DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

PREPARED IN COOPERATION WITH THE
DEPARTMENT OF PUBLIC WORKS
COMMONWEALTH OF PUERTO RICO

HYDROLOGIC INVESTIGATIONS
ATLAS HA-261

FLOODS IN THE PONCE AREA, PUERTO RICO

This Atlas has been prepared to provide factual and interpretive hydrologic information to aid the planner, the designer, or any interested person, to reach more rational decisions related to land use in the Ponce area. Flood data are tabulated, areas of inundation are delineated, and stream flood profiles are shown for the floods of October 13, 1954, and May 6, 1958. Flood-frequency curves are presented from which the magnitude of future floods of selected recurrence intervals can be estimated. Areas of inundation and flood profiles are specifically for valley conditions that existed at the time of the floods. Alterations of channels or flood plains since the 1954 and 1958 floods may affect the extent of inundation, the flood profiles of the streams, and the relation of elevation to discharge. All elevations are given in meters above mean sea level datum.

Flooding in the Ponce area has been the result of overflows from any one or from any combination of three streams: Río Bucaná, Río Portugués, and Río Matilde (formed by the confluence of Ríos Cañas and Pastillo). Areas inundated by the floods of October 13, 1954, and May 6, 1958, are delineated on a topographic base map. The 1954 flood was greater than the 1958 flood on Ríos Bucaná and Portugués, whereas the reverse was true on Ríos Matilde, Cañas, and Pastillo. Greater floods occurred prior to 1954, but not enough data are available to depict areas inundated. Although there are records of floods as early as 1852, the flood of August 8, 1899, was the first for which high-water elevations are known and it was also the greatest in the memory of residents of the area. During the flood of 1899, floodwaters were 1 to 2 meters deep in the streets near Plaza Degetau, the business center of the city of Ponce. The flood of 1954 overtopped the banks of Río Bucaná in the northeastern part of Ponce, flowed southwestward and entered Río Portugués upstream from Highway 133. The flood of 1958 inundated about 10 square miles of residential, industrial, and commercial property and agricultural lands.

Drainage basins.—The streams that cause flooding in the Ponce area drain the southern slopes of the Cordillera Central. The locations of the streams and of the study area are shown in figure 1. The land slopes steeply from the mountain divide to the relatively mild slopes of the coastal plain.

