Analysis Techniques: Flood Analysis Tutorial with Daily Data (Log-Perason Type III Distribution)

Information to get started:

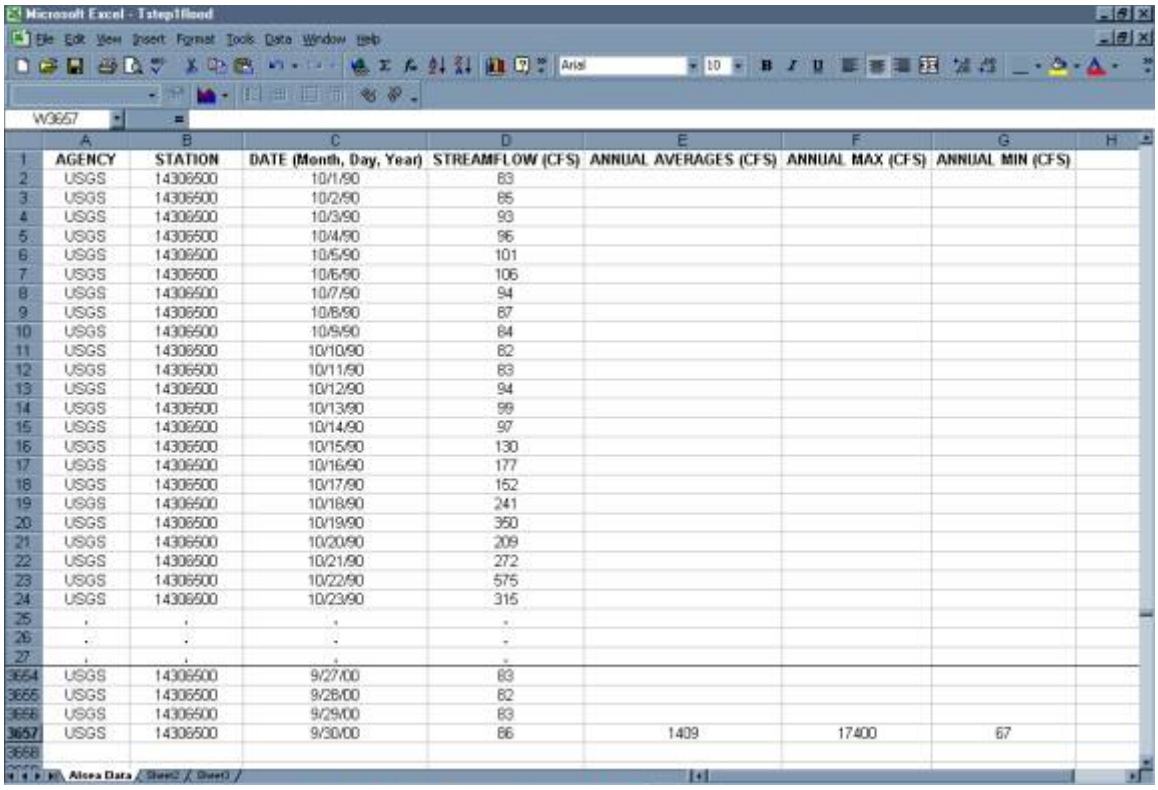
- The lesson below contains step-by-step instructions and "snapshots" of what each step looks like when carried out in a Microsoft Excel workbook. Blue shading of information in the Excel illustrations denotes changes made from the previous step. Dots placed in three consecutive rows indicate that a portion of data is hidden from sight.
- You can download an Excel workbook containing the complete data set by clicking on the "Download Data" link below. It contains each calculation step on a separate worksheet. To move between steps, click on the tabs at the bottom of the excel window.
- When you download the file, it may open in your browser window. You may wish to use the "save as" function to save the file to a local drive and then reopen it in Excel. This will make it easier to flip between the online lesson and the example workbook.
- Finally, we want to remind you that the techniques explained on this site are statistically based; therefore results must be viewed as predictions and not as facts. Please use the techniques and the information obtained from them responsibly!

Download Data

Step 1: Obtain streamflow data

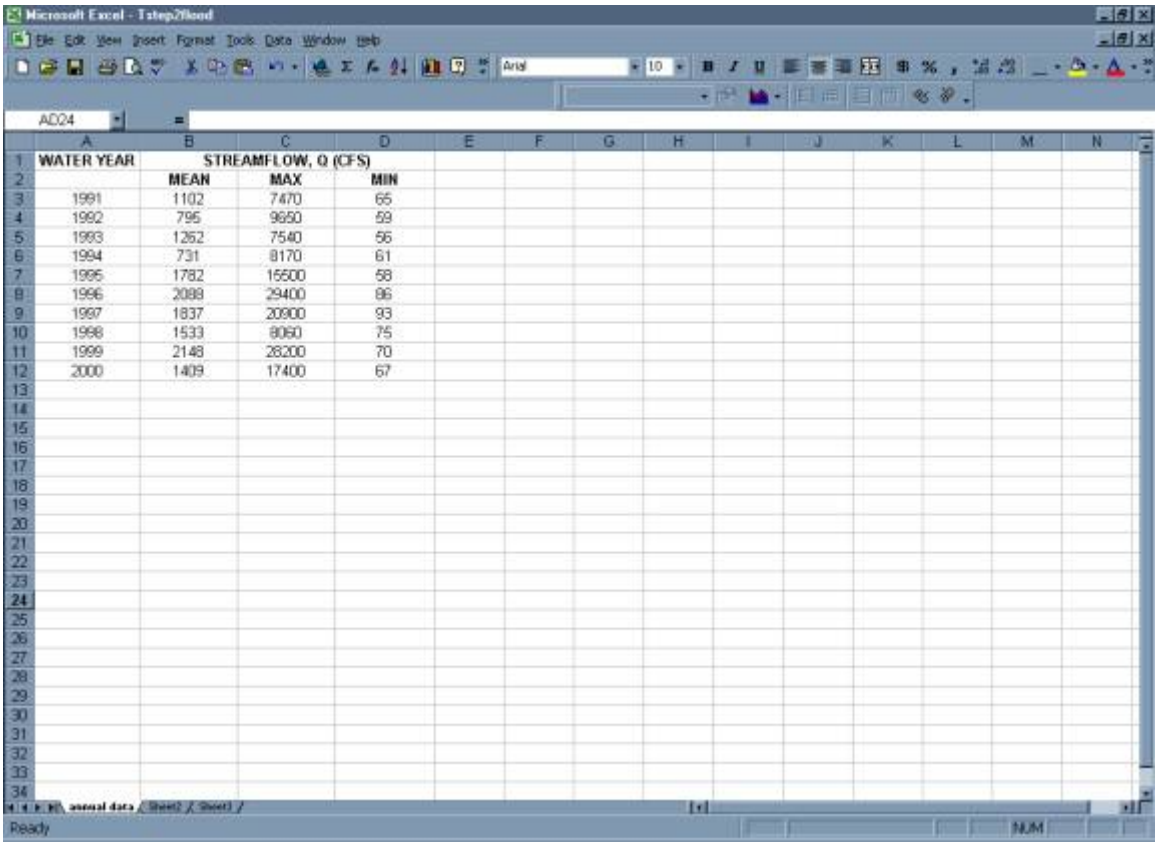
- Obtain daily streamflow data from the USGS web site.
  - Go to **http://oregon.usgs.gov**
  - Select Historical Water Data
  - Select Surface Water
  - Select Daily Data
  - Check box under Site Identifier for Site Name and Submit
  - Type in Alsea under Site Name and select match any part and Submit
  - Select gage at TIDEWATER (140306500)
  - Select Tab-separated data
  - For the tutorial, copy the data for water years 1990 through 2000 into an Excel worksheet
  - Paste special as text (this will separate the data into columns

- Calculate the maximum discharge for each water year in the period of record.
- The AVERAGE, MAX, and MIN functions in excel can be used to calculate these values for each water year. It may be more efficient to calculate the mean, maximum, and minimum flows for each water year in the period of record at one time.



