

NINTH ANNUAL REPORT
YELLOWSTONE RIVER COMPACT COMMISSION
1960

YELLOWSTONE RIVER COMPACT COMMISSION

408 Federal Building

Helena, Montana

December 15, 1960

His Excellency Joseph J. Hickey
Governor of the State of Wyoming
Cheyenne, Wyoming

His Excellency J. Hugo Aronson
Governor of the State of Montana
Helena, Montana

His Excellency John E. Davis
Governor of the State of North Dakota
Bismarck, North Dakota

Sirs:

Pursuant to Article III of the Yellowstone River Compact, the Commission created according to the terms of said Compact makes the following ninth annual report covering activities for the annual period ending September 30, 1960:

The ninth annual meeting of the Yellowstone River Compact Commission was held at Sheridan, Wyoming on November 10, 1960. The duly designated members were in attendance.

The water uses in the several states which could be considered as germane to the percentage allocations of these states within the report year were not determined. The determination of shares would be highly involved and the cost was not considered justified at the present level of water resources development. From available information, allocable uses in upstream states did not exceed allocations. No questions of water use pertinent to the Compact were referred to the Commissioners.

Stream flow reflected deficient precipitation and the greater irrigation demands of a hot summer. At the points of division, flows for the water year ending September 30, 1960 ranged from 74 to 31 percent of the average of record. September flows were the lowest of record and were generally so for the May to September period. Using the relatively dry decade of 1931-40 as a comparative base, annual flows ranged from 88 to 37 percent. The carryover storage in upstream reservoirs at the end of the period was substantially less than a year ago.

The administrative expense of the Commission during the fiscal year ending June 30, 1960 was \$8,000 of which \$4,000 was borne by the Federal Government. Equal contributions of \$2,000 each by the States of Montana and Wyoming supplied the remaining \$4,000. A budget of \$8,000 is in force for the fiscal year ending June 30, 1961.

The facilities for the diversion of waters from Christina Lake of the Yellowstone River drainage to Rock Creek of the North Platte drainage referred to in previous reports has not yet been constructed.

Respectfully submitted,

Earl Lloyd

Earl Lloyd
Commissioner for Wyoming

Fred E. Buck

Fred E. Buck
Commissioner for Montana

Frank Stermitz

Frank Stermitz
Federal Representative

GENERAL REPORT

Cost:

The work of the Commission has been financed through annual cooperative agreements between the States of Montana and Wyoming and the United States of America.

The expense of the Commission during the fiscal year ending June 30, 1960 is given:

	<u>Total Cost</u>	<u>Borne by United States</u>	<u>Borne by Wyoming Montana</u>	
Gaging Station Operation, maintenance and construction	\$7,000			
Data assembly and administra- tion	<u>1,000</u>			
Total	<u>\$8,000</u>	<u>\$4,000</u>	<u>\$2,000</u>	<u>\$2,000</u>

The budget for the fiscal year ending June 30, 1961 is in a like amount and proportionate shares. It provides for the construction of an auxiliary recording gage on the Bighorn River at Big Horn, Montana to better define flows during periods of backwater caused by high stages on the Yellowstone River. Plans and construction await definite location of the interstate highway at this point.

The budgets of the Commission do not include the salaries and necessary expense of the State representatives, nor the cost of the collection of hydrologic data which can be had from other sources.

Gaging Stations:

Discharge records were generally collected at the points of measurement designated in the Compact. Where this was not practical, supplementary discharge information was obtained to permit reasonable transfer of data to the designated points. The records of discharge are presented in Appendix B.

The flows of the 1960 water year were among the lows of record. This is fairly well illustrated by the graphic presentation for the four designated points of measurement in Appendix B. The decade of 1931-40 has been used as one basis of comparison since it was considered the period of critically low flow at the time the Compact was negotiated.

The gaging station on the Little Bighorn River near Crow Agency was discontinued on September 30, 1960. Seven years of concurrent record on the Little Bighorn River near Hardin was considered adequate for correlation in any probable study of early records. The records for Agency Canal near Crow Agency which were collected to better understand the regimen in the Crow Agency-Hardin reach were likewise concluded. During periods of backwater effect from the Yellowstone River, frequent discharge measurements were made of the Bighorn River at Big Horn. Miscellaneous measurements of the Clarks Fork Yellowstone River just above the mouth of Rock Creek were made from the newly constructed cableway.

In general a marked gain in flow occurs between Edgar and that point. Miscellaneous measurements of the discharge of the intervening Whitehorse Canal and operating data served to approximate the amount of diversion bypass.

Diversions:

The Commissioners for Montana and Wyoming are in agreement that the water uses allocable under the Compact did not reach the pro-rata share in either state in the water year as a whole. This was based upon available information on new water-right filings or permits, the general knowledge of the significance of developments since January 1, 1950 and the records of stream flow.

Storage:

In reservoirs completed after January 1, 1950:

Boysen Reservoir on the Wind River is the principal reservoir in this category, records of which are given in Appendix C. There was a net withdrawal of 172,200 acre-feet in the water year. The details of the operation of smaller reservoirs which may fall in this category were not collected.

In reservoirs existing on January 1, 1950:

Compact allocations are affected by storage in these reservoirs only as it is used for new developments. The extent of that use was known to be minor. As a matter of information, the quantities in storage on month-ends in the larger reservoirs in this category are tabulated in Appendix D.

RULES AND REGULATIONS FOR ADMINISTRATION OF
THE YELLOWSTONE RIVER COMPACT

A compact, known as the Yellowstone River Compact between the States of Wyoming, Montana and North Dakota, having become effective on October 30, 1951 upon approval of the Congress of the United States, which apportions the waters of certain interstate tributaries of the Yellowstone River which are available after the appropriative rights existing in the States of Wyoming and Montana on January 1, 1950 are supplied, and after appropriative rights to the use of necessary supplemental water are also supplied as specified in the Compact, the following rules and regulations are adopted subject to the provisions for amendment, revision or abrogation as provided herein.

Article I. Collection of Water Records.

