HYD-253

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HYD 2531

LETTER REPORT

FLOOD PROTECTION STUDY

MT. MORRISON, COLORADO PROJECT

Reply Attention: 290

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
DENVER FEDERAL CENTER
Denver, Colorado

District Engineer,
Corps of Engineers,
Department of the Army,
Railway Exchange Building,
Denver, Colorado.

Sir:

A letter dated October 7, 1947, to this office from the District Engineer, Denver, Colorado, initiated a hydraulic model study of the proposed improvement of Mount Vernon and Bear Creeks for the local flood protection for Morrison, Colorado. See Figure 1. The objectives of the study, as developed and agreed upon by representatives of the District and this office, emphasized the accomplishment of an adequate design by trial in the model. It was understood that no formal report would be prepared by this office, but that the limited data and photographs accumulated during the study would be transmitted by this letter report.

In brief summary, the study consisted of refining and improving the design of the superelevated concrete channel for conveying Mount Vernon Creek flows. Design improvements were worked out in the model with the assistance of District representatives. The hydraulic characteristics of the final design met the requirements with a comfortable margin. Further refinements to minimize cost may be accomplished but additional model tests were not considered to be justified by the District representatives.

The final design was accomplished by February 1948, and testing was suspended pending a decision from your office regarding extension of the model to include the transition in the upstream part of Mount Vernon Creek channel. In October 1948, a request was made by your office to obtain some velocity measurements of the final design in Mount Vernon Creek channel and in the confluence with Bear Creek and that this would conclude the model tests.

The model will probably be dismantled in a month or 6 weeks.

The model was constructed on a scale of 1:60 and included Bear Creek from a point 150 feet downstream from the main bridge on Highway 285 (Station 38+00 on original topographic map) to a point 200 feet downstream from Harrier Ditch heading (Station 0+00), and approximately 800 feet of Mount Vernon Creek channel upstream of its confluence with Bear Creek. The actual topography of Bear Creek and the proposed concrete channel of Mount Vernon Creek were built into the model. See Figure 2A.

The preliminary design of Mount Vernon Creek channel which was tested in the model consisted of a rectangular concrete channel 50 feet wide with two horizontal curves and one vertical curve as shown in Figure 3. The upstream curve begins with a spiral at Station 8+03 (refer to Drawing File No. M-1-3 for station numbers in Mount Vernon Creek channel) and ending with a spiral at Station 3+47 with a short 26-foot circular section in the middle of the curve. The lower curve was all circular beginning at Station 3+47 and ending where it became tangent to Bear Creek. The design included a superelevation of the channel bottom of 4.8 feet for the upper curve and a maximum of 0.6 feet at the end of the right wall for the lower curve.

Flow around the upper curve for the initial design was fairly smooth for 10,000-second-feet discharge in Mount Vernon Creek channel, but around the lower curve water piled up on the right wall and there was very little flow around the inside left wall. See Figure 2B.

Various changes were made by shaping the channel in molding plaster until the best flow conditions were achieved. As a new design was tested, visual observations were made by representatives of the District and this office; and if the flow were unsatisfactory, the design was changed without taking data except photographs. Several photographs of intermediate changes are included at the end of the report with self-explanatory titles. The final plan as tested in the model is shown in Figure 4. The profile of the final plan has a steep slope of about 5 feet in a horizontal distance of 45 feet between Stations 3+72 and 3+27 on the left side of the channel and the right side has the same profile as the original design. The final plan for the lower curve consisted of a spiral with a formula $Y = 1.907 \times 10^{-5} X^3$ for the left wall with the right wall parallel, making the channel 50 feet wide throughout the curve. The downstream part of the left curve below a point opposite the end of the right wall was circular with a radius of 100 feet. The upstream part of Mount Vernon channel from Station 8+03 to Station 5+42 is 40 feet wide and then expands to 50 feet at Station 3+47 (beginning of the lower curve) and continues at 50-feet width to the confluence with Bear Creek. The steep slope on the left side, together with the rise on the right side of the channel, results in a superelevation of 13.3 feet at the end of the right wall. At this section, the left side of Mount Vernon Creek channel is 8.0 feet lower than Bear Creek grade and the right side is 5.3 feet higher than Bear Creek grade. Beyond this section, the right side is brought to Bear Creek grade in a relatively short distance. The left side is extended at a constant slope until it meets the Bear Creek grade at Station 19+00. Extending the superelevation into Bear Creek in this manner helps in directing the Mount Vernon Creek flow.

The increased superelevation of the channel increased the flow around the left side of the lower curve and decreased the pile up around the right side. It also produced smaller depths and higher velocities in the sections where Highway 285 will cross the new concrete channel, providing adequate clearance between the water surface and the underside of the bridge.

To eliminate any possibility of having negative pressures on the bottom where it makes a sudden change in grade at Station 3+73, it is recommended that a circular curve of 100-foot radius be used to smooth the change in grade.

During operation of the model, sediment varying from coarse sand to gravel 1 inch in diameter was put in Mount Vernon Creek channel to simulate boulders passing through the channel into Bear Creek. At all discharges above 5,000 second-feet, the gravel and sand were moved into Bear Creek. From the velocity measurements taken (Figures 5 to 9), it can be seen that the flow is accelerating throughout the length of the channel for both 5,000 and 10,000 second-feet discharges. It seems reasonable to believe that any rocks and debris brought into the concrete channel will be moved into Bear Creek.

The velocities measured at the beginning of the upper curve (Station [illegible]) in the model gave prototype velocities higher than those computed for this section. The average measured velocity at Station 5+03 was 30.5 feet per second for 10,000 second-feet discharge and the computed velocity at this section was approximately 25 feet per second. However, it is felt that the velocity patterns measured in the model give a good indication of the velocity patterns to be expected in the prototype.

The velocity head was measured at five verticals and two points in each vertical to obtain the average velocity for each vertical. Two pitot-tubes with dynamic legs only, as shown in Figure 10A, were used. Velocities were determined at six sections in Mount Vernon Creek channel for discharges of 5,000 and 10,000 second-feet and at two sections in Bear Creek for a discharge of 10,000 second-feet in Mount Vernon channel and 5,000 second-feet in Bear Creek, as plotted on Figures 5, 6, 7, 8, and 9. Depths are also shown for these conditions.

Photographs of the final design tested in the model with a discharge of 10,000 second-feet in Mount Vernon Creek channel and 5,000 second-feet in Bear Creek above the confluence are shown in Figures 10B, 11A, and 11B.

Elevations of the centerline of the bottom of Bear Creek and of high water on both banks of Bear Creek were determined for a discharge of 5,200 second-feet in Mount Vernon Creek channel and 16,600 second-feet in Bear Creek, the standard project flood. These elevations corresponding to stations shown on the original topographic map are shown below.

Stations along Bear Creek	H.W. elevations right bank	Elevations bottom of centerline	H.W. elevations left bank
Ward Ditch heading		5722.50	5733.70
7+00		20.05	35.75
8+00		21.30	36.60
9+00		20.75	42.35
10+00		22.55	40.00
11+00		26.10	42.35
Harriman Ditch heading		32.60	46.20
13+00	5744.85	31.25	45.85
14+00	42.50	32.65	45.95
15+00	42.30	34.00	47.05
16+00	46.75	33.95	45.00
17+00	46.75	35.65	49.65
18+00	46.60	35.65	53.70
19+00	51.40	39.00	54.40
20+00	55.55	41.10	55.25
21+00	58.95		
22+00	58.20		
23+00	58.75		
24+00	61.40		
25+00	61.90		
26+00	62.65	5754.40	65.25
27+00	67.50	56.15	68.45
28+00	71.65	58.90	70.55
29+00	70.55	61.35	73.05
30+00	5772.40	5762.90	5777.65
31+00	75.80	65.00	81.40
32+00	77.35	67.25	81.90
33+00	79.70		90.70
34+00	79.55		87.15
35+00	78.95	73.70	86.65

