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**SUSITNA  
HYDROELECTRIC PROJECT**

FEDERAL ENERGY REGULATORY COMMISSION  
PROJECT No. 7114

**FLOOD FREQUENCY ANALYSIS**

**HARZA-EBASCO**  
SUSITNA JOINT VENTURE

**FINAL REPORT**

**JANUARY 1984  
DOCUMENT No. 474**

**ALASKA POWER AUTHORITY**

**SUSITNA HYDROELECTRIC PROJECT**

**FLOOD FREQUENCY ANALYSIS**

Report by  
Harza-Ebasco Susitna Joint Venture

Prepared for  
Alaska Power Authority

Final Report  
January 1984

NOTICE

ANY QUESTIONS OR COMMENTS CONCERNING  
THIS REPORT SHOULD BE DIRECTED TO  
THE ALASKA POWER AUTHORITY  
SUSITNA PROJECT OFFICE

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## FLOOD FREQUENCY ANALYSIS

### 1.0 SUMMARY

The flood frequency analysis based on annual, May-June and July-September maximum floods was made for the Susitna River at the Gold Creek gage. The analysis was made for flood peaks and maximum 3-, 7-, and 15-day flood volumes. The resulting 50-year flood peak and volumes were transposed to the Watana and Devil Canyon damsites to derive the 50-year flood hydrograph for the sites. The resulting hydrographs are shown on Exhibits 8 through 13. Flood peaks and volumes of other return periods are listed in Tables 1 and 2 respectively. The estimates for the Devil Canyon site represent those for without Watana conditions.

### 2.0 FLOOD FREQUENCY AT GOLD CREEK

The frequency analysis for the Gold Creek gage (Exhibit 1) was made using the procedures outlined in "Guidelines for Determining Flood Flow Frequency" prepared by the United States Water Resources Council (1).<sup>1/</sup> The annual maximum instantaneous discharges for the water years from 1949 through 1983 were used in the analysis. The frequency curve is shown on Exhibit 2 with the plotting positions from the observed data. The plotting positions on the exhibit were computed using the Weibull's formula  $p = M / (N+1)$ , where  $p$  is the relative frequency,  $M$  is the rank of the event in order of magnitude with the events arranged in descending order, and  $N$  is the number of years of record. A 95 percent one-sided upper confidence limit was also computed using the procedures given in the "Guidelines" mentioned above. Such computations are often desirable when the flood-frequency relationship is extended for a return period much longer than the period of record. The flood frequency analysis was also made for 3-, 7-, and 15-day flood volumes

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<sup>1/</sup> Refers to the numbers in "Reference" at the end of the text.

as shown on Exhibit 3. The 1983 data for flood volume were not available at the time of the analysis.

Similar analyses were made for maximum May-June floods using 1950 to 1982 data and maximum July-September floods using 1949 to 1982 data. The resulting flood peak frequency curves are shown on Exhibits 4 and 6 and the flood volume frequency curves are shown on Exhibits 5 and 7, respectively.

### 3.0 FLOOD FREQUENCY AT THE DAMSITES

The flood peak frequency relationships at Gold Creek were transposed to the Devil Canyon and Watana sites by using the following equation (2);

$$Q = Q_g \left( \frac{A}{A_g} \right)^n$$

Q = peak discharge at Devil Canyon or Watana for a given return period cfs;

$Q_g$  = peak discharge at Gold Creek for the corresponding return period, cfs;

A = drainage area upstream from Devil Canyon or Watana, square miles;

$A_g$  = drainage area upstream from Gold Creek, square miles; and

n = exponent.

The value of "n" generally varies between 0.5 to 0.8 depending on the basin but it rarely drops below 0.5. The drainage area at the Gold Creek gage is 6,160 square miles ( $\text{mi}^2$ ) and those at the Watana and Devil Canyon sites are 5,180  $\text{mi}^2$  and 5,810  $\text{mi}^2$ , respectively. Thus the drainage area ratio is 0.84 for Watana and 0.94 for Devil Canyon. Since these ratios are quite close to

1.0, the resulting estimate of flood peak based on any value of "n" between 0.5 and 0.8 would be similar. Therefore, the more conservative value of 0.5 was used without an extensive analysis of flood data to determine a more precise value of "n". Table 1 summarizes the resulting flood peak estimates for selected return periods. The flood volume-frequency relationships for Gold Creek were also transposed to the damsites, but by the straight drainage area ratios according to general practice. Table 2 summarizes the resulting flood volumes for selected return periods.

#### 4.0 FLOOD HYDROGRAPHS

The 50-year flood peaks and flood volumes shown in Tables 1 and 2 were used to derive the hydrographs shown on Exhibits 8 through 13. The annual and May-June hydrographs shown on Exhibits 8, 9, 11 and 12 were shaped after the June 1964 flood at Gold Creek and the July-September hydrograph shown on Exhibits 10 and 13 were shaped after the August 1971 flood at Gold Creek. The June 1964 and August 1971 floods are the greatest floods of record in the respective seasons. All hydrographs shown for Devil Canyon are those without-Watana conditions.

#### REFERENCES

No	Title
1	"Guidelines for Determining Flood Frequency", U.S. Water Resources Council, Bulletin 17B, Washington D.C., 1981
2	Davis, C.V. and K.E. Sorensen, ed., "Handbook of Applied Hydraulics", 3rd Ed., McGraw-Hill, New York, N.Y., 1969, p. 1-39



Table 1

## FLOOD PEAKS FREQUENCY AT WATANA AND DEVIL CANYON

Return Period (Year)	Flood Peaks (cfs)							
	Watana				Devil Canyon			
	Annual		May-June	July-Sept	Annual		May-June	July-Sept
	<u>1</u> <sup>1/</sup>	(2) <sup>2/</sup>			(3) <sup>1/</sup>	(4) <sup>2/</sup>		
2	47,600	43,500	39,000	34,200	50,400	46,000	41,300	36,300
5	64,200	57,400	51,500	45,700	68,000	60,800	54,500	48,300
10	77,500	67,000	60,800	54,500	82,100	71,000	64,400	57,700
25	95,400	79,800	73,800	67,200	101,000	84,500	78,200	71,100
50	110,000	89,500	84,400	77,800	117,000	94,800	89,400	82,400
100	125,000				132,000			
1000	184,000				194,000			

