TEXAS

ENGINEERING TECHNICAL NOTE

Subject : *HYDROLOGY*

No. : *210-18-TX4*

Reference : *PREPARATION OF DATA FOR SUBMISSION TO THE TEXAS DEPARTMENT OF HIGHWAYS AND PUBLIC TRANSPORTION WHERE FLOODWATER RETARDING STRUCTURE INUNDATES OR IMPOUNDS WATER ON EMBANKMENTS OF THE STATE HIGHWAY SYSTEM*

Date : *MARCH 1983*

SOIL CONSERVATION SERVICE
U.S. DEPARTMENT OF AGRICULTURE

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PREPARATION OF DATA FOR SUBMISSION TO THE TEXAS DEPARTMENT OF HIGHWAYS AND PUBLIC TRANSPORTATION WHERE FLOODWATER RETARDING STRUCTURE INUNDATES OR IMPOUNDS WATER ON EMBANKMENTS OF THE STATE HIGHWAY SYSTEM

INTRODUCTION

Texas supplement TX506.43 to the National Watershed Manual gives Service policy where floodwater retarding structures will inundate or impound water on embankments of the State Highway system. This technical note lists data to be prepared for submission to the Texas Department of Highways and Public Transportation and gives procedures to be used in manually developing volume runoff - frequency curves and elevation - duration curves for the 48-hour duration storm. The resulting hydrograph can be read into a computer program for flood routing or the computer program may be used to develop and route the 48-hour storm hydrograph.

DATA AND PROCEDURES

1 Volume Runoff - Frequency Curve

A. Tabulate 2- to 100-year frequency 2-day precipitation from USWB TP-49, Table 1.

B. Adjust precipitation for area. (Plate 1)

C. Adjust runoff curve number for 48-hour duration. (Plate 2)

D. Compute runoff (ES 1001

E. Determine climatic index. (Plate 3)

F Determine channel loss factor, or minimum base flow (Table 21.3 or 21.4)

G. Adjust runoff computed for channel loss or base flow. (Table

H Plot adjusted runoff (Figure 1

2. Elevation-Storage Curve for the site

3. Elevation-Duration Curve showing depth and duration for 50-year frequency flood. This should be determined in the following manner:

A. Prepare hydrograph computations for the 50-year, 48-hour storm using procedures illustrated in NEH, Section 4. (See Figure 2)

B. Route the above hydrograph through the reservoir.

C. Plot Elevation-Duration Curve from the routing.

4. Profile of the Low Section of Highway. This should include a profile of the centerline of the highway and a corresponding profile on natural ground immediately downstream from the highway. Show all bridge and culvert openings.

5. Sketch of watershed above structure showing drainage pattern - 4" to 1 mile scale. (Highway Department may wish to compute volume of runoff by their own method.)

TABLE 1

RUNOFF COMPUTATIONS FOR SITE 2

LOWER EAST FORK WATERSHED

Frequency (yrs)	2-Day Precipitation Point (inches)	2-Day Precipitation Areal (inches)	Runoff Curve Number 76 Gross (inches)	Runoff Curve Number 76 Adjusted (inches)
2	4.8	4.7	2.29	2.20
5	6.3	6.2	3.55	3.41
10	7.6	7.5	4.71	4.52
25	8.9	8.8	5.89	5.65
50	10.2	10.1	7.10	6.80
100	11.5	11.4	8.33	8.00

Drainage area is 6.86 square miles.
Areal adjustment factor is 0.99 (Plate 1).
24-hour duration curve number is 80 - 2-day is 76 (Plate 2).
Climatic index is 0.90 (Plate 3).
Channel loss factor is 0.96 (Table 21.3).

