UNITED STATES DEPARTMENT OF THE INTERIOR GEOLOGICAL SURVEY

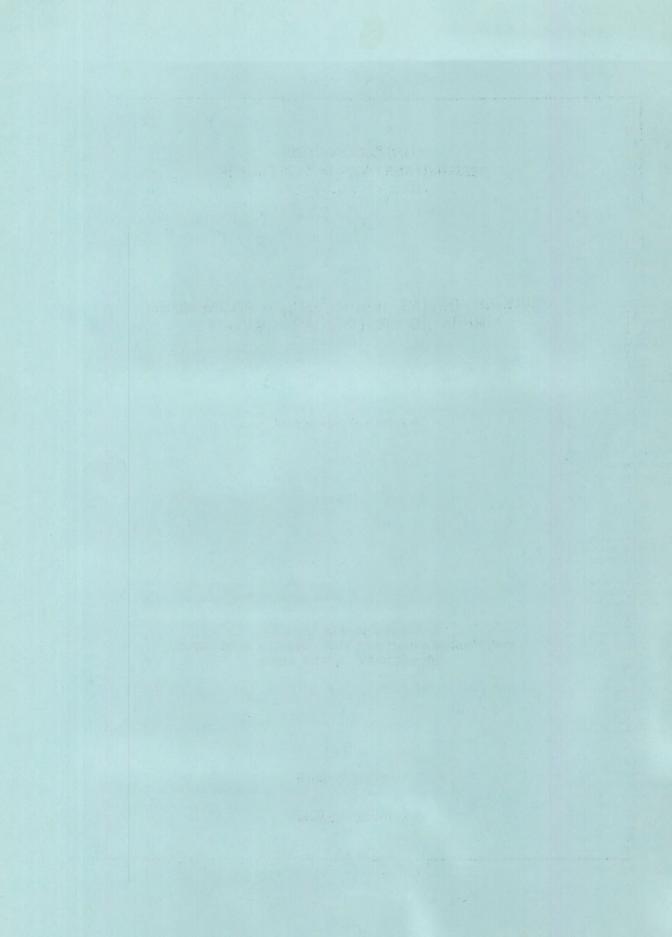
FLOODS OF MAY 1959 IN THE AUGRES AND RIFLE RIVER BASINS, MICHIGAN

By Lawrence E. Stoimenoff

Prepared in cooperation with the STATE OF MICHIGAN AND THE CORPS OF ENGINEERS, DEPARTMENT OF THE ARMY

Open-file report

Lansing, Michigan 1960



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FLOODS OF MAY 1959 IN THE AUGRES AND RIFLE RIVER BASINS, MICHIGAN

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INTRODUCTION

The floods of May 1959 in the Au Gres and Rifle River basins, Michigan, resulted from heavy rainfall during the night of May 19-20. Peak unit discharges for small drainage areas (less than about 15 square miles) were the highest ever measured in the Lower Peninsula of Michigan, and for very small areas (about one square mile) were of the same order of magnitude as those for the record Ontonagon River flood of August 1942 in the Upper Peninsula.

Because the flood area is sparsely populated, damages were largely confined to farm lands and facilities and to secondary roads and their appurtenant drainage structures.

The U. S. Geological Survey, through the district office in Lansing, Michigan, operates a network of streamgaging stations and crest-stage stations in the area affected by this flood. Six recording rain gages are operated in the upper Rifle River basin. Most of the gaging stations have been in operation for 7 to 9 years giving systematic records of stage, discharge, and volume of flow covering the range from drought to flood. This report contains records of stage and discharge at 9 gaging stations for the flood period, peak discharges at 7 crest-stage stations and 2 miscellaneous sites within the flood area, and other data pertinent to the flood.

Basic records of stage and discharge in the area covered by this report were collected and compiled under the supervision of A. D. Ash, district engineer, Surface Water Branch, Lansing district, as part of cooperative programs with the State of Michigan and the Corps of Engineers, U. S. Army. The Survey was assisted by the Michigan Water Resources Commission and the Michigan Department of Conservation in the field surveys for determination of peak flow. The Weather Bureau, the Corps of Engineers, and several inhabitants of the flood area supplied information or otherwise assisted in the collection and compilation of data presented in this report.

Most of the material on the description of the report area is taken from a report, "The Surface Waters of Michigan", by R. L. McNamee, University of Michigan Engineering Research Bulletin No. 16.

GENERAL DESCRIPTION OF THE FLOODS

Location and Description of the Area

The floods discussed in this report occurred in the east-central part of the Lower Peninsula of Michigan (fig. 1). The map of the area, includes Ogemaw and Iosco Counties and the northern half of Arenac County and shows where flood determinations were made. About 30 percent of the area is wooded and much of the remaining area is marginal land no longer used for farming. The area is sparsely populated.

The Au Gres River rises in small lakes, is about 35 miles long, and has a total fall of about 325 feet; the gradient is fairly uniform. Lakes and marsh comprise about 10 percent of the basin. | Clayey till is the predominant surface formation; sand is found only in the lower parts of the basin.

The Rifle River is about 45 miles long and falls 725 feet from headwaters to mouth. The upper tributaries rise on a tableland 1,200 feet or more above sea level, but within a very few miles and before the main river has been well formed these streams have fallen to elevations of less than 900 feet above sea level. In the lower part of the basin the river traverses slightly rolling terrain with a fairly uniform fall. Lakes and swamps, all in Ogemaw County, cover about 5 percent of the basin. Clayey till comprises nearly 40 percent of the drainage area and is well distributed over the entire basin; sandy till covers about 15 percent of the area and is mostly near the headwaters. Sands occur along the middle and lower reaches of the river and comprise nearly 40 percent of the area. Most of the developed farmland in the watershed is around the upper half of the western tributaries south of Rose City.

Precipitation

The general meteorological conditions under which the storm of May 19, 1959 developed have been described by the Weather Bureau as follows:

"The weather map for May 19 showed a low pressure trough covering the area from Minnesota southwest to the Texas Panhandle with a stationary front extending from Kansas across northern Missouri, central Illinois, thence east-southeast across southern Indiana and into Kentucky. Moisture was being carried north by southerly surface winds to this front, and then continued north while going upslope over the cooler air mass to the Michigan area, causing instability to develop and showers and thunderstorms to occur. This is a common situation for producing thunderstorm precipitation. The extremely heavy precipitation in the Rifle River basin was the result of an unusually heavy build-up of unstable cloud formations (cumulonimbus) with slow movement over a limited area. "1/

The Survey operates 6 recording rain gages in a 75-square-mile area in the upper Rifle River basin. Data from these gages and from a number of other sources scattered throughout the report area are the basis for the isohyetal map (fig. 2). The Corps of Engineers reconnoitered the flood area shortly after the floods and collected the rainfall data, some of which was of the unofficial "bucket catch" variety. Figure 2 is an adaptation of a map prepared by the Corps and compiled from the rainfall data they collected. No rain had fallen for a week prior to May 19.

