Table 5
Sheet 15 of 15

Hydrograph family 5

T_o/T_p = 25			T_o/T_p = 36			T_o/T_p = 50		
Line No.	t/T_p	q_c/q_p	Line No.	t/T_p	q_c/q_p	Line No.	t/T_p	q_c/q_p
1	0.00	.000	1	0.00	.0000	1	0.00	.0000
2	1.25	.015	2	1.50	.0195	2	2.00	.0167
3	2.50	.039	3	3.00	.0275	3	4.00	.0204
4	3.75	.043	4	4.50	.0294	4	6.00	.0214
5	5.00	.044	5	6.00	.0300	5	8.00	.0216
6	6.25	.044	6	7.50	.0301	6	10.00	.0216
7	7.50	.044	7	9.00	.0301	7	12.00	.0216
8	8.75	.044	8	10.50	.0301	8	14.00	.0216
9	10.00	.044	9	12.00	[illegible]	9	16.00	.0216
10	11.25	.044	10	13.50	.0301	10	18.00	.0216
11	12.50	.044	11	15.00	.0301	11	20.00	.0216
12	13.75	.044	12	16.50	[illegible]	12	22.00	.0216
13	15.00	.044	13	18.00	.0301	13	24.00	.0216
14	16.25	.044	14	19.50	.0301	14	26.00	.0216
15	17.50	.044	15	21.00	.0301	15	28.00	.0216
16	18.75	.045	16	22.50	.0302	16	30.00	.0216
17	20.00	.067	17	24.00	.0311	17	32.00	.0217
18	21.25	.083	18	25.50	.0364	18	34.00	.0243
19	22.50	.087	19	27.00	.0426	19	36.00	.0287
20	23.75	.087	20	28.50	.0480	20	38.00	.0329
21	25.00	.088	21	30.00	.0525	21	40.00	.0363
22	26.25	.035	22	31.50	.0561	22	42.00	.0391
23	27.50	.006	23	33.00	.0584	23	44.00	.0411
24	28.75	.002	24	34.50	.0598	24	46.00	.0423
25	30.00	.000	25	36.00	.0602	25	48.00	.0430
			26	37.50	.0167	26	50.00	.0433
			27	39.00	.0018	27	52.00	.0058
			28	40.50	.0000	28	54.00	.0002
						29	56.00	.0000

FIGURE 1

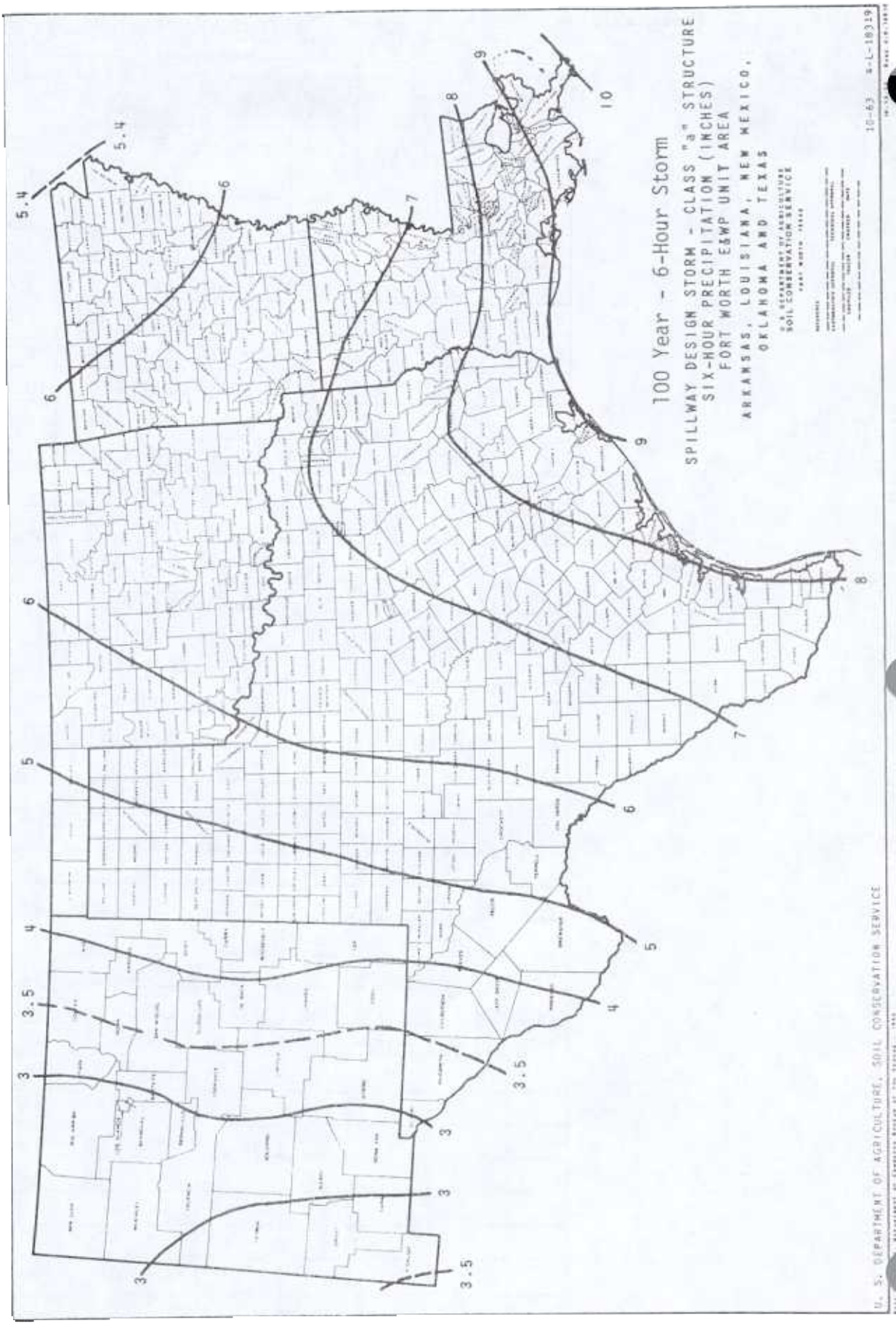
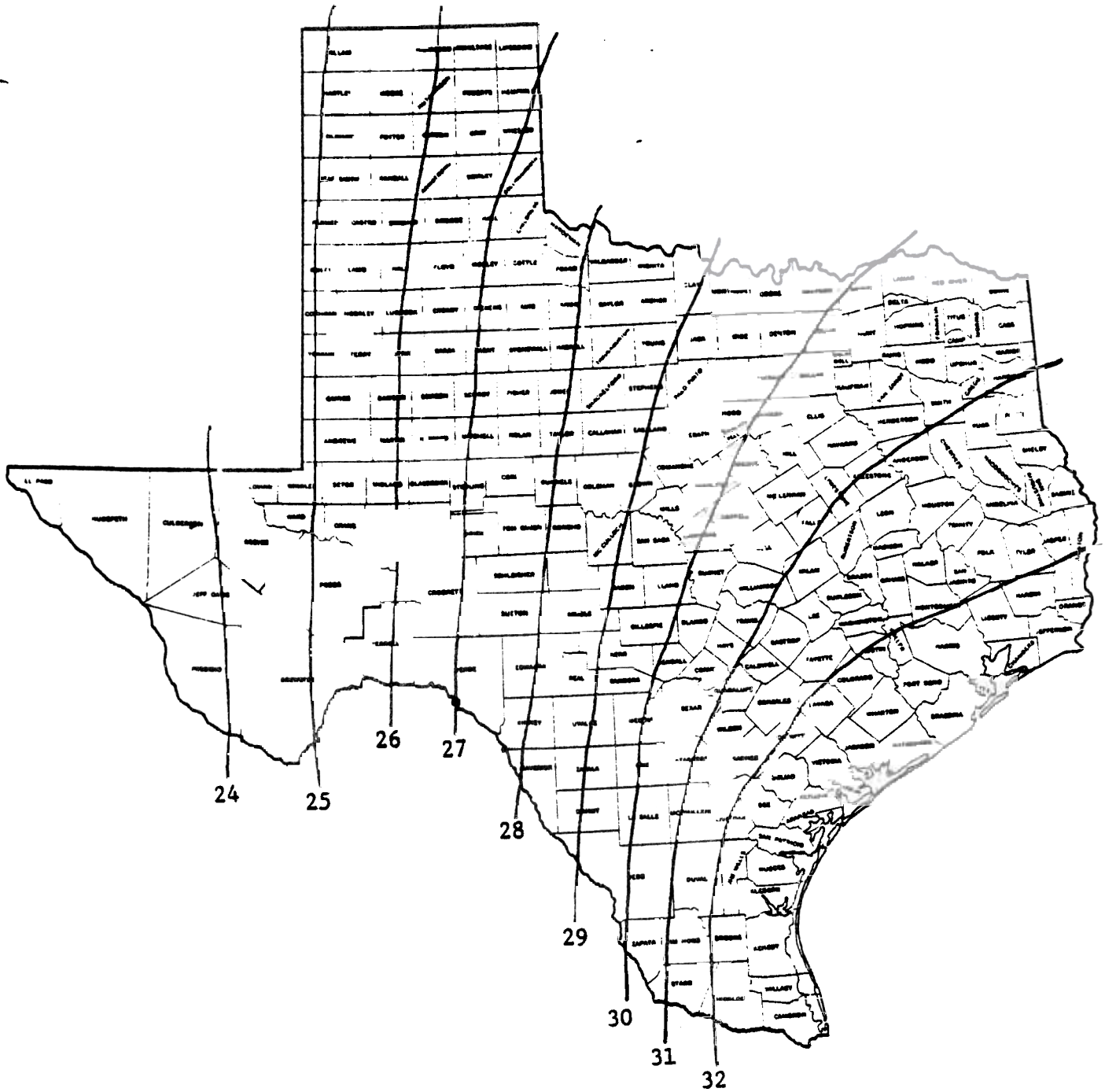

