Module 105 Runoff Computation

Study Guide

Engineering Hydrology Training Series

Module 105 Runoff Computations

Module Description

Objectives

Upon completion of this module, the participant will be able to calculate runoff volume when precipitation is known by using the CN procedure for design of a conservation practice.

The participant should be able to perform at ASK level 3 (Perform with Supervision) after completing this module.

Prerequisites

Modules 102 - Precipitation and 104 - Runoff Curve Numbers or their equivalent.

References

National Engineering Handbook, Section 4, Hydrology Engineering Field Manual
Technical Release 16, Hydrology

Length

Participant should take as long as necessary to complete this module. Training time for this module is approximately one hour.

Who May Take The Module

This module is intended for all SCS personnel who calculate runoff using the CN procedure.

Method of Completion

This module is self-study, but the state or NTC should select a resource person to answer any questions that the participant's supervisor cannot handle.

Content

This module presents methods of determining runoff using a numerical, a graphical, and two tabular methods.

Contents

Introduction

The SCS method of estimating direct runoff' from storm rainfall is based on methods developed by SCS. The hydrologic principles of the method are not new, but they are put to new uses. Because most SCS work is with ungaged watersheds (not gaged for runoff), the method was made to be used with rainfall and watershed data that are ordinarily available or easily obtainable for such watersheds.

This method is used for estimating volume of direct runoff'. The equation to estimate runoff' is:

$$Q=\frac{(P-0.2S)^2}{(P+0.8S)} \qquad (1)$$

where

Q = runoff, in.

P = rainfall, in.

S = potential maximum retention

after runoff' begins, $(\frac{1000}{CN}-10)$

This equation has been developed in Chapter 10 of the National Engineering Handbook, Section 4, Hydrology. If you are interested in formula derivation, you should refer to Module 205 - SCS Runoff' Equation. Module 105 will concern itself with runoff computations using graphs and tables.

Runoff Computation Methods

There are several methods SCS uses for converting rainfall to runoff. The solution of the SCS runoff equation (Equation (1)) is one method. Other methods are simplifications of Equation (1), using graphs and tables.

Methods

Step by step examples for the fol1owing four methods for estimating direct runoff will be given:

1. Numerical solution, NEH-4, Chapter 10

2. Tabular solution, TR-16, Rainfall-Runoff Tables for Selected Runoff Curve Numbers

3. Graphical solution, ES 1001, Solution of Runoff Equation, (NEH-4, Chapter 10; TR-55, Chapter 2)

4. Tabular solution, Table 2-1, Runoff depth for selected CN's and rainfall amounts (TR-55, Chapter 2; EFM, Chapter 2 has a similar table)

Runoff equation

$$Q = \frac{(P-0.2S)^2}{(P+0.8S)}$$

$$S = (\frac{1000}{CN} - 10)$$

Numerical Solution

Step by step procedure

1. Given data

a. CN (Module 104)

b. P (Module 102)

2. Solve for S using given CN

3. Solve for Q using given P and S from Step 2.

Example 1

1. Given data

    a. CN=77

    b. P=4.1 in.

2. S = $(\frac{1000}{CN} - 10)$

    S = $(\frac{1000}{77} - 10)$ = 12.99-10

    S = 2.99

    Q = $\frac{(P-0.2S)^2}{(P+0.8S)}$

    Q = $\frac{[4.1-0.2(2.99)]^2}{[4.1-0.8(2.99)]}$

    Q = $\frac{(4.1-0.6)^2}{4.1+2.39)} = \frac{12.25}{6.49}$

Answer: Q = 1.89 in.

TR-16 Tabular Solution

Step by step procedure

1. Given data

    a. CN (Module 104)

    b. P (Module 102)

2. Go to appropriate CN sheet ofTR-16.

3. A copy of TR-16 sheets for CN's = 65, 66, 70 & 77 is inc1uded in Appendix A (A3 through A6). Go down left column unti1 you read whole number for given P, and go right until you come to co1umn for decimal value of P. This win be the value of Q you are trying to solve for.

Example 2

1. Given data

a. CN = 77

b. P = 4.1 in.

2. Go to sheet for CN = 77 in Appendix A

3. Go down left column until you reach 4 inches. Then, move right until you reach 0.1. This intersection gives a reading of 1.89.

Answer: Q = 1.89 in.

Graphical Solution

Step by step procedure

1. Given data

a. CN

b. P

2. Go to ES 1001 in NEH-4, Chapter 10 or TR-55, Chapter 2. The vertical axis represents direct runoff, Q, in inches. The horizontal axis represents rainfall, P, in inches. The diagonally curved lines represent CNs.

