PREPARED IN COOPERATION WITH THE
PUERTO RICO DEPARTMENT OF NATURAL RESOURCES

DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

FLOOD OF SEPTEMBER 16, 1975 IN THE AÑASCO AREA, PUERTO RICO

By

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DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

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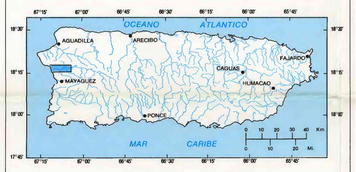


INTRODUCTION

This report documents the flood of September 16, 1975, of the Río Grande de Añasco and provides associated hydrologic data, which can be used in planning for the use of the Río Grande de Añasco flood plain.

The Añasco Valley is on the west coast of Puerto Rico about 117 km southwest of San Juan . The town of Añasco is in the northeast corner of the fan-shaped alluvial valley. Small communities are scattered over the entire valley. During major floods, Añasco and the small communities suffer severe damage.

At present the valley is mostly planted with sugarcane which supplies raw material to the Central Igualdad sugar mill located in the middle of the valley.

The continuous growth of population in the Añasco area has encouraged development of the flood plain mainly near the coast.

The study area includes about 39 km^2 of the Río Grande de Añasco flood plain (fig. 1).

Data are generally referred to in SI (International System) units. The SI units may be converted to inch-pound units by multiplying the units given by the factors shown below:

Multiply SI units	By	To obtain inch-pound units
	Length	
meter (m)	3.2808	foot (ft)
millimeter (mm)	0.03937	inch (in)
kilometer (km)	0.6214	mile (mi)
	Area	
square kilometer (km^2)	0.3861	square mile (mi^2)
	Discharge	
cubic meter per second (m^3/s)	35.31	cubic foot per second (ft^3/s)
	Temperature	
degree Celsius (C°)	1.8 C° + 32	degree Fahrenheit (°F)

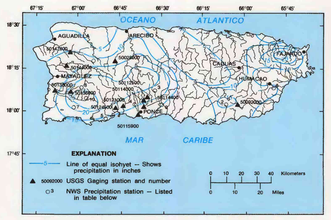
DRAINAGE BASIN

The Río Grande de Añasco basin is on the western slope of the Cordillera Central (fig. 1). The Río Grande de Añasco flows in a westerly direction through steep canyons into the coastal valley with gentle slopes and empties into Bahía de Añasco in Pasaje de la Mona. The drainage area at the mouth is about 521 km which includes 101 km of an interconnected reservoir system. This system provides water to the Lucchetti reservoir in the Río Yauco basin through tunnels for power generation and irrigation. The four reservoirs, Yahuecas, Guayo, Prieto, and Toro with a combined capacity of 25 hm^3 , constructed between 1955 and 1956, spill their floodwaters into the Río Grande de Añasco basin. The effects of this reservoir system on downstream flood peaks will vary because the storage capacity for a given flood is unknown.

The mean annual precipitation in the Río Grande de Añasco Basin ranges from 2286 mm in the headwaters to 2032 mm on the coastal plain.

FLOOD OF SEPTEMBER 16, 1975

The passage of hurricane Eloise near the north coast of Puerto Rico caused torrential rains from September 15-17, 1975, producing destructive floods in the southern and western parts of the island. Precipitation at 10 stations during September 15-17, 1975, and the distribution of precipitation throughout the island for this period are shown in figure 2.



NUMBER ON MAP	LOCATION	PRECIPITATION, IN INCHES, SEPTEMBER 15-17, 1975 SEPT 15	SEPT 16	SEPT 17	TOTAL
1	ADJUNTAS SUBSTATION	0.15	11.99	4.87	17.01
2	CARITE PLANT NO. 1	0.05	10.05	6.85	16.95
3	CERRO MARAVILLA	0.46	16.00	2.37	18.83
4	CORRAL VIEJO	0.10	7.58	8.26	15.94
5	ENSENADA	0.05	5.41	10.30	15.76
6	HUMACAO	0.40	8.02	5.22	13.64
7	LAJAS SUBSTATION	0.29	3.10	12.26	15.65
8	MARICAO 2 SSW	2.32	6.05	14.10	22.47
9	PONCE 4E	0.00	2.90	7.78	10.68
10	SABANA GRANDE 2 ENE	1.20	14.00	11.50	26.70

FIGURE 2. - Map of Puerto Rico showing isohyets for September 15-17, 1975, locations of selected precipitation and stream-gaging stations, and table showing the precipitation for the selected stations.

