UNITED STATES
DEPARTMENT OF THE INTERIOR
WATER RESOURCES DIVISION
GEOLOGICAL SURVEY

SUMMER BASE-FLOW RECESSION CURVES FOR IOWA STREAMS

By
Carroll W. Saboe
Hydraulic Engineer, USGS

Prepared in Cooperation with
THE IOWA NATURAL RESOURCES COUNCIL

Open-file Report
66-a

Iowa City, Iowa
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ABSTRACT

Base-flow recession curves for the summer months (June through September) were developed in this study for gaging stations on interior Iowa streams having five or more years of record. The tabulated data enables the user, starting with a known base flow at a gage, to estimate base flows for up to 20 days in the future. Rainfall during the period of the forecast will require that a new estimate be made after the stream again reaches base flow.

INTRODUCTION

Forecasts of probable future surface-water flows are required for many purposes. Among these are (1) administering water laws, particularly those concerned with withdrawal use for irrigation, (2) evaluating streamflow available for municipal and domestic water supply to determine possible need for supplemental supplies, and (3) evaluating adequacy of streamflow for waste dilution to determine if wastes should be temporarily stored or accelerated treatment initiated.

This report has been prepared to provide a means for making short-term forecasts of base flow of Iowa streams at gaging stations. Base-flow recession curves are used for this purpose. These curves define the relation between base-flow discharge and time. Reliable estimates of future flows up to 20 days in advance are possible when no significant rainfall occurs in the interim period.

The data presented in this report are based on records of streamflow that have been collected at gaging stations on interior Iowa streams.

The period of record available at each gaging station was used in preparing the base-flow recession data. In general, streamflow records shorter than 5 years were inadequate for this analysis.

ACKNOWLEDGMENTS

This study was undertaken at the request of the Iowa Natural Resources Council as a part of the cooperative program with the U. S. Geological Survey. The streamflow records utilized were collected by the U. S. Geological Survey in cooperation with Federal,State, local, and private agencies. These agencies are listed in the annual series of streamflow reports issued by the U. S. Geological Survey.

The work of analyzing the records and preparing the report was done at the District Office, U. S. Geological Survey, Iowa City, Iowa.

CONCEPT OF BASE FLOW

Base flow includes the ground-water component of total flow plus a component of flow known as interflow, which is water that moves in the zone above the water table and reaches the stream channels some time after surface runoff has ceased. Base flow maintains streamflow during rainless periods. For very small basins, base flow could occur a day or two after a rain.

METHOD OF ANALYSIS

For this report, hydrographs of total flow were analyzed for the months of June through September for each year of record at all gaging stations. A map showing the location of the gaging stations in Iowa appears as figure 1. During periods when there is no surface runoff, the

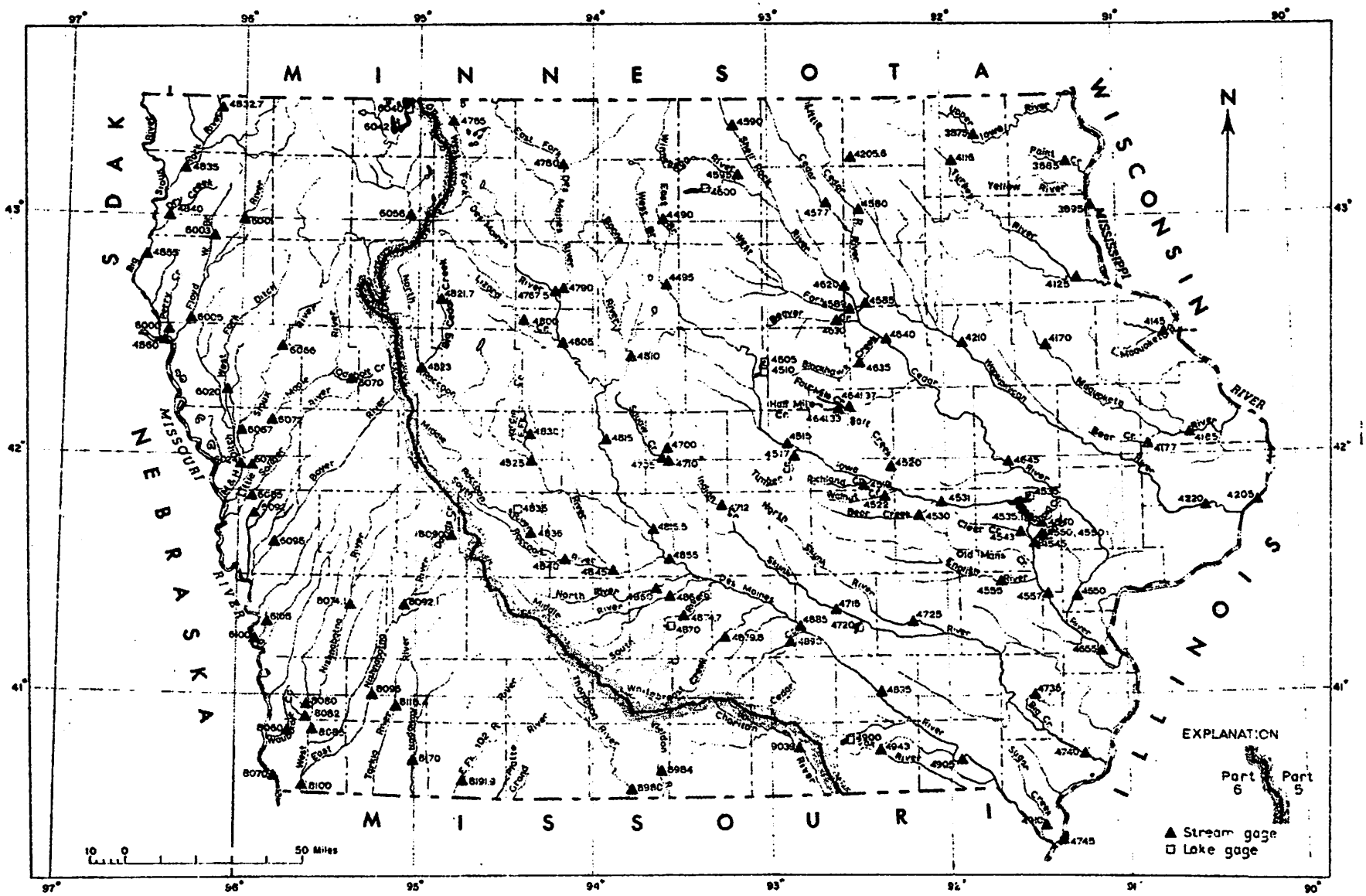

Figure 1.--Map of Iowa showing location of lake and stream gaging stations operated by the U. S. Geological Survey in cooperation with other agencies.

rate of recession appears to be essentially constant for any given base-flow discharge during the June-through-September period. This phenomenon is the basis for development of the base-flow recession curve.