3. Enter the bottom (horizontal axis) of the graph with P. Continue vertically upward until you intersect the desired CN curve. Move horizontally to the left side of the graph and read the runoff, Q, in inches.

Example 3

1. Given data

a. CN = 75

b. P = 5.0 in.

2. Go to ES 1001.

3. Refer to Figure 1. Enter the bottom of the graph with P = 5.0 in. Continue vertically upward until you intersect with the CN = 75. From this point, move horizontally to the left side of the chart and read Q = 2.45.
(Refer to page 5 in Module 105 for Figure 1)

Answer: Q = 2.45 in.

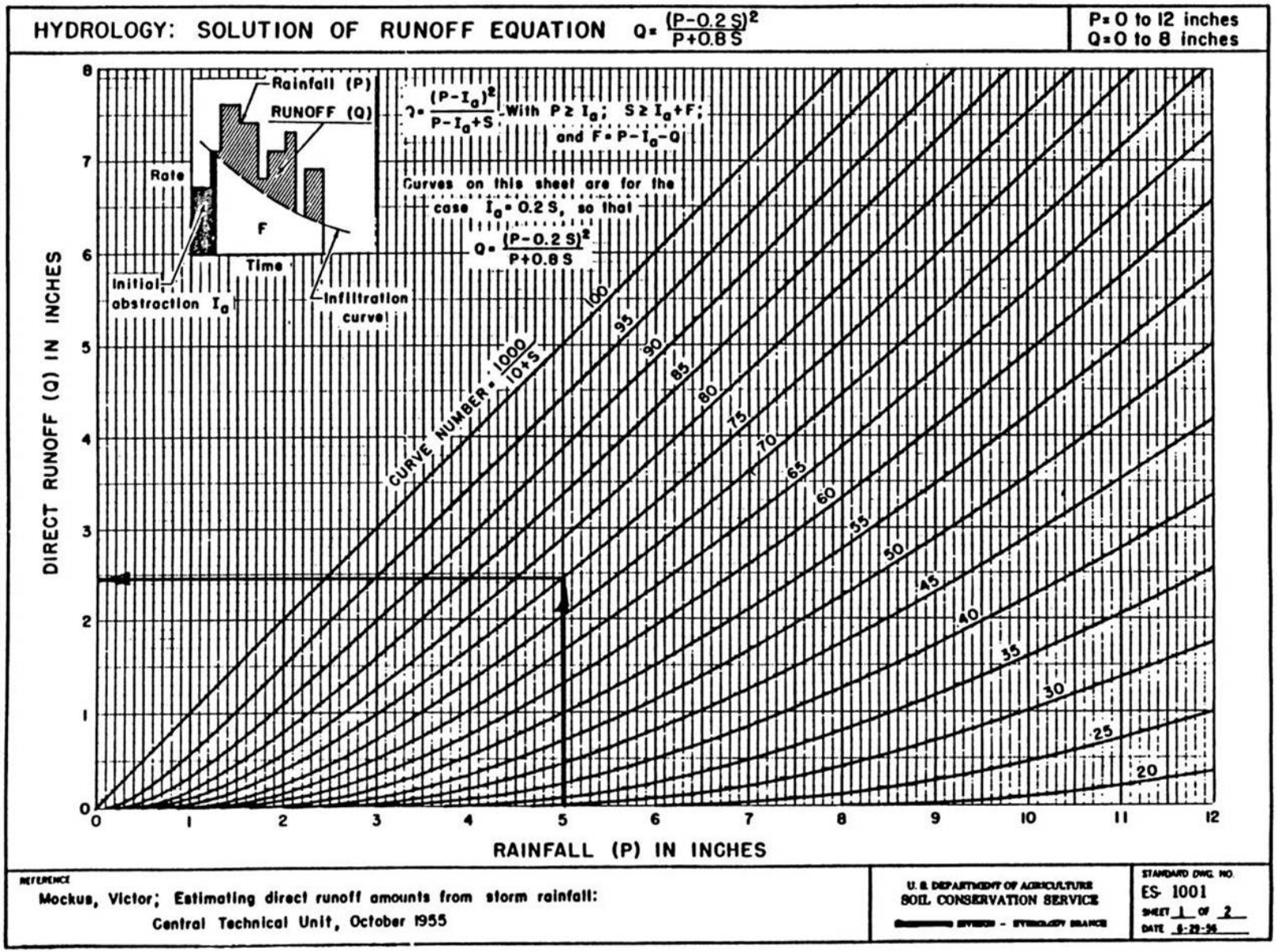

Figure 1. ***Solution of runoff equation***

[SOURCE: CHAPTER 10, NEH-4]

Example 4

1. Given data

   a. CN=77

   b. P = 4.1 in.