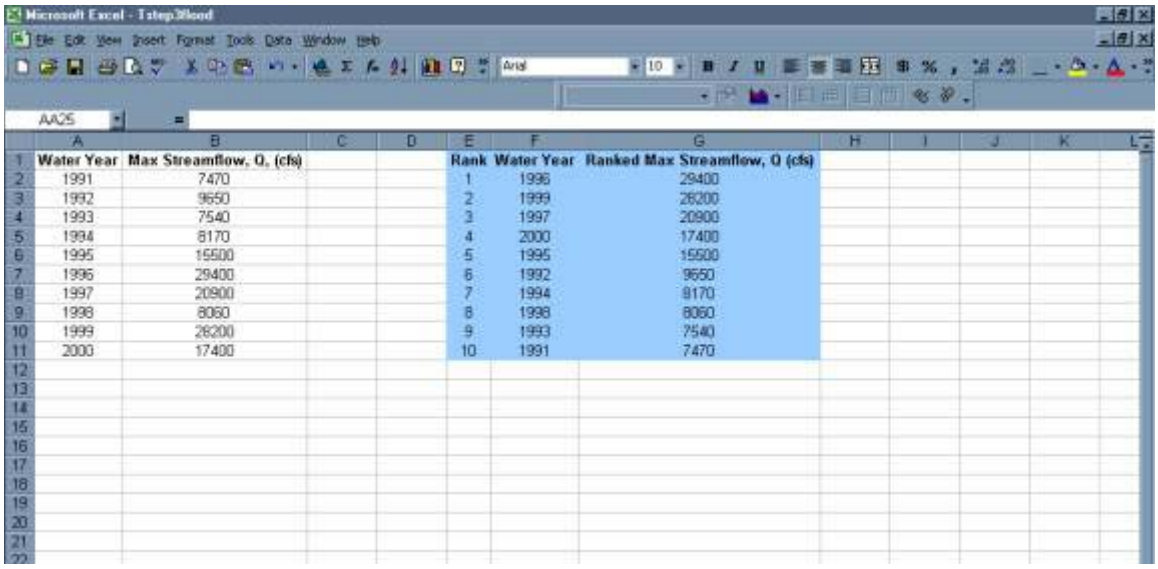
	A	B	C	D	E	F	G	H
1	AGENCY	STATION	DATE (Month, Day, Year)	STREAMFLOW (CFS)	ANNUAL AVERAGES (CFS)	ANNUAL MAX (CFS)	ANNUAL MIN (CFS)	
2	USGS	14306500	10/1/90	83				
3	USGS	14306500	10/2/90	85				
4	USGS	14306500	10/3/90	93				
5	USGS	14306500	10/4/90	96				
6	USGS	14306500	10/5/90	101				
7	USGS	14306500	10/6/90	106				
8	USGS	14306500	10/7/90	94				
9	USGS	14306500	10/8/90	87				
10	USGS	14306500	10/9/90	84				
11	USGS	14306500	10/10/90	82				
12	USGS	14306500	10/11/90	83				
13	USGS	14306500	10/12/90	94				
14	USGS	14306500	10/13/90	99				
15	USGS	14306500	10/14/90	97				
16	USGS	14306500	10/15/90	130				
17	USGS	14306500	10/16/90	177				
18	USGS	14306500	10/17/90	152				
19	USGS	14306500	10/18/90	241				
20	USGS	14306500	10/19/90	350				
21	USGS	14306500	10/20/90	209				
22	USGS	14306500	10/21/90	272				
23	USGS	14306500	10/22/90	575				
24	USGS	14306500	10/23/90	315				
25	.	.	.	.				
26	.	.	.	.				
27	.	.	.	.				
3654	USGS	14306500	9/27/00	83				
3655	USGS	14306500	9/28/00	82				
3656	USGS	14306500	9/29/00	83				
3657	USGS	14306500	9/30/00	86	1409	17400	67	
3658								

Step 2: Organize the information in a table.



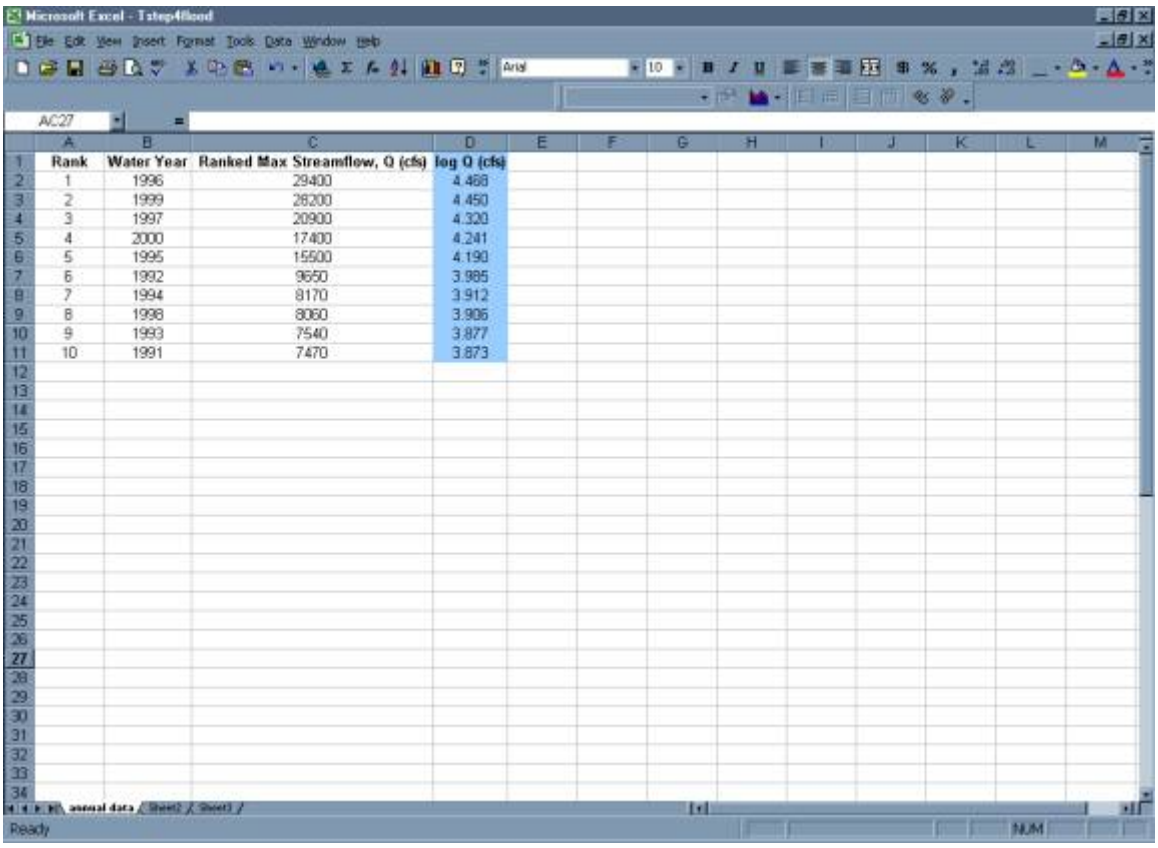
	A	B	C	D
1	WATER YEAR	STREAMFLOW, Q (CFS)		
2		MEAN	MAX	MIN
3	1991	1102	7470	65
4	1992	795	9650	59
5	1993	1262	7540	56
6	1994	731	8170	61
7	1995	1782	15500	58
8	1996	2088	29400	86
9	1997	1837	20900	93
10	1998	1533	8060	75
11	1999	2148	28200	70
12	2000	1409	17400	67

Step 3: Rank the data from largest discharge to smallest discharge. Add a column for Rank and number each streamflow value from 1 to n (the total number of values in your dataset).