- A. It shall be the joint and equal responsibility of the members of the states of Wyoming and Montana to collect, cause to be collected or otherwise furnish records of tributary stream flow at the points of measurement specified in Article V (B) of the Compact, or as near thereto as is physically or economically feasible or justified.

1. Clarks Fork

The gaging station known as Clarks Fork at Edgar, Montana and which is located in SW $\frac{1}{4}$ sec. 24, T. 4 S., R. 24 E., shall temporarily be the point of measurement for the Clarks Fork, subject to whatever mutually agreeable corrections to the stream-flow records at this point as may be deemed practical to meet the terms of the Compact.

2. Bighorn River (exclusive of Little Bighorn River)

The gaging station known as the Bighorn River near Custer, Montana and located near the center of sec. 10, T. 4 N., R. 34 E., shall temporarily be the designated point of measurement on that stream. The flow of the Little Bighorn River as measured at the gaging station near Hardin, Montana and located in S $\frac{1}{2}$, SE $\frac{1}{4}$ sec. 18, T. 1 S., R. 34 E., shall be considered the point of measurement for that stream, except that if or when satisfactory records are not available, the records for the nearest upstream station with practical corrections for intervening inflow or diversion shall be used.

3. Tongue River

The gaging station known as the Tongue River at Miles City, Montana and located in SE $\frac{1}{4}$ sec. 23, T. 7 N., R. 47 E., shall temporarily be the point of measurement for that stream.

4. Powder River

The gaging station known as the Powder River near Locate, Montana and located in NE $\frac{1}{4}$ sec. 26, T. 8 N., R. 51 E., shall temporarily be the designated point of measurement for that stream.

- B. Records of total annual diversion in acre-feet above the points of measurement designated in the Compact for irrigation, municipal and industrial uses developed after January 1, 1950 shall be furnished by the members of the Commission for their respective states, at such time as the Commission deems necessary for interstate administration as provided by the terms of the Compact. Providing that if it be acceptable to the Commission, reasonable estimates thereof may be substituted.
- C. Annual records of the net change in storage in all reservoirs, not excluded under Article V (E) of the Compact, above the specified point of measurement specified in the Compact and completed after January 1, 1950, and the annual net change in reservoirs existing prior to January 1, 1950, which is used for irrigation, municipal and industrial purposes developed after January 1, 1950, shall be the primary responsibility of the member of the Commission in whose state such works are located; providing, such data is not furnished by federal agencies under the provisions of Article III (D) of the Compact, or, collected by the Commission.

Article II. Office and Officers.

- A. The office of the Commission shall be located, and be that of the United States Geological Survey in Helena, Montana.
- B. The Chairman of the Commission shall be the federal representative as provided in the Compact.
- C. The Secretary of the Commission shall be as provided for in Article III of these rules.
- D. The credentials of each member of the Commission shall be placed on file in the office of the Commission.

Article III. Secretary

- A. The Commission, subject to the approval of the Director of the United States Geological Survey, shall enter into cooperative agreements with the U. S. Geological Survey for such engineering and clerical services as may reasonably be necessary for the administration of the Compact. Said agreements shall provide that the Geological Survey shall:
1. Maintain and operate gaging stations at or near the points of measurement specified in Article V (A) of the Compact.
 2. Assemble factual information on stream flow, diversion and reservoir storage for the preparation of an annual report to the Governors of the signatory states.
 3. Make such investigations and reports as may be requested by the Commission in aid of its administration of the Compact.
 4. Act as Secretary to the Commission.

Article IV. Budget

- A. At the annual meeting of each even numbered year or prior thereto, the Commission shall adopt a budget for operation during the ensuing biennium beginning July first. Such budget shall set forth the total cost of construction, maintenance and operation of gaging stations, the cost of engineering and clerical aid, and other necessary expenses excepting the salaries and personal expenses of the Commissioners. On odd-numbered years revisions of the budget shall be considered.
- B. It shall be the obligation of the Commissioners of the States of Montana and Wyoming to endeavor to secure from the Legislature of their respective states sufficient funds with which to meet the obligations of this Compact, except insofar as provided by the federal government.

Article V. Meetings

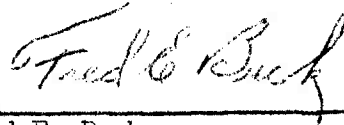
An annual meeting of the Commission shall be held on the third Tuesday of each November at some mutually agreeable point in the Yellowstone River Basin for consideration of the annual report for the water year ending the preceding September 30th, and for

the transaction of such other business consistent with its authority; provided that by unanimous consent of the Commission the date and place of the annual meeting may be changed. Other meetings as may be deemed necessary shall be held at a time and place set by mutual agreement, for the transaction of any business consistent with its authority.

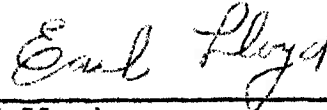
No action of the Commission shall be effective until approval by the Commissioners for the States of Wyoming and Montana.

Article VI. Amendments, Revisions and Abrogations.

The Rules and Regulations of the Commission may be amended or revised by a unanimous vote at any meeting of the Commission.



Fred E. Buck
Commissioner for Montana



Earl Lloyd
Commissioner for Wyoming

Attested:



Frank Stermitz
Federal Representative

Adopted November 17, 1953
Amended November 16, 1959

MONTHLY SUMMARY OF DISCHARGE

Clarks Fork Yellowstone River at Edgar, Montana

Location.--Lat $45^{\circ}28'00''$, long $108^{\circ}50'30''$, in $SE\frac{1}{4}SE\frac{1}{4}$ sec. 23 T. 4 S., R. 23 E., on right bank just downstream from highway bridge, half a mile east of Edgar, and 6 miles upstream from Rock Creek.

Drainage area.--2,070 sq mi, approximately.

Records available.--July 1921 to September 1960. Records since January 1950, available in annual reports of Yellowstone River Compact Commission.

Gage.--Water-stage recorder. Altitude of gage is 3,440 ft (by barometer). Prior to Sept. 18, 1940, chain gage and Sept. 18, 1940, to Aug. 31, 1953, wire-weight gage, at same site and datum.

