PRACTICABLE HYDROLOGIC CONSIDERATIONS FOR FLOOD-CONTROL STORM-SEWER DESIGNS IN MISSISSIPPI

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Introduction

The hydrologic aspects of the design of the hydraulic facilities for stormwater management are worthy of careful, detailed considerations. The liabilities that have been associated with damages resulting from some relatively recent hydraulic designs have made it desirable for the designer to create systems that will perform to higher standards than might have been selected in the past. Practitioners should continue the practice of designing the convenience system of drainage facilities to minimize flooding nuisance. Now they also must consider the convenience system and how it will function as a part of the major drainage system of an area during the occurrence of major storm events whose annual likelihoods of occurrence are smaller than ten percent. Designers must select the appropriate storm recurrence interval for their application, and then they must have access to storm intensity, duration, and frequency data for their particular site location. The rainfall data for use in such designs are available in broad form from applicable National Weather Service (NWS), National Oceanic and Atmospheric Administration (NOAA) studies.

Those NWS studies are based upon the data from all of the rainfall-observation stations of long record that are pertinent to the geographic areas to which each report pertains. The data analyses and syntheses of those reports have yielded isopluvial maps that provide statistical predictions of pertinent rainfall amounts for areas among rainfall-gaging stations even though they did not contain such stations of long record at every point of possible interest. The more than a hundred pages of those reports preserve the essence of the pertinent rainfall data that are available for the United States, but the information is not in such form or condition that allows its use by Mississippi designers most easily.

The authors used data and algorithms supplied in those studies to develop intensity-frequency-duration rainfall data for ten Mississippi cities. The cities were selected to cover the state geographically and to give preference to centers of population to the extent possible.

Information Sources

The senior author first encountered the need for rainfall-intensity-duration-frequency data about thirty years ago and was delighted to discover the Weather Bureau *Technical Paper No. 25*[1] (TP-25). It contained the essence of the long-term rainfall information that had been collected at the major weather observation stations in the area. Those were the only stations that had been gathering rainfall data for such detailed observation durations as 5 minutes. Those observation stations were located at the major airports such as New Orleans, Mobile, Shreveport, Jackson, Montgomery, Little Rock, Memphis, Nashville, and Birmingham. Data from those stations had been analyzed, and intensity-duration curves had been prepared for frequency probabilities annually likely of 50%, 20%, 10%, 4%, 2%, and 1% which are equivalent respectively to average return periods of 2 years, 5 years, 10 years, 25 years, 50 years, and 100 years. The storm durations covered by the curves spanned the range of 5 minutes to 24 hours.

A few years later, as digital computers became available to a greater degree, Hershfield[2] produced the Weather Bureau *Technical Paper No. 40*. In it he worked with the data from TP-25 for storms of longer durations, 30 minutes to 24 hours. The format in which he presented the results of his work was an isopluvial map of rainfall amounts for a storm of selected duration and frequency. The physical size of the report was large enough to allow the maps to be about 15 inches wide so that on the county-outline map of the United States the location of an individual county could be discerned by its shape among the other counties. Separate maps for 7 storm durations and for 7 frequencies constituted an atlas comprising 49 such isopluvial maps.

About 2 decades after the publication of TP-25, Frederick et al.[3] prepared the National Weather Service *NOAA Technical Memorandum NWS HYDRO-35* (HYDRO-35). Like TP-25 it is limited to a certain region of the U.S. Like the TP-40 it uses county-outline isopluvial maps of rainfall amounts for specific durations and frequencies to present the results of its data analyses and relationship syntheses. Unlike TP-40, in presenting information for 5 storm durations and for 6 frequencies, it provides maps for only 3 storm durations and for only 2 frequencies. However, along with these 6 rainfall-amount isopluvial maps equations have been provided to allow interpolation among amounts from these 6 maps for the values that would have appeared upon the other 24 maps had the inferred atlas been presented in full in the publication. The maps presented in HYDRO-35 are for durations of 5 minutes, 15 minutes, and 60 minutes and for frequencies equivalent to average return periods of 2 years and 100 years.

Methodology

The Mississippi cities that were selected for consideration are Clarksdale, Columbus, Greenville, Gulfport, Hattiesburg, Jackson, Meridian, Natchez, Tupelo, and Vicksburg. The values herein reported for these cities are satisfactory for application for the nearby counties that surround them.

Figure 1 is a typical spreadsheet computation table with summary graphs of rainfall amounts and intensities for the various durations and frequencies. It is for Clarksdale. The upper approximately one third of the figure contains rainfall amounts from TP-40 and HYDRO-35. The TP-40 values fill the rightmost portion of the area and were read directly from the maps of TP-40. The data filling the leftmost portion of the area are from HYDRO-35. The values read from HYDRO-35 maps are for the 2-year and the 100-year average return periods and are for the durations of 5 minutes, 15 minutes, and 60 minutes. The remaining values for HYDRO-35 were computed in the spreadsheet using the mathematical models from HYDRO-35.