Table 21.3.--Channel-loss factors for reduction of direct runoff

Drainage area	Climatic index, Ci						
	1.0	0.9	0.8	0.7	0.6	0.5	0.4 or less
sq. mi.							
1 or less	1.00	1.00	1.00	1.00	1.00	1.00	1.00
2	1.00	.99	.97	.96	.93	.90	.83
3	1.00	.98	.96	.92	.89	.84	.79
4	1.00	.97	.94	.91	.86	.81	.74
5	1.00	.97	.93	.90	.84	.78	.70
6	1.00	.96	.93	.88	.82	.76	.68
7	1.00	.96	.92	.87	.81	.74	.66
8	1.00	.96	.92	.86	.80	.73	.64
9	1.00	.95	.91	.85	.79	.72	.62
10	1.00	.95	.90	.84	.78	.70	.60
20	1.00	.94	.88	.80	.72	.63	.52
30	1.00	.93	.86	.78	.69	.60	.48
40	1.00	.92	.85	.76	.67	.57	.45
50	1.00	.92	.84	.75	.66	.55	.43
60	1.00	.92	.84	.74	.64	.54	.41
70	1.00	.92	.83	.73	.63	.52	.40
80	1.00	.92	.82	.72	.62	.51	.38
100	1.00	.91	.81	.71	.61	.50	.37
150	1.00	.90	.80	.69	.58	.47	.34
200	1.00	.90	.79	.68	.56	.45	.32
300	1.00	.89	.78	.65	.54	.42	.29
400	1.00	.88	.76	.64	.52	.40	.27

Table 21.4.--Minimum base flow

Ci	Base flow		Ci	Base flow	
	in./day	csm		in./day	csm
1.00	0	0	1.50	0.234	6.29
1.02	.011	.30	1.52	.239	6.43
1.04	.022	.60	1.54	.244	6.56
1.06	.033	.90	1.56	.249	6.70
1.08	.045	1.20	1.58	.254	6.83
1.10	.056	1.50	1.60*	.259	6.96
1.12	.067	1.80	1.65	.270	7.26
1.14	.078	2.10	1.70	.280	7.53
1.16	.089	2.40	1.75	.290	7.80
1.18	.100	2.70	1.80	.299	8.04
1.20	.112	3.00	1.85	.308	8.28
1.22	.123	3.30	1.90	.318	8.55
1.24	.133	3.58	1.95	.326	8.76
1.26	.144	3.87	2.00	.335	9.00
1.28	.153	4.11	2.05	.343	9.22
1.30	.163	4.38	2.10*	.351	9.44
1.32	.171	4.60	2.20	.367	9.87
1.34	.180	4.84	2.30	.382	10.27
1.36	.188	5.06	2.40	.396	10.65
1.38	.195	5.24	2.50	.410	11.02
1.40	.202	5.43	2.60	.423	11.37
1.42	.209	5.62	2.70	.436	11.72
1.44	.216	5.81	2.80	.449	12.07
1.46	.222	5.97	2.90	.461	12.40
1.48	.228	6.13	3.00**	.473	12.72

* Change in tabulation interval.

** For Ci greater than 3, use:

Base flow $= 9\,(Ci - 1)^{0.5}$ for base flow in csm

or Base flow $= 0.335\,(Ci - 1)^{0.5}$ for base flow in inches per day.