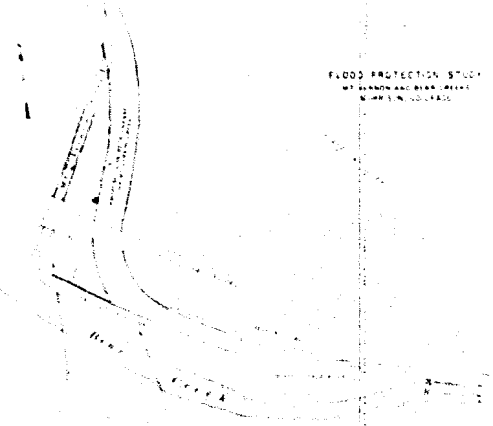
Very truly yours,

L. N. McClellan,
Chief Engineer.

Enclosures

FIGURE 1

A-1, MT VERNON CREEK ABOVE HIGHWAY 285 AT MT MORRISON NORMAL CHANNEL



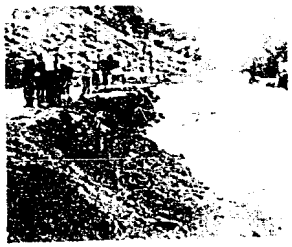
FLOOD PROTECTION STUDY
MT VERNON AND BEAR CREEKS
MORRISON, COLORADO

EXISTING CHANNELS AND PROPOSED CONSTRUCTION FOR FLOOD PROTECTION OF MOUNT MORRISON, COLORADO. CIRCLES AND ARROWS INDICATE POSITIONS AND DIRECTION OF PHOTOGRAPHS SHOWN BELOW PROJECT OF DENVER DISTRICT U.S. ARMY ENGINEERS

B-1, MT VERNON CREEK WHERE HIGHWAY 285 CROSSES AT MT MORRISON NORMAL CHANNEL

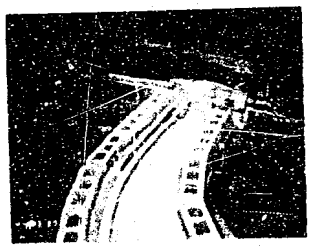
A-2, MT VERNON CREEK ABOVE HIGHWAY 285 AT MT MORRISON DAY AFTER 1938 FLOOD

C-1, BEAR CREEK BELOW MT MORRISON NORMAL CHANNEL



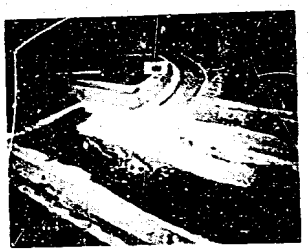
C-2, BEAR CREEK BELOW MT MORRISON DAY AFTER 1938 FLOOD

B-2, MT VERNON CREEK WHERE HIGHWAY 285 CROSSES AT MT MORRISON DAY AFTER 1938 FLOOD



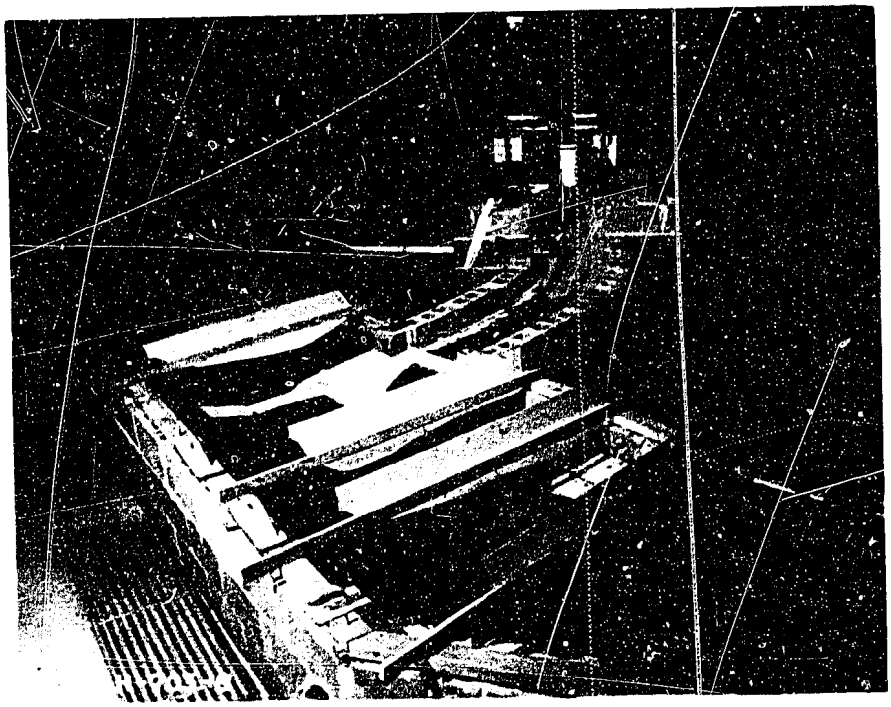
A-3, MODEL OF NEW CONCRETE CHANNEL PROPOSED FOR MT VERNON CREEK

C-3, MODEL OF PROPOSED CHANGES ON BEAR CREEK BELOW MT MORRISON



B-3, MODEL OF PROPOSED CHANGES AT CONFLUENCE OF MT VERNON AND BEAR CREEKS

FLOOD PROTECTION STUDY, MT. MORRISON, COLORADO. PROJECT OF DENVER DISTRICT U.S. ARMY ENGINEERS



A. Model was made of cinder blocks with topography and concrete channel formed in concrete. Mt. Vernon Creek channel on the right coming into Bear Creek.

B. Model of original design at confluence. 10,000 second feet in Mt Vernon Creek channel; 11,700 second feet in Bear Creek. Water piled up and overtopped outside wall of downstream curve in Mt. Vernon Creek channel.

KEUFFEL & ESSER CO., N. Y. NO. 359-11
10 X 10 to the ½ inch. 5th lines accented.
Engraving 7 X 10 in.
MADE IN U.S.A.