1/ By letter, A. H. Eichmeier, U. S. Weather Bureau, Lansing, Michigan.

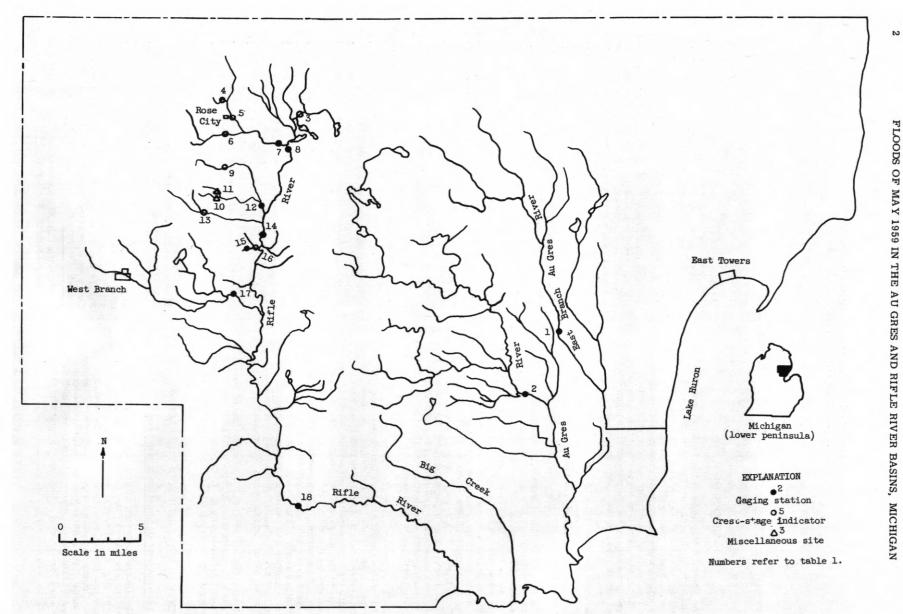


Figure 1.-- Map showing location of flood-determination points, Au Gres and Rifle River basins, May 1959.

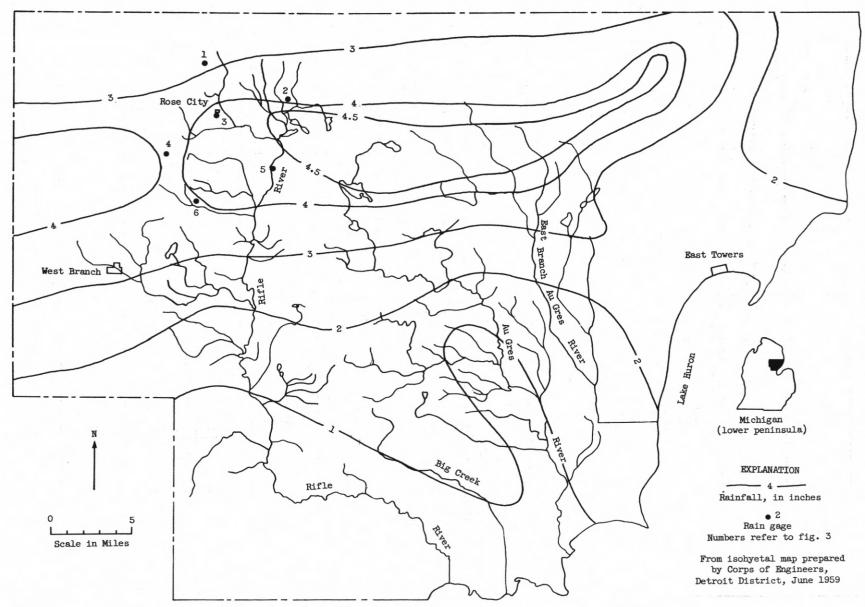


Figure 2.-- Isohyetal map, May 19-20, 1959.

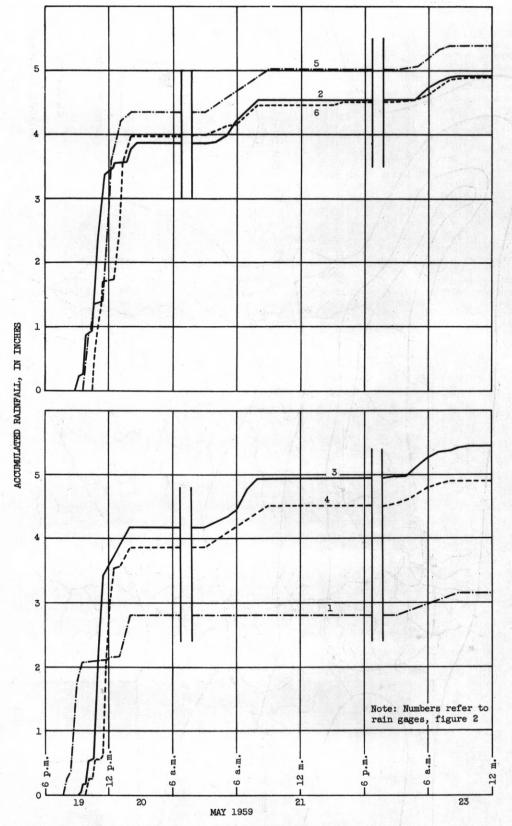


Figure 3.-- Accumulated rainfall, May 19-23; 1959, for six rain gages in the Rifle River basin, Michigan.

The flood peaks were caused by the initial downpour; subsequent rain although comparatively light (fig. 3) delayed recessions and added to flood volumes. An indication of the unusual rainfall intensities at the beginning of the storm is given by figure 4, wherein selected maximum rainfall intensities during May 19-20, 1959, are plotted on the Weather Bureau's rainfall intensity-duration-frequency curves for Alpena, Mich. Alpena, the nearest first-order weather station, is about 50 miles northeast of Rose City.