For the durations of 30 minutes and 60 minutes values are shown from both TP-40 and HYDRO-35. Such values are in excellent agreement. The values from the more recent work, HYDRO-35, have been preferred in this work for further use.

The middle third of the figure contains selected preferred values of rainfall amounts in a top half and the computed equivalent rainfall intensities in the bottom half. Graphic representations of the amounts on the left and of the intensities on the right constitute the bottom third of the figure. Table 1 contains such intensities for all 10 of the cities.

Figure 2 is a graph of rainfall intensities for a typical city, Jackson, and is of a size that is large enough to be read easily. It represents the final product of the work herein reported. Similar graphs of the other nine cities are also shown.

Conclusion

The rainfall intensity-duration-frequency graphs that have been prepared for this paper are based upon Weather Bureau and, more recently, National Weather Service rainfall data that have been gathered over more than half a century. This particular work with the data has been performed to make the pertinent information available more easily to the designers who will plan storm drainage facilities for the state of Mississippi.

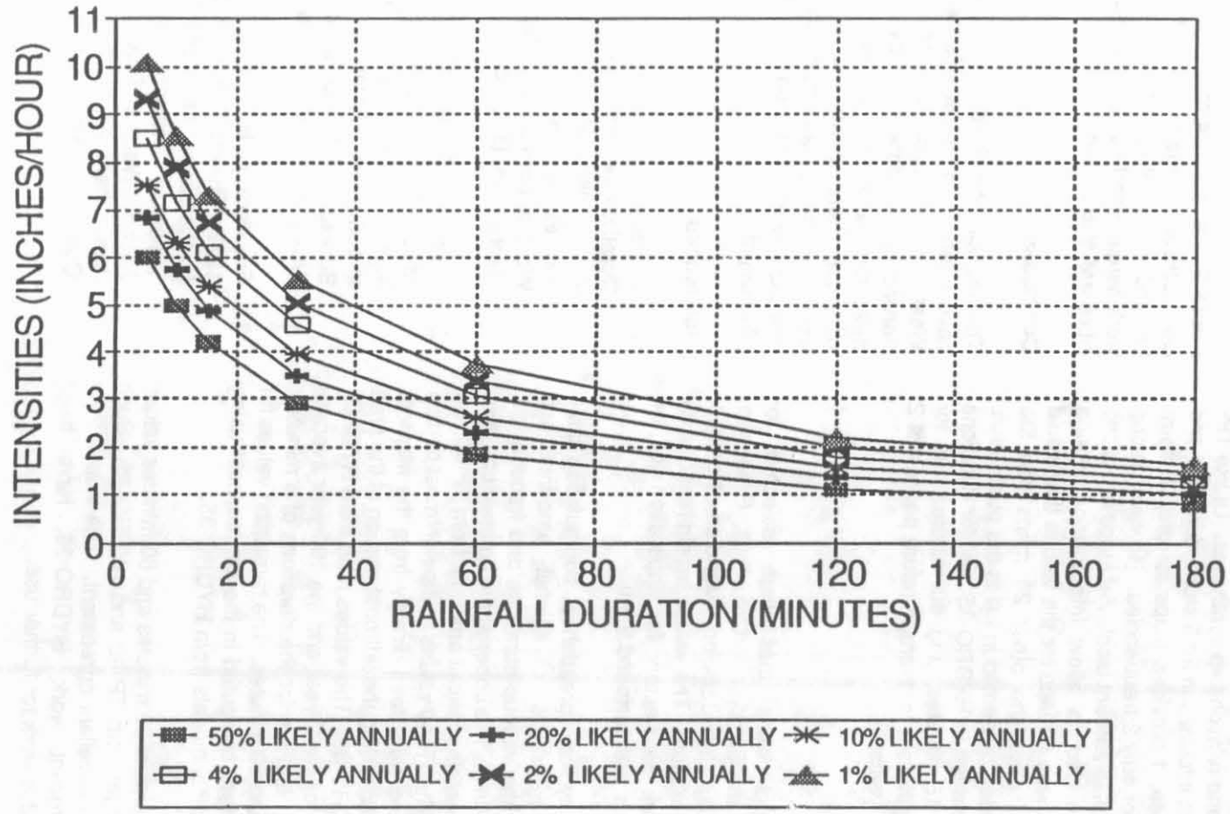
References

1. Weather Bureau, 1955: "Rainfall Intensity-Duration-Frequency Curves for Selected Stations in the United States, Alaska, Hawaiian Islands, and Puerto Rico," *Technical Paper No. 25,* Weather Bureau, U.S. Department of Commerce, Washington, D.C., 53 pp.

2. Hershfield, D. M., 1961: "Rainfall Frequency Atlas of the United States for Durations from 30 Minutes to 24 Hours and Return Periods From 1 to 100 Years," *Technical Paper No. 40,* Weather Bureau, U.S. Department of Commerce, Washington, D.C., 115 pp.

