2. Explain

MEMORANDUM

June 22, 1992

TO: David Wegner, Manager, Glen Canyon Environmental Studies Group

FROM: Ron Morgan, Water Rights Hydrologist, Hopi Tribe RPM

SUBJ: Preliminary data analysis, Little Colorado River at Grand Falls

1. Attached please find copies of two spreadsheets and 10 graphs related to the subject analytical activities. The analysis is for flow only on one station of long period of record. The water quality data, including sedimentation, will be sent to me shortly by the U. S. Geological Survey. Included in the material to be analyzed are data for four LCR stream flow stations, from the White Mountains to Cameron, and data for four of the five ephemeral streams which flow through the Hopi Reservation. Climatological data for approximately ten (10) relevant stations will be consulted to develop relationships between precipitation and flows. Systematic ground water and spring flow water quality and quantity data are sparse. The quality information related to LCR will consist primarily of LCR at Cameron and Moenkopi Wash.

2. The attached material is for your review as to format and applicability to your needs at GCES. Naturally, the eventual volume of data and analyses will be greater in the final report. However, I felt it would be a good idea to demonstrate the progress to date and to allow you an opportunity to provide guidance.

3. The final report of this material will include a narrative and interpretive section, as well as the type of graphical and statistical information in the present collection. A raw data report will be appended in hard copy and electronic format for your future use.

4. The preliminary report will be useful to establish data needs for the USGS/NAU study to be commenced in the near future, as well as to develop guidelines for future monitoring requirements to be developed in the Glen Canyon EIS.

5. Please feel free to reveal this information to your staff for comment. Should you have major problems with the methodology or the results, please communicate with me as the deficiencies become apparent.

RPM/r

cc: Nat Nutongla, Director, Hopi Water Resources Program
Arnold Taylor, Manager, Hopi Department of Natural Resources

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U. S. Geological Survey
Monthly Discharge Data
Hopi Tribal Database

Station: Little Colorado River at Grand Falls
Elevation: 4438.90 feet above mean sea level
Drainage Area: 20,700 sq. mi.

Latitude: +35d 26m 00s
Longitude: 111d 12m 00s

UTM Northing:
Easting:

Monthly Discharge in Acre-Feet; Peak Discharge in cfs

Year/Month	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual Total	Ann Peak	0 Flow Days
1925-26	---	---	2,410	946	474	18,730	83,940	10,870	0	688	5,530	47,930		27,800	
1926-27	2,370	1,120	1,000	3,000	60,980	74,950	50,500	6,050	36,990	20,660	20,840	115,300	393,760	28,800	35
1927-28	643	0	153	464	17,210	50,460	7,600	125	0	2,490	5,250	3,170	87,565	2,140	165
1928-29	87	7,300	908	543	1,420	42,350	155,300	2,420	0	96,850	110,300	93,330	510,808	50,500	78
1929-30	12,090	496	468	655	1,420	22,310	27,040	1,000	0	50,540	67,650	5,640	189,309	17,300	79
1930-31	0	1,000	4,440	1,130	12,480	29,340	13,890	12,430	2	23,230	51,340	15,870	165,152	6,530	94
1931-32	14,090	17,060	7,060	9,420	153,700	146,800	77,710	9,410	0	3,330	24,170	3,090	465,840	31,000	60
1932-33	1,900	236	89	184	7,370	25,260	18,050	10,600	0	18,280	19,610	27,650	129,229	7,500	96
1933-34	31,120	1,030	1,230	712	778	1,690	1,500	6	1,500	2,060	20,890	8,460	70,976	4,920	97
1934-35	139	0	0	19,080	27,440	38,000	72,590	2,820	0	724	32,840	21,800	215,433	7,350	157
1935-36	1,720	99	827	631	4,040	22,680	49,250	752	0	3,830	45,630	35,610	165,069	5,430	109
1936-37	335	4,920	242	18	115,800	110,900	89,090	2,530	0	6,020	2,780	6,870	339,505	21,800	137
1937-38	6,280	95	538	93	1,250	128,100	4,440	44	0	171	11,220	17,950	170,181	38,000	132
1938-39	0	0	0	377	1,610	34,250	40,120	10	0	0	2,780	4,100	83,247	6,680	217
1939-40	0	0	206	817	5,350	13,470	6,670	2	0	12,230	42,050	51,450	132,245	20,100	177
1940-41	21,650	8,600	28,770	56,698	74,900	136,700	107,600	86,370	3,970	3,820	26,700	31,010	586,788	17,000	49
1941-42	53,830	3,070	2,970	6,720	6,450	19,040	50,610	5,980	0	0	371	0	149,041	8,760	133
1942-43	666	597	0	292	6,730	53,120	12,780	0	0	0	16,730	12,080	102,995	3,900	201
1943-44	711	29	58	192	354	22,710	71,770	24,680	0	0	0	8,520	129,024	5,320	187
1944-45	2,200	1,020	1,120	508	4,900	16,810	67,280	19,590	0	9,620	35,800	666	159,514	4,650	78
1945-46	34	0	432	4,330	2,510	3,980	3,170	0	0	9,610	52,000	40,380	116,446	12,900	174
1946-47	661	14,550	4,930	3,530	8,420	6,620	815	422	0	0	74,460	12,670	127,078	10,600	120
1947-48	57,000	702	1,020	3,510	7,920	19,870	68,300	996	63	4,960	16,170	1,730	182,241	12,400	105
1948-49	2,120	2,020	3,280	16,870	13,150	85,550	76,000	6,070	4	13,340	39,290	10,750	268,444	10,400	63
1949-50	163	445	78											3,500	
1950-51	0	0	0	0	157	253	1,830	2,180	0	1,920	30,600	9,250	46,190	10,200	226
1951-52	0	0	0	0	0	20,840	19,980	0	0	39,310	5,400	21,990	107,520	26,100	
1952-53														4,140	
1953-54	0	0	0	0	0	20,840	19,980	0	0	39,310	5,400	21,990	107,520	7,450	261
1954-55	2,710	0	0	25	79	1,160	525	0	18,080	5,280	122,100	2,340	152,299	9,020	219
1955-56	0	0	121	0	3,710	7,380	2,070	47	0	0	5,340	0	18,668	2,320	241
1956-57	0	0	0	43,300	41,710	24,810	2,990	0	0	4,470	44,360	8,140	169,780	8,390	190
1957-58	12,860	9,590	2,080	228	6,500	29,940	43,160	1,170	778	987	22,310	31,470	161,073	4,560	36
1958-59	8,890	0	0	0	0	4,240	3,200	0	0	354	30,890	282	47,856	3,080	216
1959-60	12,310	33,200	22,830	22,050	8,890	89,750	18,210	99	2					7,960	
1989-90	0	0	0	0	0	0	646	0	0	5,760	6,760	8,690	21,856		308
1990-91	1,250	1,340	4,570	16,520	4,530	32,740	70,650	2,980	0	0	172	1,270	136,022		141
1991-92															
Mean	7,081	3,101	2,555	6,232	17,699	39,321	36,921	5,847	1,806	11,490	30,067	19,198	179,051	12,374	143
Max	57,000	33,200	28,770	56,698	153,700	146,800	155,300	86,370	36,990	96,850	122,100	115,300	586,788	50,500	308
Min	0	0	0	0	0	0	525	0	0	0	0	0	18,668	2,140	35