Flood Discharges

The floods of May 1959 in the Au Gres and Rifle River basins were the maximum of record at 5 of the 9 gaging stations in operation. New maxima occurred at all 7 crest-stage stations in the upper Rifle River basin.

At the crest-stage stations, the peaks occurred early in the morning of May 20. Current-meter measurements were not made, and in many cases could not have been made during the flood. Indirect measurements were made where peak flows could not be determined from a stage-discharge relation based on current-meter measurements. These measurements consisted of computation of flow through culverts, over embankments, through slope-area reaches, or of a combination of these methods. Such methods are described in various publications of the U. S. Geological Survey and other flood literature. Indirect measurement of peak flow was necessary at only 1 of the 9 gaging stations.

Rainfall was heaviest in the headwaters of the two basins. This explains why previous maxima were exceeded at headwater stations, but not at downstream stations. Vagaries of rainfall are believed to be responsible for the difference in peak unit discharge at the Au Gres River station and the East Branch Au Gres River station. Flooding may have been severe in the upper Au Gres River basin, but information and data are lacking.

On Houghton and Prior Creeks the peak discharges at the upstream stations were greater than those at the downstream stations. This is probably due to the steeper gradients above the upstream stations and to the channel and overbank storage below.

Flood Damages

There was no loss of life as a result of the floods. No homes or buildings were destroyed, nor were any trunkline highways closed. The Ogemaw County Road Commission reported that 5 bridges and 8 culverts were destroyed, and that more than one-third of the sand fill in a 2-mile grading project was washed away. Some culvert tubes were washed as far as one-quarter mile downstream from their road locations. Total damage was estimated as \$108,000 to the Road Commission - a staggering loss to a small organization.

According to the Michigan Department of Conservation, soil loss from cultivated fields was very high, and intermittent drainage channels were severely gullied. At least \$1,000 in direct damages occurred to stream improvement structures installed and maintained by the Department.

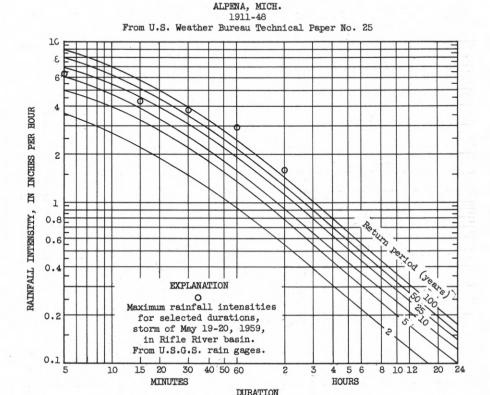


Figure 4. -- Rainfall intensity-duration-frequency curves.

STAGES AND DISCHARGES

The data presented on the following pages include: a description of each gaging station, crest-stage station, and miscellaneous site for which the peak flow was determined; a table of daily mean discharge and a table of stage and discharge at selected intervals for each gaging station; and two representative discharge hydrographs of the flood period (fig. 5). For identification purposes, reference numbers have been assigned to stations and sites in downstream order; these numbers are used throughout this report.

The hydrographs (fig. 5) show the rapid rise in river discharges as a result of the initial intense rain and the effects of the subsequent rain in slowing the recessions.

The description for each gaging station gives the location, drainage area above the gage, method of obtaining gage-height record during the flood period, datum of gage, a brief statement of the definition of the stage-discharge relation, maximum stage and discharge during the May 1959 flood, and previous maximum of record. Tables of daily mean discharge cover the period May 19-31. By the end of this period, all the stations had probably returned to base-flow conditions. Mean discharge, in cfs, and runoff, in inches, for the flood period are included in this table.

In the detailed tables stage and discharge are given at intervals which allow reproduction of stage or discharge hydrographs for the flood period.

The description for each crest-stage station and miscellaneous site g. es the location, drainage area, and peak discharge for the May 1959 flood with the method of its measurement. The previous maximum of record is given for crest-stage stations.

SUMMARY OF FLOOD STAGES AND DISCHARGES

Peak stages and discharges at 9 streamgaging stations, 7 crest-stage stations, and 2 miscellaneous sites are summarized in table 1.

The discharges listed in table 1 (p. 14) were determined by the methods mentioned in the station descriptions. The peak discharges were not affected by artificial storage, regulation, or diversion.

A period of record is shown for all gaging stations and crest-stage stations; leaders indicate a miscellaneous site at which no record of discharge has been systematically collected.

Figure 6 shows the peak discharge in cubic feet per second per square mile plotted against their respective drainage areas.

Because most of the records are relatively short and because no regional flood-frequency analysis has been made for the area of these floods, frequencies cannot be assigned to the peak unit discharges. However, some are greater than any previously recorded in the Lower Peninsula of Michigan.

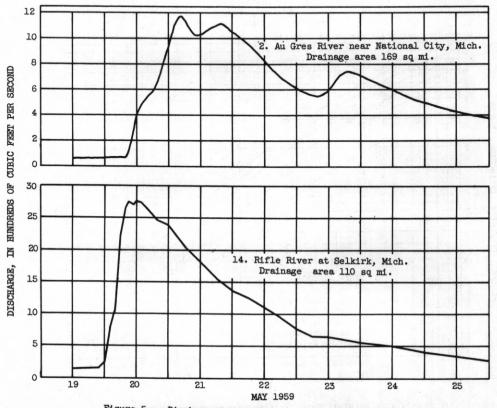


Figure 5 .-- Discharge hydrographs for stations 2, 14

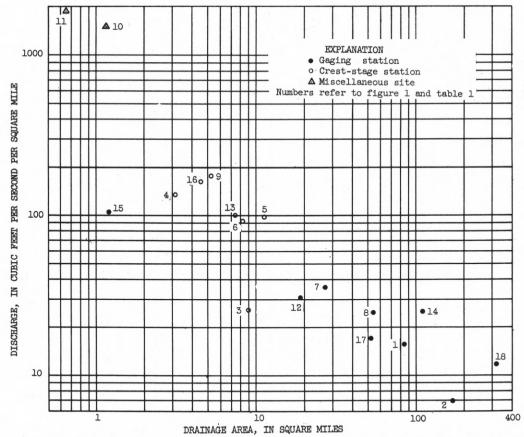


Figure 6 .-- Relation of peak unit discharge to drainage area, Au Gres and Rifle River basins, Michigan

DISCHARGE DATA

 East Branch Au Gres River at McIvor, Mich. (Gaging station)

Location. -- Lat 44°14'20", long 83°41'50", on line between secs. 3 and 10, T. 21 N., R. 6 E., on right bank 25 ft downstream from highway bridge at McIvor, 1.1 miles east of National City, and 9 miles southwest of Tawas City.