Average discharge.--39 years, 1,036 cfs (750,000 acre-ft per year).

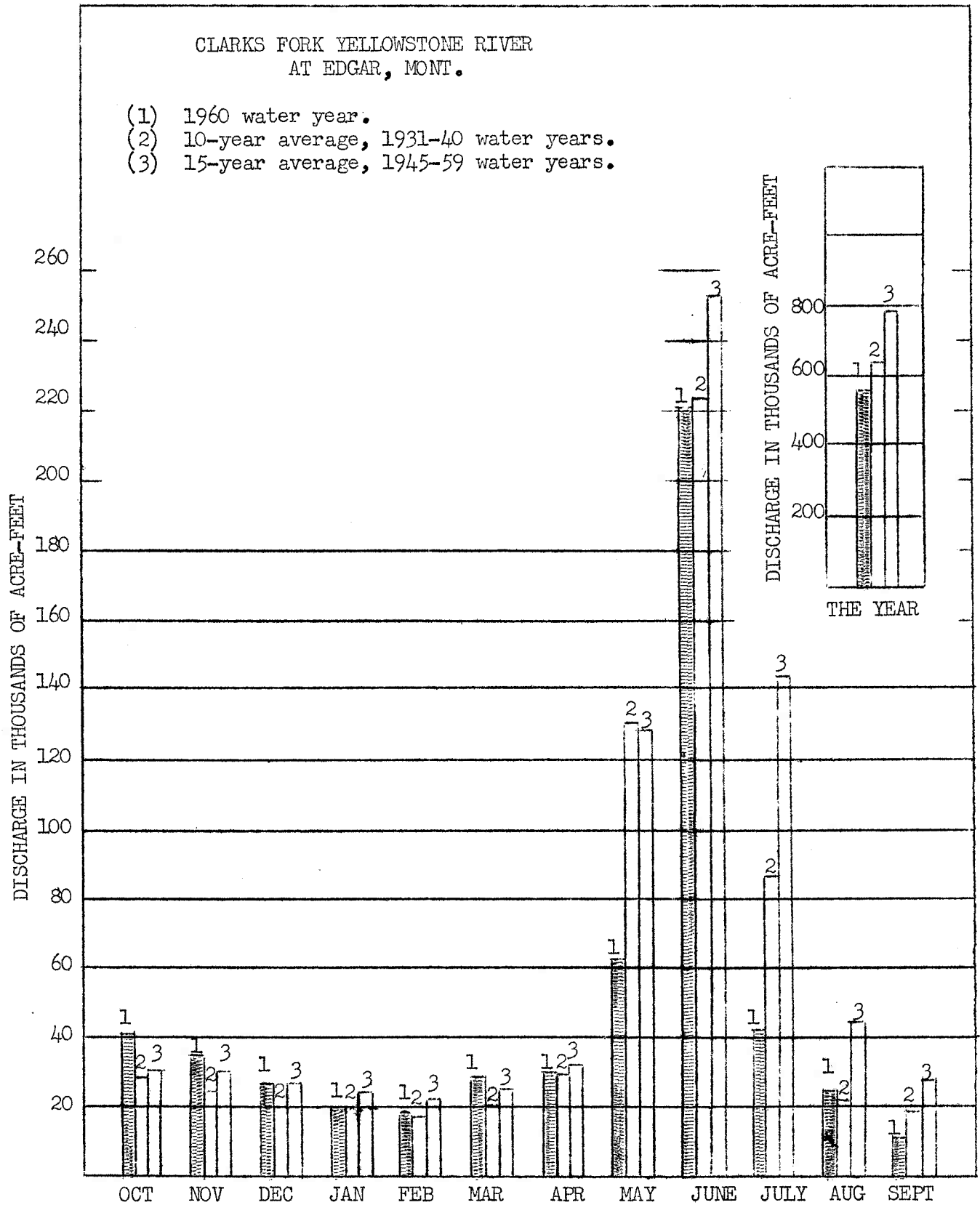
Extremes.--Maximum discharge during year, 6,220 cfs June 5 (gage height, 6.49 ft); minimum 154 cfs Sept. 3.

1921-60: Maximum discharge observed, 10,900 cfs June 2, 1936 (gage height, 8.62 ft); minimum observed, 41 cfs July 25, 1931.

Remarks.--Records good except those for periods of ice effect, which are poor. Upstream diversions for irrigation of about 41,500 acres, of which 840 acres lie below the station. In addition, about 6,300 acres of land lying above station are irrigated by diversions from the adjoining Rock Creek basin. The following discharge measurements were made of the Whitehorse Canal near point of diversion about 3 miles downstream in $SW\frac{1}{4}$ sec. 1, T. 4 S., R. 23 E: Oct. 2, 1959, 6.0 cfs; June 21, 1960, 23.8 cfs; Aug. 28, 1960, 20.6 cfs; Oct. 1, 1960, 24.6 cfs. On basis of discharge measurements and an irrigator's statement of canal operation, the seasonal diversion is estimated at about 4,900 acre-feet.

Revisions (water years).--Water Supply Paper 1509: 1924, 1932 (M).

Month	Second-foot days	Maximum	Minimum	Mean	Runoff in Acre-feet
October 1959	20,872	922	520	673	41,400
November	17,622	706	450	587	34,950
December	13,740	560	240	443	27,250
January 1960	9,750	370	180	315	19,340
February	9,500	370	240	328	18,840
March	14,229	668	270	459	28,220
April	15,313	890	384	510	30,370
May	31,357	2,090	352	1,012	62,200
June	111,250	5,510	1,480	3,708	220,700
July	21,262	1,390	272	686	42,170
August	12,362	1,260	171	399	24,520
September 1960	5,771	257	160	192	11,450
Water year 1959-60	283,028	5,510	160	773	561,400



Comparison of discharge during 1960 water year with average discharge for water years 1931-40 and 1945-59.