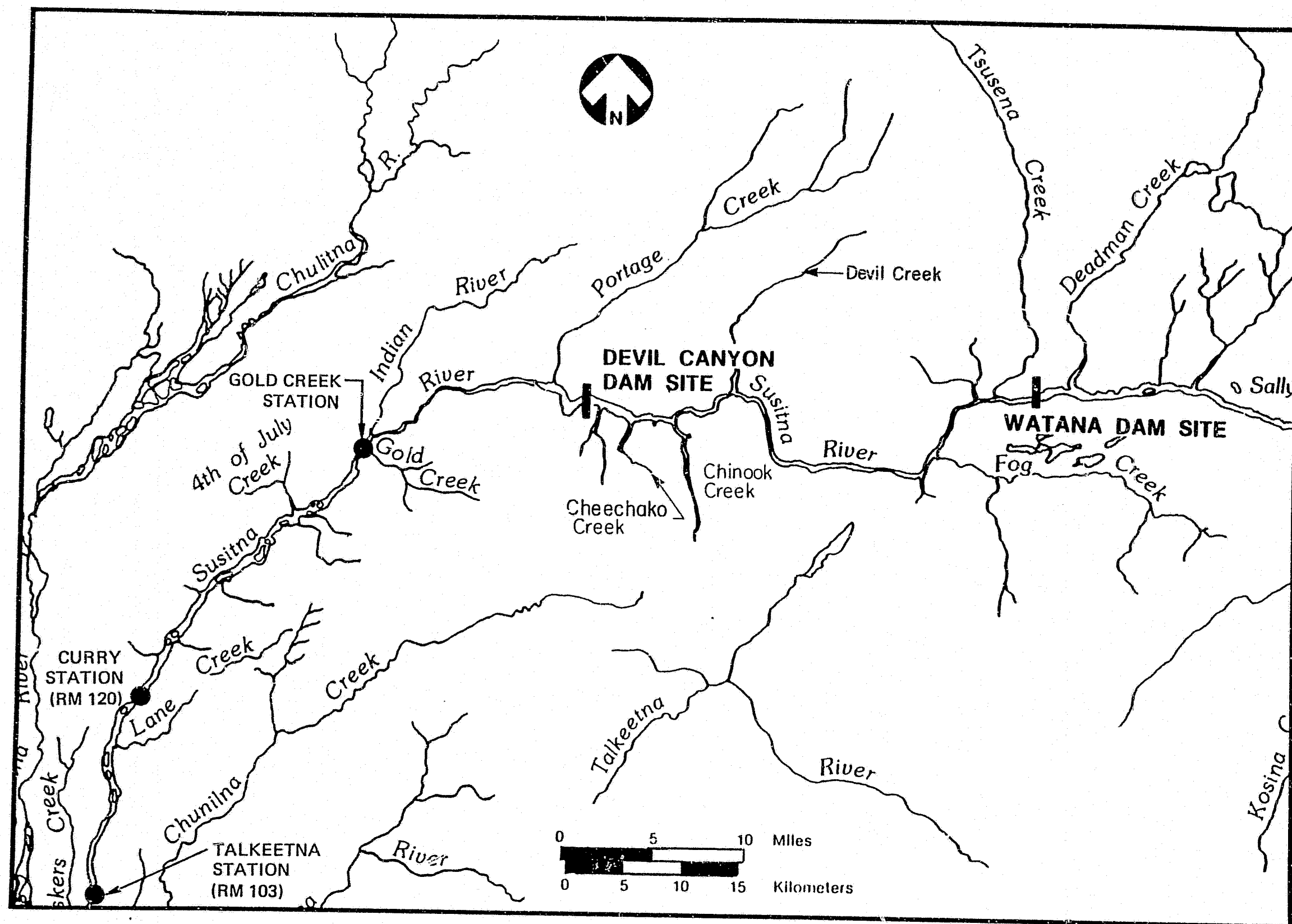
<sup>1/</sup> Corresponding to 95 percent one-sided upper confidence limit.

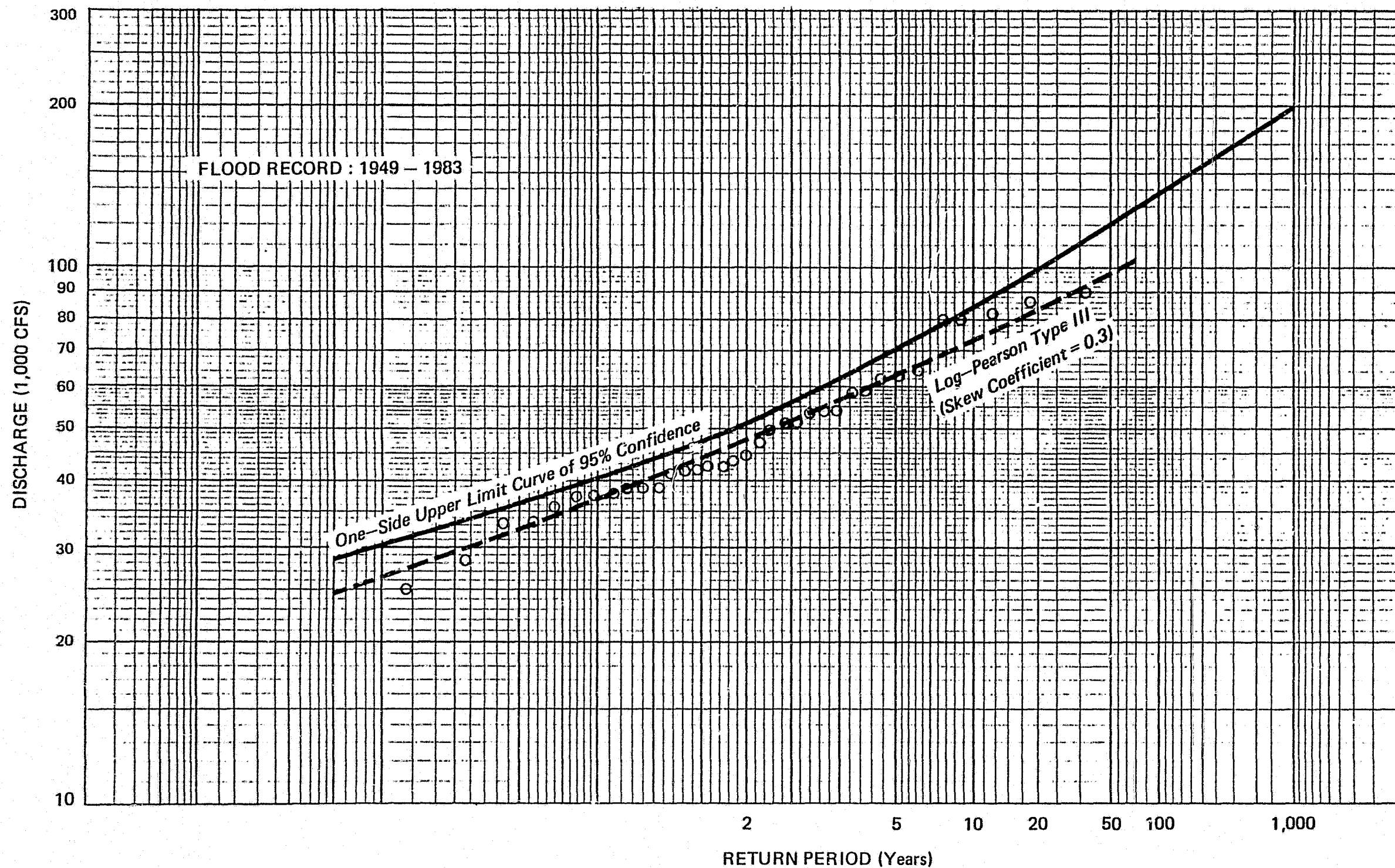
<sup>2/</sup> From the flood frequency curve, the flood frequency relationships not extended over the return period of 50 years.