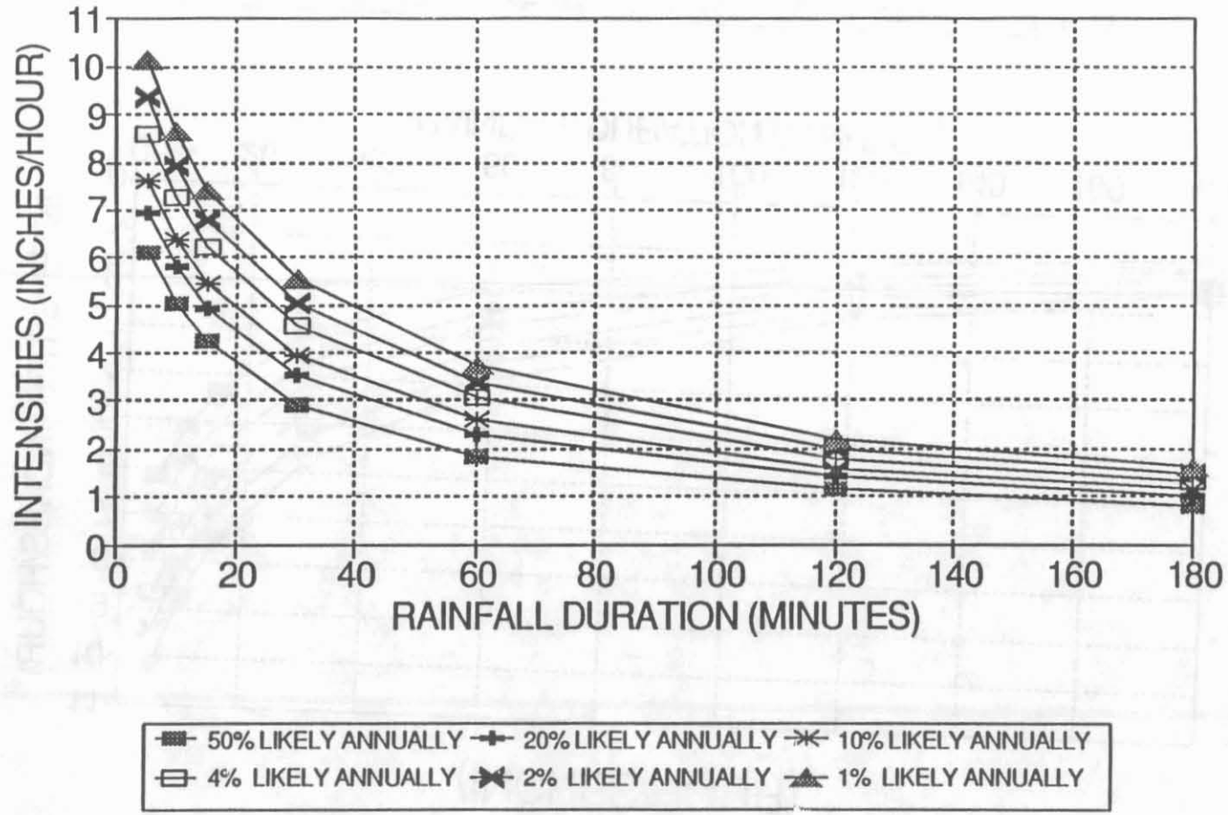
3. Frederick, R. H., V. A. Myers, and E. P. Auciello, 1977: "Five- to 60-Minute Precipitation Frequency for the Eastern and Central United States," *NOAA Technical Memorandum NWS HYDRO-35,* National Weather Service, National Oceanic and Atmospheric Administration, U.S. Department of Commerce, Silver Spring, MD, 33 pp.

RAINFALL INTENSITIES
(INCHES/HOUR)