2. Go to ES 1001 (Figure 1).

3. Enter the bottom of ES 1001 with P = 4.1 in. Continue vertically upward until you intersect with a CN = 77 curve. As you can see, there is no CN = 77 curve. The closest curves on either side of CN = 77 are CN = 75 and CN = 80. Estimate where CN = 77 curve would fall between CN = 75 and CN = 80. Move to the left and read Q = 1.9.

Answer: Q = 1.9 in.

Step by step procedure

1. Given data

   a. CN

   b. P

2. Go to Table 2-1 in TR-55, or Chapter 2, EFM.
(Refer to page A8 of Appendix A in Module 105 for Table 2-1)

3. Go down the left column until you reach the given P. Move horizontally to the right until you reach the given CN. This intersection gives the required direct runoff, Q, in inches. Some cases may require double interpolation. This will be described in the examples.

Example 5

1. Given data

   a. CN = 75

   b. P = 5.0 in.

2. Go to Table 2-1 in Appendix A.
(Refer to page A8 of Appendix A in Module 105 for Table 2-1)

3. Go down the left column until you reach 5.0 in. Move horizontally right until you reach CN = 75. Read Q = 2.45.

Answer: Q = 2.45 in.

Example 6

1. Given data

   a. CN = 77

   b. P = 5.0 in.

2. Go to Table 2-1 in Appendix A
(Refer to page A8 of Appendix A in Module 105 for Table 2-1)

3. Go down the left column until you reach 5.0. Move right until you reach CN = 75; Q = 2.45 in. Continue to the right until you reach CN = 80; Q = 2.89 in.

Difference = 2.89 in. - 2.45 in. = 0.44 in. CN = 77 is 2/5 of distance between 75 and 80, or 77-75/80-75.

Thus, for P = 5.0 in. and CN = 77, Q = 2.45 + (2/5) (0.44) = 2.63 in.

Answer: Q = 2.63 in.

Example 7

1. Given data

   a. CN= 77

   b. P = 4.1 in.

2. a. For P = 4.0 in, go down the left column until you reach 4.0.

Move right until you reach CN = 75; Q = 1.67 in.

Continue right until you reach CN = 80; Q = 2.04 in.

Difference = 2.04 - 1.67 = 0.37 in

CN = 77 is 2/5 of the difference greater 75 and 80, or

0.37 in. x 2/5 = 0.15 in.

Thus, for P = 4.0 in. and CN = 77,

Q = 1.67 + 0.15 = 1.82 in.

b. For P = 5.0 in., go down the left column until you reach 5.0. Move right until you reach CN = 75; Q = 2.45 in.

Continue right until you reach CN = 80; Q = 2.89 in.

Difference = 2.89 - 2.45 = 0.44 in.

CN = 77 is 2/5 of the difference between 75 and 80, or
0.44 in. x 2/5 = 0.18 in.

Thus, for P = 5.0 in. and CN = 77,

Q = 2.45 in. + 0.18 = 2.63 in.

c. For CN = 77, the difference between P = 4.0 in. and P = 5.0 in.

is 2.63 - 1.82 = 0.81 in.

P = 4.1 is 1/10 of the difference between 4.0 and 5.0,

or 0.81 in. x 1/10 = 0.08 in.

Thus, for P = 4.1 in. and CN = 77,

Q = 1.82 + 0.08 = 1.90 in.

Answer: Q = 1.90 in.

Activity 1

At this time, complete Activity 1 in your Study Guide to review the material just covered. After finishing the Activity, compare your answers with the solution provided. When you are satisfied that you understand the material, you may continue with the Study Guide text.
(Refer to pages 9-12 in Module 105 for Activity 1 Questions and pages 13-16 for Activity 1 Solutions)

Summary

You should now be able to use the following four methods for calculating runoff:

1. Numerical solution (NEH-4, Chapter 10)
2. TR-16 tabular solution
3. ES 1001 graphical solution
4. TR-55 tabular solution

Retain this Study Guide as a reference until you are satisfied that you have successfully mastered all the methods covered. It will provide an easy review at any time if you should encounter a problem.

If you have had problems understanding the module or if you would like to take additional, related modules, contact your supervisor.

