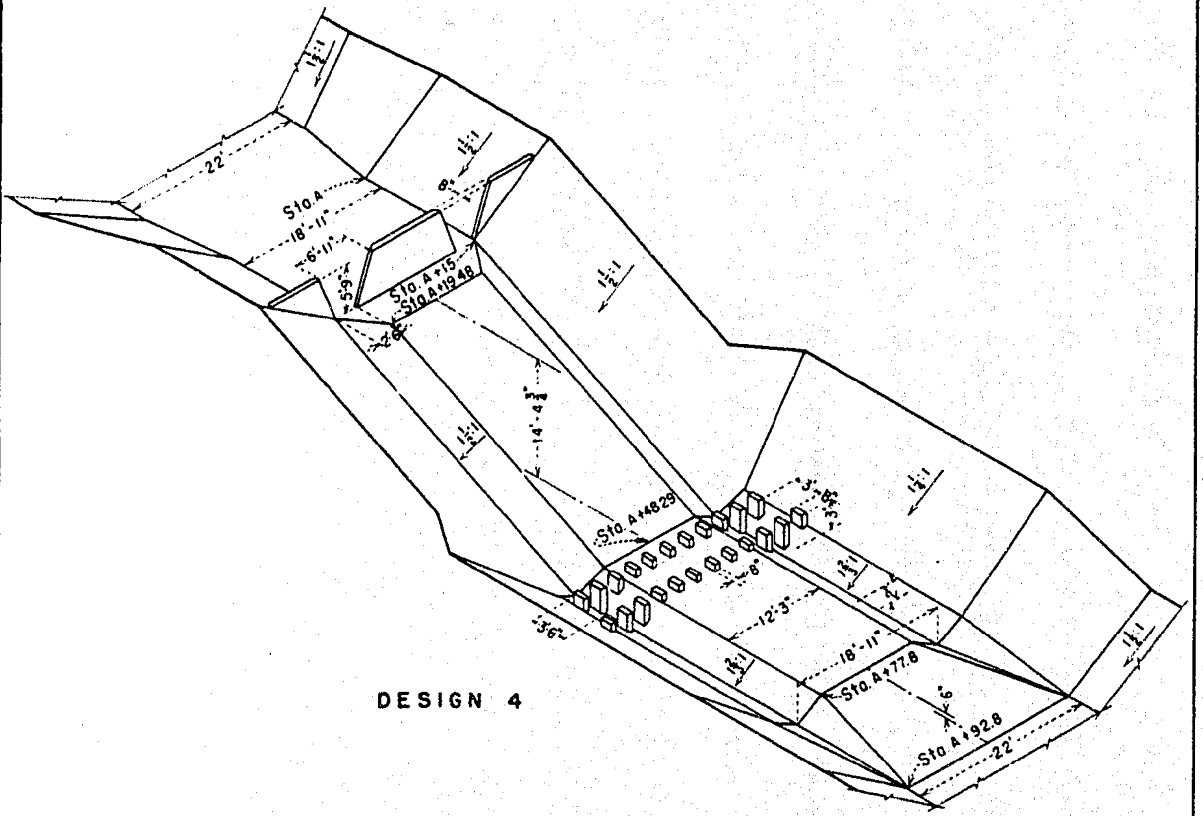




WYOMING CANAL TRAPEZOIDAL DROP
DESIGN 3 (Preliminary)
(with basin baffle piers installed)
Discharge = 410 second-feet
1:6 Scale Model



WYOMING CANAL TRAPEZOIDAL DROP
DESIGN 3
(with basin baffle piers removed)
Discharge = 410 second-feet
1:6 Scale Model



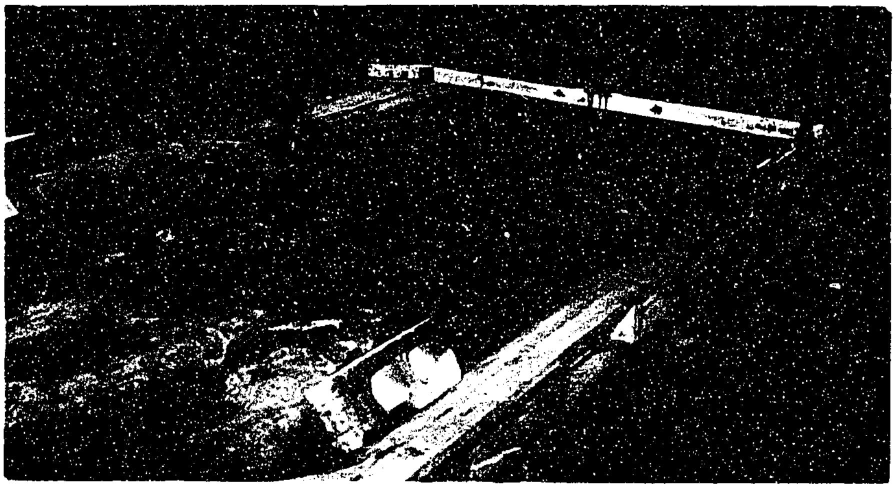
DESIGN 4

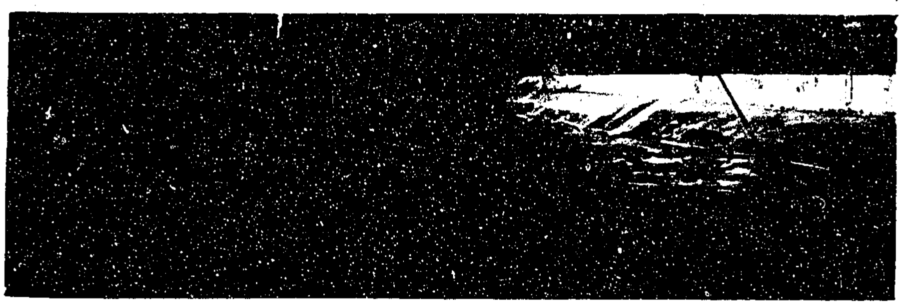
MODEL ARRANGEMENT	HEIGHT OF WAVES, FT.	
	Q = 440 C.F.S.	Q = 100 C.F.S.
Design 4 (as shown)	0.69	0.35
Design 4 (With basin baffle piers removed)	1.39	0.76
Design 5 (Same as Design 4 exept control notches moved to Sta. 0+14)	0.52	0.35
Design 5 (With basin baffle piers removed)	1.18	0.80
Design 6 (Same as Design 4 exept control notches moved to Sta. 0+13)	0.62	0.31
Design 6 (With basin baffle piers removed)	1.11	0.62