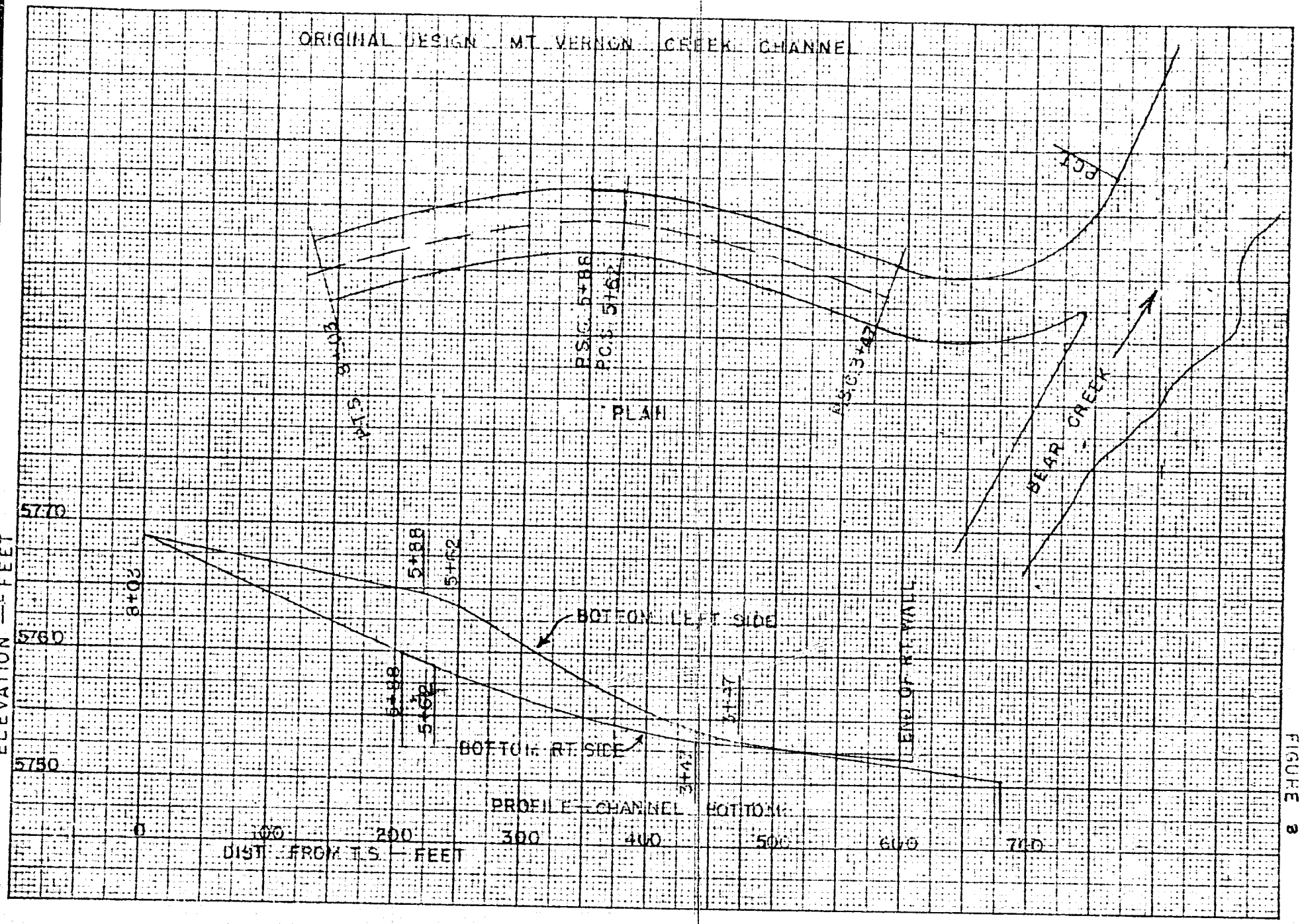


FIGURE 8

KEUFFEL & ESSER CO., N. Y. NO. 359-11
10 X 10 to the ½ inch, 5th lines accented
Engraving 7 X 10 in.
MADE IN U.S.A.

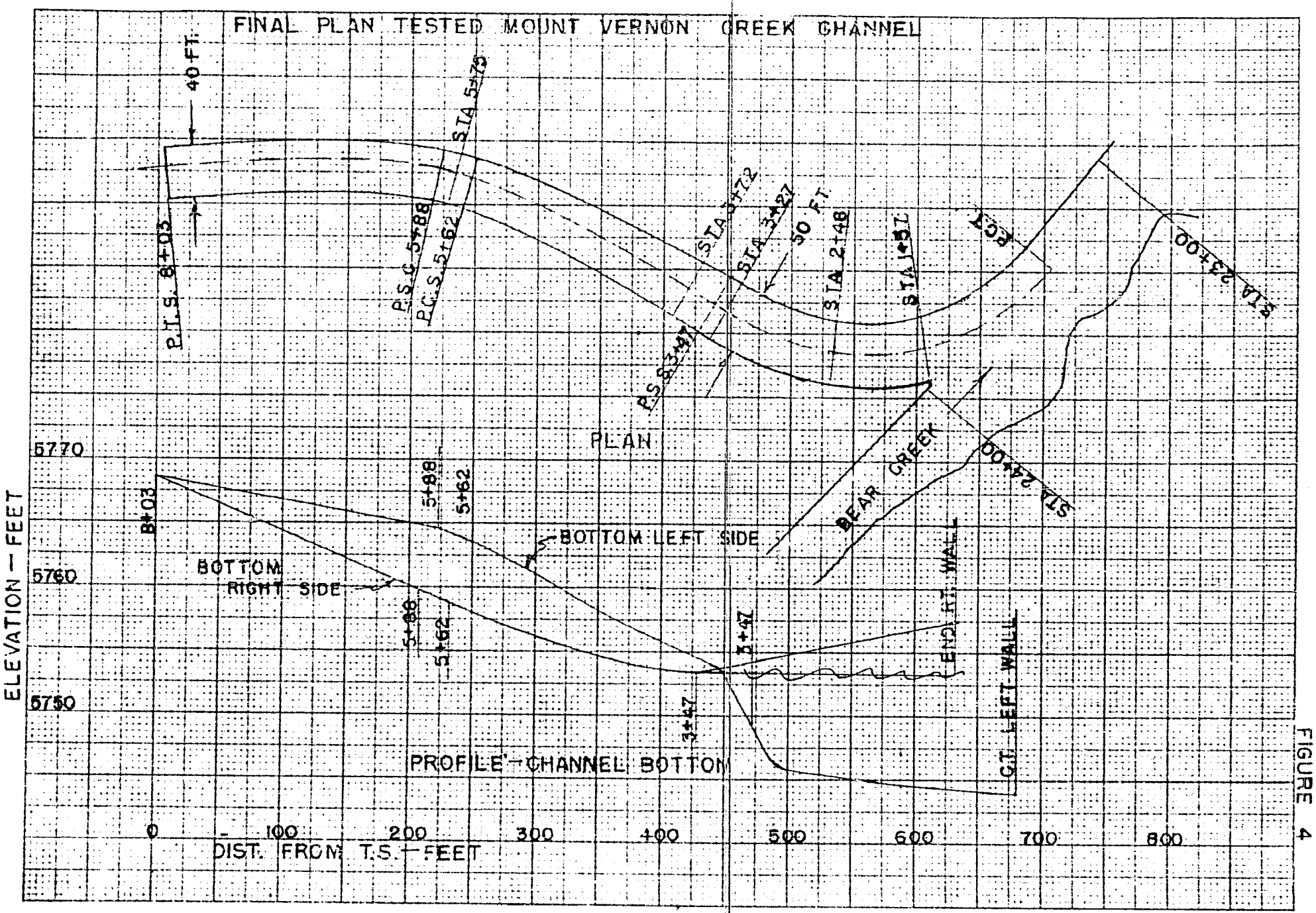
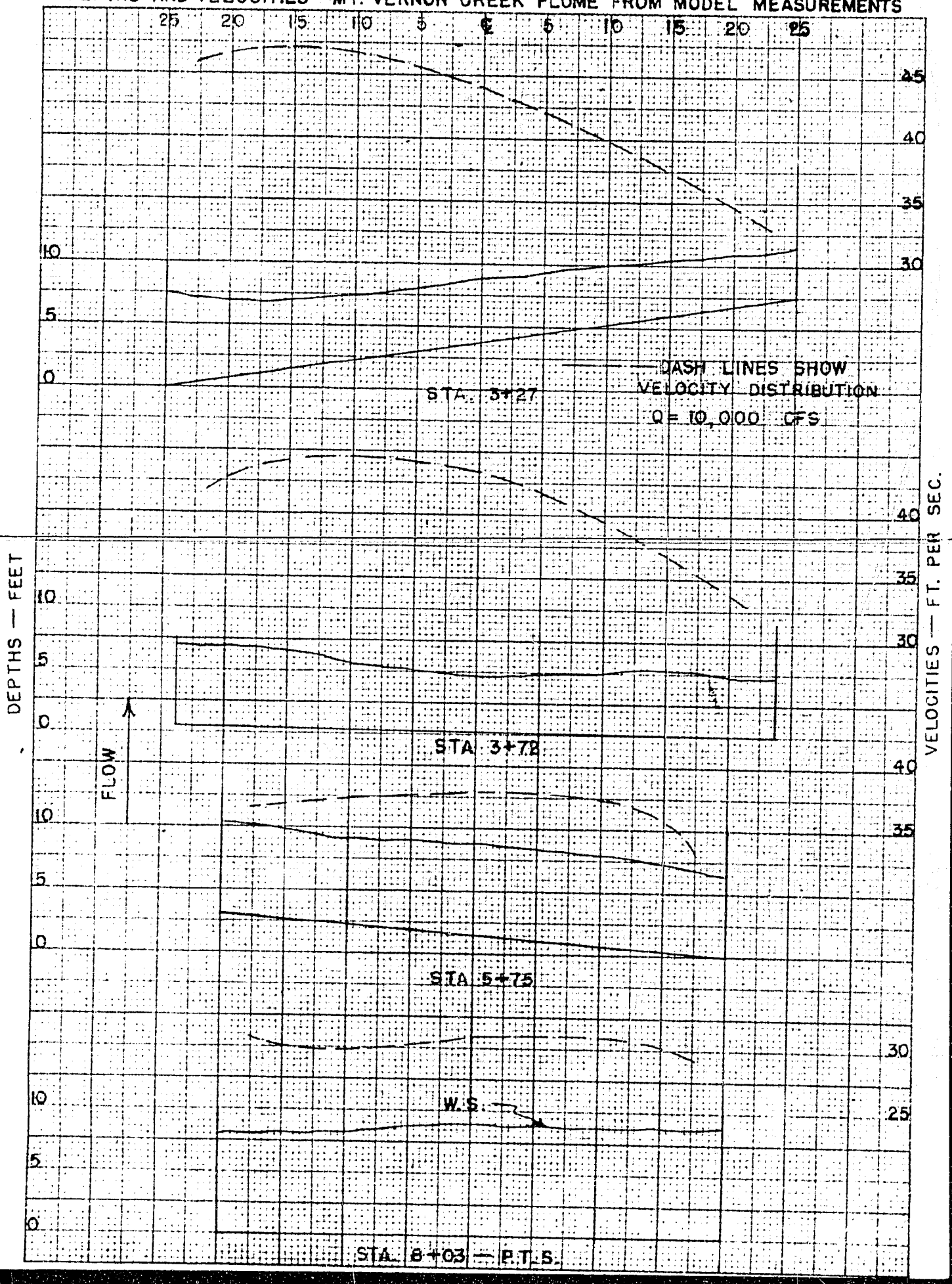