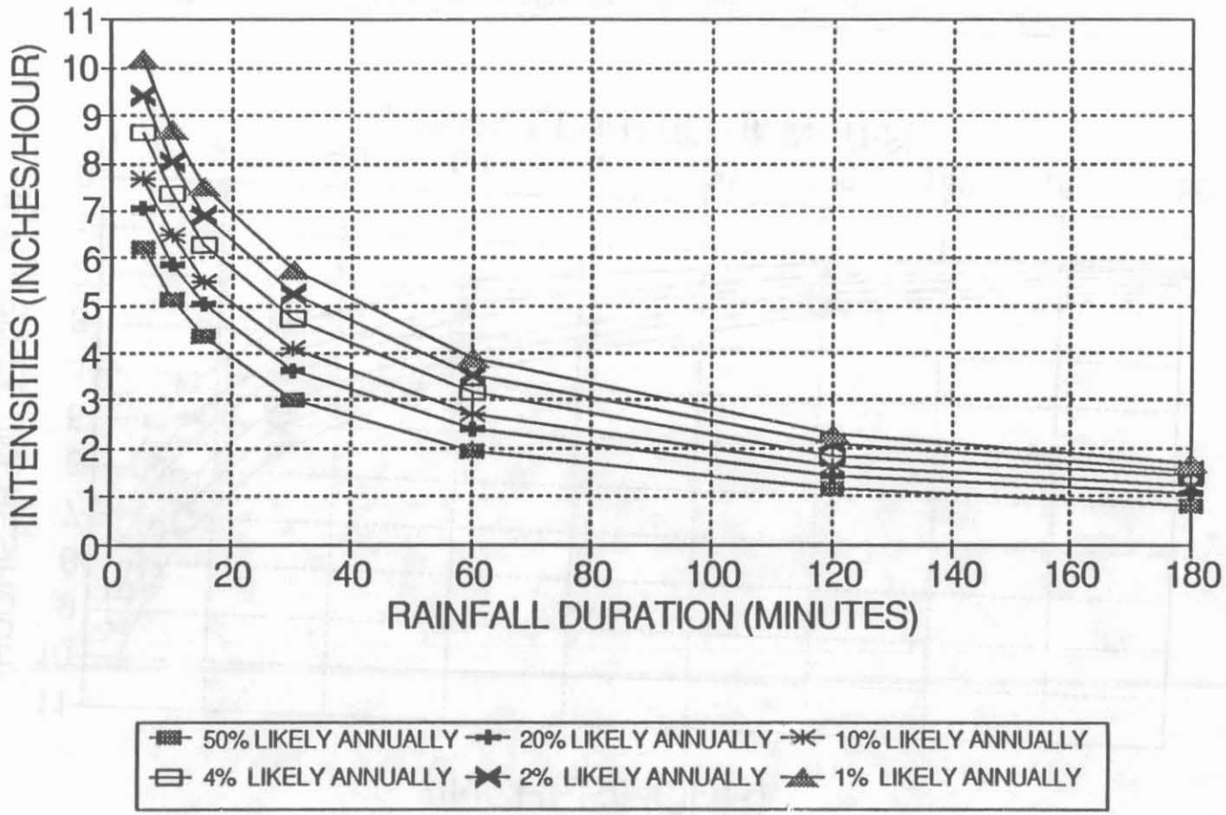
INTENSITY-DURATION-FREQUENCY GRAPH FOR CLARKSDALE

RAINFALL INTENSITIES
(INCHES/HOUR)



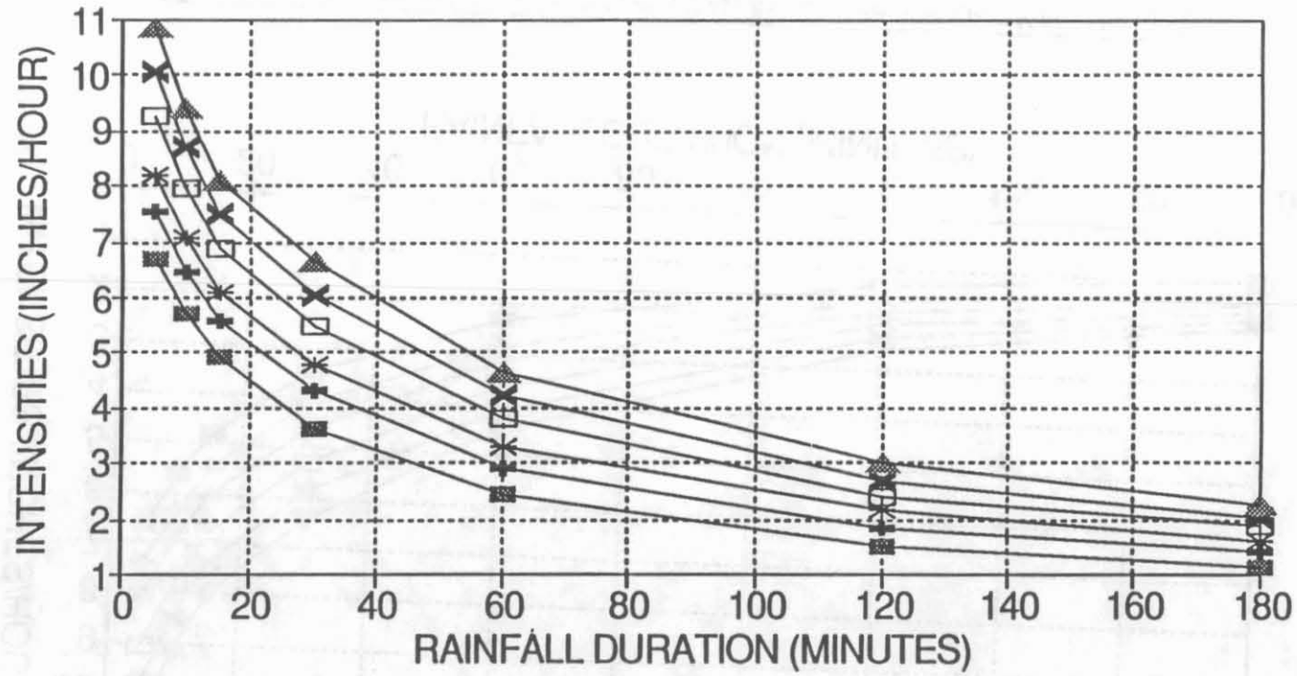
INTENSITY-DURATION-FREQUENCY GRAPH FOR COLUMBUS

RAINFALL INTENSITIES
(INCHES/HOUR)