MONTHLY SUMMARY OF DISCHARGE

Little Bighorn River near Crow Agency, Montana

Location.--Lat 45°34', long 107°27', in E $\frac{1}{2}$ SE $\frac{1}{4}$ sec. 13 T. 3 S., R. 34 E., on right bank at Chicago, Burlington & Quincy Railroad bridge, 2 miles south of Crow Agency, and 17 miles upstream from mouth.

Drainage area.--1,190 sq mi, approximately.

Records available.--April 1912 to September 1924, August 1928 to December 1932, (no winter records most years), April 1938 to September 1960. Monthly discharge only for some periods, published in WSP 1309. March 1905 to June 1906 at site at Crow Agency, 2 miles downstream, records not equivalent because Crow Agency ditch diverts water between the two sites. October 1914 to September 1940, published as Little Horn River near Crow Agency. Records since January 1950, available in annual reports of Yellowstone River Compact Commission.

Gage.--Water-stage recorder. Datum of gage is 3,045 ft above mean sea level, datum of 1929. April 11, 1912 to Sept. 30, 1918, staff or chain gage; Oct. 1 1918, to Sept. 30, 1924, Aug. 26, 1928, to Sept. 30, 1930, water-stage recorder; Oct. 1, 1930, to Dec. 5, 1932, Apr. 1, 1938, to May 6, 1947, wire-weight or chain gage; all at same site and datum.

Average discharge.--25 years (1928-29, 1930-32, 1938-60), 248 cfs (179,500 acre-feet per year).

Extremes.--Maximum discharge during year, 2,850 cfs Mar. 21; maximum gage height, 11.02 ft Mar. 19 (backwater from ice); minimum discharge, 23 cfs Sept. 30 (gage height, 3.92 ft).

1912-24, 1928-32, 1938-60: Maximum discharge observed, 6,200 cfs July 23, 1923 (gage height, 14.0 ft); no flow July 28 to Aug. 6, 1921.

Remarks.--Records good except those for periods of ice effect, which are poor.

Diversions for irrigation of about 13,700 acres above station.

Revisions (water years).--Water Supply Paper 1559: 1920-22 (M), 1923-24, 1943-44 (M).

<u>Month</u>	<u>Second-foot days</u>	<u>Maximum</u>	<u>Minimum</u>	<u>Mean</u>	<u>Runoff in Acre-feet</u>
October 1959	4,149	161	103	134	8,230
November	4,528	210	95	151	8,980
December	3,785	145	95	122	7,510
January 1960	3,415	130	85	110	6,770
February	3,380	145	90	117	6,700
March	14,049	2,490	100	453	27,870
April	4,720	218	136	157	9,360
May	4,930	253	101	159	9,780
June	6,056	280	119	202	12,010
July	1,967	110	50	63.5	3,900
August	1,118	50	26	36.1	2,220
September 1960	949	39	23	31.6	1,880
Water year 1959-60	53,046	2,490	23	145	105,200

MONTHLY SUMMARY OF DISCHARGE

Agency Canal at Crow Agency, Montana

Location.--Lat 45°35'55", long 107°27'15", near center of sec. 1, T. 3 S., R. 34 E., on downstream right abutment of bridge at intersection of U. S. Highway No. 87 and the main street of Crow Agency, a third of a mile downstream from headgate.

Records available.--Fragmentary records for 1953-60 in annual reports of Yellowstone River Compact Commission.

Gage.--Staff gage read twice daily during canal operation. Some recorder record during 1953.

Extremes.--Maximum daily discharge during year, 113 cfs June 4; no flow Nov. 10 to May 4.

Remarks.--Canal operated Oct. 1 to Nov. 9 and May 5 to Sept. 30 for irrigation of about 3,500 acres of land. Records fair because of backwater from operation of check gates downstream from gage.

<u>Month</u>	<u>Second-foot days</u>	<u>Maximum</u>	<u>Minimum</u>	<u>Mean</u>	<u>Runoff in Acre-feet</u>
October 1959	985	48	11	31.8	1,980
November 1-9, 1959	103	14	2	11.4	204
May 5-31, 1960	1,832	111	24	67.9	3,630
June	3,176	113	86	106	6,300
July	1,698	85	42	54.8	3,370
August	1,039	44	24	33.5	2,060
September 1960	<u>911</u>	<u>41</u>	<u>22</u>	<u>30.4</u>	<u>1,810</u>
Water year 1959-60	9,744	113	0		19,350

MONTHLY SUMMARY OF DISCHARGE

Little Bighorn River near Hardin, Montana

Location.--Lat $45^{\circ}44'$, long $107^{\circ}34'$, on line between SE $\frac{1}{4}$ sec. 18 and NE $\frac{1}{4}$ sec. 19, T. 1 S., R. 34 E., on right bank 425 ft upstream from highway bridge, a quarter of a mile upstream from mouth, and 2.4 miles east of Hardin.

Drainage area.--1,290 sq mi, approximately.

Records available.--June 1953 to September 1960, in reports of the Geological Survey and in annual reports of the Yellowstone River Compact Commission.

Gage.--Water-stage recorder. Altitude of gage is 2,880 ft (by barometer). Prior to Oct. 7, 1953, wire-weight gage on bridge 425 ft downstream at different datum.

Average discharge.--7 years, 197 cfs (142,600 acre-ft per year).

Extremes.--Maximum daily discharge during year, 2,500 cfs Mar. 21; maximum gage height, 11.12 ft Mar. 19 (backwater from ice); minimum discharge, 8.1 cfs Aug. 31 (gage height 2.33 ft).

1953-60: Maximum discharge, 2,990 cfs June 19, 1957, (gage height, 8.00 ft); maximum gage height, 11.16 ft Mar. 20, 1956 (backwater from ice); minimum discharge, 4.2 cfs Aug. 10, 1956 (gage height, 2.74 ft).

Remarks.--Records good except those for periods of ice effect, no gage-height record, or backwater from construction activities, which are poor. Diversions for irrigation of about 17,000 acres above station.