On September 16, 1975, the Añasco Valley suffered the most severe flood of record. All the communities on the coastal plain were inundated and extensive damage was done to private and public property. The bridge on Highway 341 over Caño Boquilla was destroyed by the floodwaters (fig. 3). The U.S. Geological Survey recovered high-water marks over the entire flooded area, and a peak discharge of 4000 m^3 /s was computed by indirect methods at gaging station 50144000 (fig. 1). The bridge at Highway 108, where the gaging station was located, was destroyed by the flood (fig. 4).

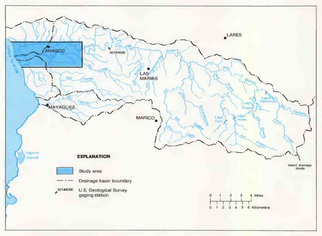


FIGURE 1. - Location of study area and drainage basin.

FIGURE 3. - Present Highway 341 bridge over Caño Boquilla, old bridge was destroyed by the September 16, 1975 flood (photograph A).

FIGURE 4. - Highway 108 over Río Grande de Añasco, which was destroyed by the September 16, 1975 flood.

Photographs of selected sites in the Añasco area during the September 16, 1975 flood are shown in figures 3-10. The photograph locations are identified on the flood map by a circular symbol with an identifying letter and an arrow showing the direction in which the respective photograph was taken. A rod marked in feet and a black arrow is used to point out the depth of floodwaters on some photographs.

FIGURE 5. - Flood height (noted by arrow) at Texaco gas station at km. 8.3, Highway 109, Barrio Espino (photograph B).

FIGURE 6. - Flood height (noted by arrow) at Colón-Gómez house, km. 5.6, Highway 109, Barrio Espino (photograph C).

FIGURE 7. - Flood height (noted by arrow) at Highway 430, Barrio Espino (photograph D).

FIGURE 8. - Flood height (noted by arrow) at the Valentín house, Comunidad Pagán, Añasco (photograph E).

FIGURE 9. - Flood height (noted by arrow) at Colmado Valentín, km. 2.4, Highway 109, Barrio Añasco Arriba (photograph F).

FIGURE 10. - Flood height (noted by arrow) at the Juan Soto house in Barrio Montefiores (photograph G).

FLOOD HISTORY

Historical records and interviews with residents in the study area indicate that the Río Grande de Añasco flood plain has been inundated extensively at least five times since 1899. The greatest flood of record occurred on September 16, 1975; the second greatest on August 8, 1899; and the third on September 13, 1928. Floods of lesser magnitude occurred on September 26, 1932, and September 23, 1952.

Continuous-stage records have been collected at Río Grande de Añasco near San Sebastián (station 50144000) from 1963 to the present. Figure 11 shows a stage-discharge curve for this station.

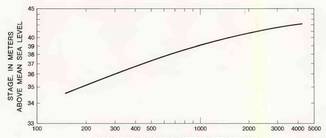


FIGURE 11. - Stage-discharge relation for gaging station 50144000, Río Grande de Añasco near San Sebastián, P.R.

FLOOD FREQUENCY

The methodology used in the discharge-frequency analysis is described in Water Resources Council Bulletin 17A (appendix 8, 1977). The flood frequency relation was determined by weighting the relation based on 17 years of record at gaging station 50144000 near San Sebastián with an estimated relation based on a regional analysis by López and others (1979). The resulting frequency curve is shown in figure 12. Stage, discharge, and recurrence interval for annual peaks at gaging station 50144000 for 1963-79 are listed in table 1. Based on the curve in figure 12, the September 16, 1975 flood was greater than a 100-year flood.