100 Year - 6-Hour Storm
SPILLWAY DESIGN STORM - CLASS "a" STRUCTURE
SIX-HOUR PRECIPITATION (INCHES)
FORT WORTH E&WP UNIT AREA
ARKANSAS, LOUISIANA, NEW MEXICO,
OKLAHOMA AND TEXAS
U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
10-63
U. S. DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE

Figure 2



FREEBOARD HYDROGRAPH STORM

Class "c" dam - None or any upstream dams

Six-Hour Precipitation (Inches): PMP

Note: PMP - Probable Maximum Precipitation

0 100 200 300 M

Base 4-L-1 82A

U. S. DEPARTMENT OF AGRICULTURE SOI CONSERVATION SERV Temple

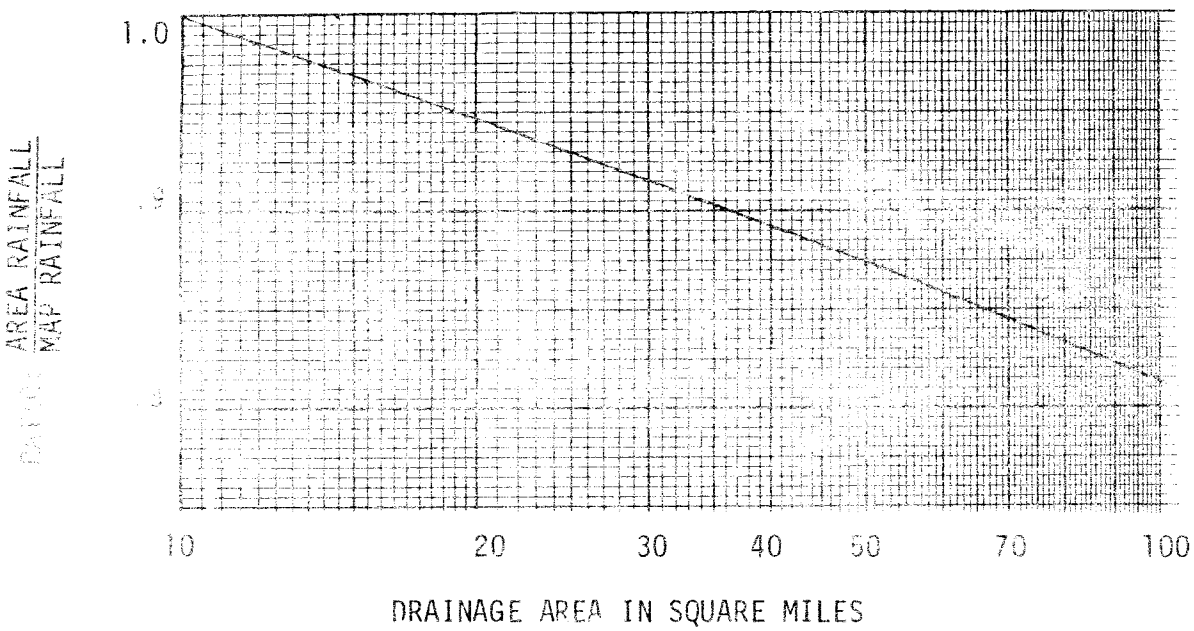


FIGURE 3A

RAINFALL RATIO FOR PMP STORM

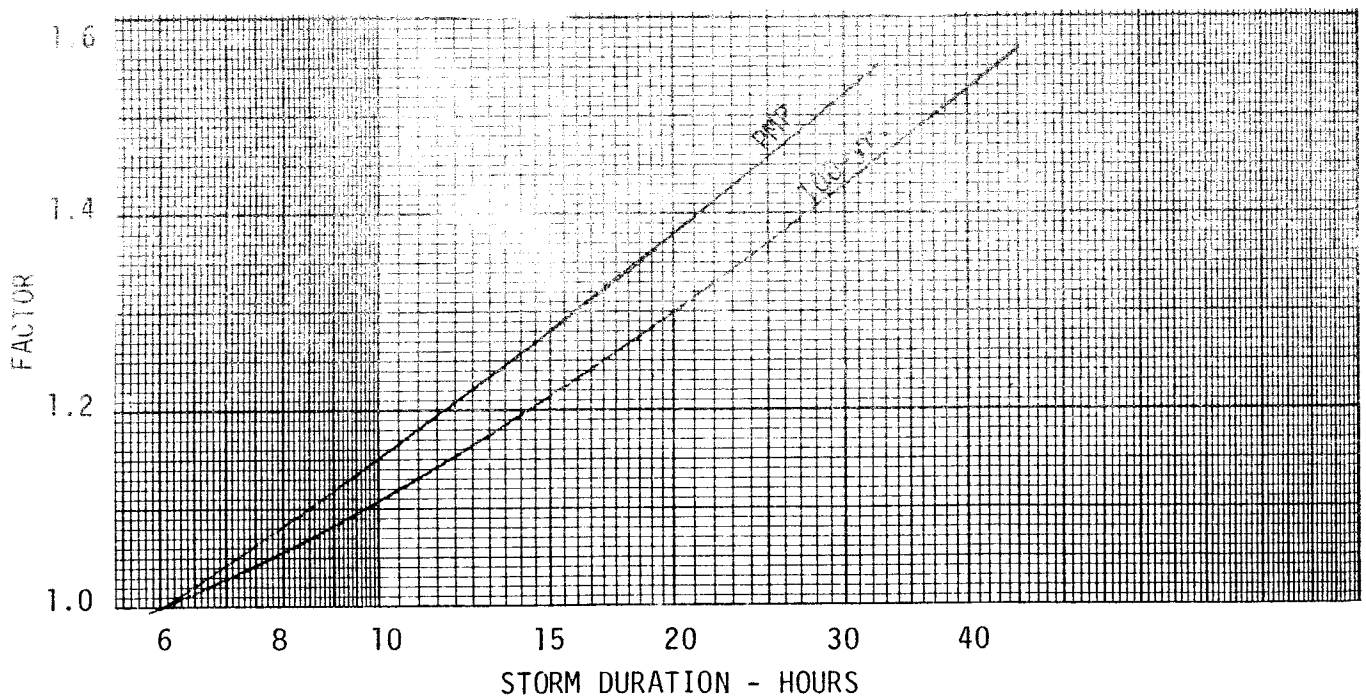
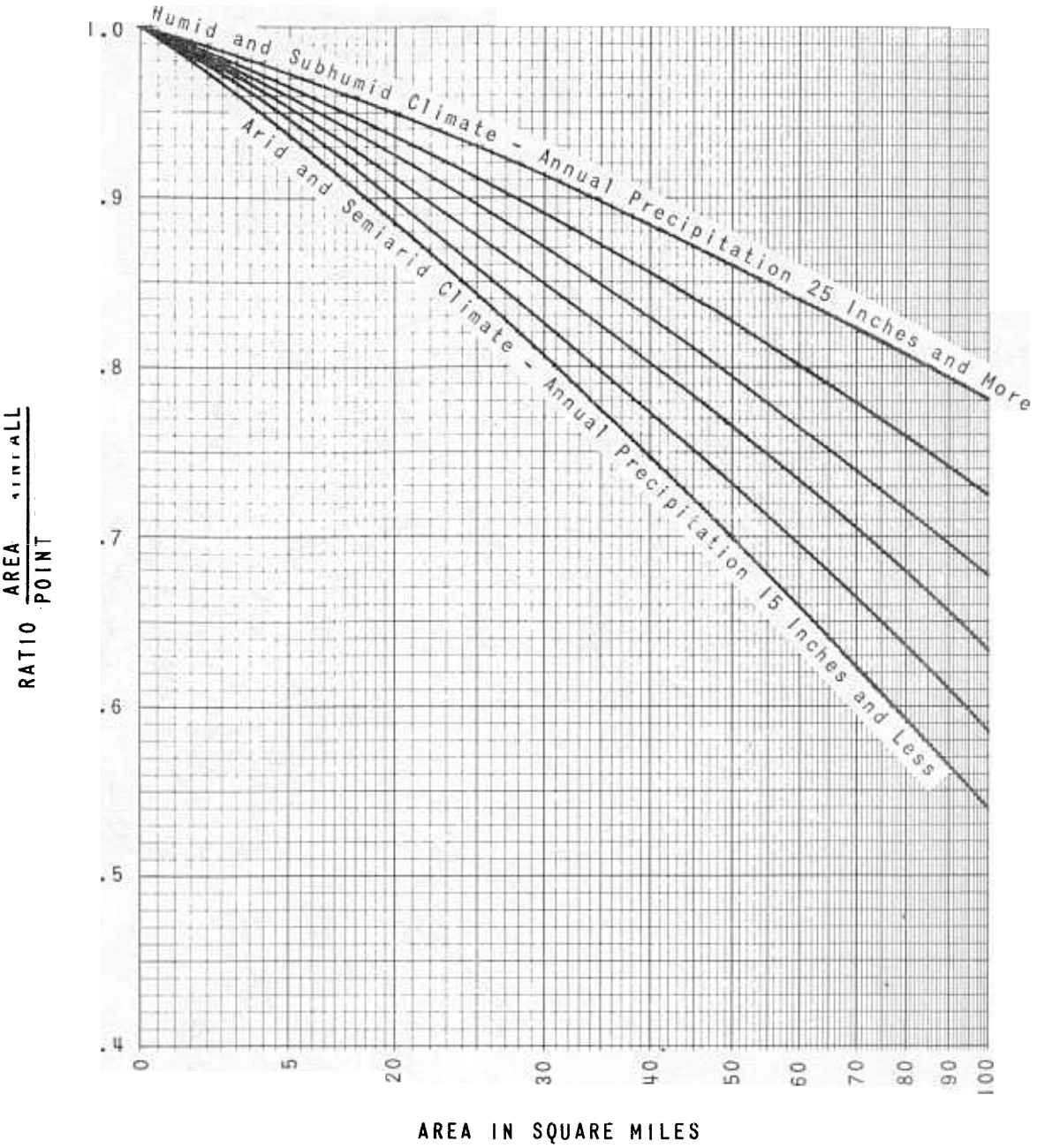


FIGURE 3B

RAINFALL DURATION ADJUSTMENT

FIGURE 4

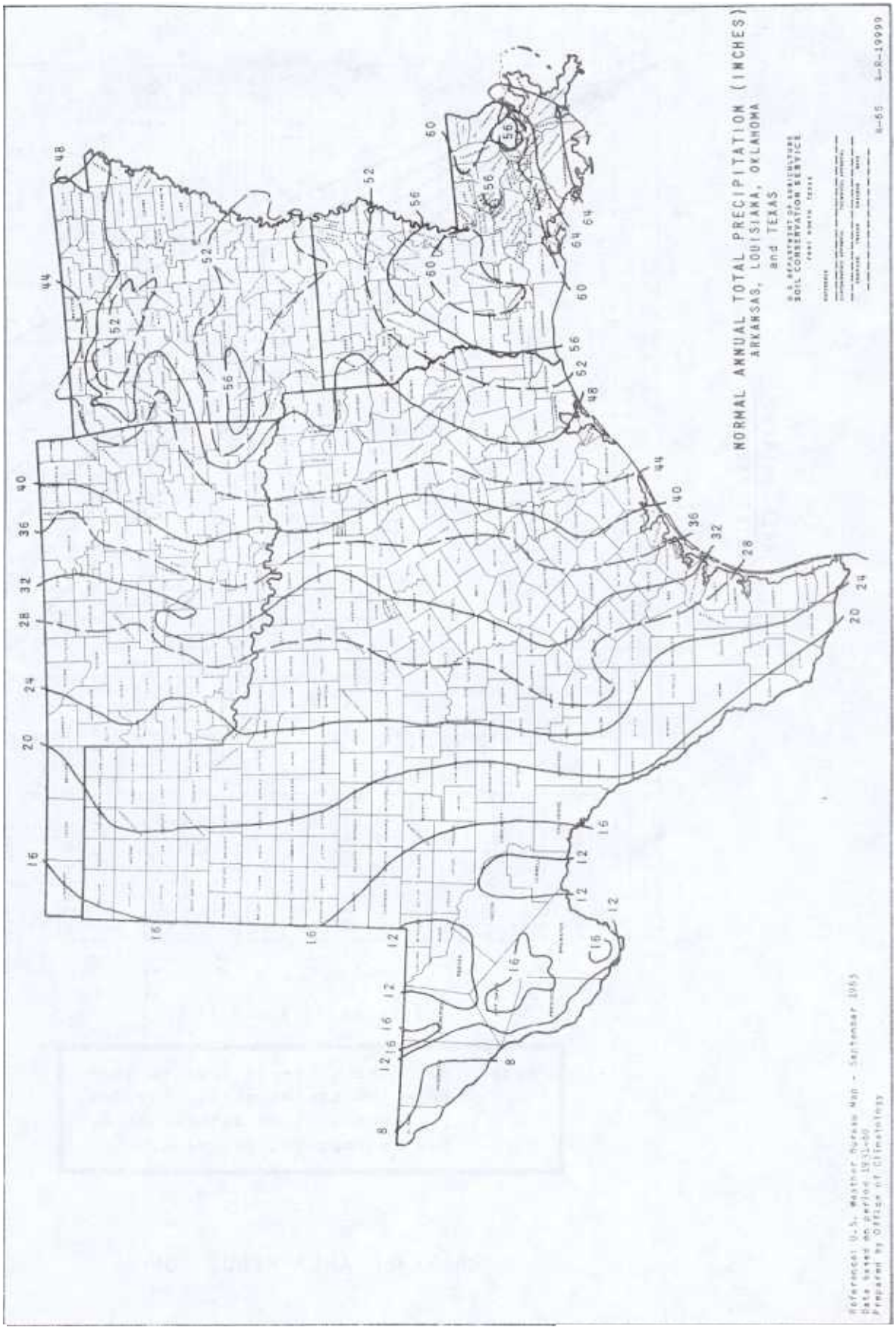


Note: When the drainage area is more than 100 square miles, the adjustment will be determined by the Engineering Division.