FIGURE 4

FIGURE 5

DEPTHS AND VELOCITIES – MT. VERNON CREEK FLUME FROM MODEL MEASUREMENTS



10 X 10 to the ½ inch, 5th lines accented.
Engraving 7 X 10 in.
MADE IN U.S.A.

FIGURE 6

DEPTHS AND VELOCITIES - MT. VERNON CREEK FLUME FROM MODEL MEASUREMENTS

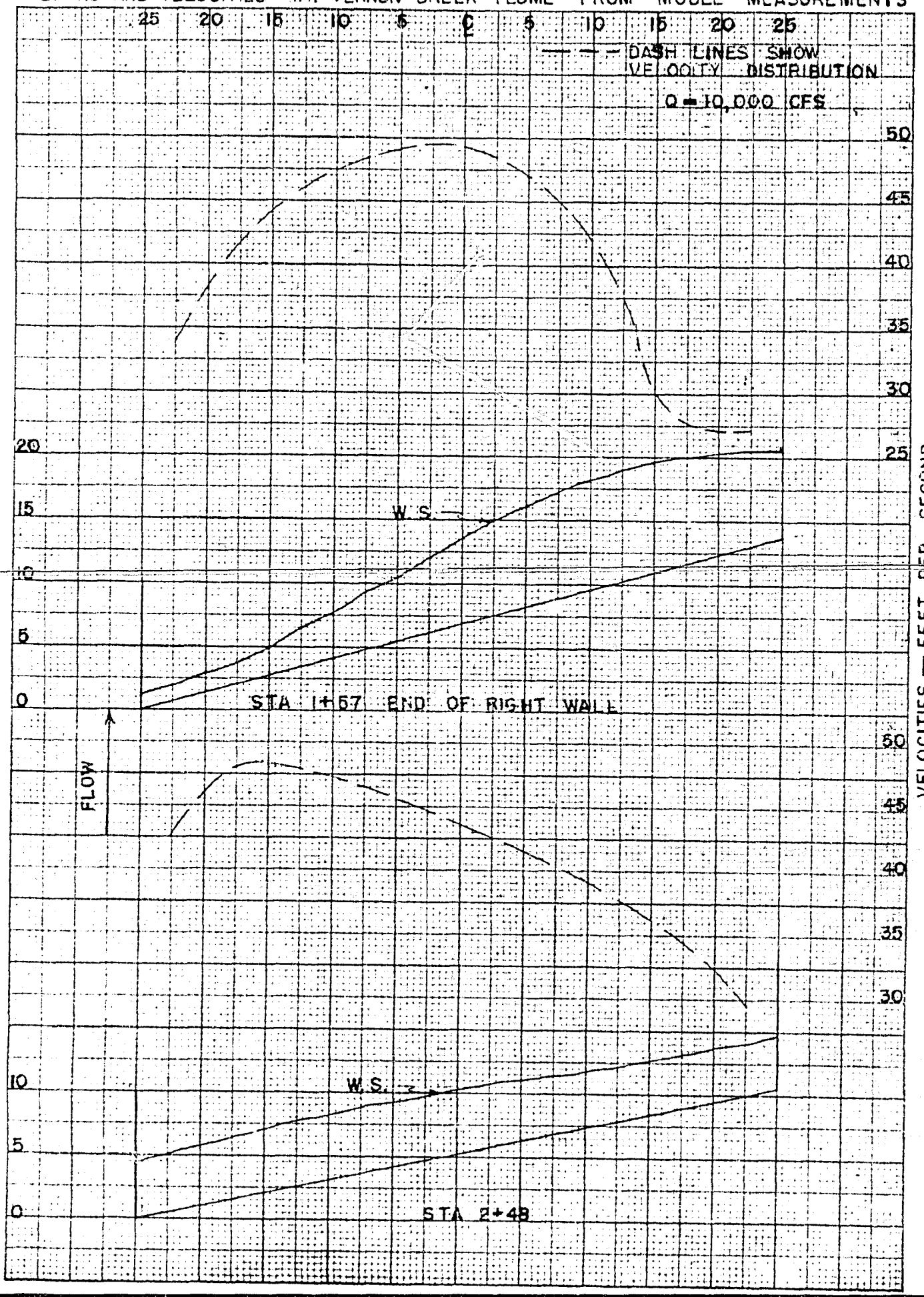


FIGURE 7

DEPTHS AND VELOCITIES — MT. VERNON CREEK FLUME FROM MODEL MEASUREMENTS

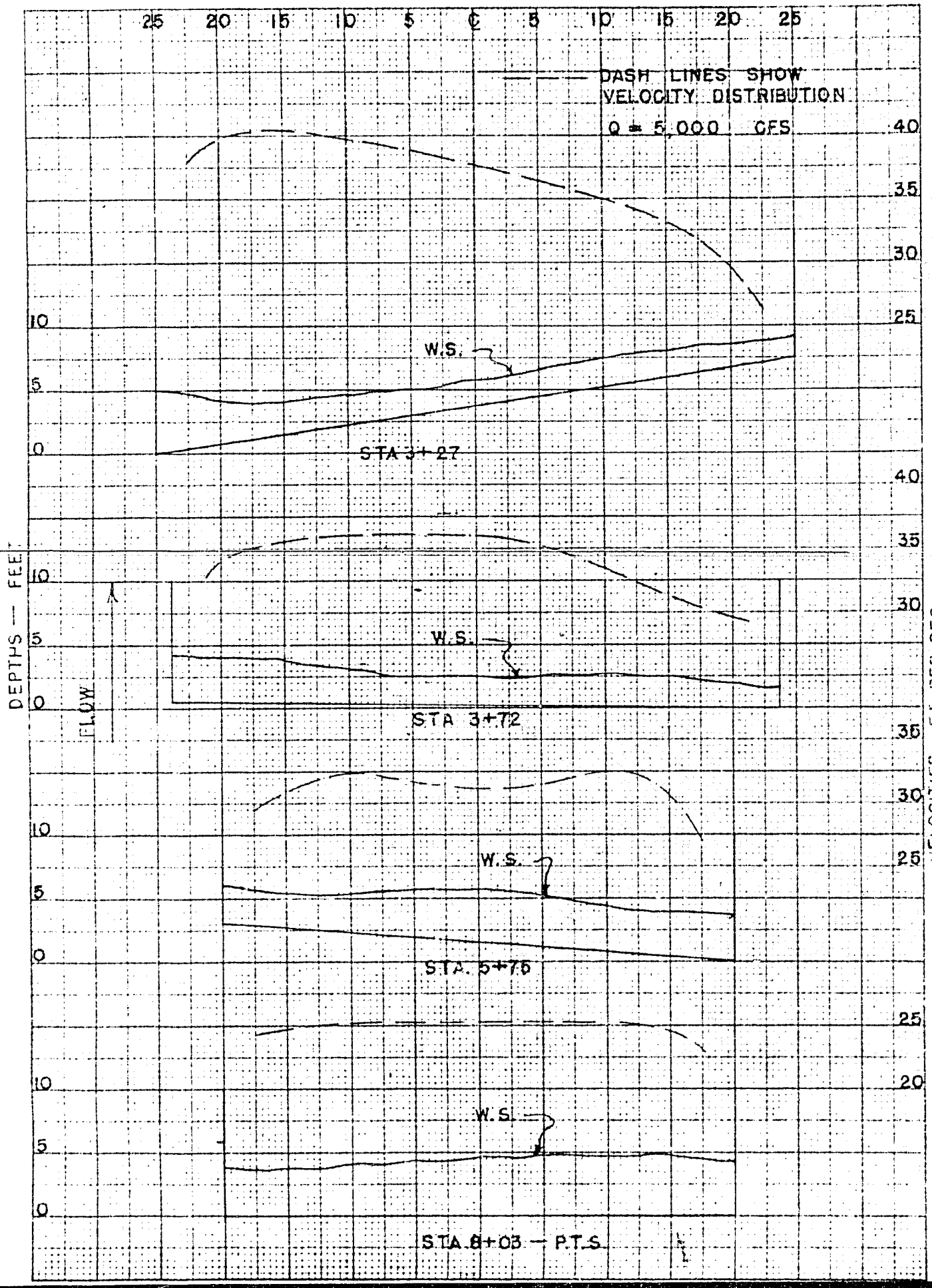
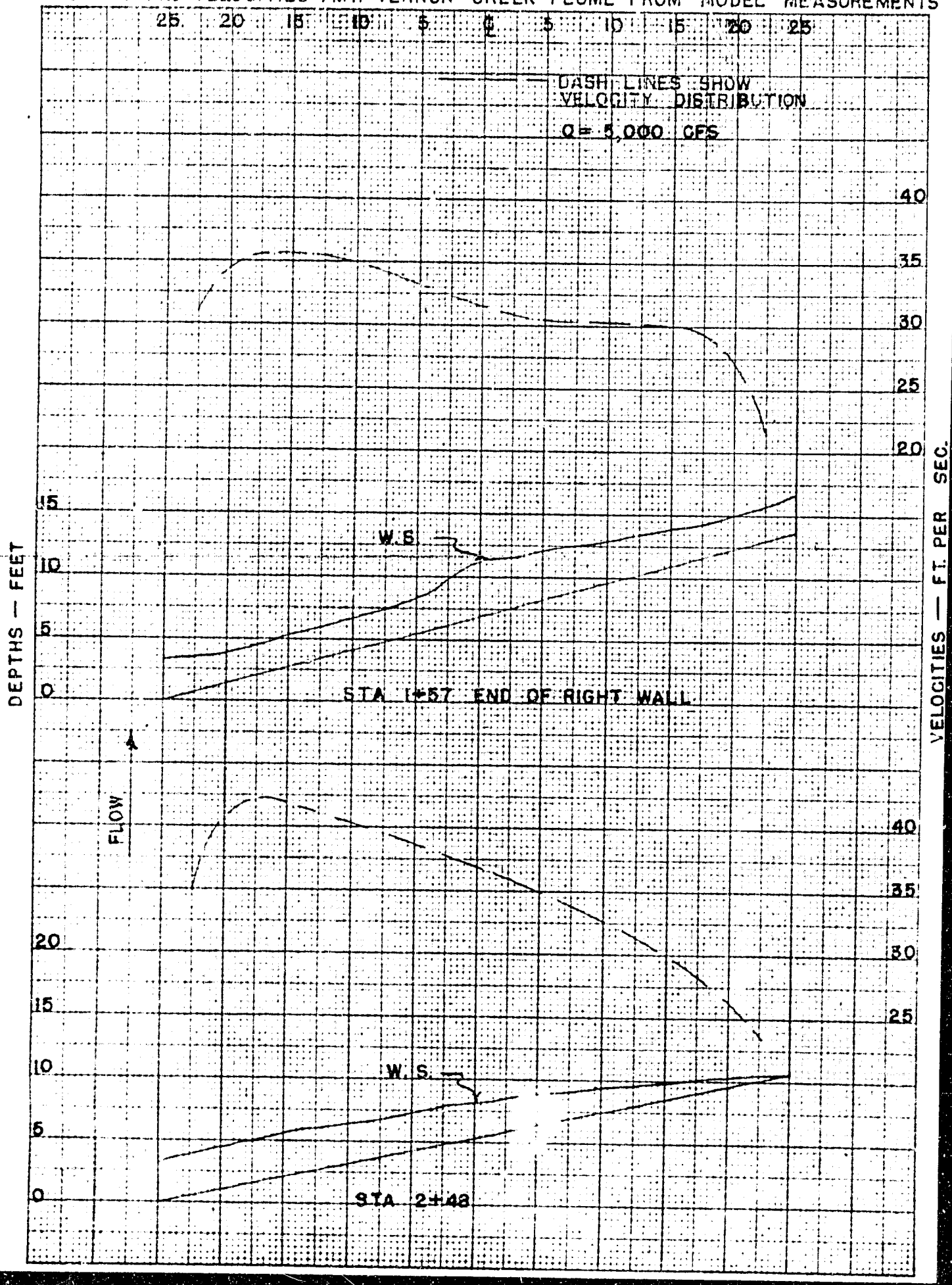