When you are satisfied that you have completed this module, remove the Certification of Completion sheet from the study guide (last page of the study guide), fill it out, and give it to your supervisor to submit through channels, to your State or NTC Training Officer.

Module 105 - Runoff Computations Activity Questions

1. Numerical solution of runoff equation

   a) Solve Q for P = 6.25 in and CN = 70.

   b) Solve Q for P = 3.2 in and CN = 66.

(Refer to page 13 in Module 105 for Solutions)

2. TR-16 tabular solution

   a) Estimate Q for P = 3.4 in and CN = 77.

   b) Estimate Q for P = 3.2 in and CN = 66.

(Refer to page 14 in Module 105 for Solutions)

3. Graphical solution

   a) Estimate Q for P = 6.0 in and CN = 70.

   b) Estimate Q for P = 6.1 in and CN = 73.

(Refer to page 15 in Module 105 for Solutions)

4. TR-55 tabular solution

   a) Estimate Q for P = 6.0 in and CN = 70.

   b) Estimate Q for P = 6.1 in and CN = 73.

(Refer to page 16 in Module 105 for Solutions)

Module 105 - Runoff Computations Activity Solutions

Activity 1

1. Numerical solution of runoff equation

a. Solve Q for P = 6.25 in and CN = 70.

Solution:

$S = \frac{1000}{CN} - 10 = \frac{1000}{70} - 10 = 14.29 - 10$

$S = 4.29$

$Q = \frac{(P-0.2S)^2}{(P+0.8S)} = \frac{[6.25-0.2(4.29)]^2}{[6.25+0.8(4.29)]}$

$Q = \frac{(6.25-0.86)^2}{(6.25+3.43)} = \frac{29.05}{9.68}$

$Q = 3.00$ in

b. Solve Q for P = 3.2 in and CN = 66.

Solution:

$S = \frac{1000}{CN} - 10 = \frac{1000}{66} - 10 = 15.15 - 10$

$S = 5.15$

$Q = \frac{(P-0.2S)^2}{(P+0.8S)} = \frac{[3.2-0.2(5.15)]^2}{[3.2+0.8(5.15)]}$

$Q = \frac{(3.2-1.03)^2}{(3.2+4.12)} = \frac{4.71}{7.32}$

$Q = 0.64$ in

2. TR-16 tabular solution

a. Estimate Q for P = 3.4 in and CN = 77.

Solution:

1) Go to sheet for CN = 77 in TR-16

2) Move down left column until you reach 3 inches.
Then move right until you reach 0.4.
This intersection gives a reading of 1.36.

3) Q = 1.36 in

b. Estimate Q for P = 3.2 in and CN = 66.

Solution:

1) Go to sheet for CN = 66 in TR-16.

2) Move down the left column until you reach 3 inches.
Then move right until you reach 0.2.
This intersection gives a reading of 0.64.

3) Q = 0.64 in

3. Graphical solution

a. Estimate Q for P = 6.0 in and CN = 70.

Solution:

1) Go to ES 1001

2) Enter the bottom of the graph with P = 60 in.
Continue vertically upward until you intersect with the CN = 70 curve.

3) Move to the left and read Q = 2.8 in

b. Estimate Q for P = 6.1 in and CN = 73.

Solution:

1) Go to ES 1001

2) Enter the bottom of the graph with P = 6.1 in. Continue vertically upward until you intersect with the CN = 73 curve. As you can see, there is no CN = 73 curve. The closest curves on either side of CN = 73 are CN 70 and CN = 75. Estimate where CN = 73 would fall between CN 70 and CN = 75, and read Q = 3.2 in.

4. TR-55 tabular solution

a. Estimate Q for P = 6.0 in and CN = 70.

Solution:

1) Go to Table 2-1 in Appendix A.

2) Go down left column until you reach P = 6.0. Move horizontally right until you reach CN = 70.
Read Q = 2.81 in.

b. Estimate Q for P = 6.1 in and CN = 73.

Solution:

1) For P = 6.0, go down the left column until you reach 6.0. Move right until you reach CN= 70; a = 2.81 in.
Continue to the right until you reach CN = 75; a = 328 in. Difference = 3.28 - 2.80 = 0.48 in. CN = 73 is 3/5 of the difference between 70 and 75, or 0.48 x 3/5 = 0.29 in. Thus, for P = 6.0 in and CN = 73, a = 2.80 + 029 = 3.09 in.