The following procedures were used to derive the base-flow recession values:

1. For base-flow periods, discharge on a beginning day and the discharge 10 days later were tabulated. A 5-day interval was used on small streams.
2. Values of beginning-day discharge were plotted as abscissa against discharge 10 days later as ordinate on logarithmic paper. A line was drawn averaging the points (line A, fig. 2). A second line was drawn ignoring all points except those farthest to the right (line B, fig. 2). Line A represents the average recession rate and line B represents approximately the maximum recession rate defined by the data.
3. Curves A and B (fig. 2) were then used to develop the curves of figure 3.

The base-flow recession data listed in table 1 were obtained from curves prepared as explained above. Curves similar to those of figure 3 can be plotted using the tabulated station data. All values of discharge are in cubic feet per second (cfs).

METHOD OF USE

For each gaging station, valued for two base-flow recession curves are shown. Curve "A" represents the average experience that has occurred at the gaging station. Use of curve "A" is recommended when evapotranspiration losses are normal or average. Curve "B" represents a more severe condition that may occur when evapotranspiration losses are abnormally large.

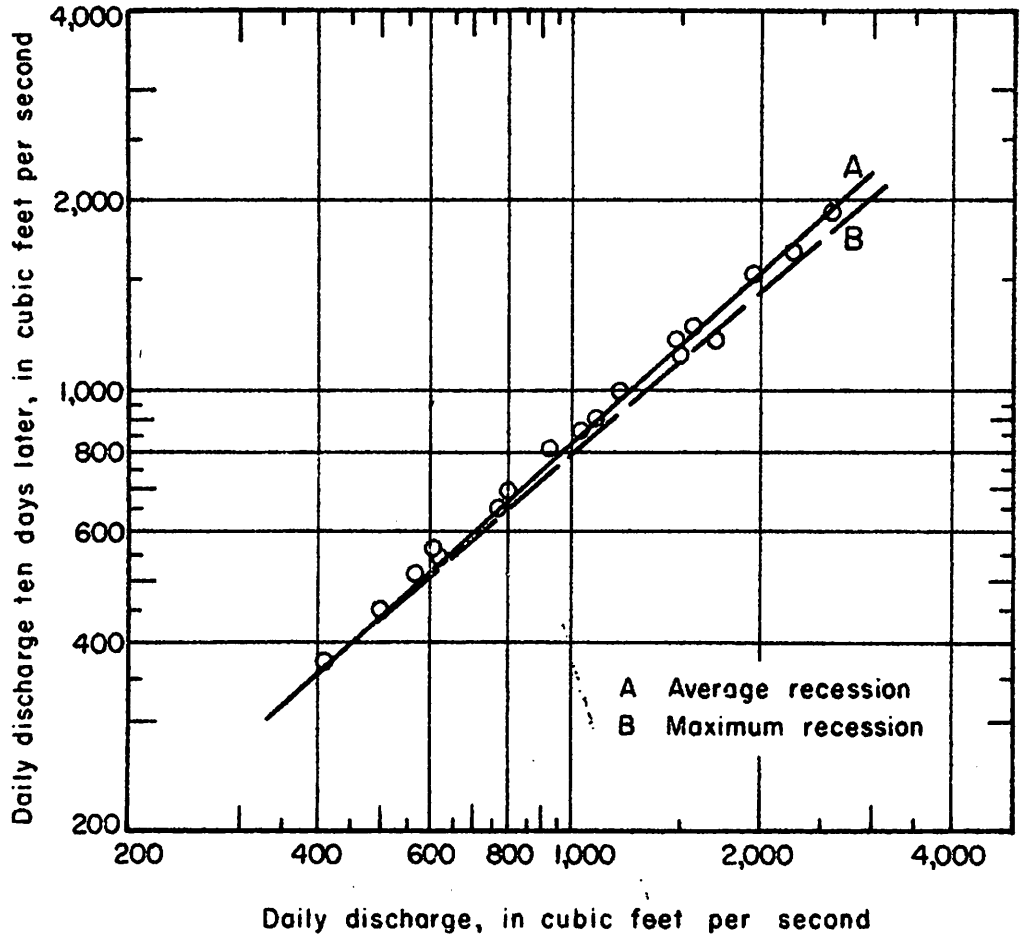

Figure 2. Relation between base flow on a selected day and that ten days later, Cedar River at Waterloo, Iowa (5,146 sq mi).

