## ECONOMIC CANAL LOCATION IN UNIFORM COUNTRIES.\*

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## **Ceneral Remarks.**

As the writer has spent practically all his time, for the past three years, in the field location of canals and laterals, the method of economic location which has been developed may be of passing interest to others engaged in work of this class.

Yardage diagrams were made of standard canal sections with capacities of from 1 200 to 25 sec-ft. and a velocity of 2.5 ft. per. sec. For capacities ranging from 1 200 to 250 sec-ft., the diagrams were of sections having intervals of 50 sec-ft.; for capacities of less than 250 sec-ft., a diagram was made for each interval of 25 sec-ft. Figs. 1 and 2 are typical sections, and Table 1 gives the dimensions of standard laterals having velocities of from 1.0 to 3.0 ft. per sec. and capacities of from 1 to 90 sec-ft. the centre-line cut, where the inside crown of the upper bank intersects the ground surface.

Whenever the full water level of the canal intersects the ground surface below the outside toe of the upper bank, the upper bank is discontinued. The note on each diagram (Figs. 1 and 2), "Do not stake out upper bank where water line intersects ground line within . . . feet of center line," indicates where this condition prevails. This point is also indicated on the diagrams by a heavy horizontal line connecting the one-bank curve with the two-bank curve of the same transverse slope, and is supplemented by an explanatory note: "These breaks indicate center line cut at which upper bank is dropped."

Under ordinary conditions of regular location, greater center cuts require one bank only, while lighter center cuts require two banks. These requirements will always be governed by the full lines of the embankment curve. When, for any reason, the lower bank only is required, the dotted line



In the yardage diagrams, Figs. 1 and 2, the centre cut on a given transverse ground slope is used as the argument for the excavation and embankment for a required canal section, the elements of which section are predetermined. The quantities are given in cubic yards per station of 100 ft. The embankment quantities are 10% in excess of the actual embankment, this being an arbitrary allowance for shrinkage and settlement. The center cuts vary from 6 ft. below the bottom of the canal to 16 ft. above grade, and the transverse ground slopes from the level to 35%, and is platted at 5% intervals.

Two embankment curves are plotted for each different transverse slope; one gives the total yardage in the upper and lower banks combined; the other gives the yardage in the lower bank alone. These two curves join or coincide at

\*Proceedings American Society Civil Engineers, August, 1911. below the horizontal line connecting the same transverse slope is used. When it is required to continue the upper bank beyond the point provided for under ordinary conditions, the dotted line above the horizontal connecting line is used.

When the embankment curve for a given transverse slope intersects the excavation curve of the same transverse slope, the intersection center cut is called "economic" and is so indicated on the diagrams. At these intersections the yardages in excavation and embankment are balanced, allowance having been made for shrinkage and settlement of the embankment quantities.

At the right of each diagram a template of the canal shows the dimensions and the elements which govern the quantities given in the diagram. The elements, n, s, and v (Basin or Kutter formula), may be varied to meet the requirements of the engineer, and will determine the dimensions of the section required. The dimensions alone govern