2) For P = 7.0 in., go down the left column until you reach 7.0. Move right until you reach CN = 70; a = 3.62 in.
Continue to the right until you read CN = 75; a = 4.15 in. Difference = 4.15 - 3.62 = 0.53 in. CN = 73 is 3/5 of the difference between 70 and 75, or 0.5 3 × 3/5 = 0.32 in.
Thus, for P = 7.0 in and CN=73, Q = 3.62 + 0.32 = 3.94 in.

3) Difference for CN = 73 between P = 6.0 and P = 7.0 is 3.94 - 3.09 = 0.85 in. P = 6.1 in is 1/10 of the difference between P = 6.0 and P = 7.0, or 0.85 × 1/10 = 0.085, use 0.09 in.
Thus, for CN = 73 and P = 6.1 in, Q = 3.09 + 0.09 = 3.18 in.

Appendix A Charts and Tables

RUNOFF FOR INCHES OF RAINFALL
(Curve 65)

Tenths / Inches	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
0										
1		0.00	0.00	0.01	0.02	0.03	0.05	0.06	0.09	0.11
2	0.14	0.16	0.19	0.23	0.26	0.30	0.34	0.38	0.42	0.46
3	0.5l	0.55	0.60	0.65	0.70	0.75	0.81	0.86	0.92	0.97
4	1.03	1.09	1.15	1.21	1.27	1.33	1.39	1.46	1.52	1.59
5	1.65	1.72	1.79	1.86	1.93	2.00	2.07	2.14	2.21	2.28
6	2.35	2.43	2.50	2.57	2.65	2.72	2.80	2.87	2.95	3.03
7	3.10	3.18	3.26	3.34	3.42	3.50	3.58	3.66	3.74	3.82
8	3.90	3.98	4.06	4.14	4.22	4.30	4.39	4.47	4.55	4.64
9	4.72	4.80	4.89	4.97	5.06	5.14	5.23	5.31	5.40	5.48
10	5.57	5.65	5.74	5.83	5.91	6.00	6.09	6.17	6.26	6.35
11	6.44	6.52	6.61	6.70	6.79	6.88	6.96	7.05	7.14	7.23
12	7.32	7.41	7.50	7.59	7.68	7.77	7.86	1.95	8.04	8.13
13	8.22	8.31	8.40	8.49	8.58	8.67	8.76	8.85	8.94	9.03
14	9.13	9.22	9.31	9.40	9.49	9.58	9.68	9.77	9.86	9.95
15	10.04	10.14	10.23	10.32	10.41	10.51	10.60	10.69	10.78	10.88
16	10.97	11.06	11.16	11.25	11.34	11.44	11.53	11.62	11.12	11.81
17	11.90	12.00	12.09	12.18	12.28	12.37	12.47	12.56	12.65	12.75
18	12.84	12.94	13.03	13.12	13.22	13.31	13.41	13. 50	13.60	13.69
19	13.79	13.88	13.98	14.07	14.17	14.26	14.35	14.45	14.54	14.64
20	14.73	14.83	14.93	15.02	15.12	15.21	15.31	15.4C	15.50	15.59

NOTE: Runoff value determined by equation $Q = \frac{(P-0.2S)^2}{(P+0.8S)}$

[SOURCE: TR-16]

RUNOFF FOR INCHES OF RAINFALL
(Curve 66)

Tenths / **Inches**	**0.0**	**0.1**	**0.2**	**0.3**	**0.4**	**0.5**	**0.6**	**0.7**	**0.8**	**0.9**
0										
1		0.00	0.01	0.01	0.02	0.04	0.06	0.08	0.10	0.13
2	0.15	0.18	0.22	0.25	0.29	0.33	0.37	0.41	0.45	0.50
3	0.55	0.59	0.64	0.69	0.75	C.80	0.86	0.91	0.97	1.03
4	1.09	1.15	1.21	1.21	1.33	1.40	1.46	1.53	1.59	1.66
5	1.73	1.80	1.81	1.94	2.01	2.08	2.15	2.22	2.29	2.37
6	2.44	2.52	2.59	2.67	2.74	2.82	2.89	2.97	3.05	3.13
7	3.21	3.28	3.36	3.44	3.52	3.60	3.68	3.76	3.85	3.93
8	4.01	4.09	4.17	4.2b	4.34	4.42	4.51	4.59	4.67	4.76
9	4.84	4.93	5.01	5.10	5.18	5.27	5.35	5.44	5.53	5.61
10	5.70	5.79	5.87	5.96	6.05	6.13	6.22	6.31	6.40	6.49
11	6.57	6.66	6.15	6.84	6.93	7.02	7.11	7.20	7.29	7.38
12	7.47	7.56	7.65	7.74	7.83	7.92	8.01	8.10	08.19	8.28
13	8.37	8.46	8.55	8.64	8.73	8.83	8.92	9.01	9.10	9.19
14	9.28	9.38	9.47	9.56	9.65	9.74	9.84	9.93	10.02	10.11
15	10.21	10.30	10.39	10.49	10.58	10.67	10.76	10.86	10.95	11.04
16	11.14	11.23	11.33	11.42	11.51	11.61	11.70	11.79	11.89	11.98
17	12.08	12.17	12.26	12.36	12.45	12.55	12.64	12.74	12.83	12.92
18	13.02	13.11	13.21	13.30	13.40	13.49	13.59	13.68	13.78	13.87
19	13.97	14.06	14.16	14.25	14.35	14.44	14.54	14.63	14.73	14.82
20	14.92	15.02	15.11	15.21	15.30	15.40	15.49	15.59	15.68	15.78