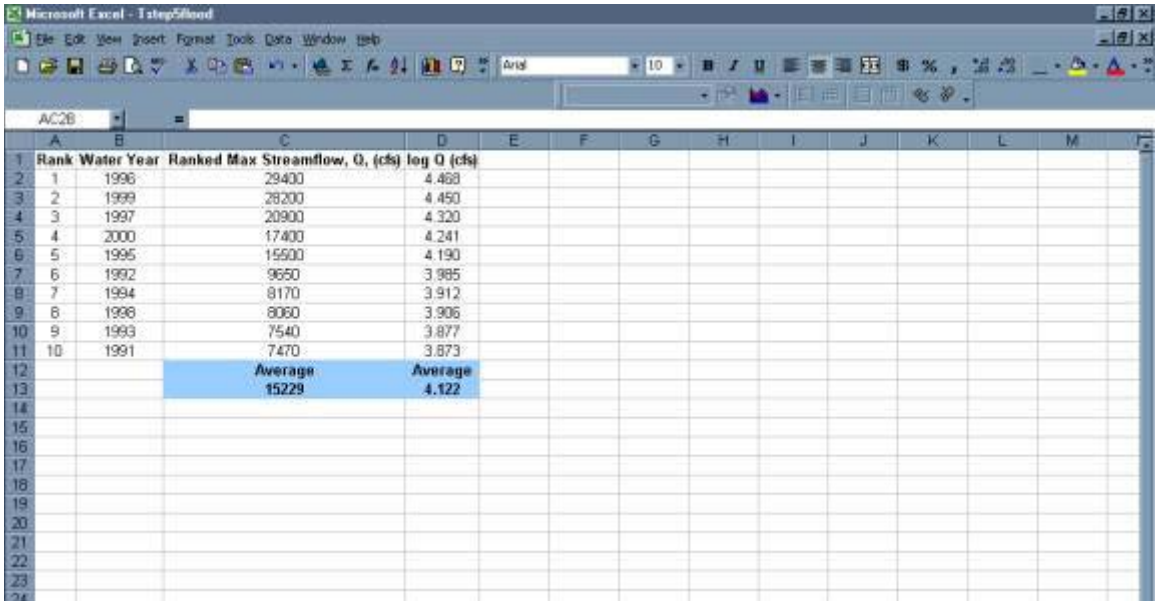
	A	B	C	D	E	F	G	H	I	J	K	L
1	Water Year	Max Streamflow, Q, (cfs)			Rank	Water Year	Ranked Max Streamflow, Q (cfs)					
2	1991	7470			1	1996	29400					
3	1992	9650			2	1999	28200					
4	1993	7540			3	1997	20900					
5	1994	8170			4	2000	17400					
6	1995	15500			5	1995	15500					
7	1996	29400			6	1992	9650					
8	1997	20900			7	1994	8170					
9	1998	8060			8	1998	8060					
10	1999	28200			9	1993	7540					
11	2000	17400			10	1991	7470					

Step 4: Create a column with the log of each max or peak streamflow using the Excel formula {log (Q)} and copy command.



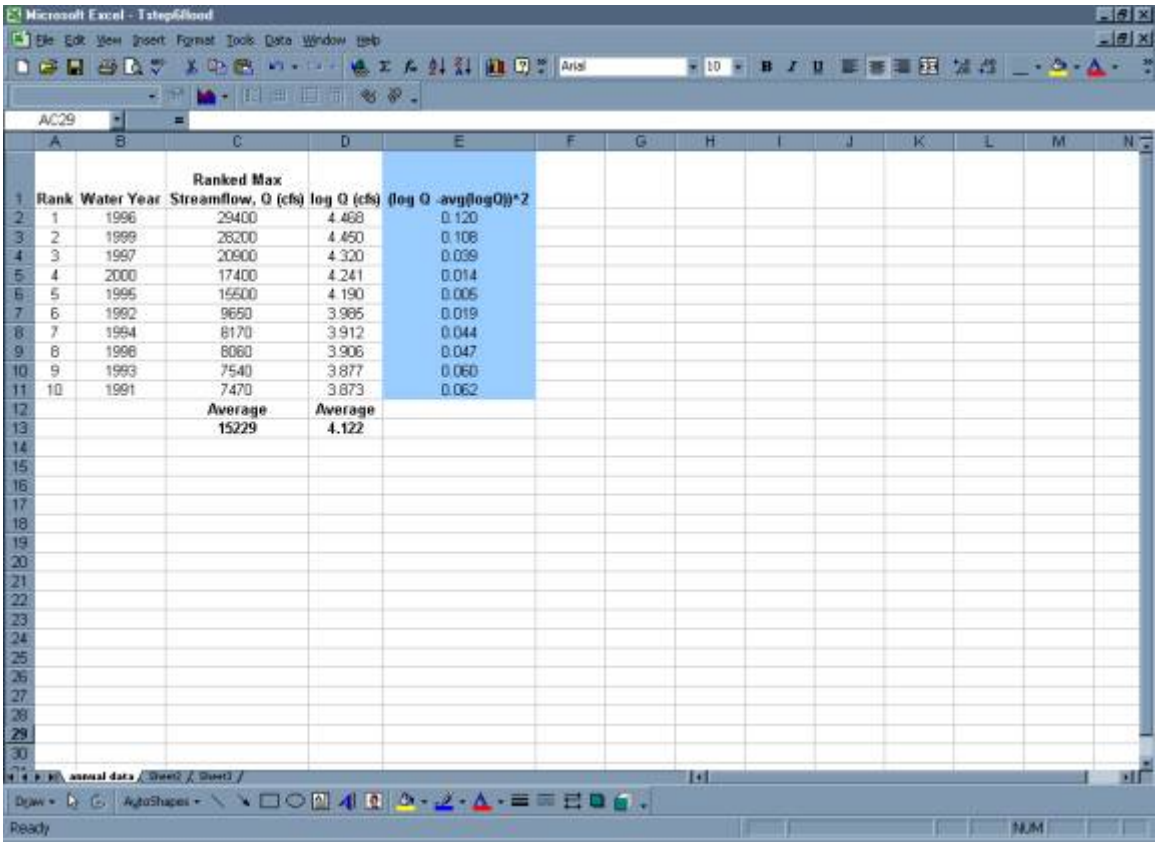
	A	B	C	D	E	F	G	H	I	J	K	L	M
1	Rank	Water Year	Ranked Max Streamflow, Q (cfs)	log Q (cfs)									
2	1	1996	29400	4.468									
3	2	1999	28200	4.450									
4	3	1997	20900	4.320									
5	4	2000	17400	4.241									
6	5	1995	15500	4.190									
7	6	1992	9650	3.985									
8	7	1994	8170	3.912									
9	8	1998	8060	3.906									
10	9	1993	7540	3.877									
11	10	1991	7470	3.873									

Step 5: Calculate the Average Max Q or Peak Q and the Average of the log (Q)



