CHAPTER 11

FREQUENCY OF COINCIDENT FLOWS

11-1. Introduction. In many cases of hydrologic design, it is necessary to consider only those events which occur coincidentally with other events. For example, a pump station is usually required to pump water only when interior runoff occurs at a time that the main river stage is above interior ponding levels. In constructing a frequency curve of interior runoff that occurs only at such times, data selected for direct use should be limited to that recorded during high river stages. In some cases, such data might not be adequate, but it is possible in these cases where the two types of events are not highly correlated to make indirect use of noncoincident data in order to establish a more reliable frequency curve of coincident events.

11-2. A Procedure for Coincident Frequency Analysis.

a. Objective. Determine an exceedance-frequency relationship for a variable C. Variable C is a function of two variables, A and B.

b. Selection of Dominant Variable. The variable that has the largest influence on variable C is designated as variable A; the less influential variable is designated as variable B. The significance of "influential" will be indicated by means of an example. Figure 11-1 shows water surface profiles along a tributary near the junction with a main river. Stage on the tributary (variable C) is a function of main river stage and tributary discharge. In Region I, main river stage, will tend to have the dominant influence on tributary stage, whereas in Region II, tributary discharge will tend to dominate. The boundary between Regions I and II cannot be precisely defined and will vary with exceedance frequency. Stage-frequency determinations will be least accurate in the vicinity of the boundary where both variables have a substantial impact on the combined result.

c. Procedure.

(1) Construct a duration curve for variable B. Discretize the duration curve with a set of "index" values of B. Index values should represent approximately equal ranges of magnitude of variable B. The area under the resulting discretized duration curve should equal the area under the original duration curve. The number of index values of B required for discretization depends on the range of variation of B and the sensitivity of variable C to B. Therefore, the number of points selected should adequately define the relationships.

(2) For each of the index values of variable B, develop a relationship between variable A and the combined result C. In the illustration (Figure 11-1) the relationship linking variables A, B and C would be obtained with a set of water surface profile calculations for various combinations of main river stage and tributary discharge.

(3) If variables A and B are independent of each other, construct an exceedance-frequency curve of variable A. If the variables are not independent,

construct a conditional exceedance-frequency curve of variable A for each index value of variable B.

(4) Using the relationship developed in step (2) and frequency curve(s) developed in step (3), construct a conditional exceedance-frequency curve of variable C for each index value of variable B.

(5) For a selected magnitude of variable C, multiply the exceedance-frequencies from each curve developed in step (4) by the corresponding proportions of time represented, and sum these products to obtain the exceedance-frequency of variable C. Repeat this step for other selected magnitudes of C until a complete exceedance-frequency curve for variable C is defined. This step is an application of the total probability theorem.

d. Seasonal Effects. The duration of frequency curves from steps (1) and (3) are assumed to represent stationary processes. That is, it is assumed that probabilities and exceedance frequencies obtained from the curves do not vary with time. In order for this assumption to be reasonably valid, it is generally necessary to follow the above procedure on a seasonal basis. Once seasonal exceedance-frequency curves have been obtained (step e), they may be combined to obtain an all-season exceedance-frequency curve.

e. Assumption of Independence. Although step (3) enables application of the procedure to situations where variables A and B are not independent, data is generally not available to establish the conditional exceedance frequency curves required by that step. Consequently, application of the procedure presented here is generally limited to situations where it is reasonable to assume that variables A and B are independent.

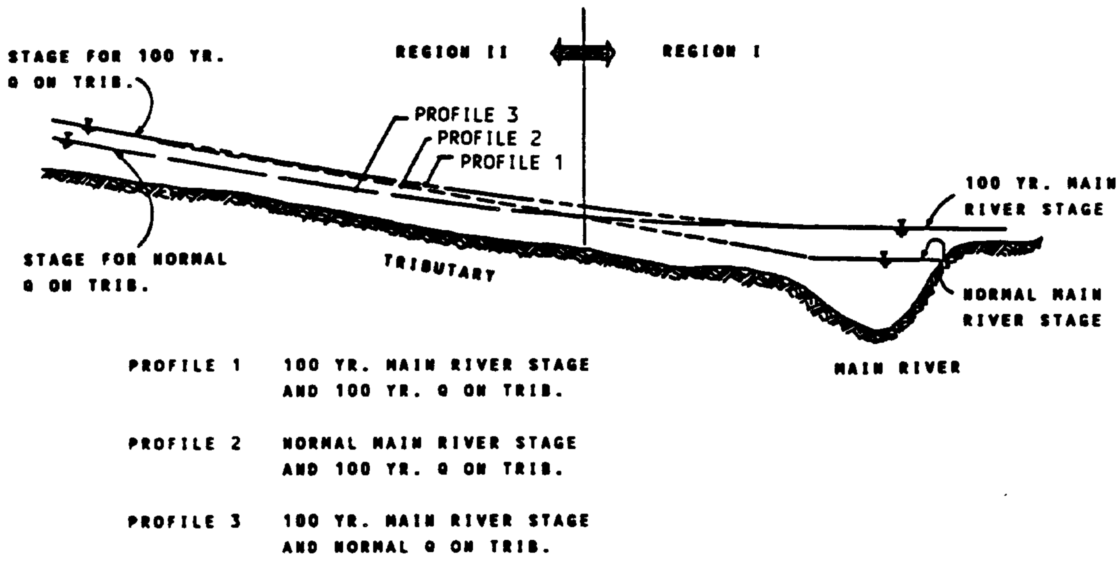

Figure 11-1. Illustration of Water Surface Profiles in Coincident Frequency Analysis.