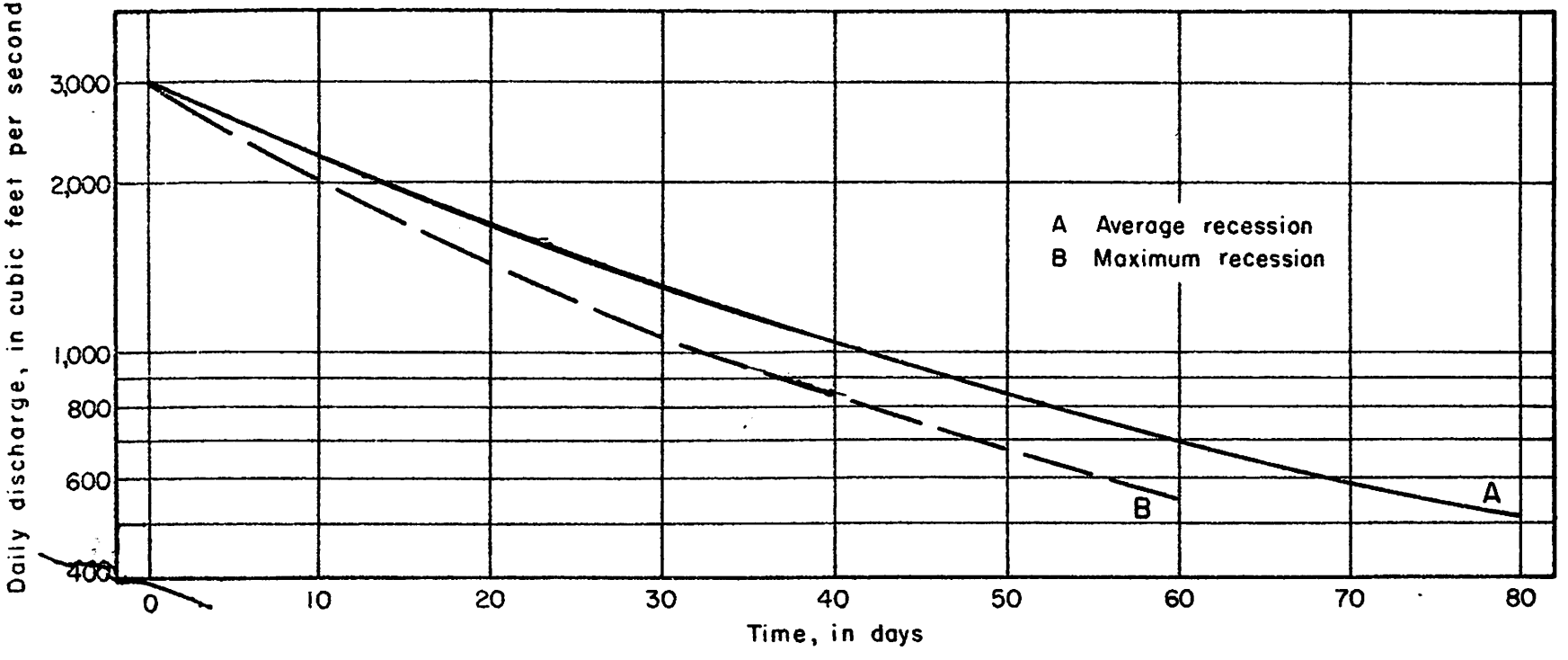

Figure 3. Base-flow recession curves, Cedar River at Waterloo, Iowa.

Other factors, undefined by this study, may also affect the recession rate. The steeper recession rate defined by curve "B" probably occurs during prolonged periods of excessively hot and windy weather. The curves are valid for periods of no rainfall and for the summer season only.

As an example, when the base-flow discharge at the Waterloo gaging station is 1,300 cfs, the estimated discharge 20 days later would be 835 cfs using curve "A", figure 3. If conditions indicate the use of curve "B", the corresponding discharge discharge would be 780 cfs 20 days later.

CONCLUSIONS

Base-flow recession curves are useful tools to estimate future discharges in a stream. However, since only short segments of base flow were used in their derivation, the length of the period of estimate should, in general, be less than 20 days. As additional low-flow records become available, the base-flow recession curves will become better defined.

TABULATED DATA

The following table (table 1) contains the data for plotting curves similar to figure 3. The gaging stations are identified by number and name. Additional information on the stations may be obtained from the latest report, "Water Resources Data for Iowa, Part 1, Surface Water Records" published yearly by the U. S. Geological Survey, The order of listing of the gaging stations in table 1 is the same as in the above publication.

Table 1. Plotting data for base-flow recession curves

Time in days	Gaging station number and name, drainage area, and discharge in cfs for curves A and B *									
	5-3875 Upper Iowa River at Decorah		5-3885 Paint Creek at Waterville		5-4116 Turkey River at Spillville		5-4125 Turkey River at Garber		5-4145 Little Maquoketa River near Durango	
	511 sq mi		42.8 sq mi		177 sq mi		1545 sq mi		130 sq mi	
	A	B	A	B	A	B	A	B	A	B
0	500	500	20.0	20.0	100	100	800	800	60.0	60.0
5	420	385	17.0	14.1	85.0	67.0	690	640	51.0	44.5
10	354	296	14.4	9.9	72.0	48.0	585	505	43.0	33.6
15	296	228	12.2	7.1	62.0	36.0	500	410	36.4	25.4
20	250	174	10.4	5.2	54.5	28.4	435	340	30.5	19.2
25	210	133	8.9	3.8	47.5	23.0	380	284	25.6	14.4
30	177	103	7.7	2.8	42.0	19.0	335	237	21.6	10.8
35	150	78	6.6	2.0	36.7	16.2	294	200	18.2	8.2
40	126	60	5.7	1.5	32.5	14.2	258	172	15.2	
45	107		4.9		29.0	12.7	228	150	12.8	
50	91		4.2		26.0	11.5	204	130	10.8	
55	77		3.7		23.4		182	114	9.0	
60	66		3.2		21.2		164	101	7.6	
65			2.8		19.2		147	90		
70			2.4		17.6		133	80		
75			2.1		16.0		120			
80			1.8		14.7		109			
85			1.6		13.7		99			
90			1.4		12.8		90			
95							82			
100							75			

* Use curve A when evapotranspiration losses are average or normal.
Use curve B during excessively hot, windy weather.

