Copy Handbook

Engineering Division
269 Federal Center
Hyattsville, Maryland

October 2, 1963

Professor G. O. Schwab
Department of Agricultural Engineering
The Ohio State University
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Columbus 10, Ohio

Dear Professor Schwab

Your inquiry of September 24, concerning a particular form of the runoff equation in Sec. 10 of NEH-4, is quite appropriate. In trying to keep the text brief we omitted some remarks that would have been helpful in following the reasoning. A fuller account would go somewhat as follows.

At the top of page 3.10-2 of NEH-4 it is better to start with a hypothesis formulated in simpler terms:

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

where $F = P - Q$, and F is taken as the actual retention during the storm. Then in (1) we are saying that F/S, the ratio of actual to potential retention of rainfall, is equal to Q/P, the ratio of actual to potential runoff. Whether we accept or reject (1) for practical use depends on its agreement with watershed data. So far we have found no good reason for rejecting (1).

Since $F = P - Q$, we can also write:

$$\frac{P - Q}{S} = \frac{Q}{P} \qquad (2)$$

which is the same as equation 2 on page 3.10-2. However, (2) does not make it clear that a dependence is involved. It is necessary to state that Q is a function of P and S. That is, $Q = f(P,S)$, so that (2) can be written:

$$\frac{P - f(P,S)}{S} = \frac{f(P,S)}{P} \qquad (3)$$

and from (3) it becomes evident that if values of P and S are assumed, then f(P,S) must be computed. Or, if a value of f(P,S) is assumed, then appropriate values of P and S must be found. In (3), as the ratio f(P,S)/P approaches one, the quantity P - f(P,S) approaches the constant S. Since (2) and (3) are identities, then as the ratio Q/P approaches one, the quantity P - Q approaches the constant S. Thus, your example with Q = P can occur only when S is zero, in which case the ratio (P - Q)/S in (2) becomes the indeterminate form 0/0. It is more enlightening to write (2) as:

$$Q = \frac{P^2}{P + S} \qquad (4)$$

since this form is more suitable for demonstration of the above statements. It is readily apparent in (4) that when S is zero, then Q = P. A series of computations, such as that given below for the case when S = 12, shows that as the ratio Q/P approaches one, the quantity (P - Q) approaches S.

P	1	10	100	1000	10000
Q:	0.0769	4.545	89.2857	988.1423	9988.0143
Q/P:	.0769	.4545	.8928	.9881	.9988
(P - Q):	.9231	5.4545	10.7143	11.8577	11.9857

I hope you find the above explanation sufficient for your needs. If it is not, I will be happy to pursue the subject further. You will note that I ignored the initial abstraction, I_a, in this explanation. Introducing I_a at the beginning makes the development much too wordy both in text and notation.

With best wishes for your new edition,

Sincerely yours

VMockus:vpe

cc: H.O.Ogrosky

Victor Mockus
Hydraulic Engineer
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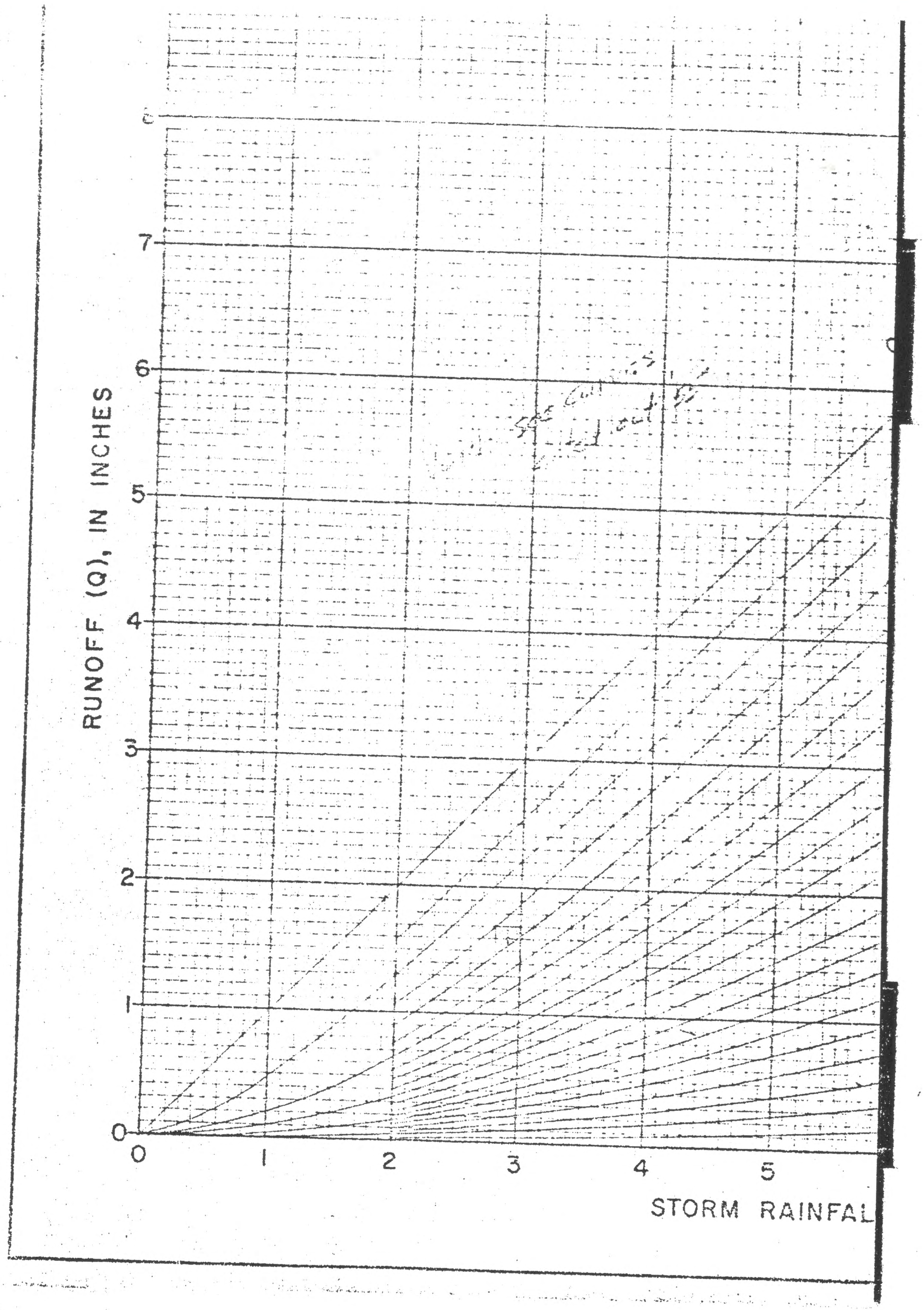
RUNOFF (Q), IN INCHES
0
1
2
3
4
5
6
7
8
0
1
2
3
4
5
STORM RAINFAL

