Table 22.—Completed computation sheets for 1st, 2nd and 3rd 6-hr increments for Leon River, TX drainage - Continued

Increment: 1,2

Drainage: Leon River, TX Area: 3,660 mi^2 Date:

	I	II	III	IV	V	VI		I	II	III	IV	V	VI
Area size	Iso.	Nomo.	Amt. 5.99	Avg. depth	ΔA	ΔV	Area size	Iso.	Nomo.	Amt. 4.93	Avg. depth	ΔA	ΔV
	A	262	15.69	15.69	10	156.9		A	290	14.30	14.30	10	143.0
	B	243	14.56	15.12	15	226.8		B	271	13.36	13.83	15	207.4
10000/1	C	227	13.60	14.08	25	352.0	15000/1	C	253	12.47	12.92	25	323.0
	D	209	12.52	13.06	50	653.0		D	232	11.44	11.96	50	598.0
	E	194	11.62	12.07	75	905.2		E	214	10.55	11.00	75	825.0
	F	178	10.66	11.14	125	1392.5		F	196	9.66	10.10	125	1262.5
	G	166	9.94	10.30	150	1545.0		G	183	9.02	9.34	150	1411.0
	H	152	9.10	9.52	250	2380.0		H	168	8.28	8.65	250	2162.5
	I	140	8.39	8.74	271	2368.5		I	156	7.69	7.98	271	2162.6
	J	128	7.67	8.03	393	3155.8		J	143	7.05	7.37	393	2896.4
	K	117	7.01	7.34	488	3581.9		K	131	6.46	6.76	488	3298.9
	L	107	6.41	6.71	582	3905.2		L	120	5.92	6.19	582	3602.6
(.60 X)	M	93	5.57	6.07	737	4473.6	(.60 X)	M	106	5.22	5.64	737	4156.7
(.75 X)	N	82	4.91	5.40	489	2640.6	(.75 X)	N	94	4.63	5.07	489	2479.2
					Sum =	27737.0						Sum =	25518.8
Area size			Amt. 4.42				Area size			Amt. 4.12			
	A	116	5.13	5.13	10	51.3		A	117	4.82	4.82	10	48.2
	B	112	4.95	5.04	15	75.6		B	113	4.66	4.74	15	71.1
1000/2	C	108.5	4.80	4.88	25	121.9	1500/2	C	110	4.53	4.60	25	114.9
	D	105	4.64	4.72	50	236.0		D	107	4.41	4.47	50	223.5
	E	103	4.55	4.60	75	345.0		E	105	4.33	4.37	75	327.8
	F	101	4.46	4.51	125	563.8		F	103	4.24	4.29	125	535.6
	G	99	4.38	4.42	150	663.0		G	100.5	4.14	4.19	150	628.5
	H	97	4.29	4.34	250	1085.0		H	99	4.08	4.11	250	1027.5
	I	95	4.20	4.25	271	1151.8		I	97	4.00	4.04	271	1094.8
	J	76	3.36	3.78	393	1485.5		J	95.5	3.93	3.97	393	1560.2
	K	63	2.78	3.07	488	1498.2		K	75.5	3.11	3.52	488	1717.8
	L	51	2.25	2.52	582	1466.6		L	605	2.49	2.80	582	1629.6
(.60 X)	M	38	1.68	2.02	737	1488.7	(.60 X)	M	45	1.85	2.23	737	1643.5
(.75 X)	N	24	1.06	1.52	489	743.3	(.75 X)	N	31	1.28	1.71	489	836.2
					Sum =	10975.7						Sum =	11459.2
Area size			Amt. 3.83				Area size			Amt. 3.52			
	A	118.5	4.54	4.54	10	45.4		A	119.5	4.21	4.21	10	42.1
	B	114.5	4.39	4.47	15	67.0		B	116	4.08	4.15	15	62.2
2150/2	C	110.5	4.25	4.32	25	108.0	3000/2	C	112.5	3.96	4.02	25	100.5
	D	108.5	4.16	4.21	50	210.5		D	110	3.87	3.92	50	196.0
	E	106.5	4.08	4.12	75	309.0		E	108	3.80	3.84	75	288.0
	F	104.5	4.00	4.04	125	505.0		F	106	3.77	3.77	125	471.2
	G	102	3.91	3.96	150	594.0		G	104	3.66	3.70	150	555.0
	H	100	3.83	3.96	250	967.5		H	102	3.59	3.63	250	907.5
	I	99	3.79	3.81	271	1032.5		I	100.5	3.54	3.56	271	964.8
	J	97	3.72	3.76	393	1477.7		J	99	3.48	3.51	393	1379.4
	K	96	3.68	3.70	488	1805.6		K	97	3.41	3.45	488	1683.6
	L	73	2.80	3.24	582	1885.7		L	96	3.38	3.40	582	1978.8
(.60 X)	M	54	2.07	2.62	737	1930.9	(.60 X)	M	67	2.36	2.97	737	2188.9
(.75 X)	N	37.5	1.44	1.91	489	934.0	(.75 X)	N	45	1.58	2.17	489	1061.1
					Sum =	11872.8						Sum =	11879.1

Table 22.—Completed computation sheets for 1st, 2nd and 3rd 6-hr increments for Leon River, TX drainage – Continued

Increment: 3

Drainage: Leon River, TX Area: 3,660 mi^2 Date:

	I	II	III	IV	V	VI		I	II	III	IV	V	VI
Area size	Iso.	Nomo.	Amt. 2.89	Avg. depth	ΔA	ΔV	Area size	Iso.	Nomo.	Amt. 2.70	Avg. depth	ΔA	ΔV
	A	104.6	3.02	3.02	10	30.2		A	105	2.84	2.84	10	28.4
	B	103.3	2.98	3.00	15	45.0		B	103.8	2.80	2.82	15	42.3
1000/3	C	102.3	2.96	2.97	25	74.2	1500/3	C	102.7	2.77	2.785	25	69.6
	D	101.3	2.93	2.945	50	147.2		D	101.7	2.74	2.755	50	137.8
	E	100.6	2.91	2.92	75	219.0		E	101	2.73	2.735	75	205.1
	F	100.3	2.90	2.905	125	393.1		F	100.7	2.72	2.725	125	340.6
	G	99.9	2.89	2.895	150	434.2		G	100.3	2.71	2.715	150	407.2
	H	99.6	2.88	2.885	250	721.2		H	100	2.70	2.705	250	676.2
	I	99.3	2.87	2.875	271	779.1		I	99.7	2.69	2.695	271	730.3
	J	82.5	2.38	2.70	393	1061.1		J	99.4	2.68	2.685	393	1055.2
	K	67	1.94	2.16	488	1054.1		K	81	2.19	2.44	488	1190.7
	L	54	1.56	1.75	582	1018.5		L	65.5	1.77	1.98	582	1152.4
(.60 X)	M	43	1.24	1.43	737	1053.9	(.60 X)	M	51.5	1.39	1.62	737	1193.9
(.75 X)	N	31	.90	1.16	489	567.2	(.75 X)	N	38	1.03	1.30	489	635.7
					Sum =	7598.0						Sum =	7865.4
Area size			Amt. 2.50				Area size			Amt. 2.30			
	A	105.3	2.63	2.63	10	26.3		A	105.7	2.43	2.43	10	24.3
	B	104.2	2.60	2.615	15	39.2		B	104.6	2.41	2.42	15	36.3
2150/3	C	103.2	2.58	2.59	25	64.8	3000/3	C	103.5	2.38	2.40	25	60.0
	D	102	2.55	2.565	50	128.2		D	102.5	2.36	2.37	50	118.5
	E	101.3	2.53	2.54	75	190.5		E	101.7	2.34	2.35	75	176.3
	F	101	2.52	2.525	125	315.6		F	101.3	2.33	2.345	125	293.1
	G	100.6	2.52	2.52	150	378.0		G	100.9	2.32	2.335	150	350.2
	H	100.3	2.51	2.515	250	628.8		H	100.5	2.31	2.315	250	578.8
	I	100	2.50	2.505	271	678.8		I	100.2	2.30	2.305	271	624.6
	J	99.7	2.49	2.495	393	980.5		J	99.9	2.30	2.30	393	903.9
	K	99.5	2.49	2.49	488	1215.1		K	99.6	2.29	2.295	488	1120.0
	L	80.5	2.01	2.25	582	1309.5		L	99.3	2.28	2.285	582	1329.9
(.60 X)	M	61	1.52	1.81	737	1334.0	(.60 X)	M	76	1.75	2.07	737	1525.6
(.75 X)	N	46.5	1.16	1.43	489	699.3	(.75 X)	N	57	1.31	1.64	489	802.0
					Sum =	7988.6						Sum =	7943.5

Table 23.—Completed computation sheet for the 1st to 3rd 6-hr increments for supplemental isohyets on the Leon River, TX drainage

Increment: 1 to 3

Drainage: Leon River, TX Area: 3,660 mi^2 Date: _____

	I	II	III	IV	V	VI		I	II	III	IV	V	VI
Area size	Iso.	Nomo.	Amt. 12.12	Avg. depth	ΔA	ΔV	Area size	Iso.	Nomo.	Amt. 10.86	Avg. depth	ΔA	ΔV
	A	171	20.72	20.72	10	207.2		A	181	19.66	19.66	10	196.6
	B	160	19.39	20.06	15	300.9		B	169	18.35	19.00	15	285.0
1900/1	C	149	18.06	18.72	25	468.0	2400/1	C	158	17.16	17.76	25	444.0
	D	138	16.73	17.40	50	870.0		D	146	15.86	16.51	50	825.5
	E	128	14.51	16.12	75	1209.0		E	134	14.55	15.20	75	1140.0
	F	118	14.30	14.90	125	1862.5		F	125	13.58	14.06	125	1757.5
	G	110	13.33	13.82	150	2073.0		G	116	12.60	13.09	150	1963.5
	H	100	12.12	12.72	250	3180.0		H	106	11.51	12.06	250	3015.0
	I	93	11.27	11.70	271	3170.7		I	97	10.53	11.02	271	2986.4
	J	84	10.18	10.72	393	4213.0		J	88	9.56	10.04	393	3945.7
	-	78	9.45	9.82	345	3387.9		K	79	8.98	9.07	488	4426.2
	K	68	8.24	8.84	143	1264.1		-	76	8.25	8.42	211	1776.6
	L	48	5.82	7.03	582	4091.5		L	58	6.30	7.28	371	2700.9
(.60 X)	M	30	3.64	4.95	737	3548.2	(.60 X)	M	36	3.91	5.34	737	3935.6
(.75 X)	N	18	2.18	3.28	489	1603.9	(.75 X)	N	21	2.28	3.50	489	1711.5
						Sum = 31449.9							Sum = 31110.0
Area size			Amt. 3.93				Area size			Amt. 3.73			
	A	118	4.64	4.64	10	46.4		A	119	4.44	4.44	10	44.4
	B	116	4.56	4.60	15	69.0		B	115	4.29	4.36	15	65.4
1900/2	C	111	4.36	4.46	25	111.5	2400/2	C	112	4.18	4.24	25	106.0
	D	108	4.24	4.30	50	215.0		D	109	4.06	4.12	50	206.0
	E	106	4.16	4.20	75	315.0		E	107	3.99	4.025	75	301.9
	F	104	4.09	4.125	125	515.6		F	105	3.92	3.955	125	494.4
	G	102	4.01	4.05	150	607.5		G	103	3.84	3.88	150	582.0
	H	100	3.93	4.97	250	1242.5		H	101	3.77	3.805	250	951.2
	I	98	3.85	3.89	271	1054.2		I	99	3.69	3.73	271	1010.8
	J	96.5	3.79	3.82	393	1501.3		J	97.5	3.64	3.665	393	1440.3
	-	95.5	3.75	3.77	345	1300.6		K	96.5	3.60	3.62	488	1766.6
	K	86	3.38	3.57	143	510.5		-	96	3.58	3.59	211	757.5
	L	68	2.67	3.03	582	1763.5		L	78	2.91	3.25	371	1205.8
(.60 X)	M	50.5	1.98	2.39	737	1761.4	(.60 X)	M	57.5	2.14	2.60	737	1916.2
(.75 X)	N	37	1.48	1.86	489	909.5	(.75 X)	N	40	1.49	1.98	489	968.2
						Sum = 11923.5							Sum = 11816.7
Area size			Amt. 2.56				Area size			Amt. 2.43			
	A	105.2	2.69	2.69	10	26.9		A	105.4	2.56	2.56	10	25.6
	B	104.1	2.66	2.675	15	40.1		B	104.3	2.53	2.545	15	38.2
1900/3	C	103	2.64	2.65	25	66.2	2400/3	C	103.3	2.51	2.52	25	63.0
	D	102	2.61	2.625	50	131.2		D	102.3	2.48	2.495	50	124.8
	E	101.2	2.59	2.06	75	195.0		E	101.5	2.47	2.475	75	185.6
	F	100.8	2.58	2.585	125	323.1		F	101.0	2.45	2.46	125	307.5
	G	100.5	2.57	2.575	150	386.2		G	100.7	2.45	2.45	150	367.5
	H	100.2	2.56	2.565	250	641.2		H	100.3	2.44	2.445	250	611.2
	I	99.8	2.55	2.555	271	692.4		I	100.0	2.43	2.435	271	659.9
	J	99.6	2.55	2.55	393	1000.2		J	99.8	2.42	2.425	393	953.0
	-	99.4	2.54	2.545	345	878.0		K	99.4	2.42	2.42	488	1181.0
	K	92	2.36	2.45	143	350.4		-	99.3	2.41	2.415	211	509.6
	L	75	1.92	2.14	582	1245.5		L	86	2.09	2.25	371	834.8
(.60 X)	M	58	1.48	1.74	737	1285.3	(.60 X)	M	66	1.60	1.89	737	1392.9
(.75 X)	N	43	1.10	1.39	489	679.7	(.75 X)	N	49.5	1.20	1.50	489	733.5
						Sum = 7940.5							Sum = 7988.1

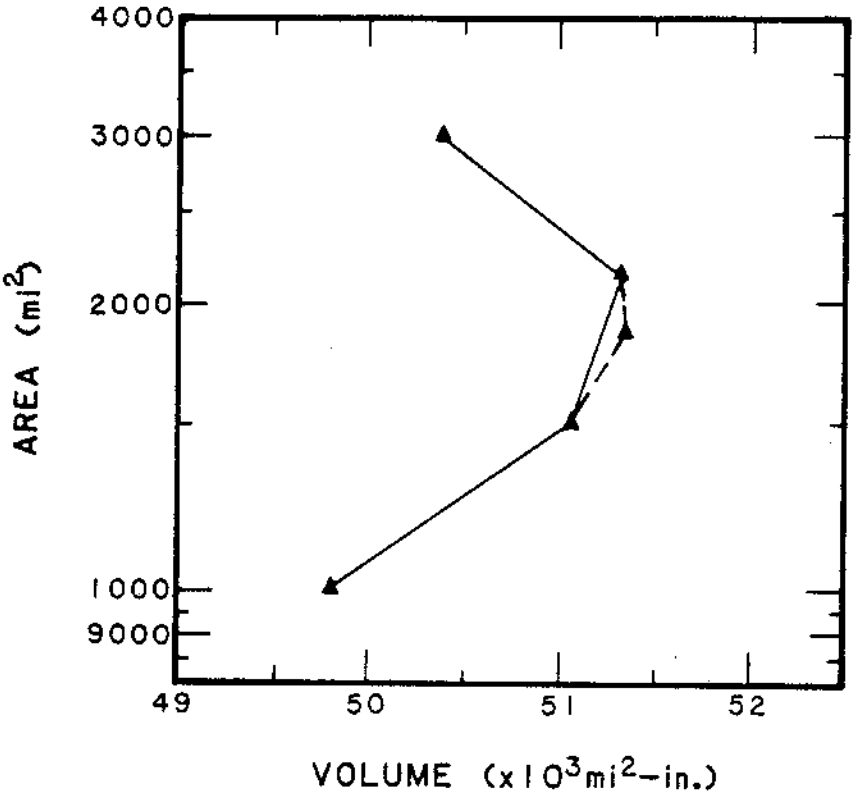

Figure 47.—Volume vs. area curve for 1st three 6-hr increments for Leon River, TX drainage.

D2. Successively subtract the 6-hr values in step D1.

6-hr periods

	1	2	3	4	5	6	7	8	9	10	11	12
Increm. PMP (in.)	12.9	4.3	2.8	2.3	1.5	1.2	1.0	0.8	0.9	0.8	0.7	0.7

We read slightly different values (read to hundreths) in smoothed data from figure 45 for the 1st three 6-hr increments, which we substitute here, for consistency.

Note that to assure a series of decreasing values it was necessary to reverse the values for the 8th and 9th increment. This does not cause any problem for our computations.

6-hr periods

	1	2	3	4	5	6	7	8	9	10	11	12
Increm. PMP (in.)	12.82	4.27	2.79	2.30	1.50	1.20	1.00	0.90	0.80	0.80	0.70	0.70

Multiply each of these 6-hr incremental PMP by 89.7% to reduce them for orientation.

	6-hr periods											
	1	2	3	4	5	6	7	8	9	10	11	12
Adj. PMP (in.)	11.50	3.83	2.50	2.06	1.34	1.08	0.90	0.81	0.72	0.72	0.63	0.63

D3. Isohyet values are then obtained by multiplying the 1st 6-hr value in step D2 by the percentages for 2,150 mi^2 from table 15 or the 1st 6-hr nomogram (fig. 16), the 2nd 6-hr value by the percentages in table 16 or figure 18, the 3rd 6-hr value by the percentages in table 17 or figure 19, and the fourth through 12th 6-hr values by the percentages in table 18 or figure 20 as shown in table 24. In section 3.5.3, we have explained that the fourth through 12th 6-hr increments are assumed uniform. Thus, a constant value is used through the extent of the area size of PMP, 2,150 mi^2 in this example.

Table 24.--Isohyet values (in.), Leon River, TX, for example 1a

Isohyet	6-hr periods 1	2	3	4	5	6	7	8	9	10	11	12
A	20.24	4.54	2.63	2.06	1.34	1.08	0.90	0.81	0.72	0.72	0.63	0.63
B	18.98	4.39	2.61	2.06	1.34	1.08	0.90	0.81	0.72	0.72	0.63	0.63
C	17.17	4.25	2.58	2.06	1.34	1.08	0.90	0.81	0.72	0.72	0.63	0.63
D	16.33	4.16	2.56	2.06	1.34	1.08	0.90	0.81	0.72	0.72	0.63	0.63
E	15.07	4.08	2.53	2.06	1.34	1.08	0.90	0.81	0.72	0.72	0.63	0.63
F	14.03	4.00	2.53	2.06	1.34	1.08	0.90	0.81	0.72	0.72	0.63	0.63
G	12.99	3.91	2.52	2.06	1.34	1.08	0.90	0.81	0.72	0.72	0.63	0.63
H	11.85	3.83	2.51	2.06	1.34	1.08	0.90	0.81	0.72	0.72	0.63	0.63
I	10.93	3.77	2.50	2.06	1.34	1.08	0.90	0.81	0.72	0.72	0.63	0.63
J	9.89	3.72	2.49	2.06	1.34	1.08	0.90	0.81	0.72	0.72	0.63	0.63
K	8.86	3.68	2.48	2.06	1.34	1.08	0.90	0.81	0.72	0.72	0.63	0.63
L	5.98	2.80	2.03	1.66	1.08	0.87	0.72	0.65	0.58	0.58	0.51	0.51
M	3.80	2.07	1.55	1.26	0.82	0.66	0.55	0.49	0.44	0.44	0.38	0.38
N	2.30	1.44	1.16	0.96	0.62	0.50	0.42	0.38	0.33	0.33	0.29	0.29

Note: The results shown in this matrix emphasize the fact that for the fourth through 12th 6-hr period the distribution of PMP is uniform across the PMP portion of the pattern (A through K) for each increment. However, isohyets L to N represent residual precipitation for the 2,150-mi^2 pattern and these isohyets are assigned decreasing values.

D4. The values in table 24 represent the incremental isohyetal values for the Leon River drainage with the 2,150-mi^2 PMP pattern placed as shown in figure 46. To obtain incremental average depths (PMP) for this drainage it is necessary to compute the incremental volumes as determined from the tabulated isohyetal values according to the procedures described for figure 41, and then divide each incremental volume by the drainage area. This results in the following incremental average depths. (See computations in table 25.)