<u>Month</u>	<u>Second-foot days</u>	<u>Maximum</u>	<u>Minimum</u>	<u>Mean</u>	<u>Runoff in Acre-feet</u>
October 1959	4,328	156	116	140	8,580
November	4,485	205	100	150	8,900
December	3,840	155	100	124	7,620
January 1960	3,405	130	80	110	6,750
February	3,480	145	90	120	6,900
March	^a 14,773	2,500	100	476	29,300
April	4,909	228	142	164	9,740
May	3,601	232	26	116	7,140
June	4,949	258	42	165	9,820
July	830	80	10	26.8	1,650
August	392.6	22	8.6	12.7	779
September 1960	^c 573.5	23	9.5	19.1	1,140
Water year 1959-60	49,566.1	2,500	8.6	135	98,320

a No gage-height record Mar. 13-15, 20-22; discharge partly estimated on basis of record for Little Bighorn River near Crow Agency.

c Backwater from bridge and road construction; discharge estimated.

MONTHLY SUMMARY OF DISCHARGE

Bighorn River at Bighorn, Montana

Location.--Lat $46^{\circ}08'50''$, long $107^{\circ}27'20''$, in NE $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 33, T. 5 N., R. 34 E., on right bank just downstream from bridge on U. S. Highway 10, three-quarters of a mile upstream from mouth, 1 mile southwest of Bighorn, and 4 miles east of Custer.

Drainage area.--23,100 sq mi, approximately.

Records available.--May 1945 to September 1959. Published as "near Custer" 1945-55. Records since January 1950, available in annual reports of Yellowstone River Compact Commission.

Gage.--Water-stage recorder. Altitude of gage is 2,690 ft (by barometer). May 11 to Dec. 6, 1945, wire-weight gage and Dec. 7, 1945, to Oct. 6, 1955, water-stage recorder, at site 4 miles upstream at different datum.

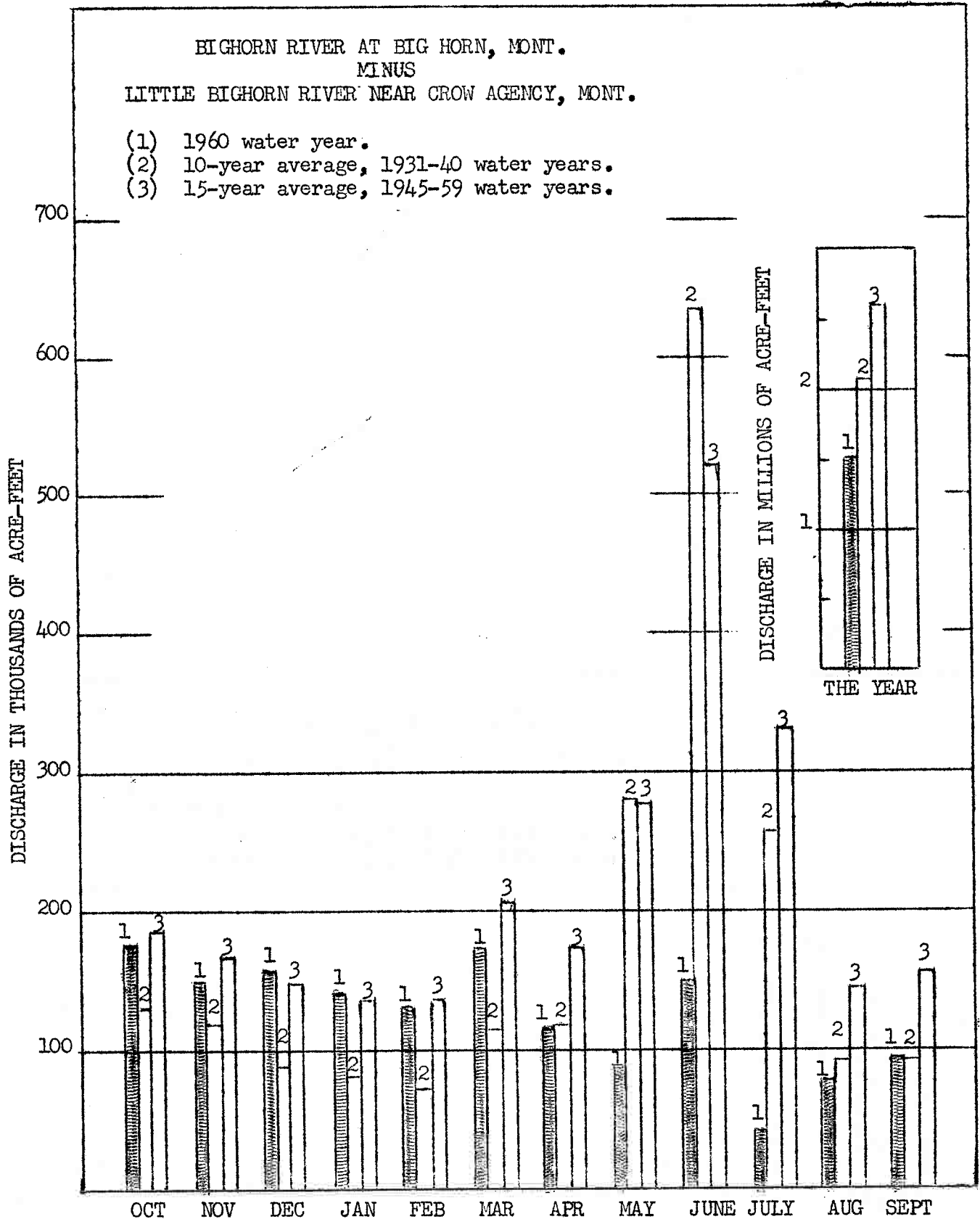
Average discharge.--15 years, 3,687 cfs (2,669,000 acre-ft per year).

Extremes.--Maximum daily discharge during year, 6,830 cfs June 12; maximum gage height, 10.10 ft Mar. 21 (backwater from ice); minimum discharge, about 260 cfs Nov. 15 (gage height, 0.62 ft), result of freezeup; minimum daily, 540 cfs July 22.

1945-60: Maximum discharge, 26,200 cfs June 24, 1947 (gage height 8.79 ft site and datum then in use), from rating curve extended above 12,500 cfs by logarithmic plotting; maximum gage height recorded, 10.65 ft, Mar. 20, 1947 (ice jam), site and datum then in use; minimum discharge, that of Nov. 15, 1959; minimum daily, that of July 22, 1960.

