State of Wyoming
Game and Fish Commission

GREEN RIVER FISH BARRIER DAM
FISH TRAP
HYDRAULIC MODEL STUDY

CIVIL ENGINEERING DEPARTMENT

Engineering Research Center
Colorado State University
Fort Collins, Colorado

August 1967

Prepared for
Johnson-Fermelia and Associates
Rock Springs, Wyoming

CER67-68JFR-12

FINAL REPORT

OF

HYDRAULIC MODEL STUDY

OF

GREEN RIVER FISH BARRIER DAM FISH TRAP

STATE OF WYOMING
GAME AND FISH COMMISSION
CHEYENNE, WYOMING

Prepared for
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by

J. F. Ruff

Colorado State University
Engineering Research Center
Civil Engineering Department
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PREFACE

The Engineering Research Center at Colorado State University is located between Horsetooth Reservoir of the Colorado Big Thompson Project and College Lake. The laboratories of the Center were strategically placed to utilize the high head, 250 ft., available from the reservoir and the storage capacity of the lakes. The Center is the focal point for research and graduate education.

There are five principal parts to the Center: the offices for staff and graduate students, the hydraulics laboratory, the fluid dynamics laboratory, hydraulics-hydrology laboratory. The research activities of the Center are in fluid mechanics, hydraulics, hydrology, ground-water, soil mechanics, hydro-biology, geomorphology and environmental engineering.

The hydraulics laboratory includes 50,000 square feet of floor space in which basic and applied research activities are undertaken. The floor of the laboratory is constructed over a large sump system, having one acre-foot capacity, which permits recirculation of water through the various research facilities. Generally, pumps are used for recirculation but the high head and large flow capacity from the reservoir can also be utilized.

The Center includes well equipped machine and woodwork shops. All research facilities of the Center are constructed on site and in the case of this model study, necessary metal work and carpentry were done by personnel in the shops. The shop personnel are particularly well experienced in the art and skill of model construction.

This model study was undertaken by Colorado State University in close coordination with Johnson-Fermelia and Associates of Rock Springs, Wyoming, for whom this work was done. The urgent need of hydraulic information for purposes of planning and design was recognized from the beginning and all information obtained from the model studies relevant to those purposes were transmitted in advance of this report. Decisions affecting model construction tests or testing program, or time schedules were made with mutual consent through assessment of appropriate information and consideration and accord with project planning.

Grateful acknowledgment is hereby expressed by the writer to personnel at Johnson-Fermelia and Associates for their cooperation, to Victor E. Anderson, graduate research assistant at CSU, for collecting and reducing the data, to personnel in the shops for their ingenious contributions in solving model construction problems, and to others contributing to the model study and the preparation of this report.

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SUMMARY

This report describes the hydraulic model study performed for a fish trap to be used in conjunction with the Green River fish barrier dam. It is the second model study relating to the dam and fish trap. The first model study provided information pertinent to the dam spillway and the fish trap boundary. This study was initiated to secure data not obtainable from the first study. The magnitude of the velocity and distribution of flow were studied. Water depths at sections in the trap corresponding to a given tailwater rating curve for the Green River were measured and recorded.

High velocity jets detrimental to a live fish condition were observed in the model of the basic fish trap. The installation of baffle blocks on the floor of the stilling basin provided a more uniform velocity distribution in the trap. It was determined that the three channel gates should be opened uniformly to provide the most favorable flow pattern downstream from the trap. In general, the model verified heads, velocities, and flow patterns, particularly out through the ports.

The chapters of this report describe the scope and criteria of the model study, the model construction and testing, and present the conclusions and recommendations. Data collected during the tests are presented in the Appendix.

Chapter I

INTRODUCTION

General Description of the Project

The Green River Fish Barrier Dam, proposed for construction, is a major feature of a system to prevent the upstream movement of "rough" fish. The dam, in conjunction with the fish trap, will eliminate the need to poison the entire fish population of this section of the Green River every three or four years. The dam site is located approximately two miles southeast of La Barge in Southwestern Wyoming.

Details of the fish trap are shown in Fig. 1. The trap will be located at the right[1] abutment of the barrier dam. Water enters the trap complex through a submerged intake and passes through three gates to two adjustable auto-weir gates. The auto-weir gates are set at specific elevations depending upon the total river discharge and thus regulate the discharge through the traps. However, the discharge through the trap will still vary between about 70 cfs and 320 cfs for total river flows up to 15,000 cfs. From the auto-weir gates the water drops to the stilling basin. The flow then passes through the trap and back into the river channel by flowing either through the three gates located along the left wall and onto the spillway via the spillway ports or through the three channel gates located in the downstream wall of the trap. Fish moving upstream encounter the barrier dam and are anticipated to move laterally across the river to the trapping complex. They may enter the trap complex by following the current discharging out of the ports between the spillway collection gallery and apron. From the spillway collection gallery, the fish pass through the three gates and continue to follow the current into the trap. Fish moving upstream near the right bank may enter the trap complex by following the current through the three channel gates and then into the trap.

Scope of the Model Study

This model study is the second model study relating to the barrier dam and fish trap complex. The first model study[2] provided information pertinent to the dam spillway and the fish trap boundary. This study was initiated to secure data relative to the fish trap that was not obtainable from the first study.

The purpose of this model study was to evaluate the hydraulic characteristics of flow through the trap complex and to provide a satisfactory environment for keeping fish alive within the the trap proper. The specific objectives of this model study are listed below:

1. Measure trap discharges (corresponding to spillway head).
2. Measure gate velocities.
3. Measure trap velocities and depths.
4. Measure gallery velocities and depths.
5. Measure port velocities.
6. Minimize turbulence and eddies and provide as uniform velocity distribution as possible through the trap.
7. Check operation with either a single channel gate fully open or the three channel gates each open one-third.

Model Criteria

The objective of this model is to develop flows dynamically and kinematically similar to the prototype. Geometric similarity must, therefore, be maintained. Dimensional analysis will show that the Froude number is important for the objectives of this study. For instance, the free overflow at the auto-weir gates and the open channel flow are dependent upon gravity. Hence, the Froude criterion prevails and was chosen to determine the geometric scale.

A model prototype relationship of 1:6 was determined to be the most feasible from an analysis of scale ratios based upon a model size required for an accurate representation of the flow conditions, available laboratory space and facilities, the ease of operation, and instrumentation available to make measurements. Table I contains some characteristic model-prototype ratios for several parameters at the selected scale.