NOTE: Runoff value determined by equation $Q = \frac{(P-0.2S)^2}{(P+0.8S)}$

[SOURCE: TR-16]

RUNOFF FOR INCHES OF RAINFALL
(Curve 70)

Tenths / Inches	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
0										0.00
1	0.00	0.01	0.03	0.04	0.06	0.08	0.11	0.14	C.17	0.20
2	0.24	0.28	0.32	0.36	0.41	0.46	0.50	0.56	0.61	0.66
3	0.72	0.71	0.83	0.89	0.95	1.01	1.07	1.14	1.20	1.27
4	1.33	1.40	1.47	1.54	1.61	1.68	1.75	1.82	1.89	1.96
5	2.04	2.11	2.19	2.26	2.34	2.42	2.49	2.57	2.65	2.73
6	2.81	2.89	2.97	3.05	3.13	3.21	3.29	3.37	3.46	3.54
7	3.62	3.70	3.79	3.87	3.96	4.04	4.13	4.21	4.30	4.38
8	4.47	4.55	4.64	4.13	4.81	4.90	4.99	5.07	5.16	5.25
9	5.34	5.43	5.52	5.60	5.69	5.78	5.87	5.96	6.05	6.14
10	6.23	6.32	6.41	6.50	6.59	6.68	6.77	6.86	6.95	7.04
11	7.13	7.23	7.32	7.41	7.50	7.59	7.68	7.78	7.87	7.96
12	8.05	8.14	8.24	8.33	8.42	8.51	8.61	8.70	8.79	8.89
13	8.98	9.07	9.17	9.26	9.35	9.45	9.54	9.63	9.73	9.82
14	9.92	10.01	10.10	10.20	10.29	10.39	10.48	10.57	10.61	10.76
15	10.86	10.95	11.05	11.14	11.24	11.33	11.43	11.52	11.62	11.71
16	11.81	11.90	12.00	12.09	12.19	12.28	12.38	12.47	12.57	12.67
17	12.76	12.86	12.95	13.05	13 .14	13.24	13.34	13.43	13.53	13.62
18	13.72	13.82	13.91	14.01	14.10	14.20	14.30	14.39	14.49	14.58
19	14.68	14.78	14.87	14.97	15.07	15.16	15.26	lS.36	15.45	15.55
20	15.65	15.74	15.84	15.94	16.03	16.13	16.23	16.32	16.42	16.52

NOTE: Runoff value determined by equation $Q = \frac{(P-0.2S)^2}{(P+0.8S)}$

[SOURCE: TR-16]

RUNOFF FOR INCHES OF RAINFALL
(Curve 77)