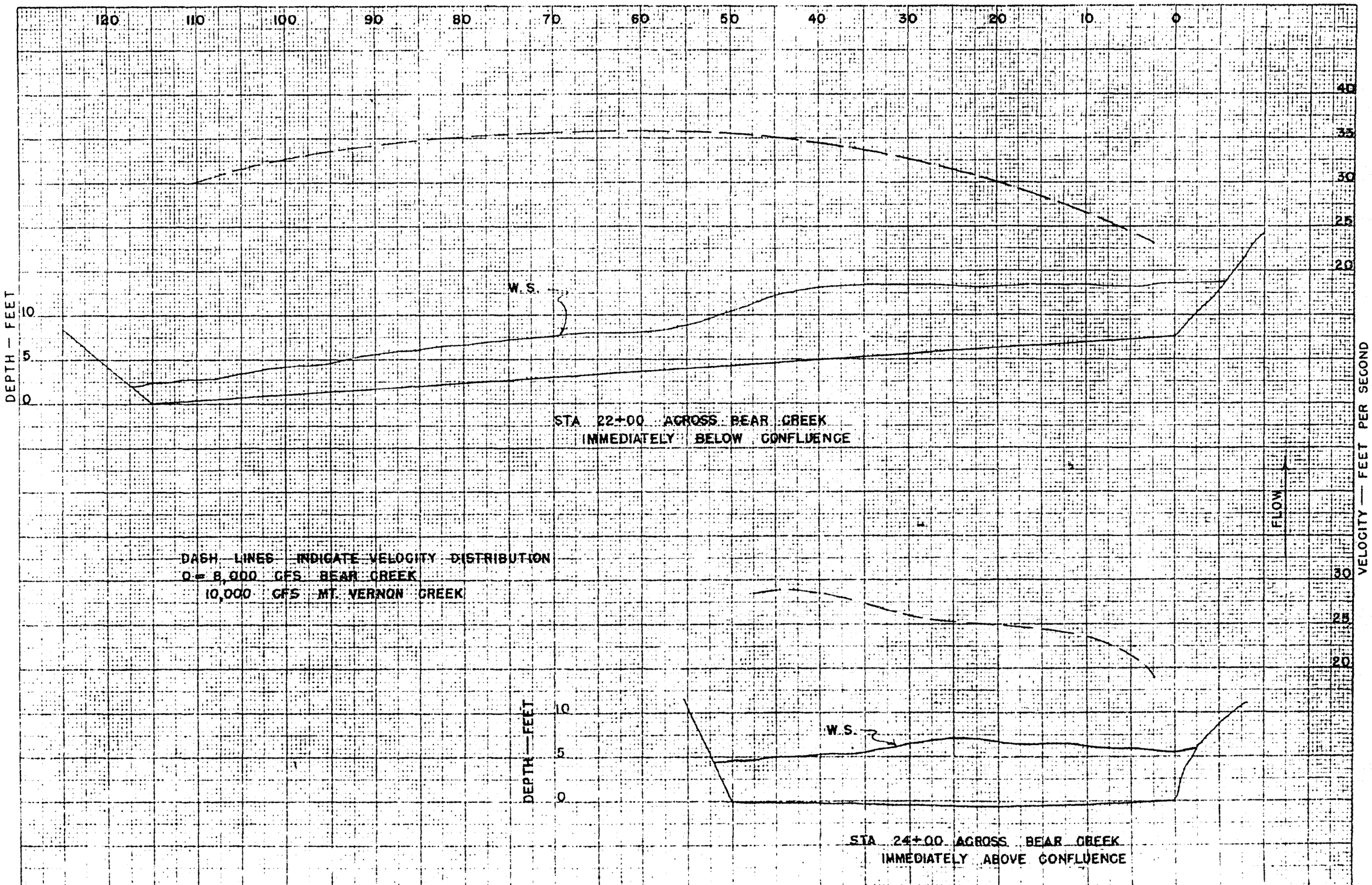
FIGURE 8

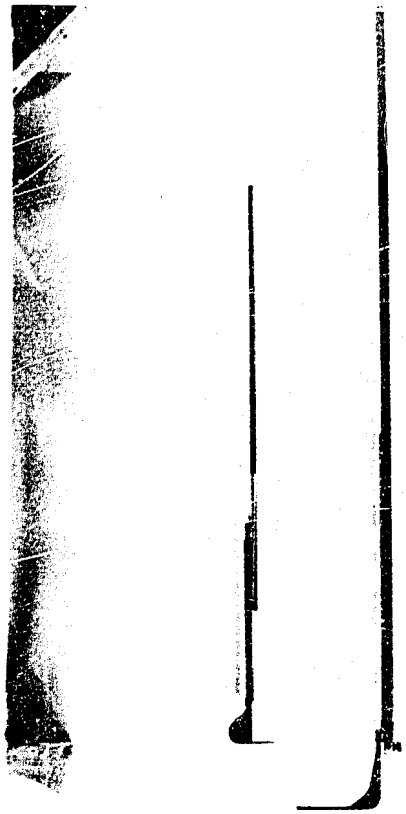
DEPTHS AND VELOCITIES – MT. VERNON CREEK FLUME FROM MODEL MEASUREMENTS



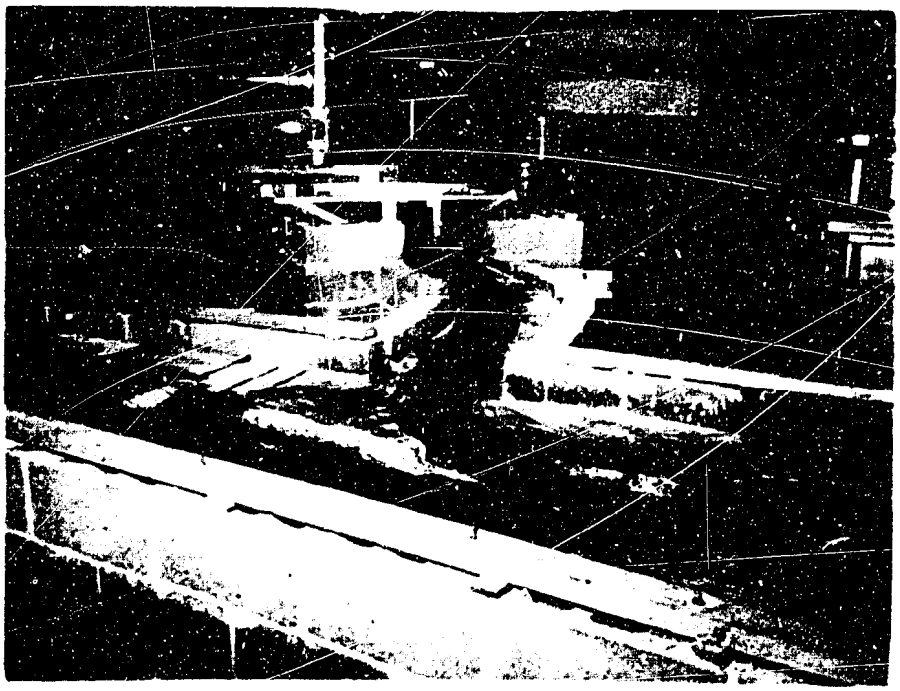
DEPTHS AND VELOCITIES — BEAR CREEK — FROM MODEL MEASUREMENTS

FIGURE 9

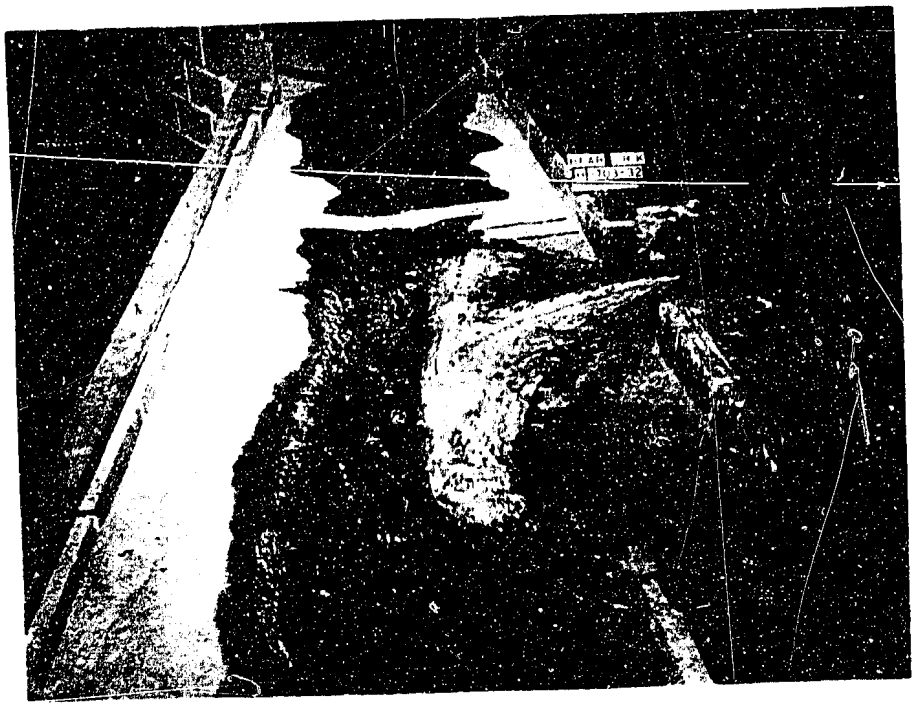




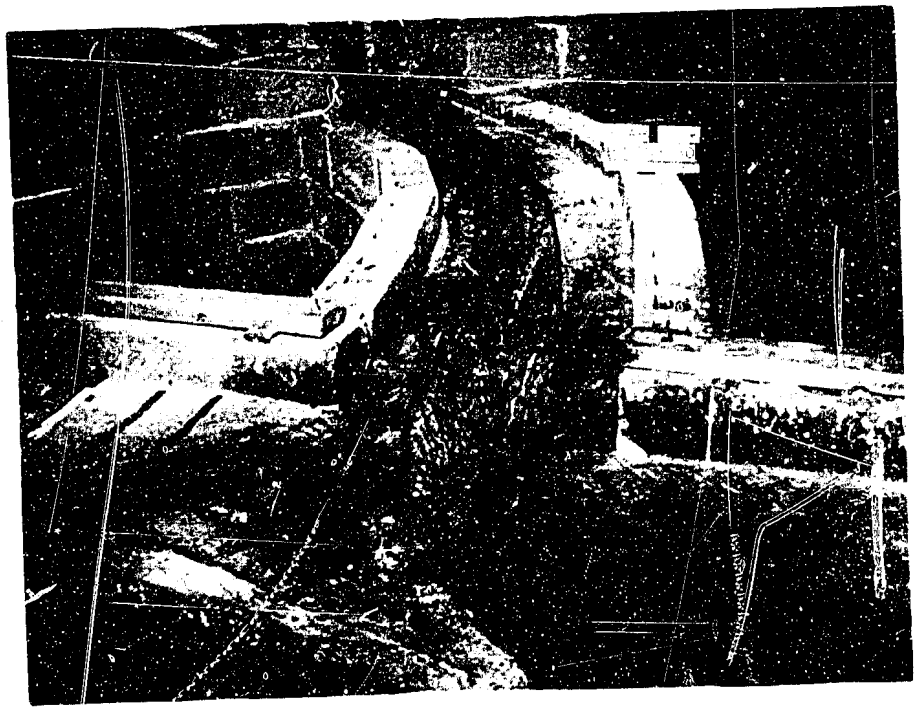
A. Pitot tubes used in determining velocities.



B. Final design tested in the model. Q in Mt. Vernon Creek channel 14,000 second-feet; Bear Creek 8,000 second-feet.

