#1. Flood Frequency Analysis Exercise

(1) Assume the design discharge is 30,000 cfs and determine the return period of this annual maximum discharge in the period 1900 to 1940, and in the period 1941-2010. What was the annual probability, p, of having a flood discharge of at least 30,000 cfs flowing through Austin in the Colorado River before 1940? After 1940?

Years with annual maximum discharge equaling or exceeding 30,000 cfs
1900-1940

Exceedence Interval		Recurrence Interval (years)
1900	1902	2
1902	1903	1
1903	1904	1
1904	1905	1
1905	1906	1
1906	1908	2
1908	1909	1
1909	1913	4
1913	1914	1
1914	1915	1
1915	1916	1
1916	1918	2
1918	1919	1
1919	1920	1
1920	1921	1
1921	1922	1
1922	1923	1
1923	1924	1
1924	1925	1
1925	1926	1
1926	1927	1
1927	1928	1
1928	1929	1
1929	1930	1
1930	1931	1
1931	1932	1
1932	1933	1
1933	1934	1
1934	1935	1
1935	1936	1
1936	1937	1
1937	1938	1
1938	1940	2
Average		**1.21**

$$T = 1.21 years$$

$$P(X > x_T) = \frac{1}{T}$$

$$P(X > x_T) = \frac{1}{1.21}$$

$$P(X > x_T) = 0.83$$

Years with annual maximum discharge equaling or exceeding 30,000 cfs
1941-2010

Exceedence Interval		Recurrence Interval (years)
1941	1957	16
1957	1958	1
1958	1960	2
1960	1961	1
1961	1975	14
1975	1977	2
1977	1987	10
1987	1992	5
1992	1997	5
1997	1999	2
1999	2002	3
2002	2005	3
2005	2010	5
Average		**5.31**