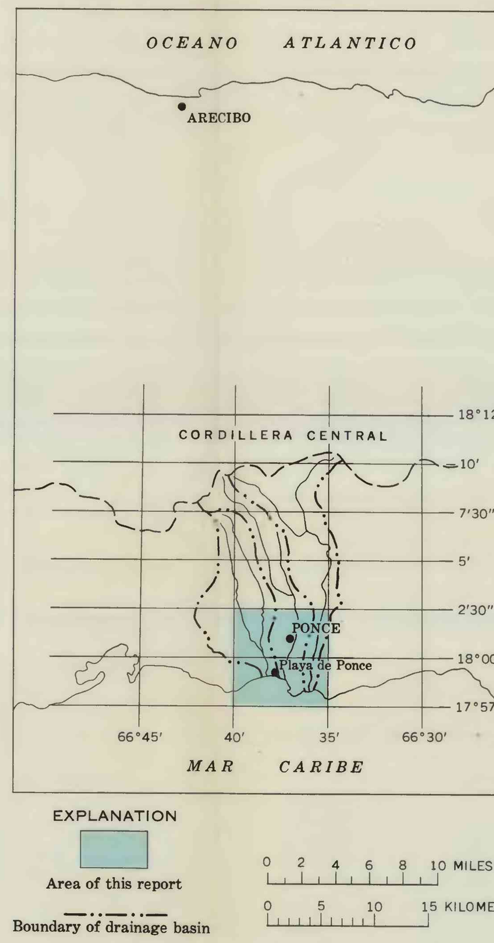

FIGURE 1.—*Location of drainage basins and study area.*

Upstream from the study area the average slope of each stream is about 0.05, but from the north end of the study area to Mar Caribe the average slope is about 0.005. Floodwaters from heavy rains in the mountains flow swiftly down steep, rocky watercourses to the coastal plain where they overtop the channels and inundate the adjacent lands. As water spills out of the channels the velocity of flow is so reduced that material carried by the water is deposited on the land. After many centuries, thick deposits of sand and gravel are built up. Such deposits form alluvial fans that begin at the juncture of mountain slopes and coastal plain and slope downward away from the banks of the channel. Parts of Ponce are situated on alluvial fans.

Río Bucaná, the most easterly of the streams in the study area, has a drainage area of 27.3 square miles at the crossing of Highway 1. The two bridges over Río Bucaná in the study area, for Highways 1 and 14, were built during the period 1914-18. Three low-level irrigation dams and one inverted siphon structure that acts as a dam, are located on Río Bucaná within the study area. These irrigation structures, except for the one at base line kilometer 4.04, probably were intact during the flood of 1899. The dams have negligible storage, but they affect the water-surface profile and hence the pattern of flooding. During the flood of October 13, 1954, and no doubt during greater floods, Río Bucaná broke out of the channel upstream from base line kilometer 5.8 and flowed southwest to Río Portugués.

Río Portugués, draining an area west of and adjacent to the basin of Río Bucaná, has a drainage area of 18.6 square miles at the crossing of Highway 14. All of the eight bridges over Río Portugués within the study area were in place before the flood of October 13, 1954. In 1899, however, there were only two bridges—those at the crossings of Highways 10 and 14—both of which were destroyed and subsequently replaced. The flow of Río Portugués has been augmented upstream from base line kilometer 3.95 by inflow from great floods on Río Bucaná.

Río Cañas, having a drainage area of 8.6 square miles, and Río Pastillo, having a drainage area of 10.7 square miles, join at base line kilometer 1.87 to form Río Matilde. The drainage basin of Río Cañas lies between the basins of Río Portugués and Río Pastillo. Within the study area there are three bridges crossing Río Cañas—one crossing Río Pastillo and two crossing Río Matilde. Prior to 1964, the roads in the valleys of Ríos Cañas, Pastillo, and Matilde were at or near valley level and offered little obstruction to floods. In 1964, however, the valley of Río Matilde was altered by the construction of Highway 2, the embankment of which is well above valley level. It is to be expected that the pattern of flood inundation also will be altered.

Flood occurrence.—The earliest flood in the Ponce area for which a record was found occurred in 1852. The flood of May 20, 1864, probably was the greatest during the period 1852-85. Of the 13 known floods that occurred during the period 1852-1953, elevations of only the flood of August 8, 1899, have been recovered. The elevations of floods during the period 1954-65 are known. It is reasonably certain that the flood of August 8, 1899, was the greatest during the period 1899-1965. Because the drainage basins are contiguous, it is probable that floods occurred on all streams of the study area on the same dates, although the relative magnitude on the several streams may have differed. The dates of known floods are listed in table 1.

Table 1.—*Floods on Ríos Bucaná, Portugués, and Matilde.*

Date	Río Bucaná, downstream side, Highway 1		Río Portugués, downstream side, Highway 14		Río Matilde, upstream side, old Highway 2	
	Elevation (meters)	Discharge (cfs)	Elevation (meters)	Discharge (cfs)	Elevation (meters)	Discharge (cfs)
1852						
May 20, 1864						
Oct. 9, 1867						
Oct. 14, 1886						
Sept. 1, 1888						
Aug. 20, 1891						
Oct. 18, 1891						
Dec. 6, 1895						
Aug. 8, 1899	14.9	35,000	19.9	35,000		
Aug. 1911						
Sept. 13, 1928						
Sept. 26, 1932						
Aug. 1940						
Oct. 13, 1954	14.2	17,000	18.8	17,600	6.0	
May 6, 1958	13.9	12,300	18.2	11,900	6.4	
Aug. 27, 1961	14.0	13,000	17.2	5,800	6.0	2,570
Aug. 28, 1963	13.6	10,000	17.1	5,400	6.3	2,780