Remarks.--Records good except those for periods of ice effect, which are poor. Diversions for irrigation of about 465,000 acres above station. Major regulation by 14 reservoirs in Wyoming and 1 in Montana with combined usable capacity of about 1,400,000 acre ft (see Appendices C and D).

<u>Month</u>	<u>Second-foot days</u>	<u>Maximum</u>	<u>Minimum</u>	<u>Mean</u>	<u>Runoff in Acre-feet</u>
October 1959	93,320	4,060	2,750	3,010	185,100
November	80,800	4,000	650	2,693	160,300
December	83,600	3,260	2,180	2,697	165,800
January 1960	74,600	3,000	1,900	2,406	148,000
February	70,850	2,750	1,800	2,443	140,500
March	103,520	6,780	1,900	3,339	205,300
April	62,050	2,730	1,600	2,068	123,100
May	49,750	3,040	1,090	1,605	98,680
June	82,160	6,830	1,070	2,739	163,000
July	21,912	996	540	707	43,460
August	40,826	2,460	864	1,317	80,980
September 1960	<u>48,818</u>	<u>2,920</u>	<u>864</u>	<u>1,627</u>	<u>96,830</u>
Water year 1959-60	812,206	6,830	540	2,219	1,611,000



Comparison of discharge during 1960 water year with average discharge for water years 1931-40 and 1945-59.

MONTHLY SUMMARY OF DISCHARGE

Tongue River at Miles City, Montana

Location.--Lat $46^{\circ}21'$, long $105^{\circ}48'$, in SE $\frac{1}{4}$ sec. 23, T. 7 N., R. 47 E., on right bank 4 miles south of Miles City and 8 miles upstream from mouth.

Drainage area.--5,380 sq mi, approximately.

Records available.--April 1938 to April 1942, April 1946 to September 1960.

Published as "near Miles City" April 1938 to April 1942. Not equivalent to records published as "near Miles City" May 1929 to September 1932. Monthly discharge only for some periods, published in WSP 1309. Records since January 1950, available in annual report of Yellowstone River Compact Commission.

Gage.--Water-stage recorder. Altitude of gage is 2,370 ft (by barometer). April 1938 to April 1942, wire-weight gage at site 8 miles upstream at different datum.

Average discharge.--17 years (1938-41, 1946-60), 357 cfs (258,500 acre-ft per year).

Extremes.--Maximum discharge during year, 6,640 cfs Mar. 20 (gage height, 7.43 ft); maximum gage height, 12.27 ft Mar. 19 (ice jam); minimum discharge, 4.2 cfs Sept. 29, 30.

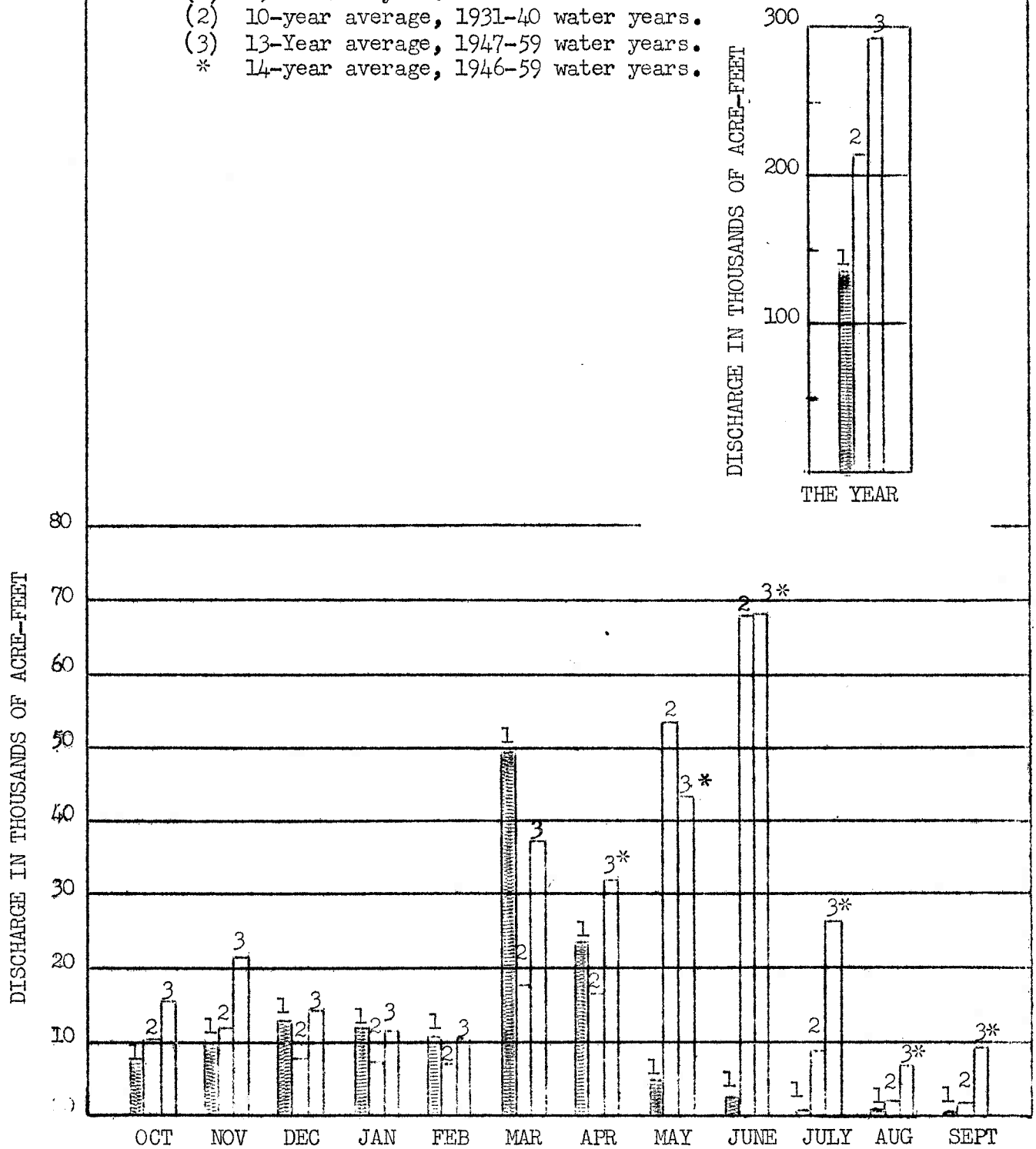
1938-42, 1946-60: Maximum discharge, 12,000 cfs Mar. 6, 1949 (gage height 10.6 ft), float measurement; maximum gage height, that of Mar. 19, 1960; no flow July 9-19, Aug. 13, 14, Sept. 28, 1940.

