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THE RIO SALADO AT FLOOD

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INTRODUCTION

The Rio Salado watershed, 24 km north of Socorro, has a drainage area of 3570 km'. It is bounded on the north by the Ladron Mountains and the Colorado Plateau and on the south by the Datil, Gallinas, Bear, and Lemitar Mountains. Alamocito Creek flows eastward from the northern slope of the Datil Mountains for 48 km at an average gradient of 18.6 m/km before joining with Gallegos Creek to form the main stem of the Rio Salado. From this confluence the Rio Salado flows eastward for about 72 km at an average gradient of 6.2 m/km to join the Rio Grande near San Acacia.

Annual precipitation ranges from an average of 430 mm in the mountainous areas to 180 mm in lower elevations. A large percentage of rainfall occurs as late summer thunderstorms which produce rapid runoff, flash flooding and severe erosion. The Rio Salado and the Rio Puerco to the north contribute about 75 percent of the sediment to the Rio Grande at San Acacia, although their flows are less than 10 percent of the Rio Grande volume at that point (U.S. Corps of Engineers, 1973). The detrimental effects of sediment-laden water on crops and on the Elephant Butte Reservoir, and fear of another 1929-sized flood, which devastated the middle Rio Grande valley, makes the Rio Salado one of the major targets of flood- and sediment-control schemes.

This paper compares channel characteristics and discharge measurements made during 1982's peak discharge to those estimated from high-water marks a few days after the flood.

FLOOD HISTORY

A graph of mean annual discharge of the Rio Salado for the 34 water-years of record (1948-1981) reveals only that wet and dry years tend to alternate; no persistent climatic effects are obvious. Although little is known about floods on the Rio Salado before installation of stream gauges in 1947, historical data and recollections of older residents show that the Rio Grande valley has been subject to many floods, both in the main river and in tributary streams. The floods of 1929 are particularly notable. Using cross-section and slope measurements, the State Engineer estimated that the Rio Salado contributed 776 m3/s to the flood of August 12 which washed out bridges, dikes and irrigation ditches, destroyed crops, and damaged many houses in San Acacia, San Antonito, La Mesa, and San Marcial. A vast amount of silt was deposited on the flooded areas. The Rio Salado contributed a lesser amount, 566 m3/s, to a second flood of larger magnitude on September 23 of that same year (New Mexico State Engineer, 1930).

Although the average discharge from October 1947 through September 1981 was reported by the U.S. Geological Survey (1981) to be 0.41 m3/s, the river flowed only 11 percent of the time. The most frequent discharge during flow days was 0.3 to 1.4 m3/s, corresponding to a 0.3 m and a 0.36 m gauge height, respectively. A maximum discharge of 1,025 m'is was recorded on July 31, 1965, corresponding to a gauge height of 1.69 m. But, since this flow did not coincide with major flows on the Rio Grande and Rio Puerco (see Heath, this guidebook), damage in the Rio Grande valley was minor. The maximum discharge estimate was obtained by measuring the height of high-water marks following the flood and extending the rating curve. A rating curve, which relates stage (gauge height) to discharge, is established for each gauge station. It is derived from periodic meter measurements of flow and simultaneous stage observations. This relationship may change when physical conditions, such as bed elevation, vegetation, and channel pattern, change at the gauge location.

Although thousands of samples are usually needed to show meaningful statistical distributions, no such sample sizes are available for streamflow. Therefore, no best distribution has been found to exist for floods. Basin characteristics influence the distribution of floods, so it is unlikely that a single distribution applies. Despite this, the Gumbel Type I distribution has been widely used, especially in the United Kingdom (Linsley and others, 1982). The mean of this distribution, which is about 275 m3/s for peak floods on the Rio Salado, has a return period of 2.33 years, corresponding to a probability of 0.43. The U.S. Geological Survey calculated the return periods for discharges of various magnitudes using a log-Pearson Type III distribution which has a similar shape to the Gumbel (fig. 1).