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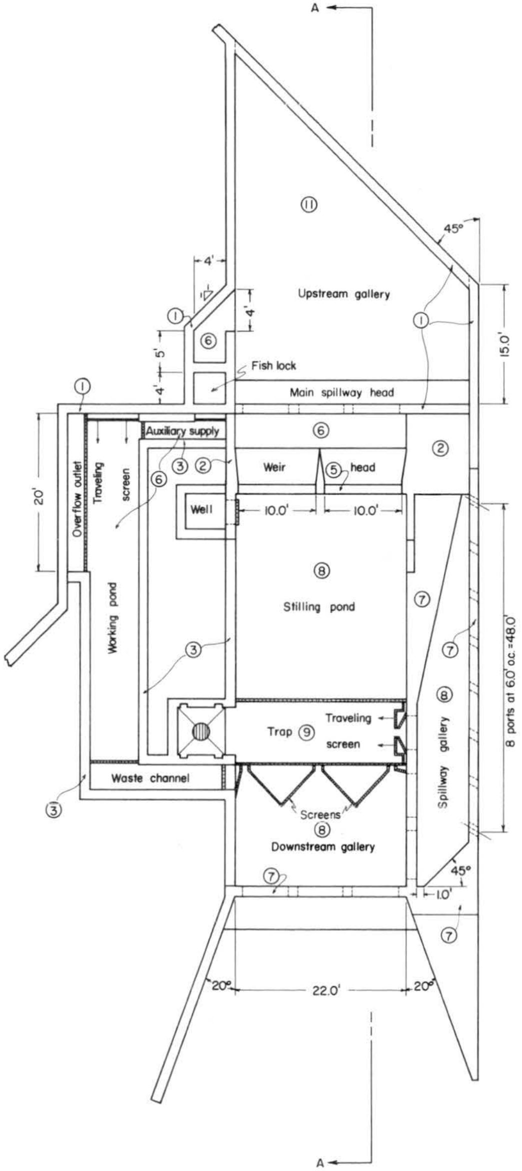
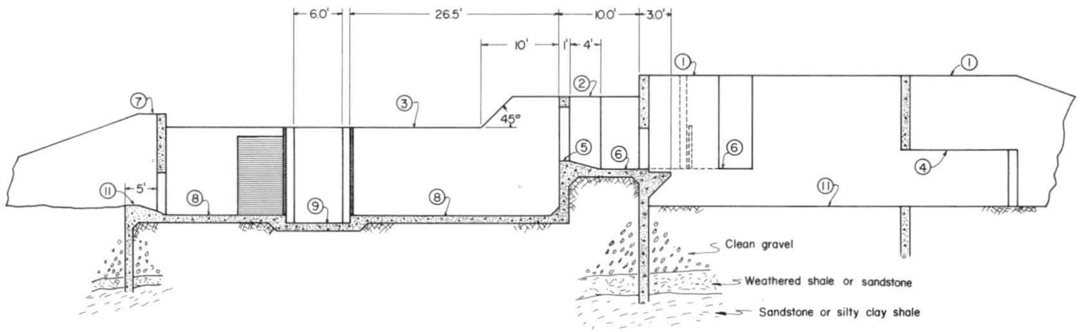
[1] Right and left as used in this report refer to the right and left of an observer looking downstream.

[2] Ruff, J. F., Green River fish barrier dam. Civil Engineering Department Report No. CER67-68JFR-3, Colorado State University, Fort Collins, Colorado, July 1967.

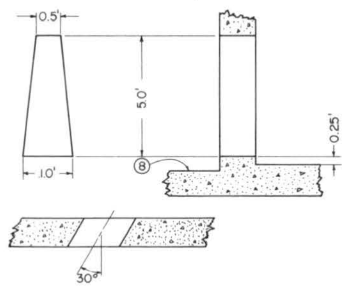




Section A-A

Table of Elevations

Number	Elevation (minimum)
1	55.0
2	52.0
3	48.0
4	45.0
5	44.0
6	43.0
7	50.0
8	37.0
9	36.0
10	34.0
11	38.0



Port details Type B

Fig. 1. Details of fish trap.

TABLE I MODEL PROTOTYPE RATIOS

Parameter	Scale Ratio: Function of Length	Scale Ratio: Numerical Ratio	Absolute Magnitude: Prototype	Absolute Magnitude: Model
Length	L_r	1:6	1 ft	2.00 in.
Area	$(L_r)^2$	1:36	1 ft^2	4.00 $in.^2$
Velocity	$(L_r)^{1/2}$	1:2.449	10 fps	4.08 fps
Discharge	$(L_r)^{5/2}$	1:88.164	100 cfs	1.134 cfs
Time	$(L_r)^{1/2}$	1:2.449	1 min	24.50 sec

Chapter II

THE MODEL

Model Construction

A photograph of the completed model is shown in Fig. 2. Dimensions of the model facilities and arrangement are given in Figure 3. The model was limited to the fish trap and only a segment of the spillway and river channel sufficient to simulate the tailwater and the discharge over the dam.

The model was constructed primarily with plywood. All surfaces were coated with fiberglass and painted to provide a waterproof seal.

Separate water supplies were provided to the fish trap and to the spillway. This was necessary to accurately measure and control the discharge of each. Water to the fish trap was supplied by a 14-in. deep-well turbine pump and measured with a calibrated orifice. Water to the spillway portion of the model was supplied by a 10-in. deep-well turbine pump and measured with a calibrated Venturi meter. The tailwater was controlled with an adjustable gate.

Instrumentation

Velocities in the model were measured with a pygmy Price current meter. The direction of flow was determined by inserting dye and making visual observations. Water depths were determined from staff gages along the walls of the model.