RAINFALL AREA REDUC ON

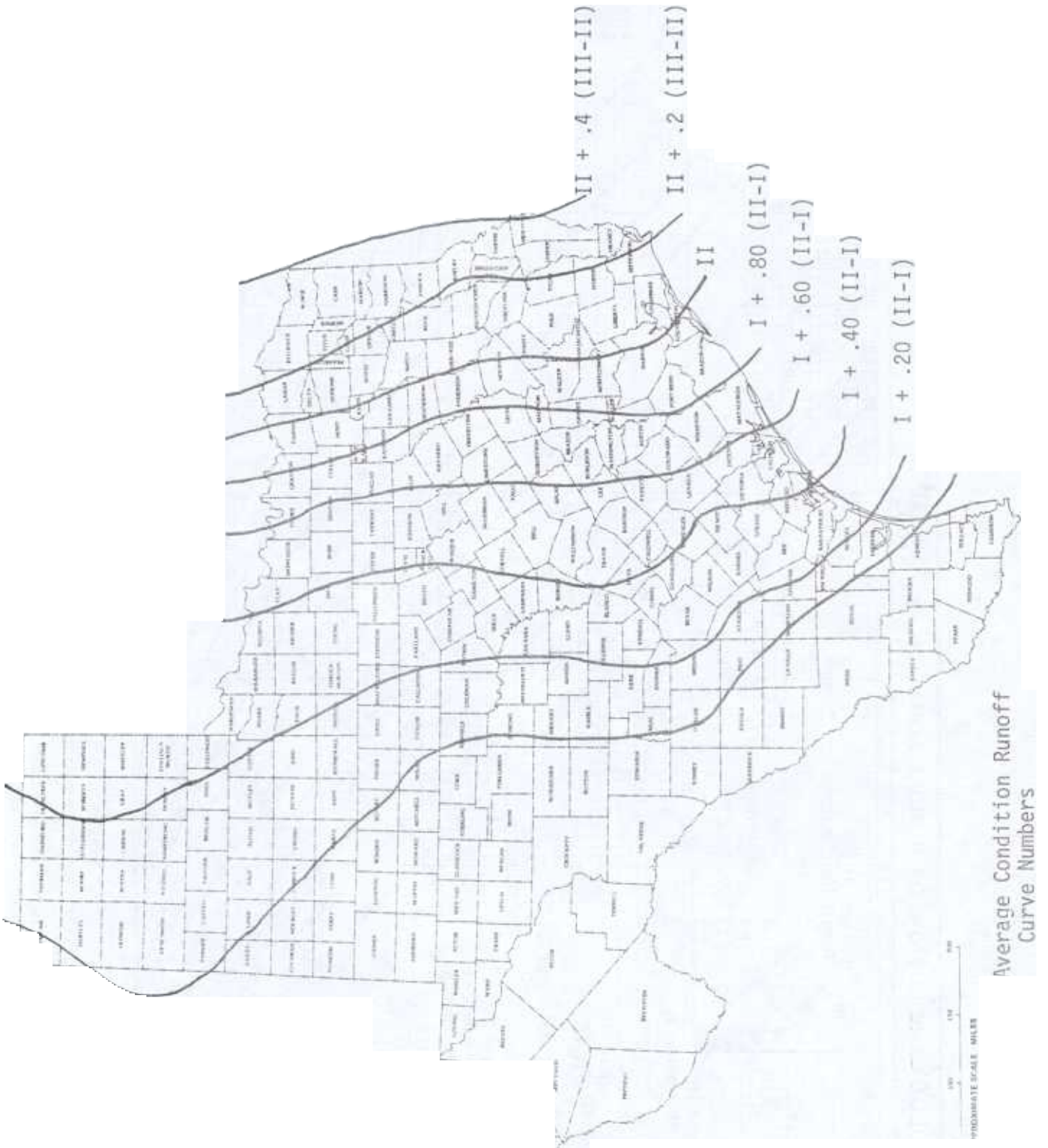
U. DEPARTMEN

FIGURE 5



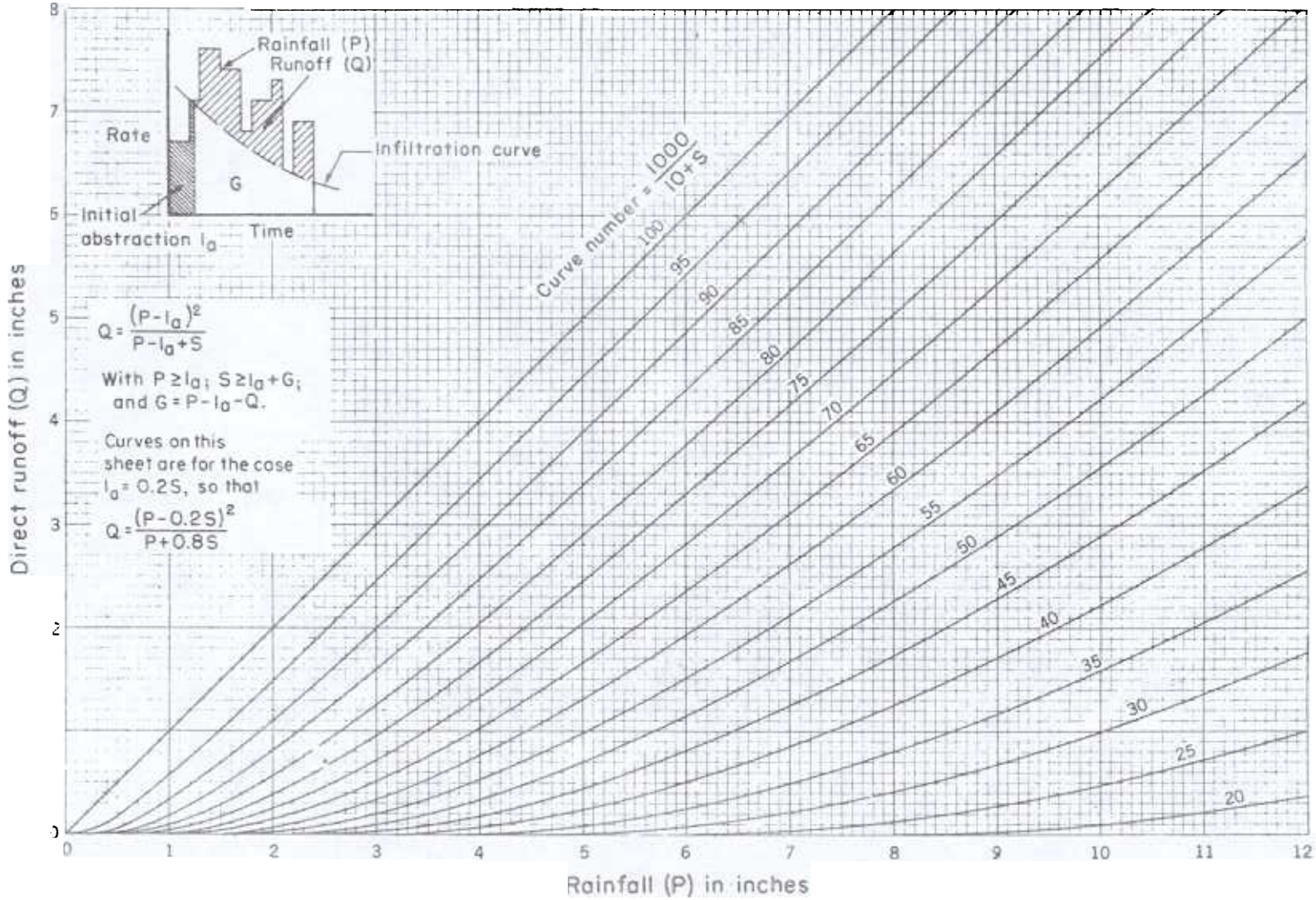
Base from U. S. Department of Commerce Bureau of the Census
USDA-SCS Fort Worth, Tex. 1966