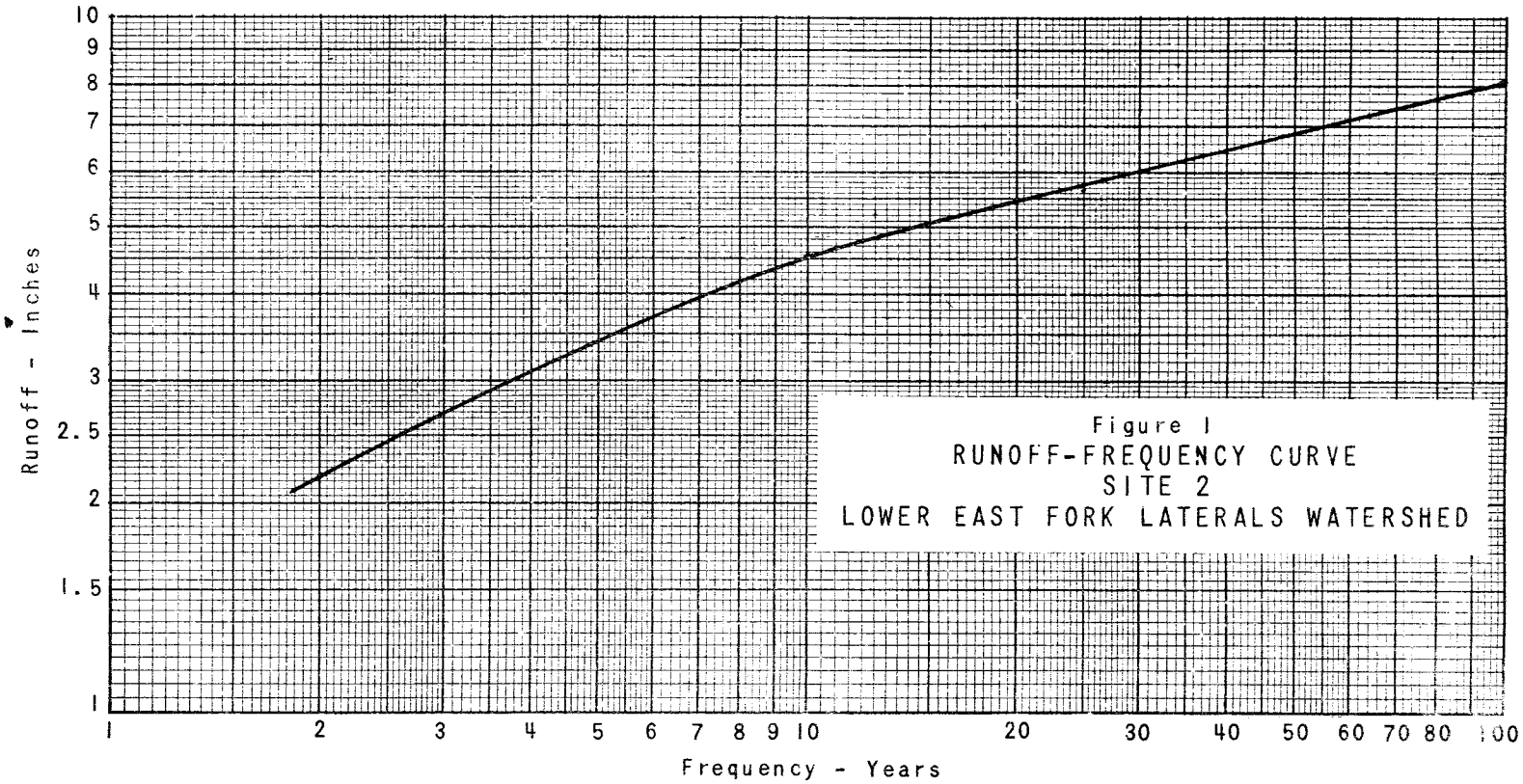

Figure 1
RUNOFF-FREQUENCY CURVE
SITE 2
LOWER EAST FORK LATERALS WATERSHED

SCS-319
6-58

Figure 2

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

HYDROGRAPH COMPUTATION
50-Yr. Flood

WATERSHED ~~OR PROJECT~~ Lower East Fork Lat. STATE Texas

STRUCTURE SITE ~~OR SUBAREA~~ 2

DR. AREA 6.86 SQ. MI. T_c 2.0 HR. RUNOFF CONDITION NO. II

RUNOFF CURVE NO. 80/76. STORM DISTRIB. CURVE B. HYDROGRAPH FAMILY NO. 2

STORM DURATION 48 HR. RAINFALL: POINT 10.2 IN. AREAL (.99)(10.2) 10.1 IN.

Q 6.80 IN. COMPUTED T_p 1.4 HR. T_o 41.6 HR.

$(T_o \div T_p)$: COMPUTED 29.7 USED 25.0 REVISED T_p 1.66.

$q_p = \frac{484\ A}{REV.\ T_p} =$ 2000 CFS. $Qq_p =$ 13,600 CFS.