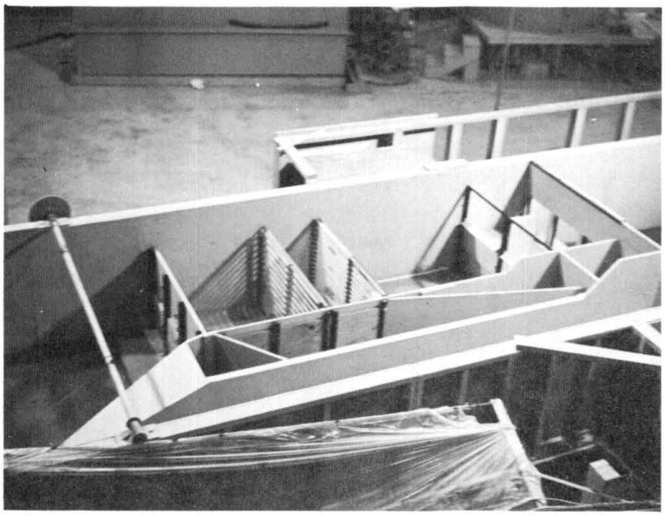


Fig. 2 Photograph of Model

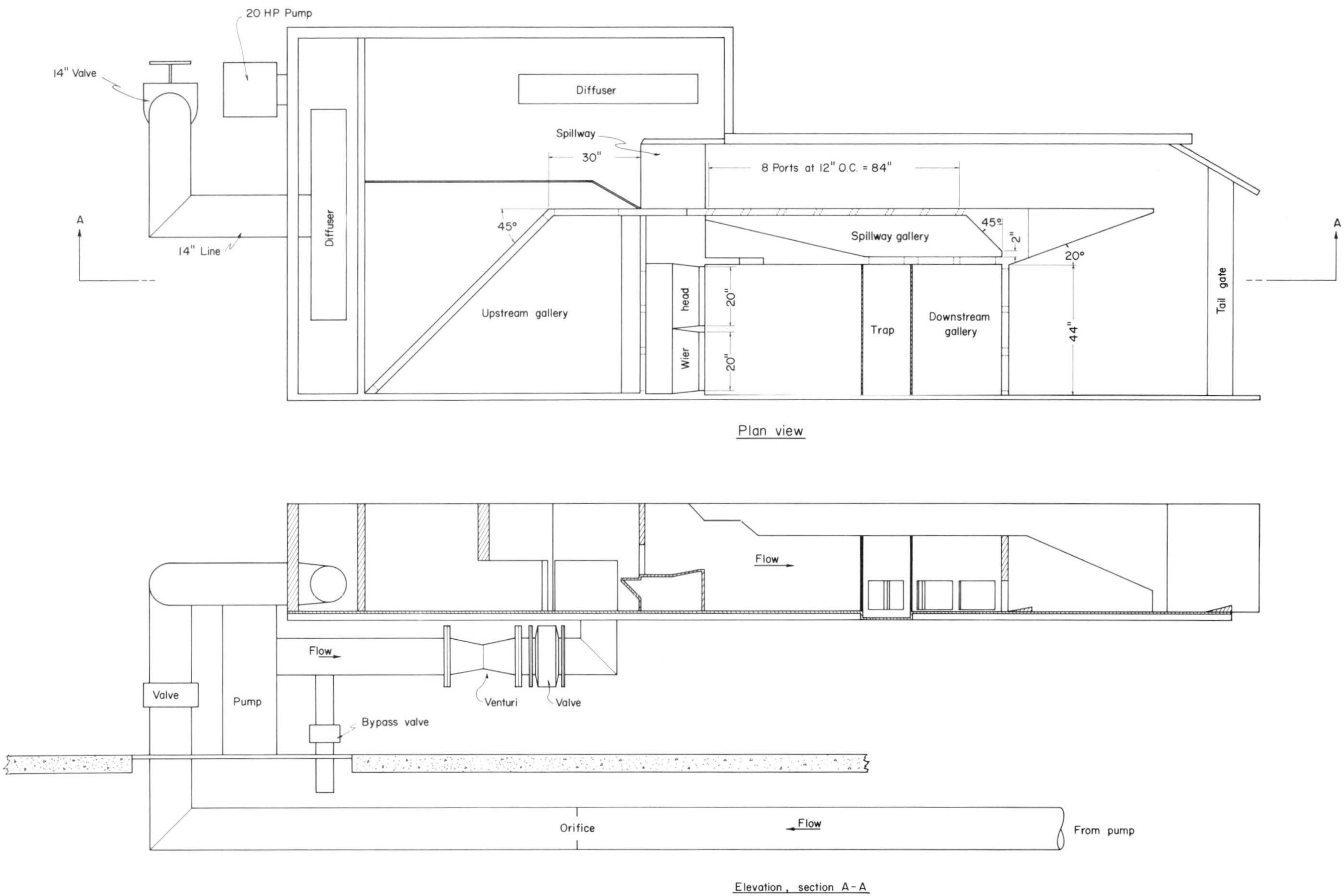


Fig 3. Schematic drawing of model.

Chapter III

MODEL TESTS AND RESULTS

Model Test Program

The model test program was designed to provide sufficient information to predict prototype behavior for a wide range of discharges with a minimum number of test runs. Tests were performed for total river discharges of about 1200 cfs, 2500 cfs, 3000 cfs, 4000 cfs, 5000 cfs, 10000 cfs and 15000 cfs. These discharges provide information at every position on the auto-weir gate. Some tests were performed at these same discharges with different opening arrangements of the channel gates, i.e. with one gate fully open and the other two closed or with the three gates each open one-third.

Velocity Measurements

The trap discharge determined for the model relative to the total and spillway discharge is given in Fig. 4 and the data are given in Table I of the Appendix. Water depths in the trap and gallery corresponding to total river discharge are given in Fig. 5. And, the tailwater rating curves for the stilling basin and river are presented in Fig. 6. The river tailwater was given and was therefore set in the model by adjusting the tailgate. The depths in the trap, stilling basin and gallery corresponding to the river tailwater were then read from the staff gages. These curves are presented here so that the reader may relate velocity to discharge or head when only the total discharge is mentioned in the following discussion.

Velocities were recorded at the locations shown in Fig. 7. The velocities were measured at 0.2d and 0.8d with d being the depth of water measured from the water surface at any specific location. Velocity data for the many test runs performed on the basic fish trap and its modifications (described hereinafter) are given in Table II of the Appendix.

Some discussion of the method used to collect the data is necessary at this point in order to more fully understand and appreciate the data and results. The velocity measurement locations within the trap (points 1, 2, 3, 4 and 5 and particularly points 1 and 5) were not rigidly fixed. This was necessary to be able to properly evaluate the flow conditions within the trap where the velocities were the most critical. Dye was injected in the stilling pool upstream from the trap and the general flow patterns through the trap were observed. For instance, in the case of the basic fish trap, higher velocity jets were observed from mid-depth to the full depth and inward from the walls of the trap approximately 5 ft^3. Velocity measurement points 1 thru 5 were then adjusted to be near the center of the jet to insure that the velocities in the jet were measured and recorded. Therefore, the velocities recorded in the Appendix would indicate generally higher velocities when compared to the average velocity over the cross section in cases where a jet was observed.

Basic Fish Trap

Details of the basic fish trap were given in Fig. 1. Velocities and heads at different sections in the basic fish trap are given in the Appendix.

The water falling into the stilling basin generated two large eddies in the stilling pool. The general flow pattern in the trap complex is shown in Fig. 8. This pattern generated jets near the walls of the complex in the vicinity of the trap. The jets were located from about mid-depth to full depth. These jets were detrimental from the standpoint of providing a satisfactory environment for keeping fish alive within the trap. The jets were not detrimental from a hydraulic standpoint since they were contained within the basin complex. Modifications were made within the stilling basin in order to dissipate the jet and are described in the following section.

Baffle Blocks

Baffle blocks were installed on the floor of the stilling basin in order to dissipate the jet moving along the wall of the trap complex. Two blocks were installed, then four and finally five during the study.

Two baffle blocks (blocks 1 and 5)[4] were installed on the floor of the stilling basin adjacent to the walls. The exact location and dimensions of the blocks are given in Fig. 9. Blocks 1 and 5 did not dissipate the jet completely and tended to move it away from the wall and closer to the center of

[3] Prototype units are used in this report unless otherwise noted.

[4] The baffle blocks were numbered 1 thru 5 from left to right and will be referred to by the numbers hereafter in this report, for example, as block 1.