FIGURE 5A


II + .4 (III-II)
II + .2 (III-II)
II
I + .80 (II-I)
I + .60 (II-I)
I + .40 (II-I)
I + .20 (II-I)
Average Condition Runoff
Curve Numbers

HYDROLOGY: SOLUTION OF RUNOFF EQUATION $Q = \frac{(P-0.2S)^2}{P+0.8S}$

P = 0 to 12 inches
Q = 0 to 8 inches



REFERENCE

Mockus, Victor; Estimating direct runoff amounts from storm rainfall: Central Technical Unit, October 1955.

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
ENGINEERING DIVISION CENTRAL TECHNICAL UNIT

STANDARD DWG. NO.
ES-1001
SHEET 1 OF 2
DATE 6-29-56

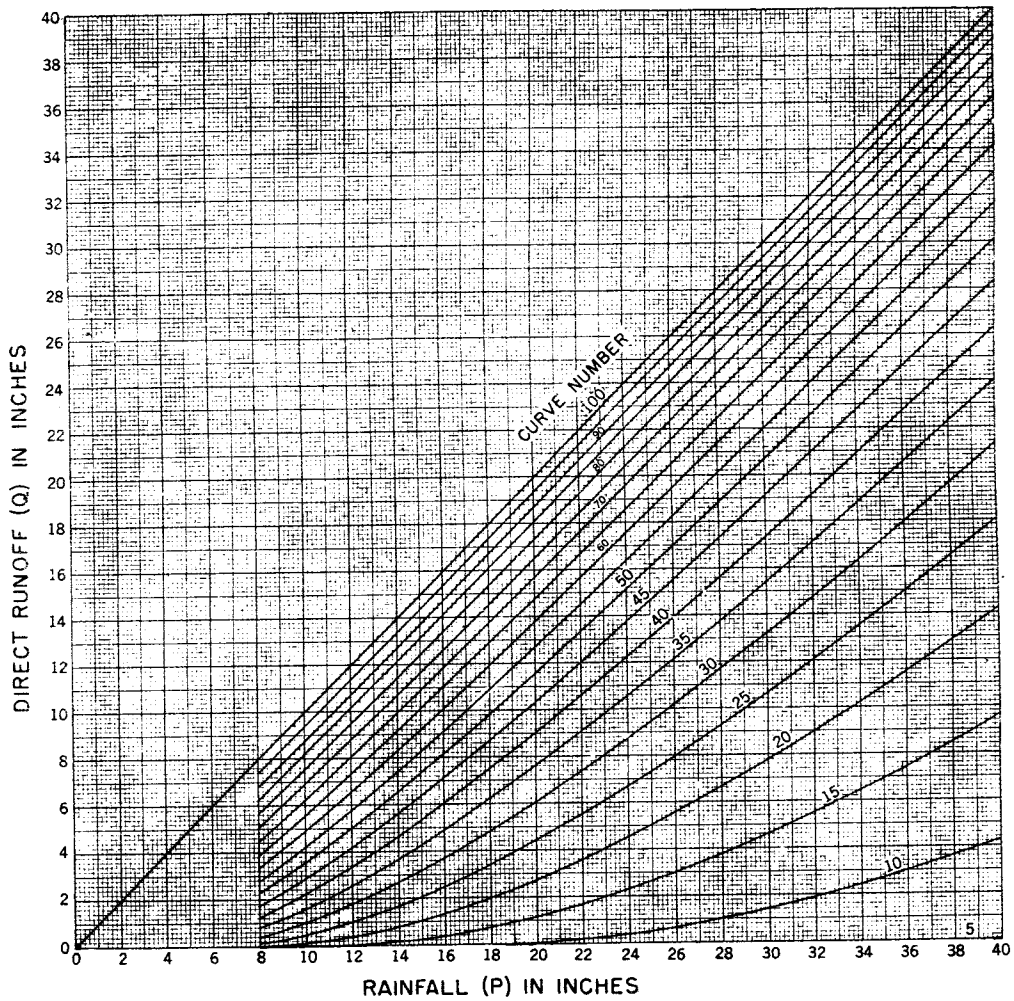
U. S. DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE, Fort Worth, Texas
FORT WORTH, TEX. 1966
10-63 4-L-18280-1

FIGURE 6

FIGURE 6A

HYDROLOGY: SOLUTION OF RUNOFF EQUATION $Q = \frac{(P-0.2S)^2}{P+0.8S}$

P = 8 to 40 inches
Q = 0. to 40 inches



REFERENCE

Mockus, Victor; Estimating direct runoff amounts from storm rainfall: Central Technical Unit, October 1955.

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
ENGINEERING DIVISION - CENTRAL TECHNICAL UNIT

STANDARD DWG. NO. ES-1001
SHEET 2 OF 2
DATE 6-27-56

10-63 4-L-18280-2 of 2

U.S. DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE, Fort Worth, Texas
USDA-SCS-FORT WORTH, TEX. 1965

SCS-ENG-319
Rev. 1-70
File Code ENG-13-14

FIGURE 7

HYDROGRAPH COMPUTATION

DATE
COMPUTED BY
CHECKED BY

WATERSHED OR PROJECT Duck Creek

STATE Texas

STRUCTURE SITE OR SUBAREA 5

DR. AREA 21.85 SQ. MI. STRUCTURE CLASS A

T_c 3.5 HR. STORM DURATION 6 HR.

POINT RAINFALL _____ IN. 100yr 5.0 PMP 26.0

ADJUSTED RAINFALL:

AREAL : FACTOR 100yr .91 PMP .94 IN. 9.72

DURATION : FACTOR 1.0 IN. 9.72

RUNOFF CURVE NO. 60

Q 4.68 IN.

HYDROGRAPH FAMILY NO. 3

COMPUTED T_p 2.45 HR.

T_o 4.50 HR.

(T_o / T_p):
COMPUTED 1.84 ; USED 2.00

REVISED T_p 2.25

$q_p = \frac{484A}{\text{REV. } T_p} =$ 4700 CFS.