Table 25.—Completed computation sheets showing typical format to get incremental drainage-average depths, Leon River, TX

Increment: 1 to 6

Drainage: Leon River, TX Area: 3,660 mi^2 Date: _____

	I	II	III	IV	V	VI
Area size	Iso.	Nomo.	Amt. 11.50	Avg. depth	ΔA	ΔV
	A		20.24	20.24	10	202.4
	B		18.98	19.61	15	294.2
2150/1	C		17.71	18.35	25	458.8
	D		16.33	17.02	50	851.0
	E		15.07	15.70	75	1177.5
	F		14.03	14.55	175	1818.8
	G		12.99	13.51	150	2026.5
	H		11.85	12.42	250	3105.0
	I		10.93	11.39	271	3086.7
	J		9.89	10.41	393	4091.1
	K		8.86	9.38	488	4577.4
	L		5.98	7.42	582	4318.4
(.60 X)	M		3.80	5.11	737	3766.1
(.75 X)	N		2.30	3.42	489	1672.4
				Total = 3660		
				Sum =		31446.3
				Avg. depth =		8.59

	I	II	III	IV	V	VI
Area size	Iso.	Nomo.	Amt. 2.06	Avg. depth	ΔA	ΔV
	A	100	2.06	2.06	10	20.6
	B	100	2.06	2.06	15	30.9
2150/4	C	100	2.06	2.06	25	51.5
	D	100	2.06	2.06	50	103.0
	E	100	2.06	2.06	75	154.5
	F	100	2.06	2.06	125	257.5
	G	100	2.06	2.06	150	309.0
	H	100	2.06	2.06	250	515.0
	I	100	2.06	2.06	271	558.3
	J	100	2.06	2.06	393	809.6
	K	100	2.06	2.06	488	1005.3
	L	80.5	1.66	1.86	582	1082.5
(.60 X)	M	61	1.26	1.46	737	1076.0
(.75 X)	N	46.5	.96	1.11	489	542.8
					Sum =	6516.5
				Avg. depth =		1.78

	I	II	III	IV	V	VI
Area size			Amt. 3.83			
	A				10	45.4
	B				15	67.0
2150/2	C				25	108.0
	D				50	210.5
	E				75	309.0
	F				125	505.0
	G				150	594.0
	H				250	967.5
	I				271	1032.5
	J				393	1477.7
	K				488	1805.6
	L				582	1887.5
(.60 X)	M				737	1930.9
(.75 X)	N				489	934.0
					Sum =	11872.8
				Avg. depth =		3.24

	I	II	III	IV	V	VI
Area size	Iso.	Nomo.	Amt. 1.34	Avg. depth	ΔA	ΔV
	A	100	1.34	1.34	10	13.4
	B	100	1.34	1.34	15	20.1
2150/5	C	100	1.34	1.34	25	33.5
	D	100	1.34	1.34	50	67.0
	E	100	1.34	1.34	75	100.5
	F	100	1.34	1.34	125	167.5
	G	100	1.34	1.34	150	201.0
	H	100	1.34	1.34	250	335.0
	I	100	1.34	1.34	271	363.1
	J	100	1.34	1.34	393	526.6
	K	100	1.34	1.34	488	653.9
	L	80.5	1.08	1.21	582	704.2
(.60 X)	M	61	0.82	0.95	737	700.2
(.75 X)	N	46.5	0.62	0.72	489	352.1
					Sum =	4238.1
				Avg. depth =		1.16

	I	II	III	IV	V	VI
Area size			Amt. 2.50			
	A				10	26.3
	B				15	39.2
2150/3	C				25	64.8
	D				50	128.2
	E				75	190.5
	F				125	315.6
	G				150	378.0
	H				250	628.8
	I				271	678.8
	J				393	980.5
	K				488	1215.1
	L				582	1309.5
(.60 X)	M				737	1334.0
(.75 X)	N				489	699.3
					Sum =	7988.6
				Avg. depth =		2.18

	I	II	III	IV	V	VI
Area size	Iso.	Nomo.	Amt. 1.08	Avg. depth	ΔA	ΔV
	A	100	1.08	1.08	10	10.8
	B	100	1.08	1.08	15	16.2
2150/6	C	100	1.08	1.08	25	27.0
	D	100	1.08	1.08	50	54.0
	E	100	1.08	1.08	75	81.0
	F	100	1.08	1.08	125	135.0
	G	100	1.08	1.08	150	162.0
	H	100	1.08	1.08	250	270.0
	I	100	1.08	1.08	271	292.7
	J	100	1.08	1.08	393	424.4
	K	100	1.08	1.08	488	527.0
	L	80.5	0.87	0.98	582	570.4
(.60 X)	M	61	0.66	0.77	737	567.5
(.75 X)	N	46.5	0.50	0.58	489	283.6
					Sum =	3421.6
				Avg. depth =		0.93

Table 25.—Completed computation sheets showing typical format to get incremental drainage-averaged depths, Leon River, TX. - Continued

Increment: 7 to 12

Drainage: Leon River, TX Area: 3,660 mi^2 Date: _____

	I	II	III	IV	V	VI
Area size	Iso.	Nomo.	Amt. 0.90	Avg. depth	ΔA	ΔV
	A	100	0.90	0.90	10	9
	B	100	0.90	0.90	15	13.5
2150/7	C	100	0.90	0.90	25	22.5
	D	100	0.90	0.90	50	45.0
	E	100	0.90	0.90	75	67.5
	F	100	0.90	0.90	125	112.5
	G	100	0.90	0.90	150	135.0
	H	100	0.90	0.90	250	225.0
	I	100	0.90	0.90	271	243.9
	J	100	0.90	0.90	393	353.7
	K	100	0.90	0.90	488	439.2
	L	80.5	0.72	0.81	582	471.4
(.60 X)	M	61	0.55	0.64	737	471.7
(.75 X)	N	46.5	0.42	0.49	489	239.6
					Sum =	2849.5
				Avg. depth =		0.78

	I	II	III	IV	V	VI
Area size	Iso.	Nomo.	Amt. 0.72	Avg. depth	ΔA	ΔV
	A	100	0.72	0.72	10	7.2
	B	100	0.72	0.72	15	10.8
2150/10	C	100	0.72	0.72	25	18.0
	D	100	0.72	0.72	50	36.0
	E	100	0.72	0.72	75	54.0
	F	100	0.72	0.72	125	90.0
	G	100	0.72	0.72	150	108.0
	H	100	0.72	0.72	250	180.0
	I	100	0.72	0.72	271	195.1
	J	100	0.72	0.72	393	282.9
	K	100	0.72	0.72	488	351.4
	L	80.5	0.58	0.65	582	378.3
(.60 X)	M	61	0.44	0.51	737	375.9
(.75 X)	N	46.5	0.33	0.39	489	190.7
					Sum =	2278.3
				Avg. depth =		0.62

	I	II	III	IV	V	VI
Area size	Iso.	Nomo.	Amt. 0.81	Avg. depth	ΔA	ΔV
	A	100	0.81	0.81	10	8.1
	B	100	0.81	0.81	15	12.2
2150/8	C	100	0.81	0.81	25	20.3
	D	100	0.81	0.81	50	40.5
	E	100	0.81	0.81	75	60.8
	F	100	0.81	0.81	125	101.3
	G	100	0.81	0.81	150	121.5
	H	100	0.81	0.81	250	202.5
	I	100	0.81	0.81	271	219.5
	J	100	0.81	0.81	393	318.3
	K	100	0.81	0.81	488	395.3
	L	80.5	0.65	0.73	582	424.9
(.60 X)	M	61	0.49	0.57	737	420.1
(.75 X)	N	46.5	0.38	0.44	489	215.2
					Sum =	2560.4
				Avg. depth =		0.70

	I	II	III	IV	V	VI
Area size	Iso.	Nomo.	Amt. 0.63	Avg. depth	ΔA	ΔV
	A	100	0.63	0.63	10	6.3
	B	100	0.63	0.63	15	9.5
2150/11	C	100	0.63	0.63	25	15.8
	D	100	0.63	0.63	50	31.5
	E	100	0.63	0.63	75	47.3
	F	100	0.63	0.63	125	78.8
	G	100	0.63	0.63	150	94.5
	H	100	0.63	0.63	250	157.5
	I	100	0.63	0.63	271	170.7
	J	100	0.63	0.63	393	247.6
	K	100	0.63	0.63	488	307.4
	L	80.5	0.51	0.57	582	331.7
(.60 X)	M	61	0.38	0.45	737	331.7
(.75 X)	N	46.5	0.29	0.34	489	166.3
					Sum =	1996.6
				Avg. depth =		0.54

	I	II	III	IV	V	VI
Area size	Iso.	Nomo.	Amt. 0.72	Avg. depth	ΔA	ΔV
	A	100	0.72	0.72	10	7.2
	B	100	0.72	0.72	15	10.8
2150/9	C	100	0.72	0.72	25	18.0
	D	100	0.72	0.72	50	36.0
	E	100	0.72	0.72	75	54.0
	F	100	0.72	0.72	125	90.0
	G	100	0.72	0.72	150	108.0
	H	100	0.72	0.72	250	180.0
	I	100	0.72	0.72	271	195.1
	J	100	0.72	0.72	393	282.9
	K	100	0.72	0.72	488	351.4
	L	80.5	0.58	0.65	582	378.3
(.60 X)	M	61	0.44	0.51	737	375.9
(.75 X)	N	46.5	0.33	0.39	489	190.7
					Sum =	2278.3
				Avg. depth =		0.62

	I	II	III	IV	V	VI
Area size	Iso.	Nomo.	Amt. 0.63	Avg. depth	ΔA	ΔV
	A	100	0.63	0.63	10	6.3
	B	100	0.63	0.63	15	9.5
2150/12	C	100	0.63	0.63	25	15.8
	D	100	0.63	0.63	50	31.5
	E	100	0.63	0.63	75	47.3
	F	100	0.63	0.63	125	78.8
	G	100	0.63	0.63	150	94.5
	H	100	0.63	0.63	250	157.5
	I	100	0.63	0.63	271	170.7
	J	100	0.63	0.63	393	247.6
	K	100	0.63	0.63	488	307.4
	L	80.5	0.51	0.57	582	331.7
(.60 X)	M	61	0.38	0.45	737	331.7
(.75 X)	N	46.5	0.29	0.34	489	166.3
					Sum =	1996.6
				Avg. depth =		0.54

	6-hr periods											
	1	2	3	4	5	6	7	8	9	10	11	12
Avg. PMP (in.)	8.59	3.24	2.18	1.78	1.16	0.93	0.78	0.70	0.62	0.62	0.54	0.54

These give a 72-hr total drainage-averaged PMP of 21.68 in., which can be compared to 27.4 in. for 3,660 mi^2 (from fig. 43), or a 21 percent reduction from HMR No. 51. The reduction is due to orientation and basin shape factors.

D5. a. At 31°45'N, 98°15'W, we read a 1/6-hr ratio of 0.306 from figure 39.

b. We adjust the scale for the nomogram in figure 40 such that the abscissa for the 20,000-mi^2 "A" isohyet reads 0.306.

c. With the scale set as in step D5b, we read ratios for the following isohyets.

Isohyet	1/6-hr ratio
A	.299
B	.298*
C	.297
D	.295*
E	.293
F	.2915*
G	.290
H	.2875*
I	.285
J	.282
K	.279

*interpolated isohyet on nomogram

d. Multiply the ratios in step D5c by the corresponding values from table 24 (1st 6-hr period only) to get the 1-hr isohyet values.

Isohyet	1-hr isohyet values
A	6.05
B	5.66
C	5.10
D	4.82
E	4.42
F	4.09
G	3.77
H	3.73
I	3.12
J	2.78
K	2.47

e. Plot the values in step D5d and those for the 4 greatest increments from table 24 and draw a smooth curve of best fit through these points with the origin as the starting point as shown in figure 48.

f. From figure 48, we can read isohyet values for any other duration less than 6 hr (see note in procedure step 7D5f).

g. The 4 greatest 6-hr incremental isohyet values for the M isohyet have also been plotted on figure 48 as an example of residual precipitation. It is apparent that this curve is flatter than those for the PMP portion of the pattern. Lesser errors are therefore likely in interpolating short duration isohyet values for residual precipitation than for those within the PMP area. (Note in procedure step 7D5f applies here and to 1-hr values for residual precipitation.)

7.3 Example 1b

As a comparison to the results of example 1a, we will now evaluate the maximum volume for the Leon River, Texas drainage when no adjustment for orientation is applied. In step B3, we obtained the orientation for PMP from figure 8 as 208° for 31°45'N, 98°15'W. Figure 10 indicates that within 40° of PMP orientation, no reduction need be applied to isohyets values. Subtracting 40° from 208°, we get an orientation of 168°. Thus, if we place the isohyetal pattern at an orientation of 168° on the Leon River drainage, as shown in figure 49, no adjustment is necessary. We must planimeter the areas between each of the incomplete isohyets, and then refer to step C in the procedure.

C. Complete the computational process of figure 41 for the area sizes considered in example 1a. We have omitted the 1,000- and 15,000-mi^2 areas based on the outcome of example 1a. Note that the nomogram percentages will be the same as those used in example 1a, but the amount heading column III is now unadjusted for orientation; i.e., smoothed values from figure 45.

Table 26 presents completed computations for this example. The preliminary maximum volume for the first 6-hr increment appears to occur between 6,500 and 10,000 mi^2. To check on this outcome, the 15,000-mi^2 area pattern volume was determined and was found to be significantly less than that at 10,000 mi^2. Computation of the 2nd and 3rd 6-hr increments for the standard isohyet areas between 4,500 and 15,000 mi^2 resulted in 18-hr volumes ranging between 45,000 and 49,000 mi^2-in.

Note that by not adjusting the isohyets for orientation, the PMP pattern area of maximum volume has greatly increased from 2,150 mi^2 in example 1a to 10,000 mi^2 in this example, but the total volume as decreased. This occurs because some of the larger isohyets become more effective as the isohyet values increase with increasing area, and combine with proportionately larger incremental areas. At the same time the volume contributed by the isohyets enclosing smaller areas has been markedly reduced.

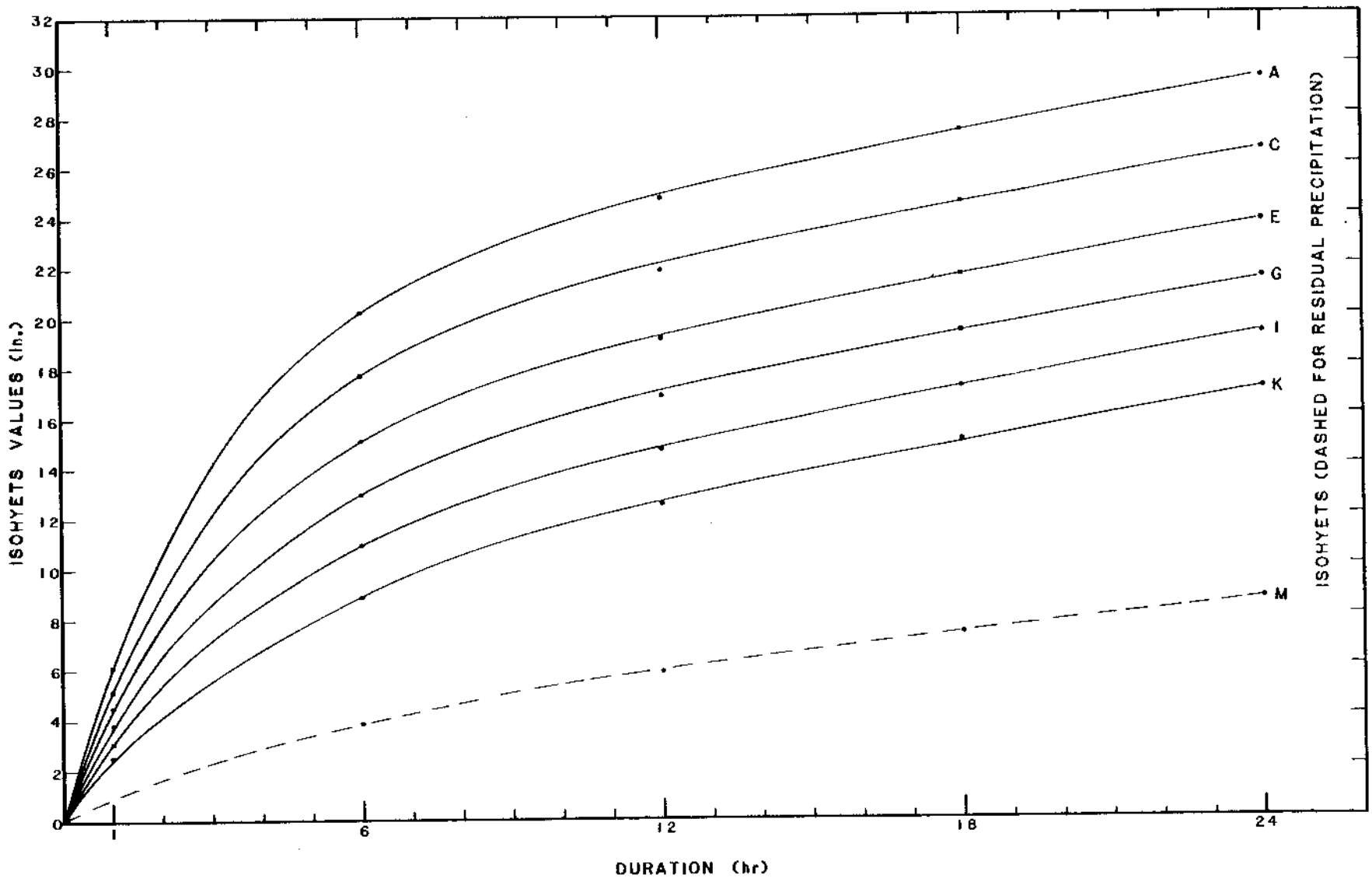

Figure 48.--Smoothed durational curves used to interpolate short-duration isohyet values for the Leon River, TX drainage.

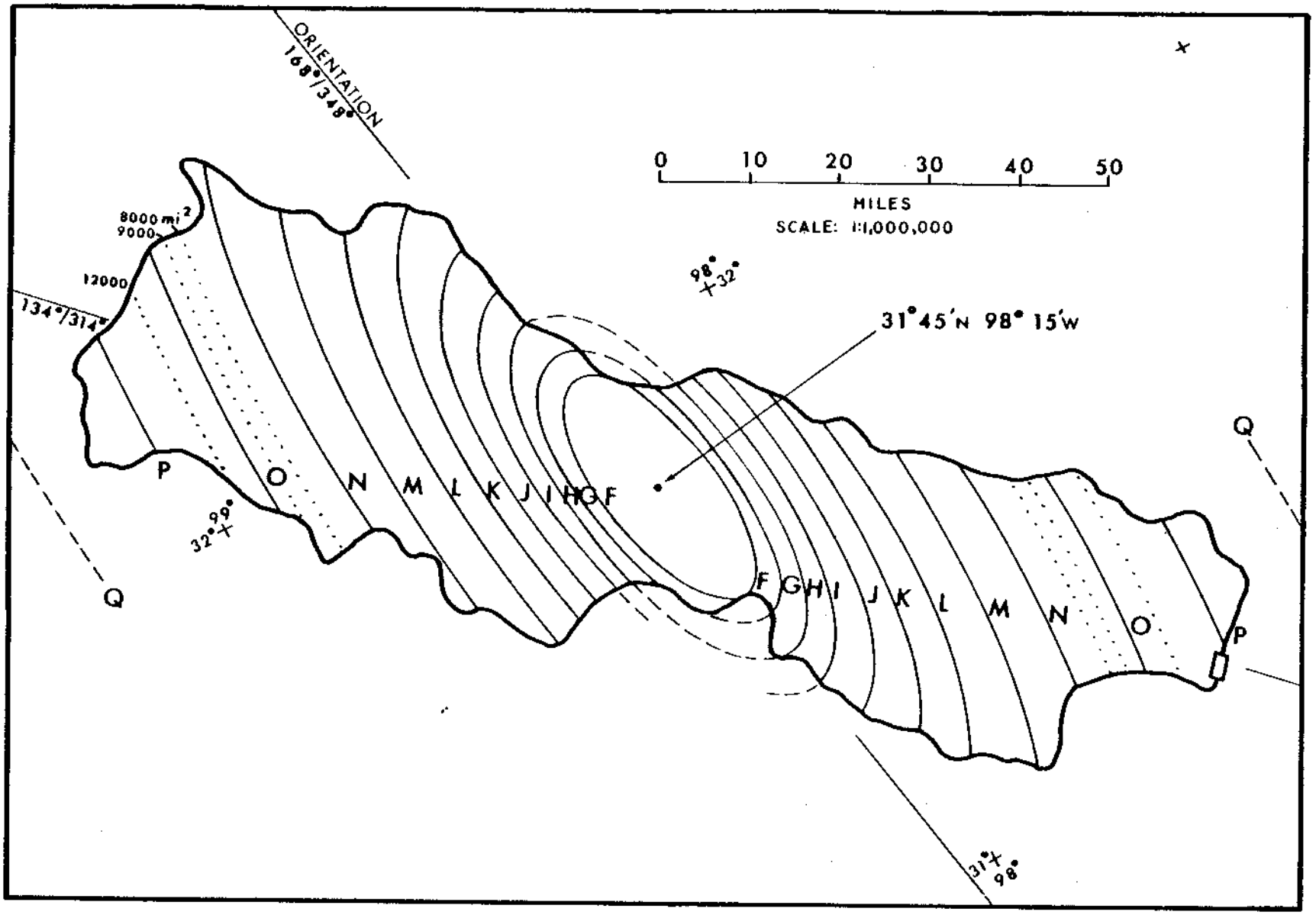

Figure 49.—Alternate placement of isohyetal pattern on Leon River, TX drainage such that no adjustment is applicable for orientation.

Table 26.—Completed computation sheets for 1st three 6-hr increments for alternate placement of pattern on Leon River, TX drainage

Increment: 1

Drainage: Leon River, TX Area: 3,660 mi^2 Date: _____

	I	II	III	IV	V	VI		I	II	III	IV	V	VI
Area size	Iso.	Nomo.	Amt. 14.35	Avg. depth	ΔA	ΔV	Area size	Iso.	Nomo.	Amt. 9.80	Avg. depth	ΔA	ΔV
	A	162	23.25	23.25	10	232.5		A	212	20.78	20.78	10	207.8
	B	152	21.81	22.53	15	338.0		B	198	19.40	20.09	15	301.4
1500/1	C	142	20.34	21.08	25	527.0	4500/1	C	184	18.03	18.72	25	468.0
	D	132	18.94	19.64	50	982.0		D	170	16.66	17.34	50	867.0
	E	122	17.54	18.22	75	1366.5		E	157	15.39	16.02	75	1201.5
	F	112	16.07	16.79	125	2098.8		F	146	14.31	14.85	125	1856.2
	G	105	15.07	15.57	125	1946.2		G	135	13.23	13.77	125	1721.2
	H	96	13.78	14.42	125	1802.5		H	124	12.15	12.69	125	1586.2
	I	88	12.68	13.20	150	1980.0		I	113	11.07	11.61	150	1741.5
	J	80	11.48	12.06	240	2894.4		J	103	10.09	10.58	240	2539.2
	K	56	8.04	9.76	340	3318.4		K	93	9.11	9.60	340	3264.0
	L	41	5.88	6.96	240	1670.4		L	83	8.13	8.62	240	2068.8
	M	26	3.73	4.80	525	2520.0		M	71	6.96	7.54	525	3958.5
	N	16	2.30	3.02	505	1525.1		N	37	3.63	5.30	505	2676.5
	O	7	1.00	1.65	535	882.8		O	18	1.76	2.70	535	1444.5
(.60 X)	P	0	0.0	0.60	445	267.0	(.60 X)	P	8	0.78	1.37	445	609.6
(.70 X)	Q	0	0.0	0.0	130	0.0	(.70 X)	Q	0	0.0	0.55	130	71.5
					Sum = 24251.6							Sum = 26583.4	

Area Size			Amt. 12.82				Area Size			Amt. 8.50			
	A	176	22.56	22.56	10	225.6		A	233	19.80	19.80	10	198.0
	B	165	21.15	21.86	15	327.9		B	218	18.53	19.16	15	287.5
2150/1	C	154	19.74	20.44	25	511.0	6500/1	C	203	17.26	17.90	25	447.4
	D	142	18.20	18.97	50	948.5		D	187	15.90	16.58	50	829.0
	E	131	16.79	17.50	75	1312.5		E	174	14.79	15.34	75	1150.5
	F	122	15.64	16.22	125	2027.5		F	160	13.60	14.20	125	1775.0
	G	113	14.49	15.06	125	1882.5		G	148	12.58	13.09	125	1636.2
	H	103	13.20	13.84	125	1730.0		H	137	11.64	12.11	125	1513.8
	I	95	12.18	12.69	150	1903.5		I	125	10.62	11.14	150	1671.0
	J	86	11.02	11.60	240	2784.0		J	113	9.60	10.11	240	2426.4
	K	77	9.87	10.44	340	3549.6		K	103	8.76	9.18	340	3121.2
	L	52	6.67	8.27	240	1984.8		L	93	7.90	8.33	240	1999.2
	M	33	4.23	5.45	525	2861.2		M	81	6.88	7.39	525	3879.8
	N	20	2.56	3.40	505	1717.0		N	70	5.95	6.42	505	3242.1
	O	9	1.15	1.86	535	995.1		O	29	2.46	4.20	535	2247.0
(.60 X)	P	2	0.26	0.79	445	351.6	(.60 X)	P	13	1.10	1.92	445	854.4
(.70 X)	Q	0	0.0	0.18	130	23.4	(.70 X)	Q	1	0.08	0.79	130	102.7
					Sum = 25135.7							Sum = 27381.2	