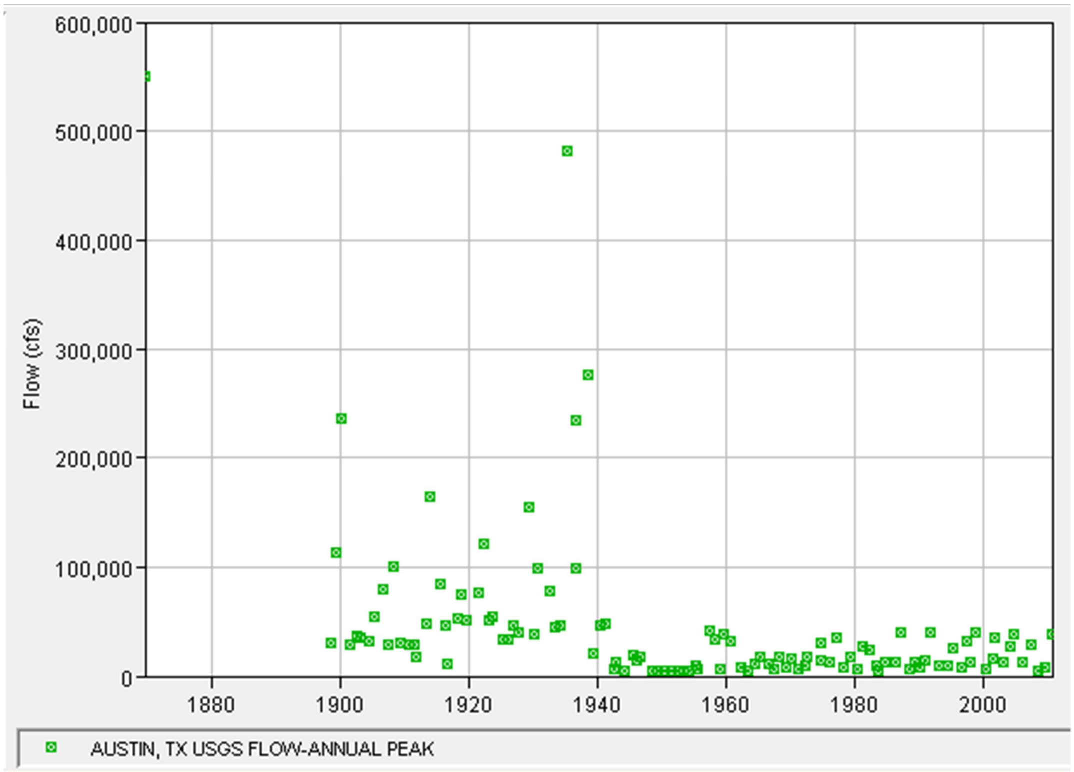
$$T = 5.31 years$$

$$P(X > x_T) = \frac{1}{T}$$

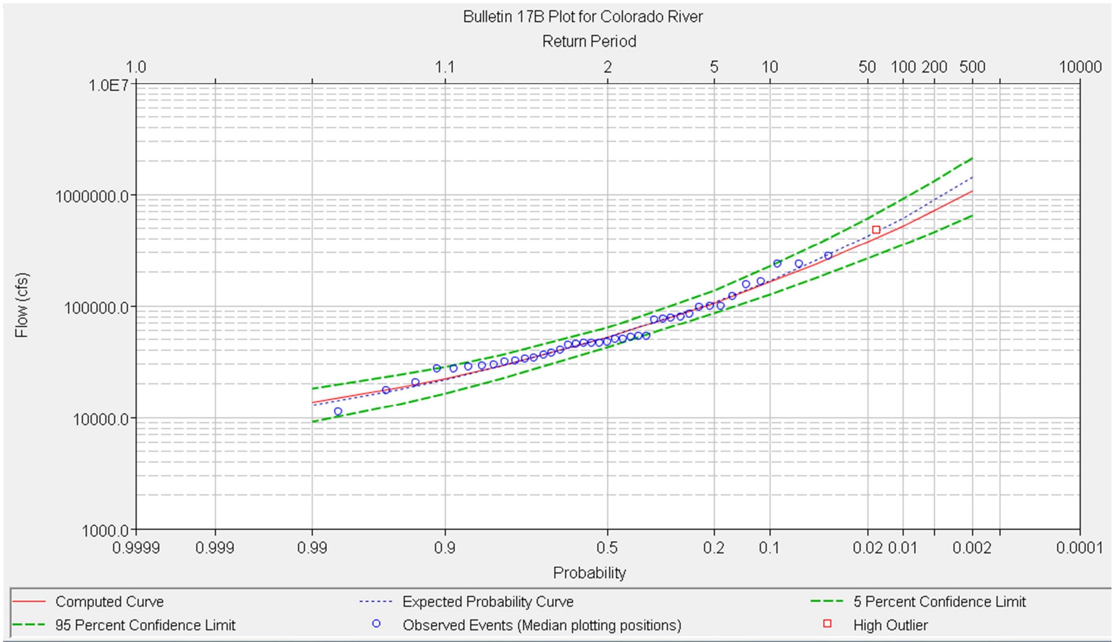
$$P(X > x_T) = \frac{1}{5.31}$$

$$P(X > x_T) = 0.19$$

(2) A plot of the flood discharges for the annual peak flows of the Colorado River at Austin including all the data and the historical flood.