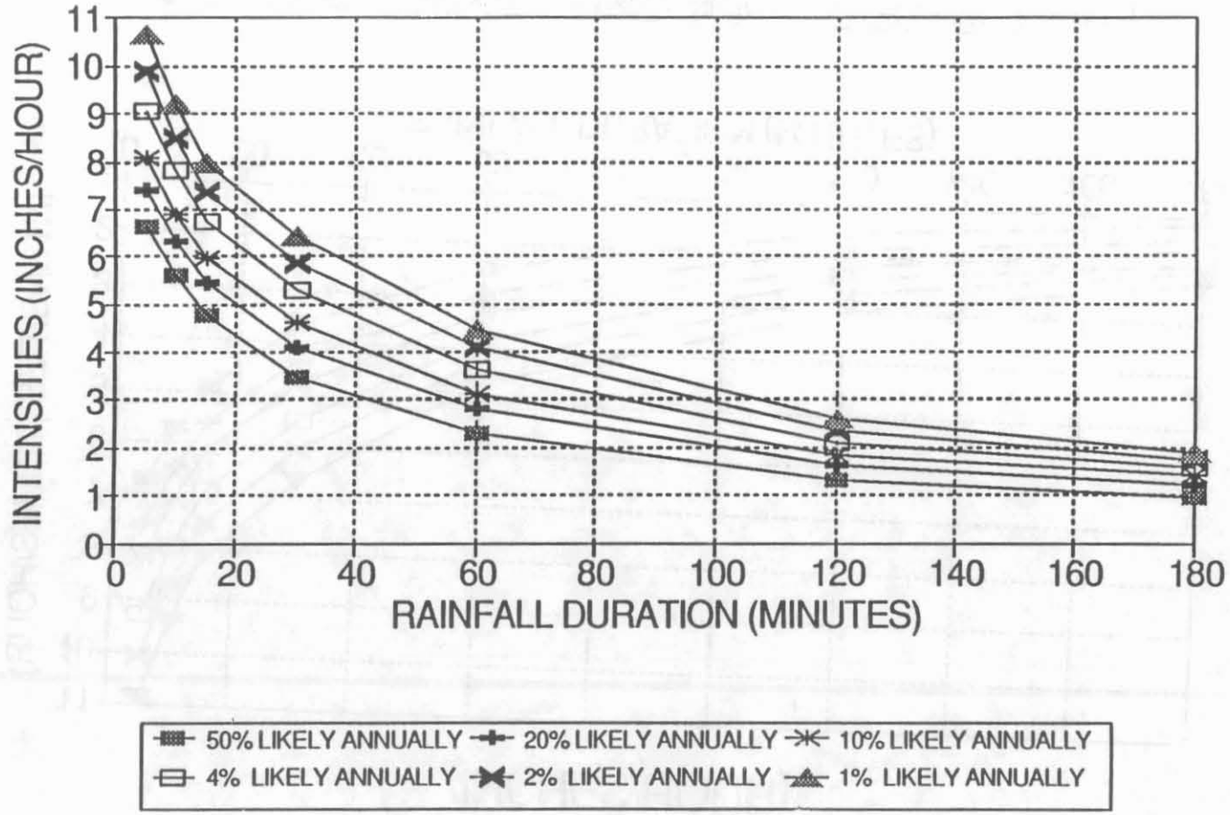
INTENSITY-DURATION-FREQUENCY GRAPH FOR GREENVILLE

RAINFALL INTENSITIES
(INCHES/HOUR)



