HYDROLOGY FOR ENGINEERS

Third Edition

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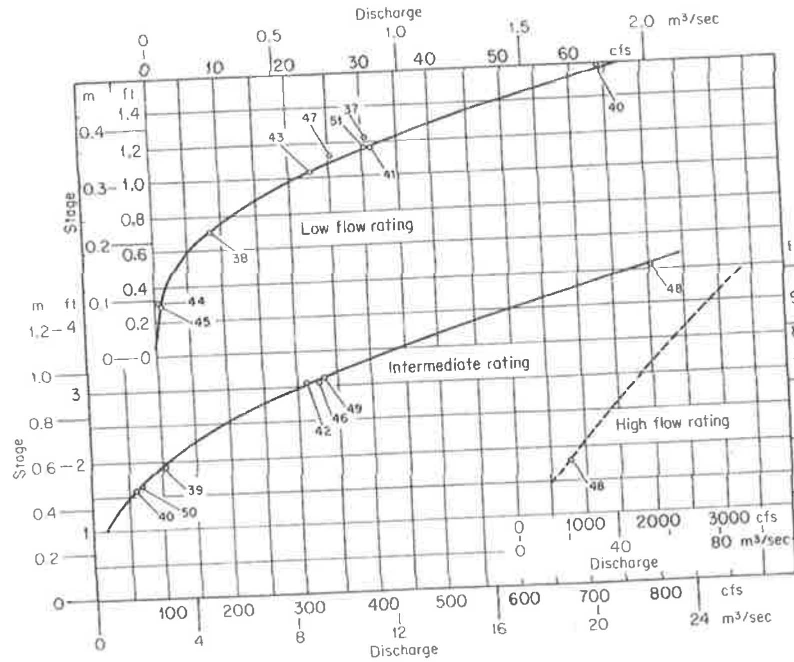

Figure 4-11 A simple stage-discharge relation.

satisfactory. Such a curve is approximately parabolic but may show some irregularities if the control changes within the range of flows experienced or if the cross section is irregular.

The dispersion of the measured data about *the mean rating curve* should be small (generally less than 2 percent). A larger dispersion indicates either (1) that the control shifts more or less continuously with scour and deposition in bed and banks or the growth of vegetation, (2) that the water-surface slope at the control varies as the result of varying backwater from tides, reservoir fluctuations, or variable tributary inflow downstream, or (3) that the measurements are not carefully made.

Under conditions of *shifting control*, discharge is usually estimated by noting the difference between the stage at the time of a discharge measurement and the stage on the mean rating curve which shows the same discharge. This difference is applied as a correction to all stages before entering the rating. If the correction changes between measurements, a linear variation with time is usually assumed.

If variable backwater is present, the rating curve must include slope as a parameter [15, 16]. The basic approach is represented by

$$\frac{q}{q_0} = \left(\frac{s}{s_0}\right)^m = \left(\frac{F}{F_0}\right)^k \tag{4-2}$$

In other words, discharge q is proportional to a power of water-surface slope s. From fluid mechanics the exponent m would be expected to be $\frac{1}{2}$. The fall F is the difference in water-surface elevation between two fixed sections and is usually measured by two conventional river gages. There is no assurance that the water-surface profile between these gages is a straight line, i.e., that $F/L = s$. Consequently the exponent k need not be $\frac{1}{2}$ and must be determined empirically.

A *slope-stage-discharge relation* requires a base gage and an auxiliary gage. The gages should be far enough apart for F to be at least 1 ft (30 cm) to minimize the effect of observational errors. The fall F applicable to each discharge measurement is determined, and if the observed falls do not vary greatly, an average value F_0 is selected. All measurements with values of $F \approx F_0$ are plotted as a simple stage-discharge relation, and a curve is fitted (Fig. 4-12). This is the q_0 curve representing the discharge when $F = F_0$. If $F \neq F_0$, the ratio F/F_0 is plotted against q/q_0 on an auxiliary chart. The discharge at any time may be computed by calculating the ratio F/F_0 and selecting a value of q/q_0 from the auxiliary curve. A value of q_0 corresponding to the existing stage is taken from the q_0 curve and multiplied by q/q_0 to give q. If the auxiliary curve plots as a straight line on logarithmic paper, the slope of the line is k in Eq. (4-2). The rating just described is known as a *constant-fall rating*, since the adopted mean fall F_0 is constant.

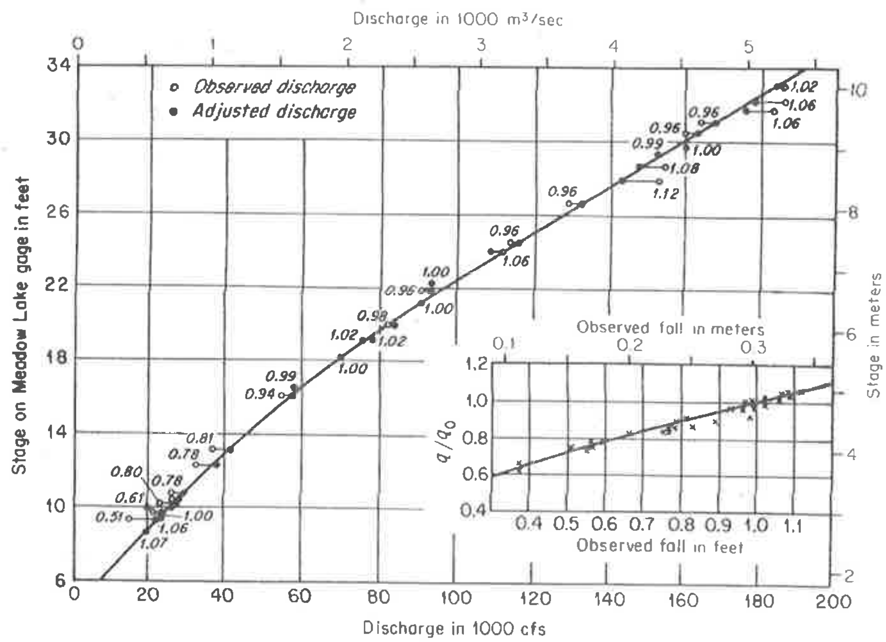

Figure 4-12 A slope-stage-discharge rating curve for the Tennessee River at Chattanooga, Tenn. (*U.S. Geological Survey.*)