DESCRIPTION OF THE LOWER REACH

The Rio Salado at the gauge station near San Acacia (fig. 2) is wide and flat; just west of the gauges the main channel is nearly 250 m wide

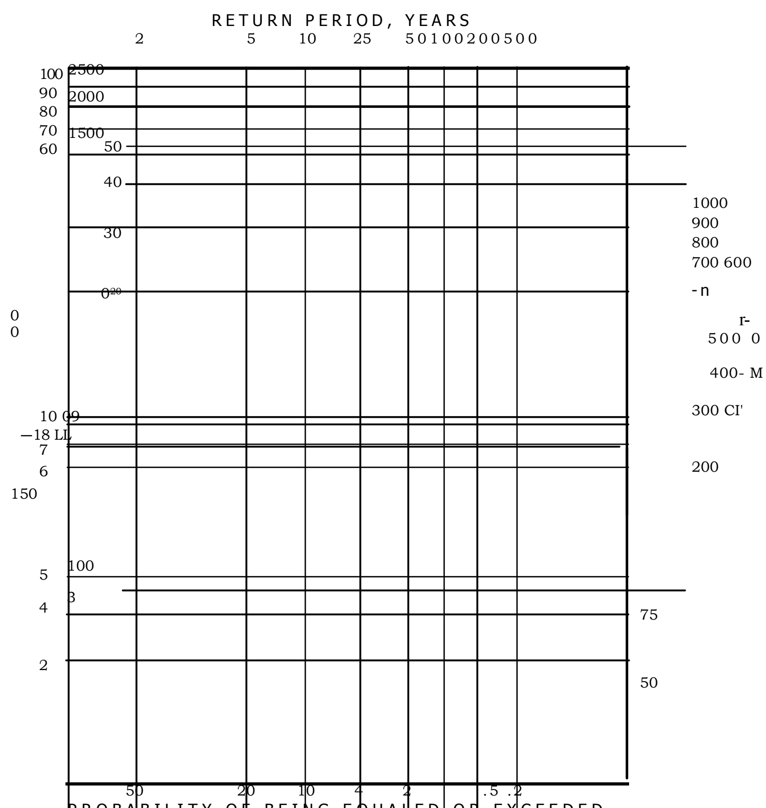

Figure 1. Log-Pearson Type III distribution of annual peak floods on the Rio Salado (U.S. Geological Survey, 1981).

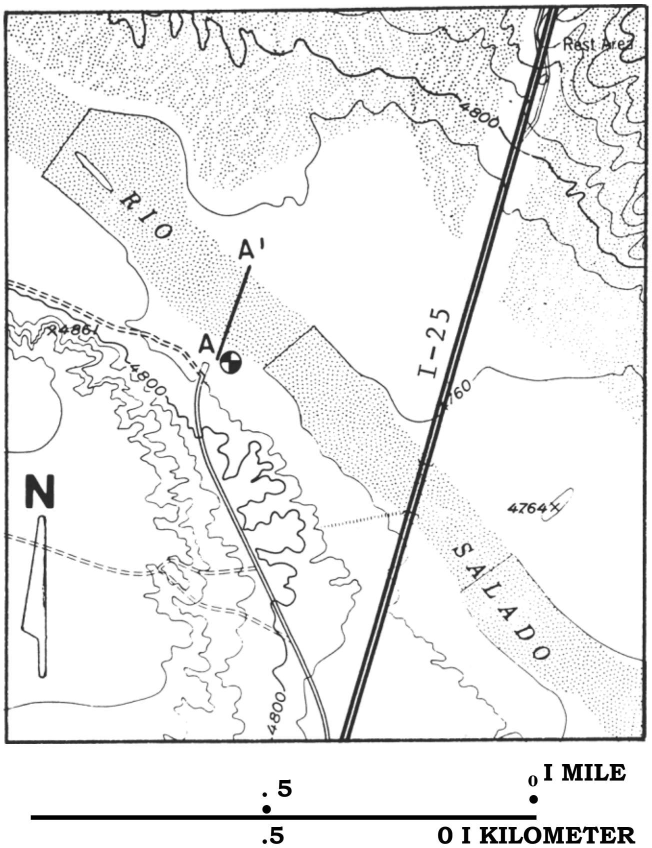

Figure 2. Map of the lower reach of the Rio Salado showing locations of the gauge station (circle) and the cross section (A-A') that was measured during and after the 1982 peak flood.