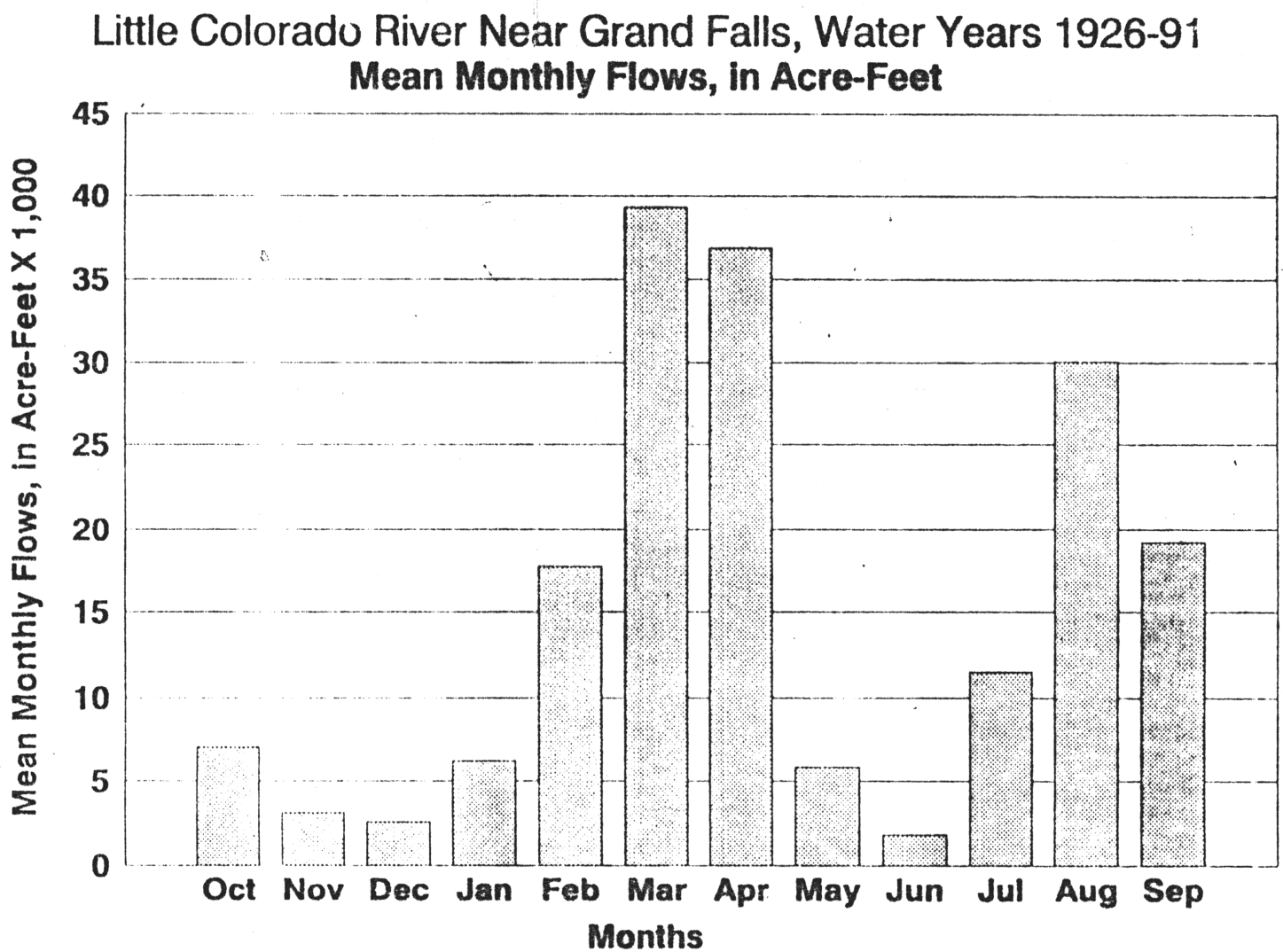
Period of Record: 1926-60 and 1990-present
Mean Discharge for Period: 179,051 Acre-Feet per Year