WYOMING CANAL TRAPEZOIDAL DROP

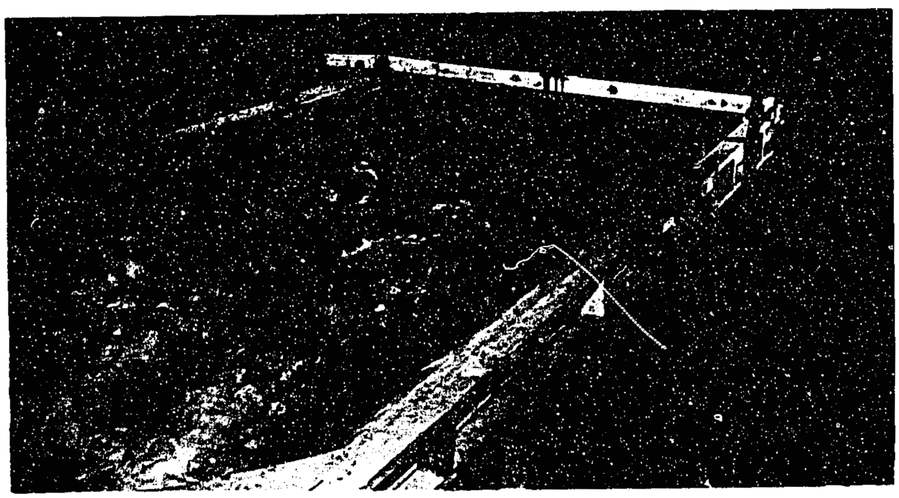
DESIGNS 4, 5, AND 6

1:6 SCALE MODEL

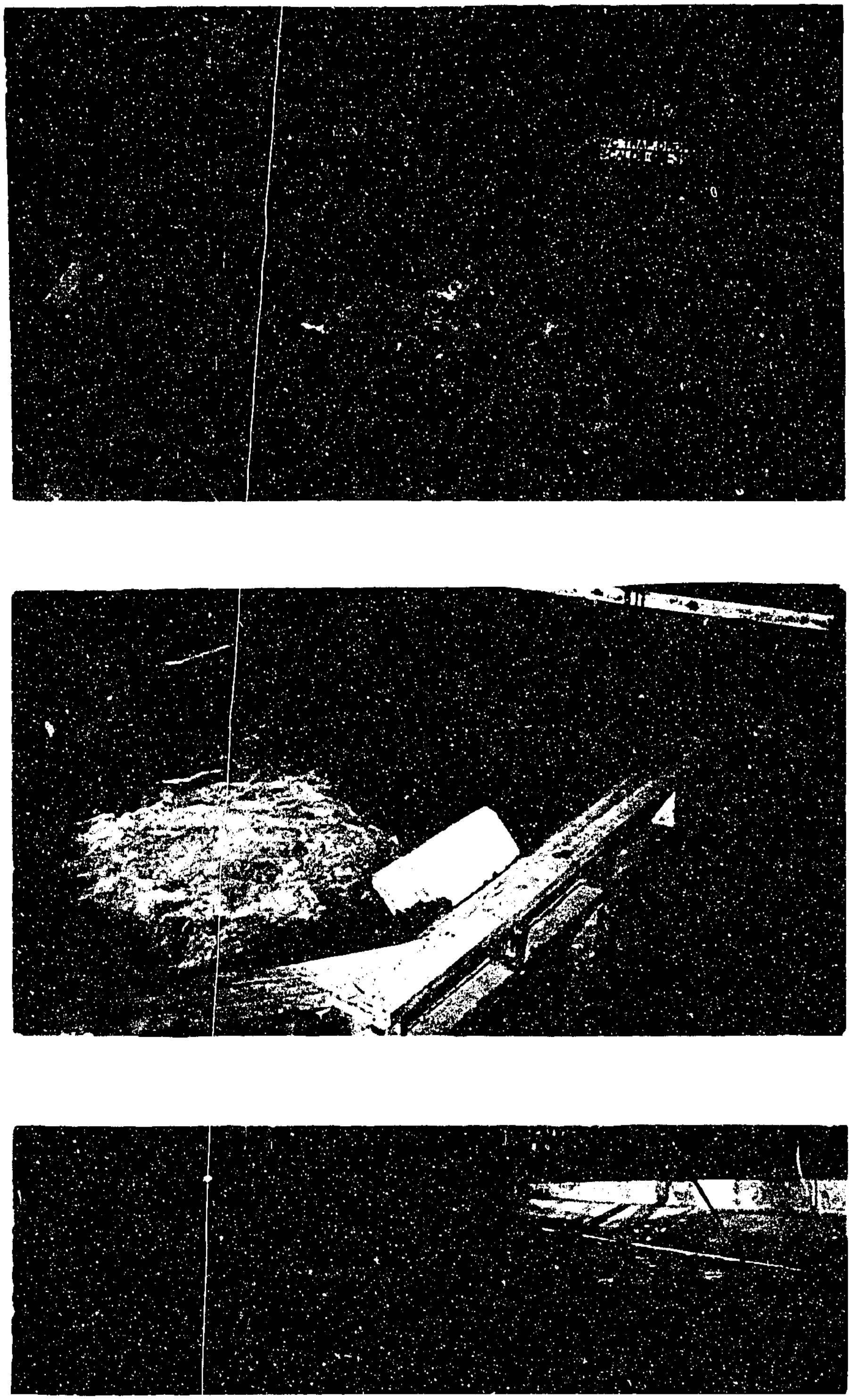




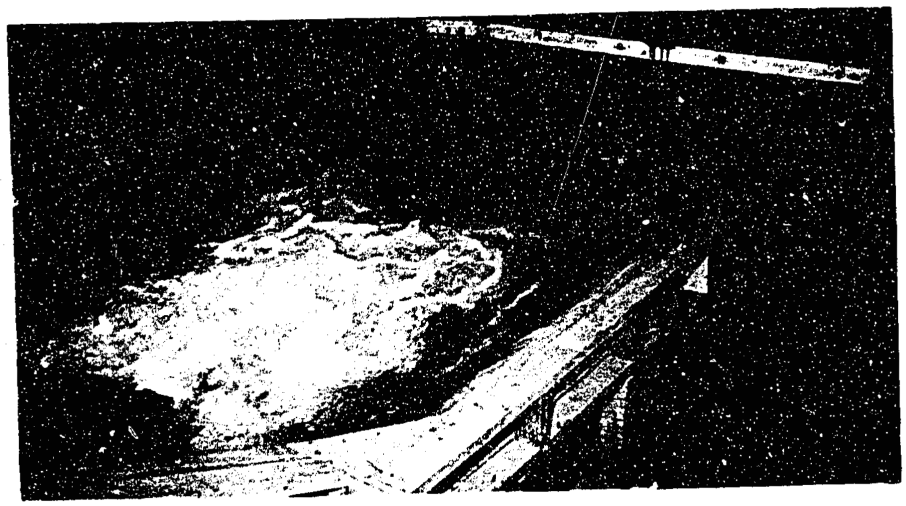
WYOMING CANAL TRAPEZOIDAL DROP
DESIGN 4
(with baffle piers installed)
Discharge = 410 second-feet
1:6 Scale Model

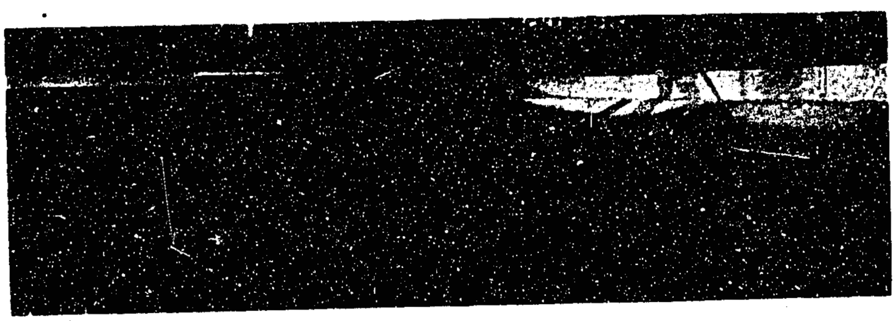


WYOMING CANAL TRAPEZOIDAL DROP
DESIGN 4
(with baffle piers removed)
Discharge = 410 second-feet
1:6 Scale Model