and 2 m deep. Grain sizes in the active channel vary from fine sand, silt, and clay veneering tops of bars to coarse pebbles and small cobbles in the meandering and anastomosing subchannels. Boulders as much as 0.6 m in diameter can be found, but the majority of grains are pebbles that range in size from 2 to 64 mm. Although the bridge pilings at the gauges serve as anchors for the roots to tamarisk (salt cedar) trees, elsewhere the main channel is essentially free of vegetation. The active channel is flanked on both sides by eolian deposits, some of which are stabilized by mesquite, creosote, grama grass, and salt bush. The piedmont slope- and alluvial-flat deposits of Pleistocene age underlying these deposits are composed of fine-grained sand and silt to coarse, angular fanglomerates (Machette, 1978).

PEAK FLOOD-SEPTEMBER 21, 1982

Figure 3a is an upstream view of the September 21 flood from the south end of the 1-25 bridge. Figure 3b was taken from the same vantage point about a month later.

Measurement During Flood

Suspended from a cable car, Emilio Pargas of the U.S. Geological Survey in Albuquerque used a Price current meter, held vertically by a 34 kg weight, to measure depth and flow velocity across the channel during the flood. He recorded the velocity at six-tenths of the depth below the surface, which roughly approximates the average velocity, about every 6 m across the channel. The area of each segment multiplied by its average velocity gives discharge for that segment. These are added together to get total discharge. Although it is desirable to complete the measurement with a minimum change in stage, the brevity of the

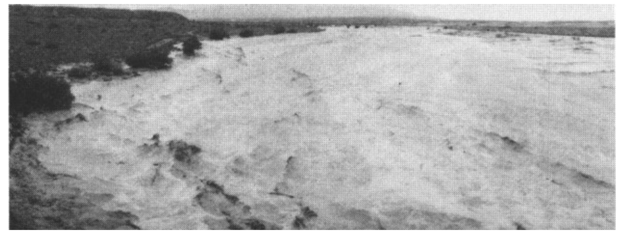

Figure 3a. Upstream view of the flood of September 21, 1982, taken from the 1-25 bridge. The gauge station and tamarisk trees at the location of bridge pilings for old U.S. 85 are just visible at left middle ground. Photo by Douglas Heath.

flood peaks seen on the hydrograph record (fig. 4) made this impossible. Most of Pargas' measurements were not made during maximum gauge height, so record less than maximum discharge. Figures 5a and 5b are the cross sections produced during his two traverses.

Measurement After Flood

On September 25, 1982, three or four anastomosing subchannels were still flowing. Members of a geomorphology class from the New Mexico Institute of Mining and Technology surveyed three cross sections, using high-water marks to estimate maximum flood depth. The section closest to the gauge station is shown in Figure 6. The three sections were combined to produce a control section.

Because of the high width-to-depth ratio of the Rio Salado, depth is best approximated not as the depth from the lowest place in the channel to high-water marks, but rather as a mean depth. For example, the high-water marks were about 1.5 m above the lowest point in the channel, the area of the cross section at this depth was 226.9 m2, the width was 237.3 m, and the hydraulic radius was 0.93 m; therefore, the mean depth equals 226.9/237.3 or 0.96 m. This is close to the value of the hydraulic radius, which is not uncommon for streams with high width-to-depth ratios. Use of the averaged depth value, in conjunction with the U.S. Geological Survey's rating curve, gave a maximum discharge of about 240 m2/s for the 1982 peak flood, a value somewhat lower than that recorded by the hydrograph (fig. 4).