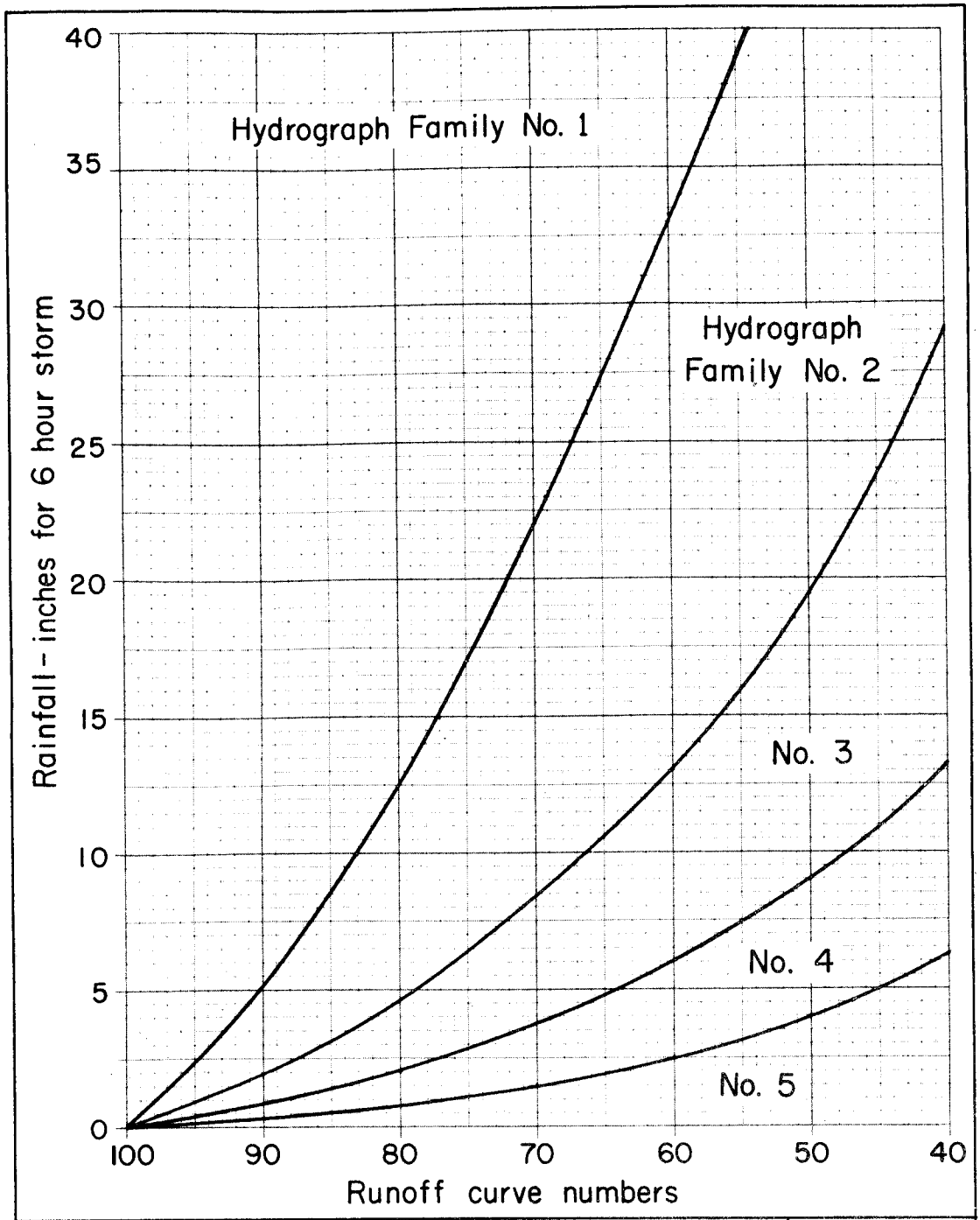
$(Q)(q_p) =$ 22000 CFS.

t(COLUMN) = (t / T_p) REV. T_p q(COLUMN) = $(q_c / q_p)(Q)(q_p)$

Q(COLUMN) = $(Q_t / Q)Q$

	$t=(t/T_p)$Rev. T_p	$q=(q_c/q_p)(Q)(q_p)$	$Q_t=(Q_t/Q)Q$
	t HOURS	q CFS	Q INCHES
1	0	0	0
2	.68	264	
3	1.36	2706	
4	2.04	7546	
5	2.72	12540	
6	3.40	14454	
7	4.08	13860	
8	4.76	12364	
9	5.44	10648	
10	6.12	8338	
11	6.80	5874	
12	7.48	3894	
13	8.16	2552	
14	8.84	1672	
15	9.52	1100	
16	10.20	726	
17	10.88	440	
18	11.56	242	
19	12.24	132	
20	12.92	88	
21	13.60	44	
22	14.28	22	
23	14.96	0	
24			
25	$\Sigma q =$	99506	
26	$\Delta t =$	0.68	
27			
28	$Q = (0.68)(99506)$		
29	$(645)(21.85)$		
30			
31	=	4.80	
32			
33	Error	= 2.56 %	
34			

FIGURE 8



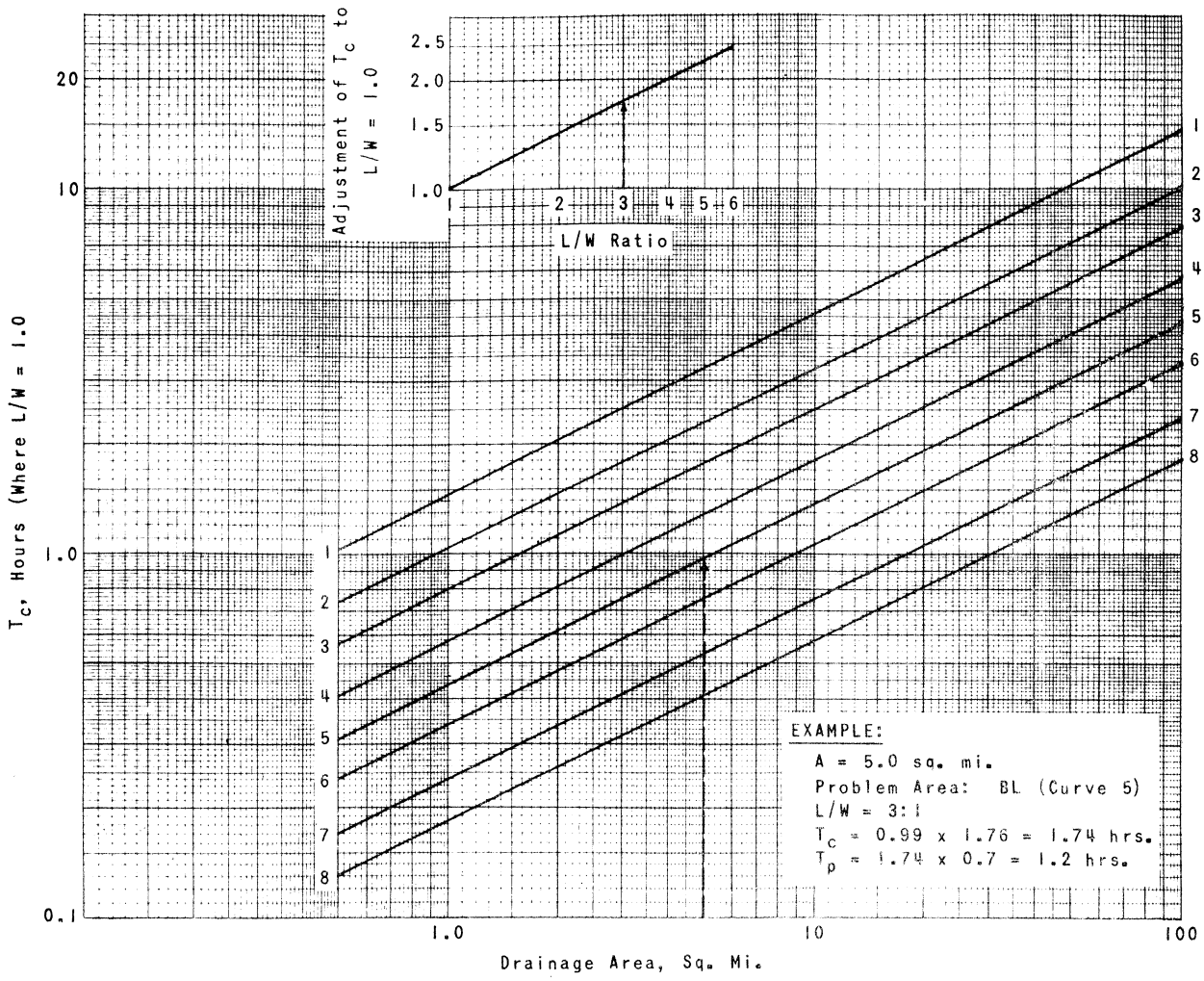
REFERENCE	U. S. DEPARTMENT OF AGRICULTURE	STANDARD DWG. NO.
CENTRAL TECHNICAL UNIT	SOIL CONSERVATION SERVICE	ES- 1011
	ENGINEERING DIVISION - HYDROLOGY BRANCH	SHEET 1 OF 1
		DATE 2-14-58

REVISED 10-12-64

FIGURE 8 — Chart for selecting a hydrograph family for a given 6-hour rainfall and runoff curve number.