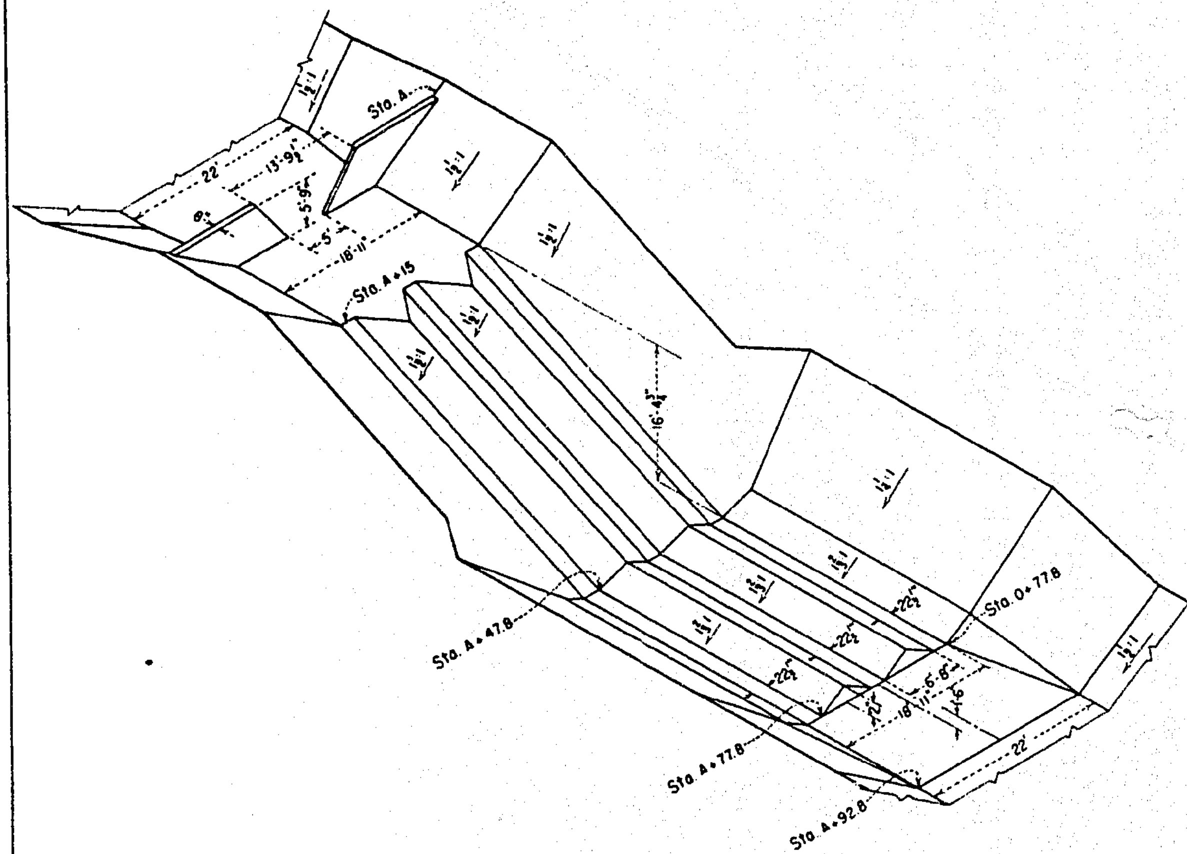
WYOMING CANAL TRAPEZOIDAL DROP
DESIGN 6
(with baffle piers installed)
Discharge = 410 second-feet
1:6 Scale Model





WYOMING CANAL TRAPEZOIDAL DROP
DESIGN 6
(with baffle piers removed)
Discharge = 410 second-feet
1:6 Scale Model

FIGURE 20
REPORT HYD. 371



MODEL ARRANGEMENT	DISCHARGE (SEC. FT.)	HEIGHT OF WAVES, FEET
Design 7	410 100	1.25 0.49

WYOMING CANAL TRAPEZOIDAL DROP

DESIGN 7

1:6 SCALE MODEL

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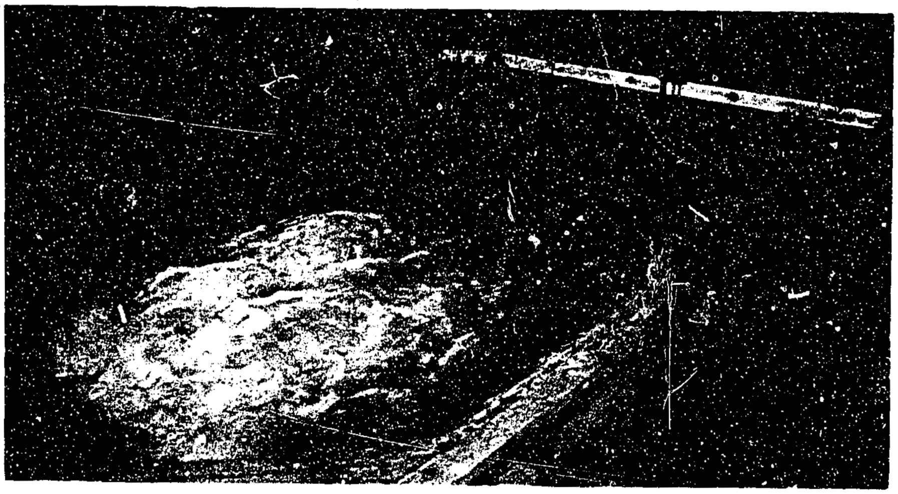
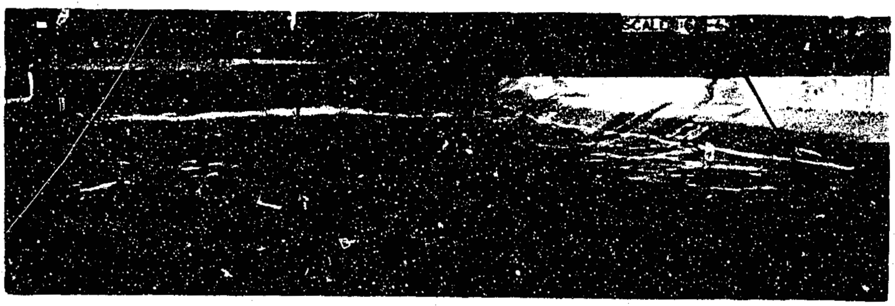
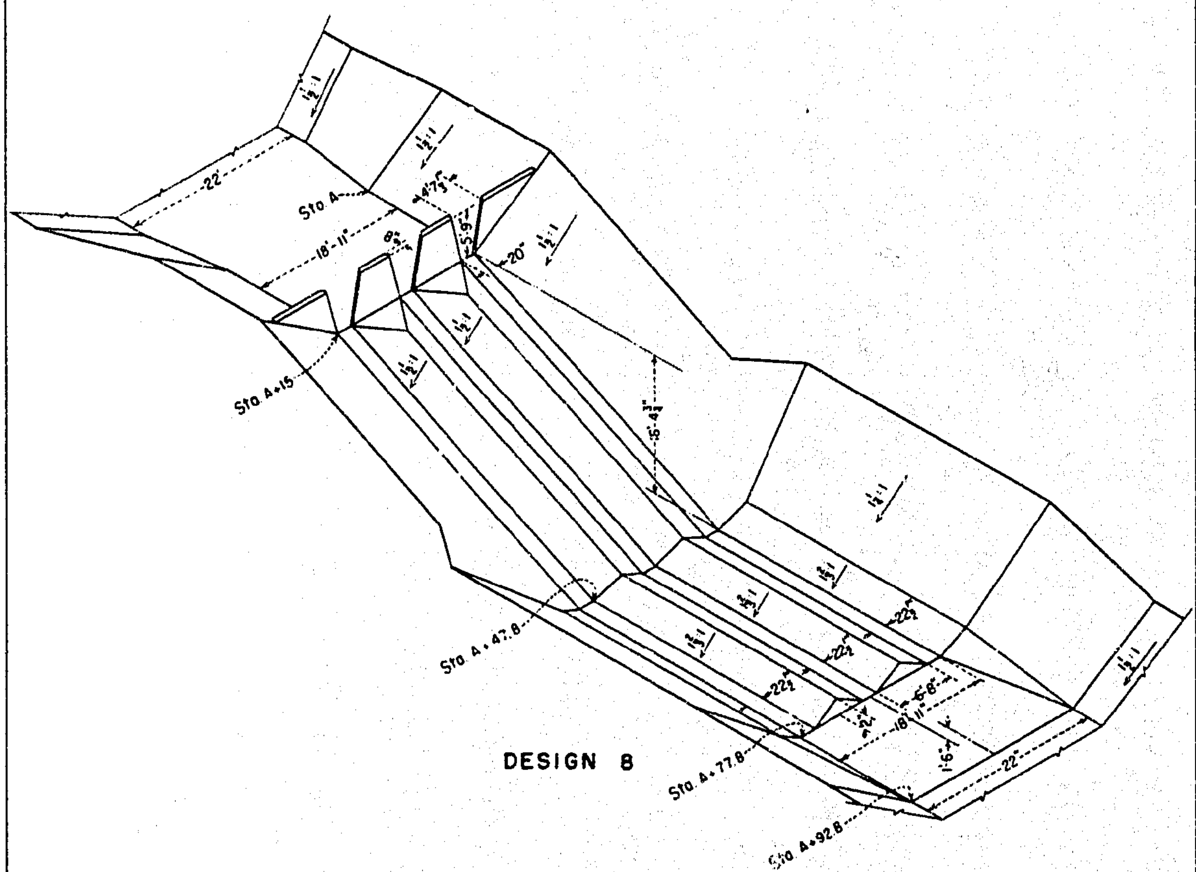