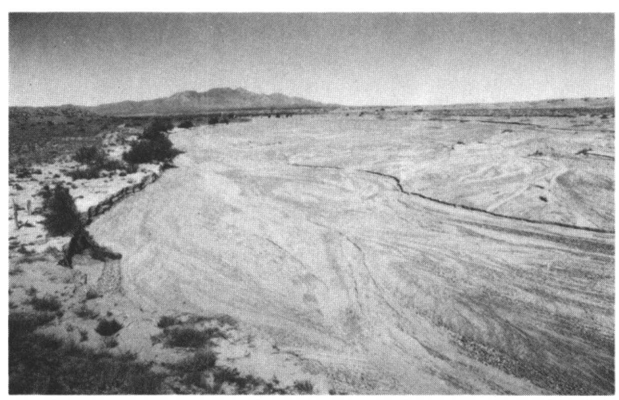

Figure 3b. View of the Rio Salado taken from the same vantage point a month later. Photo by David Love.

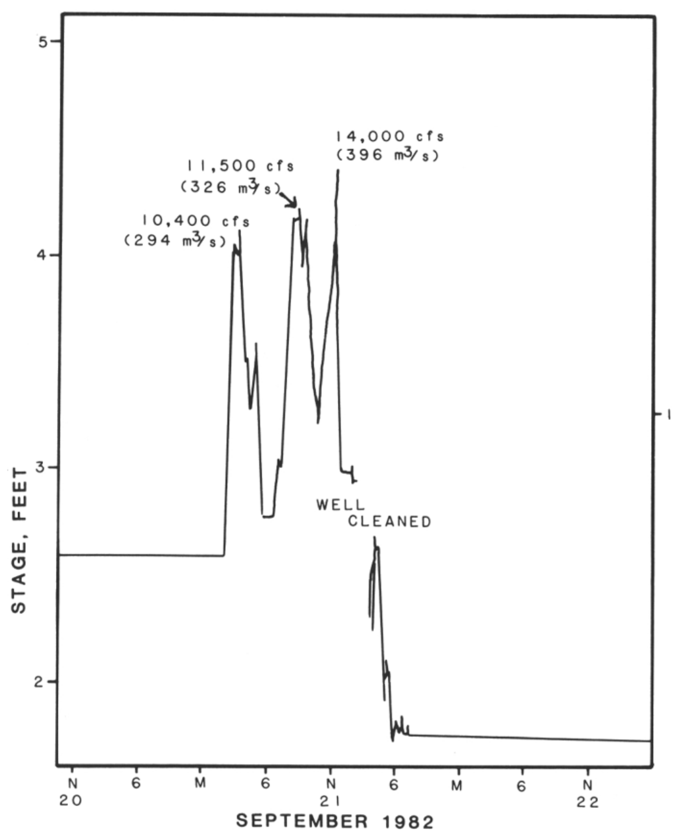

Figure 4. Hydrograph for September 20–22, 1982, recorded at t gauge station on the Rio Salado near San Acacia.

