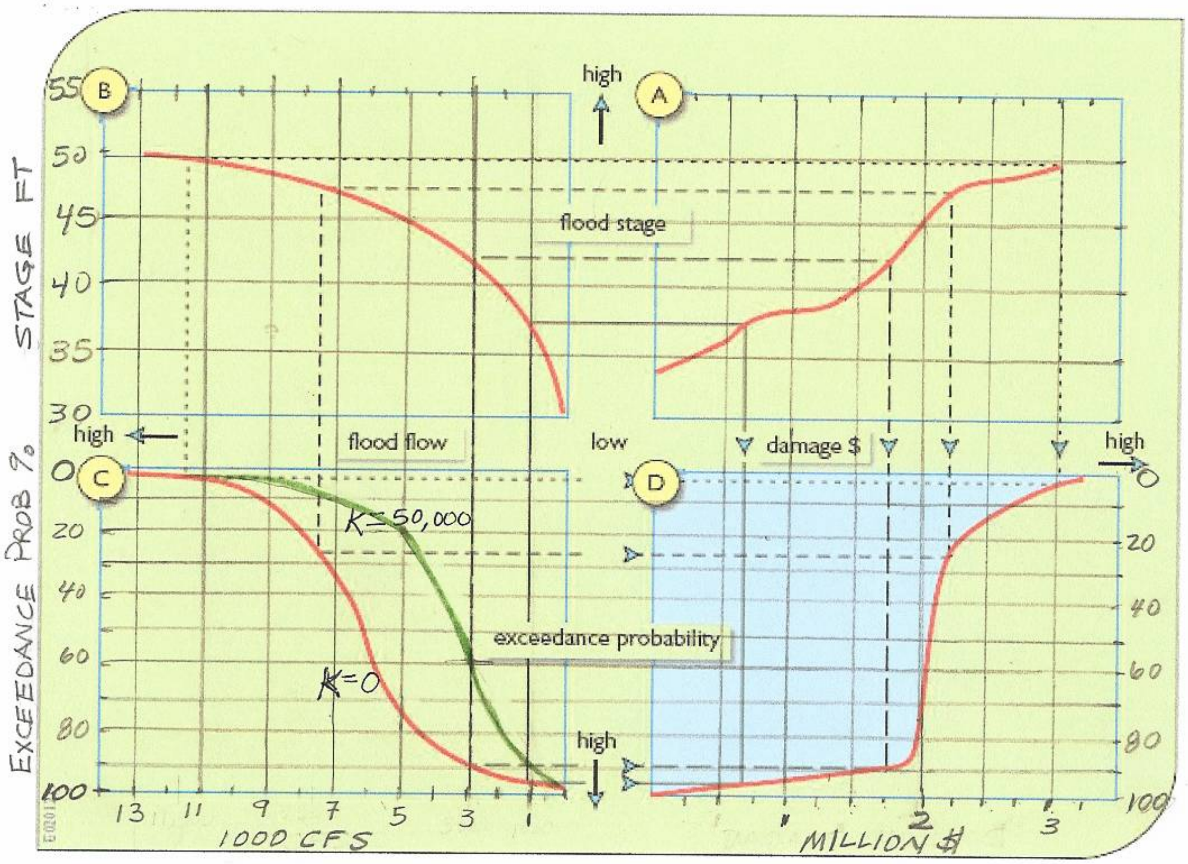
PROBLEM #1



The figure above shows the calculation of the probability of annual flood damage (quadrant D) derived from the expected stage-damage function (quadrant A), based on the stage-flow relationship (B) for the flood with expected probablility of exceeding an annual peak flow (C).

According to the data for Little City on the Big River (represented by the red lines), there is a 75% chance each year that the flood damage will equal or exceed $2M.

What flood stage is associated with this probability? What flood flow? What is the return period associated with the flow? (Show on the plot how you got your answers.)

[Note: The likelihood of a flood peak of a given magnitude or greater is often defined by its expected return period, T. How many years would one expect to wait, on average, to observe another flood equal to or greater than some specified magnitude? This is the reciprocal of the probability of observing such a flood in any given year. A *T*-year flood has a probability of being equalled or exceeded in any year of 1/*T*. For example, a 25-year flood has a probability of being equaled or exceeded in any given year of 1/25 or .04 or 4%.]