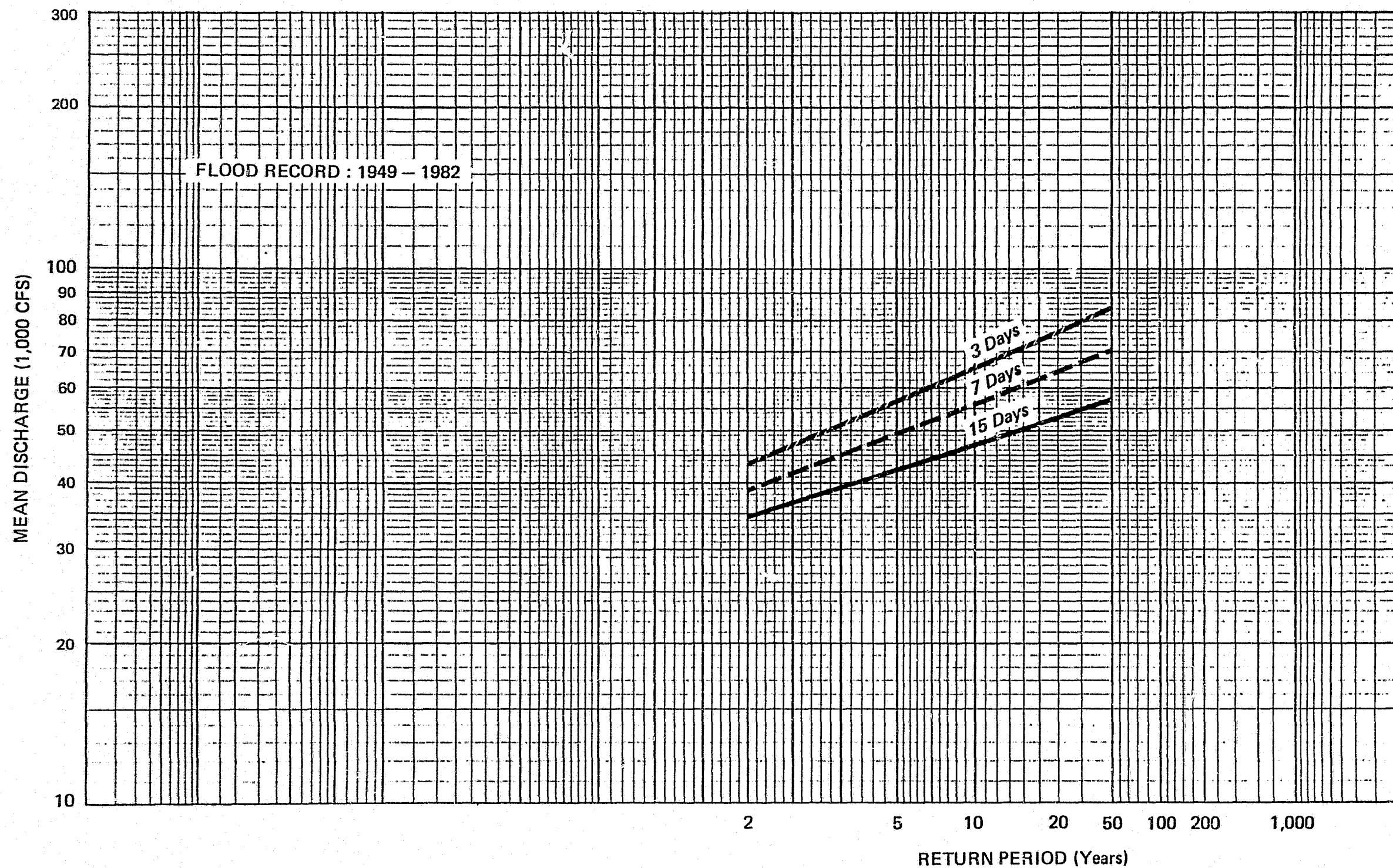
Table 2.  
Flood Volume<sup>1/</sup> Frequency at Watana and Devil Canyon

Return Period (Year)	Watana									Devil Canyon								
	Annual			May-June			July-September			Annual			May-June			July-September		
	3-day (mean discharge, cfs)	7-day (mean discharge, cfs)	15-day (mean discharge, cfs)	3-day (mean discharge, cfs)	7-day (mean discharge, cfs)	15-day (mean discharge, cfs)	3-day (mean discharge, cfs)	7-day (mean discharge, cfs)	15-day (mean discharge, cfs)	3-day (mean discharge, cfs)	7-day (mean discharge, cfs)	15-day (mean discharge, cfs)	3-day (mean discharge, cfs)	7-day (mean discharge, cfs)	15-day (mean discharge, cfs)	3-day (mean discharge, cfs)	7-day (mean discharge, cfs)	15-day (mean discharge, cfs)
2	36028	32297	28529	32188	29114	26036	28013	25766	23840	40410	36225	31998	36103	32655	29202	31420	28900	26740
5	47062	41182	35004	42242	37701	32968	36783	32521	28728	52786	46191	39261	47380	42287	36978	41257	36476	32222
10	54485	46910	39049	49592	43813	37432	43547	37379	31795	61112	52616	43798	55624	49142	41985	48843	41925	35662
25	64027	54015	43950	59732	52043	42969	53233	43970	35530	71814	60584	49295	66996	58373	48195	59707	49318	39852
50	71251	59233	47478	67900	58553	47034	61341	49210	38227	79917	66437	53252	76158	65674	52754	68802	55195	42876

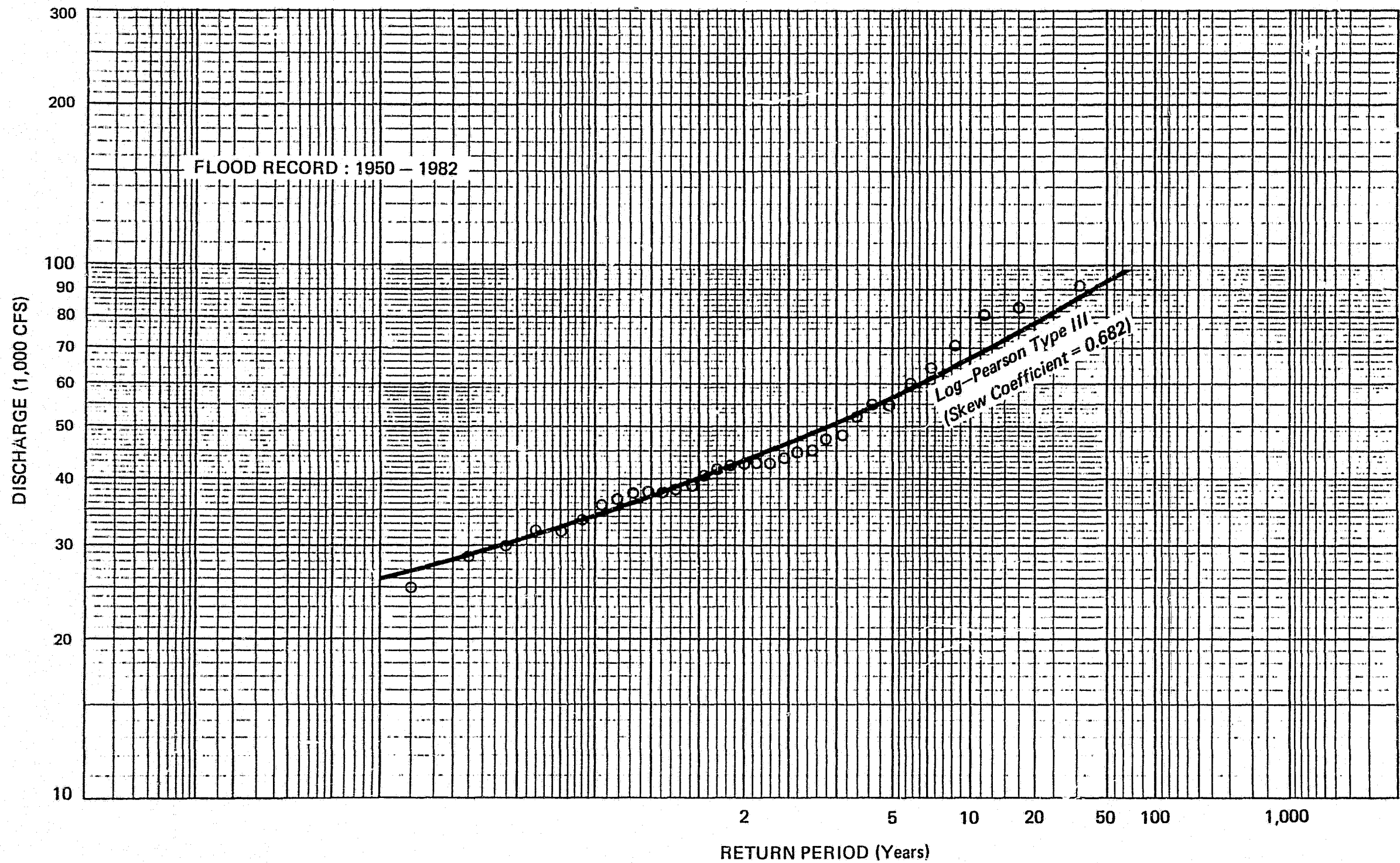
<sup>1/</sup> Volume = mean discharge in the table times the respective duration.