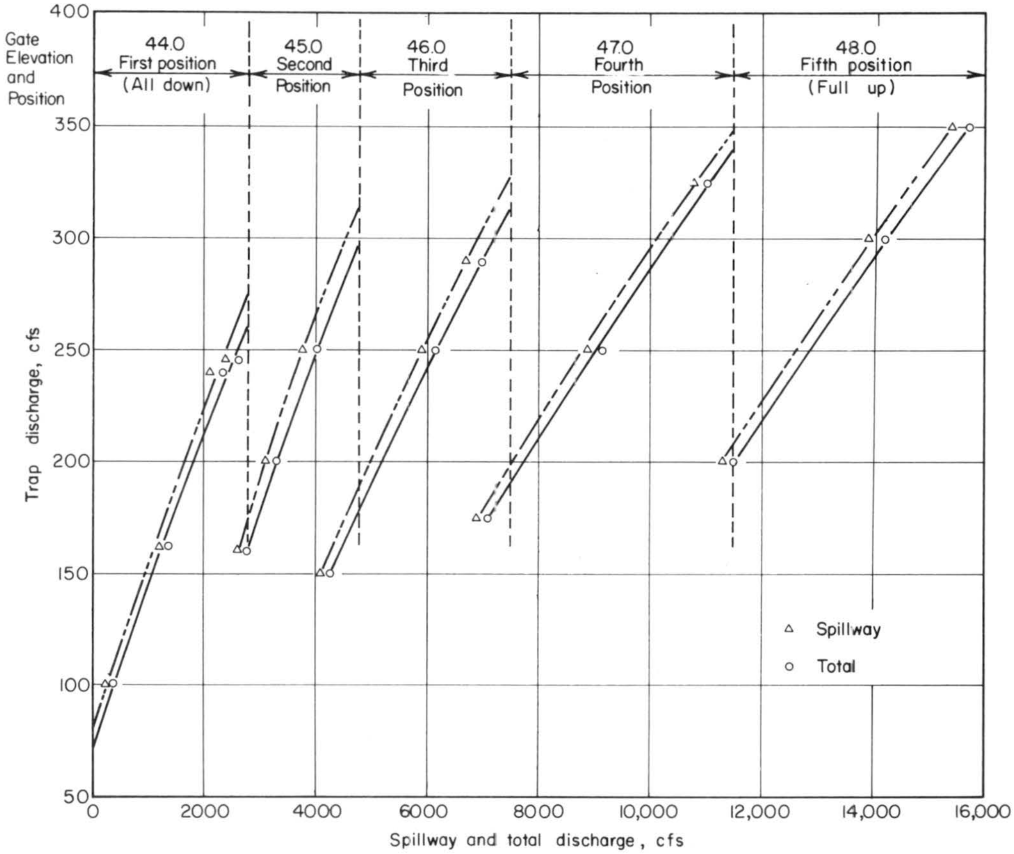


Fig. 4. Trap discharge corresponding to the total and spillway discharge.

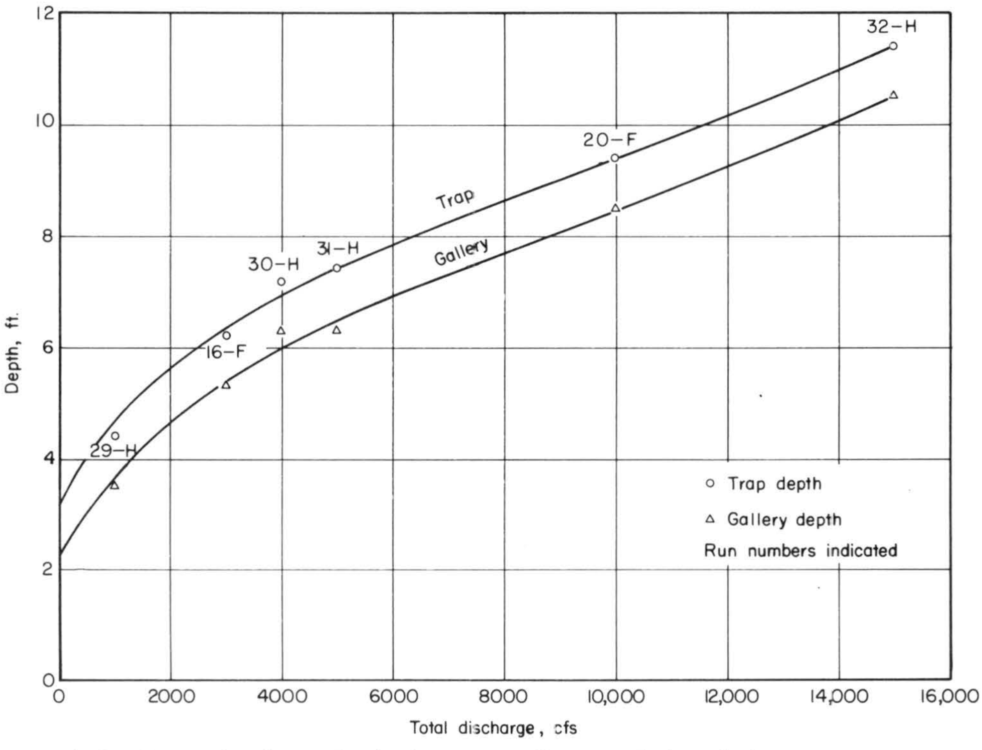


Fig. 5. Trap and gallery water depths corresponding to total river discharge.

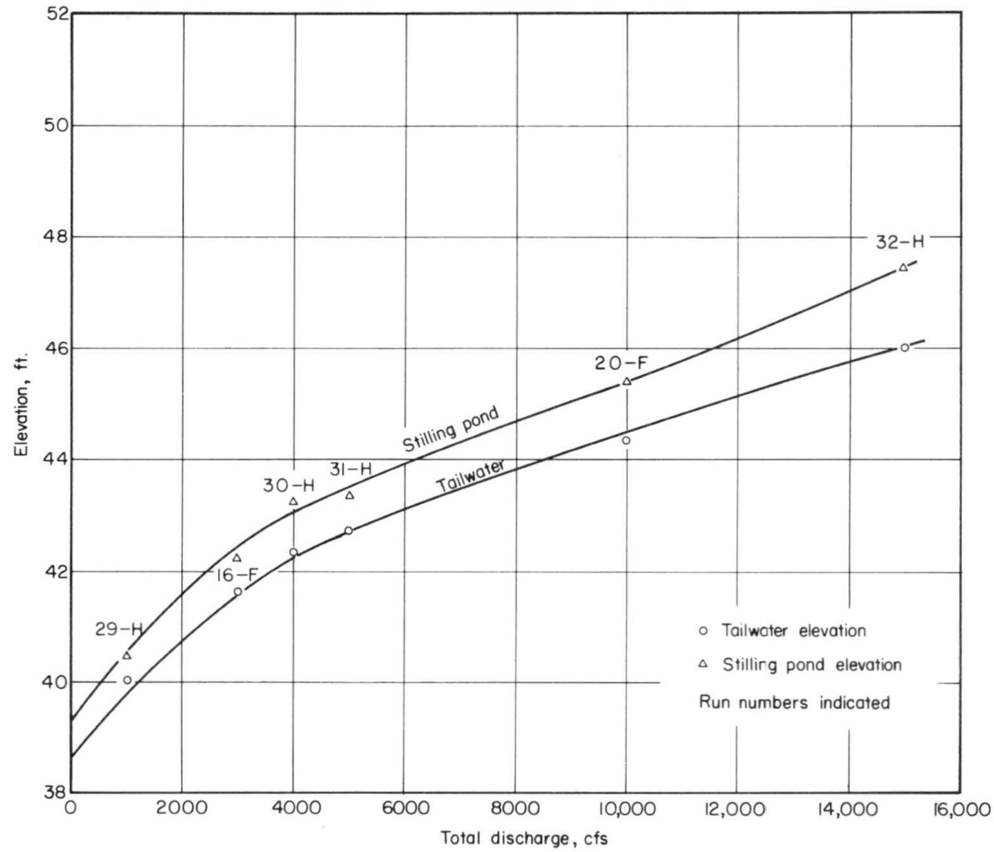


Fig. 6. Stilling basin and river tailwater rating curves.