Remarks.--Records good except those for periods of ice effect, which are poor. Diversions for irrigation of about 90,000 acres above station. Flow regulated by Tongue River Reservoir (Appendix C) and many small reservoirs (combined capacity, about 15,000 acre-ft).

<u>Month</u>	<u>Second-foot days</u>	<u>Maximum</u>	<u>Minimum</u>	<u>Mean</u>	<u>Runoff in Acre-feet</u>
October 1959	3,540	154	94	114	7,020
November	5,019	195	105	167	9,960
December	6,505	220	195	210	12,900
January 1960	5,950	210	170	192	11,800
February	5,515	210	150	190	10,940
March	25,089	5,530	145	809	49,760
April	11,947	513	195	398	23,700
May	2,537.0	244	6.0	81.8	5,030
June	1,458.0	310	6.8	48.6	2,890
July	390.2	39	5.1	12.6	774
August	559.4	64	6.4	18.0	1,110
September 1960	159.5	6.4	4.2	5.32	316
Water year 1959-60	68,669.1	5,530	4.2	188	136,200

TONGUE RIVER AT MILES CITY, MONT.

- (1) 1960 water year.
- (2) 10-year average, 1931-40 water years.
- (3) 13-Year average, 1947-59 water years.
- * 14-year average, 1946-59 water years.



Comparison of discharge during 1960 water year with average discharge for water years 1931-40 and 1947-59.

MONTHLY SUMMARY OF DISCHARGE

Powder River near Locate, Montana

Location.--Lat $46^{\circ}26'$, long $105^{\circ}18'$, in NE $\frac{1}{4}$ sec. 26, T. 8 N., R. 51 E., on right bank 50 ft downstream from bridge on U. S. Highway 12 at present site of Locate (5 miles west of former site of Locate), 3 miles upstream from Locate Creek, and 25 miles east of Miles City.

Drainage area.--13,200 sq mi, approximately.

Records available.--March 1938 to September 1960. Records since January 1950 available in annual reports of Yellowstone River Compact Commission.

Gage.--Water-stage recorder and wire-weight gage. Altitude of gage is 2,400 ft (by barometer). Prior to July 11, 1947, wire-weight gage at bridge 50 ft upstream at same datum.

Average discharge.--22 years, 592 cfs (428,600 acre-ft per year).

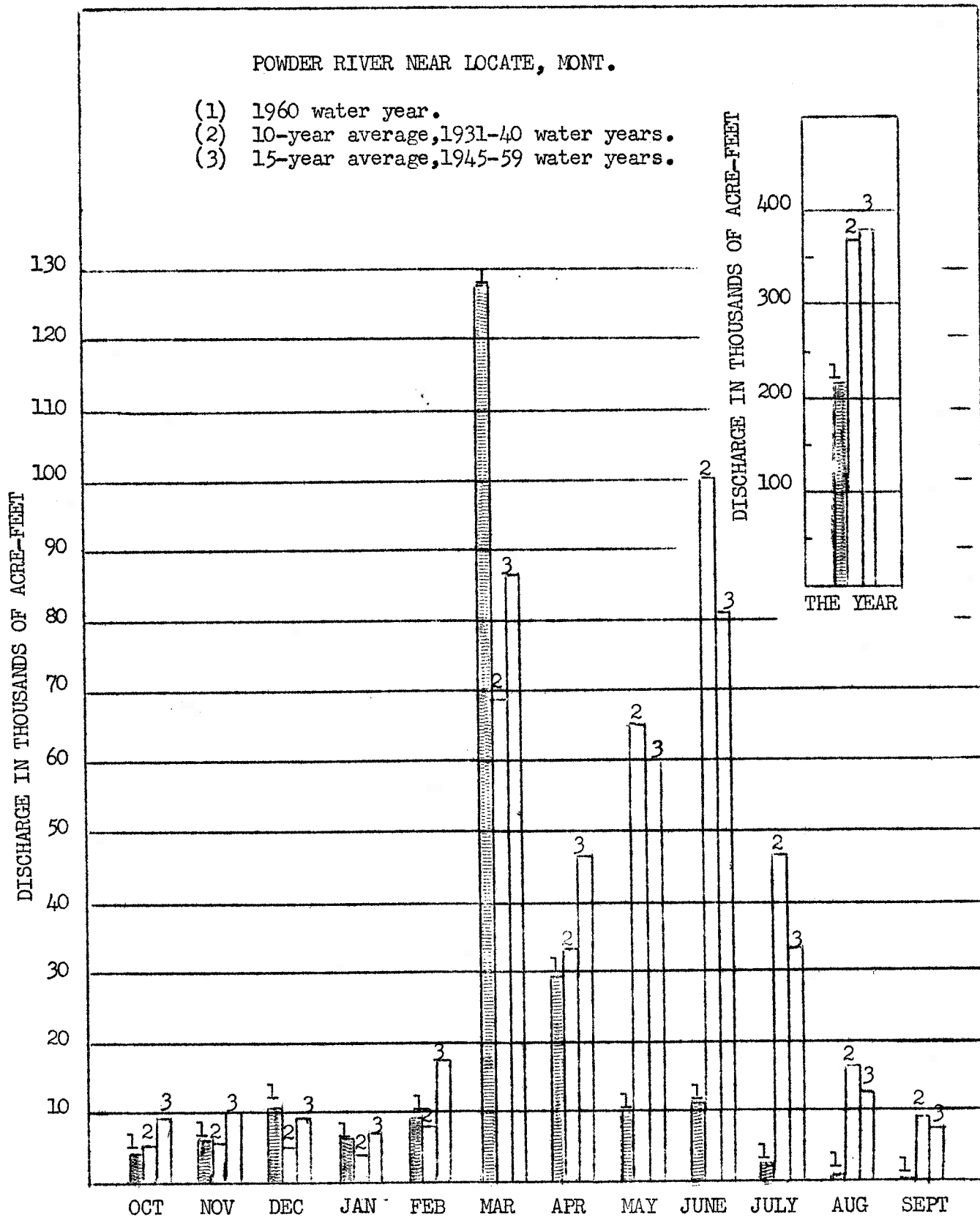
Extremes.--Maximum discharge during year, 12,900 cfs Mar. 21 (gage height, 74.5 ft); maximum gage height, 9.10 ft Mar. 19 (backwater from ice); no flow July 27, Sept. 21-27.