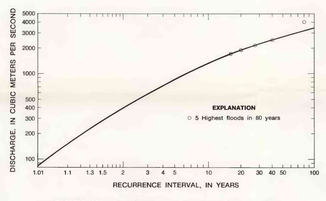


FIGURE 12. - Flood-frequency relation for station 50144000, Río Grande de Añasco near San Sebastián, P.R.

Table 1.--Annual maximum floods on the Río Grande de Añasco at gaging station 50144000.

Date	Elevation above mean sea level, in meters	Peak discharge, cubic meters per second	Recurrence interval, in years
September 27, 1963	36.80	440	2.2
October 15, 1964	34.75	160	1.1
August 25, 1965	36.09	330	1.7
June 18, 1966	35.53	250	1.4
September 1, 1967	35.36	230	1.3
November 8, 1968	35.78	280	1.5
May 17, 1969	36.62	410	2.0
September 24, 1970	35.23	210	1.3
October 26, 1971	37.59	580	2.8
October 21, 1972	36.88	450	2.2
August 11, 1973	35.33	220	1.3
September 27, 1974	35.38	230	1.3
September 16, 1975	41.95	4000	Greater than 100 years
April 29, 1976	35.61	260	1.4
September 13, 1977	35.61	260	1.4
September 24, 1978	35.60	250	1.2
August 31, 1979	38.62	850	4.8

FLOOD PROFILES

The profile shown in figure 13 was developed from high-water marks recovered by the U.S. Geological Survey and interviews with residents in the study area. The reference for the profile is an arbitrary baseline shown on the flood map. The baseline, and therefore the profile, is not confined to the configuration of the channel but follows a smoother path along and in the general direction of the floodflow. There are three bridges over the Río Grande de Añasco in the study area (table 2) and one over the Caño Boquilla flood channel, the latter destroyed by the September 16, 1975 flood.

Table 2.--Elevation of selected bridges in the Añasco area.

Map symbol	Stationing along baseline, in kilometers	Location of bridge	Elevation, in meters (MSL) Top deck	Low beam
*A	0.720	Highway 341 bridge over the Caño Boquilla	--	--
B	2.895	Highway 2 bridge over the Río Grande de Añasco	9.4	8.0
C	6.660	Highway 430 overflow bridge over Río Grande de Añasco	--	--
D	8.680	Highway 406 overflow bridge over Río Grande de Añasco	--	--

*Destroyed by the September 16, 1975 flood.

All elevations shown in the study area are referenced to mean sea level datum. Permanent reference marks were established at selected points throughout the study area (table 3) and are shown on the flood map.

Table 3.--Reference marks established by the U.S. Geological Survey in the Añasco study area.

Reference mark number (see map)	Elevation (MSL), in meters	Description of location
RM-1	19.35	Standard tablet embedded in concrete on left downstream headwall of culvert over Quebrada Cercada on Hwy 109, km 10.4.
RM-2	14.68	Standard tablet embedded in concrete on right upstream headwall of culvert on Hwy 109, km 9.0.
RM-3	13.57	Standard tablet embedded in concrete on top of concrete retention wall on left downstream side of Hwy 430 bridge over Río Grande de Añasco.
RM-4	6.90	Standard tablet embedded in concrete on left upstream headwall of culvert on Hwy 109, km 3.8.
RM-5	6.85	Standard tablet embedded in concrete on top of sidewalk at left of main entrance of Añasco Catholic Church.
RM-6	10.36	Standard tablet embedded in concrete in top of sidewalk on Hwy 109, 9 m east of km 2.4 post.
RM-7	7.36	Standard tablet embedded in concrete on top of first step of front stairway of main office of the Central Igualdad.
RM-8	5.65	Standard tablet embedded in concrete on right downstream abutment of Hwy 2 bridge over Río Grande de Añasco.
RM-9	9.44	Standard tablet embedded in concrete on top of sidewalk of Hwy 401 in front of exit gate from Añasco Public Beach.
RM-10	2.37	Standard tablet embedded in concrete on top of sidewalk on Hwy 341, km 1.3 in front of Colmado Mendizabal.
RM-11	2.36	

WATER-SURFACE CONTOURS

Water-surface contours are based on the elevations of high-water marks recovered after the September 16, 1975 flood. These contours represent equal elevations of the water surface and are normal to the direction of flow. Obstructions to the flow such as sugarcane and manmade obstacles account for the irregularities in the shapes of the high-water contours. The approximate depth of flooding at any point in the inundated area can be estimated by subtracting the ground elevation (contour) from the water-surface elevation (contour). Intermediate estimates can be obtained by interpolation.