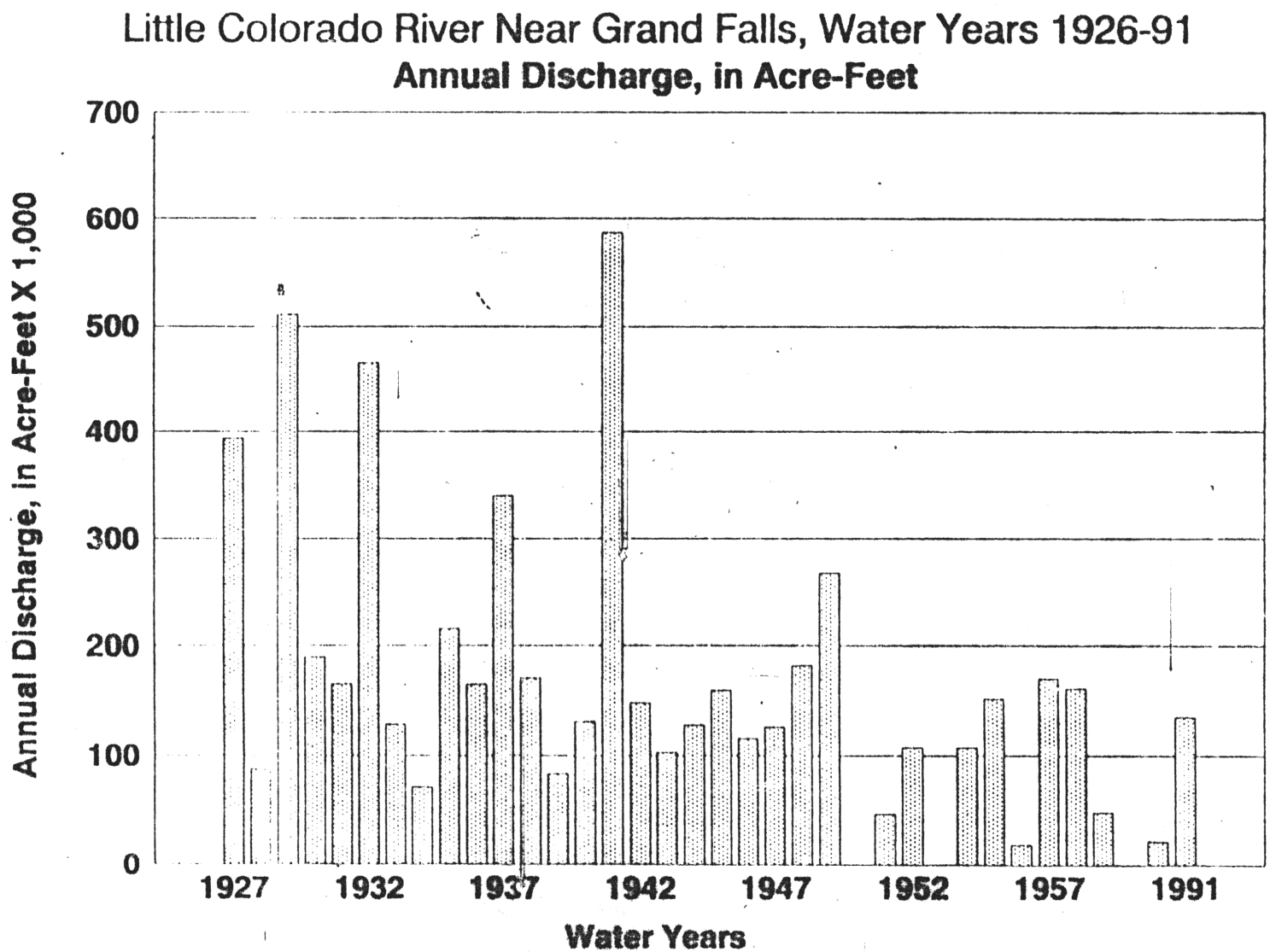
U. S. Geological Survey
Monthly Discharge Data
Hopi Tribal Database

Station: Little Colorado River at Grand Falls

Statistical Summary of Variables

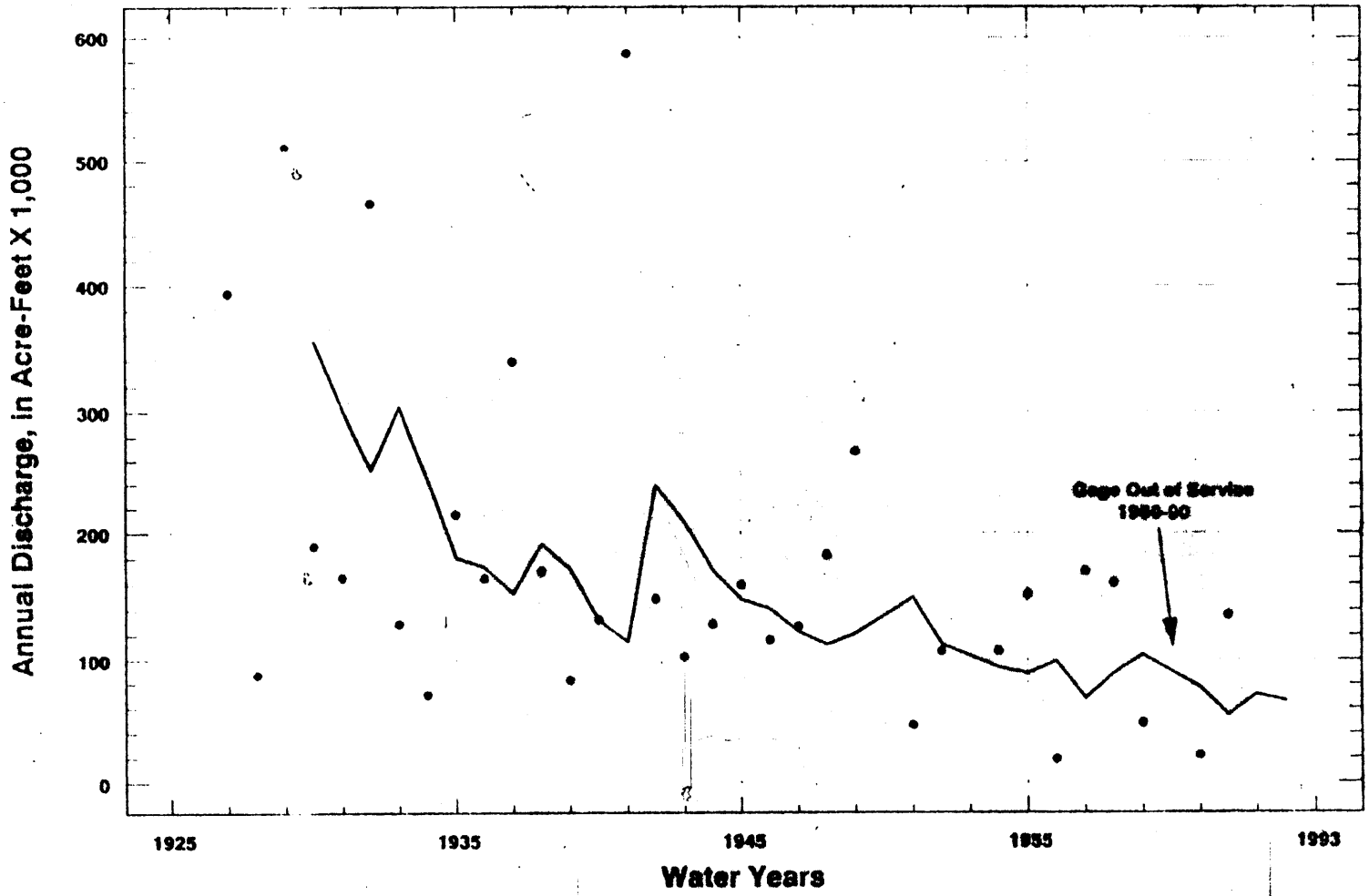
Variable:	Total Annual	Annual Peak	Zero Flow Days
Sample Size	35	33	32
Average	12,814.3	179,051	143.056
Median	8,390	149,041	135
Mode	7,960	107,520	78
Geometric Mean	9,271.88	138,088	4,917.04
Variance	125,630,000	18,403,200,000	4,917.04
Standard Deviation	11,294.4	135,658	70.1216
Standard Error	1,909.1	23,615.1	12.3959
Minimum	2,140	18,668	35
Maximum	50,500	586,788	308
Range	48,360	568,120	273
Lower Quartile	4,920	107,520	86.5
Upper Quartile	17,300	182,241	195.5
Interquartile Range	12,380	74,721	109
Skewness	1.67552	1.66701	0.363085
Standard Skewness	4.04676	3.90949	0.838508
Kurtosis	2.67983	2.44901	-0.574199
Standard Kurtosis	3.23621	2.87172	-0.663028
Coefficient of Variation	88.1391	75.7653	48.9826