WYOMING CANAL TRAPEZOIDAL DROP
DESIGN 7
Discharge = 410 second-feet
1:6 Scale Model



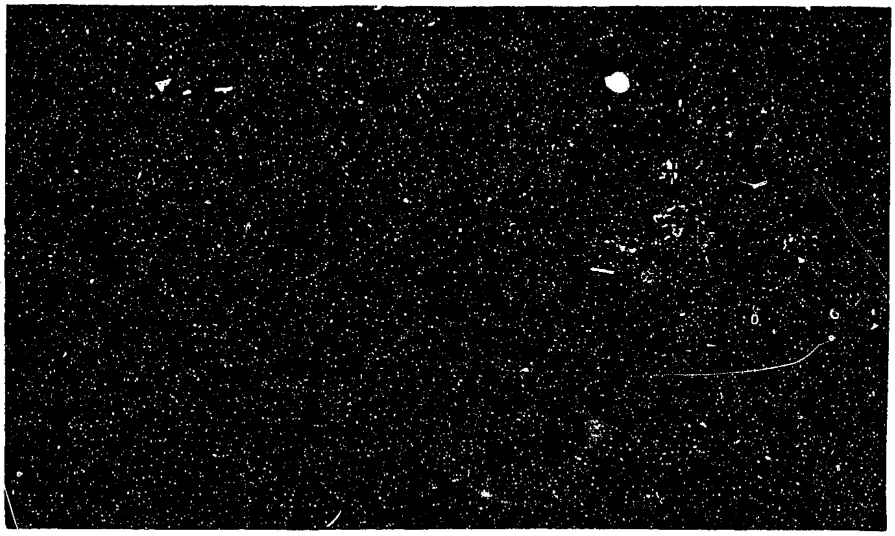
DESIGN 8

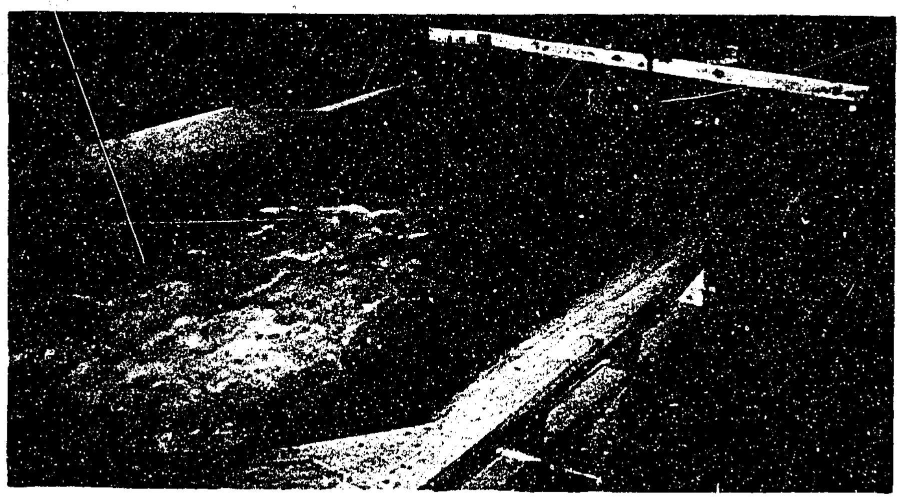
MODEL ARRANGEMENT	HEIGHT OF WAVES, FT.	
	Q = 440 C.F.S.	Q = 100 C.F.S.
Design 8 (as shown)	0.90	0.45
Design 9 (same as Design 8, except control notches moved to Sta. 0+11)	1.36	0.49
Design 10 (same as Design 8, except control notches moved to Sta. 0+6)	0.97	0.42