Table 1. Plotting data for base-flow recession curves -- continued

Time in days	Gaging station number and name, drainage area, and discharge in cfs for curves A and B *									
	5-4170 Maquoketa River near Manchester		5-4177 Bear Creek near Monmouth		5-4185 Maquoketa River near Maquoketa		5-4205.6 Wapsipinicon River near Elma		5-4210 Wapsipinicon River at Independence	
	305 sq mi		61.3 sq mi		1553 sq mi		95.2 sq mi		1048 sq mi	
	A	B	A	B	A	B	A	B	A	B
0	400	400	30.0	30.0	1500	1500	20.0	20.0	230	230
5	290	240	24.0	22.3	1210	1190	16.3	15.0	200	197
10	216	157	18.9	16.6	990	950	13.4	11.4	178	166
15	165	109	15.0	12.2	820	760	11.2	9.0	157	140
20	130	79	11.9	8.9	700	610	9.5	7.2	141	118
25	104	61	9.4	6.5	595	490	8.2	5.9	125	102
30	86	48	7.5	4.7	510	400	7.2	4.9	111	87.0
35	72	40	5.9	3.4	440	325	6.3	4.1	100	74.5
40	61	34	4.7	2.4	385	265	5.6	3.5	89.5	64.5
45	53		3.7	1.8	345	220	5.0	2.9	81.0	56.0
50	46		3.0		310	180	4.6		73.0	48.0
55	41		2.4		280		4.1		66.0	42.0
60	37		1.9		255		3.7		60.0	36.5
65					235				54.5	32.0
70					215				49.5	28.0
75					200				45.5	24.5
80					185				42.0	
85									39.0	
90									36.0	
95									33.0	
100									30.0	

* Use curve A when evapotranspiration losses are average or normal.
Use curve B during excessively hot, windy weather.

Table 1. Plotting data for base-flow recession curves -- continued

Time in days	Gaging station number and name, drainage area, and discharge in cfs for curves A and B *									
	5-4220 Wapsipinicon River near De Witt		5-4485 West Branch Iowa River near Klemme		5-4490 East Branch Iowa River near Klemme		5-4495 Iowa River near Rowan		5-4515 Iowa River near Marshalltown	
	2330 sq mi		112 sq mi		133 sq mi		429 sq mi		1564 sq mi	
	A	B	A	B	A	B	A	B	A	B
0	1000	1000	40.0	40.0	60.0	60.0	160	160	1000	1000
5	810	770	30.0	27.0	38.0	31.0	133	118	770	710
10	670	600	23.0	18.8	25.4	17.4	111	88.0	595	500
15	570	480	17.6	13.2	17.8	10.2	92.0	66.0	455	350
20	490	395	13.5	9.2	13.4	6.0	78.0	49.2	350	245
25	430	325	10.3	6.6	10.4	3.4	66.0	37.6	270	170
30	380	265	8.0	4.7	8.4		56.0	28.6	210	118
35	335	215	6.1	3.4	7.0		47.6	22.0	160	82.0
40	300	180	4.8	2.5	6.0		40.5	17.0	123	56.0
45	270	145	3.7	1.8	5.2		34.6	13.2	94.4	
50	240	120	2.9	1.3	4.6		29.8	10.6	73.0	
55	215	95.0	2.3				25.5		56.0	
60	190	76.0	1.8				22.0			
65	170						19.0			
70	152						16.3			
75	136						14.0			
80	122						12.1			

* Use curve A when evapotranspiration losses are average or normal.
Use curve B during excessively hot, windy weather.

Table 1. Plotting data for base-flow recession curves -- continued

Time in days	5-4517 Timber Creek near Marshalltown, 118 sq mi		5-4519 Richland Creek near Haven, 56.1 sq mi		5-4520 Salt Creek near Elberon, 201 sq mi		5-4522 Walnut Creek near Hartwick, 70.9 sq mi		5-4530 Bear Creek at Ladora, 189 sq mi	
	A	B	A	B	A	B	A	B	A	B
0	40.0	40.0	10.0	10.0	40.0	40.0	30.0	30.0	50.0	50.0
5	31.0	26.5	7.4	6.4	33.0	31.0	19.6	17.4	36.6	31.3
10	24.5	17.8	5.6	4.2	27.2	24.0	13.2	9.5	27.2	20.0
15	19.4	12.1	4.2	2.7	22.6	18.6	9.2	5.0	20.2	13.0
20	15.4	8.3	3.2	1.7	19.0	14.4	6.7	2.5	15.0	8.5
25	12.4	5.8	2.5	1.1	16.0	11.3	5.1	1.2	11.4	5.7
30	9.9	4.2	1.9	.60	13.4	8.9	3.9		8.7	3.8
35	8.0	3.0	1.5	.28	11.4	7.0	3.1		6.6	2.6
40	6.5	2.2	1.2		9.7	5.5	2.5		5.1	1.8
45	5.4	1.7	.96		8.3		2.1		3.9	
50	4.4		.76		7.1		1.8		3.0	
55	3.7		.60		6.1		1.6		2.4	
60	3.1		.45				1.4		1.9	
65	2.6		.32				1.2			
70	2.2		.21							
75	1.9		.11							
80	1.6									

* Use curve A when evapotranspiration losses are average or normal.
Use curve B during excessively hot, windy weather.

Table 1. Plotting data for base-flow recession curves -- continued

Time in days	Gaging station number and name, drainage area, and discharge in cfs for curves A and B *									
	5-4531 Iowa River at Marengo		5-4540 Rapid Creek near Iowa City		5-4550 Clear Creek near Coralville		5-4550 Ralston Creek at Iowa City		5-4555 English River at Kalona	
	2794 sq mi		24.6 sq mi		98.1 sq mi		3.01 sq mi		573 sq mi	
	A	B	A	B	A	B	A	B	A	B
0	1000	1000	10.0	10.0	60.0	60.0	1.9	1.9	200	200
5	790	745	6.2	6.0	41.0	41.0	1.0	.82	138	112
10	640	565	3.9	3.2	27.0	26.0	.51	.31	99.0	660
15	520	435	2.5	1.6	18.1	16.0	.24	.11	71.5	40.5
20	425	344	1.5	.69	12.0	9.4	.10	.032	53.0	25.0
25	350	272	.93	.26	8.0	5.5	.044		39.5	16.0
30	294	222	.51		5.6	3.4			30.0	10.4
35	250	184	.20		4.0	2.2			23.2	6.9
40	213	154			2.9	1.4			18.4	4.8
45	183	130			2.2				14.7	3.4
50	159	111			1.8				11.8	2.4
55	138								9.6	
60	122								7.9	
65									6.6	
70									5.6	
75									4.8	
80									4.1	
85									3.6	
90									3.2	
95									2.3	
100									2.5	

* Use curve A when evapotranspiration losses are average or normal.
Use curve B during excessively hot, windy weather.