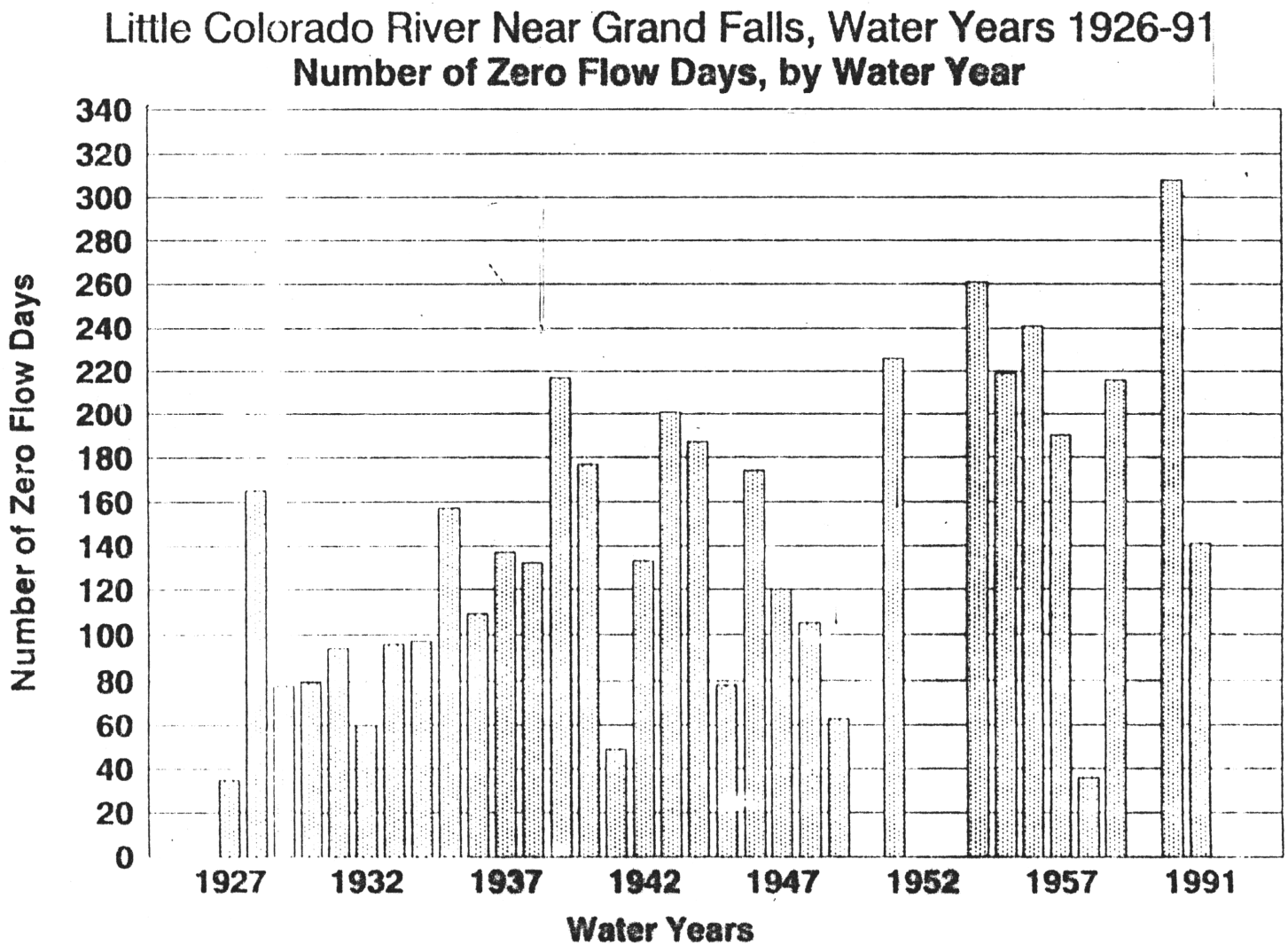

Little Colorado River Near Grand Falls, Water Years 1926-91
Mean Monthly Flows, in Acre-Feet
Mean Monthly Flows, in Acre-Feet X 1,000
45
40
35
30
25
20
15
10
5
0
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Months