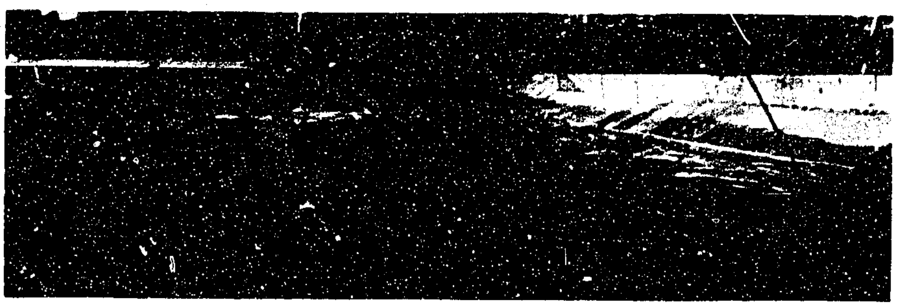
WYOMING CANAL TRAPEZOIDAL DROP

DESIGNS 8, 9, AND 10

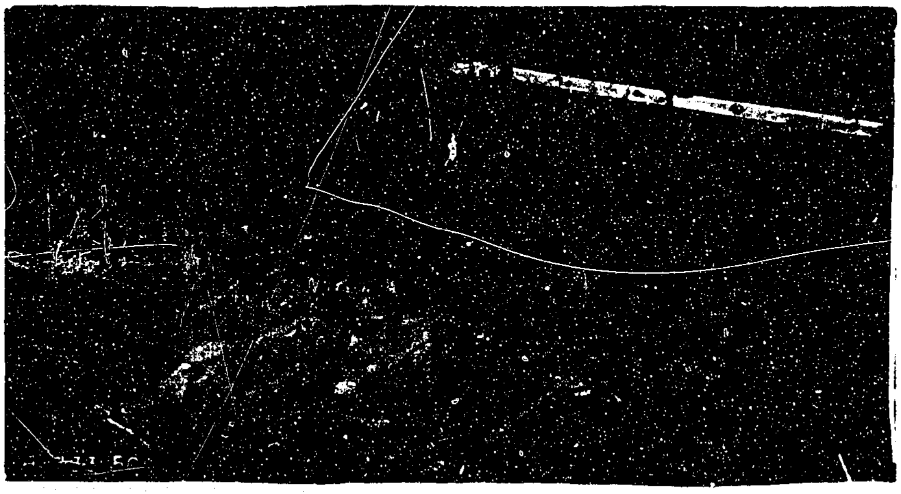
1:6 SCALE MODEL

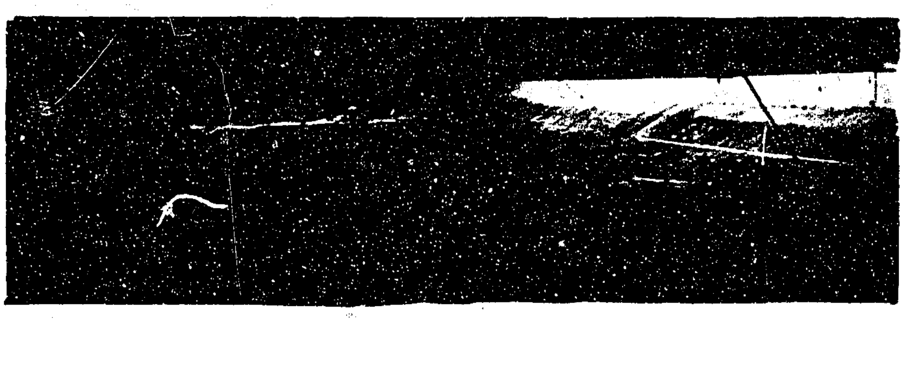




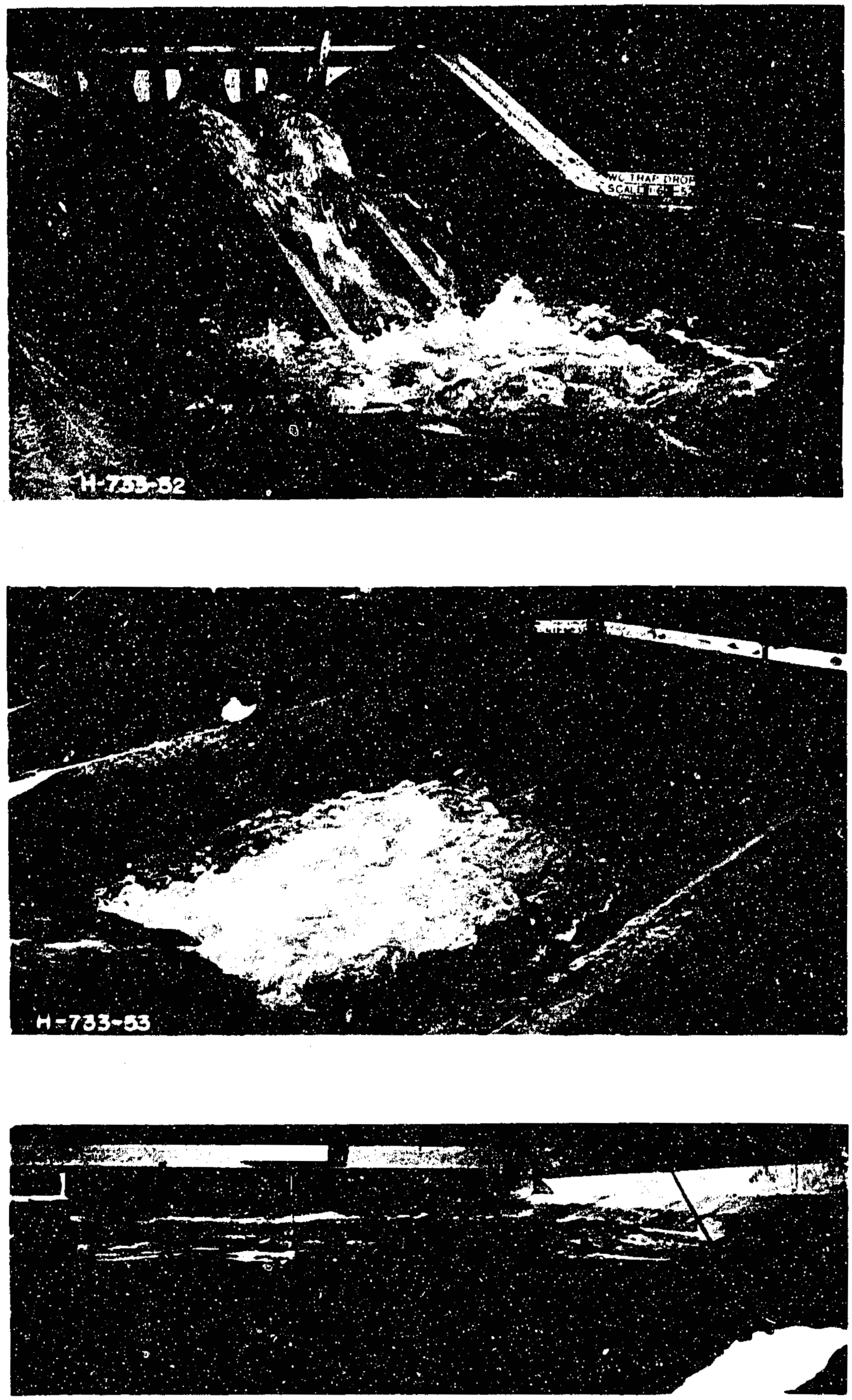


WYOMING CANAL TRAPEZOIDAL DROP
DESIGN 8
Discharge = 410 second-feet
1:6 Scale Model

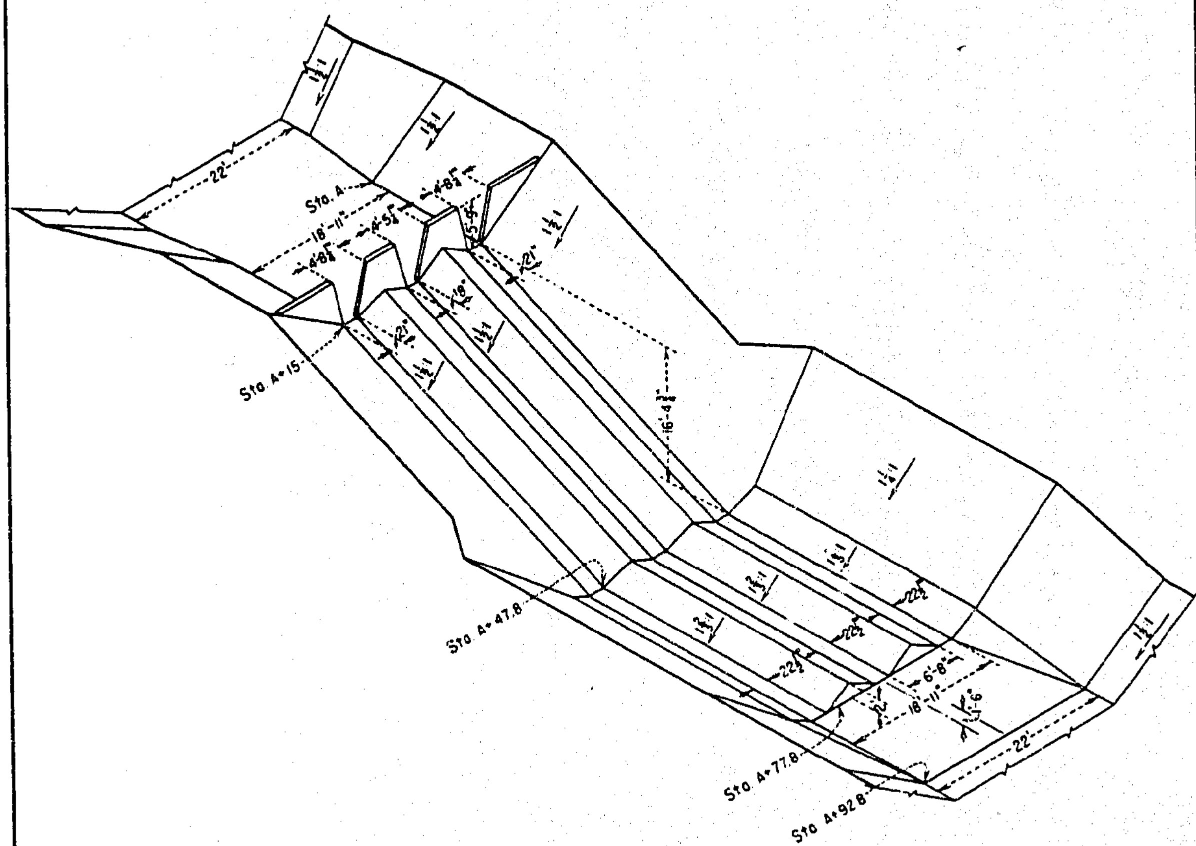




WYOMING CANAL TRAPEZOIDAL DROP
DESIGN 9
Discharge = 410 second-feet
1:6 Scale Model



WYOMING CANAL TRAPEZOIDAL DROP
DESIGN 10
Discharge = 410 second-feet
1:6 Scale Model