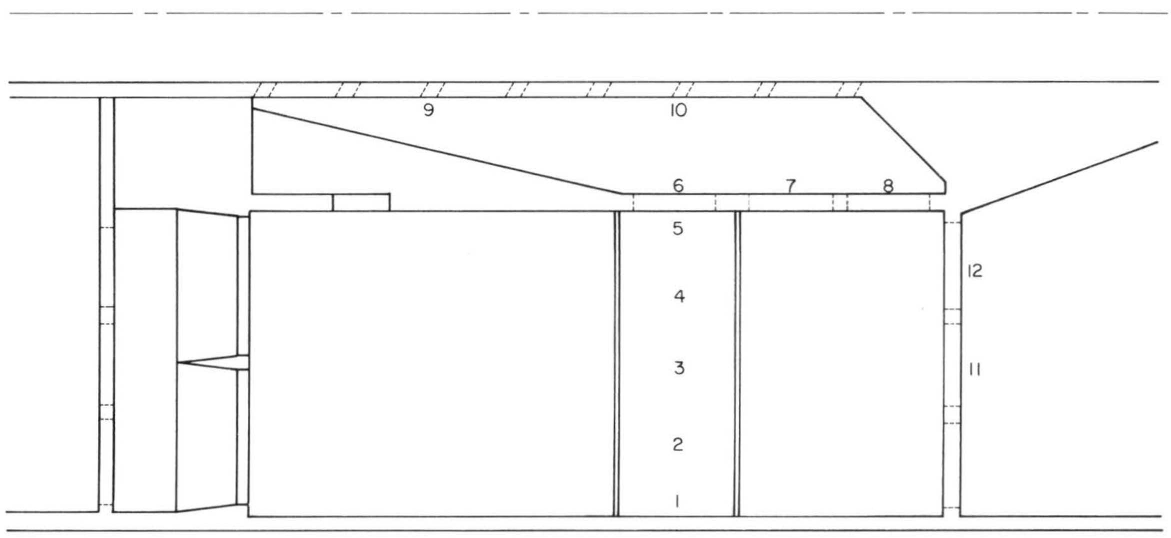


Fig. 7. Locations at which velocties were measured.

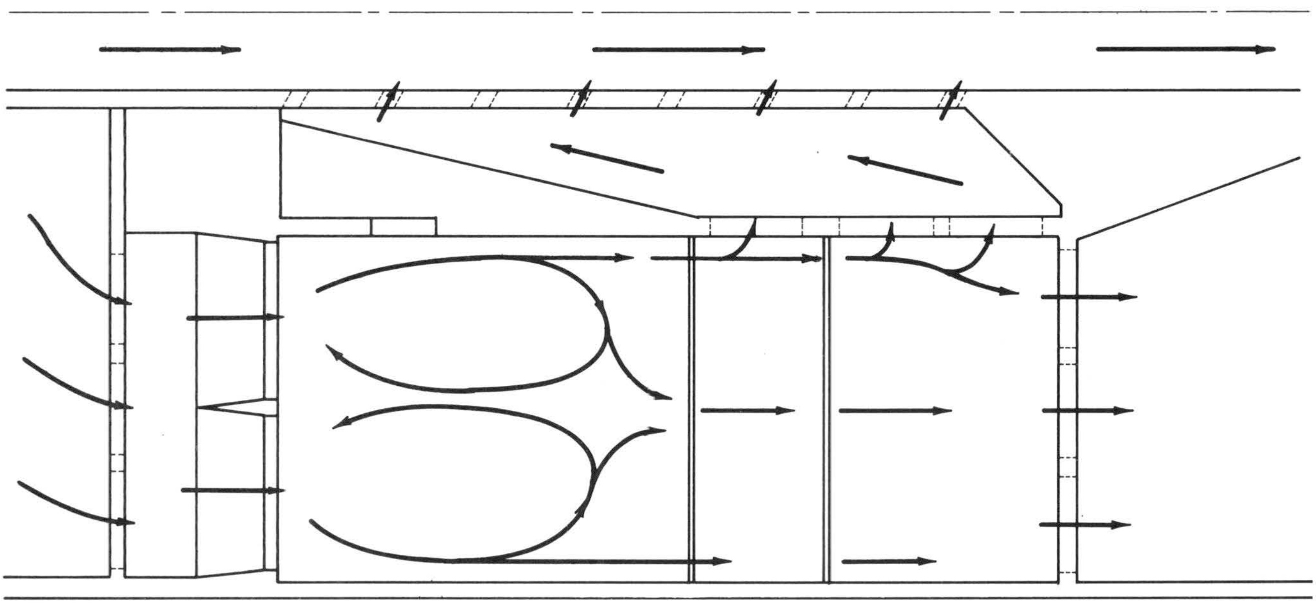


Fig. 8. General flow pattern in basic fish trap.