Area size			Amt. 11.40				Area size			Amt. 7.05			
	A	191	21.77	21.77	10	217.7		A	262	18.47	18.47	10	184.7
	B	179	20.41	21.09	15	316.4		B	243	17.13	17.80	15	267.0
3000/1	C	166	18.92	19.66	25	491.5	10000/1	C	227	16.00	16.56	25	414.1
	D	154	17.56	18.24	50	912.0		D	209	14.73	15.36	50	768.0
	E	142	16.89	16.88	75	1266.0		E	194	13.68	14.20	75	1065.0
	F	132	15.05	15.62	125	1952.5		F	178	12.55	13.11	125	1638.8
	G	122	13.91	14.48	125	1810.0		G	166	11.70	12.12	125	1515.6
	H	112	12.77	13.34	125	1667.5		H	152	10.72	11.21	125	1401.2
	I	102	11.63	12.20	150	1830.0		I	140	9.87	10.30	150	1544.2
	J	92	10.49	11.06	240	2654.4		J	128	9.02	9.44	240	2265.6
	K	83	9.46	9.98	340	3393.2		K	117	8.25	8.64	340	2937.6
	L	74	8.44	8.95	240	2148.0		L	107	7.54	7.90	340	1894.8
	M	44	5.02	6.73	525	3533.2		M	93	6.56	7.05	525	3701.2
	N	25	2.85	3.94	505	1989.7		N	82	5.78	6.16	505	3110.8
	O	12	1.37	2.11	535	1128.8		O	68	4.79	5.28	535	2824.8
(.60 X)	P	4	0.46	1.01	445	449.4	(.60 X)	P	27	1.90	3.63	445	1615.4
(.70 X)	Q	0	0.0	0.32	130	41.6	(.70 X)	Q	7	0.49	1.48	130	192.4
					Sum = 25808.3							Sum = 27341.2	

Table 26.--Completed computation sheets for 1st three 6-hr increments for alternate placement of pattern on Leon River, TX drainage - Continued

Increment: 1 to 3

Drainage: Leon River, TX Area: 3,660 mi^2 Date: _____

	I	II	III	IV	V	VI
Area size	Iso.	Nomo.	Amt. 5.80	Avg. depth	ΔA	ΔV
15000/1	A	290	16.82	16.82	10	168.2
	B	271	15.72	16.26	15	243.9
	C	253	14.67	15.20	25	379.9
	D	232	13.46	14.06	50	703.0
	E	214	12.41	12.94	75	970.5
	F	196	11.37	11.89	125	1486.2
	G	183	10.61	10.99	125	1373.8
	H	168	9.74	10.18	125	1272.5
	I	156	9.05	9.40	150	1410.0
	J	143	8.29	8.67	240	2080.8
	K	131	7.60	7.94	340	2699.6
	L	120	6.99	7.30	240	1752.0
	M	106	6.21	6.60	525	3465.0
	N	94	5.45	5.83	505	2944.2
	O	80	4.64	5.04	535	2696.4
(.60 X)	P	65	3.77	4.29	445	1909.0
(.70 X)	Q	18	1.04	2.95	130	383.5
					Sum =	25938.5

	I	II	III	IV	V	VI
Area size	Iso.	Nomo.	Amt. 3.66	Avg. depth	ΔA	ΔV
10000/2	A	122	4.54	4.54	10	45.0
	B	120.5	4.41	4.48	15	67.2
	C	117	4.28	4.34	25	108.5
	D	115	4.21	4.245	59	212.2
	E	113	4.14	4.175	75	313.1
	F	111	4.06	4.10	125	512.5
	G	109	3.99	4.025	125	503.1
	H	107	3.92	3.96	125	494.4
	I	105.5	3.86	3.89	150	583.5
	J	104	3.81	3.84	240	920.5
	K	102.5	3.75	3.78	340	1285.2
	L	101	3.70	3.72	240	894.0
	M	99	3.62	3.66	525	1921.5
	N	97	3.55	3.58	505	1810.4
	O	95	3.48	3.52	535	1880.5
(.60 X)	P	50	1.83	2.82	445	1254.9
(.70 X)	Q	14	.51	1.43	130	185.9
					Sum =	12992.4

	I	II	III	IV	V	VI
Area size	Iso.	Nomo.	Amt. 3.96	Avg. depth	ΔA	ΔV
4500/2	A	121	4.79	4.79	10	47.9
	B	117	4.63	4.71	15	70.6
	C	114	4.51	4.57	25	142.2
	D	112	4.44	4.48	50	224.0
	E	109.5	4.34	4.39	75	329.2
	F	108	4.28	4.31	125	538.8
	G	105.5	4.18	4.23	125	528.8
	H	103.5	4.10	4.14	125	517.5
	I	102	4.04	4.07	150	610.5
	J	100.5	4.00	4.02	240	964.8
	K	99	3.92	3.96	340	1346.4
	L	97.5	3.86	3.89	240	933.6
	M	96	3.80	3.83	525	2010.8
	N	59	2.34	3.07	505	1550.4
	O	39	1.54	1.94	535	1037.9
(.60 X)	P	17	0.67	1.19	445	529.6
(.70 X)	Q	00	0.00	0.47	130	61.1
					Sum =	11416.1

	I	II	III	IV	V	VI
Area size	Iso.	Nomo.	Amt. 3.50	Avg. depth	ΔA	ΔV
15000/2	A	125	4.38	4.38	10	43.8
	B	122	4.27	4.33	15	64.9
	C	119	4.17	4.22	25	105.5
	D	117	4.10	4.14	50	207.0
	E	115	4.03	4.07	75	305.0
	F	113	3.96	4.00	125	500.0
	G	111	3.89	3.93	125	491.2
	H	109	3.82	3.86	125	482.5
	I	107	3.75	3.79	150	568.5
	J	106	3.71	3.73	240	895.2
	K	104	3.64	3.68	340	1251.2
	L	102.5	3.59	3.62	240	868.8
	M	101	3.54	3.57	525	1874.2
	N	99	3.47	3.51	505	1772.6
	O	97	3.40	3.44	535	1840.4
(.60 X)	P	96	3.36	3.38	445	1504.1
(.70 X)	Q	34	1.19	2.71	130	332.3
					Sum =	13127.4

	I	II	III	IV	V	VI
Area size	Iso.	Nomo.	Amt. 3.82	Avg. depth	ΔA	ΔV
6500/2	A	122	4.66	4.66	10	46.6
	B	119	4.54	4.60	15	69.0
	C	115.5	4.41	4.48	25	112.0
	D	113	4.32	4.36	50	218.0
	E	111	4.24	4.28	75	321.0
	F	109	4.16	4.20	125	525.0
	G	107	4.08	4.12	125	515.0
	H	105	4.01	4.045	125	505.6
	I	104	3.97	3.99	150	598.5
	J	102	3.90	3.94	240	945.6
	K	100.5	3.84	3.87	340	1315.8
	L	99	3.78	3.81	240	914.4
	M	97.5	3.72	3.75	525	1968.8
	N	95.5	3.65	3.68	505	1858.4
	O	52.5	2.02	2.82	535	1508.7
(.60 X)	P	27.5	1.07	1.64	445	729.8
(.70 X)	Q	1.0	0.04	0.76	130	98.8
					Sum =	12251.0

	I	II	III	IV	V	VI
Area size	Iso.	Nomo.	Amt. 2.58	Avg. depth	ΔA	ΔV
4500/3	A	106	2.73	2.73	10	27.3
	B	105	2.72	2.72	15	40.8
	C	104	2.68	2.695	25	67.4
	D	103.1	2.66	2.67	50	133.5
	E	102.1	2.63	2.645	75	198.4
	F	101.7	2.62	2.625	125	328.1
	G	101.2	2.61	2.615	125	326.9
	H	100.9	2.60	2.605	125	325.6
	I	100.6	2.60	2.60	150	390.0
	J	100.2	2.59	2.595	240	622.8
	K	99.9	2.58	2.585	340	878.9
	L	99.6	2.57	2.575	240	618.0
	M	99.3	2.56	2.565	525	1346.6
	N	76	1.96	2.26	505	1141.3
	O	49	1.26	1.61	535	861.4
(.60 X)	P	21	0.54	0.97	445	431.6
(.70 X)	Q	0	0.00	0.38	130	49.4
					Sum =	7788.0

Table 26.—Completed computation sheets for 1st three 6-hr increments for alternate placement of pattern on Leon River, TX drainage - Continued

Increment: 3, 1

Drainage: Leon River, TX Area: 3,660 mi^2 Date:

	I	II	III	IV	V	VI		I	II	III	IV	V	VI
Area size	Iso.	Nomo.	Amt. 2.48	Avg. depth	ΔA	ΔV	Area size	Iso.	Nomo.	Amt. 7.70	Avg. depth	ΔA	ΔV
	A	106.4	2.64	2.64	10	26.4		A	247	18.98	18.98	10	189.8
	B	105.5	2.62	2.63	15	39.4		B	230	17.71	18.34	15	275.1
6500/3	C	104.5	2.59	2.605	25	65.1	8000/1	C	214	16.48	17.10	25	427.5
	D	103.5	2.57	2.58	50	129.0		D	198	15.17	15.82	50	791.0
	E	102.5	2.54	2.555	75	191.6		E	183	14.09	14.63	75	1097.2
	F	102	2.53	2.535	125	316.9		F	169	12.97	13.53	125	1691.2
	G	101.5	2.52	2.525	125	315.6		G	157	12.01	12.49	125	1561.2
	H	101.2	2.51	2.515	125	314.4		H	144	11.09	11.55	125	1443.8
	I	100.9	2.50	2.505	150	375.8		I	132	10.16	10.62	150	1593.0
	J	100.5	2.49	2.495	240	598.8		J	120	9.28	9.72	240	2332.8
	K	100.2	2.48	2.485	340	844.9		K	110	8.43	8.86	340	3012.4
	L	99.8	2.48	2.48	240	595.2		L	99	7.62	8.02	240	1924.8
	M	99.5	2.47	2.475	525	1299.4		M	87	6.70	7.16	525	3759.0
	N	98.9	2.45	2.46	505	1242.3		N	75	5.81	6.26	505	3161.3
	O	65	1.60	2.02	535	1080.7		-	69	5.31	5.56	320	1779.7
(.60 X)	P	34.5	0.86	1.30	445	578.5		O	40	3.08	4.20	215	903.0
(.70 X)	Q	1	0.02	0.61	130	79.3	(.60 X)	P	18	1.39	2.40	445	1068.0
							(.70 X)	Q	4	0.31	1.07	130	139.1
					Sum =	8093.3						Sum =	27149.6
Area size			Amt. 2.36				Area size			Amt. 7.35			
	A	106.8	2.52	2.52	10	25.2		A	254	18.67	18.67	10	186.7
	B	106	2.50	2.51	15	37.6		B	237	17.42	18.04	15	270.6
10000/3	C	105	2.48	2.49	25	62.2	9000/1	C	221	16.24	16.83	25	420.8
	D	104	2.45	2.465	50	123.2		D	203	14.92	15.58	50	779.0
	E	102.8	2.43	2.44	75	183.0		E	189	13.89	14.40	75	1080.0
	F	102.4	2.42	2.425	125	303.1		F	174	12.79	13.34	125	1667.5
	G	101.9	2.41	2.415	125	301.9		G	161	11.83	12.31	125	1538.8
	H	101.6	2.40	2.405	125	300.6		H	148	10.88	11.36	125	1420.0
	I	101.3	2.39	2.395	150	359.2		I	136	10.00	10.44	150	1566.0
	J	100.9	2.38	2.385	240	572.4		J	124	9.15	9.58	240	2299.2
	K	100.5	2.37	2.375	340	807.5		K	113	8.30	8.72	340	2964.8
	L	100.2	2.36	2.365	240	567.6		L	103	7.57	7.94	240	1905.6
	M	99.8	2.36	2.36	525	1239.0		M	90	6.65	7.11	525	3732.8
	N	99.2	2.34	2.35	505	1186.8		N	78	5.77	6.21	505	3136.0
	O	98.7	2.33	2.335	535	1249.2		-	68	5.00	5.38	435	2340.3
(.60 X)	P	59	1.37	1.95	445	867.8		O	51	3.75	4.38	100	438.0
(.70 X)	Q	18	0.42	1.08	130	140.4	(.60 X)	P	22	1.62	2.90	445	1290.5
							(.70 X)	Q	5	0.37	1.24	130	161.2
					Sum =	8326.7						Sum =	27197.8
Area size			Amt. 2.25				Area size			Amt. 6.40			
	A	107.2	2.41	2.41	10	24.1		A	274	17.54	17.54	10	175.4
	B	106.5	2.40	2.405	15	36.1		B	255	16.32	16.93	15	254.0
15000/3	C	105.5	2.37	2.385	25	59.6	12000/1	C	238	15.23	15.78	25	394.5
	D	104.4	2.35	2.36	50	118.0		D	219	14.02	14.62	50	731.0
	E	103.3	2.32	2.335	75	175.1		E	203	12.99	13.50	75	1012.5
	F	102.8	2.31	2.315	125	289.4		F	186	11.90	12.44	125	1555.0
	G	102.3	2.30	2.305	125	288.5		G	174	11.14	11.52	125	1440.0
	H	102	2.30	2.30	125	287.5		H	159	10.18	10.66	125	1332.5
	I	101.7	2.29	2.295	150	344.2		I	147	9.41	9.80	150	1470.0
	J	101.2	2.28	2.285	240	548.4		J	135	8.64	9.02	240	2164.8
	K	100.8	2.27	2.275	340	773.5		K	123	7.87	8.26	340	2808.5
	L	100.5	2.26	2.265	240	543.6		L	113	7.23	7.55	240	1812.0
	M	100.1	2.25	2.255	525	1183.9		M	99	6.34	6.78	525	3559.5
	N	99.5	2.24	2.245	505	1133.7		N	87	5.57	5.96	505	3009.8
	O	99	2.23	2.235	535	1195.7		O	73	4.67	5.12	535	2739.2
	P	78	2.21	2.22	445	987.9		-	67	4.29	4.48	220	985.6
(.60 X)	Q	42	0.95	1.83	130	237.9	(.60 X)	P	38	2.43	3.55	225	798.8
(.70 X)							(.70 X)	Q	11	0.70	1.86	130	241.8
					Sum =	8226.7						Sum =	26484.8

Table 26.—Completed computation sheets for 1st three 6-hr increments for alternate placement of pattern on Leon River, TX drainage - Continued

Increment: 2 to 3

Drainage: Leon River, TX Area: 3,660 mi^2 Date: _____

	I	II	III	IV	V	VI		I	II	III	IV	V	VI
Area size	Iso.	Nomo.	Amt. 3.75	Avg. depth	ΔA	ΔV	Area size	Iso.	Nomo.	Amt. 2.41	Avg. depth	ΔA	ΔV
	A	123	4.61	4.61	10	46.1		A	106.6	2.57	2.57	10	25.7
	B	120	4.50	4.56	15	68.4		B	105.7	2.55	2.56	15	38.4
8000/2	C	116.5	4.37	4.44	25	110.9	8000/3	C	104.8	2.52	2.535	25	63.4
	D	114	4.28	4.32	50	216.0		D	103.7	2.50	2.51	50	125.5
	E	112	4.20	4.24	75	318.0		E	102.7	2.48	2.49	75	186.8
	F	100	4.12	4.16	125	520.0		F	102.2	2.46	2.47	125	308.8
	G	108	4.05	4.085	125	510.6		G	101.7	2.45	2.455	125	306.9
	H	106	3.98	4.015	125	501.9		H	101.4	2.44	2.445	125	305.6
	I	104.5	3.92	3.95	150	492.5		I	101.1	2.44	2.44	150	366.0
	J	103	3.86	3.89	240	933.6		J	100.7	2.43	2.435	240	584.4
	K	101.5	3.81	3.835	340	1303.9		K	100.3	2.42	2.425	340	824.5
	L	100	3.75	3.78	240	907.2		L	100	2.41	2.415	240	579.6
	M	98.5	3.69	3.72	525	1953.0		M	99.6	2.40	2.405	525	1262.6
	N	96	3.60	3.63	505	1833.2		N	99	2.38	2.39	505	1207.0
	-	95	3.56	3.58	320	1145.6		-	99	2.38	2.38	320	761.6
	O	66	2.48	3.02	215	649.3		O	79	1.90	2.14	215	460.1
(.60 X)	P	37	1.39	2.04	445	907.8	(.60 X)	P	45	1.08	1.57	445	698.6
(.70 X)	Q	6	0.22	1.04	130	135.2	(.70 X)	Q	8	0.19	0.81	130	105.3
					Sum =	12653.2						Sum =	8210.8
Area size			Amt. 3.70				Area size			Amt. 2.37			
	A	123.5	4.57	4.57	10	45.7		A	106.7	2.53	2.53	10	25.3
	B	120	4.44	4.50	15	67.5		B	105.8	2.51	2.52	15	37.8
9000/2	C	117	4.33	4.38	25	109.5	9000/3	C	104.9	2.49	2.50	25	62.5
	D	115	4.26	4.30	50	215.0		D	103.8	2.46	2.475	50	123.8
	E	113	4.18	4.24	75	318.0		E	102.7	2.43	2.445	75	183.4
	F	110.5	4.09	4.135	125	516.9		F	102.3	2.42	2.425	125	303.1
	G	108.5	4.01	4.05	125	506.2		G	101.8	2.41	2.415	125	301.9
	H	106.5	3.94	3.975	125	496.9		H	101.5	2.40	2.405	125	300.6
	I	104.5	3.87	3.905	150	585.8		I	101.2	2.40	2.40	150	360.0
	J	103.5	3.83	3.85	240	924.0		J	100.8	2.39	2.395	240	574.8
	K	102	3.77	3.80	340	1292.0		K	100.5	2.38	2.385	340	810.9
	L	100.5	3.72	3.745	240	898.8		L	100	2.37	2.375	240	570.0
	M	99	3.66	3.69	525	1937.2		M	99.7	2.36	2.365	525	1241.6
	N	97	3.59	3.625	505	1830.6		N	99.1	2.35	2.355	505	1189.3
	-	95	3.52	3.56	435	1548.6		-	99	2.35	2.35	435	1022.2
	O	79	2.92	3.22	100	322.0		O	88	2.08	2.215	100	221.5
(.60 X)	P	43	1.59	2.39	445	1063.6	(.60 X)	P	52	1.23	1.74	445	774.3
(.70 X)	Q	10	0.37	1.22	130	158.6	(.70 X)	Q	12	0.28	0.94	130	122.2
					Sum =	12836.9						Sum =	8225.2
Area size			Amt. 3.58				Area size			Amt. 2.30			
	A	124.5	4.46	4.46	10	44.6		A	107	2.46	2.46	10	24.6
	B	121	4.33	4.40	15	66.0		B	106.2	2.44	2.45	15	36.8
12000/2	C	118	4.22	4.28	25	107.0	12000/3	C	105.3	2.42	2.43	25	60.8
	D	116	4.15	4.18	50	209.0		D	104.2	2.40	2.41	50	120.5
	E	114	4.08	4.12	75	309.0		E	103.0	2.37	2.385	75	178.9
	F	112	4.01	4.04	125	505.0		F	102.6	2.36	2.365	125	295.6
	G	110	3.94	3.98	125	497.5		G	102.1	2.35	2.355	125	294.4
	H	108	3.87	3.90	125	487.5		H	101.8	2.34	2.345	125	293.1
	I	106.5	3.81	3.84	150	576.0		I	101.5	2.33	2.335	150	350.2
	J	105	3.76	3.78	240	907.2		J	101	2.32	2.325	240	558.0
	K	103	3.69	3.72	340	1264.8		K	100.7	2.32	2.32	340	788.8
	L	102	3.65	3.67	240	880.8		L	100.3	2.31	2.315	240	555.6
	M	100	3.58	3.62	525	1900.5		M	99.9	2.30	2.305	525	1210.1
	N	98	3.50	3.54	505	1787.7		N	99.3	2.28	2.29	505	1156.4
	O	96	3.44	3.47	535	1856.4		O	98.8	2.27	2.275	535	1217.1
	-	95	3.40	3.42	220	752.4		-	98.3	2.26	2.265	220	498.3
(.60 X)	P	64	2.29	2.96	225	666.0	(.60 X)	P	71.5	1.64	2.01	225	452.2
(.70 X)	Q	21	0.75	1.83	130	237.9	(.70 X)	Q	27.5	0.63	1.34	130	174.2
					Sum =	13055.3						Sum =	8265.6

In view of this result, and considering the elongated shape of the drainage, greater volume might have been obtained had the pattern in figure 49 been centered at one of the fatter parts of the drainage. By doing so, it appears possible that the H isohyet could be totally enclosed in the drainage when compared with the F isohyet as placed in figure 49. However, there would be proportionately lower volumes contributed from the rest of the drainage.

We will not carry this example beyond this point, as to do so would repeat the procedure demonstrated in example 1a. The objective of this example has been to show that, particularly for a long drainage, alignment of the isohyetal pattern (isohyets reduced for orientation) with the drainage axis will generally give greater volume than will a non-aligned pattern of unreduced isohyets.

7.4 Example No. 2a

The second example describes the effect of a drainage-centered pattern vs. a pattern placement that may be considered for obtaining peak discharge. Also considered in this example will be the evaluation of subdrainages.

For this example we chose the Ouachita River, Arkansas, above Rennel Dam, a drainage encompassing about 1,600 mi^2. The drainage outline drawn to a map scale of 1:1,000,000 is shown in figure 50 and includes four typical subdrainages. The areas within the four subdrainages are:

		Area (mi^2)
1.	Above Pine Ridge	300
2.	Between Pine Ridge and Washita	278
3.	Between Washita and Blakely Mt. Dam	604
4.	Between Blakely Mt. Dam and Rennel Dam	418

As in example 1a we will concern ourselves with determining the storm area size of the PMP pattern that provides the maximum volume within the entire 1,600 mi^2 drainage.

The following steps correspond to those outlined in section 7.1.

Step

A1. The drainage center for the Ouachita River above Rennel Dam is roughly 34°36'N, 93°27'W. At this location, the following table of values is obtained from figures 18 through 42 of HMR No. 51.