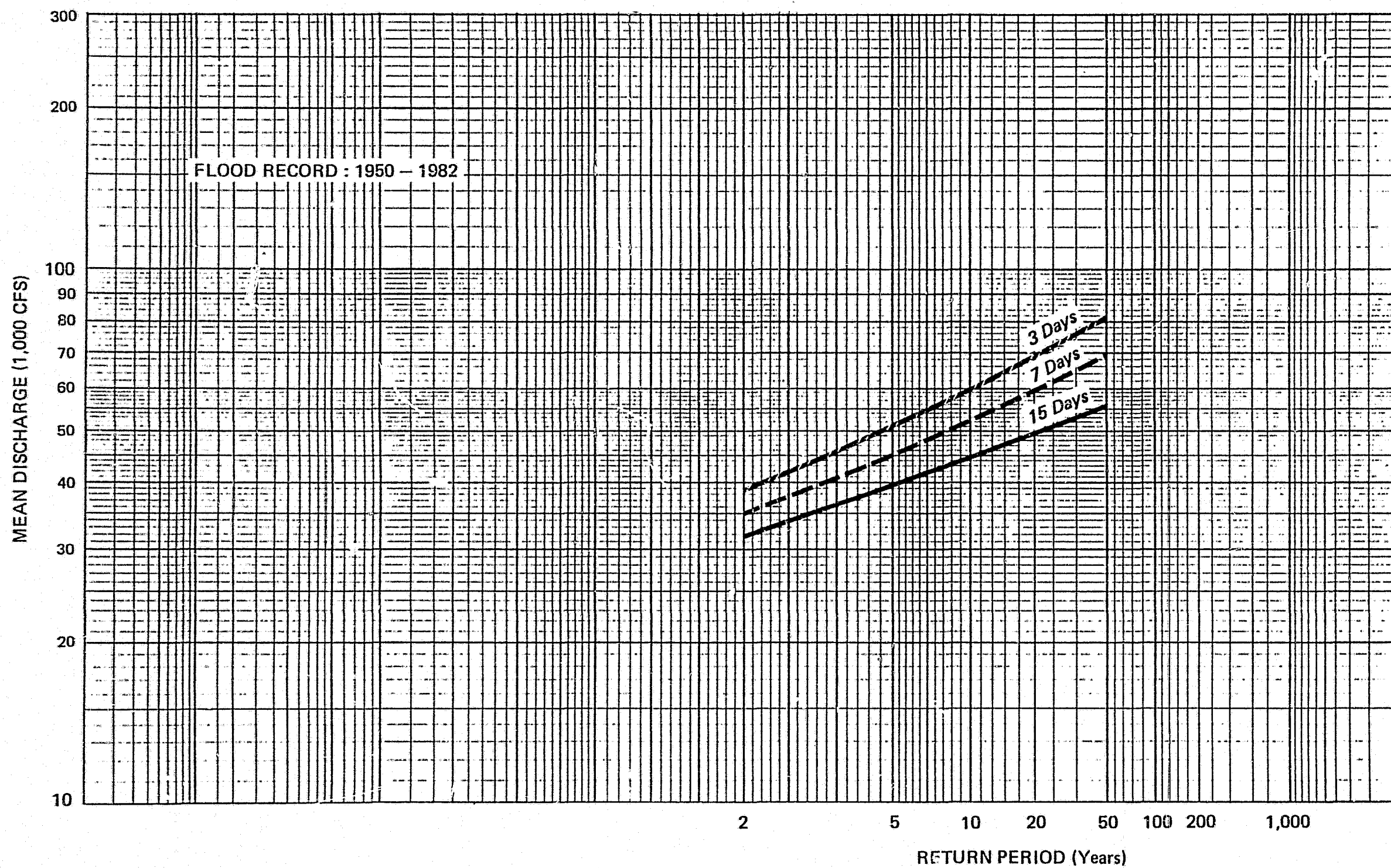


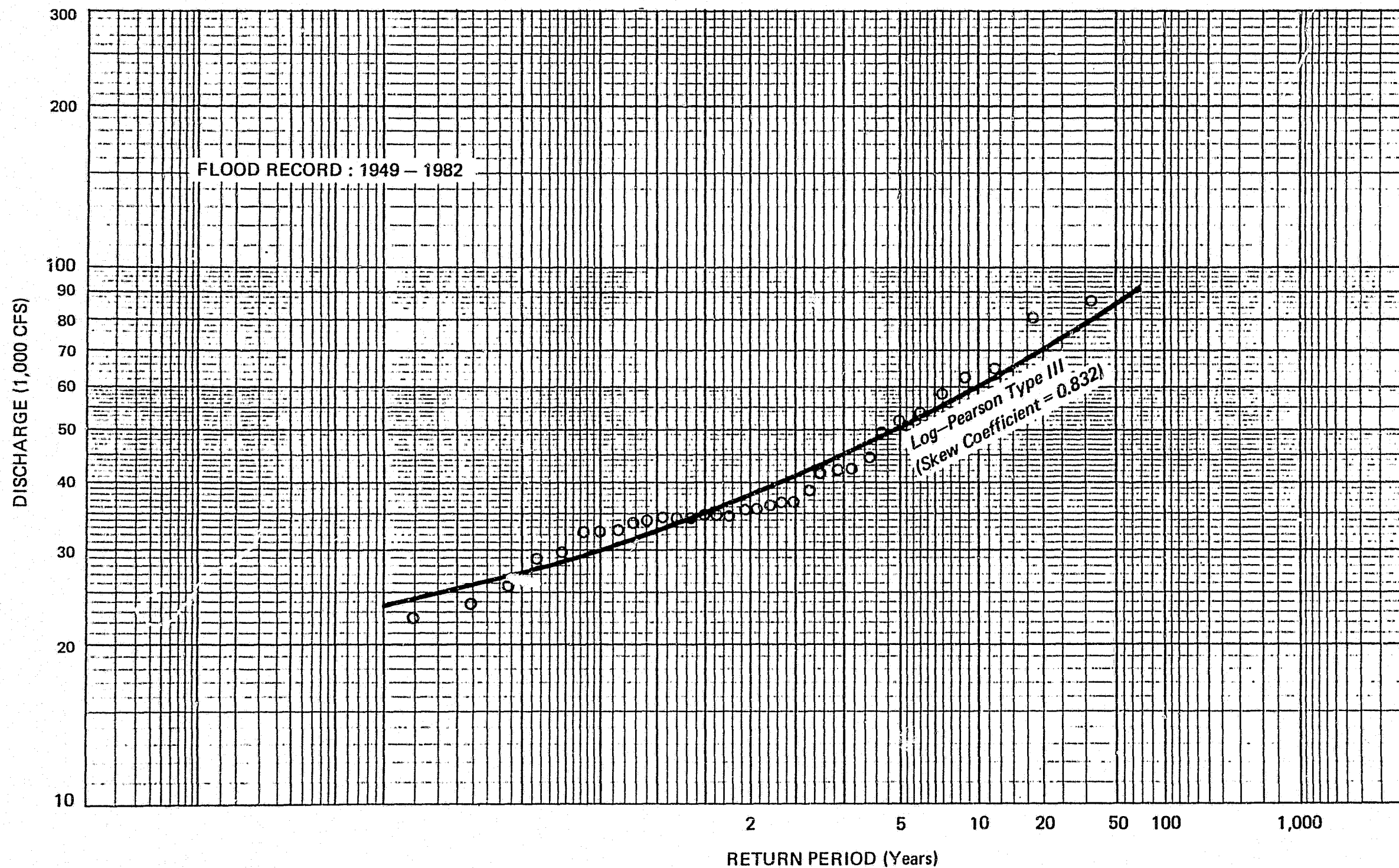




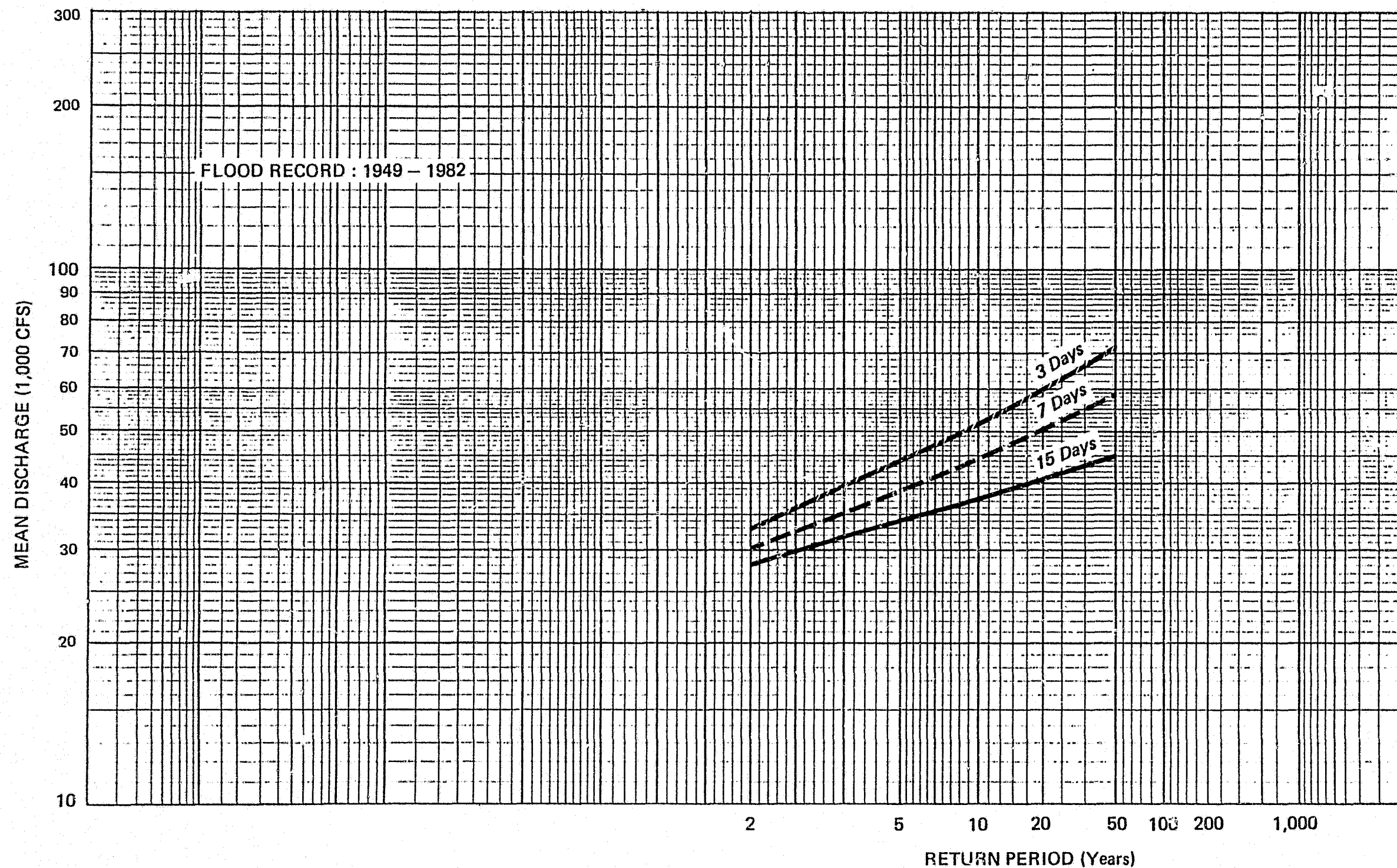


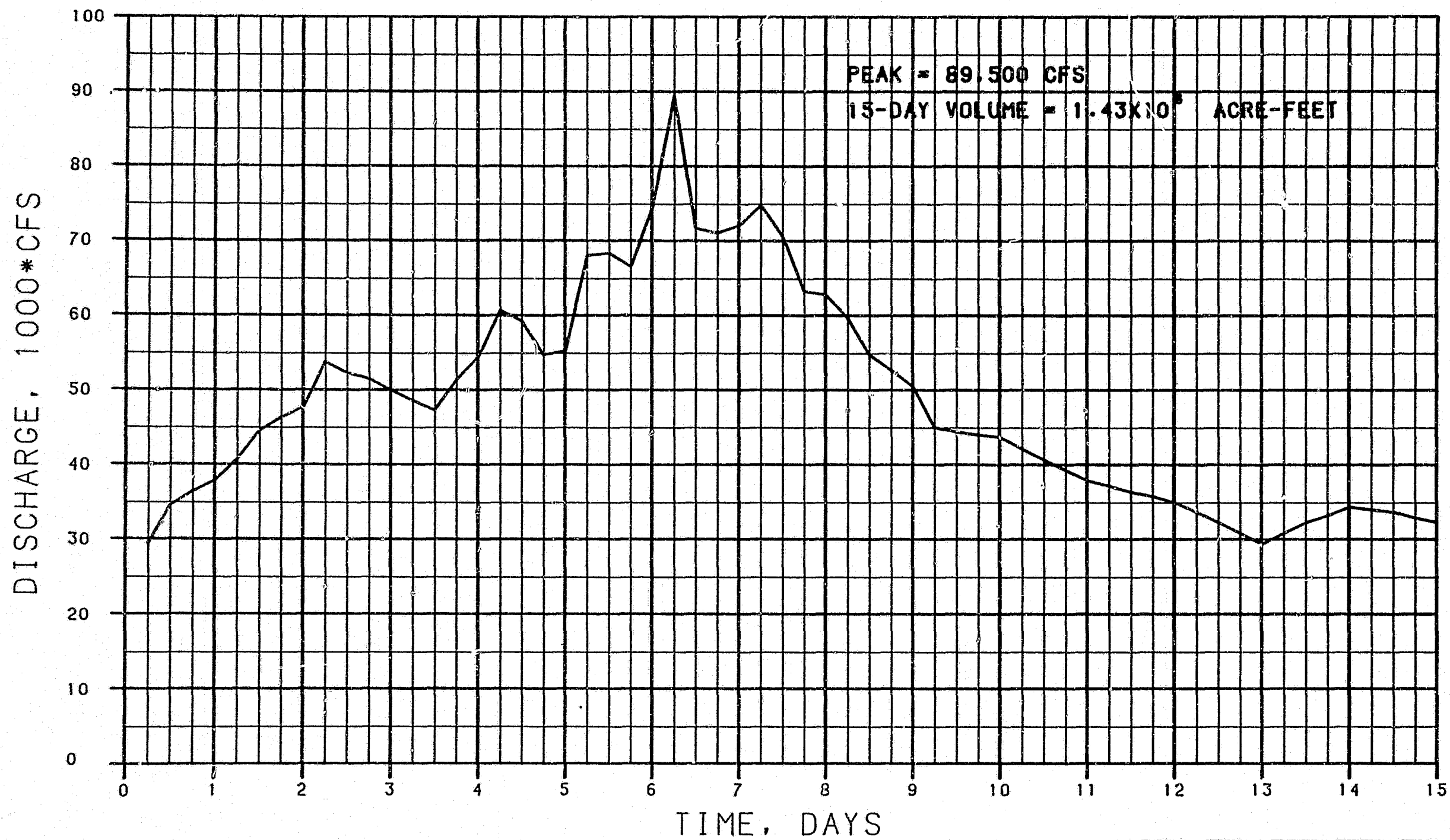