Drainage Area. --84 sq mi, approximately.

Gage-height record. --Water-stage recorder graph. Datum of gage is 646.58

Gage-height record. --Water-stage recorder graph. Datum of gage is 646.58 ft above mean sea level, datum of 1929.

Discharge record. --Stage-discharge relation defined by current-meter measurements.

Maxima. --May 19-31, 1959: Discharge, 1,310 cfs 7 p.m. May 20 (gage height, 8.88 ft).

1950 to May 18, 1959: Discharge, 865 cfs Apr. 14, 1952 (gage height, 7.67 ft).

Mean discharge, in cubic feet per second, and runoff in inches, May 1959

Date	19	20	21	22	23	24	25	26	27	28	29	30	31	19-31
Cfs	64	671	809	462	285	240	187	162	149	138	129	128	125	273
Runoff														- 1.57

Gage height, in feet, and discharge, in cubic feet per second, at indicated time, 1959

Hour	Gage height	Dis- charge									
May 19			May 20	-cont.		May 21	-cont.			-cont.	-
12 p.m.	2.16	66	6 p.m.	8.68	1230	8 p.m.		682	6 p.m.		282
May 20)		7	8.88	1310	12 p.m.		652	12 p.m.		268
2 a.m.	2.24	67	8	8.86	1300	May 22			May 24		
4	4.52	262	10	8.56	1180	6 a.m.		558	6 a.m.		261
6	5.51	371	12 p.m.		1020	12 m	5.96	440	12 m	4.29	239
8	5.62	387	May 21			6 p.m.		371	6 p.m.	4.14	224
10	6.15	473	4 a.m.		867	8	5.36	351	12 p.m.		207
12 m	6.74	588	8	7.68	853	12 p.m.		296	May 25		201
2 p.m.	7.26	718	10	7.78	888	May 23		200	6 a.m.		196
4	7.80	895	12 m	7.73	870	7 a.m.		258	12 m	3.73	186
5	8.33	1090	4 p.m.	7.30	730	10	4.92	302	6 p.m.		178
						12 m	5.07	317	12 p.m.		170

2. Au Gres River near National City, Mich. (Gaging station)

Location. --Lat 44°10'45", long 83°44'15", in NW1 sec. 32, T. 21 N., R. 6 E., on left bank 20 ft downstream from highway bridge, 1½ miles upstream from Elm Creek, 4 miles southwest of National City, 12 miles southwest of Tawas City, and 15 miles upstream from mouth.

Drainage area. -- 169 sq mi. Gage-height record .-- Water-stage recorder graph. Altitude of gage is 710 ft (by barometer). Discharge record. -- Stage-discharge relation defined by current-meter measurements.

Maxima. --May 19-31, 1959: Discharge, 1,170 cfs 4-5 a.m. May 21 (gage height, 5.62 ft).

1950 to May 18, 1959: Discharge, 2,480 cfs Apr. 4, 1959; gage height, 10.5 ft Feb. 21, 1953 (ice .jam).

Mean discharge, in cubic feet per second, and runoff, in inches. May 1959

Date	19	20	21	22	23	24	25	26	27	28	29	30	31	19-31
Cfs	57	369	1,080	818	636	597	432	334	279	238	207	189	178	416
Runoff														- 1.19

Gage height, in feet, and discharge, in cubic feet per second, at indicated time, 1959

Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge
May 19	9		May 21			May 22			May 24		
12 p.m.	1.34	57	2 a.m.	5.50	1100	6 a.m.		950	6 a.m.	4.29	652
May 20			4	5.62	1170	12 m	4.84	809	12 m	4.04	592
6 a.m.	1.36	59	5	5.62	1170	6 p.m.	4.43	688	6 p.m.	3.81	541
8	1,41	65	6	5.58	1140	12 p.m.	The second secon	604	12 p.m.		495
10	2.19	198	8	5.44	1070	May 23			May 25		
12 m	3.19	405	10	5.33	1010	4 a.m.		570	12 m	3.30	429
2 p.m.	3.59	493	12 m	5.34	1020	8	3.83	546	12 p.m.	3.05	374
4	3.79	537	4 p.m.	5.47	1080	12 m	4.04	592			
6	3.99	581	8	5.51	1110	4 p.m.	4.50	708	May 26		
8	4.38	675	12 p.m.	5.41	1050	7	4.63	745	12 m	2.86	332
12 p.m.	5.17	933				10	4.56	725	12 p.m.		299
						12 p.m.		708			

Gamble Creek at Lupton. Mich. (Crest-stage station)

Location .-- Lat 44°25'20", long 84°01'30", on line between secs. 35 and 36. T. 24 N.. R. 3 E., at culvert on county highway 0.4 mile south of Lupton. Record of peaks 1952-56 obtained at site a quarter of a mile downstream.

Drainage area. -- 8.86 sq mi, 8.96 sq mi at site used 1952-56.

Gage-height record. -- Peak stage from floodmark of 1959 and from crest-stage indicator 1952-56. Discharge record .- Peak discharge for 1959 by flow-through-culvert measurement. Stage-discharge relation 1952-56 defined by current-meter measurements below 72 cfs and extended to peak stage. Maxima.--May 19-31, 1959: Discharge, 223 cfs May 20 (gage height, 7.00 ft).

1952-56, 1958-59: Discharge, 168 cfs Apr. 4, 1956 (gage height, 3.01 ft, site and datum then

in use).

4. Bixby Creek near Rose City, Mich. (Crest-stage station)

<u>Location</u>.--Lat $44^{\circ}26^{\circ}05^{\circ}$, long $84^{\circ}07^{\circ}05^{\circ}$, in NW_{4}^{1} sec. 31, T. 24 N., R. 3 E., on left upstream wingwall of culvert on State Highway 33, 1 mile north of Rose City. Drainage area. -- 3.20 sq mi.

Gage-height record .-- Peak stage from crest-stage indicator below 5.9 ft, from floodmarks above. Discharge record. -- Stage-discharge relation defined by current-meter measurements below 50 cfs and by flow-through-culvert measurement of peak stage.