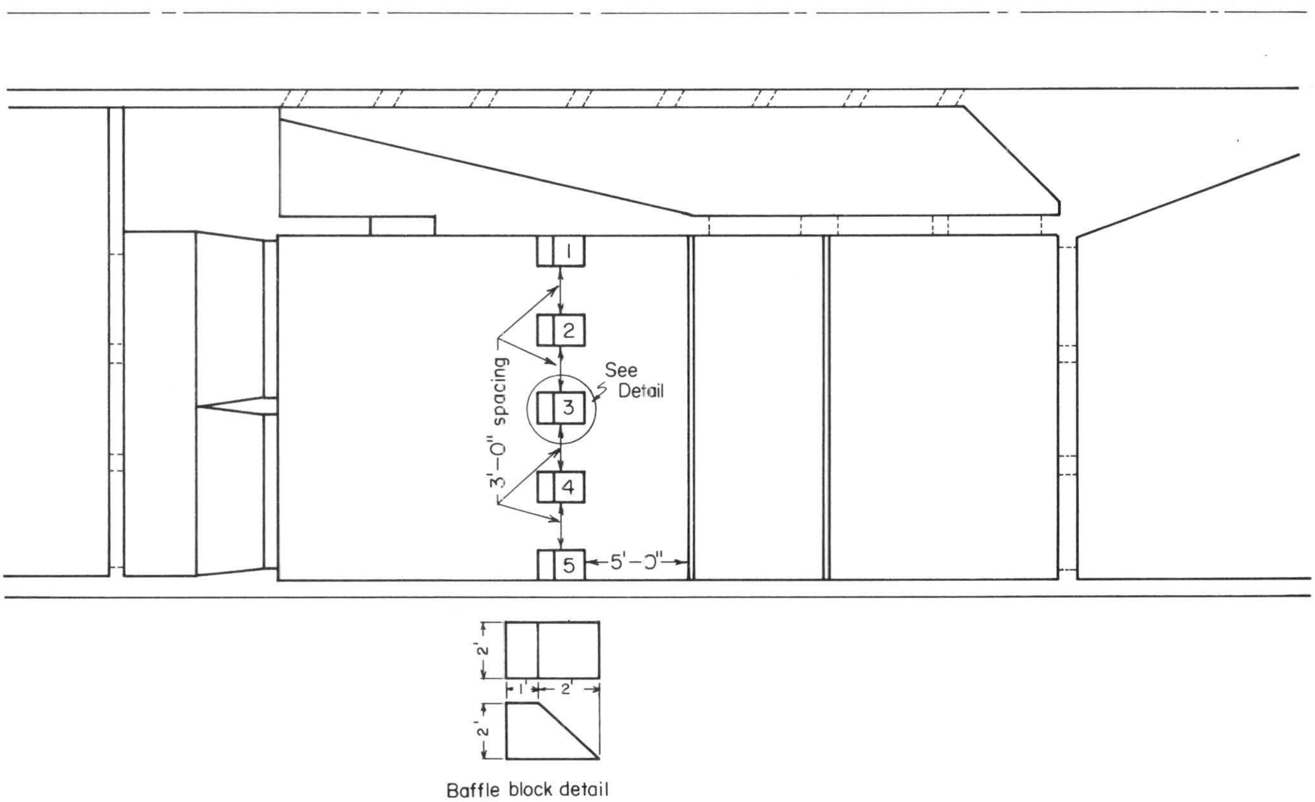


Fig. 9. Location and dimensions of baffle blocks

the trap. Blocks 2 and 4 were then installed on the basin floor, making a total of four blocks on the floor. The four blocks dissipated the jet and provided a relatively uniform velocity through the trap in almost every case. The exception being for low tailwater conditions (the lowest discharges) and the maximum total discharge of about 15000 cfs. For the low tailwater conditions blocks appeared to reduce the overall cross sectional area and forced the flow through the center of the trap creating a relatively high velocity in this center region (see runs 13-E and 21-F).

Therefore, block 3 was installed to determine if a more uniform velocity distribution could be achieved. With block 5 installed, the high velocity region was still evident at the low tailwater condition (see run 29-H). However, when the tests were performed for a total discharge of about 15000 cfs, the velocity was quite uniform throughout the trap (see run 32-H).

In an attempt to improve the conditions at the low tailwater, tests were performed with the three channel gates open one-quarter instead of one-third and with two gates open one-third. The purpose of reducing the gate openings was to increase the water depth in the stilling basin and trap gallery region. With the increased water depth in the stilling basin the velocities were more uniform through the trap cross section (see runs 33-J and 34-I) and were satisfactory.

The modified stilling basin with five baffle blocks installed provided the most uniform velocity distribution within the trap. To better visualize the effects of the blocks on the flow conditions, Fig. 10 shows the average velocities measured in the basic trap complex without the blocks (Fig. 10a) and also the average velocities measured with the five baffle blocks installed (Fig. 10b) for a total discharge of 5170 cfs.

Channel Gates

In most cases, the three channel gates are submerged by the tailwater. With the three gates each open one-third or one-quarter, a submerged jet issues from the channel gates. A roller or eddy forms above the jet causing an undulating water surface (waves on the order of 1/2-ft) immediately downstream from the fish trap wall in the transition leading to the river channel.

With three gates open one-third no significant eddies are evident near the flaring walls in the transition. With one gate fully open, large eddies formed at the sides of the jet and could provide resting areas for the fish where the fish might remain and thus reduce the efficiency of the trap.

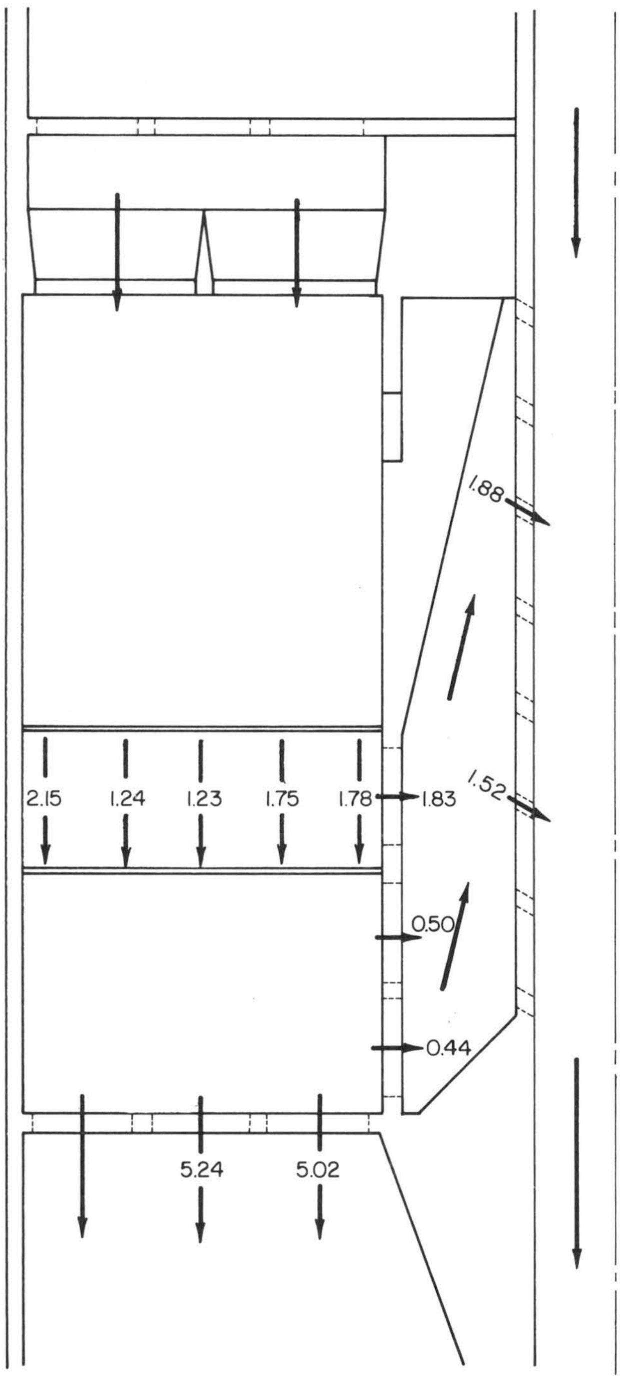


Fig. 10a. Average velocities in basic trap complex for a total discharge of 5170 cfs and trap discharge of 170 cfs.