Because of frequent floods, it has been decided to build a flood control dam on the Big River upstream of Little City. It has been determined that a 50,000 acre-ft reservoir reduce flood risk to an acceptable level. The new flood frequency plot, with the reservoir in place, is shown by the green curve.

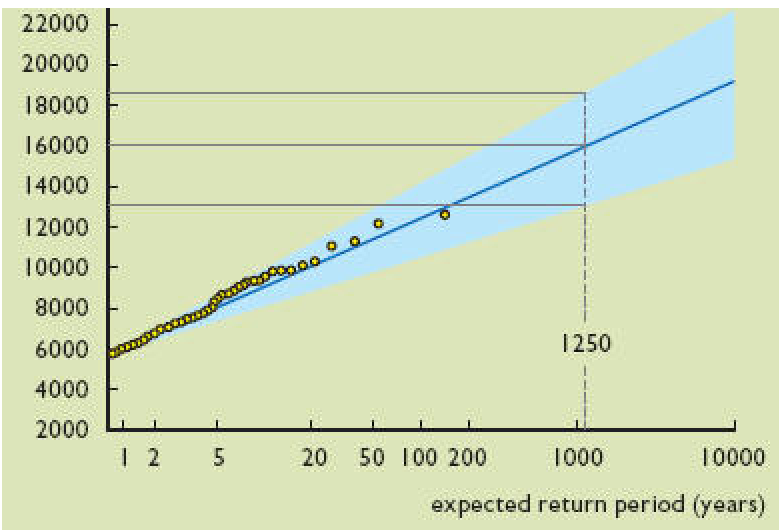
By how much has the flow been reduced for the 75% exceedance probability? What is the new expected cost of damage at that probability? What flood stage is associated with that probability? (Show on the plot how you got your answers.0

PROBLEM 2

The spillway for the Big River Dam (see Problem 1) is being designed with an ungated spillway crest at elevation 80 ft. The probable maximum flood is based on a return period of 10,000 years and has been determined to be 19,000 cfs. However, there is significant uncertainty in that value. The figure below shows the 98% confidence level in blue.

In order for the spillway to pass the instantaneous 10,000-Yr peak flow with 98% certainty, what value of Q should it be designed to pass?

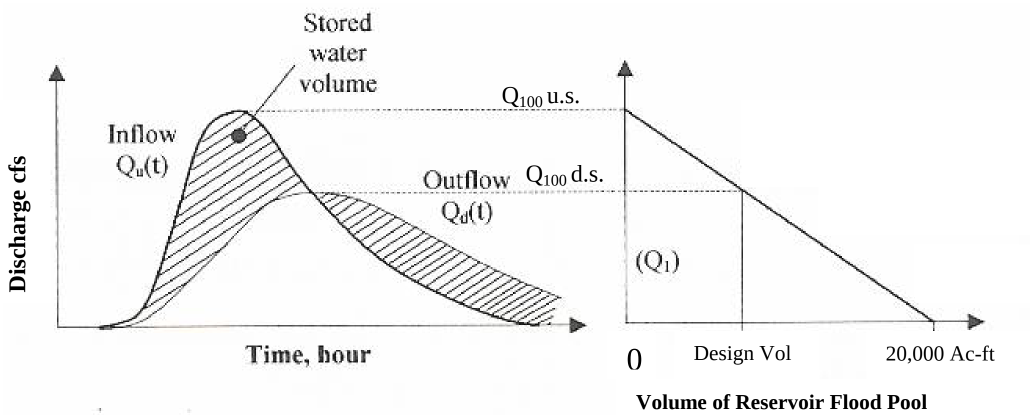
(Disregard the data on the plot for T=1250, as it is not relevant to this problem.)



The spillway is designed for a length of 70 ft and has a coefficient of discharge of 3.8 (assuming the weir equation is using units of cfs and feet). What should the elevation of the top of the dam be? (Include minimum freeboard designed for a fetch of 5 miles.)