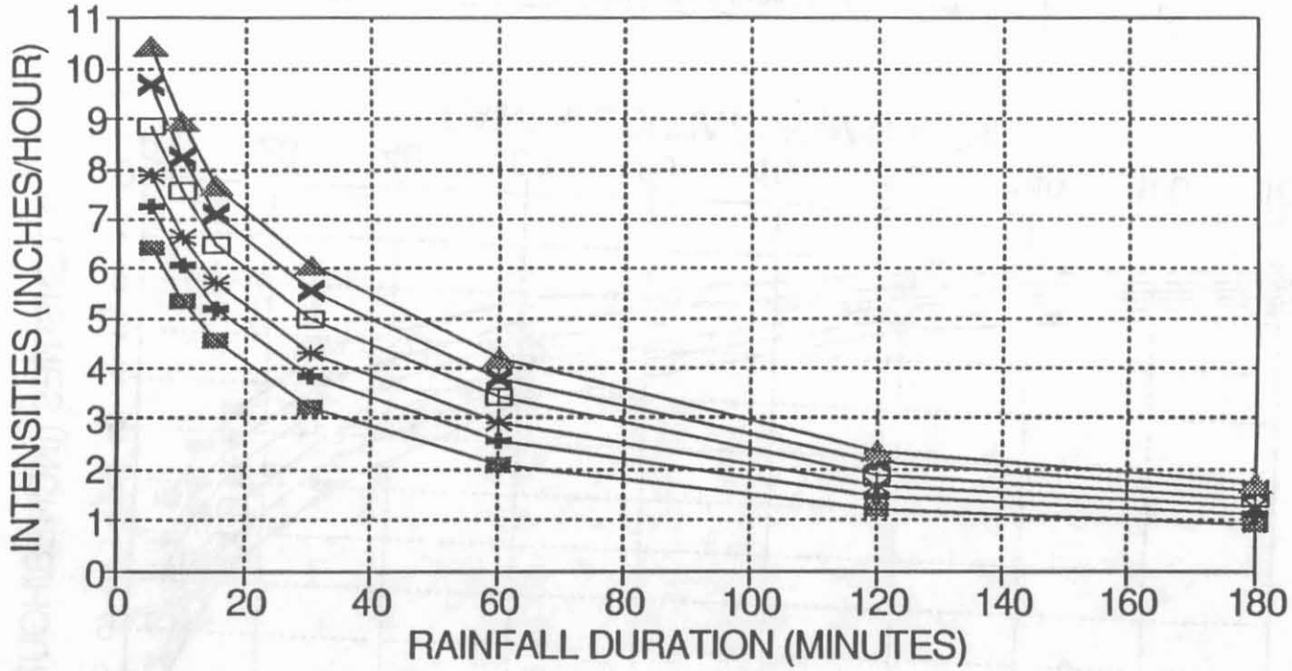
INTENSITY-DURATION-FREQUENCY GRAPH FOR GULFPORT

RAINFALL INTENSITIES
(INCHES/HOUR)



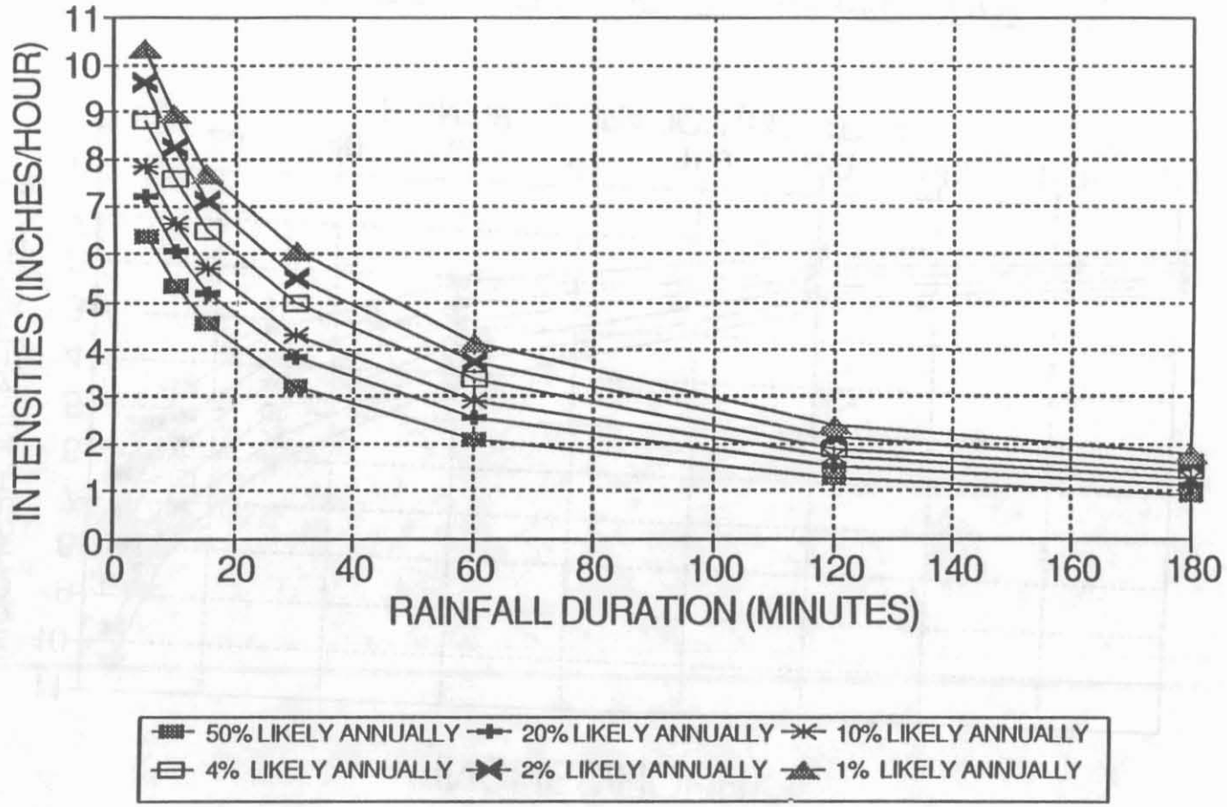
INTENSITY-DURATION-FREQUENCY GRAPH FOR HATTIESBURG

RAINFALL INTENSITIES
(INCHES/HOUR)