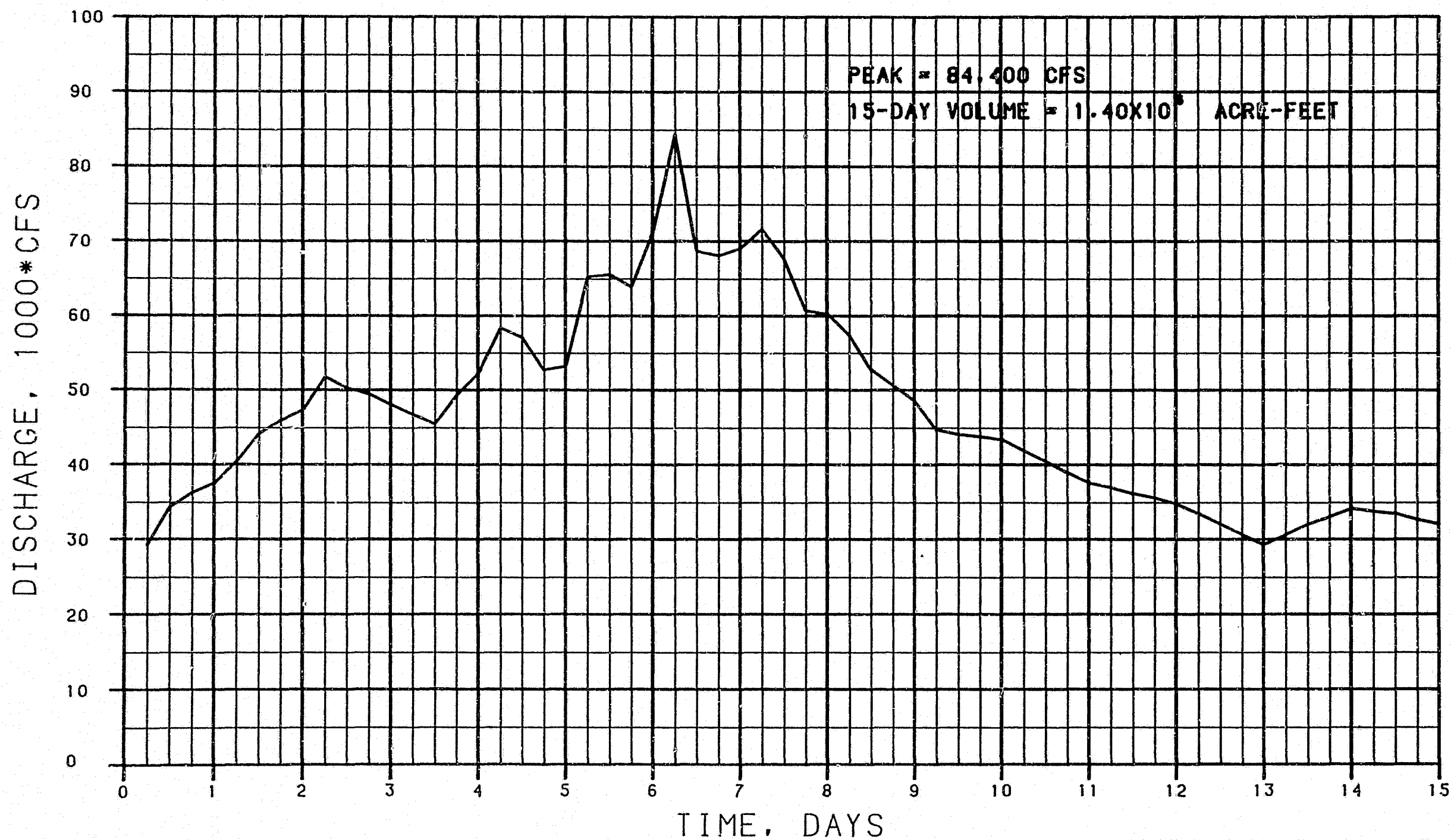








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50-YEAR ANNUAL MAXIMUM FLOOD HYDROGRAPH AT WATANA	