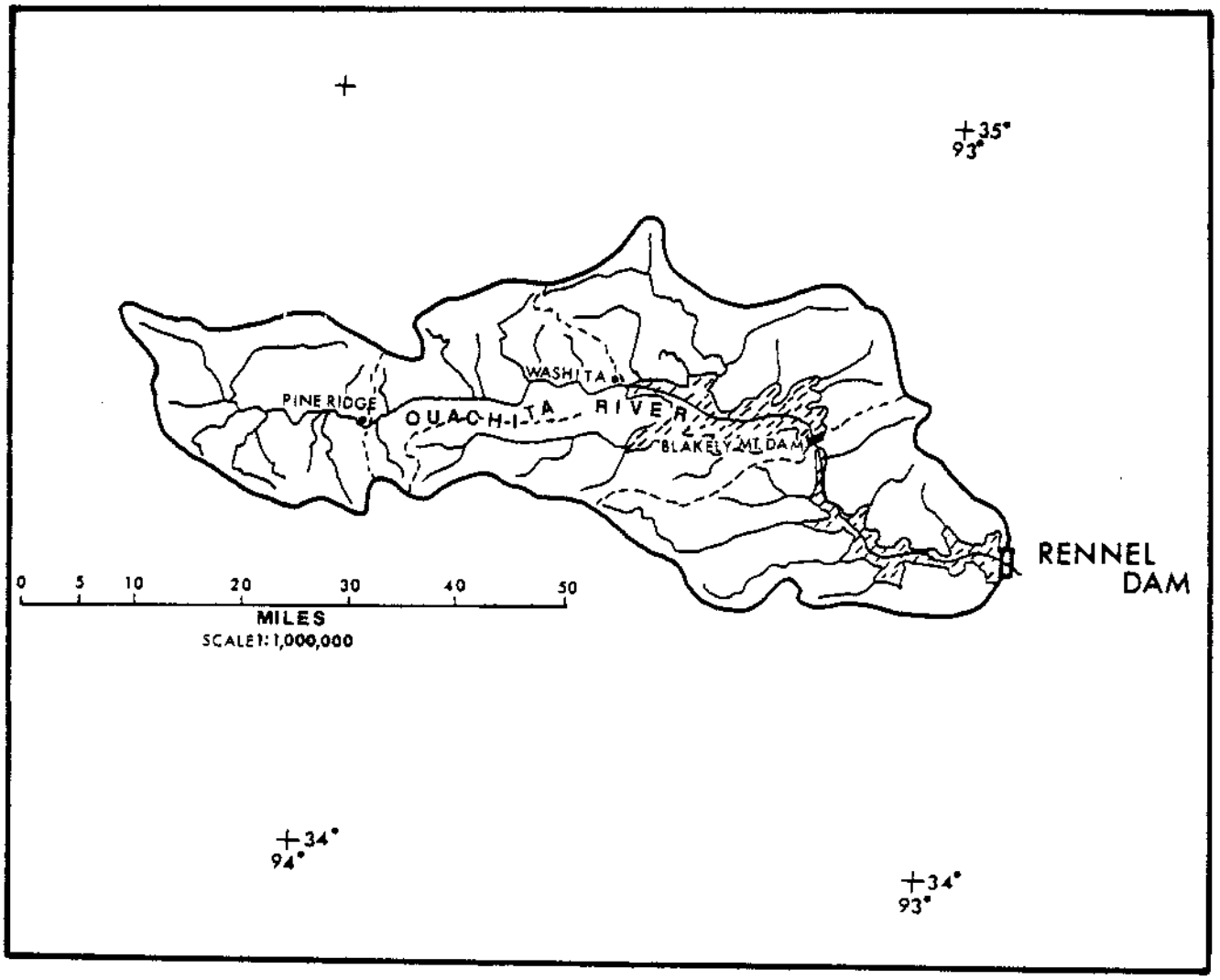

Figure 50.—Ouachita River, AR (1,600 mi^2) above Rennel Dam showing drainage.

	Duration (hr)				
Area (mi^2)	6	12	24	48	72
10	30.0	35.9	40.6	44.6	47.1
200	22.2	27.0	31.2	34.7	37.7
1000	16.3	21.0	25.3	29.0	31.2
5000	9.5	13.5	17.7	21.6	24.2
10000	7.3	10.7	14.0	18.0	20.8

A2. The storm-area averaged PMP depths in step A1 are plotted in figure 51 and smooth curves drawn. Notice that to obtain a consistent set of curves, it has not been possible to draw through all the data points.

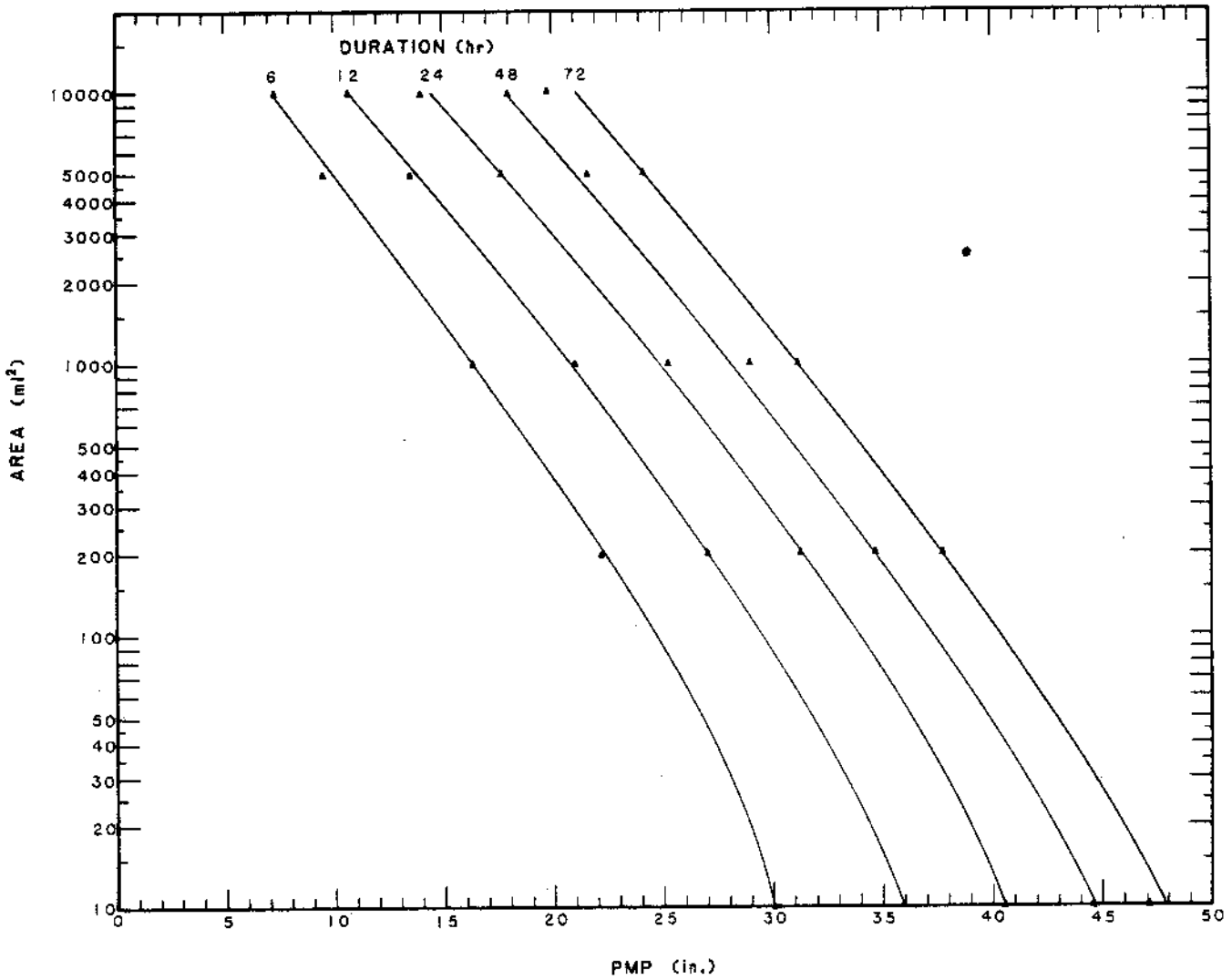

Figure 51.—Depth-area-duration curves for 34°36'N, 93°27'W applicable to the Ouachita River AR, drainage.

A3. From figure 51 we read off the data for at least 4 standard isohyet area sizes larger and smaller than the area of the drainage. We have chosen the areas in the following table.

	Duration (hr)				
Area (mi^2)	6	12	24	48	72
450	19.3	24.0	28.2	31.2	34.3
700	17.7	22.3	26.3	29.5	32.6
1000	16.3	20.8	24.9	28.0	31.1
1500	14.7	19.1	23.1	26.4	29.4
2150	13.3	17.5	21.5	24.8	27.8
3000	12.0	16.0	20.0	23.4	26.4
4500	10.4	14.2	18.2	21.5	24.6
6500	8.9	12.6	16.5	19.8	23.0

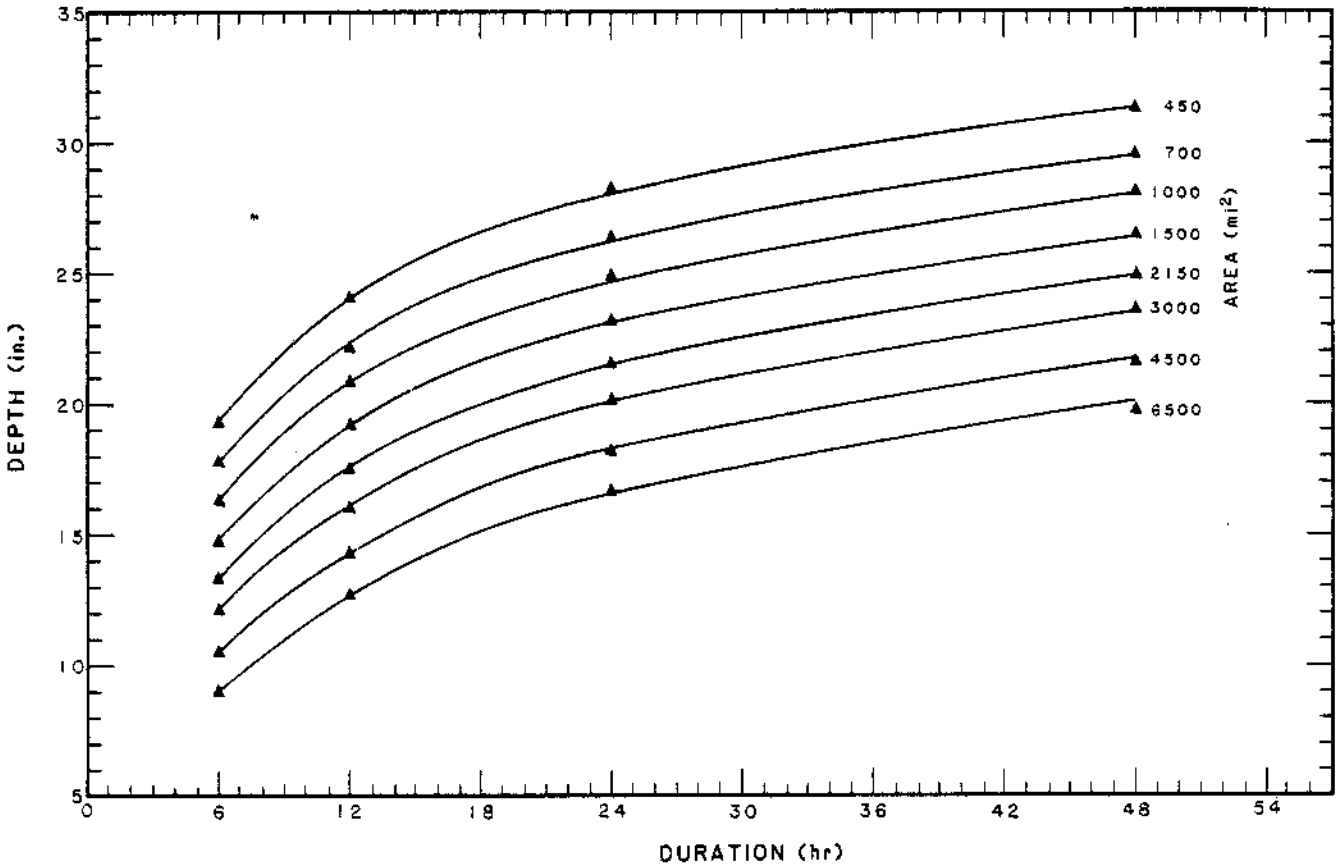

Figure 52.—Depth-duration curves for selected area sizes at 34°36'N, 93°27'W.

A4. A smooth depth-duration curve is drawn for each of the eight area sizes listed in step A3, as shown in figure 52. From these curves, values are interpolated for 18-hr durations.

Area (mi^2)	18-hr Duration
450	26.5
700	24.9
1000	23.2
1500	21.6
2150	20.0
3000	18.6
4500	16.8
6500	15.2

A5. Incremental differences are obtained for the 1st three 6-hr periods through subtraction of successive 6-hr values.

Area (mi^2)	6-hr periods 1	2	3
450	19.3	4.7	2.5
700	17.7	4.6	2.6
1000	16.3	4.5	2.4
1500	14.7	4.4	2.5
2150	13.3	4.4	2.5
3000	12.0	4.0	2.6
4500	10.4	3.8	2.6
6500	8.9	3.7	2.6

These values should then be plotted and fit by smooth curves as demonstrated in figure 53. The results from this figure provide smooth incremental values read to hundredths.

Area (mi^2)	6-hr periods 1	2	3
450	19.32	4.73	2.54
700	17.70	4.63	2.54
1000	16.34	4.51	2.54
1500	14.79	4.36	2.54
2150	13.40	4.21	2.53
3000	12.05	4.05	2.52
4500	10.35	3.86	2.51
6500	8.80	3.67	2.50

Note that within each column, the values consistently decrease as compared to the unsmoothed values.

B1. The isohyetal pattern from figure 5 is placed over the drainage outline drawn to a scale of 1:1,000,000 as shown in figure 54. It was judged that the best fit of the isohyetal pattern was to enclose the H isohyet by the drainage outline.

B2. For the isohyetal pattern placement in figure 54, the orientation is 095°. Since this orientation does not fall between the specified range of 135° and 315°, we add 180° to get an orientation of 275° (effectively the other end of the orientation line).

B3. From figure 8, the orientation for PMP at 34°36'N, 93°27'W is about 235°. The difference between the orientation of the pattern laid over the drainage and that of PMP from figure 8 is 40°. On the basis of the model shown in figure 10, no adjustment need be made to the values in step A5.

B4. This step is skipped as no reduction is required.

C. Now we can determine the maximum volume for PMP isohyetal pattern areas given in step A5. This computation is performed using the form provided in figure 41 and is completed for the

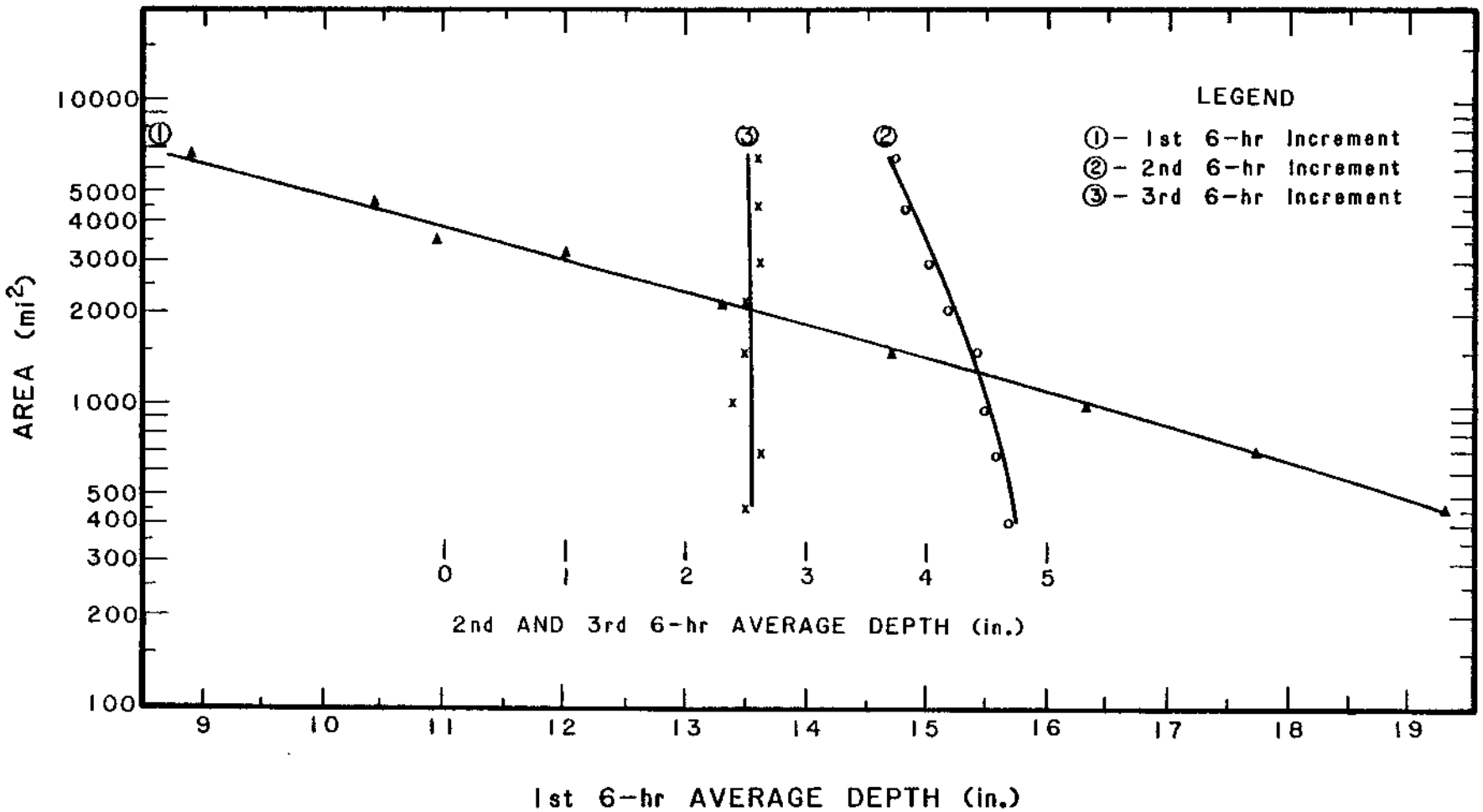

Figure 53.--Smoothing curves for 6-hr incremental values at selected area sizes for Ouachita River, AR drainage.

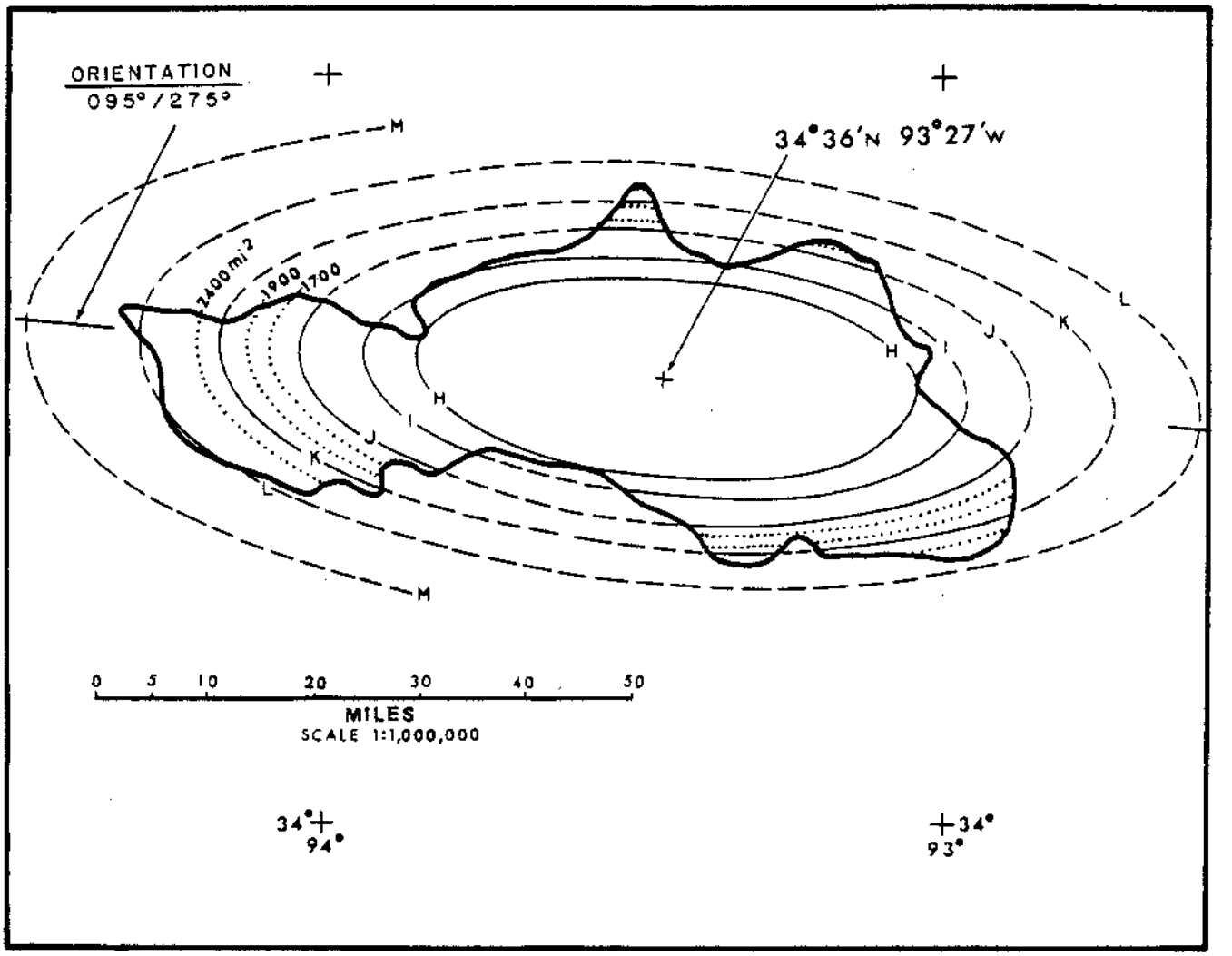

Figure 54.--Isohyetal pattern placed on the Ouachita River, AR drainage to give maximum precipitation volume.

1st 6-hr incremental period as shown in table 27, following the steps outlined in section 7.1c.

In this computation, it was decided that the average depth of rainfall over the small portion of the drainage between isohyets L and M was insignificant to the volume computation, and therefore only the volume within the L isohyet has been determined.

Following the computation through the 1st 6-hr period, we find volumes that range between 19,000 and 22,000 mi^2-in. with the maximum between 1,500 and 2,150 mi^2. When computing the 2nd and 3rd 6-hr increments, we can narrow in on the range of areas to those areas between 1,000 and 4,500 mi^2 (table 27). The results from summation of the incremental volumes at corresponding area sizes indicates that the maximum volume occurs at 2,150 mi^2.