PROBLEM 3

The flood pool of the Big River Reservoir is designed to reduce the outflow of the 100-year flood, Q_{100}, as indicated in quadrant A of the figure in Problem 1. The figure on the left below depicts the reduction of the peak of the 100 year flood downstream of the dam, with the high peak being before the dam was built and the lower peak the post-dam 100-year flood downstream. (It also represents the transformation of the 100-yr flood hydrograph as it passes through the reservoir.) The storage efficiency curve on the right shows flood release as a function of flood pool volume for the 100-yr flood. For a flood release of Q_{100}, the required volume is zero. For a flood release of zero, the required volume is the entire volume of the 100-yr hydrograph, which has been determined to be 20,000 acre-ft.



From this plot, determine the size of the flood pool required for Big Reservoir.

Show all your calculations.

(This is a "back of the envelope" calculation since you are estimating numbers that you pick off the plots visually. The answer will not be exact, but you should be clear about where you got all your numbers.)

PROBLEM 4 (For CVEN 5838 credit only)

A reservoir will have an uncontrolled spillway crest at El 1071 m.
The coefficient of discharge is 1.7 and the exponent is assumed to be 1.5.

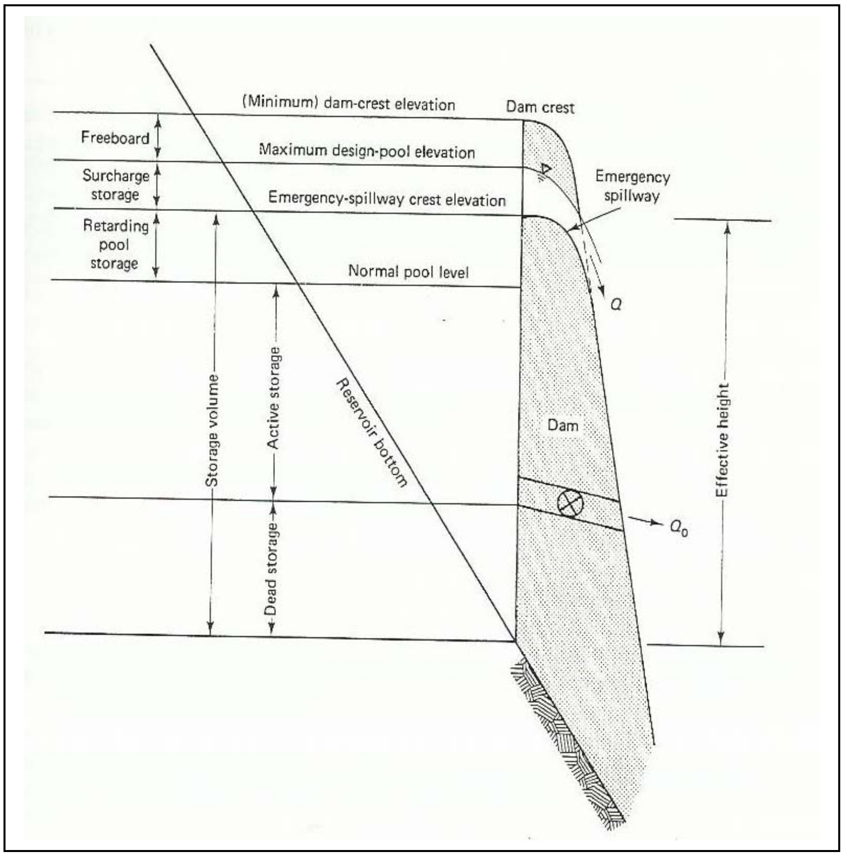
The top of the conservation pool (bottom of flood storage pool) is at 1070.
The reservoir's area-elevation relationship is:

Area = 100 ha at Elev 1070 and increases by 0.1 ha per meter increase in Elevation

The design calls for the initial elevation to be at the top of the conservation pool when the design flood commences.

The spillway design hydrograph is as follows with the base flow of 17 continuing at t=20.

Time hrs	Inflow cms
0	17
1	20
2	50
3	90
4	140
5	200
6	240
7	230
8	215
9	190
10	165
11	130
12	105
13	85
14	65
15	50
16	35
17	25
18	20
19	17
20	17



What spillway crest length is required to limit the maximum downstream Q to 100 cms?
What is the max pool level?
(See spreadsheet program StorageIndicationProgram_HW2_Prob4.xls)
How sensitive is the solution to the coefficient of discharge?
How sensitive is the solution to the crest length?