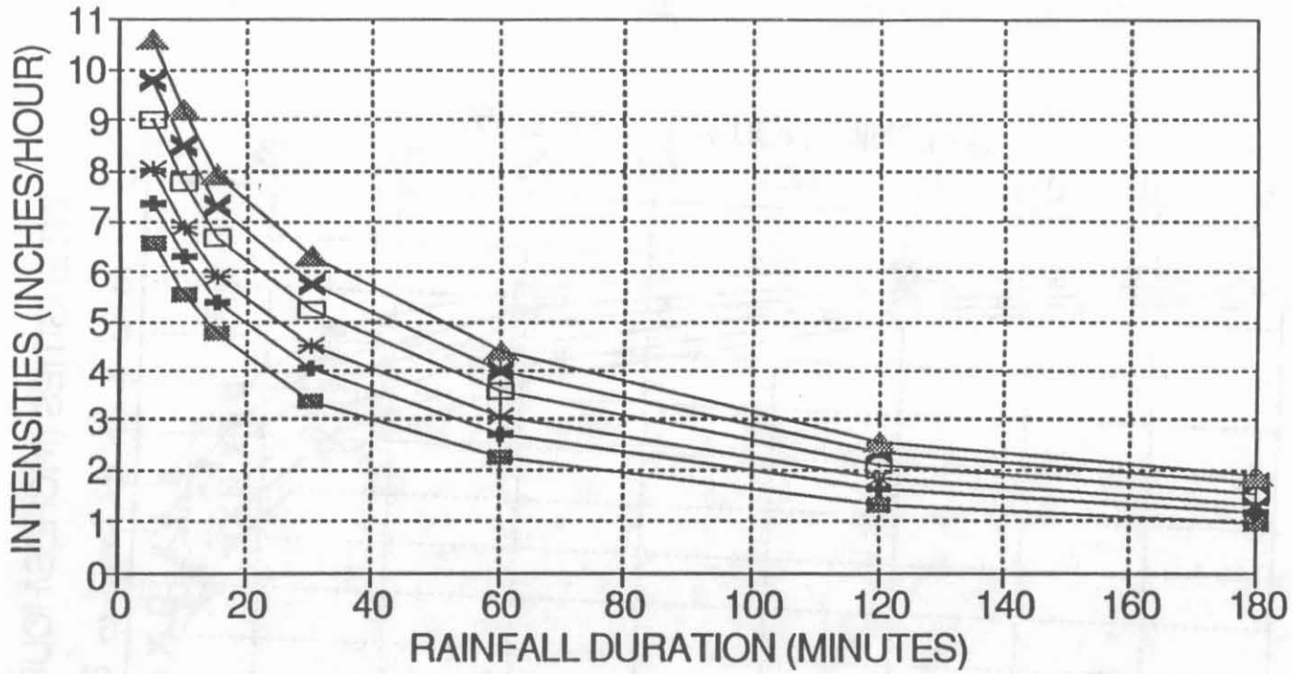
INTENSITY-DURATION-FREQUENCY GRAPH FOR JACKSON

RAINFALL INTENSITIES
(INCHES/HOUR)