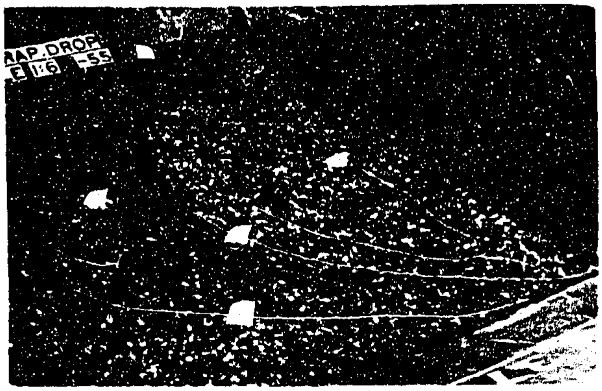


MODEL ARRANGEMENT	DISCHARGE (SEC. FT.)	HEIGHT OF WAVES, FEET
Design II	410	0.96
	100	-

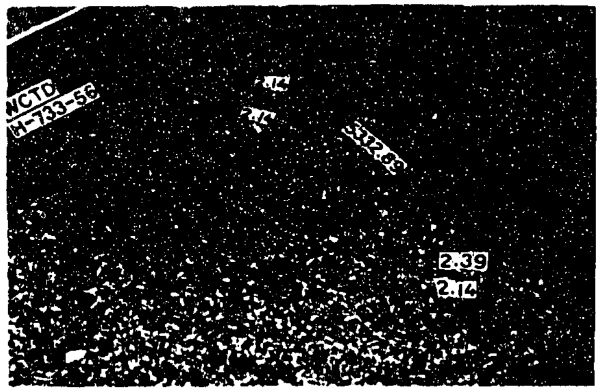
WYOMING CANAL TRAPEZOIDAL DROP

DESIGN II

1:6 SCALE MODEL

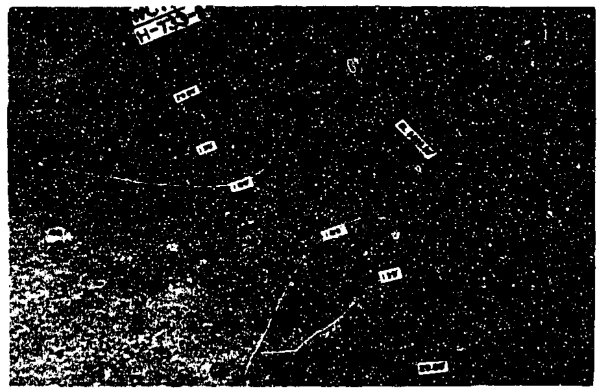


A. Original transition

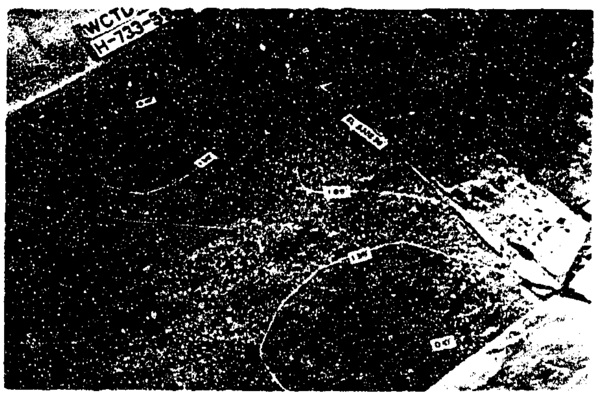


B. Design A (pea gravel in canal)

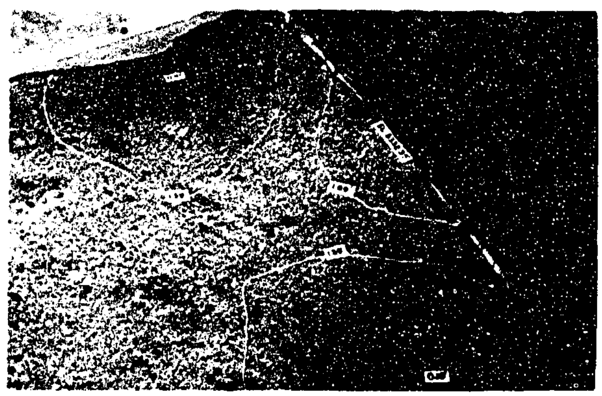
C. Design A (sand in canal)



D. Design B



E. Design C



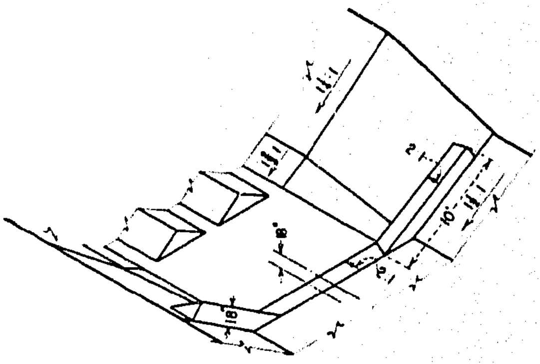
F. Design D

WYOMING CANAL TRAPEZOIDAL DROP

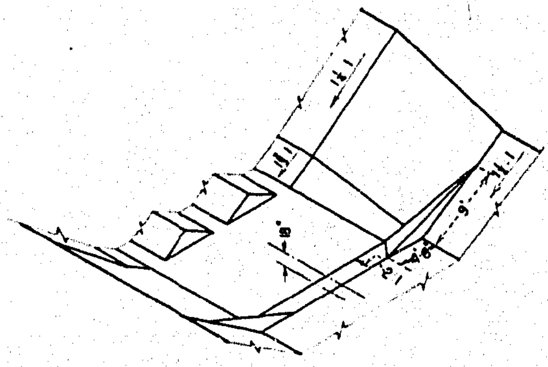
Scour patterns after discharge of 410 second-feet using different sills at downstream end of transition