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

	1.66	13600						
LINE NO.	t HOURS	q CFS	LINE NO.	t HOURS	q CFS	LINE NO.	t HOURS	q CFS
1	0	0	21	43.20	190	41		
2	2.16	30	22	45.36	50	42		
3	4.32	80	23	47.52	10	43		
4	6.48	190	24	49.68	0	44		
5	8.64	330	25			45		
6	10.80	1200	26	Σq =	14290	46		
7	12.96	2860	27	ΔT =	2.16	47		
8	15.12	1990	28			48		
9	17.28	1320	29	$Q = \frac{(2.16)(14290)}{(645)(6.86)}$		49		
10	19.44	970	30			50		
11	21.60	770	31	=	6.98	51		
12	23.76	670	32			52		
13	25.92	600	33			53		
14	28.08	530	34			54		
15	30.24	480	35			55		
16	32.40	450	36			56		
17	34.56	420	37			57		
18	36.72	400	38			58		
19	38.88	380	39			59		
20	41.04	370	40			60		

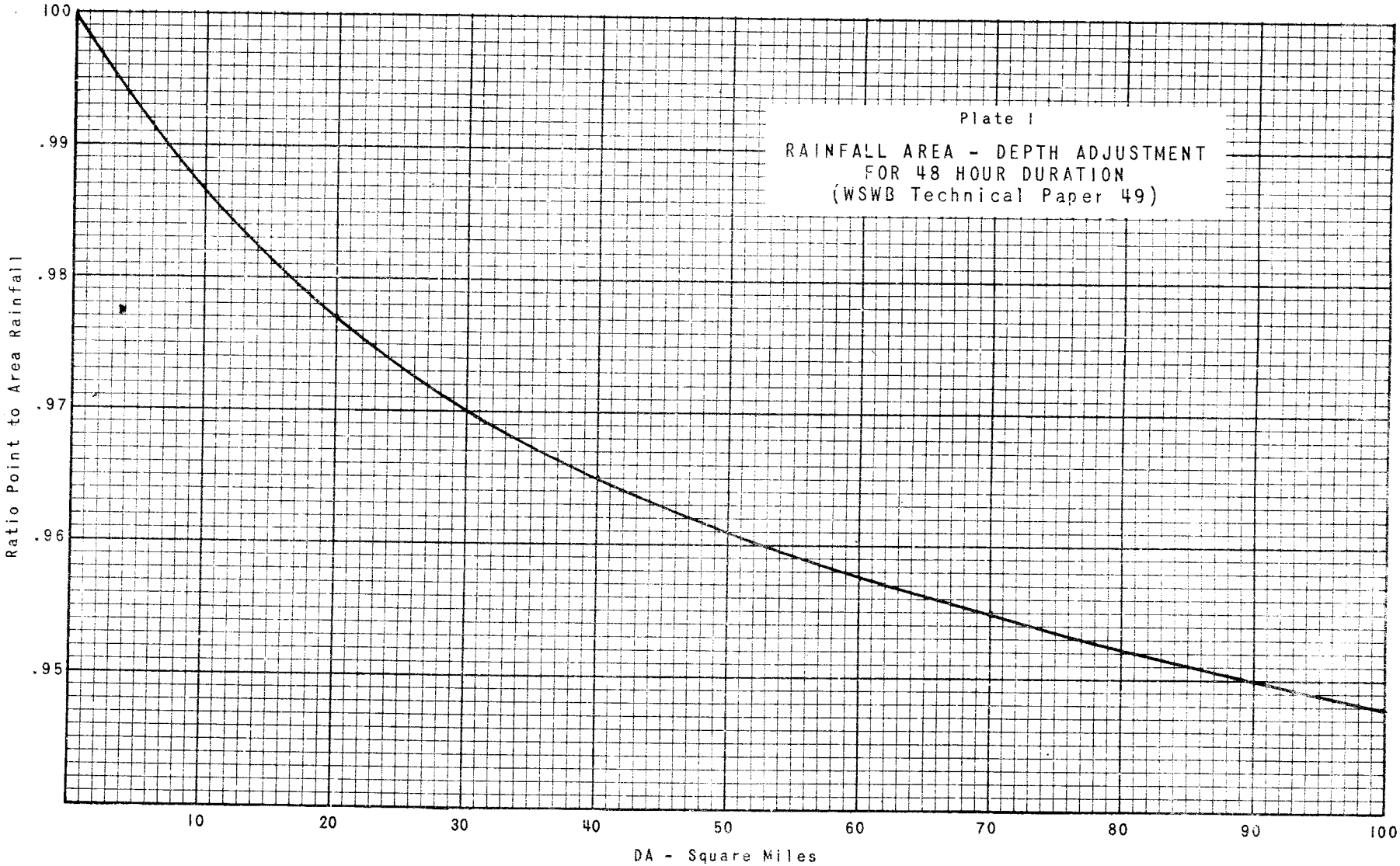
Plate I
RAINFALL AREA - DEPTH ADJUSTMENT
FOR 48 HOUR DURATION
(WSWB Technical Paper 49)
Ratio Point to Area Rainfall
100
.99
.98
.97
.96
.95
10
20
30
40
50
60
70
80
90
100
DA - Square Miles