INUNDATED AREA

The area inundated by the September 16, 1975 flood has been delineated on a topographic map with a 10-m contour interval, scale 1:20,000. The flood boundaries were determined using the high-water marks, field inspection of the flooded area immediately after the flood, and aerial photos taken by the Puerto Rico Highway Authority eight days after the flood (September 24, 1975). The information in the map will be valuable for future studies. The pattern of inundation of future floods, even of the same magnitude, will be affected by new highways and bridges, new buildings, landfills, or by relocation or excavation of the stream channel.

COOPERATION AND ACKNOWLEDGMENTS

This report was prepared under a cooperative agreement between the Puerto Rico Department of Natural Resources and the U.S. Geological Survey.

ADDITIONAL INFORMATION

Additional information related to this report can be obtained from the U.S. Geological Survey, G.P.O. Box 4424, San Juan, Puerto Rico 00936.

SELECTED REFERENCES

Fields, F.K., 1971, Floods in the Añasco area, Puerto Rico: U.S. Geological Survey Hydrologic Investigations Atlas HA-375.

Haire, W.J., 1972, Flood of October 5-10, 1970, in Puerto Rico: Puerto Rico Water Resources Bulletin 12, 42 p.

López, M.A., Colón-Dieppa, Eloy, and Cobb, E.D., 1979, Floods in Puerto Rico, magnitude and frequency: U.S. Geological Survey Water Resources Investigations 78-141, 66 p.

United States Water Resources Council, 1977, Guidelines for determining flood-flow frequency: Bulletin no. 17A of the Hydrology Committee, 163 p.