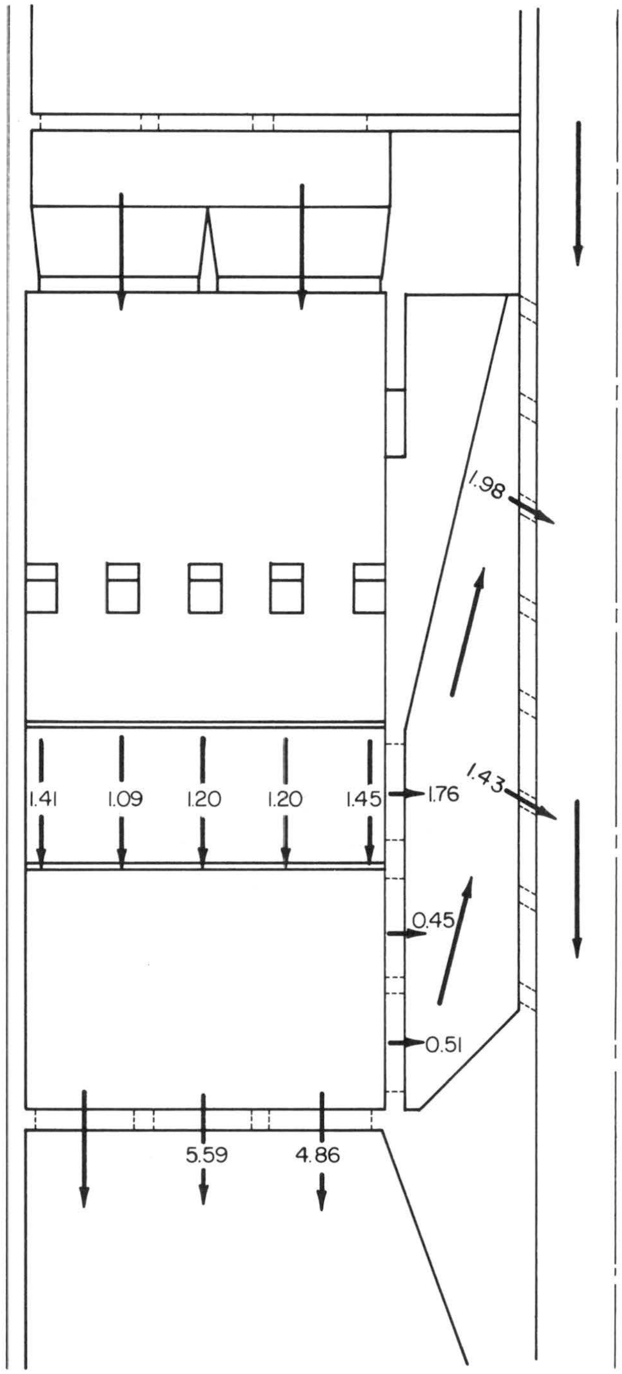


Fig. 10b. Average velocities in trap complex with five blocks installed in stilling pond for a total discharge of 5170 cfs and trap discharge of 170 cfs.

Chapter IV

CONCLUSIONS AND RECOMMENDATIONS

The trap discharge corresponding to the river discharge is given in Fig. 4. Trap and gallery water depths are given in Fig. 5. The stilling basin tailwater relative to the river tailwater is given in Fig. 6.

The basic fish trap generated higher velocities near the walls of the stilling basin than was anticipated and these jets continued through the trap proper causing a relatively nonuniform velocity which was considered detrimental for mountain live fish. With the model it was possible to try different arrangements of baffle blocks in an attempt to provide a more uniform distribution in the trap. An arrangement of five baffle blocks provided the most satisfactory velocity distribution for the greatest number of conditions. It is suggested that five baffle blocks be installed in the prototype structure. The baffle blocks should be located and have dimensions as given in Fig. 9. In order to prevent any significant eddy areas from forming downstream from the trap it is suggested that the operating procedure always provide for the three channel gates to be open in preference to just one gate as originally planned (the opening depending upon the discharge but normally being one-third open). Also, from the model, it was found that for discharge up to about 2000 cfs it is suggested that the trap be operated with the three channel gates open one-quarter instead of one-third. This adjustment is necessary to increase the depth of water in the trap complex and provide a more uniform velocity distribution through the trap.

APPENDIX

TABLE I DISCHARGE RATING CURVE DATA

Weir Crest Elevation (ft.)	Trap Discharge (cfs)		Upstream Head (ft.)	Spillway Discharge (cfs)	Total Discharge (cfs)
	Q_m (Model)	Q_p (Prototype)			
44.0	1.14	100	45.25	250	350
	1.85	162	45.85	1200	1362
	2.73	240	46.45	2100	2340
45.0	1.82	160	46.75	2600	2760
	2.28	200	47.05	3100	3300
	2.83	250	47.40	3750	4000
46.0	1.70	150	47.60	4100	4250
	2.83	250	48.35	5900	6150
	3.30	290	48.65	6700	6990
47.0	2.00	175	48.75	6900	7075
	2.83	250	49.35	8800	9050
	3.70	325	49.90	10,700	11,025
48.0	2.28	200	50.05	11,300	11,500
	3.40	300	50.75	13,900	14,200
	3.96	350	51.10	15,400	15,750

TABLE II VELOCITIES IN FISH TRAP

Run		2-A**	8-B	9-D	13-E	29-H	33-J	34-I	23-A	5-B	18-F	31-H	27-A	4-B	10-D	16-F	14-E
Spillway Discharge		1030	1030	1030	1030	1030	1030	1030	5000	5000	5000	5000	3000	3000	3000	3000	3000
Trap Discharge		158	158	158	158	158	158	158	170	170	170	170	180	180	180	180	180
Elevations																	
Upstream		46.0	46.0	46.0	46.0	46.0	46.0	46.0	48.0	48.0	48.0	48.0	47.0	47.0	47.0	47.0	47.0
Stilling Pond		40.3	40.1	40.6	40.6	40.3	40.6	40.6	43.1	43.0	43.0	43.1	42.2	42.2	42.1	42.1	42.1
Downstream Gallery		40.4	40.3	40.7	40.7	40.4	40.8	40.8	43.3	43.2	43.2	43.3	42.3	42.3	42.2	42.2	42.2
Spillway Gallery		40.5	40.4	40.8	40.8	40.5	40.8	40.8	43.4	43.3	43.3	43.4	42.3	42.3	42.3	42.3	42.3
Tailwater		40.0	40.0	39.9	40.0	40.0	40.0	40.0	42.7	42.7	42.7	42.7	41.6	41.6	41.6	41.6	41.6
Trap weir		44.0	44.0	44.0	44.0	44.0	44.0	44.0	46.0	46.0	46.0	46.0	45.0	45.0	45.0	45.0	45.0
Velocities																	
Pt. 1	.2d*	2.03	1.45	1.54	1.79	1.79	1.67	1.72	1.79		1.79	1.47	1.94		1.84	2.18	1.98
	.8d	1.77	1.54	1.54	1.23	1.35	1.42	1.42	2.50		1.30	1.35	1.49		1.94	1.42	1.42
2	.2d	2.08	2.06	1.79	1.04	2.18	2.26	1.98	1.05	1.05	1.30	0.93	1.72	1.20	1.30	1.59	1.72
	.8d	1.64	1.98	1.79	1.30	1.72	1.79	1.72	1.42	0.88	1.05	1.25	1.18	1.42	1.72	1.10	1.10
3	.2d	2.74	2.57	2.11	2.45	2.62	2.45	2.45	1.10		1.10	1.30	2.45		1.54	1.79	1.91
	.8d	2.69	2.67	2.18	1.98	2.49	2.16	2.21	1.35		1.18	1.10	1.54		1.67	1.79	1.59
4	.2d	1.54	1.67	1.98	2.01	1.79	1.98	2.26	1.30		1.10	1.35	1.42		1.54	1.67	1.72
	.8d	1.18	1.98	1.67	1.72	1.84	1.70	1.98	2.21		1.30	1.05	0.93		1.23	1.42	1.67
5	.2d	2.57	1.94	1.72	1.94	1.84	1.79	1.35	1.35	1.72	1.67	1.47	1.72	1.94	1.98	1.84	1.91
	.8d	1.54	1.94	2.62	1.67	1.30	1.18	1.25	1.30	1.30	1.42	1.42	1.30	1.72	1.91	1.30	1.42
6	.2d	2.03	1.72	1.79	1.94				1.76	1.72	1.91	1.81		2.18	2.18	2.06	1.98
	.8d	2.35	1.94	3.14	1.91				1.91	1.42	1.10	1.72	1.91	1.59	1.84	1.10	1.30
7	.2d	0.81	0.42	0.98	0.81				0.47	0.64		0.42		0.61	0.64	0.54	0.37
	.8d	0.54	0.69	1.30	1.30				0.54	0.81		0.49	0.69	0.71	0.81	0.32	0.64
8	.2d	0.74	0.64	1.10	1.03				0.51	0.69		0.55		0.61	0.88	0.49	0.83
	.8d	0.83	0.37	0.98	0.93				0.37	0.42		0.47	0.98	0.71	0.93	0.64	0.69
9	.2d	1.62	1.18	1.79	1.49				1.86	2.16	1.94	1.96		2.94	1.84	1.94	1.84
	.8d	1.84	1.18	2.01	1.30				1.91	2.01	1.42	2.01	1.91	2.82	2.01	1.91	2.06
10	.2d	1.84	1.30	1.98	1.72				1.50	1.91		1.41		2.01	1.91	1.72	1.84
	.8d	1.20	1.45	1.59	1.84				1.54	2.01		1.46	1.84	2.11	2.18	2.01	1.98
11	.2d			4.90	5.37				5.11			5.65			5.15		5.49
	.8d	5.32	5.90	4.78	5.19		6.82		5.37	3.43	5.83	5.43	4.43	3.60	4.14	5.61	4.78
12	.2d								5.31			5.11					
	.8d	7.11	5.66				9.75		4.73	5.32	5.78	4.62	4.07	5.19		6.03	