Maxima. -- May 19-31, 1959: Discharge, 423 cfs May 20 (gage height, 6.55 ft).
1952 to May 18, 1959: Discharge, 234 cfs Apr. 4, 1956 (gage height, 4.76 ft).

Houghton Creek at Rose City, Mich. (Crest-stage station)

<u>Location</u>.--Lat $44^{\circ}25'15"$, long $84^{\circ}06'25"$, in NE₄ sec. 6, T. 23 N., R. 3 E., on right downstream wingwall of highway bridge a quarter of a mile east of Rose City.

Drainage area. -- 11.2 sq mi.

Gage-height record .-- Peak stage from crest-stage indicator.

<u>Discharge record.</u>--Stage-discharge relation defined by current-meter measurements below 150 cfs and by slope-area measurement at peak stage.

Maxima. -- May 19-31, 1959: Discharge, 1,090 cfs May 20 (gage height, 4.34 ft).

1952 to May 18, 1959: Discharge, 720 cfs Apr. 4, 1956 (gage height, 3.64 ft).

6. Wilkins Creek near Rose City, Mich. (Crest-stage station)

Location.--Lat 44°24'25", long 84°06'50", in NE_{4}^{1} sec. 7, T. 23 N., R. 3 E., on right upstream abutment of culvert on State Highway 33, 1 mile south of Rose City.

Drainage area. -- 8.22 sq mi.

Gage-height record. -- Peak stage from crest-stage indicator.

Discharge record. -- Stage-discharge relation defined by current-meter measurements below 100 cfs and by flow-through-culvert measurement at peak stage.

Maxima. --May 19-31, 1959: Discharge, 748 cfs May 20 (gage height, 4.68 ft).
1952 to May 18, 1959: Discharge, 255 cfs Apr. 4, 1956 (gage height, 2.95 ft).

7. Houghton Creek near Lupton, Mich. (Gaging station)

Location. -- Lat 44°23'50", long 84°02'55", in SE1/4 sec. 10, T. 23 N., R. 3 E., on right bank half a mile upstream from mouth, 3 miles downstream from Wilkins Creek, and 3 miles southwest of Tupton.

Drainage area. -- 27 sq mi, approximately.

Gage-height record. --Water-stage recorder graph. Altitude of gage is 860 ft (by barometer).

Discharge record. --Stage-discharge relation defined by current-meter measurements below 400 cfs and by slope-area measurement of peak flow.

 $\frac{\text{Maxima.}-\text{May 19-31, 1959: Discharge, 955 cfs 12 m. May 20 (gage height, 7.15 ft in gage well, 7.40 ft from floodmarks).$

1950 to May 18, 1959: Discharge, 575 cfs Apr. 4, 1956 (gage height, 6.31 ft in gage well).

Mean discharge, in cubic feet per second, and runoff, in inches, May 1959

														19-31
Cfs	48	580	326	226	142	114	84	72	66	61	59	58	58	146
Runoff														2.61

Gage height, in feet, and discharge, in cubic feet per second, at indicated time, 1959

Hour	Gage height	Dis- charge									
May 19			May 20	-cont.		May 21	-cont.		May 23	-cont.	
12 p.m.	2.40	52	6 p.m.	6.56	704	8 p.m.	5.22	314	2 p.m.	3.58	146
May 20			8	6.35	620	10	5.25	320	4	3.63	151
2 a.m.	3.65	152	10	6.13	544	12 p.m.	5.23	316	6	3.64	152
4	4.30	211	12 p.m.	5.90	475	May 22			8	3.62	150
6	5.05	288	May 21			6 a.m.	4.90	271	12 p.m.	3.50	140
8	6.42	648	4 a.m.	5.51	378	12 m	4.40	221	May 24		
10	7.02	894	8	5.17	305	6 p.m.	3.97	181	12 m	3.15	112
11	7.10	930	10	5.05	288	12 p.m.		149	12 p.m.	2.90	92
12 m	7.15	955	12 m	4.97	278	May 23			May 25		
1 p.m.	7.08	921	2 p.m.	4.98	279	4 a.m.		134	12 m	2.80	84
2	7.00	885	4	5.03	285	8	3.37	130	12 p.m.	2.68	74
4	6.79	796	6.	5.13	299	12 m	3.49	139			

8. Rifle River at "The Ranch" near Lupton, Mich. (Gaging station)

Location. -- Lat 44°23'35", long 84°02'15", in $SW_{\frac{1}{4}}$ sec. 11, T. 23 N., R. 3 E., on left bank a quarter of a mile downstream from Houghton Creek and 3 miles southwest of Lupton.

Drainage area. -- 54 sq mi, approximately.

Gage-height record. -- Water-stage recorder graph. Altitude of gage is 850 ft (by barometer).

Discharge record. -- Stage-discharge relation defined by current-meter measurements.

Maxima. --May 19-31, 1959: Discharge, 1,330 cfs 2 p.m. May 20 (gage height, 10.10 ft in gage well, 10.6 ft from outside gage).

1950 to May 18, 1959: Discharge, 750 cfs Apr. 4, 1956 (gage height, 9.90 ft in gage well).

Mean discharge, in cubic feet per second, and runoff, in inches, May 1959

Date	19	20	21	22	23	24	25	26	27	28	29	30	31	19-31
														269
Runoff														- 2.41

Gage height, in feet, and discharge, in cubic feet per second, at indicated time, 1959

Hour	Gage height	Dis- charge									
May 19)		May 20	o-cont.		May 21			May 23		
10 p.m.	6.66	93	11 a.m.		1180	6 a.m.		640	4 a.m.	8.90	325
12 p.m.	7.00	116	12 m	10.04	1230	12 m	9.58	577	8	8.80	305
May 20			1 p.m.	10.08	1300	6 p.m.	9.59	584	12 m	8.77	300
l a.m.	7.73	180	2	10.10	1330	12 p.m.	9.60	590	4 p.m.	8.80	305
2	8.30	239	3	10.07	1280	May 22			6	8.79	304
4	8.80	305	4	10.02	1190	6 a.m.	9.52	538	12 p.m.	8.65	283
6	9.22	407	6	9.94	1060	12 m	9.39	471	May 24		
8	9.66	650	8	9.85	920	6 p.m.	9.25	418	12 m	8.27	236
10	9.92	1030	12 p.m.	9.75	765	12 p.m.	9.05	358	12 p.m.	7.94	201

9. Prior Creek near Rose City, Mich. (Crest-stage station)

Location.--Lat 44°22'25", long 84°06'45", in NE $\frac{1}{4}$ sec. 19, T. 23 N., R. 3 E., on downstream end of left abutment of culvert on State Highway 33, $3\frac{1}{4}$ miles south of Rose City.