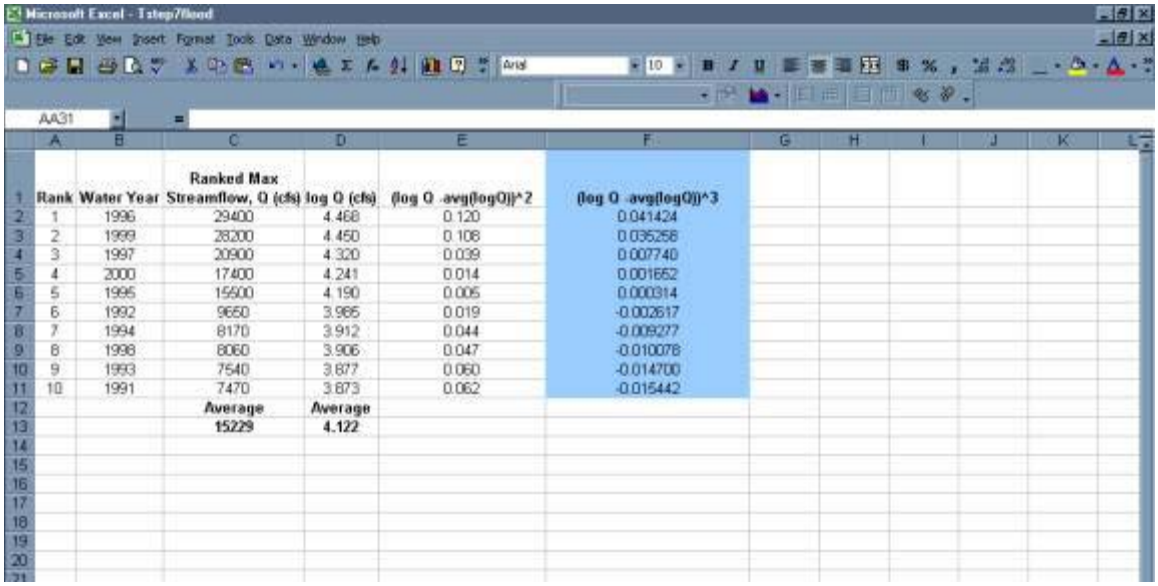
Rank	Water Year	Ranked Max Streamflow, Q, (cfs)	log Q (cfs)
1	1996	29400	4.468
2	1999	28200	4.450
3	1997	20900	4.320
4	2000	17400	4.241
5	1995	15500	4.190
6	1992	9650	3.985
7	1994	8170	3.912
8	1998	8060	3.906
9	1993	7540	3.877
10	1991	7470	3.873
		Average	**Average**
		15229	**4.122**

Step 6: Create a column with the excel formula {(log Q – avg(logQ))^2}



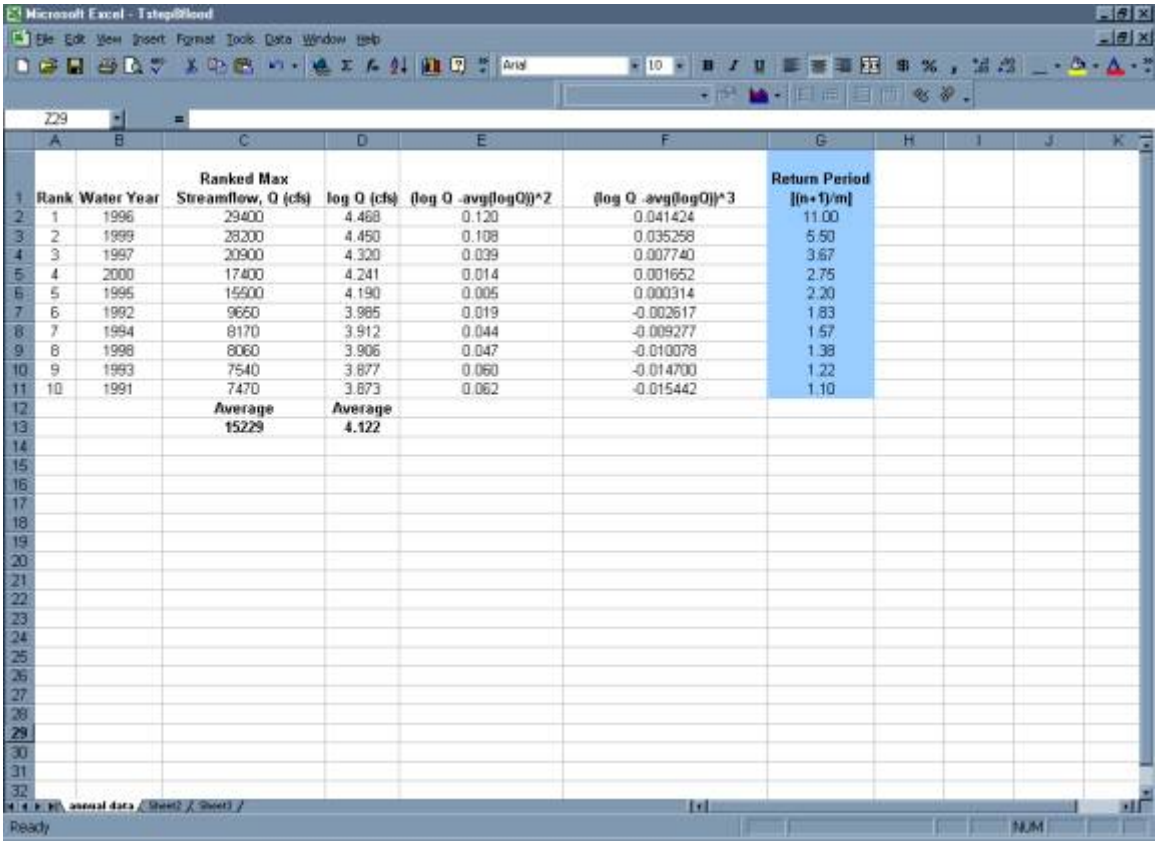
Rank	Water Year	Ranked Max Streamflow, Q (cfs)	log Q (cfs)	(log Q -avg(logQ))^2
1	1996	29400	4.468	0.120
2	1999	28200	4.450	0.108
3	1997	20900	4.320	0.039
4	2000	17400	4.241	0.014
5	1995	15500	4.190	0.005
6	1992	9650	3.985	0.019
7	1994	8170	3.912	0.044
8	1998	8060	3.906	0.047
9	1993	7540	3.877	0.060
10	1991	7470	3.873	0.062
		Average	**Average**	
		15229	**4.122**	