1:6 Scale Model

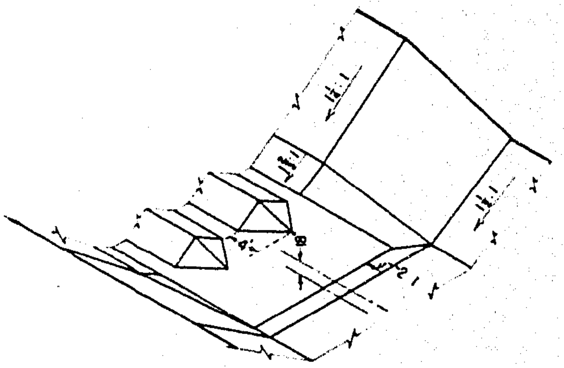
FIGURE 29
REPORT HYD 371



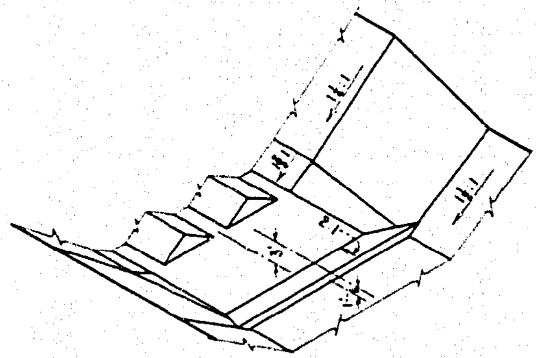
DESIGN E



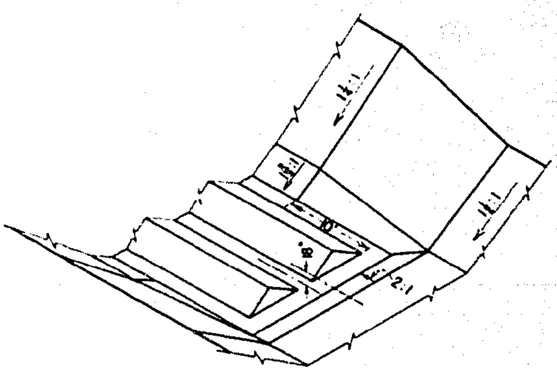
DESIGN F



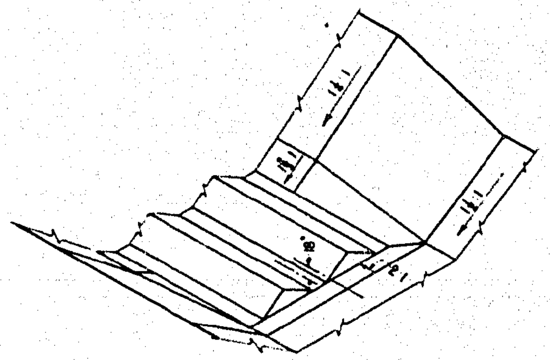
DESIGN G



DESIGN H



DESIGN I



DESIGN J

WYOMING CANAL TRAPEZOIDAL DROP

MODIFICATIONS TO FLOOR OF TRANSITION AT END OF BASIN

1:6 SCALE MODEL

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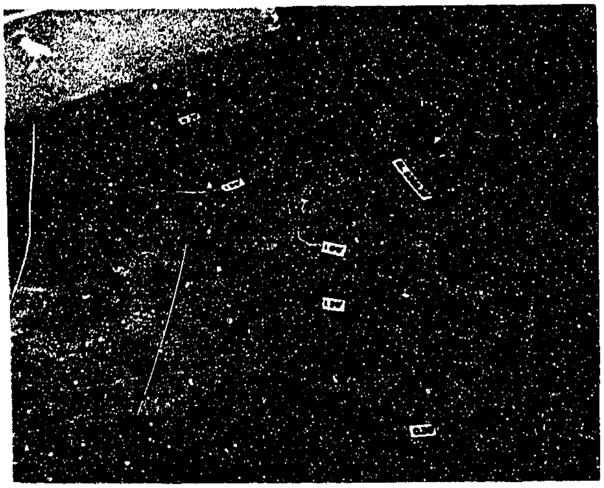
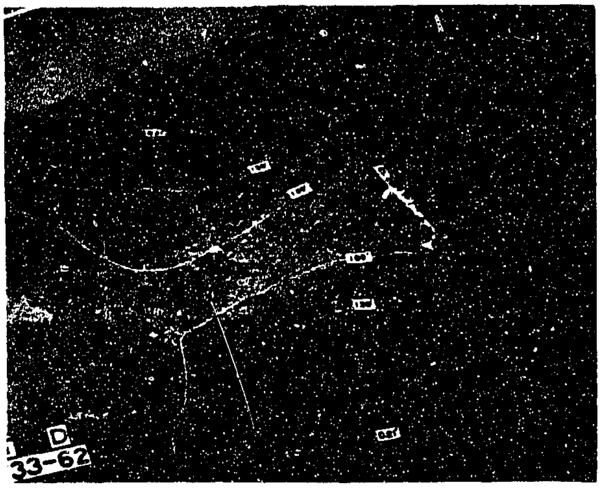
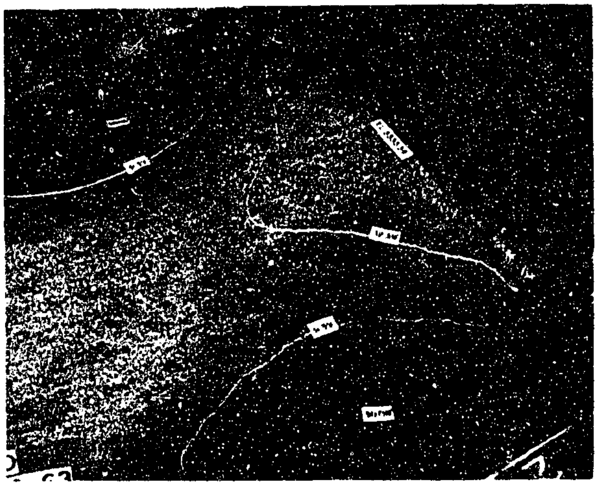


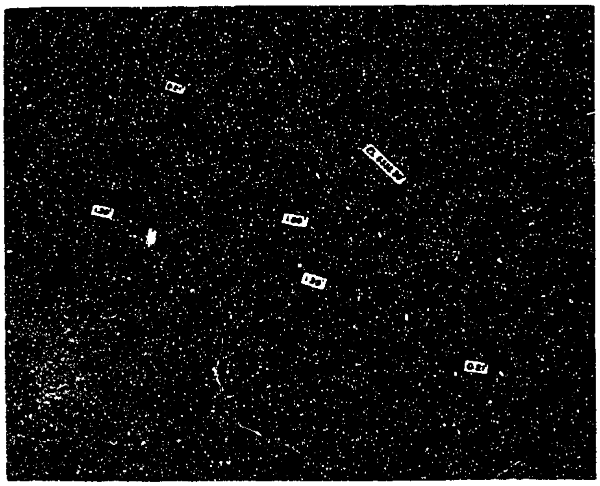
A. Design E



B. Design F



C. Design H

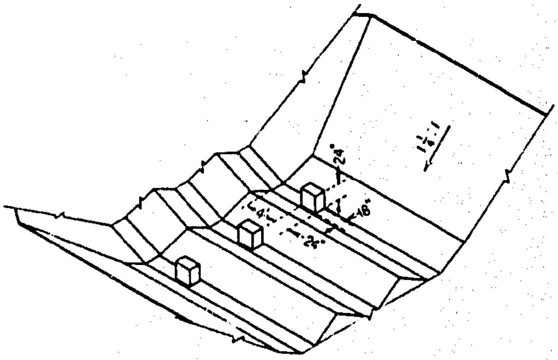


D. Design J

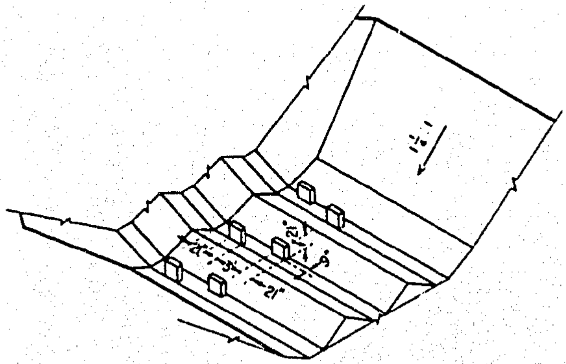
WYOMING CANAL TRAPEZOIDAL DROP

Scour patterns after discharge of 410 second-feet using different sills and lengths of ridges in transition