Little Colorado River Near Grand Falls, Water Years 1926-91
Annual Discharge, in Acre-Feet
Annual Discharge, in Acre-Feet X 1,000
700
600
500
400
300
200
100
0
1927
1932
1937
1942
1947
1952
1957
1991
Water Years

Little Colorado River near Grand Falls, Water Years 1926-91

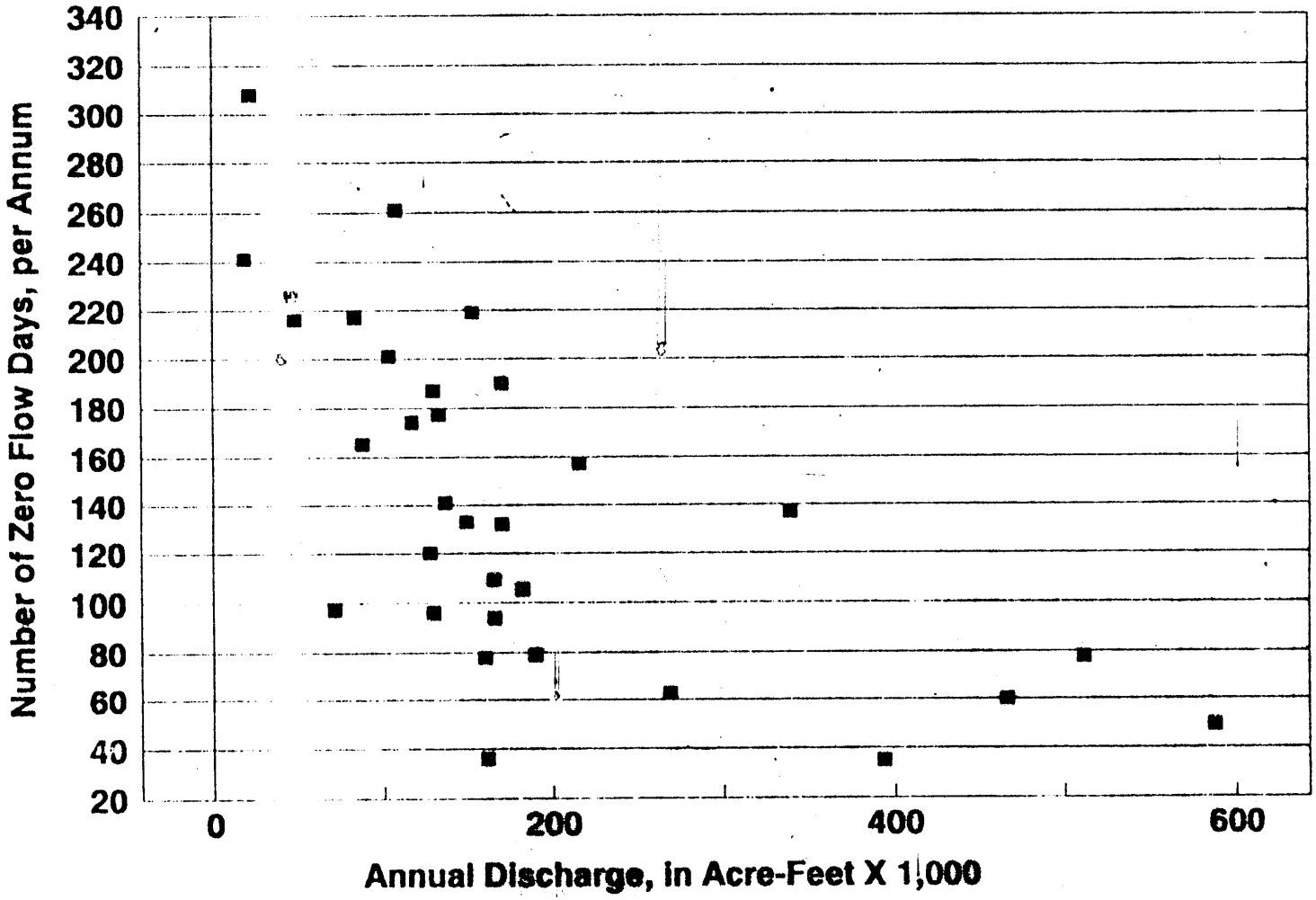
Trend Analysis: Quadratic Time Smoothing of Annual Discharge Data