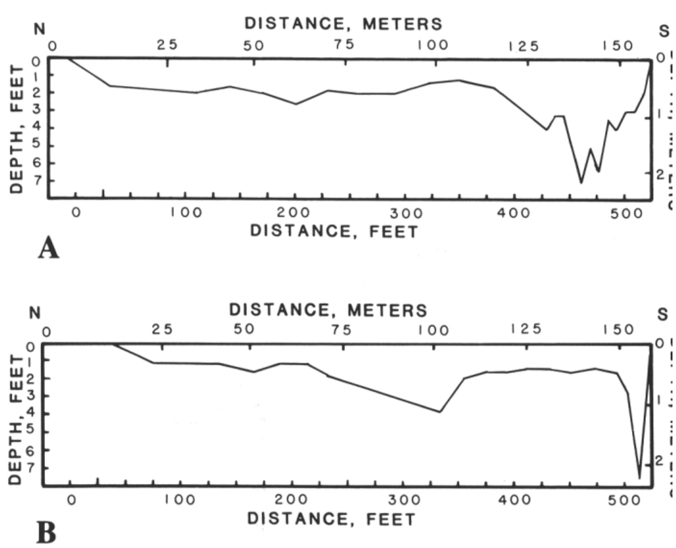

Figure 5. Cross sections of the Rio Salado measured by Emilio Parg of the U.S. Geological Survey at the gauge station near San Acac during the flood of September 21, 1982. (A) Measured beginning 11:00 a.m. at a gauge height of 1.07 m and ending at 12:45 p.m. a gauge height of 0.91 m. The peak discharge of the day, 396 m³/ occurred at noon at a gauge height of 1.34 m. Discharge for this secti was calculated to be 152 m³/s using an averaged gauge height of 1.(m. (B) Measured beginning at 2:45 p.m. at a gauge height of 0.75 and ending at 3:30 p.m. at the same gauge height. Discharge for th section was calculated to be 90 m³/s.

The channel characteristics derived from data collected during and after the 1982 peak flood compare well, even though the U.S. Geological Survey's n values are slightly lower than those of the control section, and they would estimate a higher discharge between 0.5 and 0.6 m.

The cross section near the gauge station underwent striking changes in appearance during high flow that did not significantly alter overall channel characteristics and discharge estimates made during and after the 1982 peak flood.

ACKNOWLEDGMENTS

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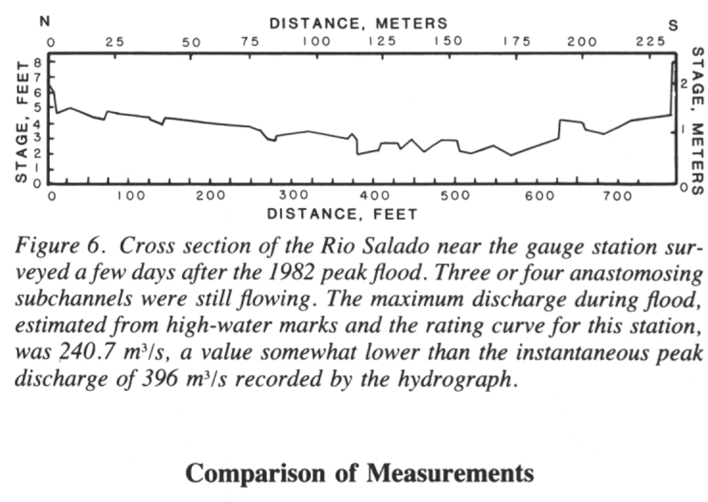


Figure 6. Cross section of the Rio Salado near the gauge station surveyed a few days after the 1982 peak flood. Three or four anastomosing subchannels were still flowing. The maximum discharge during flood, estimated from high-water marks and the rating curve for this station, was 240.7 m³/s, a value somewhat lower than the instantaneous peak discharge of 396 m³/s recorded by the hydrograph.