FIGURE 9

Curve No.	Problem Areas
1	CO_2, FC_4, LT(La)
2	CO_1, FC_2, LH (La), LT(Ark), RG_3
3	FC_1, HP, LH(Ark), OH_2, RG_2, ZH_2
4	BH, CP, CT, OH_1, ZH_1
5	BL, D^{30}, F^{10}, FC_3, GP, J^4, RG_1 RP
6	D^{21}, D^{29}, E^9, F^9, GS(Okla), J^2, RR
7	E^{10}, J^5
8	E^5, E^8, F^{11}, GS(Tex), TP, EP



DRAINAGE AREA - TIME OF CONCENTRATION
RELATIONSHIP BY PROBLEM AREAS
BASED ON CONVERSION FROM PLATE 6
IN FORT WORTH EWP-H-1 (Rev.)

U. S. DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE, Fort Worth, Texas 4-65 4-L-19976
USDA-SCS-FORT WORTH, TEX. 1965

FIGURE 10

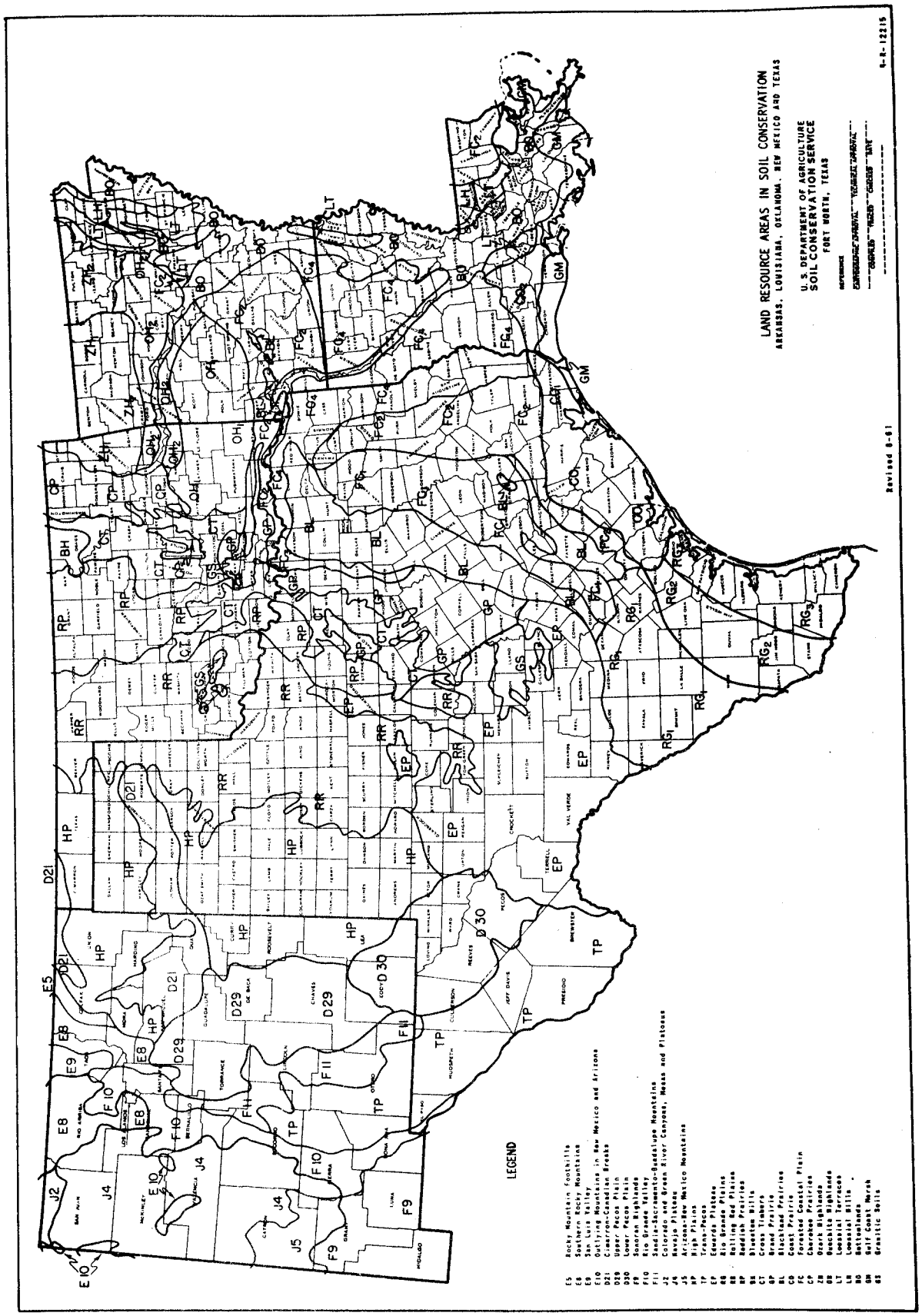
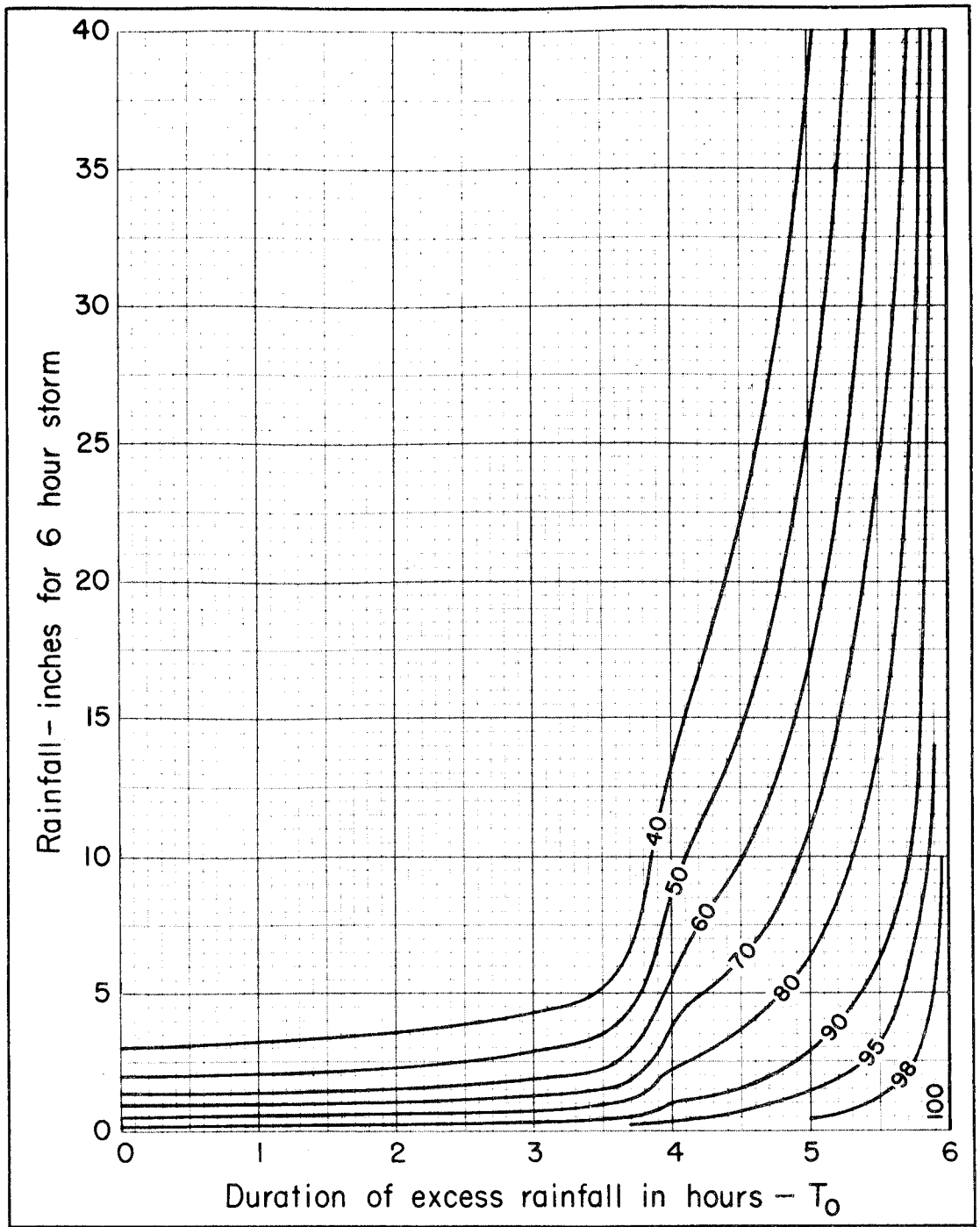