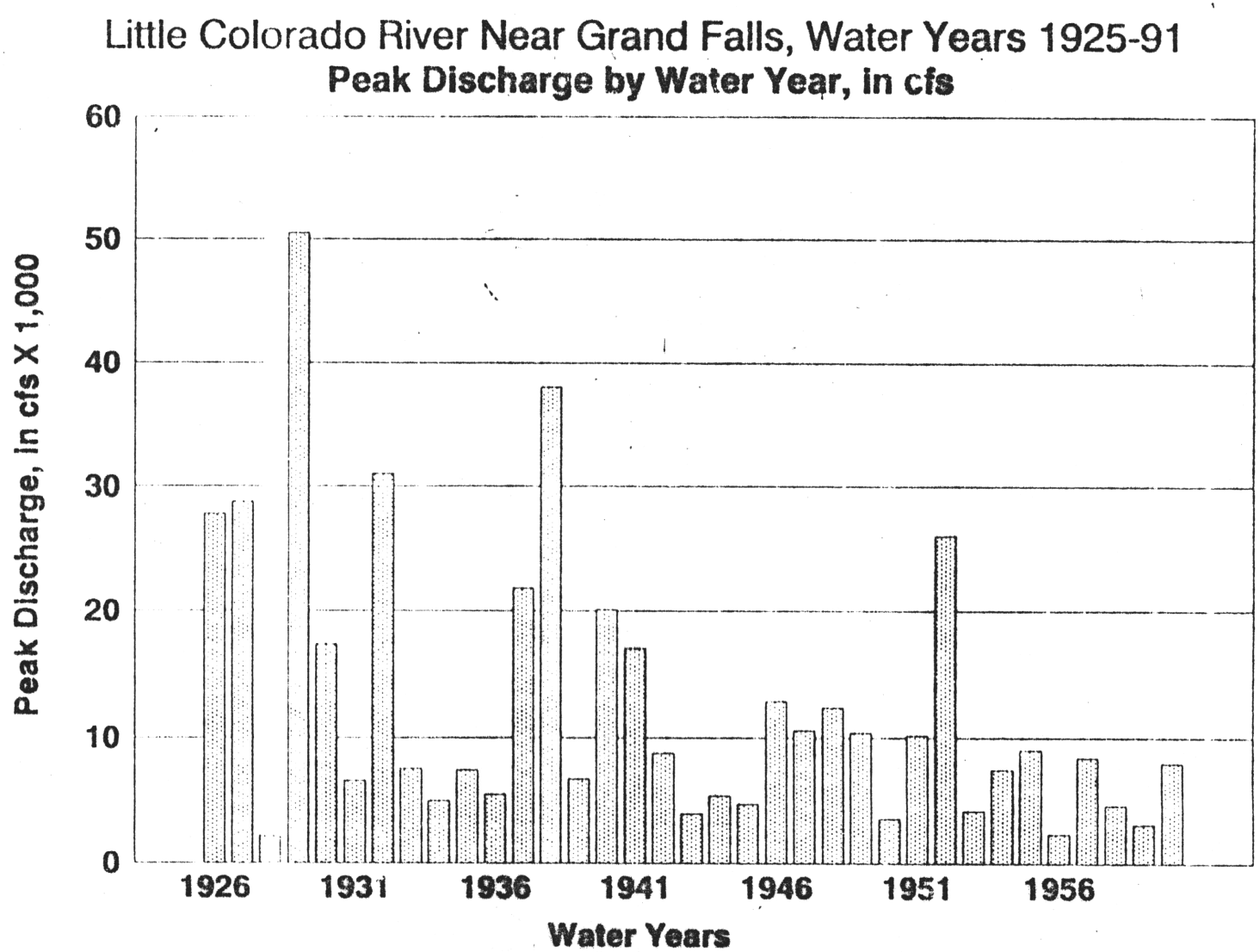



Little Colorado River Near Grand Falls, Water Years 1926-91
Number of Zero Flow Days, by Water Year
Number of Zero Flow Days
340
320
300
280
260
240
220
200
180
160
140
120
100
80
60
40
20
0
1927
1932
1937
1942
1947
1952
1957
1991
Water Years

