# 3.0 HISTORY OF PRECIPITATION, FLOWS AND SEDIMENT

## 3.1 Precipitation History

Precipitation in the Rio Grande watershed comes in two forms: snow and rain. Although snowfall occurs in the area of the study reach, it is short lived and does not usually produce flow events in the channel whereas snowfall in the headwaters provides water for spring runoff (Figure 3). Local rainfall from thunderstorms produce short-lived sporadic flow events in the Rio Grande, and may occur throughout the year but most often in July, August and September. Each type of flow event, spring runoff and summer thunderstorm runoff, produce distinct sediment supplies: spring runoff carries a relatively low amounts of sediment, while the thunderstorm/arroyo fed summer events are rich in sediment (Figure 4).

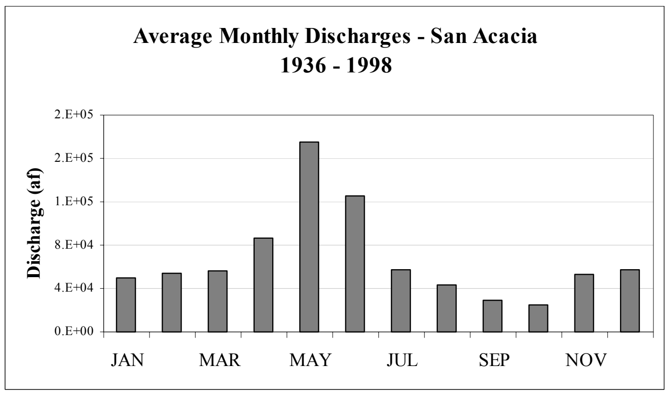


**Figure 3**: Average monthly discharges – USGS Rio Grande gage at the San Acacia Floodway

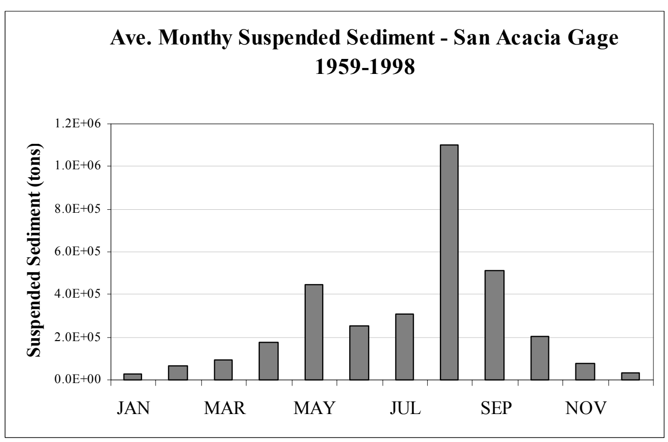


**Figure 4**: Average monthly suspended sediment – USGS Rio Grande gage at the San Acacia Floodway.

Although the yearly precipitation patterns are not entirely consistent between all weather station gages in the Rio Grande watershed, snow pack data indicate a relatively low pack in the mid-1970's, and returning to a larger pack in the 1980's and 1990's (Figure 5). Snow pack and mountain precipitation data was compiled for four stations in the Rio Grande headwaters

(Hydrosphere, 2000), ranging in elevation from 9,000 to 10,600 feet, and containing data from 1948 to the present (Figure 1). Wolf Creek Pass, the highest elevation gage, had the clearest trends and indicated that there was a relatively low snowfall period from about 1972 to 1977. Although data from other weather stations do not show exactly the same trends, they are not inconsistent with Wolf Creek data (Figure 5).