Run		28-A	11-D	12-E	17-F	30-H	3-A	6-B	7-C	24-A	26-G	20-F	22-E	25-A	21-F	32-H
Spillway Discharge		4000	4000	4000	4000	4000	2570	2570	2570	10,000	10,000	10,000	10,000	15,000	15,000	15,000
Trap Discharge		230	230	230	230	230	239	239	239	275	275	275	275	305	305	305
Elevations																
Upstream		47.4	47.4	47.4	47.4	47.4	46.6	46.6	46.6	49.7	49.7	49.7	49.7	50.9	50.9	50.9
Stilling Pond		43.0	43.0	43.2	43.0	43.0	42.0	42.1	42.6	45.6	45.1	45.4	45.1	47.3	47.3	47.3
Downstream Gallery		43.2	43.2	43.3	43.2	43.2	42.2	42.3	42.7	45.6	45.3	45.4	45.3	47.4	47.4	47.4
Spillway Gallery		43.3	43.3	43.4	43.3	43.3	42.3	42.4	42.8	45.7	45.4	45.5	45.4	47.5	47.5	47.5
Tailwater		42.3	42.3	42.3	42.3	42.3	41.3	41.3	41.4	44.3	44.3	44.3	44.3	46.0	46.0	46.0
Trap weir		45.0	45.0	45.0	45.0	45.0	44.0	44.0	44.0	47.0	47.0	47.0	47.0	48.0	48.0	48.0
Velocities																
Pt. 1	.2d	2.45	1.59	1.98	1.98	1.98		1.94		1.94	1.98	1.91	2.21	1.54	1.47	1.54
	.8d	2.99	1.96	1.91	1.79	1.30		2.06		4.36	4.26	0.81	1.30	4.26	0.86	0.86
2	.2d	1.30	2.45	1.67	1.49	1.67	1.98	2.06	2.67	1.72	1.84	0.86	1.59	1.42	1.54	1.23
	.8d	1.98	2.99	2.01	1.84	1.25	2.45	2.82	3.31	2.94	3.31	1.79	1.59	3.92	1.05	1.79
3	.2d	1.59	1.30	1.59	1.42	1.30		1.59		1.49	1.30	1.72	1.30	1.30	1.91	1.59
	.8d	2.50	1.54	2.21	1.49	0.86		1.84		2.13	1.94	1.96	1.72	2.77	2.72	0.98
4	.2d	1.79	1.23	1.15	1.49	1.54		1.42		1.67	1.15	1.47	1.30	0.98	1.47	1.25
	.8d	3.14	2.89	1.42	1.18	1.25		1.10		2.87	1.94	1.47	1.96	2.62	2.06	1.35
5	.2d	1.94	2.11	2.01	1.79	2.01	2.28	2.67	2.62	2.25	1.91	1.59	1.54	1.42	1.79	1.42
	.8d	2.67	2.57	2.13	1.96	1.47	2.45	2.62	2.62	3.48	4.14	1.91	2.01	3.55	1.10	1.10
6	.2d		2.08	2.99	2.89		2.99	3.19				1.96				
	.8d		1.98	2.21	2.01		2.55	2.18		1.59	1.30	1.79	1.89	1.91	1.72	
7	.2d		1.05	0.64	0.81		0.96	0.81								
	.8d		0.93	0.93	0.93		1.30	0.98		1.91	0.93		1.10	1.84		
8	.2d		1.18	0.69	0.69		0.98	0.93								
	.8d		1.10	0.83	0.69		0.74	0.98		1.84	1.91		1.30	1.94		
9	.2d		2.38	2.25	2.57		2.60	2.62	2.67			0.98				
	.8d		2.45	1.94	2.21		2.79	2.06	2.06	1.59	2.01	0.93	1.42	0.98	1.42	
10	.2d		1.84	2.18	1.96		1.69	2.62	2.62			1.47				
	.8d		1.84	1.94	1.98		1.79	1.98	2.57	2.38	2.25	1.94	1.79	2.01	1.84	
11	.2d		6.54	7.55												
	.8d		4.95	5.83	6.84		4.24	6.08	3.72	8.72	6.91	8.53	7.20	8.01	8.18	
12	.2d															
	.8d				6.88		6.79	5.37	5.15	8.58		8.53		8.58	8.18	

Notes: * d is the depth of water measured from the water surface
** Run Numbering System:

Letter	Description
-A	No blocks in stilling pond. All gates 1/3 open.
-B	Blocks #1 and 5 installed in stilling pond. All gates 1/3 open.
-C	Blocks #1 and 5 installed in stilling pond. All gates open 1.25 ft (prototype).
-D	Blocks #1 and 5 installed in stilling pond. Center gate fully open.
-E	Blocks #1, 2, 4 and 5 installed in stilling pond. Center gate fully open.
-F	Blocks #1, 2, 4 and 5 installed in stilling pond. All gates 1/3 open.
-G	No blocks in stilling basin. Center gate fully open.
-H	5 blocks, all gates 1/3 open.
-I	5 blocks installed in stilling pond. Middle gate closed, outer gates 1/3 open.
-J	5 blocks installed in stilling pond. All gates open 1/4 (1.25 ft).