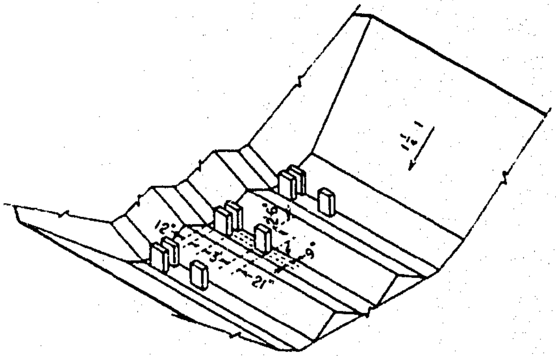
1:6 Scale Model



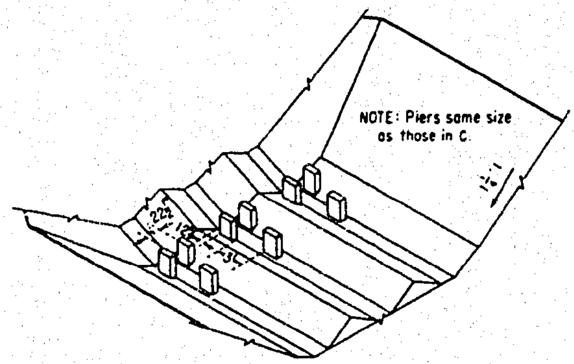
PLAN A



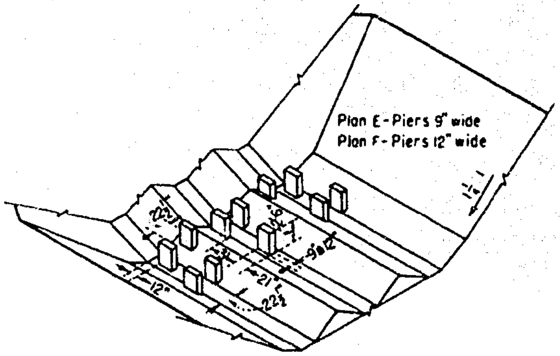
PLAN B



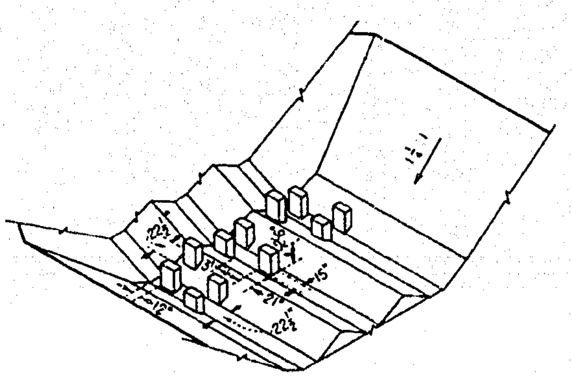
PLAN C



PLAN D



PLANS E AND F

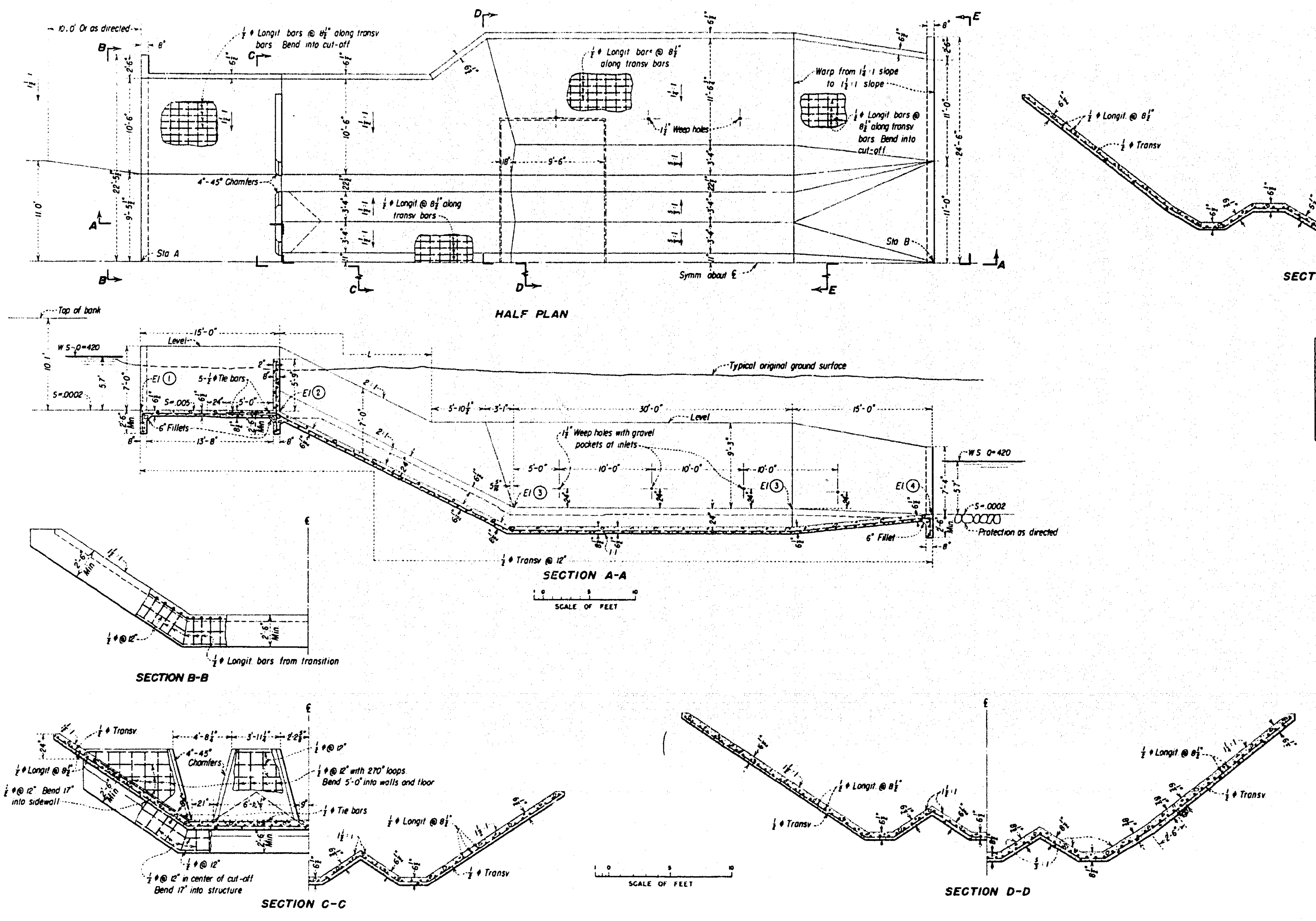


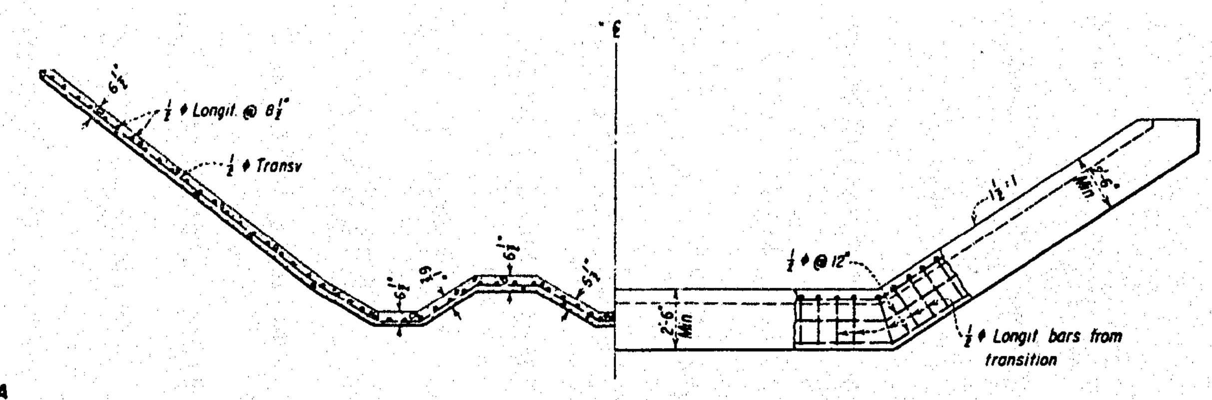
PLAN G

WYOMING CANAL TRAPEZOIDAL DROP

DIFFERENT BAFFLE PIER ARRANGEMENTS TESTED IN RECOMMENDED BASIN

1:6 SCALE MODEL





STRUCTURE DATA

STA. A	EL. (1)	EL. (2)	EL. (3)	EL. (4)	L	STA. B
2262+00	5322.01	5321.93	5312.51	5312.01	14'-4"	2262+83.29
2275+00	5311.77	5311.69	5301.27	5300.77	16'-4"	2275+85.29
2394+00	5277.45	5277.37	5268.95	5268.45	12'-4"	2394+81.29
2427+00	5255.83	5255.75	5247.33	5246.83	12'-4"	2427+81.29
2458+25	5236.24	5236.16	5227.74	5227.24	12'-4"	2459+06.29
2472+00	5226.98	5226.90	5218.48	5217.98	12'-4"	2472+81.29
2504+00	5208.37	5208.29	5199.87	5199.37	12'-4"	2504+81.29

ESTIMATED QUANTITIES

	(I)	(II)	(III)
Concrete	98 Cu. Yds.	100 Cu. Yds.	102 Cu. Yds.
Reinforcement steel	8100 Lbs.	8300 Lbs.	8500 Lbs.

NOTES

All reinforcement shall be placed so that the centers of bars in the outer layer will be $2\frac{1}{2}$" from face of concrete, unless otherwise shown.

Lap all bars 34 diameters at splices. Stagger splices.

Entire structure to be placed on undisturbed earth or thoroughly compacted fill.

Loops with 270° bends, radii of 4 bar diameters to be provided as shown.

(I) Data for drop at Sta's. 2394+00, 2427+00, 2458+25, 2472+00 and 2504+00.

(II) Data for drop at Sta. 2262+00.

(III) Data for drop at Sta. 2275+00.

THIS DRAWING SUPERSEDES DWG. NO. 36-D-1622

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
RIVERTON PROJECT - WYOMING
WYOMING CANAL - STA. 2262+00 TO STA. 2504+82
TRAPEZOIDAL CONCRETE DROPS

DRAWN E.E.G. ... SUBMITTED C. R. Burky
TRACED R.A.B. ... RECOMMENDED A.B. Reeve
CHECKED W.A.K. ARB ... APPROVED W. H. Nalder, Asst. Chief Engineer

DENVER, COLORADO, JULY 7, 1948 — 36-D-1662

Figure 33
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WYOMING CANAL TRAPEZOIDAL DROP

The Prototype at Station 2241+25