Table 1. Plotting data for base-flow recession curves — continued

Time in days	Gaging station number and name, drainage area, and discharge in cfs for curves A and B *									
	5-4580 Little Cedar River near Ionia		5-4585 Cedar River at Janesville		5-4589 West Fork Cedar River at Finchford		5-4590 Shell Rock River near Northwood		5-4595 Winnebago River at Mason City	
	306 sq mi		1661 sq mi		846 sq mi		300 sq mi		526 sq mi	
	A	B	A	B	A	B	A	B	A	B
0	150	150	1000	1000	400	400	150	150	200	200
5	123	114	820	780	324	290	108	97.5	163	148
10	101	86.0	695	620	265	210	80.0	63.5	134	112
15	83.0	64.4	590	505	217	156	60.5	42.6	110	84.2
20	67.0	48.8	510	420	180	117	47.0	29.7	91.0	65.0
25	55.0	36.4	440	350	150	87.0	36.6	21.3	76.5	50.8
30	45.0	27.4	385	295	126	67.0	29.2	16.1	64.0	40.4
35	37.0	20.3	335	252	106	51.0	23.7		54.4	32.4
40	30.0	15.0	296	220	89.0	40.0	19.6		46.5	26.5
45	24.6		265	194	75.6		16.5		40.0	21.7
50	20.2		238	173	64.4		14.2		35.0	18.2
55	16.4		216	156	55.4		12.2		30.6	
60	13.4		197	140	47.8		10.6		26.8	
65			180		42.0				23.6	
70			165		37.0				21.0	
75			152							
80			142							

* Use curve A when evapotranspiration losses are average or normal.
Use curve B during excessively hot, windy weather.

Table 1. Plotting data for base-flow recession curves -- continued

Time in days	Gaging station number and name, drainage area, and discharge in cfs for curves A and B *									
	5-4620 Shell Rock River at Shell Rock		5-4630 Beaver Creek at New Hartford		5-4635 Blackhawk Creek at Hudson		5-4640 Cedar River at Waterloo		5-4645 Cedar River at Cedar Rapids	
	1746 sq mi		347 sq mi		303 sq mi		5146 sq mi		6510 sq mi	
	A	B	A	B	A	B	A	B	A	B
0	1400	1400	100	100	100	100	3000	3000	7000	7000
5	1120	1040	71.0	61.5	56.5	41.0	2560	2420	5600	5400
10	905	800	52.0	39.5	35.5	20.5	2220	2020	4480	4150
15	745	622	39.4	26.0	24.2	11.3	1930	1690	3620	3220
20	615	490	30.0	17.9	17.3	6.8	1680	1440	2980	2500
25	515	390	23.4	12.7	12.8	4.1	1470	1230	2450	1960
30	435	316	18.4	9.4	9.6		1300	1060	2050	1540
35	374	260	14.7	7.0	7.2		1160	935	1730	1230
40	324	215	12.0	5.4	5.2		1030	835	1470	980
45	282	181	9.9	4.3			925	745	1260	795
50	248	153	8.3				840	670	1080	640
55	222	131	7.0				760	605	950	
60	198	113	6.0				695	550	840	
65	178		5.2				640			
70	162		4.5				590			
75	148						550			
80	136						510			

* Use curve A when evapotranspiration losses are average or normal.
Use curve B during excessively hot, windy weather.

Table 1. Plotting data for base-flow recession curves -- continued

Time in days	Gaging station number and name, drainage area, and discharge in cfs for curves A and B *									
	5-4650 Cedar River near Conesville		5-4700 Skunk River near Ames		5-4705 Squaw Creek at Ames		5-4710 Skunk River below Squaw Creek near Ames		5-4712 Indian Creek near Mingo	
	7785 sq mi		315 sq mi		204 sq mi		556 sq mi		276 sq mi	
	A	B	A	B	A	B	A	B	A	B
0	10,000	10,000	100	100	100	100	190	190	100	100
5	7,700	7,000	65.0	54.0	54.5	47.5	140	116	67.5	51.0
10	6,050	5,040	42.5	28.5	30.0	20.5	102	70.0	47.0	27.3
15	4,850	3,720	27.5	15.0	16.4	8.4	74.0	42.0	32.5	14.8
20	3,900	2,800	18.0	7.7	8.8	2.9	53.0	24.5	22.8	8.3
25	3,180	2,160	11.8	3.9	4.7		37.5	14.0	16.2	4.6
30	2,640	1,700	7.8		2.5		26.5	7.7	11.7	
35	2,180	1,360	5.2				18.5		8.5	
40	1,850	1,120	3.4				13.0		6.3	
45	1,590	940					9.1		4.7	
50	1,370	800					6.3			
55	1,200									
60	1,060									
65	940									
70	845									
75	760									
80	695									
85	635									
90	585									

* Use curve A when evapotranspiration losses are average or normal.
Use curve B during excessively hot, windy weather.

Table 1. Plotting data for base-flow recession curves -- continued

Time in days	Gaging station number and name, drainage area, and discharge in cfs for curves A and B *									
	5-4715 Skunk River near Oskaloosa		5-4725 North Skunk River near Sigourney		5-4735 Big Creek near Mount Pleasant		5-4740 Skunk River at Augusta		5-4765 West Fork Des Moines River at Estherville	
	1635 sq mi		730 sq mi		106 sq mi		4303 sq mi		1372 sq mi	
	A	B	A	B	A	B	A	B	A	B
0	800	800	400	400	18.0	18.0	1000	1000	290	290
5	560	490	265	210	10.0	8.7	770	675	200	184
10	405	310	179	117	5.7	4.4	600	480	142	123
15	293	202	124	68.0	3.4	2.3	475	350	100	86.0
20	220	140	87.0	41.7	2.2	1.3	384	268	73.8	60.5
25	166	97.0	62.0	27.0	1.4	.72	315	214	55.3	43.0
30	129	72.0	45.0	18.2	.90	.37	265	176	42.2	31.5
35	102	54.0	33.0	12.4	.56	.15	224	147	32.6	23.5
40	82.3	41.5	24.8		.32		194	126	25.6	18.0
45	68.0	32.2	19.0		.14		167		20.7	
50	55.5	25.5	15.0				145		17.2	
55	46.0		12.0							
60	38.4									
65	32.3									
70	27.5									
75	23.7									
80	20.9									
85	18.6									
90	17.0									

* Use curve A when evapotranspiration losses are average or normal.
Use curve B during excessively hot, windy weather.