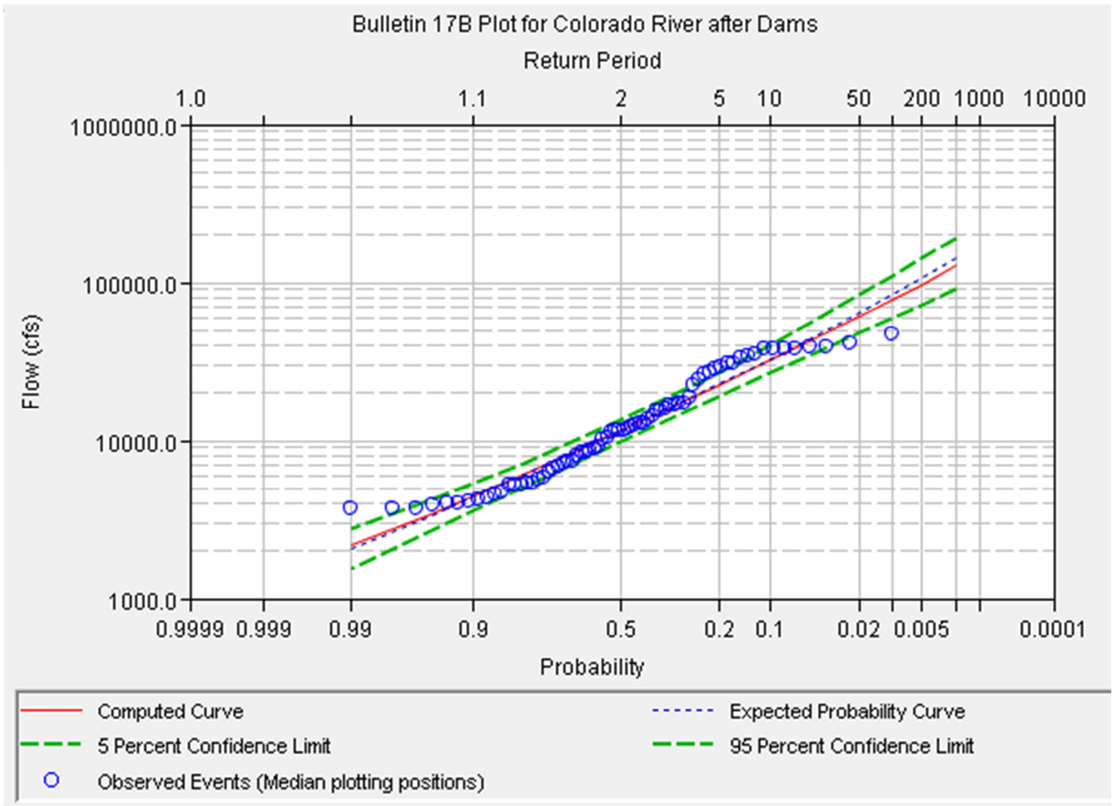


(3) A plot and a table of results for the frequency analysis for the Colorado River at Austin for the period 1900 to 1940.



Computed Curve	Expected Probability	Percent Chance Exceedance	Confidence Limits	
			0.05	0.95
Flow (cfs)			Flow (cfs)	
1,066,182.40	1,428,381.40	0.2	2,141,525.60	651,738.60
716,499.60	885,877.70	0.5	1,322,901.40	463,397.80
523,817.00	613,816.60	1	906,087.30	353,765.40
377,632.30	423,193.50	2	611,165.30	266,414.00
237,958.70	254,000.80	5	352,078.00	177,787.40
162,453.60	168,950.20	10	224,569.80	126,485.00
105,994.10	108,007.90	20	137,399.40	85,413.70
51,931.20	51,931.20	50	63,653.20	42,101.10
28,923.50	28,596.00	80	36,010.70	22,158.10
22,338.40	21,906.10	90	28,379.90	16,470.30
18,468.40	17,940.70	95	23,895.70	13,193.50
13,624.10	12,982.40	99	18,227.30	9,214.50

(4) A plot and a table of results for the frequency analysis for the Colorado River at Austin for the period 1941 to 2010. Using the "Computed Curve Flows" make a comparison of the 2, 5, 10, 50 and 100 year design discharges for the two periods. By what amount did the construction of the dams reduce the 100 year flood flow of the Colorado River at Austin? What are the 95% confidence limits on the 100 year flood discharge estimate for the "After Dams" condition?



Computed Curve	Expected Probability	Percent Chance Exceedance	Confidence Limits 0.05	0.95
Flow (cfs)			Flow (cfs)	
127,143.80	141,741.30	0.2	193,368.70	91,919.20
97,256.90	105,519.80	0.5	142,135.30	72,391.40
78,196.30	83,293.10	1	110,703.40	59,562.20
61,802.30	64,776.30	2	84,618.60	48,218.80
43,684.70	44,962.80	5	57,068.30	35,229.80
32,288.30	32,873.90	10	40,624.90	26,711.30
22,558.70	22,766.80	20	27,320.90	19,111.70
11,619.50	11,619.50	50	13,539.10	9,963.90
6,161.40	6,111.10	80	7,277.30	5,081.70
4,473.30	4,405.10	90	5,396.30	3,566.30
3,454.10	3,372.00	95	4,256.40	2,668.10
2,156.70	2,054.40	99	2,779.30	1,563.30

Flow		Before/After Dams conditions (%)	Percent Chance Exceedance	Return Period (years)
1900-1940 (cfs)	1941-2010 (cfs)			
523,817	78,196	15%	1	100
377,632	61,802	16%	2	50
267,286	47,756	18%	4	25
162,454	32,288	20%	10	10
105,994	22,559	21%	20	5
51,931	11,620	22%	50	2