1938-60: Maximum discharge observed, 31,000 cfs Feb. 19, 1943 (gage height, 11.23 ft), from rating curve extended above 17,000 cfs; no flow Jan. 16 to Feb. 12, Feb. 22-24, 1950, July 27, Sept. 21-27, 1960.

Remarks.--Records good except those for periods of ice effect, which are poor. Diversions for irrigation of about 52,000 acres above station. Some regulation by tributary reservoirs with combined usable capacity of 36,800 acre-ft.

Revisions (water years).--Water Supply Paper 926: 1939. Water Supply Paper 1309: 1938-39 (M), 1942 (M).

<u>Month</u>	<u>Second foot days</u>	<u>Maximum</u>	<u>Minimum</u>	<u>Mean</u>	<u>Runoff in Acre-ft</u>
October 1959	2,140	114	16	69.0	4,240
November	3,268	140	70	109	6,480
December	5,200	210	120	168	10,310
January 1960	3,215	130	75	104	6,380
February	4,625	195	120	159	9,170
March	64,648	12,400	125	2,085	128,200
April	14,775	948	263	492	29,310
May	5,018	372	70	162	9,950
June	5,640	628	24	188	11,190
July	1,450.4	200	0	46.8	2,880
August	72.4	4.9	0.4	2.34	144
September 1960	5.6	0.4	0	0.19	11
Water year 1959-60	110,057.4	12,400	0	299	218,300



Comparison of discharge for 1960 water year with average discharge for water years 1931-40 and 1945-59.

RESERVOIRS COMPLETED AFTER JANUARY 1, 1950

BOYSEN RESERVOIR

Water-stage recorder at dam on Wind River, about 21 miles south of Thermopolis, Wyoming. Reservoir formed by earth-fill dam, construction of which began in 1947. Storage began October 11, 1951. Dead storage, 62,000 acre-feet at elevation 4657.0. Usable contents, 758,000 acre-feet at elevation 4725.0 (top of gates). Crest of dam at elevation 4758.

Records given herein represent usable contents. Water is used for irrigation and power development. Allocation for flood control provided. Data furnished by U. S. Bureau of Reclamation.

Extremes.—Maximum usable contents during year, 456,900 acre-feet Nov. 3-5; minimum, 273,100 acre-feet Sept. 21.

1953-60: Maximum usable contents, 857,400 acre-feet, July 5, 1957; minimum, 189,800 acre-feet March 18, 19, 1956.

<u>Month</u>	<u>Water-Surface elevation in feet</u>	<u>*Contents in Acre-feet</u>	<u>Change in contents during month in acre-feet</u>
September 30, 1959	4,702.08	384,800	
October 31	4,702.80	394,300	+ 9,500
November 30	4,702.34	388,200	- 6,100
December 31	4,701.46	376,700	- 11,500
January 31, 1960	4,699.97	357,800	- 18,900
February 29	4,698.38	338,500	- 19,300
March 31	4,698.31	337,600	+ 900
April 30	4,698.88	344,500	+ 6,900
May 31	4,696.78	319,700	- 24,800
June 30	4,697.32	325,900	+ 6,200
July 31	4,693.24	280,400	- 45,500
August 31	4,688.82	234,600	- 45,800
September 30, 1960	4,686.58	212,600	- 22,000
Water year 1959-60			-172,200

* Does not include dead storage of 62,000 acre-feet.

RESERVOIRS IN EXISTENCE ON JANUARY 1, 1950

The extent, if any, of the use of reservoirs in this category which may be subject to Compact allocations was not determined. As a matter of hydrologic interest, the month-end contents in acre-feet of four reservoirs are given. The first three reservoirs are in the Bighorn River Basin in Wyoming and data on contents were furnished by the U. S. Bureau of Reclamation. Tongue River Reservoir in Montana is operated under the supervision of the Montana State Water Conservation Board which agency furnished operating data.

Contents in Acre-feet

	<u>Bull Lake</u>	<u>Pilot Butte Reservoir</u>	<u>a/ Buffalo Bill Reservoir</u>	<u>b/ Tongue River Reservoir</u>
September 30, 1959	57,300	3,400	283,700	15,000
October 31	57,200	5,700	250,100	14,200
November 30	56,000	7,200	239,900	14,000
December 31, 1959	50,700	8,000	216,500	14,200
January 31, 1960	39,500	10,500	200,700	14,000
February 29	37,800	15,900	182,000	13,900
March 31	36,700	26,000	187,500	24,600
April 30	32,400	21,800	189,800	19,400
May 31	27,000	15,400	179,800	19,900
June 30	71,200	26,100	335,700	27,500
July 31	65,200	21,500	288,900	16,400
August 31	50,700	6,400	222,600	5,800
September 30, 1960	47,900	3,000	169,800	800

a/ Revised capacity table based on survey of 1959; previous contents based on survey of 1941.

b/ Contents based upon sedimentation surveys of October, 1948.

c/ Contents generally interpolated from readings made six or less days prior to month end.