H. O. Ogrosky, Chief, Hydrology Branch,
Engineering Division, SCS

Victor Mockus, Hydraulic Engineer, SCS,
Beltsville, Md.

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ENGINEERING - Hydrology - Rainfall-runoff relation

The October 9th memorandum by William W. Fox (through Morton Markowitz), and the October 12th transmittal memorandum by R. E. Rallison, contain questions concerning the proportion:

$$\frac{P - Q}{S} = \frac{Q}{P} \qquad (1)$$

which is the basis for the runoff equation given in the present Hydrology Guide.

It is necessary to recall some ancient history in order to give the background for (1). When the first edition of the Guide came out, page V-3-1 had the equation:

$$Q = \frac{KP^2}{KP + 1} \qquad (2)$$

which, by taking S = 1/K, could be converted to:

$$Q = \frac{P^2}{P + S} \qquad (3)$$

This was the original form of the runoff equation, later modified to the form we now use. The basis for (2) above was:

$$\frac{Q}{P} \cdot \frac{1}{(P - Q)} = K \qquad (4)$$

$\frac{Q}{P} = K(P-Q)$

where K is a constant for a given watershed condition. For example, when K = 0.3 you get runoff curve No. 75 in the old system (see figure V-3-1).

To answer Markowitz's question as to the reason for equating the two ratios of (1), it is necessary to say only that since (4) is true it follows that (1) is true, since (1) is derived from (4). However, another question can be raised. Equation (4) is algebraically true. Is it factually true? This can be answered by using actual rainfall and runoff records. These records must be on-site records, since both (1) and (4) imply that there is no lag in the appearance of Q at the gaging point. Also, since Q begins when P begins, the initial abstraction must be accounted for. To answer my own question,

equation (4) is factually true as far as we can tell from the limited data available. The various disproofs that are occasionally offered cannot be taken seriously as long as they are based on data not meeting the requirements about lag and I_a. That we do not consider lag in applying the present runoff equation is our fault, not the equation's. There are some compensating factors that reduce the possible error when lag is neglected in applications, but there are other factors that still need looking into.

Rallison plotted runoff curves of the old system, using semi-log paper, and could not come up with equation (3). Semi-log paper, if properly used, is unsuitable for rainfall-runoff plottings, since you will always get an equation that is dimensionally incorrect. Equation (3) is dimensionally correct, therefore it cannot be derived using semi-log paper.

There is one more question that may possibly be raised: Where did (4) come from? That is, how was (4) derived? The answer is it wasn't derived, it was discovered by searching for it. This was hard work, but it was worth it to get out of the smog created by all the infiltration equations.

cc:
Rallison - Portland
W.W.Fox-Berkeley,Calif.
Mockus

Mockus:ef