LAND RESOURCE AREAS IN SOIL CONSERVATION
ARKANSAS, LOUISIANA, OKLAHOMA, NEW MEXICO AND TEXAS
U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
FORT WORTH, TEXAS
LEGEND
E5 Rocky Mountain Foothills
E8 Southern Rocky Mountains
E9 San Luis Valley
E10 Outlying Mountains in New Mexico and Arizona
D21 Cimarron-Canadian Breaks
D29 Upper Pecos Plain
D30 Lower Pecos Plain
F9 Sonoran Highlands
F10 Rio Grande Valley
F11 Sandia-Sacramento-Guadalupe Mountains
J2 Colorado and Green River Canyons, Mesas and Plateaus
J4 Navajo Plateau
J5 Arizona-New Mexico Mountains
HP High Plains
TP Trans-Pecos
EP Edwards Plateau
RG Rio Grande Plains
RR Rolling Red Plains
RP Reddish Prairies
BH Blueston Hills
CT Cross Timbers
GP Grand Prairie
BL Blackland Prairies
CO Coast Prairie
FC Forested Coastal Plain
CP Cherokee Prairies
ZH Ozark Highlands
OH Ouachita Highlands
LT Loessial Terraces
LH Loessial Hills
BO Bottomlands
GM Gulf Coast Marsh
GS Granitic Soils
Revised 8-61
6-R-12215

FIGURE 11



REFERENCE CENTRAL TECHNICAL UNIT	U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE ENGINEERING DIVISION - HYDROLOGY BRANCH	STANDARD DWG. NO. ES- 1012 SHEET 1 OF 1 DATE 2-14-58

REVISED 10-12-64

FIGURE 11 – Duration of excess rainfall for runoff curve numbers 40 to 100

(Rev 1-76)

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

EMERGENCY SPILLWAY HYDROGRAPH DESIGN

Page of

CONTROL WORDS							CARD NUMBER
TITLE 1							
TITLE 2	STRUCTURE CLASS DATE						
	CURVE NUMBER	TIME OF CONCENTRATION	RAINFALL DURATION 1/	AREA RAINFALL 2/ EM.SPW.	AREA RAINFALL 2/ FREEBOARD	DRAINAGE AREA Sq.Mi.	
HYDRO							
	EM.SPW. CREST ELEVATION	CASE NUMBER 3/	FULL PRINT 4/	SIDE SLOPE RATIO, Z	EM.SPW. SLOPE, %		
SPILLWAY							
	ROUTING CODE 5/	PLOTTING CODE 6/	STREAM ROUTING INFORMATION SERIES SITES ONLY VELOCITY FT/SEC	LENGTH Ft.	COEFF. "C"	STREAM CODE 7/	
GENERAL							
	Bo 1	L 1	Bo2	L 2	Bo 3	L 3	
SPW. SIZE							

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80

	ELEVATION	STORAGE Ac.Ft.	Q, cfs No. 1	Q, cfs No. 2	Q, cfs No. 3		
STAGE-CFS 8/							
STAGE-CFS							
STAGE-CFS							
STAGE-CFS							
STAGE-CFS							
STAGE-CFS							
STAGE-CFS							
STAGE-CFS							
STAGE-CFS							
STAGE-CFS							
STAGE-CFS							
STAGE-CFS							
STAGE-CFS							
STAGE-CFS							
STAGE-CFS							
STAGE-CFS							
STAGE-CFS							
STAGE-CFS							
STAGE-CFS							
STAGE-CFS							
END TABLE	9/		FOOTNOTES ON REVERSE SIDE				
END W/S							
END JOB	KEYPUNCH NOTE: Uniform 10 column fields. Punch decimals and control words.						

FIGURE 12

FOOTNOTES

1/ RAINFALL DURATION - Use 6 hours, or the T_c in hours, whichever is the greater.

2/ AREAL RAINFALL - Modify point rainfall by using the reduction factors in Drawing ES-1003(a) when drainage area exceeds 10 sq. mi. If the rainfall duration exceeds 6 hours, use the factors shown in Drawing ES-1003(c) to increase rainfall amounts.

3/ CASE NUMBER - Insert case number 1, 2, 3, 4, 8, or leave blank. If a case number is inserted, the computer will calculate spillway discharges using the cases as shown in TR-39, May 1968. If the case number is zero or left blank, then it is necessary to fill in the E. S. discharge values in the "Elevation-Storage-Discharge" table. See Note 8.

4/ FULL PRINT - 0 - If only the printout up to Hp and time to maximum Hp is desired, leave this space blank or insert a 0.

1 - If complete printout is desired for the routed discharges until there is no flow in the E. S. spillway, use code 1. This also includes the duration of E. S. flow in the summary printout.

2 - Code 2 prints out the detailed routing information of code 1 and the critical velocity at the control section of the E. S. spillway for each discharge. If the exit slope is listed for the E. S., then the V_e will be printed for each critical discharge. Also, Oe/B is printed at the end of the routing.

5/ ROUTING CODES - 0 = normal routing of single sites
1 = any upper site in series
2 = lowest site in series
3 = intermediate site in series

6/ PLOTTING CODES - 0 = no plot desired
1 = output to be plotted

7/ STREAM CODES - 0 = single site, the first of a group of sites above a lower site, or an intermediate site.
1 = other upper sites in a group

8/ TABLE - The first line of the "Elevation-Storage-Discharge" table should give the elevation of the crest of the principal spillway, zero discharge, and the storage for when routing begins, even though the storage value is not correct for the principal spillway crest elev. When the 10-day drawdown through the principal spillway is above the crest of the principal spillway, the second line should contain the 10-day drawdown elevation, the storage should be increased 0.1 ac. ft. from line 1 and the principal spillway discharge should be listed for the drawdown elevation. When a case number is listed, give elevation-storage, and principal spillway flow up to the elevation of the emergency spillway crest. The emergency spillway elevation should be listed in this table. Above the E. S. crest elevation the program will add the computed E. S. flow to the P. S. discharge beginning at the E. S. crest elevation to obtain total discharge. (If this procedure is not accurage enough, then show the desired P. S. discharge to be added for each elev. above the E. S. crest). It is recommended that elevation and storage be tabulated by 0.5 foot increments of stage for the first 2.0 feet above the crest of the E. S. After that, one foot or even larger increments of elevation may be used. 25 lines may be used for the stage-storage-discharge tabulation.

5.L-29.933.2(2)

9/ Delta Time - Table contains 300 points - Enter Time Increment if other than program defined .25 hr is desired.