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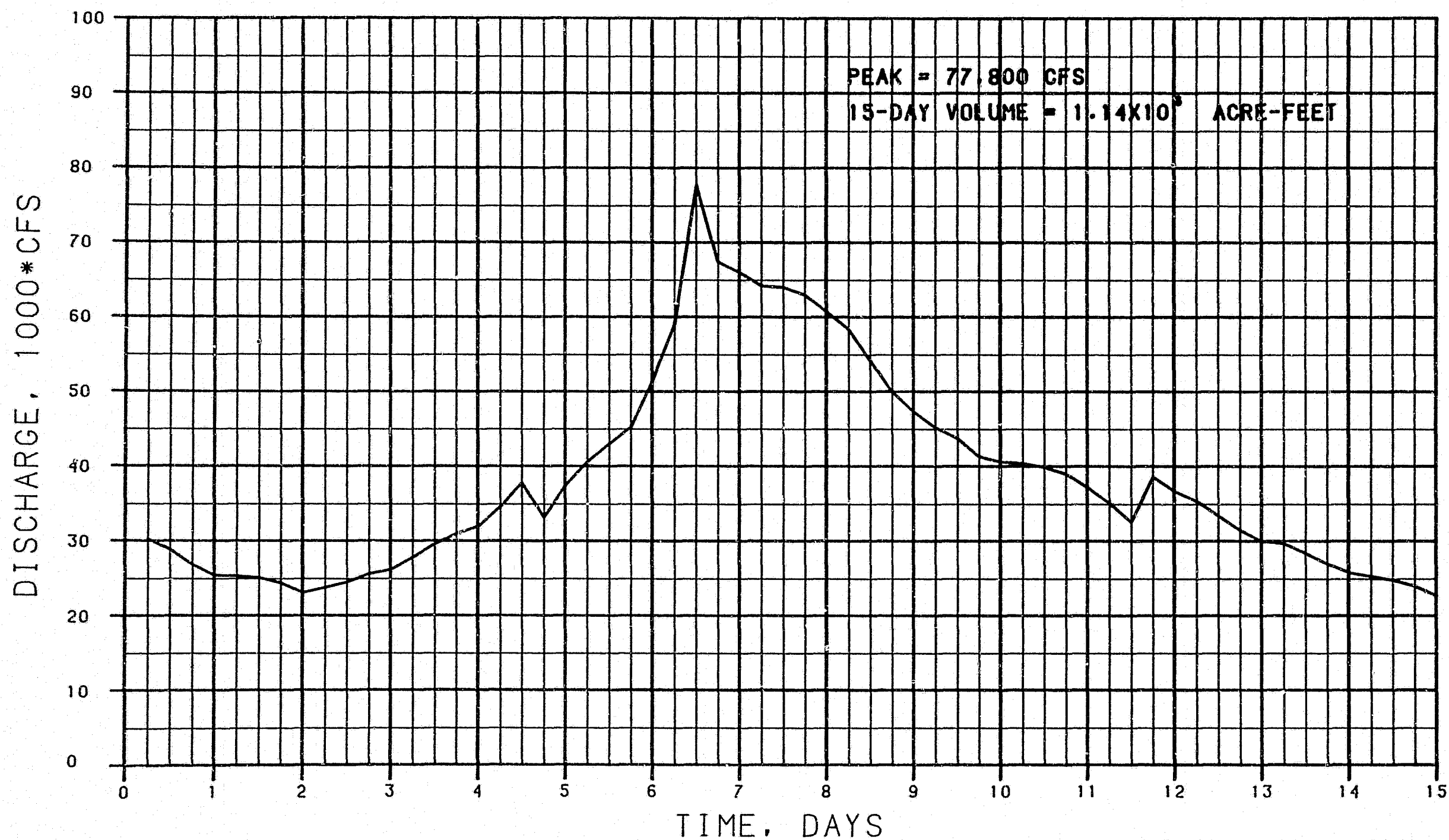
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HYDROLOGY