Little Colorado River near Grand Falls, Water Years 1926-91

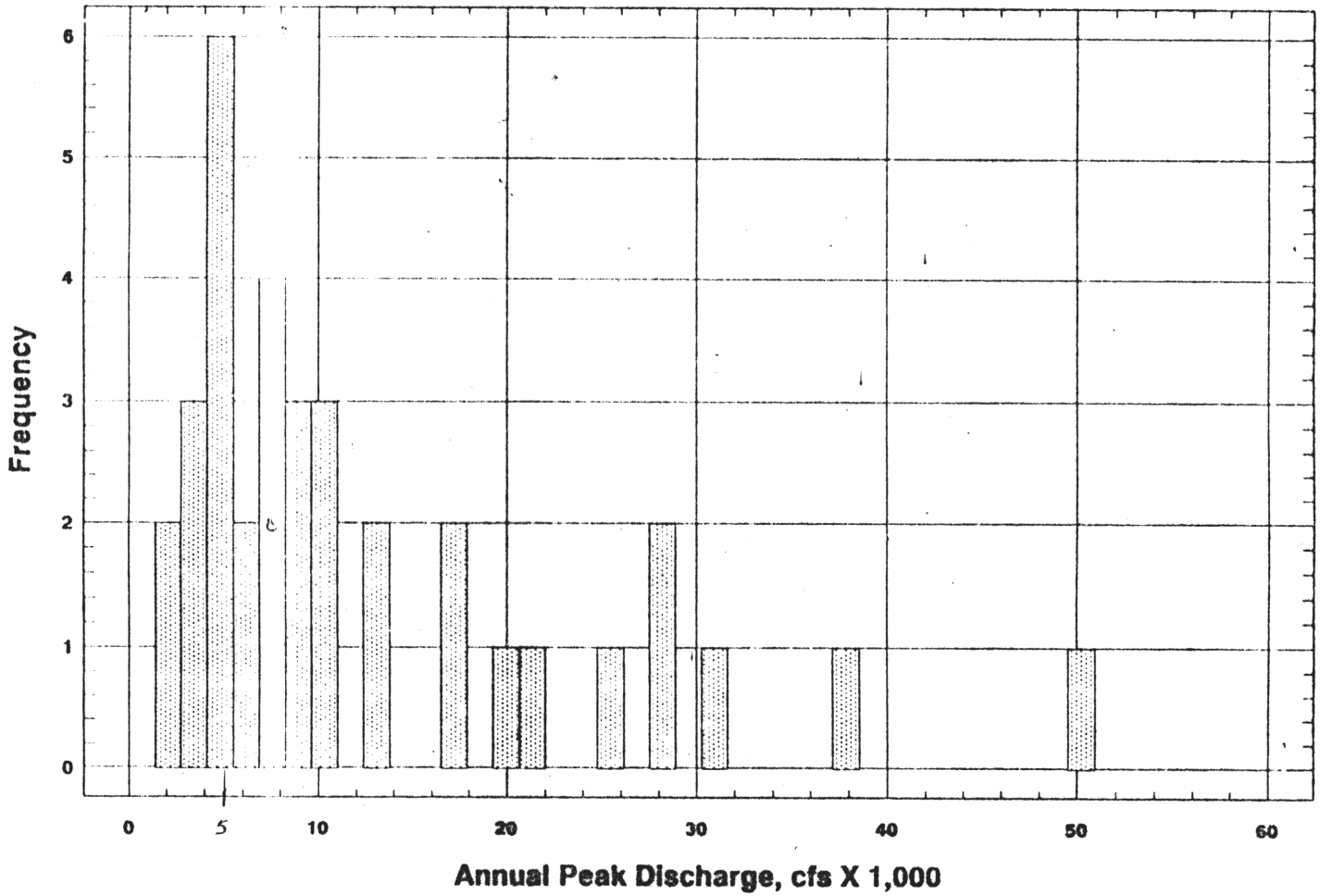
Annual Discharge vs. Zero Flow Days



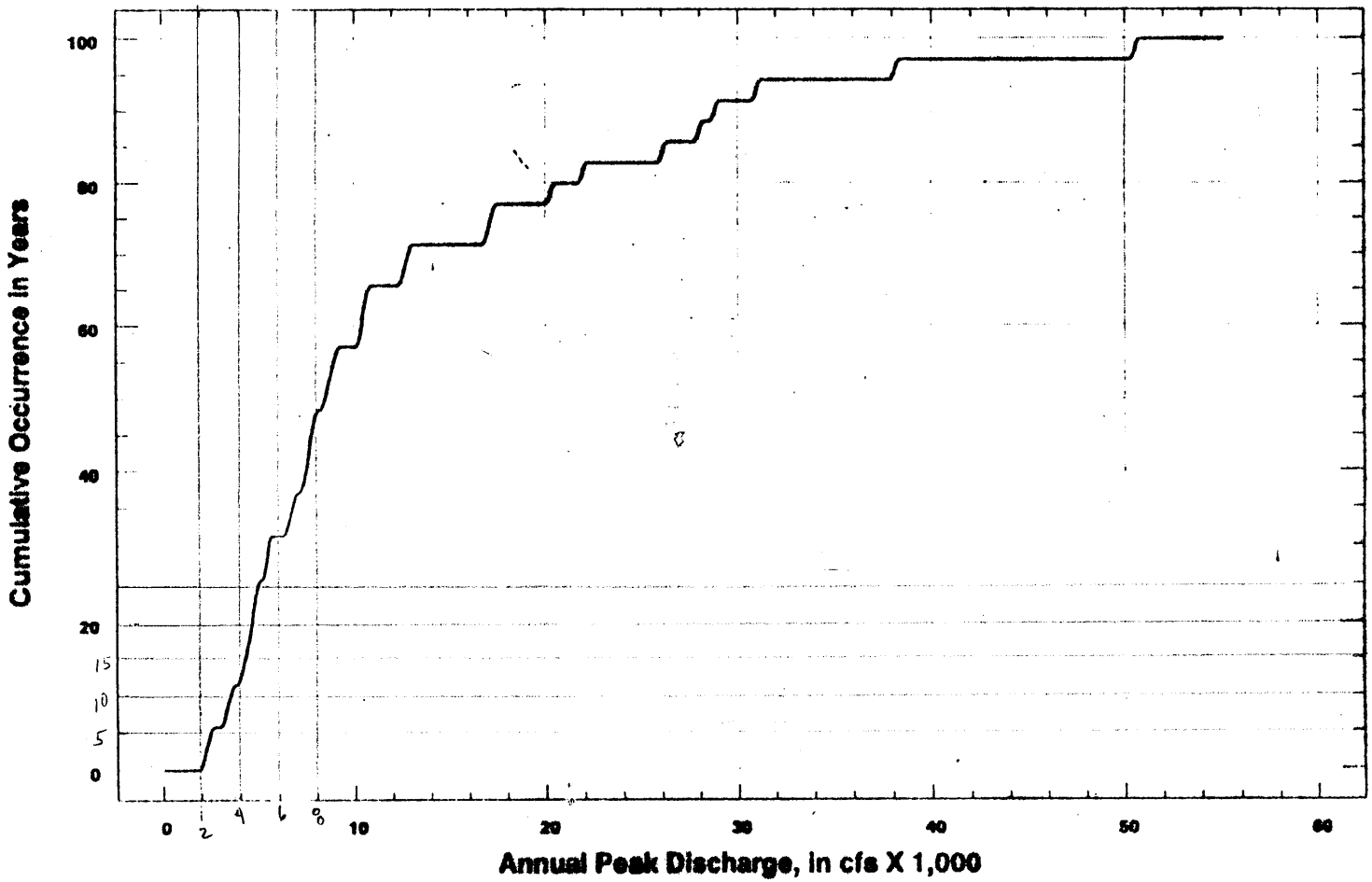

Little Colorado River Near Grand Falls, Water Years 1925-91
Peak Discharge by Water Year, in cfs
Peak Discharge, in cfs X 1,000
60
50
40
30
20
10
0
1926
1931
1936
1941
1946
1951
1956
Water Years