Step 7: Create a column with the excel formula {(log Q – avg(logQ))^3



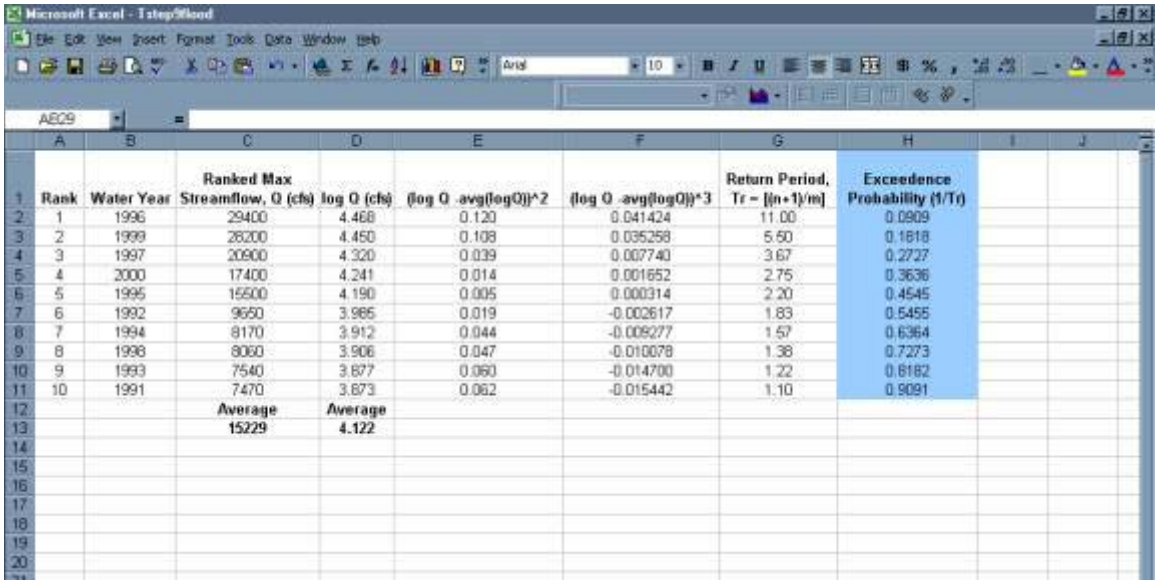
Rank	Water Year	Ranked Max Streamflow, Q (cfs)	log Q (cfs)	(log Q -avg(logQ))^2	(log Q -avg(logQ))^3
1	1996	29400	4.468	0.120	0.041424
2	1999	28200	4.450	0.108	0.035258
3	1997	20900	4.320	0.039	0.007740
4	2000	17400	4.241	0.014	0.001652
5	1995	15500	4.190	0.005	0.000314
6	1992	9650	3.985	0.019	-0.002617
7	1994	8170	3.912	0.044	-0.009277
8	1998	8060	3.906	0.047	-0.010078
9	1993	7540	3.877	0.060	-0.014700
10	1991	7470	3.873	0.062	-0.015442
		Average	Average		
		15229	4.122		

Step 8: Create a column with the return period (Tr) for each discharge using Excel formula {(n+1)/m}. Where n = the number of values in the dataset and m = the rank.



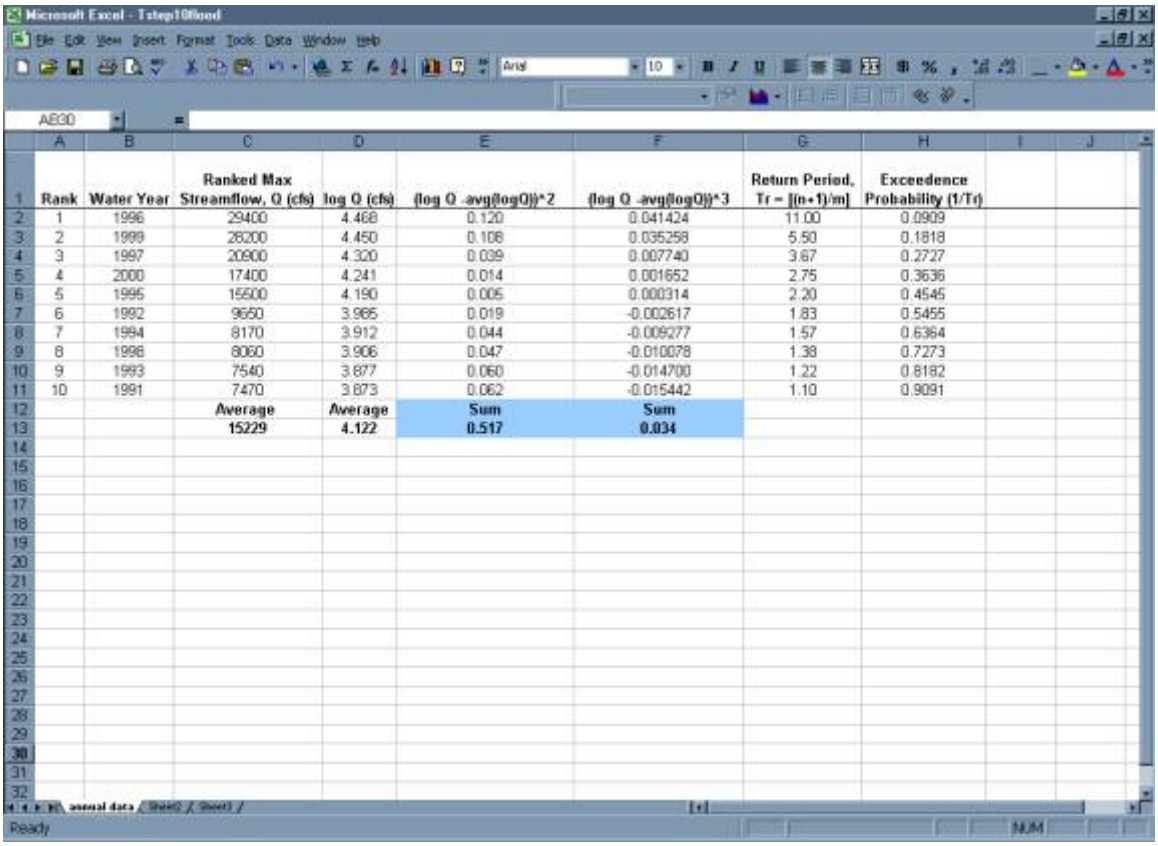
Rank	Water Year	Ranked Max Streamflow, Q (cfs)	log Q (cfs)	(log Q -avg(logQ))^2	(log Q -avg(logQ))^3	Return Period [(n+1)/m]
1	1996	29400	4.468	0.120	0.041424	11.00
2	1999	28200	4.450	0.108	0.035258	5.50
3	1997	20900	4.320	0.039	0.007740	3.67
4	2000	17400	4.241	0.014	0.001652	2.75
5	1995	15500	4.190	0.005	0.000314	2.20
6	1992	9650	3.985	0.019	-0.002617	1.83
7	1994	8170	3.912	0.044	-0.009277	1.57
8	1998	8060	3.906	0.047	-0.010078	1.38
9	1993	7540	3.877	0.060	-0.014700	1.22
10	1991	7470	3.873	0.062	-0.015442	1.10
		Average	Average			
		15229	4.122			

Step 9: Complete the table with a final column showing the exceedence probability of each discharge using the excel formula {=1/Return Period or 1/Tr} and the copy command.



Rank	Water Year	Ranked Max Streamflow, Q (cfs)	log Q (cfs)	(log Q -avg(logQ))^2	(log Q -avg(logQ))^3	Return Period, Tr = [(n+1)/m]	Exceedence Probability (1/Tr)
1	1996	29400	4.468	0.120	0.041424	11.00	0.0909
2	1999	28200	4.450	0.108	0.035258	5.50	0.1818
3	1997	20900	4.320	0.039	0.007740	3.67	0.2727
4	2000	17400	4.241	0.014	0.001652	2.75	0.3636
5	1995	15500	4.190	0.005	0.000314	2.20	0.4545
6	1992	9650	3.985	0.019	-0.002617	1.83	0.5455
7	1994	8170	3.912	0.044	-0.009277	1.57	0.6364
8	1998	8060	3.906	0.047	-0.010078	1.38	0.7273
9	1993	7540	3.877	0.060	-0.014700	1.22	0.8182
10	1991	7470	3.873	0.062	-0.015442	1.10	0.9091
		Average	Average				
		15229	4.122				

Step 10: Calculate the Sum for the {(logQ – avg(logQ))^2} and the {(logQ – avg(logQ))^3} columns.