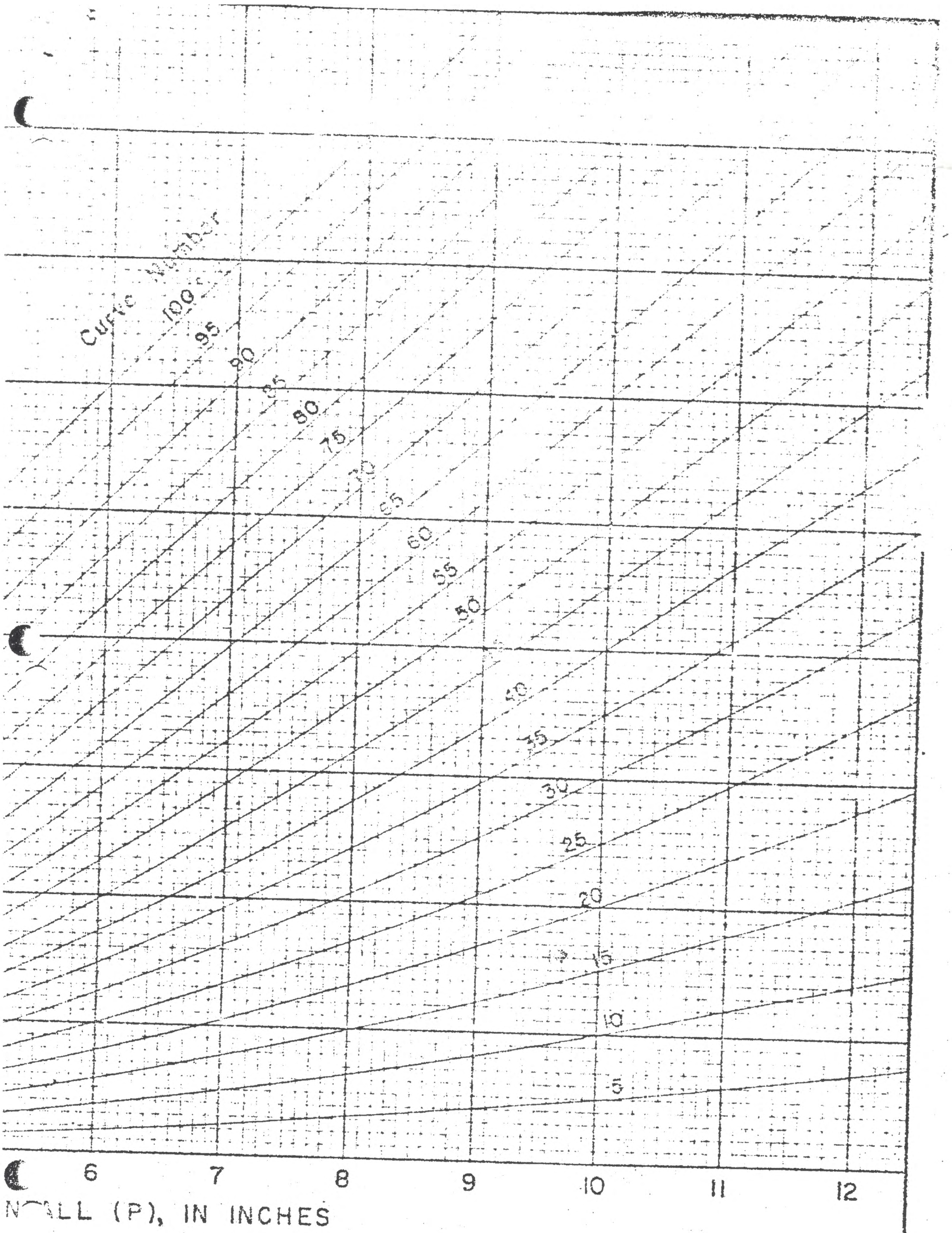
Curve Number
100
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
6
7
8
9
10
11
12
NFALL (P), IN INCHES

Fig. V-3-1