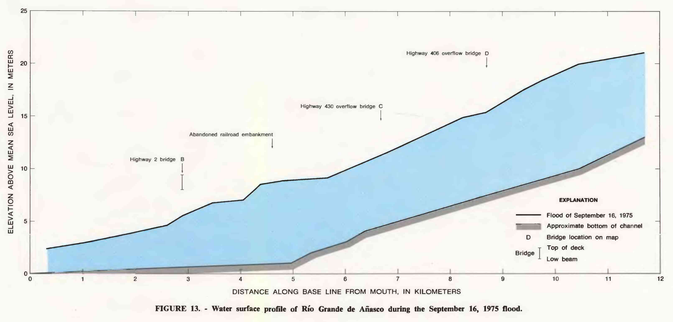
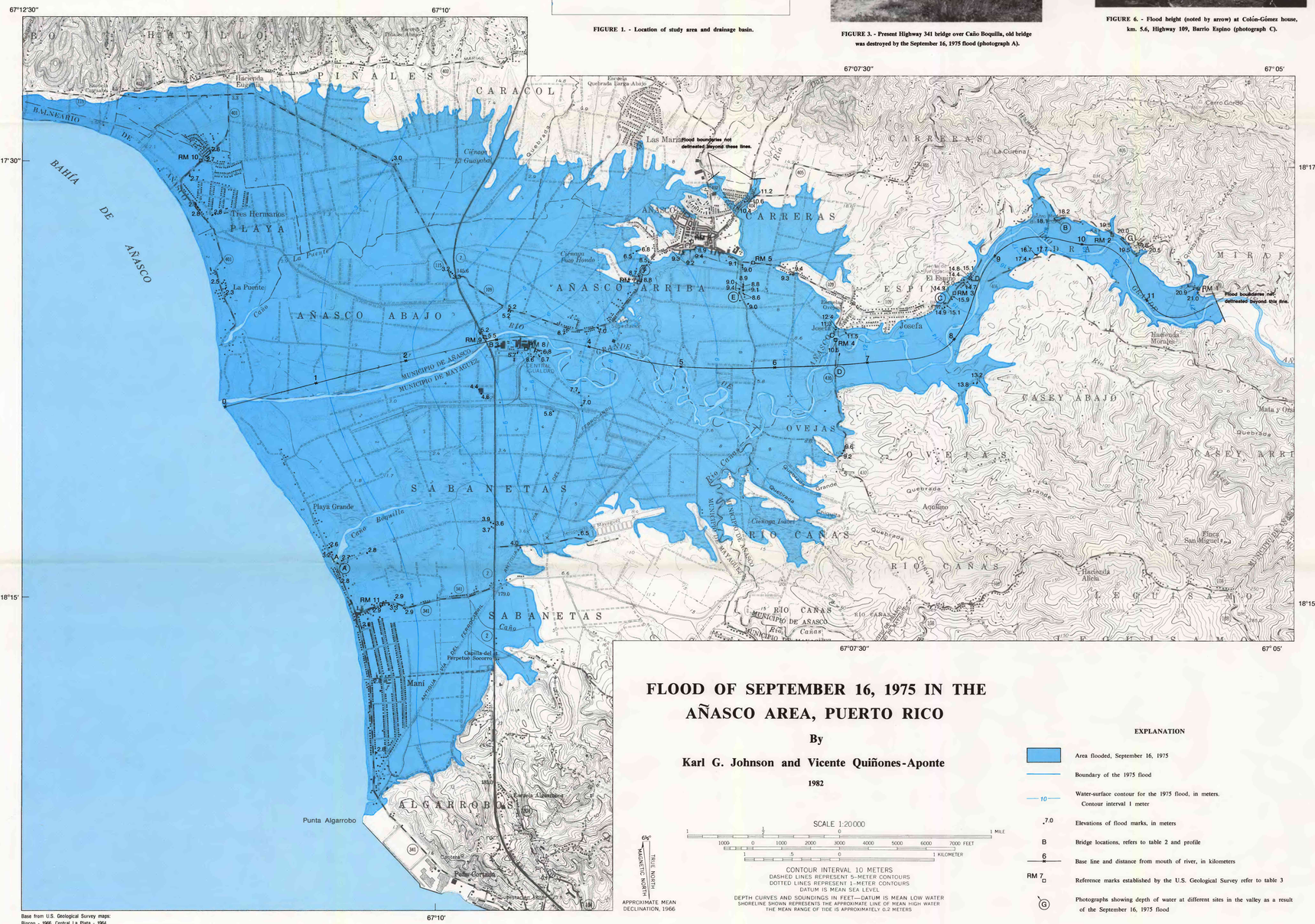


FIGURE 13. - Water surface profile of Río Grande de Añasco during the September 16, 1975 flood.



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1982

SCALE 1:20000

CONTOUR INTERVAL 10 METERS
DASHED LINES REPRESENT 5-METER CONTOURS
DOTTED LINES REPRESENT 1-METER CONTOURS
DATUM IS MEAN SEA LEVEL

DEPTH CURVES AND SOUNDINGS IN FEET—DATUM IS MEAN LOW WATER
SHORELINE SHOWN REPRESENTS THE APPROXIMATE LINE OF MEAN HIGH WATER
THE MEAN RANGE OF TIDE IS APPROXIMATELY 0.2 METERS

APPROXIMATE MEAN DECLINATION, 1966

EXPLANATION

- Area flooded, September 16, 1975
- Boundary of the 1975 flood
- 10 — Water-surface contour for the 1975 flood, in meters. Contour interval 1 meter
- .7.0 — Elevations of flood marks, in meters
- B — Bridge locations, refers to table 2 and profile
- 6 — Base line and distance from mouth of river, in kilometers
- RM 7 — Reference marks established by the U.S. Geological Survey refer to table 3
- G — Photographs showing depth of water at different sites in the valley as a result of the September 16, 1975 flood

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