Rank	Water Year	Ranked Max Streamflow, Q (cfs)	log Q (cfs)	(log Q -avg(logQ))^2	(log Q -avg(logQ))^3	Return Period, Tr = [(n+1)/m]	Exceedence Probability (1/Tr)
1	1996	29400	4.468	0.120	0.041424	11.00	0.0909
2	1999	28200	4.450	0.108	0.035258	5.50	0.1818
3	1997	20900	4.320	0.039	0.007740	3.67	0.2727
4	2000	17400	4.241	0.014	0.001652	2.75	0.3636
5	1995	15500	4.190	0.005	0.000314	2.20	0.4545
6	1992	9650	3.985	0.019	-0.002617	1.83	0.5455
7	1994	8170	3.912	0.044	-0.009277	1.57	0.6364
8	1998	8060	3.906	0.047	-0.010078	1.38	0.7273
9	1993	7540	3.877	0.060	-0.014700	1.22	0.8182
10	1991	7470	3.873	0.062	-0.015442	1.10	0.9091
		Average	Average	Sum	Sum		
		15229	4.122	0.517	0.034		

Step 11: Calculate the variance, standard deviation, and skew coefficient as follows:

variance =

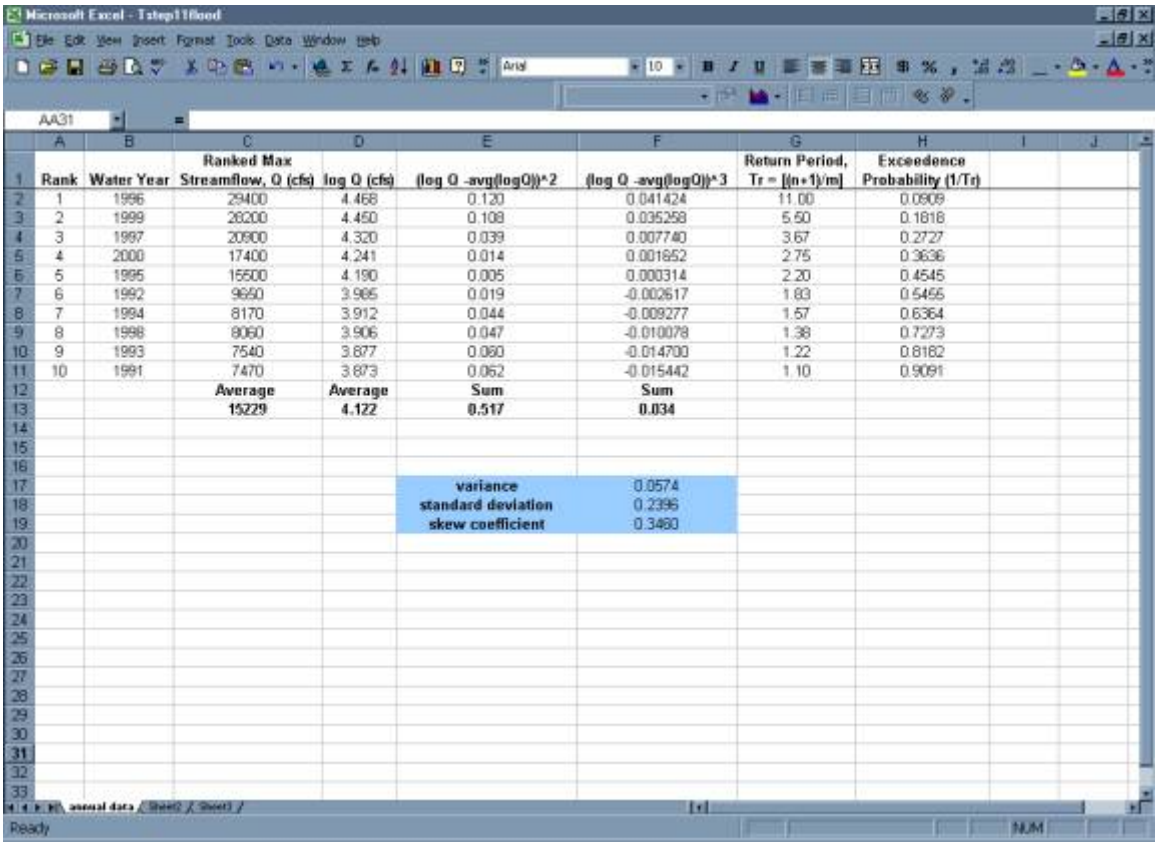
$$\frac{\sum_{i}^{n}(\log Q - avg(\log Q))\,\hat{}\,2}{n-1}$$

standard deviation =

$$\sigma \log Q = \sqrt{variance}$$

skew coefficient =

$$\frac{n \times \sum_{i}^{n}(\log Q - avg(\log Q))\,\hat{}\,3}{(n-1)(n-2)(\sigma \log Q)\,\hat{}\,3}$$