Table 1. Plotting data for base-flow recession curves -- continued

Time in days	Gaging station number and name, drainage area, and discharge in cfs for curves A and B*									
	5-4780 East Fork Des Moines River near Burt		5-4790 East Fork Des Moines River at Dakota City		5-4800 Lizard Creek near Clare		5-4805 Des Moines River at Fort Dodge		5-4810 Boone River near Webster City	
	462 sq mi		1308 sq mi		257 sq mi		4190 sq mi		844 sq mi	
	A	B	A	B	A	B	A	B	A	B
0	60.0	60.0	500	500	140	140	1400	1400	230	230
5	44.0	37.0	348	310	108	100	1060	945	148	138
10	28.6	19.3	250	200	85.8	72.0	820	640	98.0	86.0
15	16.4	9.4	185	133	67.0	52.5	625	445	67.0	54.5
20	9.1	5.0	138	91.0	53.0	38.5	485	319	46.5	35.6
25	5.7	3.0	105	65.0	42.0	28.4	377	232	33.4	24.0
30	3.7	2.1	80.0	47.5	33.4	21.2	300	175	25.0	17.0
35	2.7		62.5	35.4	26.4	15.8	243	134	19.0	12.0
40	2.0		50.0	26.8	21.0	12.0	198	106	14.8	9.0
45			39.6	21.0	16.7	9.1	162		11.8	
50			32.2	17.0	13.3	7.0	135		9.4	
55			26.3		10.4	5.3	114			
60			21.8		8.3	4.1	98.0			
			18.5		6.6					
			16.0		5.3					
					4.2					
					3.3					

* Use curve A when evapotranspiration losses are average or normal.
Use curve B during excessively hot, windy weather.

Table 1. Plotting data for base-flow recession curves -- continued

Time in days	Gaging station number and name, drainage area, and discharge in cfs for curves A and B *									
	5-4815 Des Moines River near Boone		5-4821.7 Big Cedar Creek near Varina		5-4823 North Raccoon River near Sac City		5-4825 North Raccoon River near Jefferson		5-4830 East Fork Hardin Creek near Churdan	
	5511 sq mi		80.0 sq mi		713 sq mi		1619 sq mi		24.0 sq mi	
	A	B	A	B	A	B	A	B	A	B
0	1500	1500	25.0	25.0	200	200	300	300	10.0	10.0
5	1110	1030	16.0	15.2	136	116	222	200	6.2	4.8
10	830	720	10.8	9.3	93.5	71.0	169	139	3.8	2.3
15	630	515	7.6	5.6	66.0	44.5	129	100	2.3	1.2
20	490	380	5.5	3.4	47.5	30.0	102	74.0	1.4	.43
25	390	282	4.1	2.0	35.0	21.0	80.5	55.0	.82	.16
30	315	215	3.2	1.2	27.0	15.2	65.5	42.5	.48	
35	256	166	2.5		21.0	11.2	54.0	33.8	.27	
40	214	134	2.0		16.6	8.4	45.0	28.0	.15	
45	182		1.6		13.2		38.0			
50	156		1.4		10.8		32.6			
55	134		1.2				28.6			
60	117		1.0				25.4			
65							22.4			
70							20.0			

* Use curve A when evapotranspiration losses are average or normal.
Use curve B during excessively hot, windy weather.

Table 1. Plotting data for base-flow recession curves -- continued

Time in days	Gaging station number and name, drainage area, and discharge in cfs for curves A and B *									
	5-4836 Middle Raccoon River at Panora		5-4840 South Raccoon River at Redfield		5-4845 Raccoon River at Van Meter		5-4855 Des Moines River below Raccoon at Des Moines		5-4860 North River near Norwalk	
	440 sq mi		988 sq mi		3441 sq mi		9879 sq mi		349 sq mi	
	A	B	A	B	A	B	A	B	A	B
0	200	200	500	500	900	900	4300	4300	100	100
5	144	117	366	362	660	640	3100	2780	63.0	58.0
10	107	70.0	275	263	485	455	2260	1810	38.5	30.5
15	83.0	45.0	208	194	355	325	1670	1170	22.7	14.4
20	65.5	30.5	160	144	260	233	1270	790	13.3	6.0
25	53.5	22.0	126	107	190	167	980	540	7.5	2.2
30	44.5		100	80.0	138	120	775	385	4.2	
35	38.0		79.0	60.0	103	87.5	625	282	2.3	
40	33.0		63.5	46.0	76.5	64.0	512	214		
45	29.0		51.5	35.0	57.5		425	166		
50	26.0		42.0	27.0	43.5		355	133		
55	23.5		34.6				300			
60			29.0				260			
65			24.8				227			
70			21.5				200			
75							177			
80							158			

* Use curve A when evapotranspiration losses are average or normal.
Use curve B during excessively hot, windy weather.