Tenths / **Inches**	**0.0**	**0.1**	**0.2**	**0.3**	**0.4**	**0.5**	**0.6**	**0.7**	**0.8**	**0.9**
0							0.00	0.00	0.01	0.03
1	0.05	0.07	0.10	0.13	0.17	0.21	0.25	0.30	0.34	0.39
2	0.45	0.50	0.56	0.62	0.68	0.14	0.80	0.87	0.93	1.00
3	1.07	1.14	1.21	1.28	1.36	1.43	1.50	1.58	1.66	1.73
4	1.81	1.89	1.97	2.05	2.13	2.21	2.29	2.37	2.46	2.54
5	2.62	2.71	2.79	2.97	2.96	3.04	3.13	3.22	3.30	3.39
6	3.48	3.56	3.65	3.74	3.83	3.92	4.01	4.10	4.18	4.21
7	4.36	4.45	4.54	4.63	4.12	4.82	4.91	5.00	5.09	5.18
8	5.27	5.36	5.46	5.55	5.4	5.13	5.83	5.92	6.01	6.1C
9	6.20	6.29	6.38	6.48	6.57	6.66	6.76	6.85	6.95	7.04
10	7.13	7.23	7.32	7.42	7.51	7.61	7.70	7.79	1.89	7.98
11	8.08	8.17	8.27	8.36	8.46	8.56	8.65	8.75	8.84	8.94
12	9.03	9.13	9.22	9.32	9.42	9.51	9.61	9.70	9.80	9.90
13	9.99	10.09	10.19	10.28	10.38	10.47	10.57	10.67	10.76	10.86
14	10.96	11.05	11.15	11.25	11.34	11.44	11.54	11.64	11.73	11.83
15	11.93	12.02	12.12	12.22	12.31	12.41	12.51	12.61	12.70	12.80
16	12.90	13.00	13.09	13.19	13.29	13. 39	13.43	13.58	13.68	13.78
17	13.87	13.97	14.07	14.17	14.26	14. 36	14.46	14.56	14.65	14.75
18	14.85	14.95	15.05	15.14	15.24	15. 34	15.44	15.54	15.63	15.13
19	15.83	15.93	16.03	16.12	16.22	16.32	16.42	16.52	16.61	16.71
20	16.81	16.91	17.01	17.11	17.20	17.30	17.40	17.50	11.60	17.70

NOTE: Runoff value determined by equation $Q = \frac{(P-0.2S)^2}{(P+0.8S)}$

[SOURCE: TR-16]

Table 2.1-Runoff depth for selected CN's and rainfall amounts[1]

Runoff depth for curve number of-													
Rainfall	40	45	50	55	60	65	70	75	80	85	90	95	98
……..……...inches…….													
1.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.08	0.17	0.32	0.56	0.79
1.2	.00	.00	.00	.00	.00	.00	.03	.07	.15	.27	.46	.74	.99
1.4	.00	.00	.00	.00	.00	.02	.06	.13	.24	.39	.61	.92	1.18
1.6	.00	.00	.00	.00	.01	.05	.11	.20	.34	.52	.76	1.11	1.38
1.8	.00	.00	.00	.00	.03	.09	.17	.29	.44	.65	.93	1.29	1.58
2.0	.00	.00	.00	.02	.06	.14	.24	.38	.56	.80	1.09	1.48	1.77
2.5	.00	.00	.02	.08	.17	.30	.46	.65	.89	1.18	1.53	1.96	2.27
3.0	.00	.02	.09	.19	.33	.51	.71	.96	1.25	1.59	1.98	2.45	2.77
3.5	.02	.08	.20	.35	.53	.75	1.01	1.30	1.64	2.02	2.45	2.94	3.27
4.0	.06	.18	.33	.53	.76	1.03	1.33	1.67	2.04	2.46	2.92	3.43	3.77
4.5	.14	.30	.50	.74	1.02	1.33	1.67	2.05	2.46	2.91	3.40	3.92	4.26
5.0	.24	.44	.69	.98	1.30	1.65	2.04	2.45	2.89	3.37	3.88	4.42	4.76
6.0	.50	.80	1.14	1.52	1.92	2.35	2.81	3.28	3.78	4.30	4.85	6.41	5.76
7.0	.84	1.24	1.68	2.12	2.60	3.10	3.62	4.15	.1.69	5.25	6.82	6.41	6.76
8.0	1.25	1.74	2.25	2.78	3.33	3.89	4.46	5.04	5.63	6.21	6.81	7.40	7.76
9.0	1.71	2.29	2.88	3.49	4.10	4.72	5.33	5.95	6.57	7.18	7.79	8.40	8.76
10.0	2.23	2.89	3.56	4.23	4.90	5.56	6.22	6.88	7.52	8.16	8.78	9.40	9.76
11.0	2.78	3.52	4.26	5.00	5.72	6.43	7.13	7.81	8.48	9.13	9.77	10.39	10.76
12.0	3.38	4.19	5.00	5.79	6.56	7.32	8.05	8.76	9.45	10.11	10.76	11.39	11.76
13.0	4.00	4.89	5.76	6.61	7.42	8.21	8.98	9.71	10.42	11.10	11.76	12.39	12.76
14.0	4.65	5.62	6.55	7.44	8.0	9.12	9.91	10.67	11.39	12.08	12.75	13.39	13.76
15.0	5.33	6.36	7.35	8.29	9.19	10.04	10.85	11.63	12.37	13.07	13.74	14.39	14.76
[1]Interpolate the values shown to obtain runoff depths for CN's or rainfall amounts not shown													