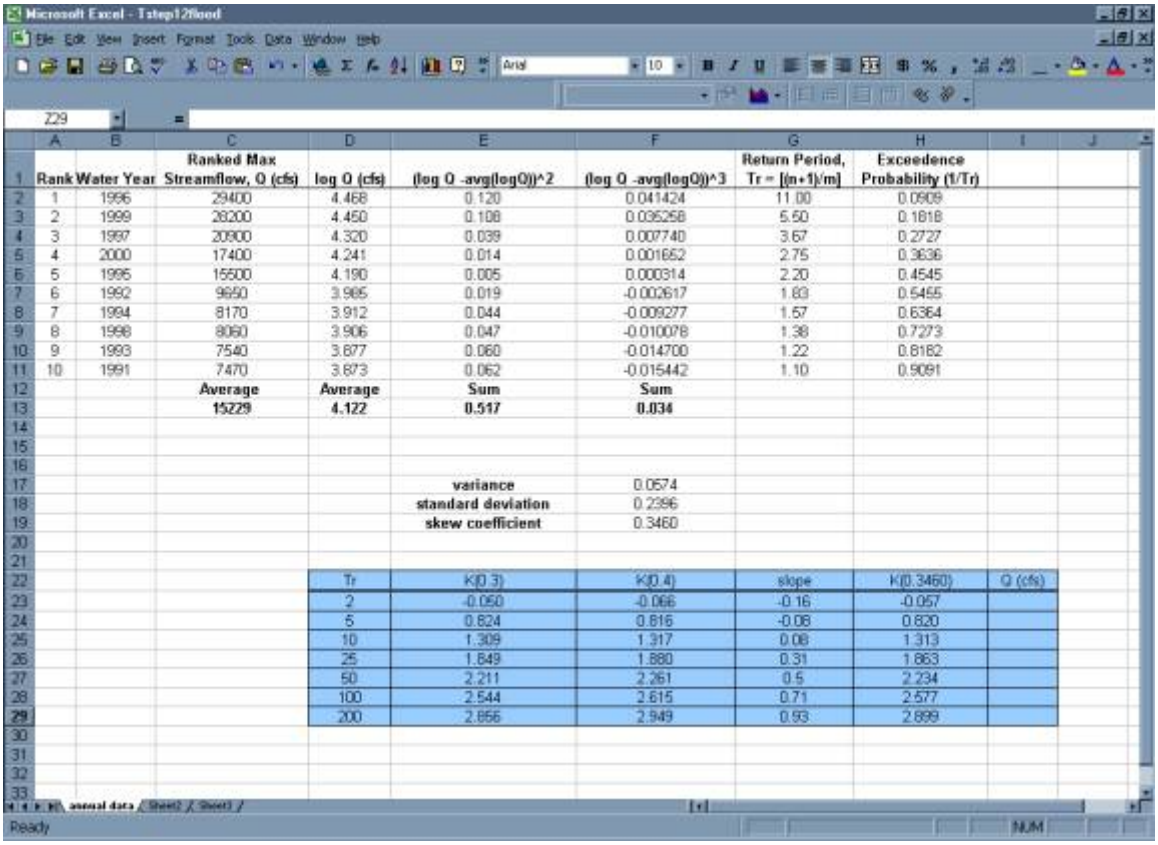


	A	B	C	D	E	F	G	H
1	Rank	Water Year	Ranked Max Streamflow, Q (cfs)	log Q (cfs)	(log Q -avg(logQ))^2	(log Q -avg(logQ))^3	Return Period, Tr = [(n+1)/m]	Exceedence Probability (1/Tr)
2	1	1996	29400	4.468	0.120	0.041424	11.00	0.0909
3	2	1999	28200	4.450	0.108	0.035258	5.50	0.1818
4	3	1997	20900	4.320	0.039	0.007740	3.67	0.2727
5	4	2000	17400	4.241	0.014	0.001652	2.75	0.3636
6	5	1995	15500	4.190	0.005	0.000314	2.20	0.4545
7	6	1992	9650	3.985	0.019	-0.002617	1.83	0.5455
8	7	1994	8170	3.912	0.044	-0.009277	1.57	0.6364
9	8	1998	8060	3.906	0.047	-0.010078	1.38	0.7273
10	9	1993	7540	3.877	0.060	-0.014700	1.22	0.8182
11	10	1991	7470	3.873	0.062	-0.015442	1.10	0.9091
12			Average	Average	Sum	Sum		
13			15229	4.122	0.517	0.034		
17					variance	0.0574		
18					standard deviation	0.2396		
19					skew coefficient	0.3480		

Step 12: Calculate k values

- Use the **frequency factor table** and the skew coefficient to find the **k values** for the 2,5,10,25,50,100, and 200 **recurrence intervals**
- If the skew coefficient is between two given skew coefficients in the table than you can linearly extrapolate between the two numbers to get the appropriate k value. To view the frequency factor table click on the button below.

Show Me



Rank	Water Year	Ranked Max Streamflow, Q (cfs)	log Q (cfs)	(log Q -avg(logQ))^2	(log Q -avg(logQ))^3	Return Period, Tr = [(n+1)/m]	Exceedence Probability (1/Tr)
1	1996	29400	4.468	0.120	0.041424	11.00	0.0909
2	1999	26200	4.450	0.108	0.035256	5.50	0.1818
3	1997	20900	4.320	0.039	0.007740	3.67	0.2727
4	2000	17400	4.241	0.014	0.001652	2.75	0.3636
5	1995	15500	4.190	0.005	0.000314	2.20	0.4545
6	1992	9650	3.985	0.019	-0.002617	1.83	0.5455
7	1994	8170	3.912	0.044	-0.009277	1.57	0.6364
8	1998	8060	3.906	0.047	-0.010078	1.38	0.7273
9	1993	7540	3.877	0.060	-0.014700	1.22	0.8182
10	1991	7470	3.873	0.062	-0.015442	1.10	0.9091
		Average	Average	Sum	Sum		
		15229	4.122	0.517	0.034		

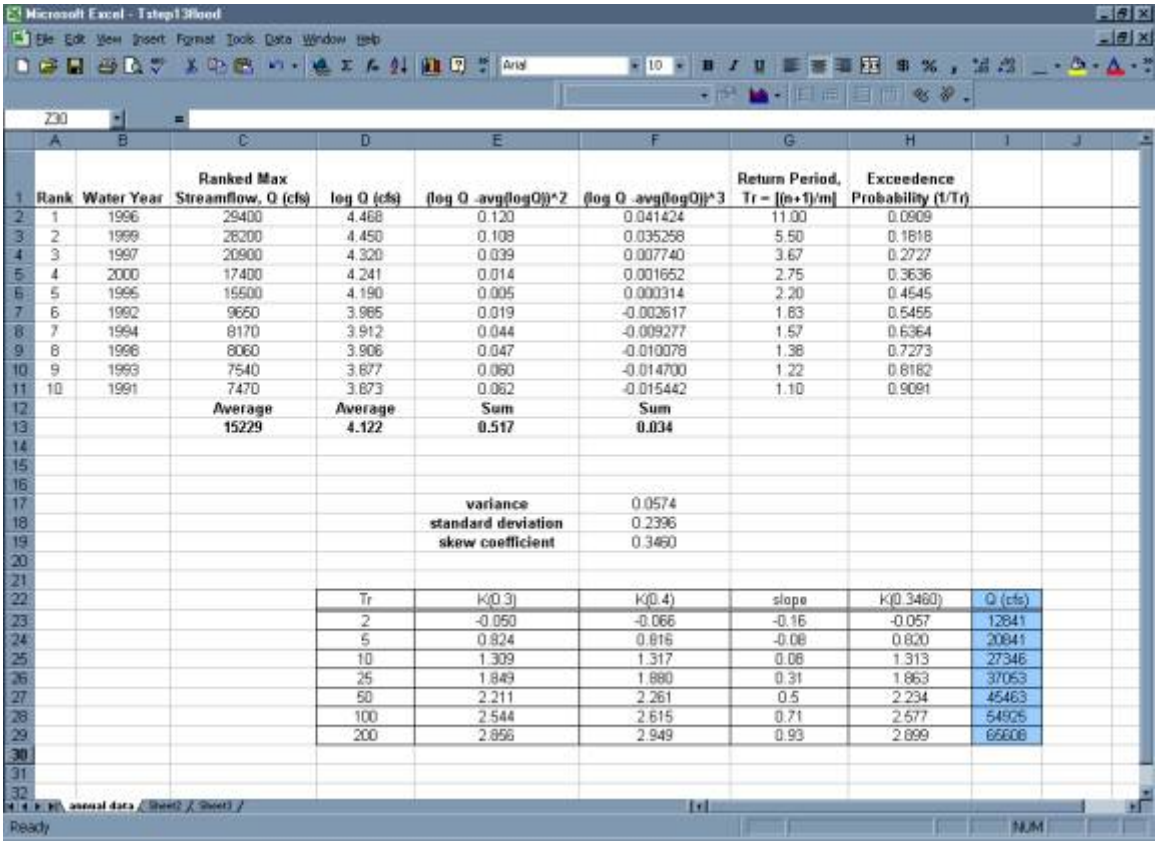
variance	0.0574
standard deviation	0.2396
skew coefficient	0.3460

Tr	K(0.3)	K(0.4)	slope	K(0.3460)	Q (cfs)
2	-0.050	-0.066	-0.16	-0.057	
5	0.824	0.816	-0.08	0.820	
10	1.309	1.317	0.08	1.313	
25	1.849	1.880	0.31	1.863	
50	2.211	2.261	0.5	2.234	
100	2.544	2.615	0.71	2.577	
200	2.856	2.949	0.93	2.899	