The 100-year flood flow is reduced by:

$$523{,}817 - 78{,}196$$
$$445{,}621 cfs$$

5% Confidence Limit: $110{,}703 cfs$
95% Confidence Limit: $59{,}562 cfs$

#2. 12.1.3 Calculate the probability that a 100-year flood will occur at a given site at least once during the next 5, 10, 50 and 100 years. What is the chance that a 100-year flood will not occur at this site during the next 100 years?

$$P(X \geq x_T) = 1 - \left(1 - \frac{1}{T}\right)^N$$

$T = 100yr$
$N = 5, 10{,}50\ and\ 100yr$

N	$P(X \geq x_T)$
5	0.05
10	0.10
50	0.39
100	0.63

What is the chance that a 100-year flood will not occur at this site during the next 100 years?

$$P(X < x_T) = 1 - P(X \geq x_T)$$

$$P(X < x_T) = 1 - 0.63$$

$$P(X < x_T) = 0.37$$

#3. 12.5.1 Perform a frequency analysis for the annual maximum discharge of Walnut Creek using the data given in Table 12.5.1, employing the log-Pearson Type III distribution without the U.S. Water Resources Council corrections for skewness and outliers. Compare your results with those given in Table 12.5.2 for the 2-, 5-, 10-, 25-,50- and 100-year events.

Year	Flow (cfs)	y=log(x)	$(y - \overline{y})^2$	$(y - \overline{y})^2$
1967	303	2.4814	1.3395	-1.5502
1968	5,640	3.7513	0.0127	0.0014
1969	1,050	3.0212	0.3814	-0.2356
1970	6,020	3.7796	0.0198	0.0028
1971	3,740	3.5729	0.0043	-0.0003
1972	4,580	3.6609	0.0005	0.0000
1973	5,140	3.7110	0.0052	0.0004
1974	10,560	4.0237	0.1481	0.0570
1975	12,840	4.1086	0.2207	0.1037
1976	5,140	3.7110	0.0052	0.0004
1977	2,520	3.4014	0.0564	-0.0134
1978	1,730	3.2380	0.1606	-0.0644
1979	12,400	4.0934	0.2067	0.0940
1980	3,400	3.5315	0.0115	-0.0012
1981	14,300	4.1553	0.2668	0.1378
1982	9,540	3.9795	0.1161	0.0396
Total		58.2206	2.9555	-1.4280

n= 16
$\overline{y}$= 3.6388

Sy= 0.4439
Cs= -1.2440

A Return Period [yr]	B Frequency factor (K_T)	C y_t=log(Qt)	D Qt [cfs]
2	0.202	3.7285	5,351
5	0.841	4.0121	10,282
10	1.076	4.1164	13,074
25	1.264	4.1999	15,844
50	1.355	4.2403	17,388
100	1.420	4.2691	18,583

Column B: Interpolating from Table 12.3.1
Column C: $y_t = \bar{y} + K_T S_y$
Column D: $Q_t = 10^{y_t}$

#4. 14.2.1 Determine the 10-year, 1-hour design rainfall intensity and depth for Chicago from the IDF curve given in Fig. 14.2.1.

$T = 10yr$
$T_d = 1hr = 60min$

(Fig. 14.2.1)
$i = 2.1in/hr$

The results are similar for 2-, 5- and 10-year events. For the rest, the computed results are almost significantly smaller.

#5. 14.5.1 Use Eq. (14.5.1) for the world's greatest recorded rainfalls to develop and plot a 24-hour design hyetograph in 1-hour time increments by the alternating block method.

$$P = 422T_d^{0.475}$$

Duration Td [hr]	Cumulative Precipitation [mm]	Incremental Precipitation [mm]	Precipitation [mm]
1	422	422	39
2	587	165	41
3	711	125	43
4	815	104	46
5	906	91	49
6	988	82	53
7	1,063	75	58
8	1,133	70	65
9	1,198	65	75
10	1,260	61	91
11	1,318	58	125
12	1,374	56	422
13	1,427	53	165
14	1,478	51	104
15	1,527	49	82

16	1,575	48	70
17	1,621	46	61
18	1,666	45	56
19	1,709	43	51
20	1,751	42	48
21	1,792	41	45
22	1,832	40	42
23	1,871	39	40
24	1,909	38	38