Table 27.—Completed computation sheets for 1st three 6-hr increments for Ouachita River, AR drainage

Increment: 1

Drainage: Ouachita River, AR Area: 1,600 mi^2 Date:

	I	II	III	IV	V	VI		I	II	III	IV	V	VI
Area size	Iso.	Nomo.	Amt. 19.32	Avg. depth	ΔA	ΔV	Area size	Iso.	Nomo.	Amt. 14.79	Avg. depth	ΔA	ΔV
	A	132	25.50	25.50	10	255.0		A	162	23.88	23.88	10	238.8
	B	124	23.96	24.73	15	371.0		B	152	22.40	23.14	15	347.1
450/1	C	116	22.41	23.18	25	579.6	1500/1	C	142	20.93	21.66	25	541.5
	D	108	20.87	21.64	50	1082.0		D	132	19.52	20.22	50	1011.0
	E	101	19.52	20.20	75	1515.0		E	122	18.04	18.78	75	1408.5
	F	93	17.97	18.74	125	2342.5		F	112	16.51	17.28	125	2160.0
	G	86	16.62	17.30	150	2593.0		G	105	15.53	16.02	150	2403.0
	H	63	12.17	14.90	250	3725.0		H	96	14.15	24.84	250	3710.0
	I	50	9.66	10.92	242	2642.6		I	88	13.02	13.59	242	3288.8
	J	38	7.34	8.50	242	2057.0		J	80	11.79	12.40	242	3000.8
	K	30	5.80	6.57	224	1471.7		K	56	8.25	10.02	224	2244.5
	L	23	4.44	5.12	192	983.0		L	41	6.06	7.16	192	1374.7
					Sum =	19617.4						Sum =	21728.7
Area size			Amt. 17.70				Area size			Amt. 13.40			
	A	140	24.78	24.78	10	247.8		A	176	23.58	23.58	10	235.8
	B	132	23.36	24.12	15	361.8		B	165	22.11	22.84	15	342.6
700/1	C	124	21.95	22.66	25	566.5	2150/1	C	154	20.64	21.38	25	534.5
	D	115	20.36	21.16	50	1058.0		D	142	19.03	19.84	50	992.0
	E	107	18.94	19.65	75	1473.8		E	131	17.55	18.29	75	1371.8
	F	98	17.35	18.14	125	2267.5		F	122	16.35	16.05	125	2006.2
	G	92	16.28	16.82	150	2523.0		G	113	15.14	15.74	150	2361.0
	H	84	14.87	15.58	250	3895.0		H	103	13.80	14.47	250	3617.5
	I	63	11.15	13.01	242	3148.4		I	95	12.73	13.26	242	3208.9
	J	48	8.50	9.82	242	2376.4		J	86	11.52	12.12	242	2933.0
	K	36	6.37	7.44	224	1666.6		K	77	10.32	10.92	224	2446.1
	L	27	4.78	5.58	192	1071.4		L	52	5.97	8.64	192	1658.9
					Sum =	20656.2						Sum =	21708.3
Area size			Amt. 16.34				Area size			Amt. 12.05			
	A	149	24.35	24.35	10	243.5		A	191	23.02	23.02	10	230.2
	B	140	22.88	23.58	15	353.7		B	179	21.57	22.30	15	334.5
1000/1	C	131	21.41	22.12	25	553.0	3000/1	C	166	20.00	20.78	25	519.5
	D	122	19.93	20.67	50	1033.5		D	154	18.56	19.28	50	964.0
	E	113	18.46	19.20	75	1440.0		E	142	17.11	17.84	75	1338.0
	F	104	16.99	17.72	125	2215.0		F	132	15.91	16.51	125	2063.8
	G	97	15.85	16.42	150	2463.0		G	122	14.70	15.30	150	2295.0
	H	89	14.54	15.20	250	3800.0		H	112	13.50	14.10	250	3525.0
	I	82	13.40	13.97	242	3380.7		I	102	12.29	12.90	242	3121.8
	J	60	9.80	11.60	242	2807.2		J	92	11.09	11.69	242	2829.0
	K	44	7.19	8.50	224	1904.0		K	83	9.88	10.48	224	2347.5
	L	32	5.23	6.21	192	1192.3		L	74	8.92	9.40	192	1804.8
					Sum =	21385.9						Sum =	21373.1

Table 27.—Completed computation sheets for 1st three 6-hr increments for Ouachita River, AR drainage – Continued

Increment: 1, 2

Drainage: Ouachita River, AR Area: 1,600 mi^2 Date:

	I	II	III	IV	V	VI
Area size	Iso.	Nomo.	Amt. 10.35	Avg. depth	ΔA	ΔV
4500/1	A	212	21.94	21.94	10	219.4
	B	198	20.49	21.22	15	318.3
	C	184	19.04	19.76	25	494.0
	D	170	17.60	18.32	50	916.0
	E	157	16.25	16.92	75	1269.0
	F	146	15.11	15.68	125	1960.0
	G	135	13.97	14.54	150	2181.0
	H	124	12.83	13.40	250	3350.0
	I	113	11.70	12.26	242	2966.9
	J	103	10.66	11.18	242	2705.6
	K	93	9.63	10.14	224	2271.4
	L	83	8.59	9.11	192	1749.1
					Sum =	20409.7

	I	II	III	IV	V	VI
Area size	Iso.	Nomo.	Amt. 4.36	Avg. depth	ΔA	ΔV
1500/2	A	117	5.10	5.10	10	51.0
	B	113	4.93	5.02	15	74.2
	C	110	4.80	4.87	25	121.8
	D	107	4.67	4.74	50	237.0
	E	105	4.58	4.63	75	347.2
	F	103	4.49	4.54	125	567.5
	G	100.5	4.38	4.44	150	666.0
	H	99	4.32	4.35	250	1087.5
	I	97	4.23	4.28	242	1035.8
	J	95.5	4.16	4.20	242	1016.4
	K	75.5	3.29	3.73	224	835.5
	L	60	2.62	2.96	192	568.3
					Sum =	6608.2

Area size			Amt. 8.80			
6500/1	A	233	20.50	20.50	10	205.0
	B	218	19.18	19.84	15	297.6
	C	203	17.86	18.52	25	463.0
	D	187	16.46	17.16	50	858.0
	E	174	15.31	15.88	75	1191.0
	F	160	14.08	14.70	125	1837.5
	G	148	13.02	13.55	150	2032.5
	H	137	12.06	12.54	250	3135.0
	I	125	11.00	11.53	242	2790.3
	J	113	9.94	10.47	242	2533.7
	K	103	9.06	9.50	224	2128.0
	L	93	8.18	8.62	192	1655.0
					Sum =	19126.6

Area size			Amt. 4.21			
2150/2	A	118.5	4.99	4.99	10	49.9
	B	114.5	4.82	4.91	15	73.7
	C	111	4.67	4.75	25	118.8
	D	108.5	4.57	4.62	50	231.0
	E	106.5	4.48	4.53	75	339.8
	F	104.5	4.40	4.44	125	555.0
	G	102	4.29	4.35	150	652.5
	H	100	4.21	4.25	250	1062.5
	I	98.5	4.15	4.18	242	1011.6
	J	97	3.08	4.12	242	997.0
	K	95	4.00	4.04	224	904.9
	L	73	3.07	3.54	192	679.7
					Sum =	6676.4

Area size			Amt. 4.51			
1000/2	A	116	5.23	5.23	10	52.3
	B	112	5.05	5.14	15	77.1
	C	108.5	4.89	4.97	25	124.3
	D	105	4.74	4.82	50	241.0
	E	103	4.65	4.70	75	352.5
	F	101	4.56	4.61	125	576.2
	G	99	4.46	4.51	150	676.5
	H	97	4.37	4.42	250	1105.0
	I	95	4.28	4.33	242	1047.9
	J	76	3.43	3.86	242	934.1
	K	63	2.48	3.14	224	703.4
	L	51	2.30	2.57	192	493.4
					Sum =	6383.7

Area size			Amt. 4.05			
3000/2	A	119.5	4.84	4.84	10	48.4
	B	116	4.70	4.77	15	71.6
	C	112.5	4.56	4.63	25	115.8
	D	110	4.46	4.51	50	225.5
	E	108	4.37	4.42	75	331.5
	F	106	4.29	4.33	125	541.3
	G	104	4.21	4.25	150	637.5
	H	102	4.13	4.17	250	1042.5
	I	100	4.05	4.09	242	989.8
	J	99	4.01	4.03	242	975.3
	K	97	3.93	3.97	224	889.3
	L	96	3.89	3.91	192	750.7
					Sum =	6619.2

Table 27.—Completed computation sheets for 1st three 6-hr increments for Ouachita River, AR drainage - Continued

Increment: 2, 3

Drainage: Ouachita River, AR Area: 1,600 mi^2 Date:

	I	II	III	IV	V	VI
Area size	Iso.	Nomo.	Amt. 3.86	Avg. depth	ΔA	ΔV
4500/2	A	121	4.67	4.67	10	46.7
	B	117	4.52	4.60	15	68.9
	C	114	4.40	4.46	25	111.5
	D	112	4.32	4.36	50	218.0
	E	109.5	4.23	4.28	75	321.0
	F	108	4.17	4.20	125	525.0
	G	105.5	4.07	4.12	150	618.0
	H	103.5	4.00	4.04	250	1010.0
	I	102	3.94	3.97	242	960.7
	J	100.5	3.88	3.91	242	946.2
	K	99	3.82	3.85	224	862.4
	L	97.5	3.76	3.79	192	727.7
					Sum =	6416.1

	I	II	III	IV	V	VI
Area size	Iso.	Nomo.	Amt. 2.53	Avg. depth	ΔA	ΔV
2150/3	A	105.3	2.66	2.66	10	26.6
	B	104.2	2.64	2.65	15	39.8
	C	103.2	2.61	2.625	25	65.6
	D	102	2.58	2.595	50	129.8
	E	101.3	2.56	2.57	75	192.8
	F	101	2.56	2.56	125	320.0
	G	100.6	2.54	2.55	150	382.5
	H	100.3	2.54	2.54	250	635.0
	I	100	2.52	2.53	242	612.3
	J	99.7	2.52	2.52	242	609.8
	K	99.5	2.52	2.525	224	565.6
	L	80.5	2.04	2.28	192	437.8
					Sum =	4017.6

Area size			Amt. 2.54			
1000/3	A	104.6	2.66	2.66	10	26.6
	B	103.3	2.62	2.64	15	39.6
	C	102.3	2.60	2.61	25	65.3
	D	101.3	2.57	2.59	50	129.5
	E	100.6	2.56	2.57	75	192.8
	F	100.3	2.55	2.56	125	320.0
	G	99.9	2.54	2.55	150	382.5
	H	99.6	2.53	2.54	250	635.0
	I	99.3	2.52	2.53	242	612.3
	J	82.5	2.10	2.31	242	559.0
	K	67	1.70	1.90	224	425.6
	L	54	1.37	1.54	192	295.7
					Sum =	3683.9

Area size			Amt. 2.51			
3000/3	A	105.7	2.65	2.65	10	26.5
	B	104.6	2.63	2.64	15	39.6
	C	103.5	2.60	2.62	25	65.4
	D	102.5	2.57	2.59	50	129.5
	E	101.7	2.55	2.56	75	192.0
	F	101.3	2.54	2.55	125	318.8
	G	100.9	2.53	2.54	150	381.0
	H	100.5	2.52	2.53	250	632.5
	I	100.2	2.52	2.52	242	609.8
	J	99.9	2.51	2.52	242	609.8
	K	99.6	2.50	2.51	224	562.2
	L	99.2	2.49	2.50	192	480.0
					Sum =	4046.8

Area size			Amt. 2.54			
1500/3	A	105	2.67	2.67	10	26.7
	B	103.8	2.64	2.66	15	39.8
	C	102.7	2.61	2.63	25	65.8
	D	101.7	2.58	2.60	50	130.0
	E	101.0	2.57	2.58	75	193.5
	F	100.7	2.56	2.57	125	321.2
	G	100.3	2.55	2.56	150	384.0
	H	100	2.54	2.55	250	637.5
	I	99.7	2.53	2.535	242	613.5
	J	99.4	2.52	2.525	242	611.0
	K	81	2.06	2.29	224	513.0
	L	65.5	1.66	1.86	192	357.1
					Sum =	3893.1

Area size			Amt. 2.51			
4500/3	A	106	2.66	2.66	10	26.6
	B	105	2.64	2.65	15	39.8
	C	104	2.61	2.63	25	65.8
	D	103.1	2.59	2.60	50	130.0
	E	102.1	2.56	2.58	75	193.5
	F	101.7	2.55	2.56	125	320.0
	G	101.2	2.54	2.55	150	382.5
	H	100.9	2.53	2.54	250	635.0
	I	100.6	2.53	2.53	242	612.3
	J	100.2	2.52	2.53	242	612.3
	K	99.9	2.51	2.52	224	564.5
	L	99.6	2.50	2.51	192	481.9
					Sum =	4064.2

Table 27.—Completed computation sheets for 1st three 6-hr increments for Ouachita River, AR drainage - Continued

Increment: 1, 2

Drainage: Ouachita River, AR Area: 1,600 mi^2 Date:

	I	II	III	IV	V	VI		I	II	III	IV	V	VI
Area size	Iso.	Nomo.	Amt. 14.30	Avg. depth	ΔA	ΔV	Area size	Iso.	Nomo.	Amt. 4.30	Avg. depth	ΔA	ΔV
	A	167	23.88	23.88	10	238.8		A	117.5	5.05	5.05	10	50.5
	B	156	22.31	23.10	15	346.4		B	114	4.90	4.98	15	74.6
1700/1	C	145	20.74	21.52	25	538.1	1700/2	C	110.5	4.75	4.83	25	120.8
	D	135	19.30	20.02	50	1001.0		D	107.5	4.62	4.69	50	234.5
	E	125	17.88	18.59	75	1394.2		E	105	4.52	4.57	75	342.8
	F	116	16.59	17.24	125	2155.0		F	103.5	4.45	4.49	125	561.2
	G	107	15.30	15.94	150	2391.0		G	101	4.34	4.40	150	660.0
	H	98	14.01	14.52	250	3630.0		H	99	4.26	4.30	250	1075.0
	I	91	13.01	13.51	242	3269.4		I	97	4.17	4.22	242	1021.2
	J	82	11.73	12.37	242	2993.5		J	96	4.13	4.15	242	1004.3
	-	79	11.30	11.52	87	1002.2		-	95.5	4.10	4.12	87	358.4
	K	62	8.87	10.08	137	1381.0		K	80	3.44	3.77	137	516.5
	L	44	6.29	7.58	192	1455.4		L	64	2.74	3.07	192	589.4
					Sum =	21796.0						Sum =	6609.2
Area size			Amt. 13.85				Area size			Amt. 4.25			
	A	171	23.68	23.68	10	236.8		A	118	5.02	5.02	10	50.2
	B	160	22.16	22.92	15	343.8		B	116	4.93	4.98	15	74.6
1900/1	C	149	20.64	21.40	25	535.0	1900/2	C	111	4.72	4.83	25	120.8
	D	138	19.11	19.88	50	994.0		D	108	4.59	4.66	50	233.0
	E	128	17.73	18.42	75	1381.5		E	106	4.51	4.5	75	341.3
	F	118	16.34	17.03	125	2128.8		F	104	4.42	4.47	125	558.8
	G	110	15.24	15.79	150	2368.5		G	102	4.34	4.38	150	657.0
	H	100	13.85	14.54	250	3635.0		H	100	4.25	4.30	250	1075.0
	I	93	12.88	13.36	242	3233.1		I	98	4.17	4.21	242	1018.8
	J	84	11.63	12.26	242	2966.9		J	96.6	4.10	4.14	242	1001.9
	-	78	10.80	11.22	144	1615.7		-	95.5	4.06	4.08	144	587.5
	K	68	9.42	10.11	80	808.8		K	86	3.66	3.86	80	308.8
	L	48	6.65	8.04	192	1543.7		L	68	2.87	3.28	192	629.8
					Sum =	21791.6						Sum =	6657.5
Area size			Amt. 12.94				Area size			Amt. 4.15			
	A	181	23.42	23.42	10	234.2		A	119	4.94	4.94	10	49.4
	B	169	21.87	22.64	15	339.6		B	115	4.77	4.86	15	72.8
2400/1	C	158	20.44	21.16	25	528.9	2400/2	C	112	4.65	4.71	25	117.8
	D	146	18.89	19.66	50	983.0		D	109	4.52	4.59	50	229.3
	E	134	17.34	18.12	75	1359.0		E	107	4.44	4.48	75	336.0
	F	125	16.18	16.76	125	2095.0		F	105	4.36	4.40	125	550.0
	G	116	15.01	15.60	150	2340.0		G	103	4.27	4.32	150	647.3
	H	106	13.72	14.36	250	3590.0		H	101	4.19	4.23	250	1057.5
	I	97	12.55	13.14	242	3179.9		I	99	4.11	4.15	242	1004.3
	J	88	11.39	11.97	242	2896.7		J	97.5	4.05	4.08	242	987.4
	K	79	10.22	10.77	224	2412.5		K	96.5	4.00	4.025	224	901.6
	-	76	9.83	10.80	70	756.0		-	96	3.98	3.99	70	279.3
	L	58	7.50	8.67	122	1057.7		L	78	3.24	3.61	122	440.4
					Sum =	21772.5						Sum =	6613.1

Table 27.—Completed computation sheets for 1st three 6-hr increments for Ouachita River, AR drainage - Continued

Increment: 3

Drainage: Ouachita River, AR Area: 1,600 mi^2 Date:

	I	II	III	IV	V	VI		I	II	III	IV	V	VI
Area size	Iso.	Nomo.	Amt. 2.54	Avg. depth	ΔA	ΔV	Area size	Iso.	Nomo.	Amt.	Avg. depth	ΔA	ΔV
	A	105.1	2.67	2.67	10	26.7							
	B	104	2.64	2.66	15	39.8							
1700/3	C	102.8	2.61	2.63	25	65.8							
	D	101.9	2.59	2.60	50	130.0							
	E	101.1	2.57	2.58	75	193.5							
	F	100.7	2.56	2.57	125	321.2							
	G	100.4	2.55	2.56	150	384.0							
	H	100	2.54	2.55	250	637.5							
	I	99.7	2.53	2.54	242	614.7							
	J	99.5	2.53	2.53	242	612.3							
	-	99.3	2.52	2.525	87	219.7							
	K	86	2.18	2.35	137	322.0							
	L	70	1.78	1.98	192	380.2							
					Sum =	3947.4							
Area size			Amt. 2.53										
	A	105.2	2.66	2.66	10	26.6							
	B	104.1	2.63	2.65	15	39.7							
1900/3	C	103	2.61	2.62	25	65.5							
	D	102	2.58	2.60	50	130.0							
	E	101.2	2.56	2.57	75	192.8							
	F	100.8	2.55	2.56	125	320.0							
	G	100.5	2.54	2.55	150	382.5							
	H	100.2	2.54	2.54	250	635.0							
	I	99.8	2.52	2.53	242	612.3							
	J	99.6	2.52	2.52	242	609.8							
	-	99.4	2.51	2.525	144	363.4							
	K	92	2.33	2.42	80	193.6							
	L	75	1.90	2.12	192	407.0							
					Sum =	3978.2							
Area size			Amt. 2.52										
	A	105.4	2.66	2.66	10	26.6							
	B	104.3	2.63	2.65	15	39.7							
2400/3	C	103.3	2.60	2.62	25	65.4							
	D	102.3	2.58	2.59	50	129.5							
	E	101.5	2.56	2.57	75	192.8							
	F	101	2.55	2.56	125	320.0							
	G	100.7	2.54	2.55	150	382.5							
	H	100.3	2.53	2.54	250	635.0							
	I	100	2.52	2.53	242	612.3							
	J	99.8	2.51	2.52	242	609.8							
	K	99.4	2.50	2.51	224	562.2							
	-	99.3	2.50	2.50	70	175.0							
	L	86	2.17	2.34	122	285.5							
					Sum =	4036.3							

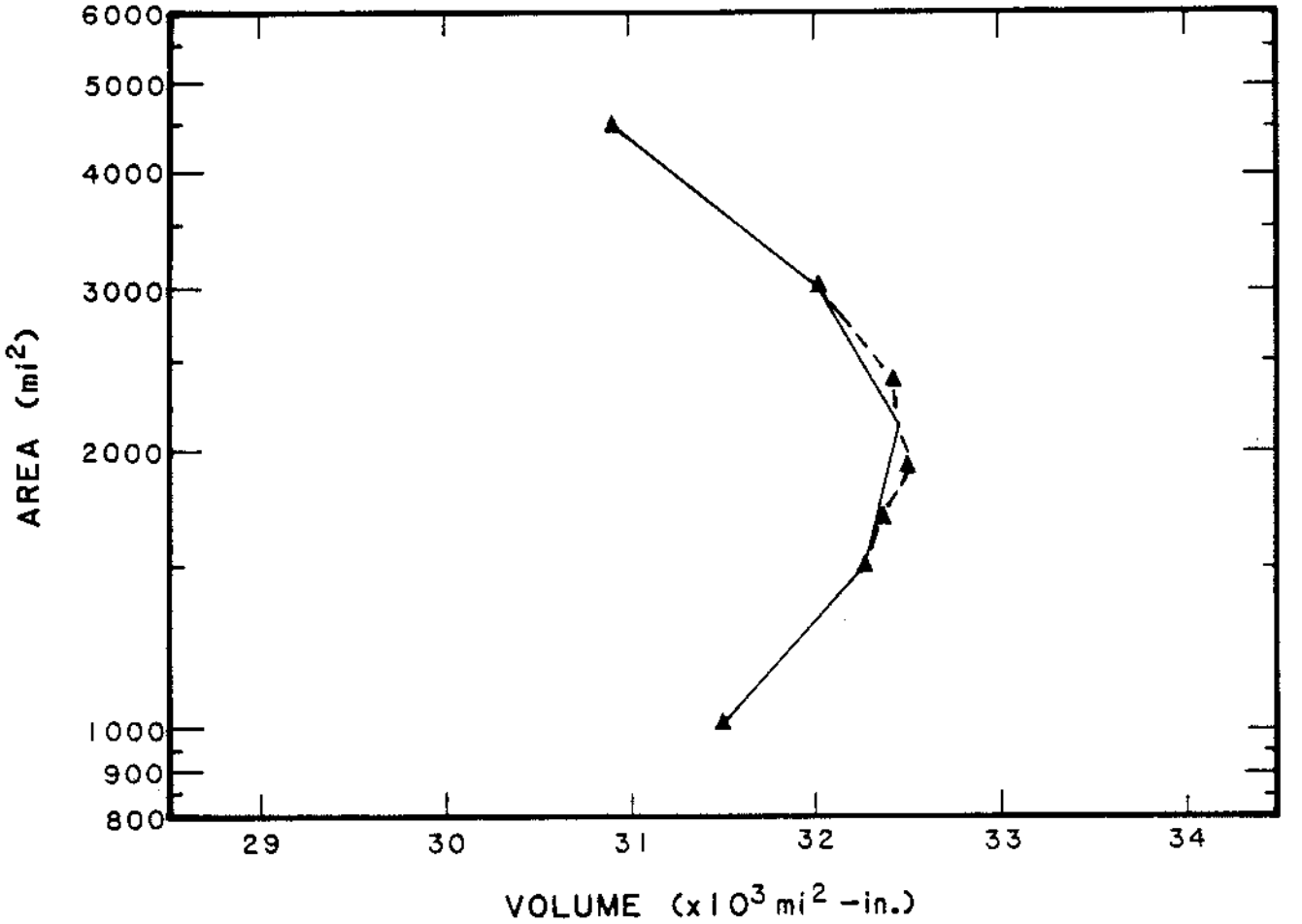

Figure 55.—Volume vs. area curve for 1st three 6-hr increments for Ouachita River, AR drainage.

As recommended in the procedure, we should compute volumes for supplemental area sizes on either side of 2,150 mi^2. We chose 1,700, 1,900 and 2,400 mi^2 (see table 27 for computations). Supplemental isohyets for these three area sizes have been added to figure 54 as the dotted isohyets. The additional computations result in the conclusion that the 1,900-mi^2 area pattern provides the greatest volume (about 32,400 mi^2-in.). (See the dashed line in figure 55.)

Step

D1. For an area size of 1,900 mi^2, it is necessary to return to figure 51 and read off depth-duration values as follows:

	Duration (hr)				
	6	12	24	48	72
1,900 mi^2 PMP (in.)	13.8	18.1	22.1	25.4	28.1

Plotting these data on a linear depth-duration diagram, we read off the following 6-hr values.

	Duration (hr)											
	6	12	18	24	30	36	42	48	54	60	66	72
1,900-mi^2 PMP (in.)	13.8	18.1	20.5	22.1	23.1	23.9	24.6	25.4	26.1	26.8	27.4	28.0

D2. Subtract the 6-hr value in step D1 from the 12-hr value, the 12-hr from the 18-hr, etc., to get the 12 incremental values.