Step 13: Using the general equation, list the discharges associated with each recurrence interval

general equation =

$$\log QTr = avg(\log Q) + [K\ (Tr, Cs)] \times \sigma \log Q$$

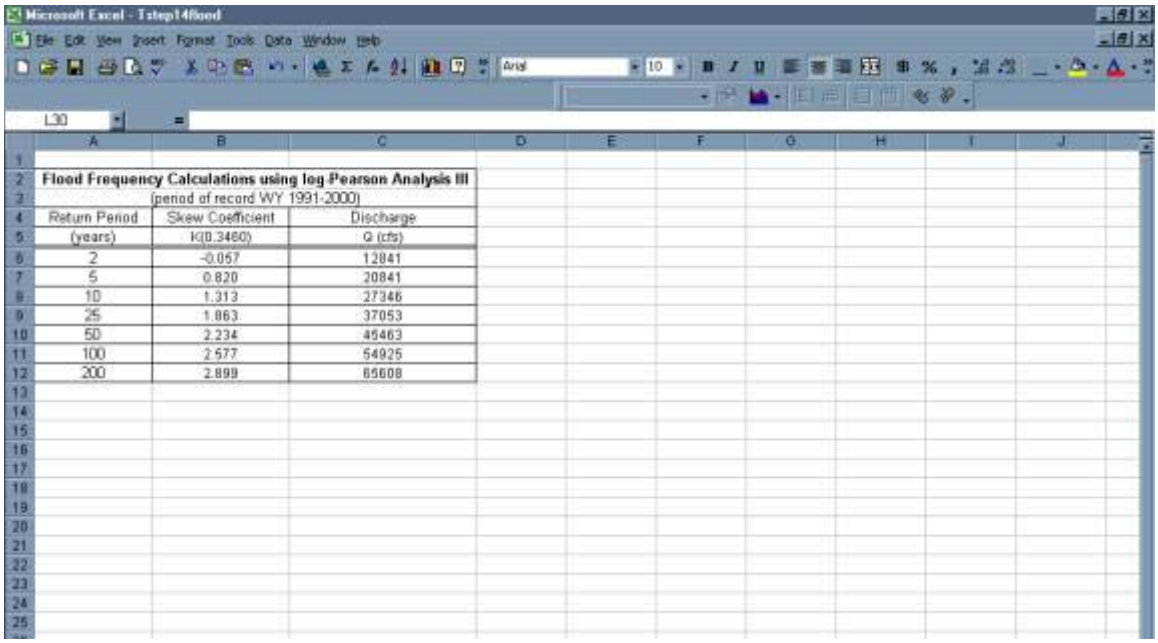


Rank	Water Year	Ranked Max Streamflow, Q (cfs)	log Q (cfs)	(log Q -avg(logQ))^2	(log Q -avg(logQ))^3	Return Period, Tr = [(n+1)/m]	Exceedence Probability (1/Tr)
1	1996	29400	4.468	0.120	0.041424	11.00	0.0909
2	1999	28200	4.450	0.108	0.035258	5.50	0.1818
3	1997	20900	4.320	0.039	0.007740	3.67	0.2727
4	2000	17400	4.241	0.014	0.001652	2.75	0.3636
5	1995	15500	4.190	0.005	0.000314	2.20	0.4545
6	1992	9650	3.985	0.019	-0.002617	1.83	0.5455
7	1994	8170	3.912	0.044	-0.009277	1.57	0.6364
8	1998	8060	3.906	0.047	-0.010078	1.38	0.7273
9	1993	7540	3.877	0.060	-0.014700	1.22	0.8182
10	1991	7470	3.873	0.062	-0.015442	1.10	0.9091
		Average	**Average**	**Sum**	**Sum**		
		15229	**4.122**	**0.517**	**0.034**		

variance	0.0574
standard deviation	0.2396
skew coefficient	0.3460

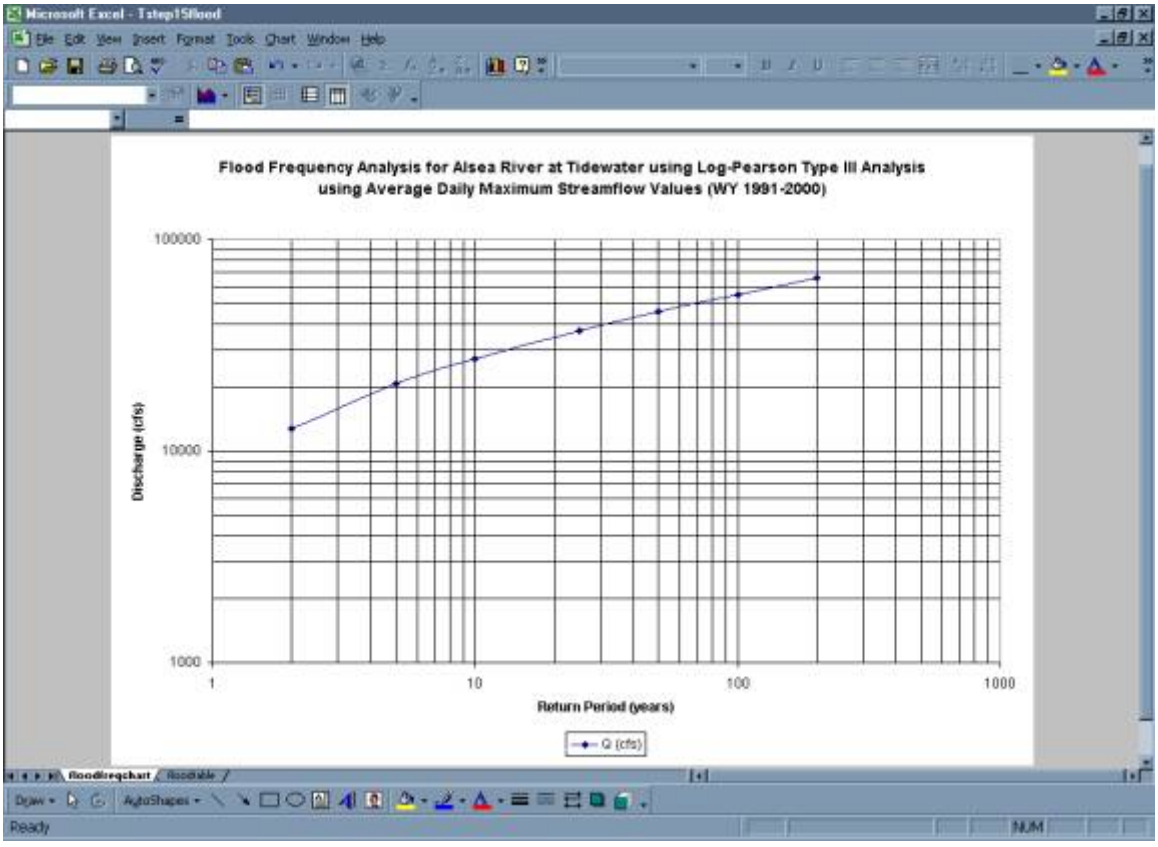
Tr	K(0.3)	K(0.4)	slope	K(0.3460)	Q (cfs)
2	-0.050	-0.066	-0.16	-0.057	12841
5	0.824	0.816	-0.08	0.820	20841
10	1.309	1.317	0.08	1.313	27346
25	1.849	1.880	0.31	1.863	37053
50	2.211	2.261	0.5	2.234	45463
100	2.544	2.615	0.71	2.577	54926
200	2.856	2.949	0.93	2.899	65608

Step 14: Create table of Discharge values found using the log – Pearson analysis



Flood Frequency Calculations using log Pearson Analysis III (period of record WY 1991-2000)		
Return Period (years)	Skew Coefficient K(0.3460)	Discharge Q (cfs)
2	-0.057	12841
5	0.820	20841
10	1.313	27346
25	1.863	37053
50	2.234	45463
100	2.577	54925
200	2.899	65608

Step 15: Create Plot



- Below is a comparison of flood frequency analysis completed using mean daily data versus instantaneous discharge data. As can be seen, had you completed this analysis using instantaneous peak discharge data, the result would have been a more conservative estimation of the discharges associated with each return period.