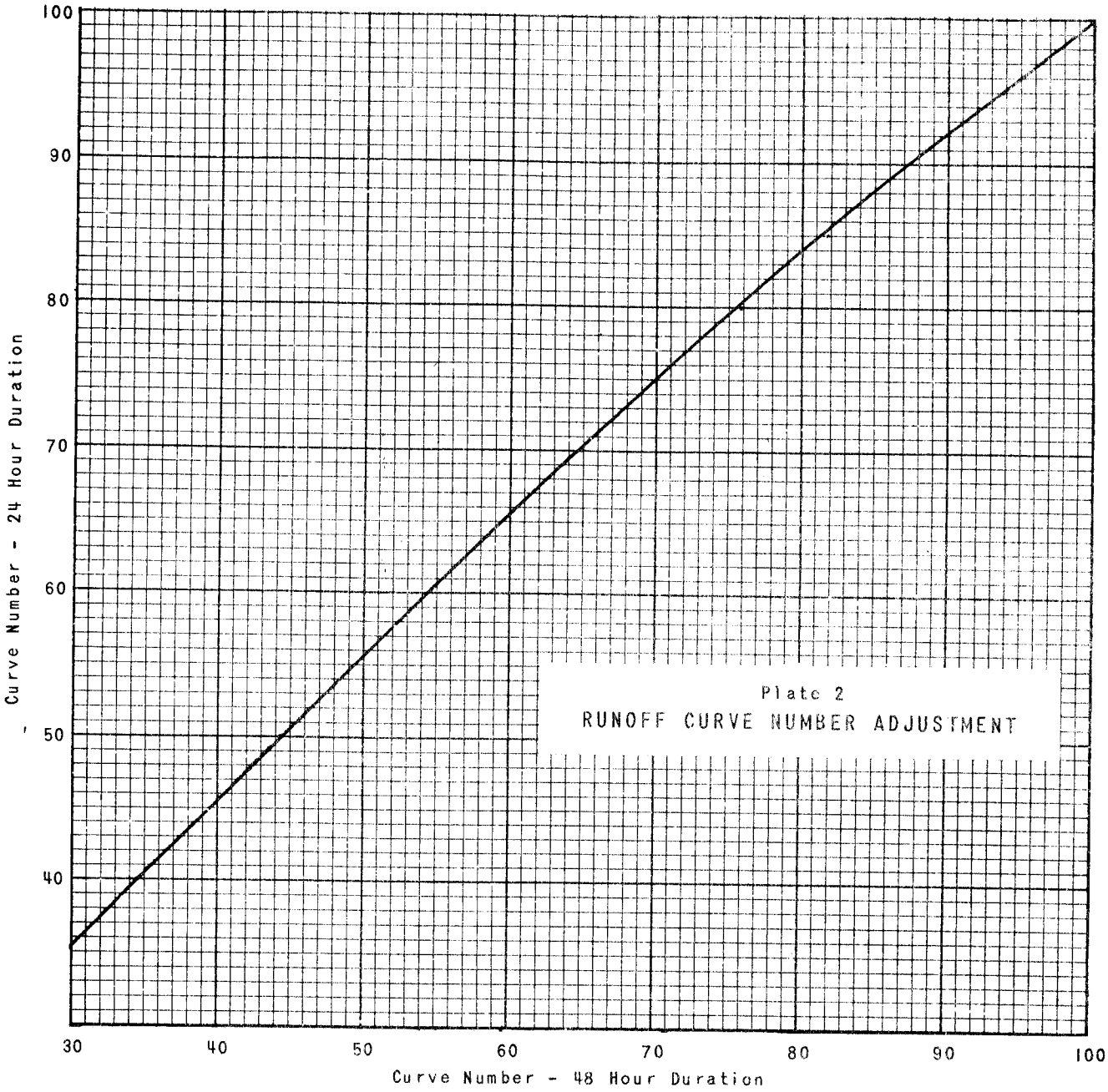

Plate 2
RUNOFF CURVE NUMBER ADJUSTMENT