Little Colorado River near Grand Falls, Water Years 1925-91

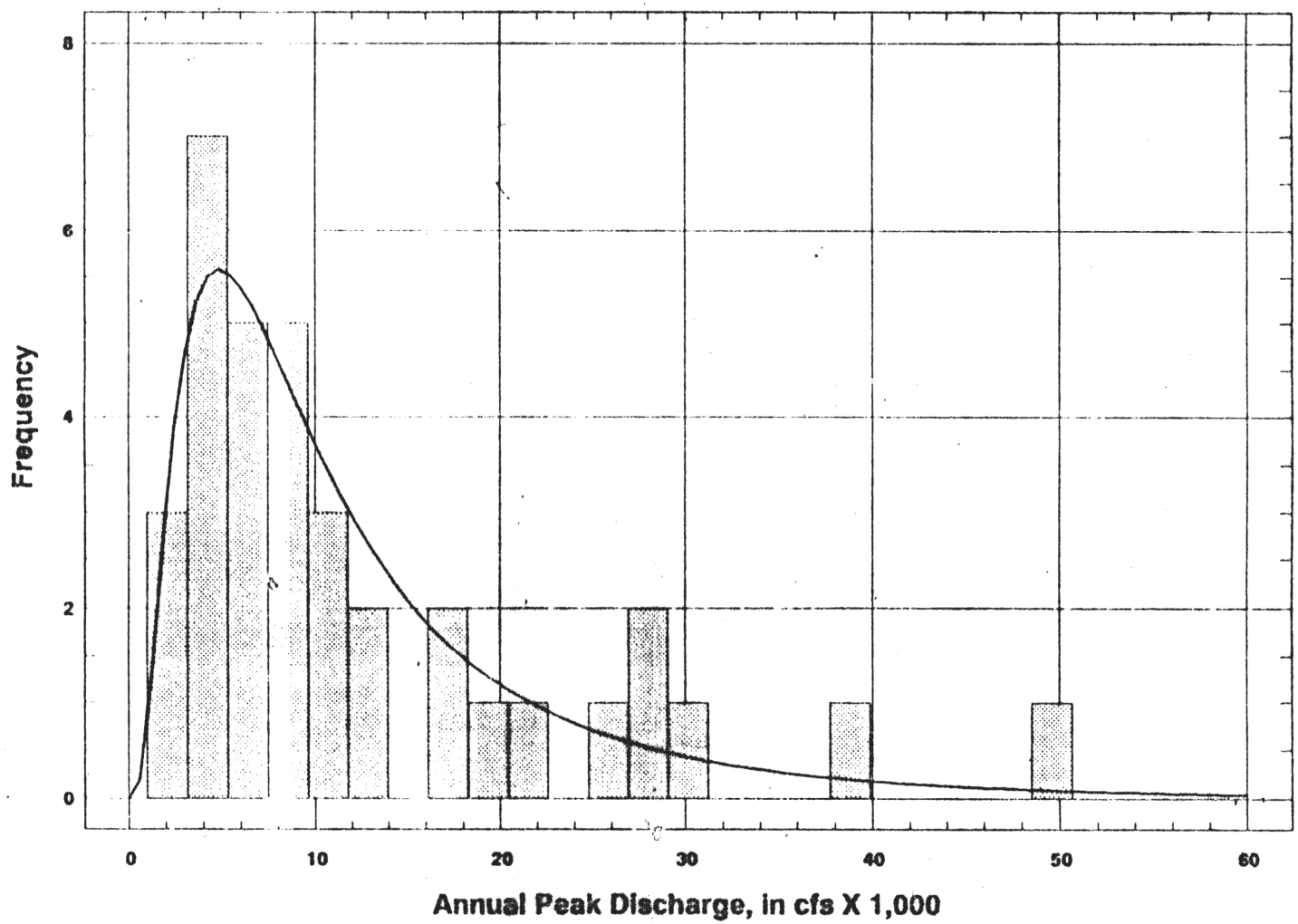
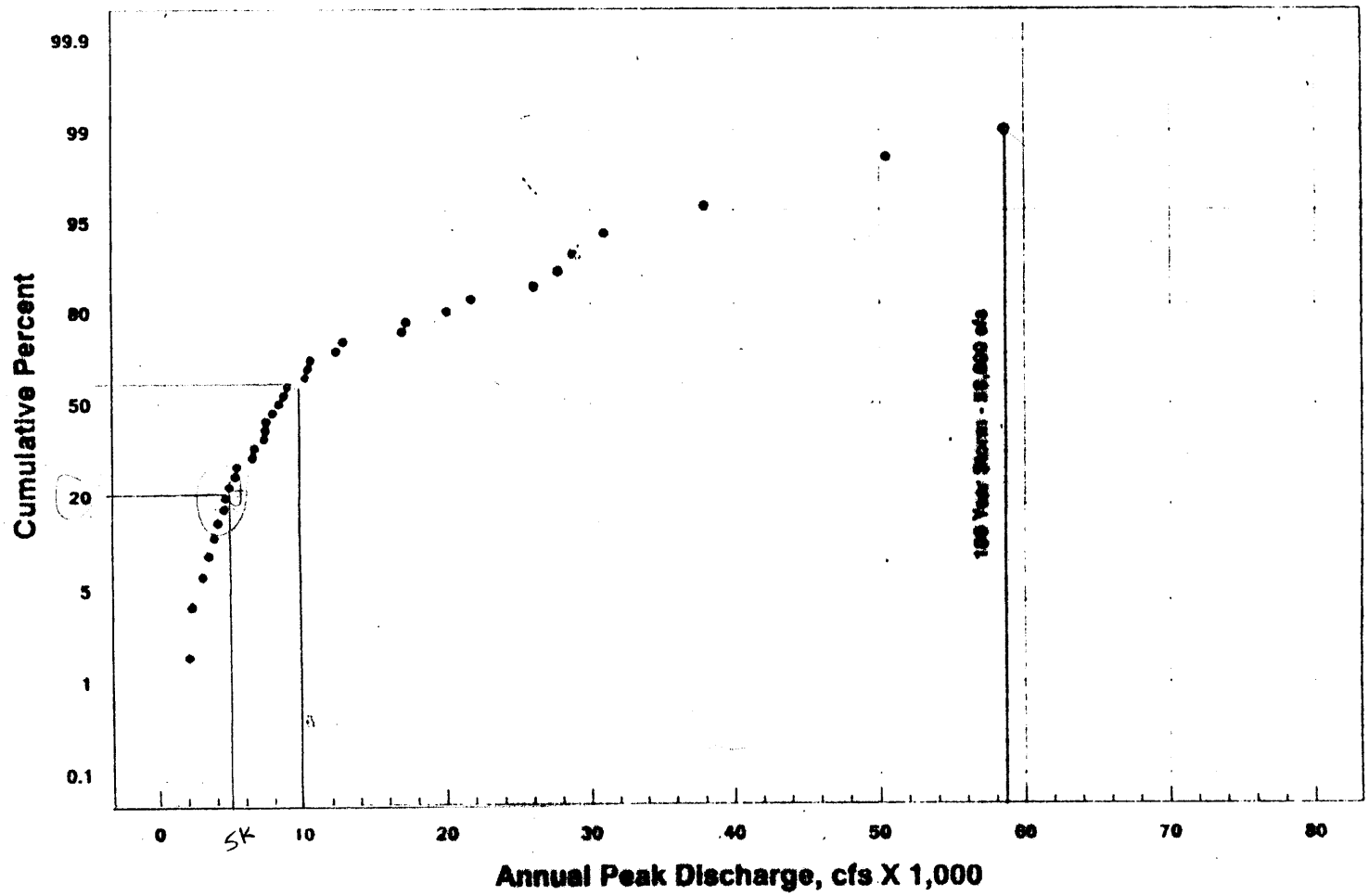
Peak Discharge Frequency Histogram



Little Colorado River near Grand Falls, Water Years 1925-91
Cumulative Relative Frequency Graph



Little Colorado River near Grand Falls, Water Years 1925-91
Lognormal Frequency Distribution Fit



Little Colorado River near Grand Falls, Water Years 1925-91
Normal Probability Distribution Fitting