Table 1. Plotting data for base-flow recession curves -- continued

Time in days	Gaging station number and name, drainage area, and discharge in cfs for curves A and B *									
	5-4864.9 Middle River near Indianola		5-4874.7 South River near Ackworth		5-4885 Des Moines River near Tracy		5-4890 Cedar Creek near Bussey		5-4895 Des Moines River at Ottumwa	
	503 sq mi		460 sq mi		12,479 sq mi		374 sq mi		13,374 sq mi	
	A	B	A	B	A	B	A	B	A	B
0	100	100	100	100	8000	8000	15.0	15.0	8000	8000
5	73.0	68.0	47.5	41.0	5950	5550	10.2	8.8	5750	5400
10	54.0	43.5	24.2	16.5	4600	3900	7.3	5.5	4250	3720
15	40.5	25.4	13.3	6.6	3550	2780	5.3	3.6	3140	2600
20	30.0	13.0	7.8	2.6	2780	2010	3.9	2.5	2400	1850
25	21.7	5.7	4.9	1.0	2200	1480	3.0	1.8	1870	1360
30	15.0		3.2		1760	1110	2.4	1.3	1480	1010
35	9.9		2.2		1410	835	1.9	1.0	1180	760
40	5.7		1.6		1150	640	1.6	.80	960	580
45					940	500	1.3		780	445
50					780	390	1.1		650	350
55					650	308	.96		545	280
60					550	250	.84		465	228
65					470				400	
70					405				345	
75					352				304	
80					310				270	
85					272					
90					240					
95					214					
100					190					

* Use curve A when evapotranspiration losses are average or normal.
Use curve B during excessively hot, windy weather.

Table 1. Plotting data for base-flow recession curves -- continued

Time in days	Gaging station number and name, drainage area, and discharge in cfs for curves A and B *									
	5-4905 Des Moines River at Keosauqua		5-4910 Sugar Creek near Keokuk		5-4943 Fox River near Bloomfield		6-4832.7 Rock River at Rock Rapids		6-4835 Rock River near Rock Valley	
	14,038 sq mi		105 sq mi		87.7 sq mi		788 sq mi		1600 sq mi	
	A	B	A	B	A	B	A	B	A	B
0	9000	9000	25.0	25.0	20.0	20.0	180	180	150	150
5	6350	6100	16.0	9.3	9.4	7.9	114	75.0	122	114
10	4650	4200	10.1	3.8	4.8	3.4	71.5	34.0	98.0	86.5
15	3460	2970	6.3	1.6	2.6	1.7	45.0	17.8	80.0	66.0
20	2650	2120	3.9	.78	1.5	.88	28.0	10.1	65.0	50.5
25	2040	1520	2.4		.91	.49	17.4		52.5	38.5
30	1600	1120	1.5		.59	.30	10.5		43.0	30.0
35	1270	830	.90		.40				35.3	23.5
40	1030	635			.28				29.0	18.4
45	850	496							24.1	14.6
50	715	398							20.0	11.7
55	605	330							16.6	
60	515	282							13.8	
65	445	248							11.7	
70	385	224							9.8	
75	338									
80	300									
85	270									
90	244									
95	220									
100	200									

* Use curve A when evapotranspiration losses are average or normal.
Use curve B during excessively hot, windy weather.

Table 1. Plotting data for base-flow recession curves -- continued

Time in days	Gaging station number and name, drainage area, and discharge in cfs for curves A and B*									
	6-4840 Dry Creek at Hawarden		6-6000 Perry Creek at 38th Street Sioux City		6-6001 Floyd River at Alton		6-6003 West Branch Floyd River near Struble		6-6005 Floyd River at James	
	48.4 sq mi		65.1 sq mi		265 sq mi		181 sq mi		882 sq mi	
	A	B	A	B	A	B	A	B	A	B
0	20.0	20.0	15.0	15.0	15.0	15.0	20.0	20.0	160	160
5	10.3	9.2	9.4	7.5	10.0	7.1	13.1	8.8	126	121
10	5.4	3.5	6.8	3.5	6.6	3.2	8.6	4.1	100	92.5
15	2.9	1.0	5.1	1.4	4.3	1.3	5.5	1.9	80.5	71.5
20	1.6	.23	3.9	.41	2.7	.45	3.5	.95	65.0	55.0
25	.90		2.9		1.6	.13	2.2	.49	52.0	43.0
30	.52		2.1		.96		1.3		42.5	34.0
35	.30		1.4		.54		.76		34.7	27.0
40			.82		.29		.44		28.6	21.4
45			.39						23.8	17.2
50									20.2	14.0
55									17.1	
60									14.6	
65									12.4	
70									10.7	

* Use curve A when evapotranspiration losses are average or normal.
Use curve B during excessively hot, windy weather.

Table 1. Plotting data for base-flow recession curves -- continued

Time in days	Gaging station number and name, drainage area, and discharge in cfs for curves A and B*									
	6-6020 West Fork Ditch at Holly Springs		6-6024 Monona-Harrison ditch near Turin		6-6056 Little Sioux River at Gillett Grove		6-6066 Little Sioux River at Correctionville		6-6067 Little Sioux River at Kennebec	
	399 sq mi		900 sq mi		1334 sq mi		2500 sq mi		2738 sq mi	
	A	B	A	B	A	B	A	B	A	B
0	150	150	200	200	400	400	500	500	700	700
5	108	91.0	156	143	290	287	382	380	580	560
10	81.5	61.5	124	105	212	209	302	300	480	445
15	62.5	42.5	98.0	78.0	156	150	237	230	398	354
20	48.0	30.8	79.5	60.0	117	107	188	180	330	273
25	38.0	22.5	65.0	47.0	88.0	77.0	149	141	273	217
30	30.6	17.0	54.5	37.8	67.5	54.8	121	111	226	170
35	25.0	13.2	46.5	31.2	52.5	39.0	97.0	87.0	188	132
40	20.4	10.5	40.0	26.3	41.5	27.8	78.0	68.0	156	103
45	16.8	8.6	34.6	22.4	33.3	19.8	64.0	53.5	130	80.0
50	14.2	7.4	30.3	19.6	27.0	14.1	52.5	42.0	107	62.0
55	12.0		26.9		21.8		43.0		89.5	
60	10.2		24.0		17.9		35.5		74.5	
65	8.9		21.7		14.8				62.0	
70	7.9		19.8		12.4				51.0	

* Use curve A when evapotranspiration losses are average or normal.
Use curve B during excessively hot, windy weather.

