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FLOW CONDITIONS IN FLUMES*

Observations Made Show That Where Water Flows At High Velocity Investigations Should Be Made Before Final Designs Are Adopted

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In connection with experimental investigations made on the North Platte project during the irrigation season of 1916, several observations were made of flow conditions at the Congo flume on the Low-Line Canal. These observations were made primarily for the purpose of determining the inlet and outlet losses and the value of Kutter's *n* for the flume. However, studies made of the data submitted revealed an interesting and important condition of flow separate from the original objects of the investigations.

The flume under consideration is of the semi-circular steel type, with smooth interior, known commercially as a Hess No. 204. The inside diameter is 10.823 ft. It is constructed on a tangent and has a total length between head walls of 240 ft. The field observations consisted of: (1) Profile of water surface; (2) profile of sub-grade; (3) elevation of top of flume; (4) measurement of discharge through the flume.

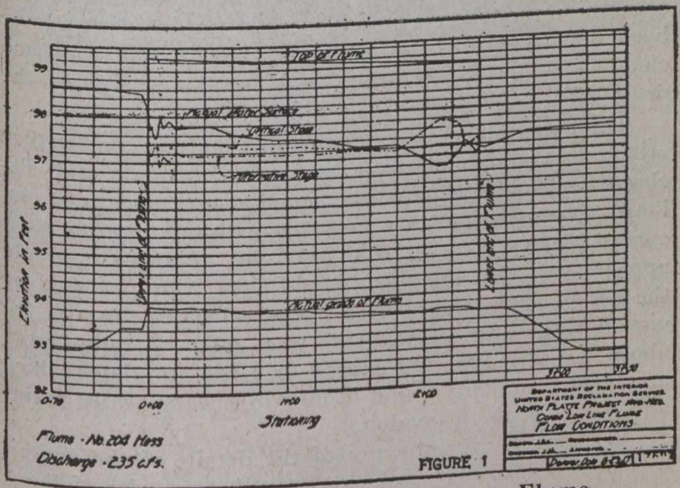

Fig. 1.—Flow Conditions in Congo Flume

The observations made on July 20th, 1916, were taken as representative of flow conditions. Fig. 1 has been prepared on which are shown in full lines the profiles of actual subgrade, actual water surface, and the top of the flume. The discharge through the flume at the time of making the above observations was 235 cu. ft. per second.

An examination of the water-surface profile shows that the flow through the flume is decidedly unstable, especially at the upper and lower ends of the flume. This general unstable condition of flow, together with the decided drop and jump in the water surface at the lower end, was identical in each test made and led to the belief that the flow must be at or near the critical depth. To substantiate the above theory studies have been made of the flow conditions throughout the flume.

*From "Reclamation Record."

With a discharge of 235 second-feet, various depths in the flume were assumed and the resulting area, velocity, and velocity-head for each depth computed. These data were plotted (see Fig. 2) with the depths in the flume as abscissae and the energy required to maintain the flow at these depths as ordinates. The energy required is equal to $D + h_v$ where D represents static head and h_v velocity

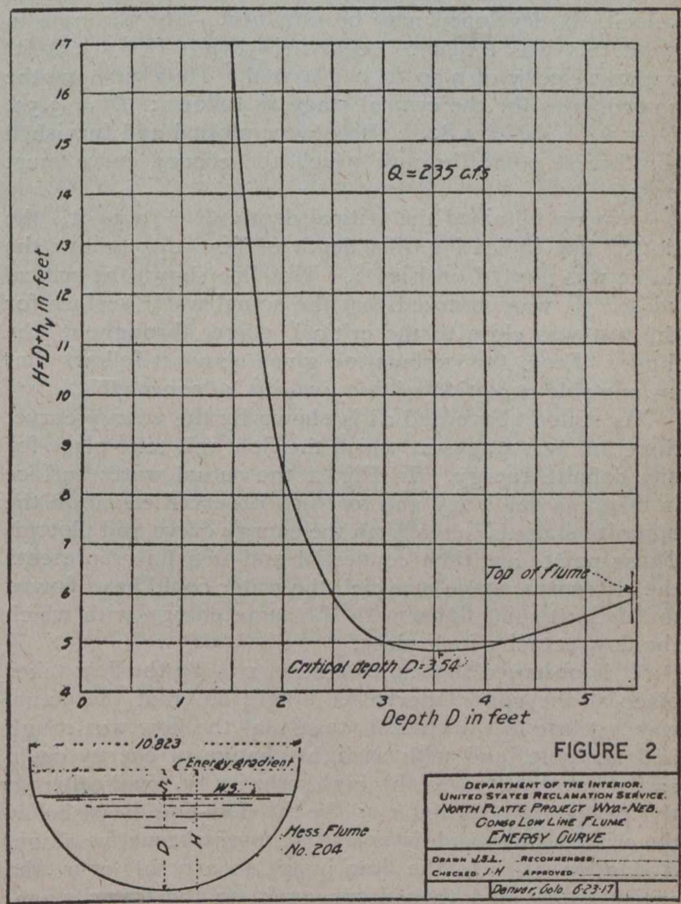

Fig. 2.—Energy Curve

head. The resulting energy curve for a flow of 235 second-feet through the flume was then drawn.

From the shape of the curve it follows that there are two depths at which the flow will take place with the same energy. These two depths are known as the lower alternative stage (stage of high velocity) and the upper alternative stage (stage of low velocity). The curve also demonstrates that there is one depth at which the two stages merge, this being the lowest point on the curve and hence the depth of flow requiring the least energy. This depth is known as the critical depth.