	6-hr periods											
	1	2	3	4	5	6	7	8	9	10	11	12
Increm. PMP(in.)	13.8	4.3	2.4	1.6	1.0	0.8	0.7	0.8	0.7	0.7	0.6	0.6

Now the values for the 1st three increments can be replaced by the smoothed values obtained from figure 53, read to hundreths. Note, that to maintain a consistently decreasing set of values with increasing period it is necessary to interchange the incremental values for the 7th and 8th period to get a final smooth set of depth-duration values of:

	6-hr periods											
	1	2	3	4	5	6	7	8	9	10	11	12
Increm. PMP(in.)	13.85	4.25	2.53	1.60	1.00	0.80	0.80	0.70	0.70	0.70	0.60	0.60

D3. Form the matrix of isohyet values shown in table 28 by multiplying the 1st 6-hr value in step D2 times the isohyet percentages for 1,900 mi^2 from the 1st 6-hr nomogram (fig. 16), the 2nd 6-hr value in step D2 times the percentages for 1,900 mi^2 from figure 18, etc., and each of the fourth through 12th 6-hr values times the percentages from figure 20.

D4. Incremental average depths for the Ouachita River drainage with the 1,900-mi^2 PMP storm pattern placed as shown in figure 54 can be obtained using the incremental isohyetal labels in step D3 and the 6-hr incremental depths from step D2, as was done for example 1a. These results (computations shown in table 29) are,

	6-hr periods											
	1	2	3	4	5	6	7	8	9	10	11	12
Drainage avg. PMP (in.)	13.62	4.16	2.49	1.55	0.98	0.78	0.78	0.68	0.68	0.68	0.59	0.59

Table 28.—Isohyet values (in.), Ouachita River, AR, for example 2a

(Isohyet)	6-hr periods 1	2	3	4	5	6	7	8	9	10	11	12
A	23.68	5.02	2.66	1.60	1.00	0.80	0.80	0.70	0.70	0.70	0.60	0.60
B	22.16	4.93	2.63	1.60	1.00	0.80	0.80	0.70	0.70	0.70	0.60	0.60
C	20.64	4.72	2.61	1.60	1.00	0.80	0.80	0.70	0.70	0.70	0.60	0.60
D	19.18	4.59	2.58	1.60	1.00	0.80	0.80	0.70	0.70	0.70	0.60	0.60
E	17.73	4.51	2.56	1.60	1.00	0.80	0.80	0.70	0.70	0.70	0.60	0.60
F	16.41	4.42	2.55	1.60	1.00	0.80	0.80	0.70	0.70	0.70	0.60	0.60
G	15.24	4.34	2.54	1.60	1.00	0.80	0.80	0.70	0.70	0.70	0.60	0.60
H	13.92	4.25	2.54	1.60	1.00	0.80	0.80	0.70	0.70	0.70	0.60	0.60
I	12.88	4.17	2.52	1.60	1.00	0.80	0.80	0.70	0.70	0.70	0.60	0.60
J	11.63	4.10	2.52	1.60	1.00	0.80	0.80	0.70	0.70	0.70	0.60	0.60
1900 mi^2	10.80	4.06	2.51	1.60	1.00	0.80	0.80	0.70	0.70	0.70	0.60	0.65
K	9.35	3.66	2.33	1.47	0.92	0.74	0.74	0.64	0.64	0.64	0.55	0.55
L	6.58	2.89	1.90	1.19	0.74	0.60	0.60	0.52	0.52	0.52	0.45	0.45

Note the results shown in this matrix of isohyet values emphasize the fact that for the fourth through 12th 6-hr period the distribution of PMP is uniform across the PMP portion of the pattern (A through 1,900 mi^2) for each increment. However, isohyets outside the 1,900-mi^2 isohyet (K and L) represent the residual precipitation for the 1,900-mi^2 pattern, and these isohyets are assigned decreasing values.

These give a 72-hr total drainage-averaged PMP of 27.59 in. and can be compared to the 29.2 in. from figure 51 for 1,600 mi^2, or a 6 percent reduction from HMR No. 51. This small reduction is in part caused by the fact that no adjustment was made for orientation and the fact that the basin shape is relatively elliptical.

D5. In this example, isohyetal values for durations less than 6 hr were not required. If they were needed, they would be computed at this point.

E. Temporal Distribution

The isohyet values listed in the matrix of step D3 may be reordered according to the limitations given in section 2.3. Remember that if reordering is done, it must be done consistently for all isohyets covering the drainage.

F. Subdrainage Average Depths

Figure 56 shows the four subdrainages within the Ouachita River Drainage (above Rennel Dam) covered by the isohyetal pattern. It is often of interest to determine the incremental average depths of precipitation applied to each subdrainage. For this example we will demonstrate the steps to determine average depth

Table 29.--Completed computation sheets showing typical format to get incremental drainage-average depths, Ouachita River, AR .

Increment: 1 to 7

Drainage: Ouachita River, AR Area: 1,600 mi^2 Date: _____

	I	II	III	IV	V	VI
Area size	Iso.	Nomo.	Amt. 13.85	Avg. depth	A	V
1900/1	A				10	236.8
	B				15	343.8
	C				25	535.0
	D				50	994.0
	E				75	1381.5
	F				125	2128.4
	G				150	2368.5
	H				250	3635.0
	I				242	3233.1
	J				242	2966.9
	-				144	1615.7
	K				80	808.8
	L				192	1543.7
				Total =	1600	
				Sum =		21791.6
				Avg. depth =		13.62

	I	II	III	IV	V	VI
Area size	Iso.	Nomo.	Amt. 1.60	Avg. depth	A	V
1900/4	A	100	1.60	1.60	10	16.0
	B	100	1.60	1.60	15	24.0
	C	100	1.60	1.60	25	40.0
	D	100	1.60	1.60	50	80.0
	E	100	1.60	1.60	75	120.0
	F	100	1.60	1.60	125	200.0
	G	100	1.60	1.60	150	240.0
	H	100	1.60	1.60	250	400.0
	I	100	1.60	1.60	242	387.2
	J	100	1.60	1.60	242	387.2
	-	100	1.60	1.60	144	230.4
	K	92	1.35	1.48	80	118.4
	L	74.5	1.19	1.27	192	243.8
				Sum =		2487.0
				Avg. depth =		1.55

Area size			Amt. 4.25			
1900/2	A				10	50.2
	B				15	74.6
	C				25	120.8
	D				50	233.0
	E				75	341.3
	F				125	558.8
	G				150	657.0
	H				250	1075.0
	I				242	1018.8
	J				242	1001.9
	-				144	587.5
	K				80	308.8
	L				192	629.8
				Sum =		6657.5
				Avg. depth =		4.16

Area size			Amt. 1.00			
1900/5	A	100	1.00	1.00	10	10.0
	B	100	1.00	1.00	15	15.0
	C	100	1.00	1.00	25	25.0
	D	100	1.00	1.00	50	50.0
	E	100	1.00	1.00	75	75.0
	F	100	1.00	1.00	125	125.0
	G	100	1.00	1.00	150	150.0
	H	100	1.00	1.00	250	250.0
	I	100	1.00	1.00	242	242.0
	J	100	1.00	1.00	242	242.0
	-	100	1.00	1.00	144	144.0
	K	92	0.92	0.96	80	76.8
	L	74.5	0.74	0.83	192	159.4
				Sum =		1564.2
				Avg. depth =		.98

Area size			Amt. 2.53			
1900/3	A				10	26.6
	B				15	39.7
	C				25	65.5
	D				50	130.0
	E				75	192.8
	F				125	320.0
	G				150	382.5
	H				250	635.0
	I				242	612.3
	J				242	609.8
	-				144	363.4
	K				80	193.6
	L				192	407.0
				Sum =		3978.2
				Avg. depth =		2.49

Area size			Amt. 0.80			
1900/6,7	A	100	0.80	0.80	10	8.0
	B	100	0.80	0.80	15	12.0
	C	100	0.80	0.80	25	20.0
	D	100	0.80	0.80	50	40.0
	E	100	0.80	0.80	75	60.0
	F	100	0.80	0.80	125	100.0
	G	100	0.80	0.80	150	120.0
	H	100	0.80	0.80	250	200.0
	I	100	0.80	0.80	242	193.6
	J	100	0.80	0.80	242	193.6
	-	100	0.80	0.80	144	115.2
	K	92	0.74	0.77	80	61.6
	L	74.5	0.60	0.67	192	128.6
				Sum =		1252.6
				Avg. depth =		.78

Table 29.--Completed computation sheets showing typical format to get incremental drainage-average depths, Ouachita River, AR - Continued

Increment: 8 to 12

Drainage: Ouachita River, AR Area: 1,600 mi^2 Date:

	I	II	III	IV	V	VI
Area size	Iso.	Nomo.	Amt. 0.70	Avg. depth	ΔA	ΔV
1900/8,9, 10	A	100	0.70	0.70	10	7.0
	B	100	0.70	0.70	15	10.5
	C	100	0.70	0.70	25	17.5
	D	100	0.70	0.70	50	35.0
	E	100	0.70	0.70	75	52.5
	F	100	0.70	0.70	125	87.5
	G	100	0.70	0.70	150	105.0
	H	100	0.70	0.70	250	175.0
	I	100	0.70	0.70	242	169.4
	J	100	0.70	0.70	242	169.4
	-	100	0.70	0.70	144	100.8
	K	92	0.64	0.67	80	53.6
	L	74.5	0.52	0.58	192	111.4
					Sum =	1094.6
				Avg. depth =		.68

	I	II	III	IV	V	VI
Area size	Iso.	Nomo.	Amt.	Avg. depth	ΔA	ΔV
		100	0.60			
1900/11,12	A	100	0.60	0.60	10	6.0
	B	100	0.60	0.60	15	9.0
	C	100	0.60	0.60	25	15.0
	D	100	6.60	0.60	50	30.0
	E	100	0.60	0.60	75	45.0
	F	100	0.60	0.60	125	75.0
	G	100	0.60	0.60	150	90.0
	H	100	0.60	0.60	250	150.0
	I	100	0.60	0.60	242	145.2
	J	100	0.60	0.60	242	145.2
	-	100	0.60	0.60	144	86.4
	K	92	0.55	0.58	80	46.4
	L	74.5	0.45	0.50	192	96.0
					Sum =	939.2
				Avg. depth =		.59

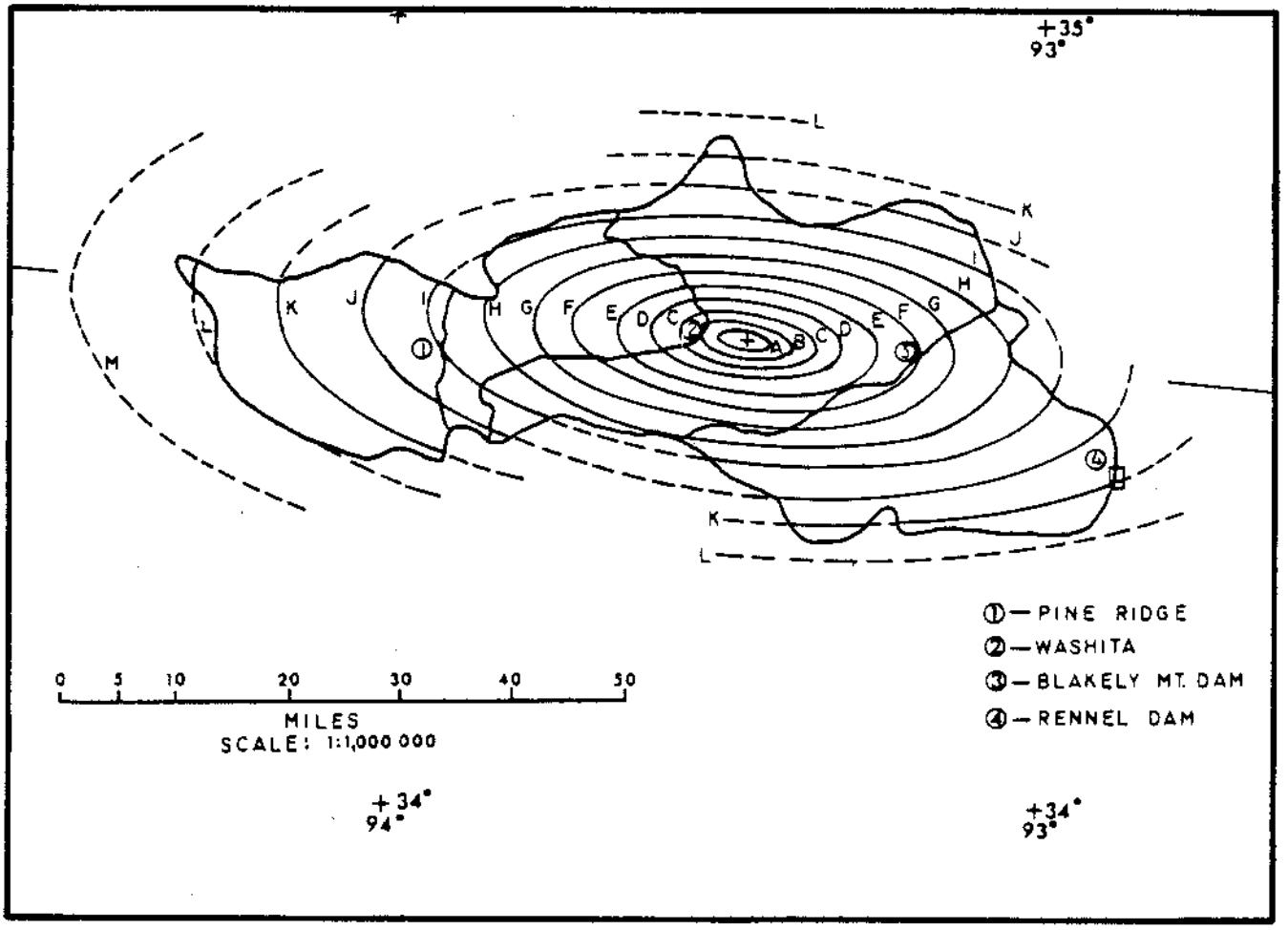

Figure 56.—Isohyetal pattern placed on the Ouachita River, AR drainage relative to subdrainages.

over the subdrainage between Pine Ridge and Washita (278 mi^2). From figure 56 we see that this subdrainage is covered by isohyets B through K.

Step

F1. Planimeter the areas between isohyets for each isohyet that crosses the subdrainage to obtain the areas used in column V of the computation sheet shown in table 30.

F2. Use the isohyet values in step D3 to fill in column III in table 30. Follow the computational procedure outlined in steps C5 to C8 to obtain the subdrainage incremental volumes. Note that for the fourth through 12th 6-hr periods it is not necessary to formally compute the volumes, since the subregion is not covered by residual precipitation, and

Table 30.—Completed computation sheet for determining average depths for 1st three 6-hr increments over subdrainage between Blakely Mt. Dam and Washita, AR

Increment: 1 to 3

Drainage: Ouachita River, AR Area: _____ Date: _____

	I	II	III	IV	V	VI		I	II	III	IV	V	VI
Area Size	Iso.	Nomo.	Amt.	Avg. depth	ΔA	ΔV	Area size	Iso.	Nomo.	Amt.	Avg. depth	ΔA	ΔV
	A												
	B		22.16										
1900/1	C		20.64	21.40	7.7	164.8							
	D		19.18	19.91	15.8	314.6							
	E		17.73	18.46	40.7	751.3							
	F		16.41	17.07	21.4	365.3							
	G		15.24	15.82	25.7	406.6							
	H		13.92	14.58	47.0	685.3							
	I		12.88	13.40	59.8	801.3							
	J		11.63	12.22	55.6	679.4							
	K		9.35	10.49	4.3	45.1							
				Total =	278.0								
					Sum =	4213.7							
				Avg. depth =		15.2 in.							
Area size			Amt.										
	A												
	B		4.93										
1900/2	C		4.72	4.82	7.7	37.4							
	D		4.59	4.66	15.8	73.6							
	E		4.51	4.55	40.7	185.2							
	F		4.42	4.46	21.4	95.4							
	G		4.34	4.38	25.7	112.6							
	H		4.25	4.30	47.0	202.1							
	I		4.17	4.21	59.8	251.8							
	J		4.10	4.14	55.6	230.2							
	K		3.66	3.88	4.3	16.7							
					Sum =	1205.0							
				Avg. depth =		4.3 in.							
Area size			Amt.										
	A												
	B		2.63										
1900/3	C		2.61	2.62	7.7	20.2							
	D		2.58	2.595	15.8	41.0							
	E		2.56	7.57	40.7	104.6							
	F		2.55	2.555	21.4	54.7							
	G		2.54	2.545	25.7	65.4							
	H		2.54	2.54	47.0	119.4							
	I		2.52	2.53	59.8	151.3							
	J		2.52	2.52	55.6	140.1							
	K		2.33	2.42	4.3	10.4							
					Sum =	707.1							
				Avg. depth =		2.5 in.							

thus the average depths for these increments will be the same as the incremental PMP amounts.

F3. The average depths for the subdrainage between Pine Ridge and Washita are thus,

	6-hr periods											
	1	2	3	4	5	6	7	8	9	10	11	12
Subdrainage. avg. depth (in.)	15.2	4.3	2.5	1.6	0.9	0.8	0.8	0.8	0.8	0.8	0.8	0.7

7.5 Example No. 2b

In this example we want to suggest that a placement of the isohyetal pattern closer to the outlet may be advantageous to bring about a greater peak discharge, however, the result is a lower volume than the drainage-centered placement considered in example 2a. Figure 57 shows the displacement of our standard pattern toward the drainage outlet. One might judge that a somewhat better placement is possible than that shown. However, for the purpose of illustration, it was believed necessary not to change the original orientation in order to show that any reduction in volume was due to difference other than orientation.

For this example, it is not necessary to start over by obtaining new values from HMR NO. 51.* Therefore, we can proceed directly to the computation of volume previously determined in table 27, and it is only necessary to change the incremental areas as a result of planimetering figure 57. The computations for the 1st three 6-hr increments for the standard isohyetal areas as recomputed in table 31 are shown to be roughly 10 percent lower than those for the drainage-centered placement (fig. 54).

In table 31, we find that unlike the result from example 2a, the area of PMP determined by maximum volume in the drainage has increased from 1,900 mi^2 to the vicinity of 3,000 mi^2. This result implies a less intense storm has been considered. Although not shown, a reduction in volume would also have occurred had we applied the same isohyet values from table 28 to the pattern shown in figure 57. These results support our claim that a placement that may be advantageous to obtaining a maximum peak discharge in general will give less than maximum volume.

Although relocation of a PMP storm pattern closer to the drainage outlet results in a a smaller drainage volume, one should consider the impact of concentrating a more intense storm pattern near the dam. A more intense storm here means a PMP storm pattern area less than that giving the maximum volume of precipitation in the drainage, but which contains greater central depths. For the example storm shown in figure 54, we might consider a PMP storm pattern for 450 mi^2 or 1,000 mi^2 and compute the peak discharge. Since we do not have sufficient information to compute the peak discharge, it is left to the user to make such tests. From these tests the user can determine whether other more

*The user may need to redetermine these if the pattern is moved a significant distance.

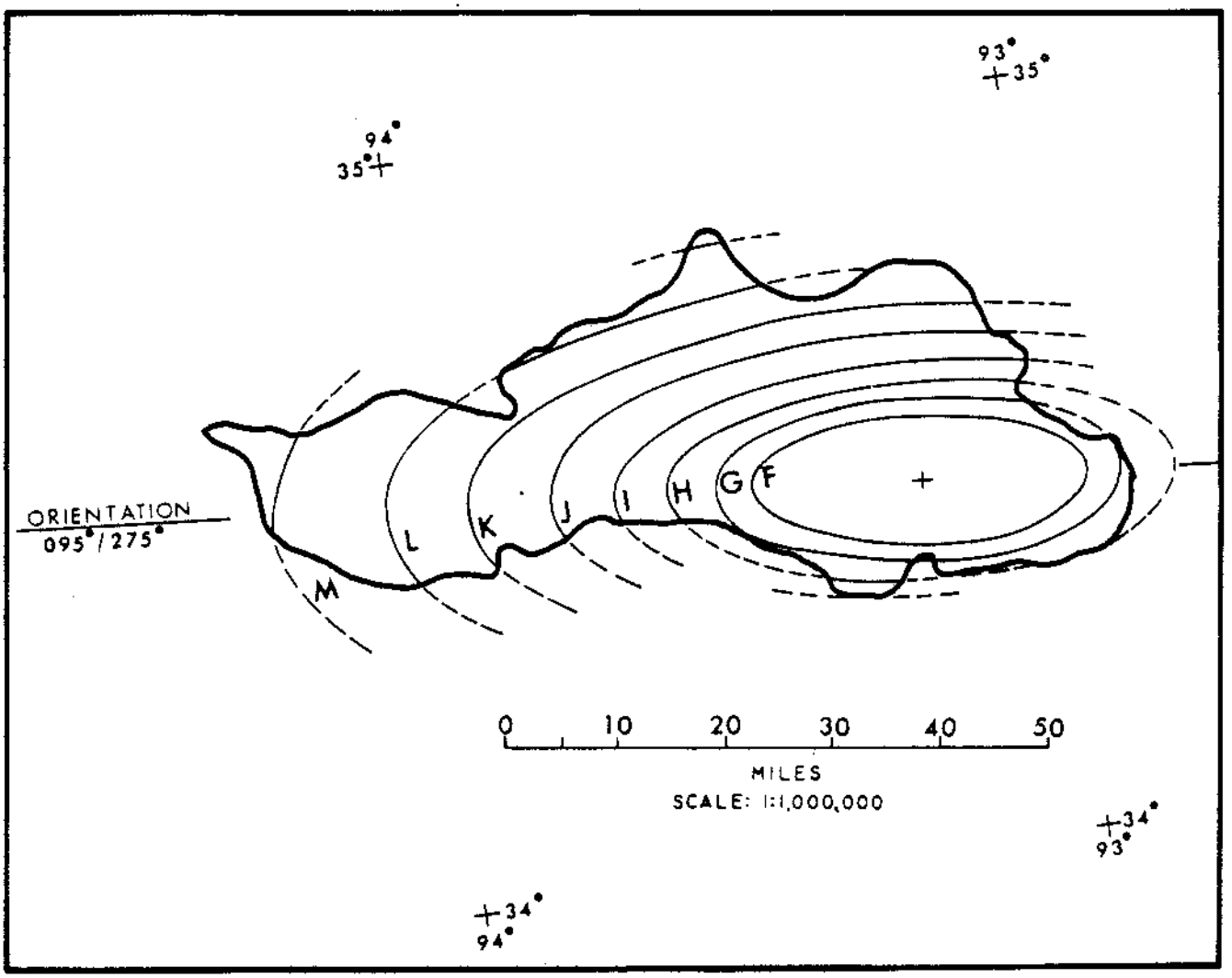

Figure 57.—Alternate placement of isohyetal pattern on Ouachita River, AR drainage typical of determination of peak discharge.

intense storms or pattern repositions will yield more critical peak flows. It should be noted again that drainage-averaged depths from any PMP pattern smaller than that which gives maximum volume in the drainage, will be less than drainage-averaged PMP.