Drainage area. -- 5.22 sq mi.

Gage-height record. -- Peak stage from crest-stage indicator. Datum of gage is 905.95 ft above mean sea level, datum of 1929.

Discharge record. --Stage-discharge relation defined by current-meter measurements below 170 cfs and by flow-through-culvert measurement at peak stage.

Maxima. -- May 19-31, 1959: Discharge, 910 cfs May 20 (gage height, 3.44 ft).
1952 to May 18, 1959: Discharge, 123 cfs Apr. 4, 1956 (gage height, 2.44 ft).

10. South Branch Ammond Creek near Rose City, Mich. (Miscellaneous site)

Location.--Lat $44^{\circ}20^{\circ}50^{\circ}$, long $84^{\circ}07^{\circ}10^{\circ}$, in NE^{1}_{h} sec. 36, T. 23 N., R. 2 E., at culvert on State Highway 33, 5 miles south of Rose City.

Drainage area. -- 1.14 sq mi.

Maximum. -- May 19-31, 1959: Discharge, 1,710 cfs May 20, by flow-through-culvert and flow-over-embankment measurement.

11. North Branch Ammond Creek near Rose City, Mich. (Miscellaneous site)

Location.--Lat 44° 21'10", long 84° 07'36", in SE $\frac{1}{4}$ sec. 27, T. 23 N., R. 2 E., at culvert on State Highway 33, 4 3/4 miles south of Rose City.

Drainage area.--0.646 sq mi.

Maximum. -- May 19-31, 1959: Discharge, 1,210 cfs May 20, by flow-through-culvert and flow-over-embankment measurement.

DISCHARGE DATA

12. Prior Creek near Selkirk, Mich. (Gaging station)

<u>Location</u>.--Lat $44^{\circ}20'10''$, long $84^{\circ}04'00''$, in SE_{4}^{1} sec. 33, T. 23 N., R. 3 E., on right bank a quarter of a mile upstream from mouth, half a mile downstream from Ammond Creek, and $1\frac{1}{2}$ miles north of Selkirk.

Drainage area. -- 19 sq mi, approximately.

Gage-height record .- - Water-stage recorder graph. Altitude of gage is 840 ft (by barometer). Discharge record .-- Stage-discharge relation defined by current-meter measurements below 380 cfs and extended to peak stage.

Maxima. -- May 19-31, 1959: Discharge, 584 cfs 6 a.m. May 20 (gage height, 5.64 ft). 1950 to May 18, 1959: Discharge, 314 cfs Apr. 3, 1959; gage height, 5.23 ft Apr. 4, 1956 (backwater from logs).

Mean discharge, in cubic feet per second, and runoff, in inches. May 1959 19-31 19 20 21 24 29 30 31 Date 22 23 25 26 27 28 94 Cfs 13 379 156 56 28 24 21 18 19 17 70.4 54 36 Runoff - -- 1.79

Gage height, in feet, and discharge, in cubic feet per second, at indicated time, 1959

Hour	Gage height	Dis- charge									
May 19	9		May 20	-cont.		May 2			May 23		
10 p.m.		12	8 a.m.		530	5 a.m.		171	6 a.m.	3.00	54
11	2.02	25	9	5.51	506	10	4.66	152	10	3.08	56
12 p.m.	2.52	40	10	5.49	494	5 p.m.	4.40	125	5 p.m.	3.03	55
May 20)		11	5.53	518	7	4.50	135	12 p.m.	3.12	58
l a.m.	3.93	92	12 m	5.54	524	9	4.52	137	May 24		
2	4.53	138	2 p.m.	5.48	488	12 p.m.	4.50	135	6 a.m.	3.17	60
3	4.78	171	4	5.34	407	May 22			12 m	3.05	56
4	5.00	230	6	5.24	352	3 a.m.	4.43	128	12 p.m.	2.62	43
5	5.54	524	8	5.17	314	9	4.10	101	May 25		
6	5.64	584	10	5.11	280	7 p.m.	3.41	69	12 m	2.37	35
7	5.62	572	12 p.m.	5.03	244	12 p.m.	3.23	62	12 p.m.	2.21	30

13. Klacking Creek near Selkirk, Mich. (Crest-stage station)

<u>Location.</u> --Lat $44^{\circ}21^{\circ}05^{\circ}$, long $84^{\circ}08^{\circ}35^{\circ}$, in NEL sec. 2, T. 22 N., R. 2 E., on left upstream wingwall of highway culvert 3 3/4 miles northwest of Selkirk.

Drainage area. -- 7.42 sq mi.

Gage-height record .-- Peak stage from crest-stage indicator.

Discharge record .-- Stage-discharge relation defined by current-meter measurements below 60 cfs and by flow-through-culvert measurement at peak stage.

Maxima.--May 19-31, 1959: Discharge, 738 cfs May 20 (gage height, 6.59 ft).

1952 to May 18, 1959: Discharge, 155 cfs Apr. 4, 1956 (gage height, 2.70 ft).

14. Rifle River at Selkirk. Mich. (Gaging station)

Location.--Lat $44^{\circ}18^{\circ}50^{\circ}$, long $84^{\circ}04^{\circ}00^{\circ}$, in NE $^{1}_{u}$ sec. 9, T. 22 N., R. 3 E., on left bank at upstream side of highway bridge at Selkirk, 12 miles downstream from Prior Creek.

Drainage area. -- 110 sq mi.

Gage-height record. --Water-stage recorder graph. Datum of gage is 828.47 ft above mean sea level, datum of 1929.

Discharge record. -- Stage-discharge relation defined by current-meter measurements.

Maxima. -- May 19-31, 1959: Discharge, 2,760 cfs 12 m. May 20 (gage height, 6.76 ft).

1950 to May 18, 1959: Discharge, 1,680 cfs Apr. 4, 1956 (gage height, 4.94 ft).