Frequency of occurrence.—We have no means of predicting the date a flood of a given magnitude will occur. If a long record of flood events is available, however, we can predict how often on the average the flood will recur and the probability of its occurrence in any year. The recurrence interval, or frequency of a flood of specific magnitude, is the average length of time during which that flood will be equaled or exceeded once. For floods greater than the 10-year flood, the reciprocal of the recurrence interval is virtually the probability of occurrence in a year; thus a 20-year flood will have a 5-percent chance of occurring in any year, and a 50-year flood will have 2-percent chance of occurring in any year.

The relation of stage to frequency for Río Bucaná at Highway 1 and for Río Portugués at Highway 14 is shown by the curves in figure 2. The relations of discharge to frequency for Río Bucaná in the reach upstream from overflow to Río Portugués and in the reach between overflow and Highway 1 are shown by the curves at the top of figure 3. The relation of discharge to frequency for Río Portugués in the reach upstream from inflow from Río Bucaná is shown by the curve in the middle of figure 3. The upper curve for Río Bucaná was derived from the discharge-frequency relation defined for Río Portugués.

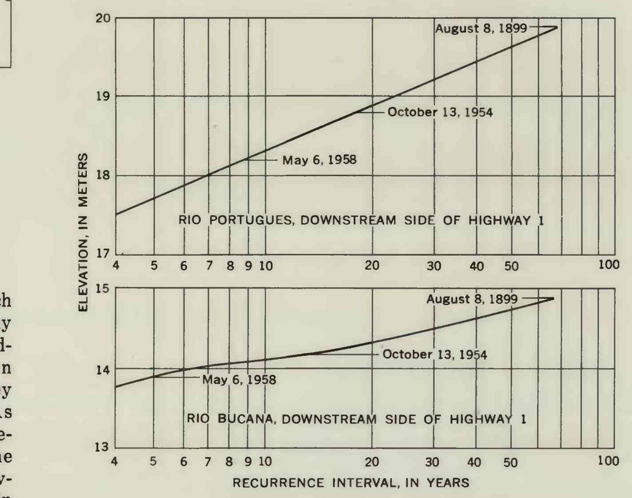

FIGURE 2.—*Stage-frequency relations.*

Flood data recovered for Ríos Matilde, Cañas, and Pastillo are not adequate to define flood-frequency relations directly. To give some concept of the approximate magnitude of future floods on these streams, discharge-frequency relations have been estimated on the basis of known geographic and statistical parameters and the discharge-frequency relation for Río Portugués. The estimated discharge-frequency relations are shown by dashed lines at the bottom of figure 3.