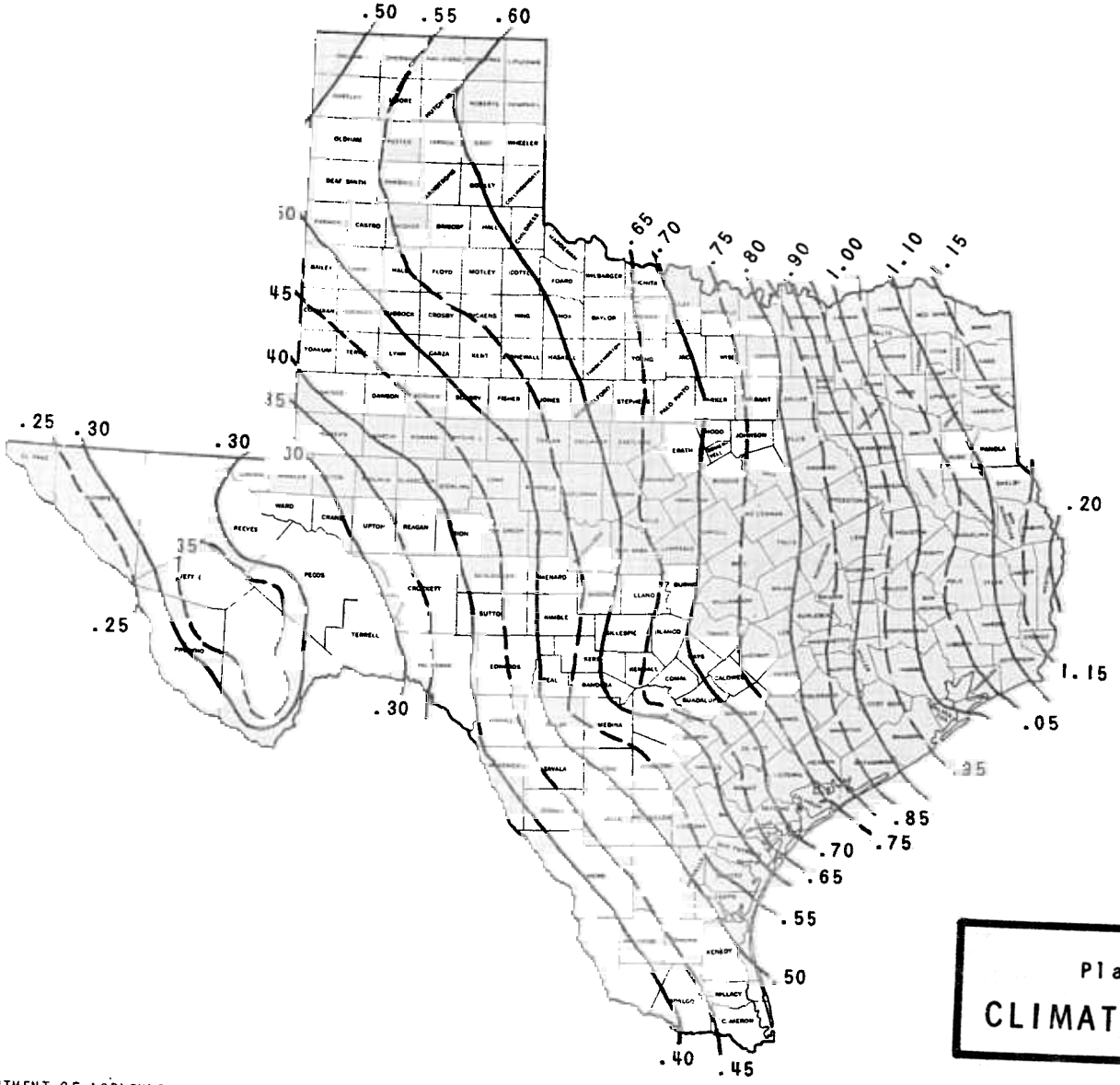

Plate 3

CLIMATIC INDEX

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