(210-VI.TR.55, Second Ed., June 1986)

(Direct runoff vs. Rainfall graph on page A7 of Appendix of Module 105 did not transfer)

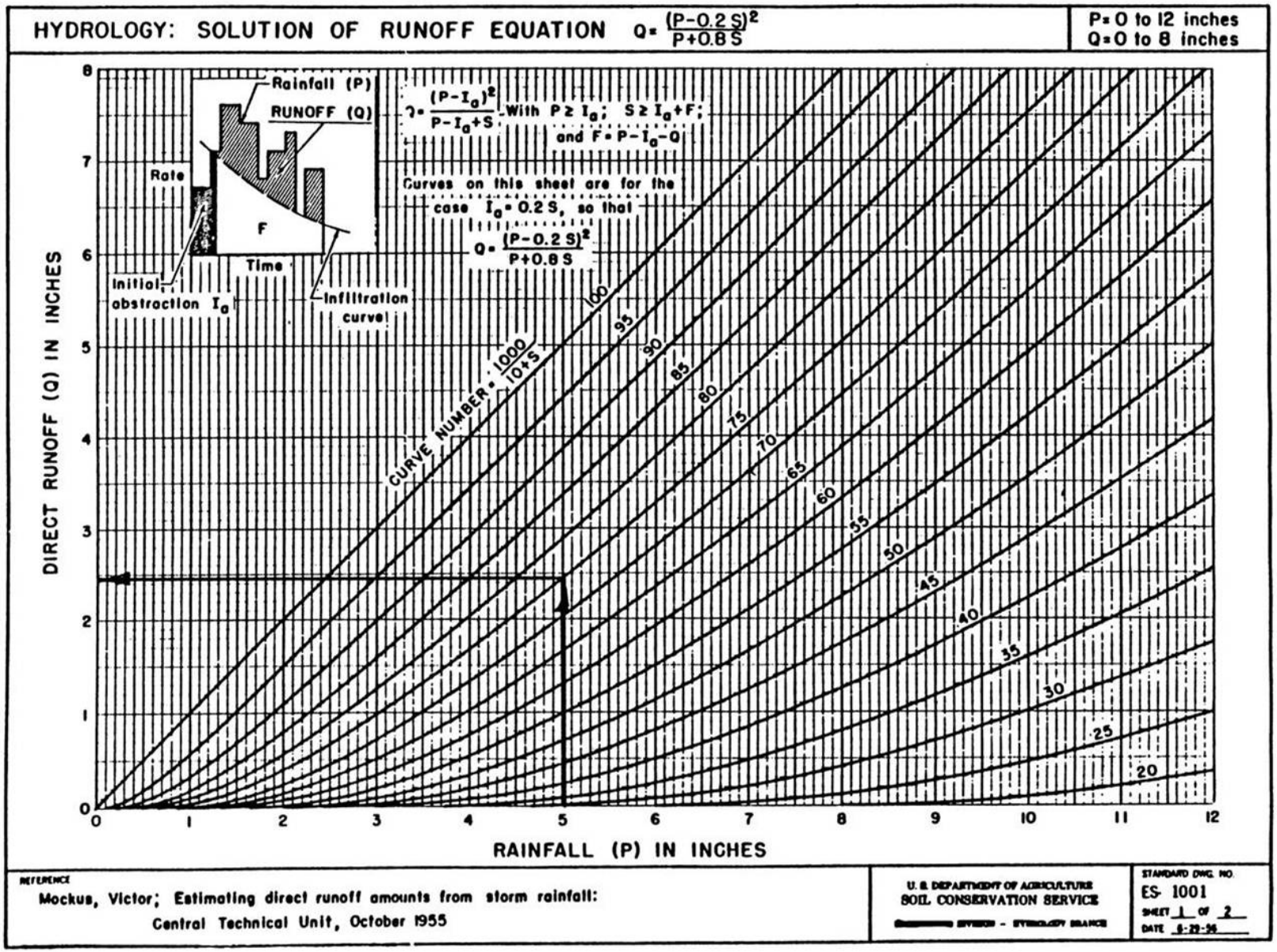

Figure 1. ***Solution of runoff equation***

[SOURCE: CHAPTER 10, NEH-4]