50-YEAR MAY-JUNE  
MAXIMUM FLOOD HYDROGRAPH  
AT WATANA

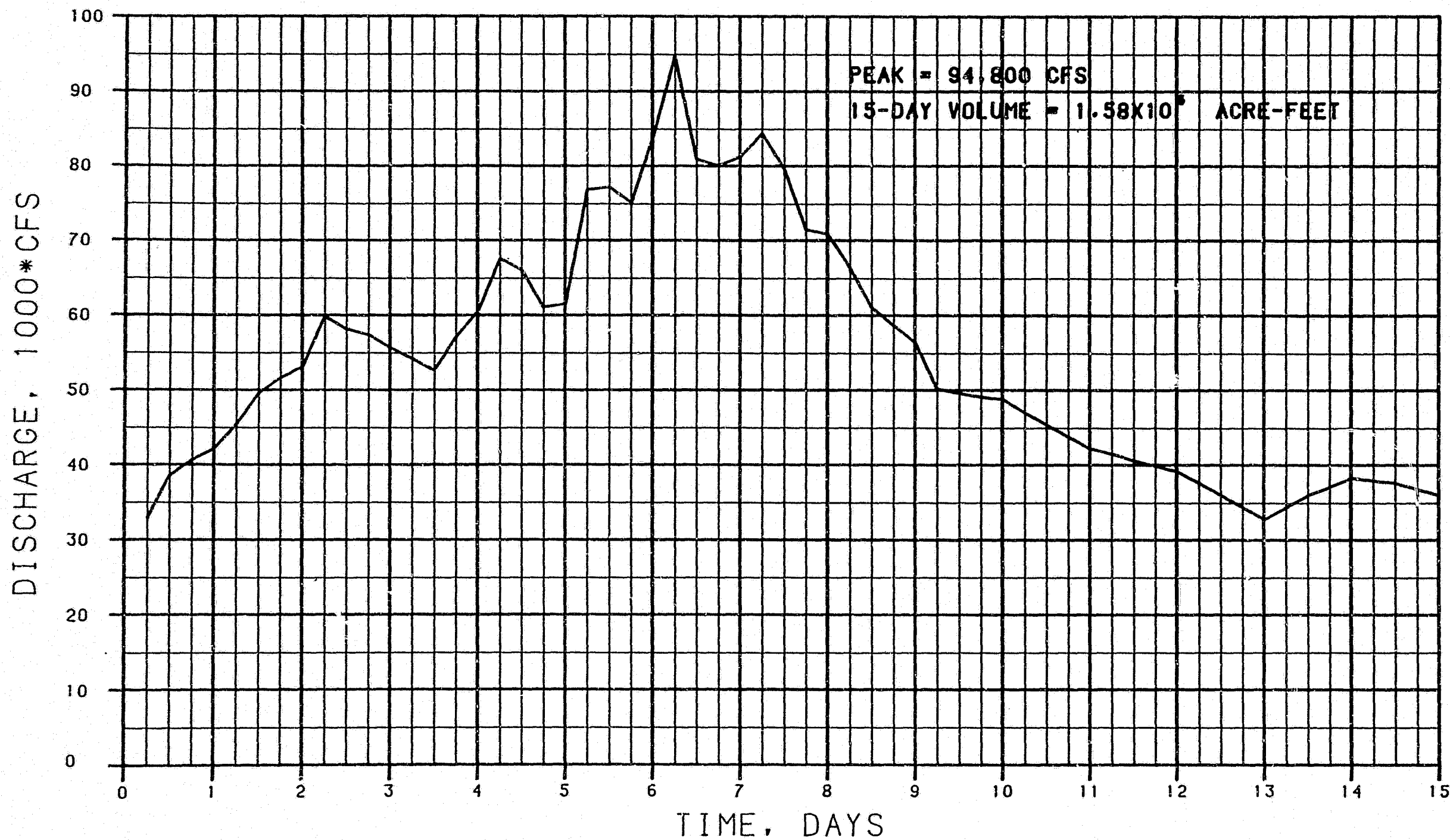
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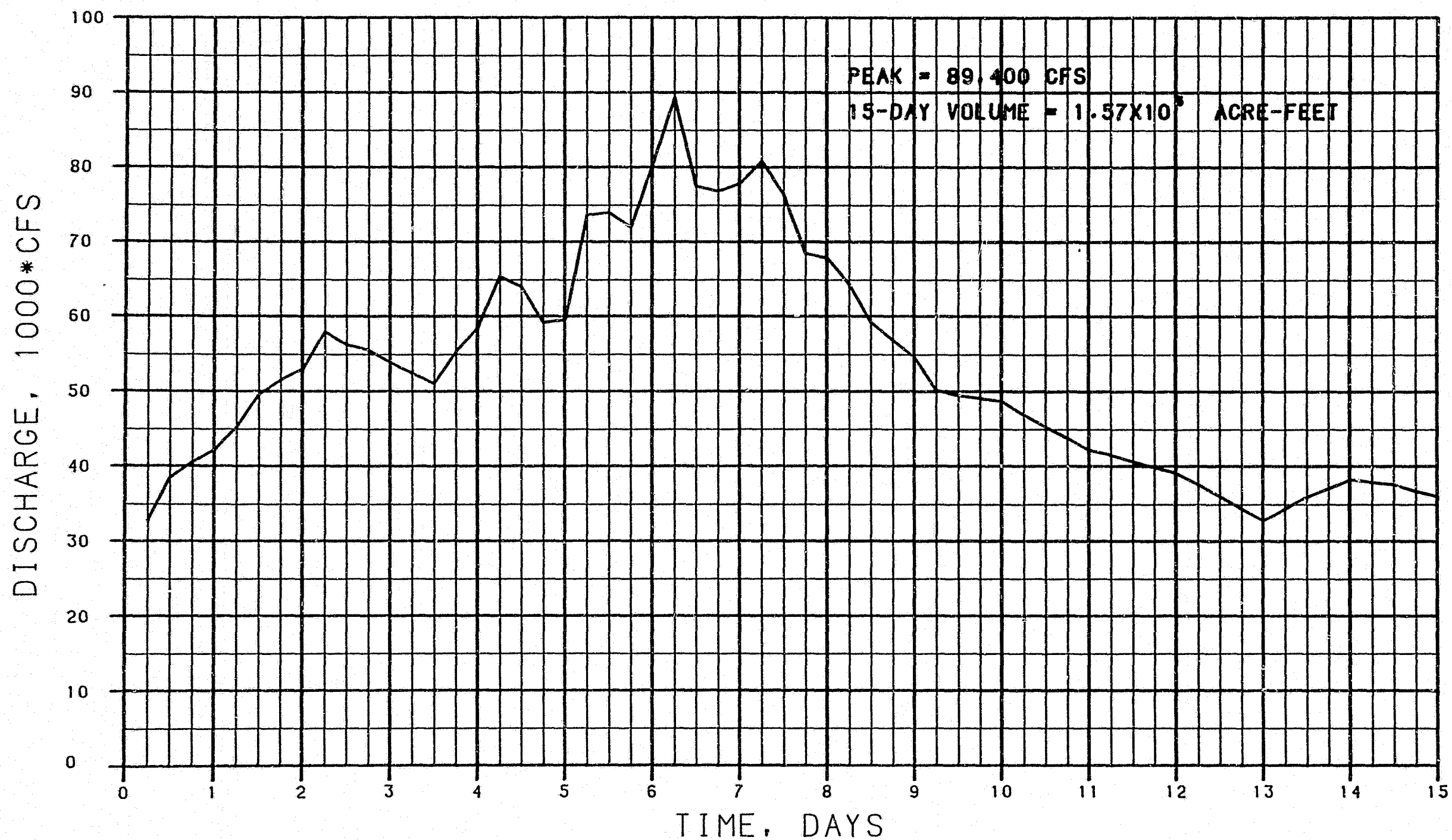
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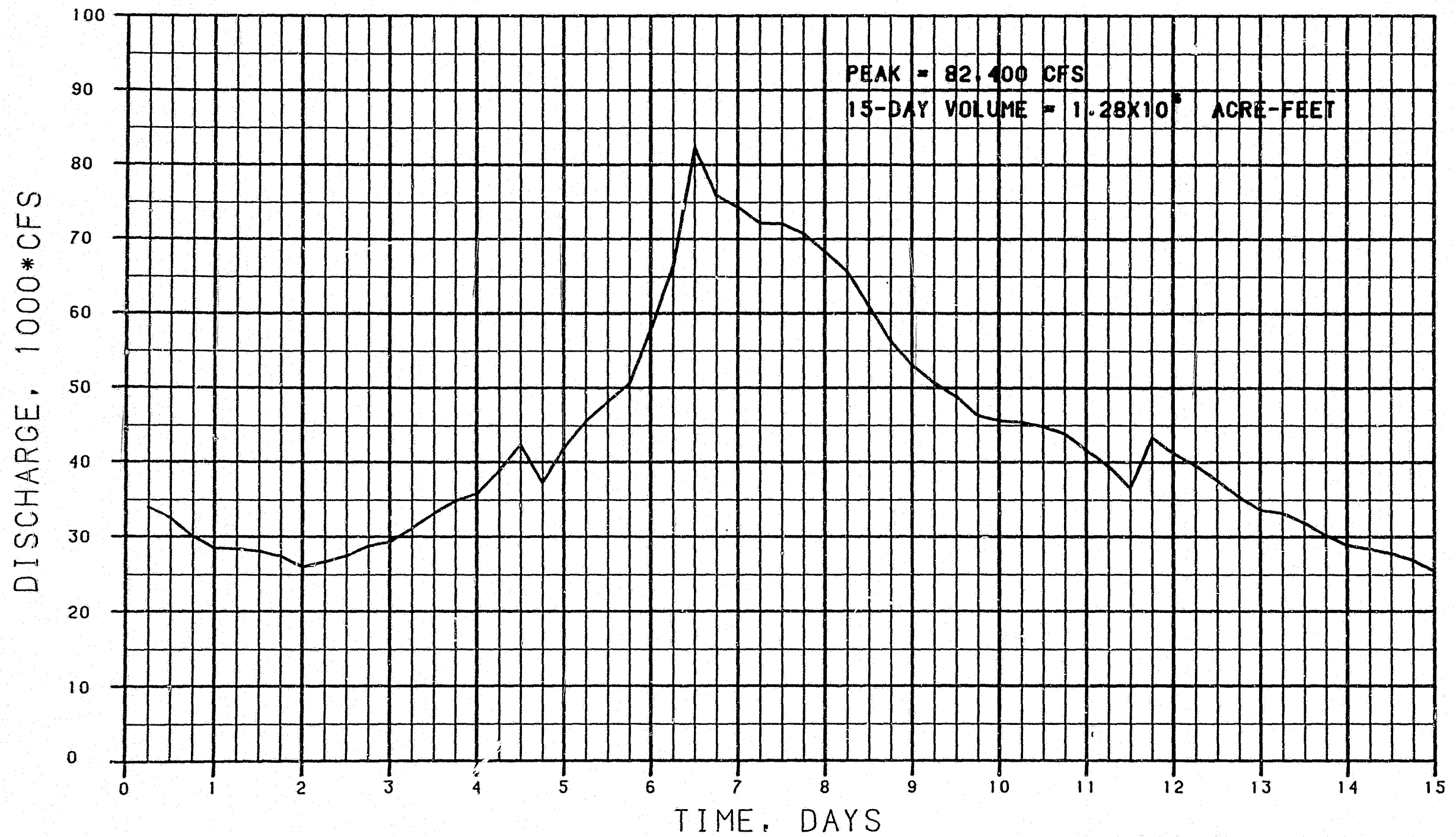
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EXHIBIT

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HYDROLOGY

**50-YEAR JULY-SEPTEMBER  
MAXIMUM FLOOD HYDROGRAPH  
AT DEVIL CANYON**

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