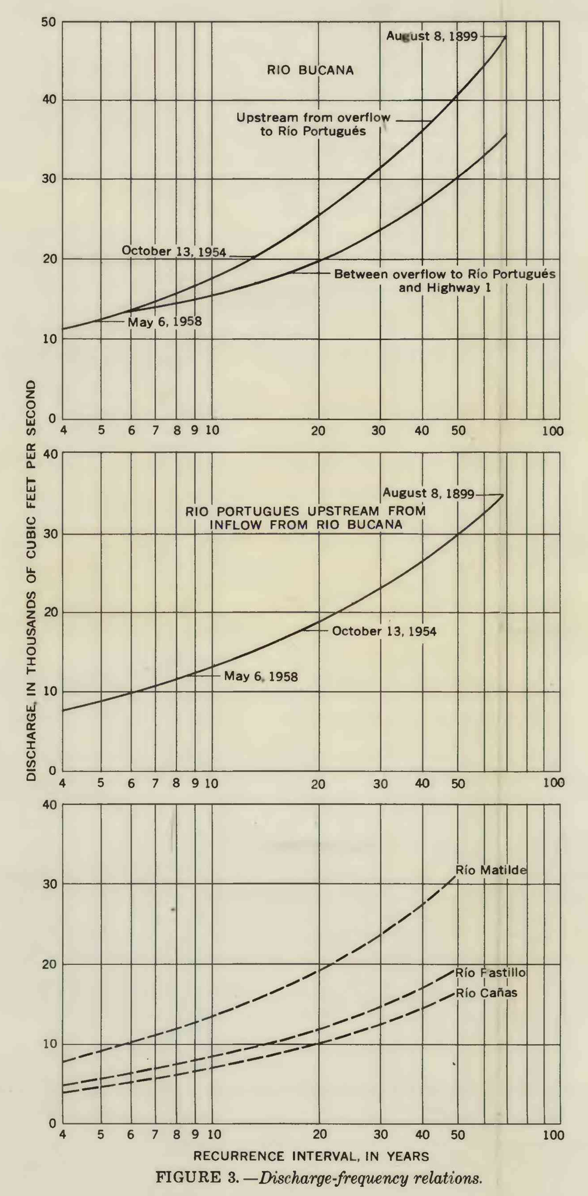

FIGURE 3.—*Discharge-frequency relations.*

Flood profiles.—Profiles of the peak water-surface elevations for the floods of October 13, 1954, and May 6, 1958, on Ríos Bucaná, Portugués, Cañas, and Pastillo, are shown in figure 4. Distances on the flood profiles are measured along the profile base lines marked on the map. These flood profiles depict the water-surface elevation along the base line and the adjacent flood plain where the flow is parallel to the base line. The profiles are not representative of the water-surface elevation in areas where the floodwaters flow away from the base line. For example, the flood profile does not indicate the water-surface elevation in the area flooded by flow leaving Río Bucaná between base line kilometers 6 and 7 and entering Río Portugués above base line kilometer 4.

Water-surface contours.—Estimated water-surface contours for the 1954 flood have been drawn in areas where the flood profile is not shown. The elevations of floodmarks upon which the water-surface contours were based were scattered through the flood plains of Río Matilde, Río Portugués, and Río Bucaná and are shown on the map. Floodflows for these three rivers merged and caused the inundation pattern shown on the map.

The 1958 floodmarks on the Río Matilde flood plain were 0.2 meter to 0.3 meter higher than the 1954 floodmarks; therefore, this small difference should be added to the 1954 water-surface contours west of Highway 132 and south of Highway 2 to estimate the 1958 water-surface contours.

The unusual configuration of the water-surface contours along Río Bucaná is due to the dikes that confine the floodflow in the channel at a higher elevation than the surrounding flood plain. Floodwaters spilling over the dikes quickly drop to an elevation that conforms to the ground contours and flow down-slope.

Depth of flooding.—The difference between the elevation of a horizontal line projected perpendicularly from the flood-profile base line to a point and the ground elevation at the point is the depth of flooding. Where water-surface contours have been drawn, the depth of flooding is the difference between the water-surface elevation, shown by the water-surface contours, and the ground elevation at the point.

Some changes in the elevation of the ground caused by fill for construction of housing or highways have taken place since the 1958 flood. The effect of these changes is not shown on the inundation map. An assessment of the effect of these changes on the pattern and depth of flooding will require a detailed analysis at each site where the changes have occurred. Proposed changes that will encroach on the channels or flood plains should be considered carefully in the light of past events.

Additional information.—Additional information relating to floods on streams in the Ponce area can be obtained from the U.S. Geological Survey, San Juan, Puerto Rico, or from the Sección de Control de Inundaciones, Negociado de Operaciones, Departamento de Obras Públicas, Stop 22½ Avenida Ponce de León, Santurce, Puerto Rico.