Table 1. Plotting data for base-flow recession curves -- continued

Time in days	Gaging station number and name, drainage area, and discharge in cfs for curves A and B *									
	6-6070 Odebolt Creek near Arthur		6-6072 Maple River at Mapleton		6-6075 Little Sioux River near Turin		6-6085 Soldier River at Pisgah		6-6095 Boyer River at Logan	
	39.3 sq mi		669 sq mi		3526 sq mi		407 sq mi		871 sq mi	
	A	B	A	B	A	B	A	B	A	B
0	20.0	20.0	300	300	1000	1000	160	160	250	250
5	15.7	13.4	235	224	795	755	138	131	204	198
10	12.5	9.1	186	170	625	560	120	106	172	160
15	10.0	6.1	148	130	490	420	104	85.0	142	128
20	8.2	4.2	120	100	385	312	89.0	68.0	118	103
25	6.8	3.1	96.5	77.5	300	233	77.0	54.0	99.5	82.5
30	5.7	2.3	78.5	60.5	237	174	66.0	43.0	83.5	65.0
35	4.8	1.9	64.5	48.0	186	128	56.5	33.8	70.0	51.0
40	4.1	1.5	53.0	38.5	146	96.0	48.0	26.6	58.5	40.0
45	3.5	1.3	44.0	30.5	114	72.0	40.5	20.8	49.0	31.5
50	3.0		37.5	25.0	90.0		34.0	16.3	41.0	24.5
55	2.6		31.8		71.0		28.5		34.8	
60	2.3		27.2				23.6		29.2	
65	2.0		23.2				19.4		24.9	
70	1.8		20.0				15.6		21.3	
75	1.6		17.3						18.2	
80	1.5		15.0						15.6	

* Use curve A when evapotranspiration losses are average or normal.
Use curve B during excessively hot, windy weather.

Table 1. Plotting data for base-flow recession curves -- continued

Time in days	Gaging station number and name, drainage area, and discharge in cfs for curves A and B *									
	6-6105 Indian Creek at Council Bluffs		6-8060 Waubonsie Creek near Bartlett		6-8074.1 West Nishnabotna River at Hancock		6-8080 Mule Creek near Malvern		6-8085 West Nishnabotna River at Randolph	
	7.99 sq mi		30.4 sq mi		609 sq mi		10.6 sq mi		1326 sq mi	
	A	B	A	B	A	B	A	B	A	B
0	3.0	3.0	10.0	10.0	300	300	10.0	10.0	500	500
5	2.1	1.6	7.0	6.4	234	171	6.9	6.6	430	405
10	1.5	.78	5.0	4.0	182	98.0	5.0	4.3	372	324
15	1.1	.32	3.6	2.4	142	57.0	3.7	2.8	320	256
20	.76		2.6	1.3	110	33.0	2.7	1.7	275	200
25	.50		1.9		86.0		2.0	1.0	238	156
30	.29		1.3		67.0		1.5	.56	206	120
35					52.0		1.0	.23	177	91.0
40					40.0		.68		153	69.0
45							.39		132	51.5
50							.15		113	38.0
55									96.0	
60									81.0	
65									68.5	
70									57.0	

* Use curve A when evapotranspiration losses are average or normal.
Use curve B during excessively hot, windy weather.

Table 1. Plotting data for base-flow recession curves -- continued

Time in days	Gaging station number and name, drainage area, and discharge in cfs for curves A and B *									
	6-8090 Davids Creek near Hamlin		6-8092.1 East Nishnabotna River near Atlantic		6-8095 East Nishnabotna River at Red Oak		6-8100 Nishnabotna River above Hamburg		6-8118.4 Tarkio River at Stanton	
	26.0 sq mi		432 sq mi		894 sq mi		2806 sq mi		49.3 sq mi	
	A	B	A	B	A	B	A	B	A	B
0	13.0	13.0	300	300	300	300	1000	1000	20.0	20.0
5	10.0	8.9	230	212	257	237	840	800	13.4	11.0
10	7.4	5.9	180	153	216	186	710	640	8.9	6.1
15	5.4	3.8	142	113	180	143	595	510	5.8	3.3
20	4.0	2.4	113	83.0	148	108	500	410	3.7	1.7
25	2.9	1.4	91.0	63.0	121	82.0	420	327	2.3	.90
30	2.0	.82	75.0	48.5	98.0	60.5	358	260	1.4	.46
35	1.4	.44	62.0	38.0	79.0	44.0	300	208	.83	.24
40	1.0	.18	52.0	30.0	63.0	31.0	255	166	.48	
45	.66		44.5		50.0		216	133	.27	
50	.42		37.6		38.5		184	106	.15	
55	.24		32.4		29.5		156			
60			28.2		22.0		133			
65							114			
70							97.0			
75							84.0			
80							72.0			

* Use curve A when evapotranspiration losses are average or normal.
Use curve B during excessively hot, windy weather.

Table 1. Plotting data for base-flow recession curves -- continued

Time in days	Gaging station number and name, drainage area, and discharge in cfs for curves A and B*							
	6-8170 Nodaway River at Clarinda		6-8980 Thompson River at Davis City		6-8984 Weldon River near Leon		6-9039 Chariton River at Rathbun	
	762 sq mi		701 sq mi		104 sq mi		551 sq mi	
	A	B	A	B	A	B	A	B
0	200	200	150	150	18.0	18.0	100	100
5	157	154	91.0	78.0	10.1	6.5	36.0	30.0
10	126	121	59.5	43.0	5.7	2.3	15.5	9.5
15	100	93.0	41.0	25.2	3.2	.68	7.7	3.1
20	79.5	71.5	28.7	14.6	1.8	.27	4.3	1.1
25	63.5	54.5	21.0	8.6	1.0		2.7	
30	50.5	42.0	15.4	4.9	.55		1.8	
35	41.0	32.0	11.4	2.4				
40	33.0	24.3	8.4					
45	26.5	18.4	6.0					
50	21.5	14.0	4.2					
55	17.2		2.5					
60	13.7		1.2					
65	11.2							

* Use curve A when evapotranspiration losses are average or normal.
Use curve B during excessively hot, windy weather.