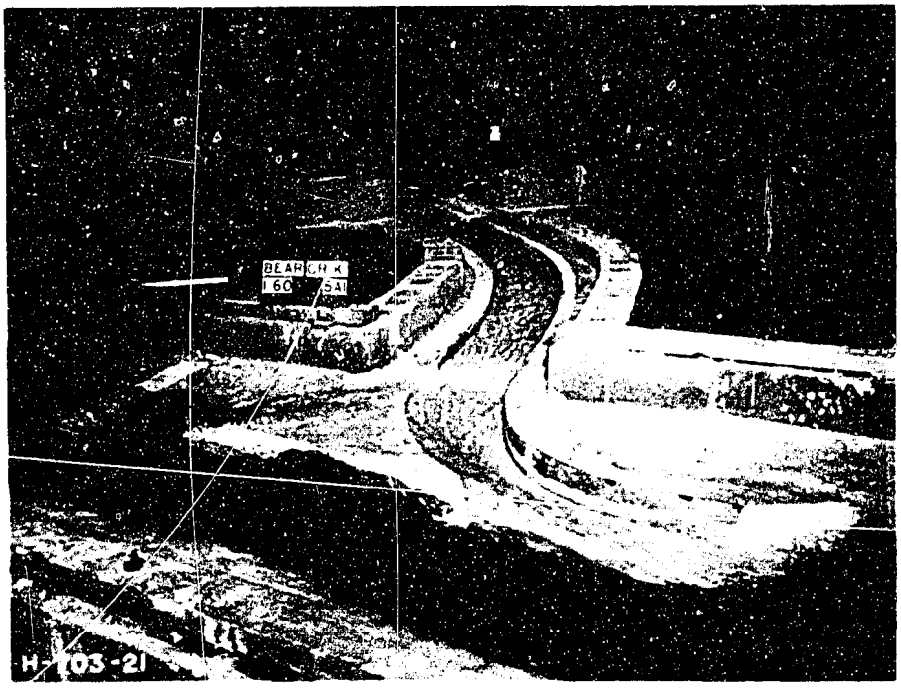


A. Confluence of final design tested in model. Q is 10,000 second-feet in Mt. Vernon Creek channel; 2,000 second-feet in Bear Creek. Note increased flow around inside wall of curve and logs pile up against outside wall.

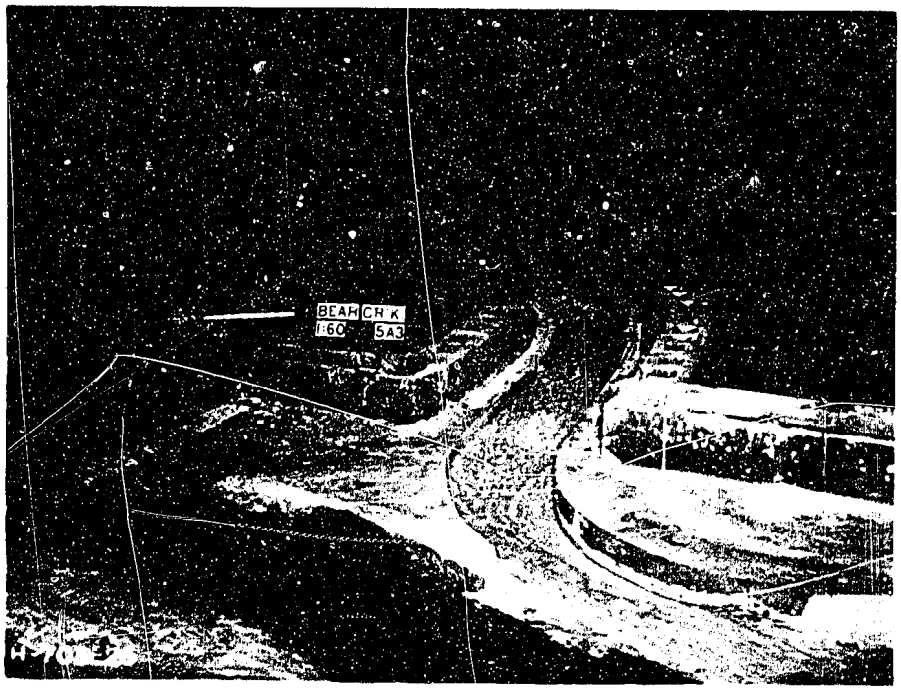


B. Mt. Vernon Creek channel final design tested in model. Discharge 10,000 second-feet.

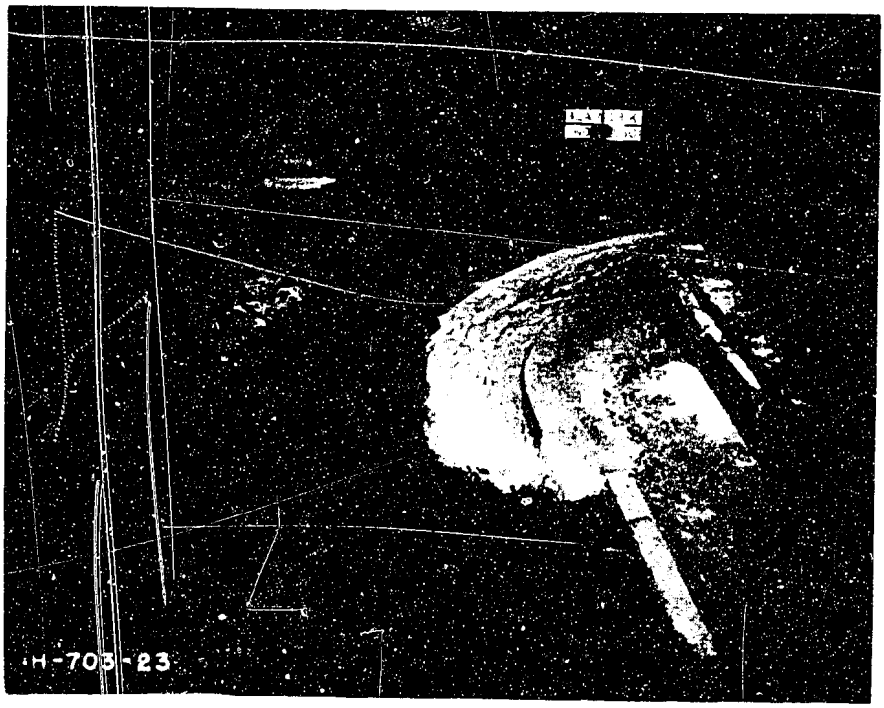
A. Bear Creek below confluence with Mt. Vernon Creek channel. Discharge 21,770 second-feet.