14. Rifle River at Selkirk. Mich .- cont.

Mean discharge, in cubic feet per second, and runoff, in inches, May 1959

19-31 Date 27 28 30 31 Cfs 139 2,200 1.830 1.090. 633 480 340 263 224 195 178 175 167 609 Runoff - 2.68

Gage height, in feet, and discharge, in subic feet per second, at indicated time, 1959

Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge
May 19			May 20	-cont.		May 2			May 23		
10 p.m. /	1.84	138	9 a.m.	6.74	2750	6 a.m.		2060	6 a.m.	3.35	645
12 p.m.	2.21	237	10	6.71	2730	12 m	5.37	1810	12 m	3.34	640
May 20			11	6.66	2690	6 p.m.		1560	6 p.m.	3.21	584
1 a.m.	3.16	579	12 m	6.76	2760	12 p.m.	4.68	1370	12 p.m.	3.12	548
2	3.61	775	2 p.m.	6.72	2730	May 22			May 24		10000
3	3.82	880	4	6.61	2660	6 a.m.		1260	12 m	2.96	486
4	4.16	1060	6	6.45	2540	12 m	4.24	1100	12 p.m.	2.72	402
5	5.06	1600	8	6.33	2460	6 p.m.	3.94	940	May 25		and the second second
6	6.00	2230	10	6.26	2410	12 p.m.	3.62	780	12 m	2.53	336
7	6.53	2600	12 p.m.	6.23	2390		The Section of		12 p.m.	2.38	284
8	6.65	2680			1		and the second	-	ar and round in the grant		Town Available

15. South Branch Shepards Creek near Selkirk, Mich. (Gaging station)

Location. -- Lat 44°18'25", long 84°05'10", in SE¹/₄ sec. 8, T. 22 N., R. 3 E., on right bank 200 ft upstream from mouth and 1 mile southwest of Selkirk.

Drainage area. -- 1.20 sq mi.

Gage-height record. --Water-stage recorder graph. Altitude of gage is 845 ft (by barometer).

Discharge record. --Stage-discharge relation defined by current-meter measurements below 40 cfs and extended by logarithmic plotting.

Maxima. -- May 19-31, 1959: Discharge, 125 ofs 3 a.m. May 20 (gage height, 3.99 ft).
1951 to May 18, 1959: Discharge, 181 ofs Apr. 3, 1956 (gage height, 4.42 ft).

Mean discharge, in cubic feet per second, and runoff, in inches, May 1959

19 20 21 22 23 26 27 28 29 30 31 19-31 Date Cfs 0.15 32 10 2.8 2.4 1.7 .84 .52 .36 .21 .21 .17 .16 3.96 Runoff -

Gage height, in feet, and discharge, in cubic feet per second, at indicated time, 1959

Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge
May 19)		May 20	-cont.	awas tarring	May 2			May 22		
10 p.m.	1.26	0.12	9 a.m.	3.00	29	2 a.m.		7.0	6 a.m.	2.00	3.6
11	1.50	.65	10	2.88	23	4	2.17	6.3	12 m	1.91	2.5
12 p.m.	1.55		11	2.75	19	6	2.33	9.3	6 p.m.	1.81	1.7
May 20		Tariff Bulletin	12 m	2.65	16	8	2.65	16 -	12 p.m.	1.75	1.4
1 a.m.	2.11	5.3	1 p.m.	2.56	14	9	2.74	19	May 23	Table of	
2	3.50	65	2	2.50	13	10	2.65	16	5 a.m.	1.72	1.3
3	3.99	125	3	2.48	12	12 m	2.55	14	9	1.92	2.6
4	3.74	92	4	2.43	11	2 p.m.	2.48	12	2 p.m.	1.97	3.2
5	3.75	94	5	2.40	11	4	2.40	11	8	1.95	2.9
6	3.63	79	6	2.37	10	6	2.31	8.9	12 p.m.	1.91	2.5
7	3.43	59	8	2.35	9.7	8	2.24	7.6	THE REAL PROPERTY.		
8	3.18	40	10	2.32	9.1	10	2.18	6.5			
		1000	12 p.m.	2.26	7.9	12 p.m.	2.12	5.4			

Shepards Creek near Selkirk, Mich. (Crest-stage station)

Location. -- Lat 44°18'25", long 84°05'00", in SE1/4 sec. 8, T. 22 N., R. 3 E., on left upstream wingwall of highway culvert 1 mile southwest of Selkirk.

Drainage area. -- 4.51 sq mi. Gage-height record. -- Peak stage from crest-stage indicator.

Discharge record. -- Stage - discharge relation defined by current-meter measurements below'll0 cfs and by flow-through-culvert and flow-over-embankment measurement at peak stage.

Maxima. -- May 19-31, 1959: Discharge, 726 cfs May 20 (gage height, 4.57 ft).
1952 to May 18, 1959: Discharge, 454 cfs Apr. 4, 1956 (gage height, 4.46 ft).

DISCHARGE DATA

17. West Branch Rifle River near Selkirk, Mich. (Gaging station)

Location. -- Lat 44°15'40", long 84°06'30", in NE_{4}^{1} sec. 31, T. 22 N., R. 3 E., on left bank half a mile downstream from Campbell Creek, $3\frac{1}{2}$ miles upstream from mouth, 4 miles southwest of Selkirk, and $6\frac{1}{2}$ miles southeast of town of West Branch.

Drainage area. -- 52 sq mi, approximately.

Gage-height record. -- Water-stage recorder graph. Altitude of gage is 796 ft (by barometer).

Discharge record. --Stage-discharge relation defined by current-meter measurements.

Maxima. --May 19-31, 1959: Discharge, 884 cfs 5-6 p.m. May 20 (gage height, 8.39 ft).

1952 to May 18, 1959: Discharge, 1,160 cfs Apr. 4, 1956 (gage height, 8.80 ft), from rating curve extended above 660 cfs by logarithmic plotting.