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Table 31.—Completed computation sheets for 1st three 6-hr increments for alternate placement of pattern on Ouachita River, AR drainage

Increment: 1

Drainage: Ouachita River, AR Area: 1,600 mi^2 Date:

	I	II	III	IV	V	VI		I	II	III	IV	V	VI
Area size	Iso.	Nomo.	Amt. 17.70	Avg. depth	ΔA	ΔV	Area size	Iso.	Nomo.	Amt. 13.40	Avg. depth	ΔA	ΔV
	A	140	24.78	24.78	10	247.8		A	176	23.58	23.58	10	235.8
	B	132	23.36	24.07	15	361.0		B	165	22.11	22.84	15	342.6
700/1	C	124	21.95	22.66	25	566.5	2150/1	C	154	20.64	21.38	25	534.5
	D	115	20.36	21.16	50	1058.0		D	142	19.03	19.84	50	992.0
	E	107	18.94	19.65	75	1473.8		E	131	17.55	18.29	75	1371.8
	F	98	17.35	18.14	125	2267.5		F	122	16.35	16.95	125	2118.8
	G	92	16.28	16.82	140	2354.8		G	113	15.14	15.74	140	2203.6
	H	84	14.87	15.58	140	2181.2		H	103	13.80	14.47	140	2025.8
	I	63	11.15	13.01	115	1496.2		I	95	12.73	13.26	115	1524.9
	J	48	8.50	9.82	160	1571.2		J	86	11.52	12.12	160	1939.2
	K	36	6.37	7.44	210	1562.4		K	77	10.32	10.92	210	2293.2
	L	27	4.78	5.58	260	1450.8		L	52	6.97	8.64	260	2246.4
	M	18	3.19	3.98	225	895.5		M	33	4.42	5.70	225	1282.5
	N	10	1.77	2.48	50	124.0		N	20	2.68	3.55	50	177.5
					Sum =	16310.7						Sum =	19288.6
Area size			Amt. 16.34				Area size			Amt. 12.05			
	A	149	24.35	24.35	10	243.5		A	191	23.02	23.02	10	230.2
	B	140	22.88	23.62	15	354.3		B	179	21.57	22.30	15	334.5
1000/1	C	131	21.40	22.14	25	553.5	3000/1	C	166	20.00	20.78	25	519.5
	D	122	19.93	20.66	50	1033.0		D	154	18.56	19.28	50	964.0
	E	113	18.46	19.20	75	1440.0		E	142	17.11	17.84	75	1338.0
	F	104	16.99	17.73	125	2216.2		F	132	15.90	16.50	125	2062.5
	G	97	15.85	16.42	140	2298.8		G	122	14.70	15.30	140	2142.0
	H	89	14.54	15.20	140	2128.0		H	112	13.50	14.10	140	1974.0
	I	82	13.40	13.97	115	1606.6		I	102	12.29	12.90	115	1483.5
	J	60	9.80	11.60	160	1856.0		J	92	11.09	11.69	160	1870.4
	K	44	7.19	8.50	210	1785.0		K	83	10.00	10.54	210	2213.4
	L	32	5.23	6.21	260	1614.6		L	74	8.92	9.46	260	2459.6
	M	21	3.43	4.33	225	974.2		M	44	5.02	6.97	225	1568.2
	N	12	1.96	2.70	50	135.0		N	25	3.01	4.02	50	201.0
					Sum =	18238.7						Sum =	19360.8
Area size			Amt. 14.79				Area size			Amt. 10.35			
	A	162	23.96	23.96	10	239.6		A	212	21.94	21.94	10	219.4
	B	152	22.48	23.22	15	348.3		B	198	20.49	21.22	15	318.3
1500/1	C	142	21.00	21.74	25	543.5	4500/1	C	184	19.04	19.76	25	494.0
	D	132	19.52	20.26	50	1013.0		D	170	17.60	18.32	50	916.0
	E	122	18.04	18.78	75	1408.5		E	157	16.25	16.92	75	1269.0
	F	112	16.56	17.30	125	2162.5		F	146	15.11	15.68	125	1960.0
	G	105	15.53	16.04	140	2245.6		G	135	13.97	14.54	140	2035.6
	H	96	14.20	14.86	140	2080.4		H	124	12.83	13.40	140	1876.0
	I	88	13.02	13.61	115	1565.2		I	113	11.70	12.26	115	1409.9
	J	80	11.83	12.42	160	1987.2		J	103	10.66	11.18	160	1788.8
	K	56	8.28	10.06	210	2112.6		K	93	9.62	10.14	210	2129.4
	L	41	6.06	7.17	260	1864.2		L	83	8.59	9.10	260	2366.0
	M	26	3.84	4.95	225	1113.8		M	71	7.35	7.97	225	1793.2
	N	16	2.37	3.10	50	155.0		N	37	3.83	5.59	50	279.5
					Sum =	18839.4						Sum =	18855.1

Table 31.—Completed computation sheets for 1st three 6-hr increments for alternate placement of pattern on Ouachita River, AR drainage - Continued

Increment: 2

Drainage: Ouachita River, AR Area: 1,600 mi^2 Date:

	I	II	III	IV	V	VI		I	II	III	IV	V	VI
Area size	Iso.	Nomo.	Amt. 4.63	Avg. depth	ΔA	ΔV	Area size	Iso.	Nomo.	Amt. 4.21	Avg. depth	ΔA	ΔV
	A	114.5	5.30	5.30	10	53.0		A	118.5	4.99	4.99	10	49.9
	B	110	5.09	5.20	15	78.0		B	114.5	4.82	4.90	15	73.5
700/2	C	107	4.95	5.02	25	125.5	2150/2	C	111	4.67	4.74	25	118.5
	D	104	4.81	4.88	50	244.0		D	108.5	4.57	4.62	50	231.0
	E	101	4.68	4.74	75	355.0		E	106.5	4.48	4.52	75	339.0
	F	99	4.58	4.63	125	578.8		F	104.5	4.40	4.44	125	555.0
	G	97	4.49	4.54	140	635.6		G	102	4.29	4.34	140	607.6
	H	95	4.40	4.445	140	622.3		H	100	4.21	4.25	140	595.0
	I	78	3.61	4.005	115	460.6		I	99	4.17	4.19	115	481.8
	J	65.5	3.03	3.32	160	531.2		J	97	4.08	4.12	160	659.2
	K	54	2.50	2.76	210	579.6		K	96	4.04	4.06	210	852.6
	L	44	2.04	2.27	260	590.2		L	73	3.07	3.56	260	925.6
	M	32	1.48	1.76	225	396.0		M	54	2.27	2.67	225	600.8
	N	19.5	0.90	1.19	50	59.5		N	37.5	1.58	1.92	50	96.0
					Sum =	5309.3						Sum =	6185.5
Area size			Amt. 4.51				Area size			Amt. 4.05			
	A	116	5.23	5.23	10	52.3		A	119.5	4.84	4.84	10	48.4
	B	112	5.05	5.14	15	77.1		B	116	4.70	4.77	15	71.6
1000/2	C	108.5	4.89	4.97	25	124.2	3000/2	C	112.5	4.56	4.64	25	115.0
	D	105	4.74	4.82	50	241.0		D	110	4.46	4.51	50	225.0
	E	103	4.64	4.69	75	351.8		E	108	4.37	4.42	75	331.5
	F	101	4.56	4.60	125	575.0		F	106	4.29	4.33	125	541.2
	G	99	4.46	4.51	140	631.4		G	104	4.21	4.25	140	595.0
	H	97	4.37	4.42	140	618.8		H	102	4.13	4.17	140	483.8
	I	95	4.28	4.32	165	496.8		I	100.5	4.07	4.10	115	471.5
	J	76	3.43	3.86	160	617.6		J	99	4.01	4.04	160	646.5
	K	63	2.84	3.14	210	659.4		K	97	3.93	3.97	210	833.7
	L	51	2.30	2.57	260	668.2		L	96	3.89	3.91	260	1016.6
	M	38	1.71	2.01	225	452.2		M	67	2.71	3.30	225	742.5
	N	24	1.08	1.40	50	70.0		N	45	1.82	2.26	50	113.0
					Sum =	5635.8						Sum =	6336.7
Area size			Amt. 4.36				Area size			Amt. 3.86			
	A	117	5.10	5.10	10	51.0		A	121	4.67	4.67	10	46.7
	B	113	4.93	5.02	15	75.0		B	117	4.52	4.60	15	69.0
1500/2	C	110	4.80	4.86	25	121.5	4500/2	C	114	4.40	4.46	25	111.5
	D	107	4.66	4.73	50	236.5		D	112	4.32	4.36	50	218.0
	E	105	4.58	4.62	75	346.5		E	109.5	4.23	4.28	75	321.0
	F	103	4.49	4.54	125	567.5		F	108	4.17	4.20	125	525.0
	G	100.5	4.38	4.44	140	621.6		G	105.5	4.07	4.12	140	576.8
	H	99	4.32	4.35	140	609.0		H	103.5	4.00	4.04	140	565.6
	I	97	4.23	4.28	115	492.2		I	102	3.94	3.97	115	456.6
	J	95.5	4.16	4.20	160	672.0		J	100.5	3.88	3.91	160	625.6
	K	75.5	3.29	3.72	210	781.2		K	99	3.82	2.85	210	808.5
	L	60.5	2.64	2.96	260	769.6		L	97.5	3.76	3.79	260	985.4
	M	45	1.96	2.30	225	517.5		M	96	3.71	3.74	225	841.5
	N	31	1.35	1.66	50	83.0		N	59	2.28	3.00	50	150.0
					Sum =	5944.1						Sum =	6301.2

Table 31.—Completed computation sheets for 1st three 6-hr increments for alternate placement of pattern on Ouachita River, AR drainage - Continued

Increment: 3

Drainage: Ouachita River, AR Area: 1,600 mi^2 Date:

Area size	I Iso.	II Nomo.	III Amt. 2.54	IV Avg. depth	V ΔA	VI ΔV
700/3	A	104.2	2.65	2.65	10	26.5
	B	102.9	2.61	2.63	15	39.3
	C	101.7	2.58	2.595	25	64.9
	D	100.8	2.56	2.57	50	128.5
	E	100.2	2.54	2.55	75	191.2
	F	99.9	2.54	2.54	125	317.5
	G	99.6	2.53	2.535	140	354.9
	H	99.2	2.52	2.525	140	353.5
	I	85	2.16	2.34	115	269.1
	J	70.5	1.79	1.98	160	316.8
	K	58.5	1.48	1.64	210	344.4
	L	47	1.19	1.34	260	348.4
	M	37	0.94	1.06	225	238.5
	N	25.5	0.65	0.80	50	40.0
					Sum =	3033.5

Area size	I Iso.	II Nomo.	III Amt. 2.53	IV Avg. depth	V ΔA	VI ΔV
2150/3	A	105.3	2.66	2.66	10	26.6
	B	104.2	2.64	2.65	15	39.8
	C	103.2	2.61	2.625	25	65.6
	D	102	2.58	2.595	50	129.8
	E	101.3	2.56	2.57	75	192.8
	F	101	2.56	2.56	125	320.0
	G	100.6	2.54	2.55	140	357.0
	H	100.3	2.54	2.54	140	355.6
	I	100	2.53	2.535	115	291.5
	J	99.7	2.52	2.525	160	404.0
	K	95.5	2.42	2.47	210	518.7
	L	80.5	2.04	2.23	260	579.8
	M	61	1.54	1.79	225	402.8
	N	46.5	1.18	1.36	50	68.0
					Sum =	3752.0

Area size			Amt. 2.54			
1000/2	A	104.6	2.66	2.66	10	26.6
	B	103.3	2.62	2.64	15	39.6
	C	102.3	2.60	2.61	25	65.2
	D	101.3	2.57	2.585	50	129.2
	E	100.6	2.56	2.565	75	192.4
	F	100.3	2.55	2.555	125	319.4
	G	99.9	2.54	2.545	140	356.3
	H	99.6	2.53	2.535	140	354.9
	I	99.3	2.52	2.525	115	290.4
	J	82.5	2.10	2.31	160	369.6
	K	67	1.70	1.90	210	399.0
	L	54	1.73	1.16	260	301.6
	M	43	1.09	1.23	225	276.8
	N	31	0.79	0.94	50	47.0
					Sum =	3168.0

Area size			Amt. 2.52			
3000/3	A	105.7	2.66	2.66	10	26.6
	B	104.6	2.64	2.65	15	39.8
	C	103.5	2.61	2.625	25	65.6
	D	102.5	2.58	2.595	50	129.8
	E	101.7	2.56	2.57	75	192.8
	F	101.3	2.55	2.555	125	319.4
	G	100.9	2.54	2.545	140	356.3
	H	100.5	2.53	2.535	140	354.9
	I	100.2	2.52	2.525	115	290.4
	J	99.9	2.52	2.52	160	403.2
	K	99.6	2.51	2.515	210	528.2
	L	99.3	2.50	2.505	260	651.3
	M	76	1.92	2.21	225	497.2
	N	57	1.44	1.68	50	84.0
					Sum =	3939.5

Area size			Amt. 2.54			
1500/3	A	105	2.67	2.67	10	26.7
	B	103.8	2.64	2.655	15	39.8
	C	102.7	2.61	2.625	25	65.6
	D	101.7	2.58	2.595	50	129.8
	E	101	2.56	2.57	75	192.8
	F	100.7	2.56	2.56	125	320.0
	G	100.3	2.55	2.555	140	357.7
	H	100	2.54	2.545	140	356.3
	I	99.7	2.53	2.535	115	291.5
	J	99.4	2.52	2.525	160	404.0
	K	81	2.06	2.29	210	480.9
	L	65.5	1.66	1.86	260	483.6
	M	51.5	1.31	1.48	225	333.0
	N	38	0.96	1.14	50	57.0
					Sum =	3548.7

Area size			Amt. 2.51			
4500/3	A	106	2.66	2.66	10	26.6
	B	105	2.64	2.65	15	39.8
	C	104	2.61	2.625	25	65.6
	D	103.1	2.59	2.60	50	130.0
	E	102.1	2.56	2.575	75	193.0
	F	101.7	2.55	2.555	125	319.4
	G	101.2	2.54	2.545	140	356.3
	H	100.9	2.53	2.535	140	354.9
	I	100.6	2.52	2.525	115	290.4
	J	100.2	2.52	2.52	160	403.2
	K	99.9	2.51	2.515	210	528.2
	L	99.6	2.50	2.505	260	651.3
	M	99.3	2.49	2.495	225	591.4
	N	76	1.91	2.20	50	110.0
					Sum =	4030.2

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APPENDIX

The 53 storms listed in the Appendix to HMR 51 were chosen as the sample of storms to be used initially in this study. However, in the study of storm shapes and orientations it was found that this sample was particularly small when questions of regional variation, regional averages, or statistical distributions were considered. For this reason a subordinate storm sample was created to provide additional guidance in some of these discussions.

The subordinate sample of storms was derived from the major storms listed in "Storm Rainfall" (U.S. Army Corps of Engineers 1945-). This file includes storms from as early as the 1870's and is continually updated as new storms are studied. Some additional storm data are available from other agencies and from storms studied by the Hydrometeorological Branch. We concentrated on the 253 storms whose areas were 10,000 mi^2 or larger and whose durations were 60 hr or longer, since we believe the larger/longer storms were more useful in pointing up possible differences. We also imposed a controlling factor in our storm selection, that only storms whose 72-hr depth was 90 percent or more of the total-storm depth (20,000 mi^2, 72 hr) would be used, because we wanted storms that basically represented extreme 3-day rains. These are listed in table A.1.

The distribution of the 253 storms according to area and duration classes is shown in table A.2.

The regional distribution of this sample is shown in figure A.1, which includes the orientation of the respective rainfall patterns. One feature shown in this figure is that even in this sample of 253 storms, there are local regions for which no storms satisfying the areal and durational criteria of our sample occur. That is not to say that storms of these magnitudes have not occurred in these regions, but rather that we have no records of such storms.

The distribution of the 253 storms relative to area size and shape ratio classes is given in table A.3. These results can be compared to those in table 7 for the 53 storm sample.

Table A.1.--253 Major storms (listed in Storm Rainfall, ≥ 10,000 mi^2 and ≥ 60 hr; 72 hr ≥ 90% total storm amount at 20,000 mi^2, arranged in chronological order)

Date	Station nearest center	Lat. (°)	Lat. (')	Long. (°)	Long. (')	Tot. st. dur. (hr)	Tot. st. area (mi^2)	1000-mi^2 24-hr amt. (in.)
9/10-13/1878	Jefferson, OH	41	45	80	46	84	90,000	11.0
9/20-24/82	Paterson, NJ	40	55	74	10	108	40,000	7.9
7/27-31/87	Union Pt., GA	33	37	83	04	114	100,000	9.0
9/8-12/88	Greenwood, SC	34	12	82	10	120	120,000	8.4
5/30-6/1/89	Wellsboro, PA	41	45	77	17	60	82,000	8.3
3/5-9/91	Kosciusko, MS	33	05	89	35	114	185,000	7.2
6/23-27/91	Larrabee, IA	42	52	95	30	96	30,000	9.3
7/24-28/92	Minneapolis, MN	45	04	93	18	108	20,000	6.4
5/25-29/93	Marianna, AR	34	44	90	49	96	175,000	7.7
8/26-28/93	Manning, SC	33	41	80	12	66	54,000	11.1
9/6-10/93	Franklin, LA	29	47	91	30	114	40,000	10.4
3/17-20/94	Washington, AR	33	48	93	40	72	112,000	6.0
5/17-22/94	Bridgeton, NJ	39	26	75	14	120	57,000	5.1
5/29-31/94	Ward District, CO	40	04	105	32	60	25,300	4.6
8/3-6/94	Folkland, NC	35	34	77	38	96	72,800	6.4
12/16-20/95	Phillipsburg, MO	37	34	92	47	96	110,000	6.5
6/4-7/96	Greeley, NE	41	33	98	32	78	84,000	9.2
7/6-8/96	Greenwood, SC	34	11	82	09	66	118,000	6.0
9/27-30/96	Bloomery, WV	39	23	78	22	66	50,000	6.8
7/12-14/97	Southington, CT	41	39	72	53	60	44,000	6.7
7/18-22/97	Lambert, MN	47	47	95	55	102	80,000	5.8
7/25-27/97	Butternut, WI	46	00	90	30	66	15,000	8.6
7/26-29/97	Jewell, MD	38	46	76	34	96	32,000	6.2
12/31-1/3/97	Pine Bluff, AR	34	12	92	00	78	118,000	5.7
12/1-4/97	Jackson, MS	32	17	90	11	96	70,000	6.6
5/2-6/98	Norman, OK	35	13	97	28	84	68,000	6.0
6/2-6/98	Pine River Dam, MN	46	41	94	07	102	30,000	5.7
8/26-29/98	St. Andrews Bay, FL	30	10	85	42	96	64,000	7.0
8/30-9/3/98	Port Royal, SC	32	23	80	42	120	42,000	9.6
9/28-10/1/98	Pensacola, FL	30	25	87	13	84	75,500	8.1
10/2-4/98	Highlands, NC	35	02	83	12	66	60,000	5.9
6/27-7/1/99	Hearne, TX	30	52	96	37	108	78,000	21.1
12/8-11/99	Port Gibson, MS	31	58	90	59	66	30,000	7.3
4/15-18/1900	Eutaw, AL	32	47	87	50	84	75,000	11.3
7/14-17/00	Primghar, IA	43	05	95	38	78	100,000	9.1
9/7-11/00	Elk Point, SD	42	41	96	40	102	50,000	6.1
10/27-30/00	La Crosse, WI	43	48	91	15	78	15,200	6.7
5/18-22/01	Lumberton, NC	34	32	79	00	108	79,600	6.2
7/1-6/01	New Folden, MN	48	22	96	20	108	50,000	6.1
3/25-29/02	Ripley, MS	34	42	88	57	114	100,000	8.6

Table A.1 - 253 Major storms (listed in Storm Rainfall, ≥ 10,000 mi^2 and ≥ 60 hr; 72 hr ≥ 90% total storm amount at 20,000 mi^2, arranged in chronological order) - Continued

Date	Station nearest center	Lat. (°)	Lat. (')	Long. (°)	Long. (')	Tot. st. dur. (hr)	Tot. st. area (mi^2)	1000-mi^2 24-hr amt. (in.)
9/20-24/02	Wakeeney, KS	39	01	99	53	108	81,600	5.3
9/24-27/02	Colora, MD	39	40	76	06	72	40,000	5.6
8/24-28/03	Woodburn, IA	40	57	93	35	96	59,000	10.3
9/7-10/03	Burlington, KS	38	12	95	45	72	40,900	5.7
9/28-10/1/03	Gainesville, TX	33	37	97	08	90	50,000	7.5
10/7-11/03	Paterson, NJ	40	55	74	10	96	35,000	10.9
5/1-3/04	Boxelder, CO	40	59	105	11	66	21,200	3.4
6/1-5/04	Hartshorne, OK	34	51	95	33	84	66,000	7.2
6/2-5/04	Spearfish, SD	44	29	103	47	78	12,300	3.4
9/12-15/04	Friesburg, NJ	39	35	75	25	66	35,000	6.7
9/26-30/04	Rociada, NM	35	52	105	27	90	70,000	5.4
2/10-13/05	Putman, GA	32	14	84	25	72	80,000	5.8
6/3-8/05	Medford, WI	45	08	90	20	120	67,000	7.0
7/18-21/05	Hartshorne, OK	34	51	95	33	84	100,000	6.8
10/16-19/05	New Haven, MO	38	38	91	13	69	26,000	6.6
8/21-25/06	Hartington, NE	42	37	97	16	96	33,900	4.7
8/22-26/06	Warsaw, MO	38	15	93	21	102	24,300	6.6
5/7-10/07	Lafayette, LA	30	14	91	59	96	49,000	9.0
5/28-31/07	Sugarland, TX	29	36	95	38	90	80,000	8.7
7/13-16/07	Nemaha, NE	40	20	95	41	96	40,000	7.9
5/21-25/08	Chatanooga, OK	34	25	98	39	108	175,000	6.1
7/28-31/08	New Bern, NC	35	07	77	03	72	29,000	5.9
8/23-28/08	Vade Meccum, NC	36	26	80	28	120	69,600	9.5
9/16-20/08	Cameron, LA	29	45	93	20	102	22,000	10.1
10/19-24/08	Meeker, OK	35	30	96	54	126	80,000	8.6
5/24-28/09	Shoccoa, MS	32	39	89	53	114	70,000	7.2
7/4-7/09	Bethany, MO	40	15	94	02	66	27,000	7.3
7/18-23/09	Ironwood, MI	46	27	90	11	108	50,000	10.0
9/6-9/09	Topeka, KS	39	04	95	37	78	39,000	6.9
9/19-22/09	St. Francisville, LA	30	46	91	22	66	31,000	10.2
6/6-11/10	Boonville, MO	38	58	92	45	120	70,000	2.9
10/3-6/10	Golconda, IL	37	22	88	29	90	70,000	7.4
2/16-18/11	Woodward (nr), OK	36	27	99	23	60	44,400	4.5
4/12-15/11	Benton, AR	34	33	92	37	60	75,000	4.9
8/28-31/11	St. George, GA	30	30	82	02	84	39,000	13.5
4/11-14/12	Arnegard, ND	47	48	103	25	90	10,700	2.0
5/19-22/12	Gladwin, MI	43	59	84	29	72	37,156	4.6
6/14-18/12	Johnstown, PA	40	20	78	55	120	50,000	4.0
9/22-25/12	Emmitsburg, Md	39	41	77	21	72	40,000	4.6
9/22-25/12	Camden, SC	34	15	80	37	72	16,000	5.5