Comparison of Measurements

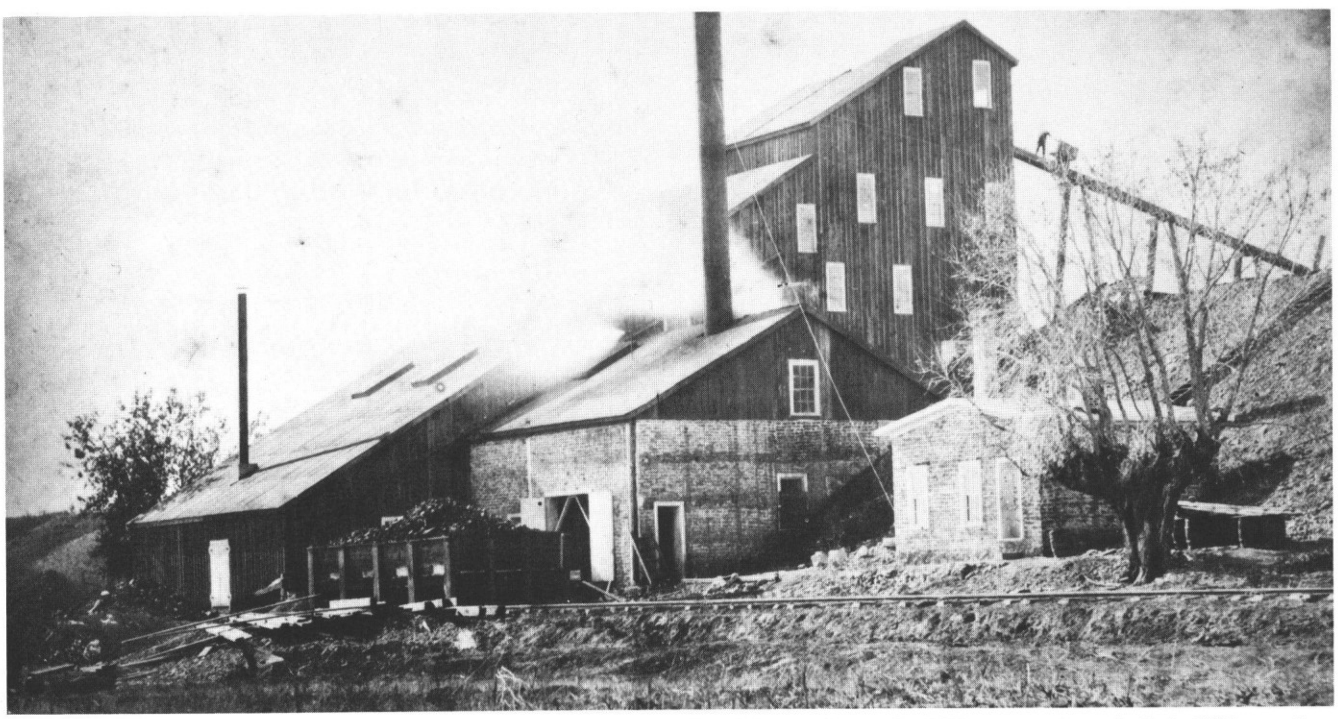
Channel characteristics derived from data collected during and after the 1982 peak flood are as follows:

Control section (after flood):						U.S. Geological Survey (during flood):					
Depth (m)	Q (m^3/s)	Area (m^2)	P (m)	R (m)	n	Depth (m)	Q (m^3/s)	Area (m^2)	P (m)	R (m)	n
0.5	27.2	24.5	95.6	0.26	0.028	0.50	89.8	41.8	150	0.28	0.015
0.6	60.9	41.6	131.1	0.32	0.024	0.84	152.3	54.9	164	0.3	0.013
0.9	215.2	95.6	220.4	0.43	0.019						

where Q = discharge (from rating curve)
depth = gauge height − 0.24 m
P = wetted perimeter
R = hydraulic radius = A/P
n = Manning's n; a measure of channel roughness that usually varies from 0.015 to 0.030 for channels of this type.

The channel characteristics derived from data collected during and after the 1982 peak flood compare well, even though the U.S. Geological Survey's n values are slightly lower than those of the control

The commuter during the 1880's and later was met at the AT&SF depot and/or shuttled around town in these lovely glass-windowed coaches of the Socorro Transit Company here shown changing motive power at the local (and doubtless affiliated) livery stable. The last of these coaches, living out its days on display at the Val Verde hotel, was "borrowed" for use in a parade in Belen, never to be seen again. Photo by Joseph E. Smith, courtesy Ed Smith; New Mexico Bureau of Mines and Mineral Resources collection.



Torrance ten-stamp mill, ca 1882. This mill (which stood on present-day Cuba road near the I-25 overpass) was built in 1881 to reduce ores from the mine of the same name and was, at least initially, successful. Some $175,000 in silver had been produced by 1883. But losses of both silver and mercury (used in the amalgamation process) coupled with falling ore grades led to eventual failure. Although the mill reopened on many occasions by as many different companies, it was never a great success. Mercury could be readily recovered, according to local old-timers, by simply digging in the sand floor well up into the 20th century. Photo by E. A. Bass, courtesy Socorro County Historical Society.