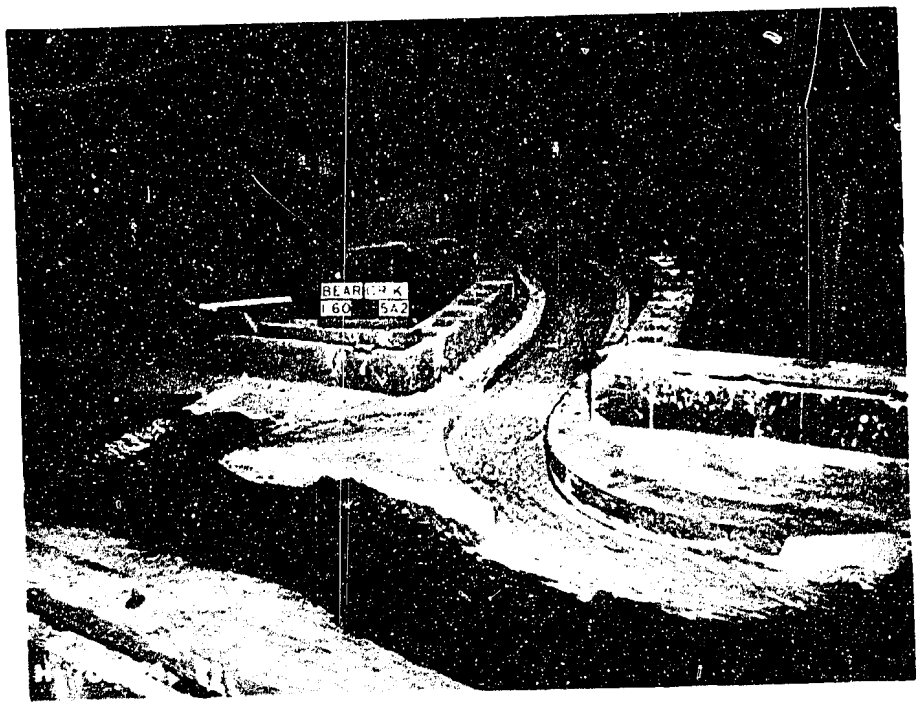
B. Final design concept upper channel of Mt. Vernon Creek is 50 ft. wide. Discharge Mt. Vernon Creek channel 10,000 second-feet; Bear Creek 21,000 second-feet.



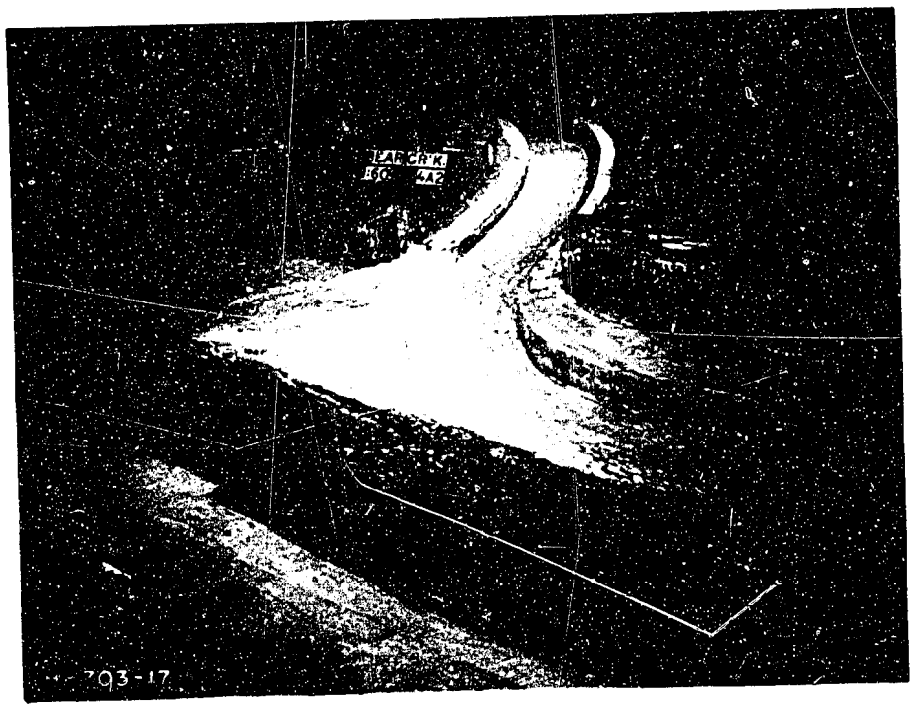
A. The [illegible] design concept upper channel of Mt. Vernon Creek is [illegible] ft. [illegible]. Discharge Mt. Vernon Creek channel 7,000 [illegible] feet; Bear Creek 10,000 [illegible].



B. Design same as A above. Discharge 10,000 second-feet in Mt. Vernon Creek channel; 10,000 second-feet in Bear Creek.

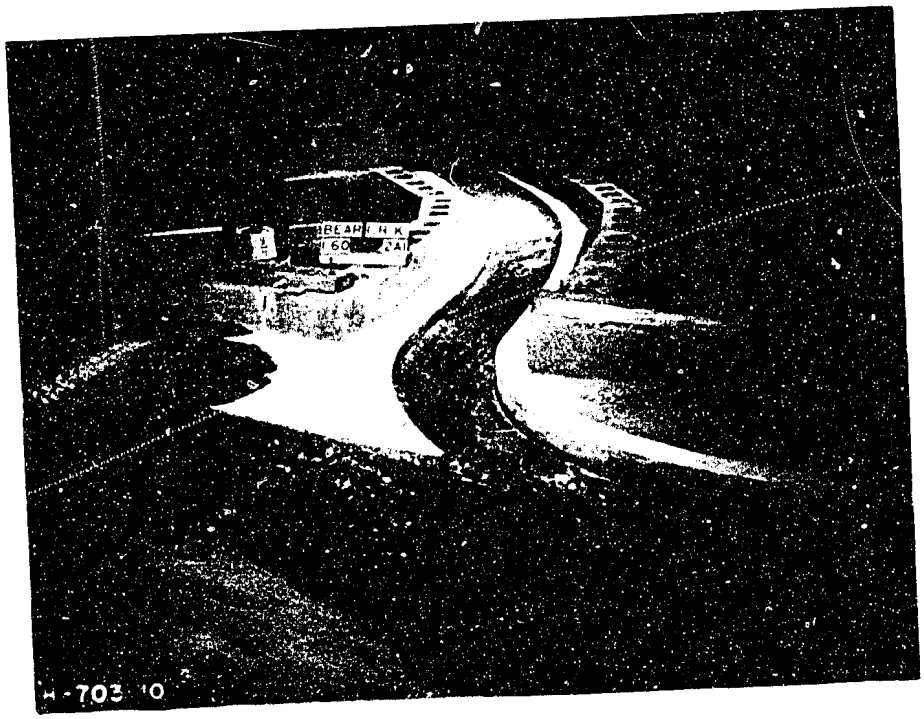


A. Final design except upper channel of Mt. Vernon Creek channel is 50 ft. wide. Discharge in Mt. Vernon Creek 5,000 second-feet; Bear Creek 10,000 second-feet.



B. Intermediate design with left side of Mt. Vernon Creek channel lowered beginning at circular part of upper curve. End of right wall novel upstream. Discharge, Mt. Vernon Creek 5,000 second-feet; Bear Creek 10,000 second-feet.

A. Design same as Figure 14B. Discharge, 1B. Vernon Creek channel 7,000 second-feet; Bear Creek 10,000 second-feet.



B. Intermediate design same as original except super-elevation of 7.2 ft. maximum in downstream curve. Discharge 1B. Vernon Creek 10,000 second-feet; Bear Creek 11,750 second-feet.

Design same as Figure 15B. Discharge, Mt. Vernon Creek channel 5,000 second-feet; Bear Creek 0.