Table A.1 - 253 Major storms (listed in Storm Rainfall, ≥ 10,000 mi^2 and ≥ 60 hr; 72 hr ≥ 90% total storm amount at 20,000 mi^2, arranged in chronological order) - Continued

Date	Station nearest center	Lat. (°)	Lat. (')	Long. (°)	Long. (')	Tot. st. dur. (hr)	Tot. st. area (mi^2)	1000-mi^2 24-hr amt. (in.)
7/12-15/13	Toboso, OH	40	03	82	13	84	17,000	5.9
12/1-5/13	San Marcos (nr), TX	29	52	97	57	96	70,000	9.3
3/24-28/14	Merryville, LA	30	46	93	32	96	125,000	10.7
4/24-28/14	Merryville, LA	30	46	93	32	96	100,000	8.1
4/29-5/2/14	Clayton, NM	36	20	103	06	66	36,500	7.9
6/25-28/14	Hazelton, ND	46	29	100	17	90	66,000	6.8
6/25-28/14	Morris, MN	45	35	95	55	60	45,000	4.7
2/12-14/15	Onida, SD	44	42	100	04	60	50,000	3.1
6/2-7/15	Henrietta, TX	33	48	98	12	138	60,000	4.7
9/6-9/15	Moran, KS	37	56	95	10	96	24,000	7.6
5/14-19/16	York, NY	42	52	77	52	120	21,400	3.8
7/13-17/16	New Ulm, MN	44	19	94	28	96	30,000	5.6
7/15-17/16	Altapass, NC	35	53	82	01	108	37,000	15.0
9/10-12/16	Cunningham, KS	37	39	98	24	60	44,000	4.4
9/14-16/17	Hatteras, NC	35	15	75	40	60	25,000	6.5
3/12-15/18	Holcomb, WV	38	15	80	34	66	17,200	4.0
5/9-13/18	Mountain Home, AR	36	20	92	30	78	70,000	5.7
8/19-22/18	Mayville, ND	47	30	97	19	78	24,000	4.8
10/24-27/18	Tryon, NC	35	13	82	14	72	17,200	7.1
10/26-31/18	Highlands, NC	35	02	83	12	120	107,000	6.7
11/6-8/18	Neosha, MO	36	52	94	22	72	34,500	4.5
3/14-16/19	Atchison, KS	39	34	95	07	60	33,000	5.0
6/22-24/19	Clinton, IL	40	08	88	58	66	20,000	5.1
8/25-29/19	Warrensburg, MO	38	46	93	44	102	19,900	9.3
9/16-19/19	Bruning, NE	40	20	97	34	66	58,350	7.4
10/7-12/19	Anahugo, TX	29	47	94	40	120	60,000	8.1
10/25-28/19	Steelville, MO	37	59	91	22	60	84,000	6.8
12/6-10/19	Selma, AL	32	25	87	02	90	116,000	7.5
1/21-24/20	Pontotoc, MS	34	15	89	00	84	100,000	2.8
2/3-6/20	Runnymede, VA	37	01	76	39	60	20,000	-
5/9-12/20	Vale, SD	44	37	103	24	78	54,000	3.8
6/15-18/20	W. Newton, PA	40	13	79	36	84	30,000	3.8
9/6-9/20	Memphis, TN	35	09	90	03	66	24,000	3.7
3/11-14/21	Magnolia, MS	31	06	90	28	72	42,000	10.1
6/2-6/21	Pueblo (nr), CO	38	27	105	04	114	144,000	7.8
6/17-21/21	Springbrook, MT	47	18	105	35	108	52,600	11.3
10/29-11/2/21	Marion, NC	35	41	82	01	96	24,000	4.6
11/16-19/21	Searcy, AR	35	15	91	44	78	130,000	7.4
2/19-23/22	West Branch, MI	44	19	84	17	114	35,000	3.5
4/24-27/22	Weatherford, TX	32	45	97	48	66	65,700	7.6

Table A.1 - 253 Major storms (listed in Storm Rainfall, ≥ 10,000 mi^2 and ≥ 60 hr; 72 hr ≥ 90% total storm amount at 20,000 mi^2, arranged in chronological order) - Continued

Date	Station nearest center	Lat. (°)	Lat. (')	Long. (°)	Long. (')	Tot. st. dur. (hr)	Tot. st. area (mi^2)	1000-mi^2 24-hr amt. (in.)
6/8-11/22	Wrightstown, WI	44	20	88	12	84	45,000	6.1
6/9-12/22	Syracuse (nr), NY	43	04	76	16	84	20,000	4.2
7/9-12/22	Grant City, MO	40	29	94	25	78	113,500	9.3
9/27-10/1/23	Savageton, WY	43	52	105	47	108	95,000	6.6
7/11-14/24	Fort Scott, KS	37	51	94	42	72	35,000	5.6
8/3-6/24	West Bend, WI	43	25	88	11	90	50,000	6.7
9/13-17/24	Beaufort, NC	34	44	76	39	96	100,000	11.5
12/4-8/24	Brownsville, KY	37	13	86	15	108	32,400	6.2
5/27-29/25	Eagle Pass, TX	28	43	100	30	60	47,100	7.1
6/1-3/25	St. Joseph, MO	39	46	94	55	66	64,000	4.9
9/23-26/25	Freeman Springs, AR	35	40	93	06	90	75,000	3.9
3/20-22/26	St. Francisville, LA	30	46	91	22	66	28,200	5.9
8/23-26/26	Donaldsonville, LA	30	06	90	58	72	50,000	11.5
9/2-5/26	Columbus, KS	37	15	94	52	78	50,000	5.9
9/17-21/26	Bay Minette, AL	30	53	87	47	120	35,700	13.7
9/25-30/26	Eufaula, OK	35	17	95	35	108	40,000	6.6
2/11-14/27	Clinton, LA	30	52	91	00	72	50,000	7.0
3/17-20/27	Tuscumbia, MO	38	15	92	27	60	32,000	4.2
4/12-16/27	Jefferson, LA	29	40	90	05	108	250,000	14.7
5/5-9/27	Belvidere, SD	43	50	101	16	108	150,000	3.7
5/20-23/27	Kaplan, LA	30	01	92	19	72	12,500	8.1
7/12-15/27	Ardmore, OK	34	12	97	08	96	33,000	8.6
8/11-14/27	Bison, KS	38	31	99	12	72	34,000	6.6
11/2-4/27	Kinsman Notch, NH	44	03	71	45	60	60,000	7.8
5/14-16/28	Woodville, MS	31	06	91	18	60	34,000	8.0
6/12-17/28	Crystal Sprngs, MS	31	59	90	26	108	20,000	8.6
6/28-30/28	Clinton, TN	36	06	84	08	66	70,000	7.7
7/5-8/28	Berthold, ND	48	20	101	46	72	20,000	5.8
7/18-21/28	Mt. Ayr, IA	40	43	94	14	84	19,500	3.8
8/9-13/28	Settle, NC	36	01	80	46	96	24,000	7.0
8/10-13/28	Cheltenham, MD	38	44	76	51	66	35,000	8.8
8/13-17/28	Caesars Head, SC	35	07	82	38	102	77,300	9.4
9/4-7/28	Marion, SC	34	11	79	23	72	19,600	4.9
9/16-19/28	Darlington, SC	34	17	79	02	96	100,000	10.8
11/15-17/28	Lebo, KS	37	55	95	26	60	60,000	8.1
3/11-16/29	Elba, AL	31	25	86	04	114	100,000	16.1
7/16-18/29	Woodville, MS	31	09	91	18	66	24,000	5.4
9/20-23/29	Gallinas (nr), NM	35	09	105	39	72	17,000	2.6
9/23-28/29	Glenville, GA	31	56	81	56	120	70,000	13.1
9/29-10/3/29	Vernon, FL	30	38	85	43	84	103,000	9.3

Table A.1 - 253 Major storms (listed in Storm Rainfall, ≥ 10,000 mi^2 and ≥ 60 hr; 72 hr ≥ 90% total storm amount at 20,000 mi^2, arranged in chronological order) - Continued

Date	Station nearest center	Lat. (°)	Lat. (')	Long. (°)	Long. (')	Tot. st. dur. (hr)	Tot. st. area (mi^2)	1000-mi^2 24-hr amt. (in.)
1/6-11/30	Arkadelphia, AR	34	07	93	03	114	70,000	5.4
5/15-19/30	Camden, AR	33	36	92	49	108	116,000	7.3
6/12-15/30	Washington, IA	41	17	91	41	63	70,000	7.7
10/9-12/30	Porter, NM	35	12	103	17	60	27,700	7.2
7/20-25/31	Conklingville, NY	43	19	73	56	120	17,000	3.1
6/2-6/32	Meeker, OK	35	30	96	54	84	70,000	8.7
7/3-8/32	Clay, WV	38	28	81	05	120	36,000	5.6
7/31-8/3/32	Lexington, KY	38	02	84	36	72	23,300	5.8
9/5-7/32	Abilene, TX	32	26	99	41	60	20,400	4.5
10/4-6/32	Elka Park, NY	42	10	74	14	66	60,000	7.4
10/4-7/32	Elka Park, NY	42	10	74	14	96	29,000	6.9
10/14-18/32	Tuscaloosa, AL	33	14	87	37	90	70,000	6.8
10/15-18/32	Rocky Mount, NC	37	00	79	54	72	50,000	7.4
12/21-24/32	Sulphur, OK	34	30	96	58	66	100,000	6.7
4/11-14/33	Durham, NH	43	08	70	56	60	20,000	5.0
7/22-27/33	Logansport, LA	31	58	94	00	126	100,000	14.8
8/20-24/33	Peekamoose, NY	41	56	74	23	108	66,000	8.2
2/27-3/4/34	De Ridder, LA	30	50	93	16	126	200,000	7.2
6/6-8/34	Akron, IA	42	49	96	33	66	53,400	5.2
9/4-9/34	Beaufort, NC	34	44	76	39	108	19,000	7.3
11/19-21/34	Millry, AL	31	38	88	19	66	130,000	9.0
11/28-12/1/34	Southport, NC	33	55	78	01	84	90,000	6.4
1/18-21/35	Hernando, MS	34	50	90	00	84	98,500	7.9
5/2-7/35	Melville, LA	30	41	91	44	126	133,000	11.1
5/16-20/35	Simmesport, LA	30	59	91	48	102	75,000	10.4
7/6-10/35	Hector, NY	42	30	76	53	90	38,500	8.6
9/2-6/35	Easton, MD	38	46	76	01	114	48,469	10.8
12/5-8/35	Satsuma (nr), TX	29	54	96	37	60	56,500	13.9
7/29-8/2/36	Blountstown, FL	30	26	85	02	120	100,000	6.7
9/14-18/36	Broome, TX	31	47	100	50	96	70,000	13.8
9/25-28/36	Hillsboro, TX	32	01	97	08	90	157,000	9.9
4/24-28/37	Clear Springs, MD	39	40	77	54	114	20,000	6.1
5/26-30/37	Ragland, NM	34	49	103	44	84	37,000	3.3
6/11-13/37	Circle, MT	47	30	105	34	60	62,000	4.0
8/31-9/3/37	Wolverine, MI	45	17	84	37	72	19,000	7.0
9/6-10/37	Bentonville, AR	36	22	94	13	84	42,750	6.1
9/30-10/4/37	New Orleans, LA	29	57	90	04	114	20,000	11.3
10/17-20/37	Caesars Head, SC	35	07	82	38	72	15,000	6.1
3/28-31/38	Ford's Ferry, KY	37	28	88	06	84	25,000	6.0
4/5-9/38	Lock No. 2, AL	32	08	88	02	108	95,000	7.9

Table A.1 - 253 Major storms (listed in Storm Rainfall, ≥ 10,000 mi^2 and ≥ 60 hr; 72 hr ≥ 90% total storm amount at 20,000 mi^2, arranged in chronological order) - Continued

Date	Station nearest center	Lat. (°)	Lat. (')	Long. (°)	Long. (')	Tot. st. dur. (hr)	Tot. st. area (mi^2)	1000-mi^2 24-hr amt. (in.)
6/26-28/38	Odessa, DE	39	28	75	40	60	10,500	5.3
8/12-15/38	Koll, LA	30	20	92	45	90	34,000	12.0
8/30-9/4/38	Loveland (nr), CO	40	23	105	04	126	21,500	3.1
9/17-22/38	Buck, CT	41	40	72	40	120	67,000	7.7
3/9-12/39	Charleston, IL	39	29	88	11	72	70,000	3.9
8/6-9/40	Miller Island, LA	29	45	92	10	84	36,200	18.4
9/2-6/40	Hallett, OK	36	15	96	36	90	20,000	13.6
11/22-25/40	Hempstead, TX	30	08	96	08	78	78,000	14.2
5/26-31/41	Jennings, LA	30	13	92	39	120	54,000	5.6
8/28-31/41	Hayward, WI	46	00	91	28	78	60,000	9.1
9/20-23/41	McColleum Ranch, NM	32	10	104	44	78	38,000	6.3
10/17-22/41	Trenton, FL	29	48	82	57	138	25,000	18.2
10/18-22/41	Lindsborg, KS	38	34	97	40	96	16,000	7.9
4/17-21/42	Kenton (nr), OK	36	55	102	58	102	54,500	3.1
5/19-23/42	Carbondale, PA	40	48	76	08	96	12,000	5.0
6/23-26/42	Clifton Hill, MO	39	25	92	42	72	35,000	6.9
7/2-6/42	Spring Branch, TX	29	55	98	25	96	52,800	6.9
8/7-10/42	Charlottesville, VA	38	02	78	30	96	24,500	5.3
8/29-9/1/42	Rancho Grande, NM	34	56	105	06	84	35,600	6.8
10/11-17/42	Big Meadows, VA	38	31	78	26	156	25,000	9.1
12/27-30/42	Ashville, AL	33	51	86	20	79	30,950	9.7
1/16-19/43	River Falls, AL	31	21	86	32	66	40,000	8.7
5/6-12/43	Warner, OK	35	29	95	18	144	212,000	11.1
5/12-20/43	Mounds (nr), OK	35	52	96	03	192	200,000	8.5
7/27-29/43	Devers, TX	30	02	94	35	60	33,000	13.7
6/10-13/44	Stanton, NE	41	52	97	03	78	16,000	9.3
6/2-5/44	Colony, WY	44	56	104	12	72	36,000	3.4
9/12-15/44	New Brunswick, NJ	40	29	74	27	96	50,000	5.6
8/26-29/45	Hockley, TX	30	02	95	51	72	34,000	13.4
5/25-28/46	Renovo, PA	41	20	77	45	78	16,800	4.7
8/12-15/46	Cole Camp (nr), MO	38	29	93	13	78	45,000	8.3
8/12-16/46	Collinsville, IL	38	40	89	59	114	20,400	9.0
5/25-30/47	Plattsmouth, NE	41	01	95	53	132	300,000	-
6/2-7/47	Browning (nr), MO	40	03	93	06	120	306,000	4.8
6/10-13/47	Earlham, IA	41	28	94	07	78	300,000	-
6/18-23/47	Holt (nr), MO	39	27	94	20	120	306,000	5.6
6/23-26/47	Annapolis, MD.	37	22	90	42	66	306,000	2.3
6/26-30/47	Lathrop, MO	39	33	94	20	96	306,000	4.1
8/10-13/47	Plentywood, MT	48	45	104	30	72	64,329	3.9
8/24-27/47	Dallas, TX	32	51	96	51	72	30,000	9.3

Table A.1 - 253 Major storms (listed in Storm Rainfall, ≥ 10,000 mi^2 and ≥ 60 hr; 72 hr ≥ 90% total storm amount at 20,000 mi^2, arranged in chronological order) - Continued

Date	Station nearest center	Lat. (°)	Lat. (')	Long. (°)	Long. (')	Tot. st. dur. (hr)	Tot. st. area (mi^2)	1000-mi^2 24-hr amt. (in.)
4/22-25/50	Monmouth (nr), IL	40	55	90	43	60	20,000	4.6
9/3-7/50	Yankeetown, FL	29	03	82	42	96	43,500	30.2
8/9-13/51	Council Grove, KS	38	40	96	30	108	57,000	6.6
6/23-28/54	Vic Pierce, TX	30	22	101	23	120	27,900	18.4
8/10-15/55	New Bern, NC	35	07	77	03	126	69,000	8.9
8/11-15/55	Slide Mt., NY	42	01	42	25	120	81,000	6.0
8/15-19/55	Big Meadows, VA	38	31	78	26	96	50,000	5.5
8/17-20/55	Westfield, MA	42	07	72	45	72	35,000	12.4
5/18-21/60	New Prague, MN	44	35	93	35	85	10,000	4.4
9/10-13/61	Bay City, TX	28	58	95	57	90	100,000	9.6
9/11-13/61	Shelbina, MO	39	41	92	03	60	121,000	7.1
3/2-5/66	Courtenay (nr), ND	47	14	98	35	72	35,000	3.1
6/19-23/72	Zerbe, PA	40	37	76	32	96	130,000	12.3

Table A.2.—Distribution of 253 major storms by duration and area size classes

Area (10^3 mi^2) / Dur. (hr)	10-<20	20-<30	30-<40	40-<50	50-<60	60-<70	70-<80	80-<90	90-<100	100-<120	120-<140	140-<160	160-<180	189-<200	200-<300	≥300	Total
60	1	7	4	5	2	3	2	2	.	.	1	.	.	.	.	.	27
66	2	7	5	1	4	4	1	.	.	2	1	.	.	.	.	1	28
72	10	3	10	4	3	1	1	1	.	1	.	.	.	.	.	.	34
78	4	1	3	1	2	1	2	1	.	3	1	.	.	.	.	1	20
84	2	2	5	2	.	2	3	.	3	3	.	.	.	.	.	.	22
90	1	1	2	.	2	1	4	1	.	2	.	1	.	.	.	.	15
96	1	5	6	3	3	1	4	.	.	4	2	.	1	.	.	1	31
102	1	2	1	.	2	.	2	1	.	1	.	.	.	.	.	.	10
108	1	2	2	2	4	1	2	1	2	1	.	1	1	.	1	.	21
114	.	3	1	2	.	.	2	.	.	3	.	1	.	1	.	.	13
120	1	2	2	1	3	4	2	1	.	1	1	.	.	.	.	2	20
126	.	1	.	.	.	1	.	1	.	1	1	.	.	.	1	.	6
132	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1
138	.	.	.	.	.	1	.	.	.	.	.	.	.	1	.	.	2
144	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	1
≥150	.	1	.	.	.	.	.	.	.	.	.	.	.	.	1	.	2
Total	24	37	41	21	25	20	25	9	5	22	7	3	2	2	4	6	253

Table A.3.—Shape ratios of 253 major storm isohyetal patterns relative to area size classes

Area size category (10^3 mi^2)	Shape ratio 1	2	3	4	5	6	7	8	Total no. of storms
	% of total storms in category								
10 to < 20	17	33	29	8	4	4	4		24
20 to < 30	8	25	36	11	11	3		6	36
30 to < 40	2	41	22	17	12	5			41
40 to < 50		24	33	19	19		5		21
50 to < 60	8	38	8	15	19	8	4		26
60 to < 75	6	28	25	19	6	11	3	3	36
75 to <100		22	22	26	17	9	4		23
100 to <125	9	17	30	26	4	4	9		23
≥ 125	4	35	39	4	17				23
									Total 253

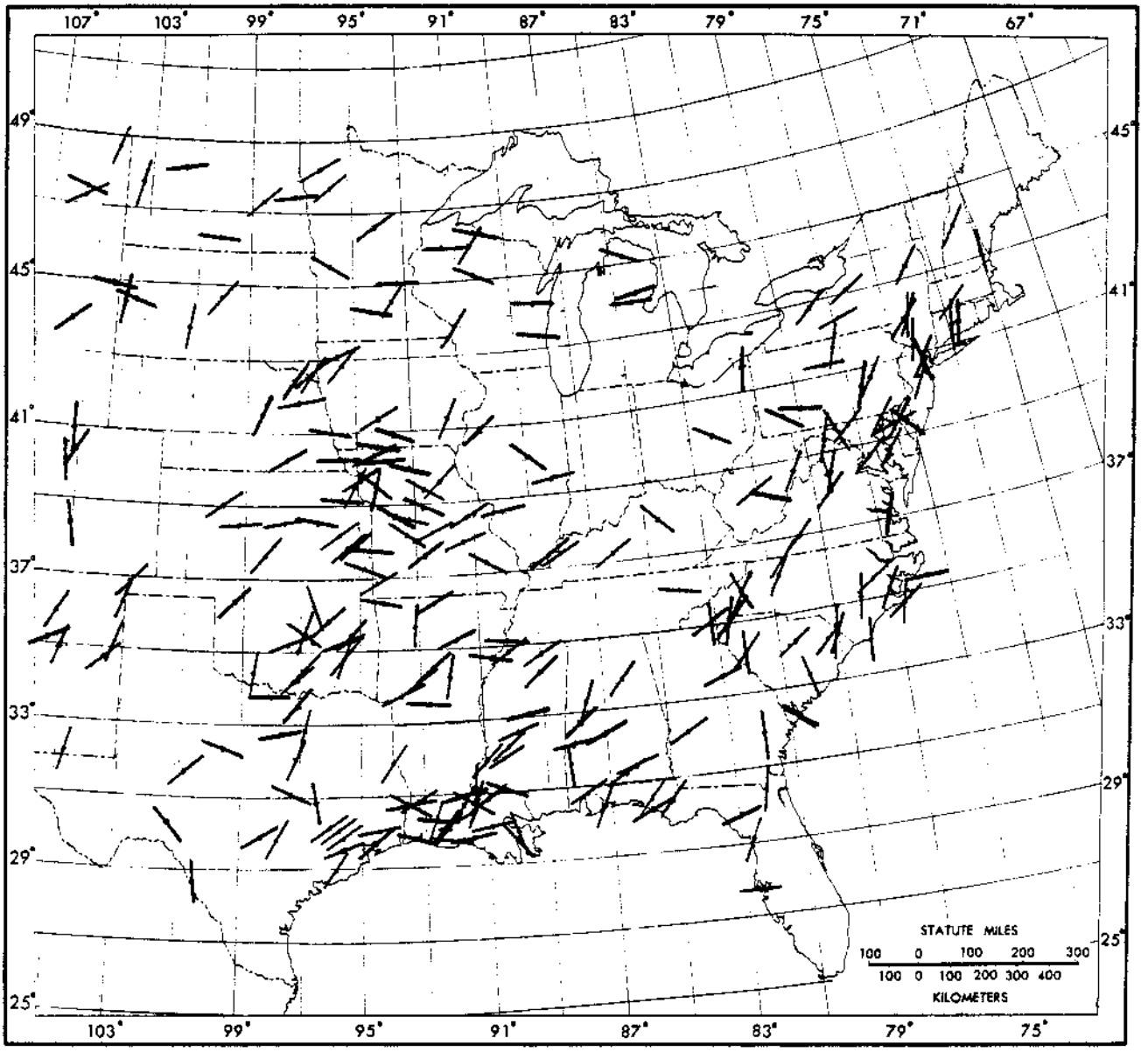

Figure A.1.—Regional distribution of 253 major storms listed in table A1 showing orientation of total-storm precipitation patterns.