Mean discharge, in cubic feet per second, and runoff, in inches, May 1959

19 20 21 25 28 29 30 19-31 Date 22 23 24 26 31 77 70 57 Cfs 47 604 509 282 200 172 110 88 63 60 180 Runoff -1.67

Gage height; in feet, and discharge, in cubic feet per second, at indicated time, 1959

Hour	Gage height	Dis- charge									
May 19		May 20-cont.		May 21-cont.		May 23		5			
10 p.m.	2.90	48	2 p.m.		827	12 m	6.54	486	6 a.m.		169
12 p.m.	3.02	58	4	8.35	875	4 p.m.	6.51	480	12 m	4.42	203
May 20			5	8.39	884	6	6.43	464	6 p.m.	4.58	223
2 a.m.	3.50	96	6	8.39	884	12 p.m.	6.09	402	12 p.m.		214
4	4.15	168	8	8.33	869	May 2			May 24		
6	5.90	372	10	8.17	824	6 a.m.		324	12 m	4.18	171
8	6.82	536	12 p.m.	7.87	740	12 m	5.10	261	9 p.m.	3.94	142
10	7.47	656	May 2	i		6 p.m.	4.73	244	12 p.m.		127
12 m	7.88	743	4 a.m.	7.00	570	12 p.m.	4.40	200			
			8	6.62	500						

18. Rifle River at Michigan Highway 70, near Sterling, Mich. (Gaging station)

Location.--Lat 44°04', long 84°02', in SW_{4}^{1} sec. 5, T. 19 N., R. 4 E., on left bank 30 ft down-stream from bridge on State Highway 70, 3 miles north of Sterling, and 18 miles upstream from

Drainage area. -- 320 sq mi, approximately.

Gage-height record .-- Water-stage recorder graph. Altitude of gage is 641 ft (by barometer).

Discharge record .-- Stage-discharge relation defined by current-meter measurements.

Maxima. -- May 19-31, 1959: Discharge, 3,760 cfs 8:30 a.m. May 21 (gage height, 10.99 ft).

1936 to May 18, 1959: Discharge, 5,340 cfs Mar 28, 1950 (gage height, 13.74 ft) from rating curve extended above 3800 cfs.

Mean discharge, in cubic feet per second, and runoff, in inches, May 1959

30 19-31 19 20 21 22 25 26 27 28 29 31 Date 24 262 1,350 3,470 2,230 1,430 1,130 Cfs 402 380 357 1,038 850 650 528 456 Runoff

Gage height, in feet, and discharge, in cubic feet per second, at indicated time, 1959

Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge	Hour	Gage height	Dis- charge
May 1: 12 p.m. May 2: 4 a.m. 6 8 10 12 m 2 p.m. 4 6 8 10 12 p.m. May 2: 2 a.m. 4	2.06 2.15 2.35 4.10 5.20 6.07 6.87 7.82 8.87 9.69 10.19	267 276 288 335 830 1160 1760 2170 2700 3100 3360 3540 3660	May 2: 6 a.m. 8 8:30 9 10 12 m 2 p.m. 4 8 12 p.m. May 2: 6 a.m. 12 m 6 p.m.	10.98 10.99 10.97 10.93 10.82 10.64 10.37 9.72 9.25	3740 3720 3670 3580 3440 3120 2880	May 23 4 a.m. 8 10 2 p.m. 7 12 p.m. May 24 6 a.m. 12 p.m. 12 p.m. 4 p.m. 7 12 p.m.	6.30 6.04 6.07 5.97 5.77 5.64 5.35 5.12 4.88 4.60	1530 1430 1440 1400 1330 1290 1200 1140 1060 980 872 785 827 755	May 26 12 m 12 p.m. May 27 12 m 12 p.m. May 28 12 m 12 p.m. May 30 12 m 12 p.m. May 30 12 m 12 p.m.	3.46 3.22 3.06 2.94 2.80 2.71 2.60 2.54 2.56	638 570 525 491 452 428 398 382 388 362 357 350

			Period of record	Maximum flood p	reviously	y known	Maximum dur	959 flood	1	
						74-		the second	Discharge	
No.	Stream and place of determination	Drainage area (sq mi)		Date	Gage height (feet)	Dis- charge (Cfs)	Time	Gage height (feet)	Cfs	Cfs per
1	East Branch Au Gres River at	84	1950-59	Apr. 14, 1952	7.67	865	May 20, 7 p.m.	8.88	1,310	15.6
2	Au Gres River near National	169	1950-59	Apr. 4, 1959 Feb. 21, 1953	¹10.5	2,480	May 21, 4-5 a.m.	5.62	1,170	6.9
3	Gamble Creek at Lupton	² 8.86	1952-56, 1959	Apr. 4, 1956	23.01	168	May 20	7.00	223	25.2
4 5 6 7 8	Bixby Creek near Rose City Houghton Creek at Rose City Wilkins Creek near Rose City Houghton Creek near Lupton Rifle River at "The Ranch" near Lupton	3.20 11.2 8.22 27 54	1952-59 1952-59 1952-59 1950-59 1950-59	Apr. 4, 1956 Apr. 4, 1956 Apr. 4, 1956 Apr. 4, 1956 Apr. 4, 1956	4.76 3.64 2.95 36.31 39.90	234 720 255 575 750	May 20 May 20 May 20 May 20, 12 m May 20, 2 p.m.	6.55 4.34 4.68 47.15 510.10	423 1,090 748 955 1,330	132 97.3 91.0 35.4 24.6
9	Prior Creek near Rose City South Branch Ammond Creek near Rose City	5.22	1952-59	Apr. 4, 1956	2.44	123	May 20 May 20	3.44	910 1,710	174 1,500
11	North Branch Ammond Creek near Rose City	.646	-		-	-	May 20	-	1,210	1,870
12	Prior Creek near Selkirk	19	1950-59	Apr. 3, 1959 Apr. 4, 1956	6 5.23	314	May 20, 6 a.m.	5.64	584	30.7
13	Klacking Creek near Selkirk	7.42	1952-59	Apr. 4, 1956	2.70	155	May 20	6.59	738	99.5
14	Rifle River at Selkirk	110	1950-59	Apr. 4, 1956	4.94	1,680	May 20, 12 m	6.76	2,760	
15	South Branch Shepards Creek near Selkirk	1.20	1951-59	Apr. 3, 1956	4.42	181	May 20, 3 a.m.	3.99	125	10.4
16	Shepards Creek near Selkirk	4.51	1952-59	Apr. 4, 1956	4.46	454	May 20	4.57	726	161
17	West Branch Rifle River near Selkirk	52	1952-59	Apr. 4, 1956	8.80	1,160	May 20, 5-6 p.m.	8.39	884	17.0
18	Rifle River at Michigan High- way 70, near Sterling	320	1936-59	Mar. 28, 1950	13.74	5,340	May 21, 8:30a.m.	10.94	3,760	11.8

¹ Ice jam
2 Site and datum used 1952-56, drainage area 8.96 sq mi.
3 In gage well

In gage well, 7.40 ft from outside floodmark. In gage well, 10.6 ft from outside gage. Backwater from logs.