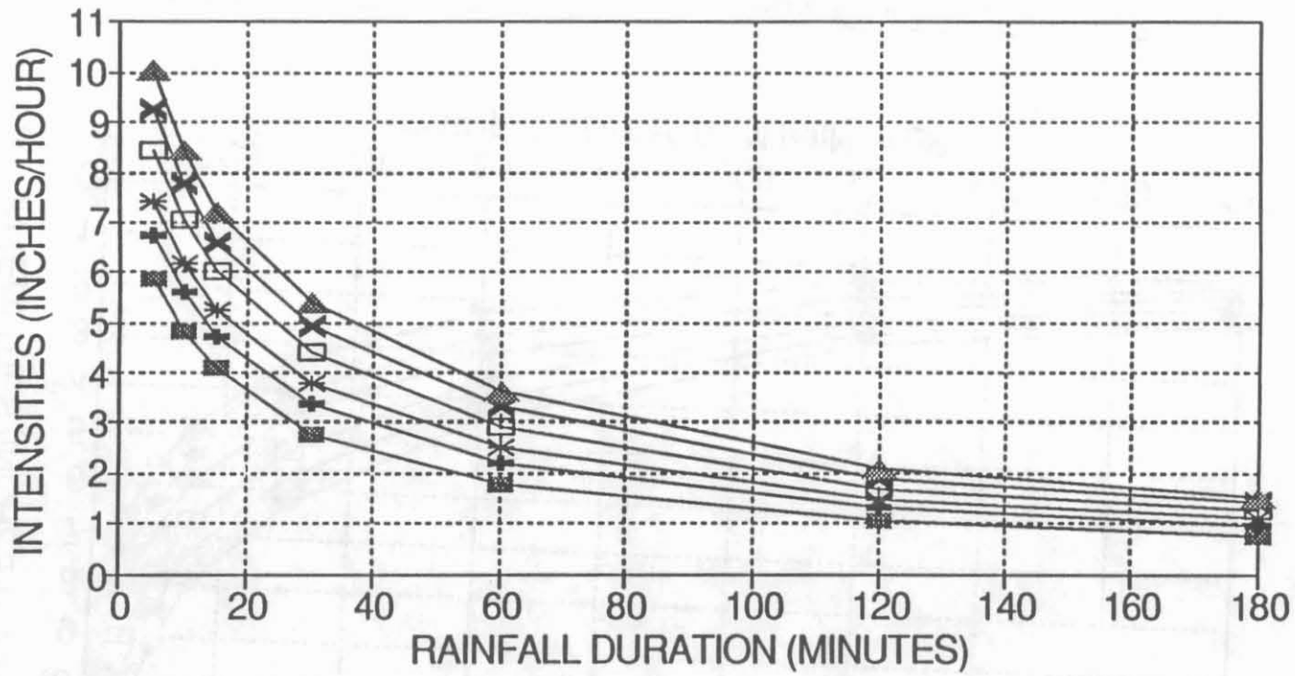
INTENSITY-DURATION-FREQUENCY GRAPH FOR MERIDIAN

RAINFALL INTENSITIES
(INCHES/HOUR)



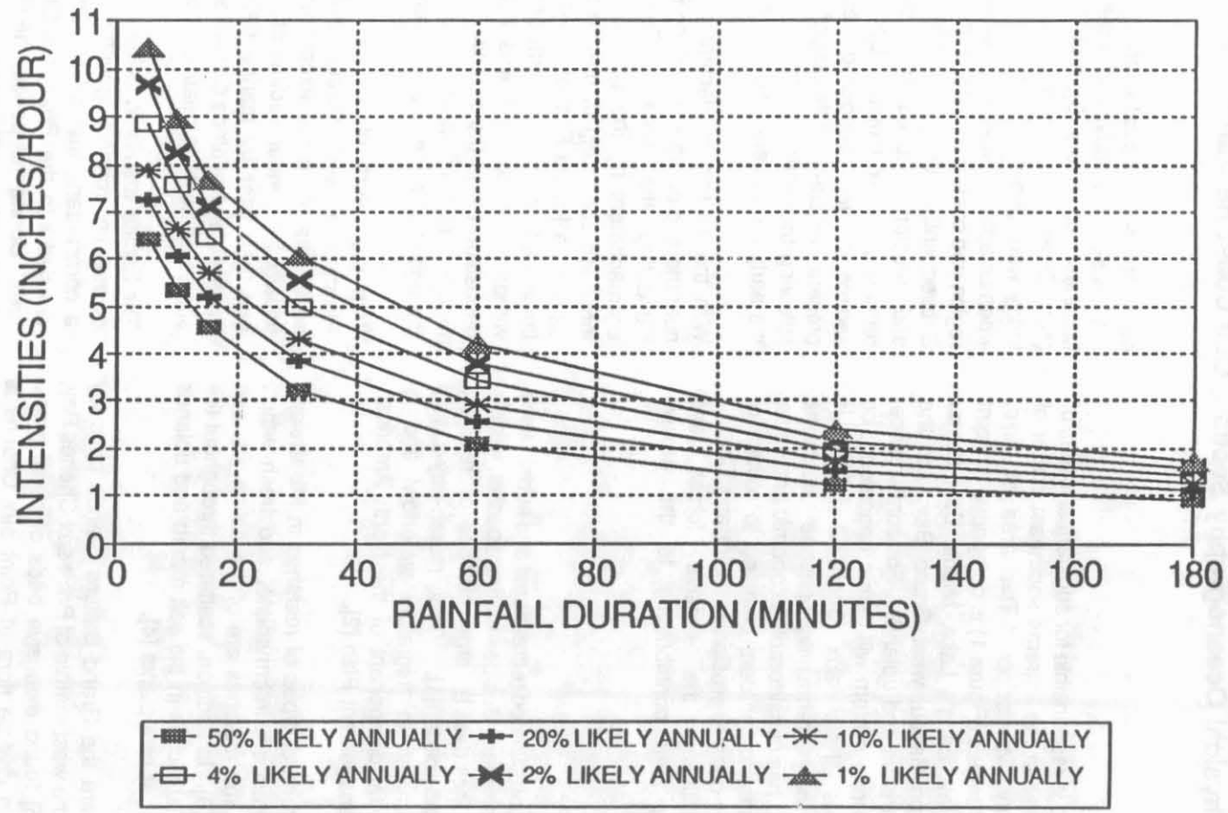
INTENSITY-DURATION-FREQUENCY GRAPH FOR NATCHEZ

RAINFALL INTENSITIES
(INCHES/HOUR)



INTENSITY-DURATION-FREQUENCY GRAPH FOR TUPELO

RAINFALL INTENSITIES
(INCHES/HOUR)



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