Cooperation and acknowledgment.—This report was prepared as a part of a flood-mapping program by authority of a cooperative agreement between the Department of Public Works, Commonwealth of Puerto Rico, and the Water Resources Division, U.S. Geological Survey. Much of the flood data were furnished by the Department of Public Works. Historical flood information was obtained from documents made available by the General Archives of the Institute of Puerto Rican Culture. Additional flood data were obtained from newspapers and from residents of the Ponce area.

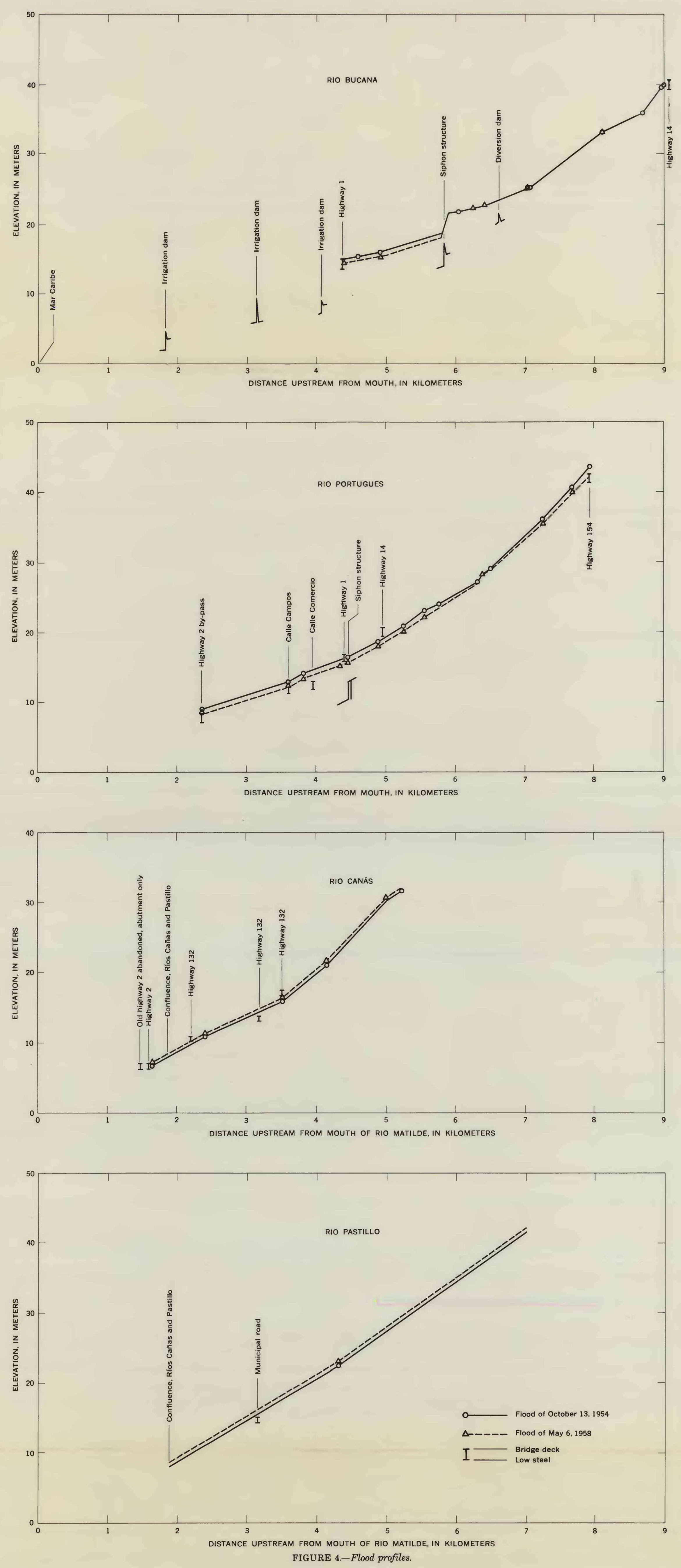

FIGURE 4.—*Flood profiles.*

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