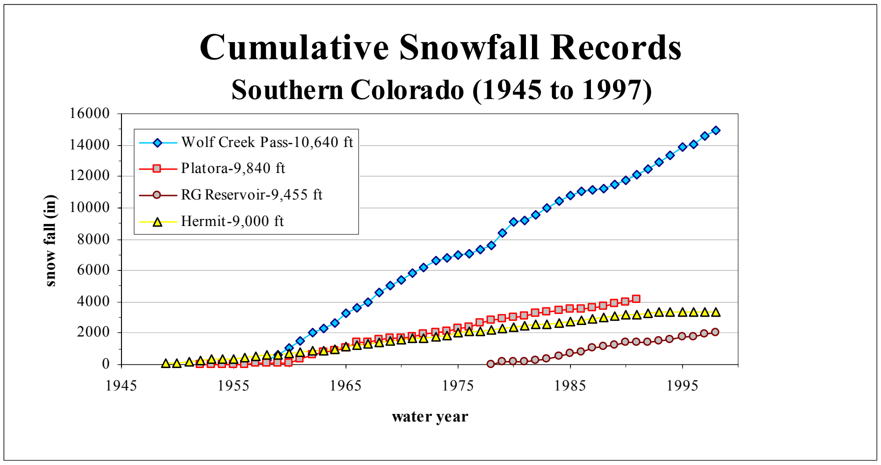


**Figure 5**: Cumulative snowfall records in southern Colorado.

Summer precipitation trends were assessed from the weather station data at both Socorro and Bernardo (Figure 1). Data at the Socorro station dates from 1931 to the present (Figure 6), while Bernardo station data began in 1962 (Hydrosphere, 2000). Precipitation records at both Socorro and Bernardo indicate a relatively high rainfall post-1970, but low rainfall prior to 1970. Coupled with the snow pack data, low snowfall trends in the mountains appear to be associated with relatively higher summer precipitation, and vice-versa.

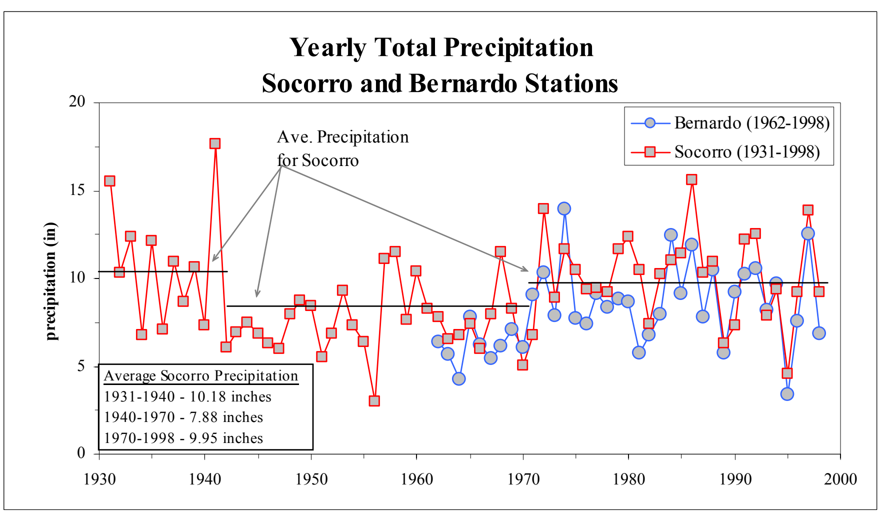


**Figure 6**: Yearly total precipitation at Socorro, NM and Bernardo, NM.

## 3.2 Gaged Stream Flow and Sediment History

Data from two USGS Rio Grande stream gages, San Acacia (# 08354900) and San Marcial (# 08358400) were used to determine the water discharge-suspended sediment history. Discharge for the San Acacia gage dates from 1936 to the present, while suspended sediment only dates back to 1949. The San Marcial gage has a more extensive record, with discharge data collected back to 1895 and suspended sediment back to 1925.

The volume of both water and sediment has varied greatly throughout the period of record for both the San Acacia and San Marcial gages. These gages receive most of their yearly flow in May and June (Figure 3), but receive most of their sediment in August (Figure 4), which is a pattern commonly referred to as the scour and fill cycle. According to data at the San Marcial gage, 1941 was as the largest water year on record while 1929 was the largest sediment year on record. Anecdotal information indicates that approximately 64 floods occurred between 1822 and 1942, and of these floods, 5 were valley filling event or flows estimated to be over 100,000 cfs (Scurlock, 1998). Annual trends of the quantity of water and suspended sediment passing the San Acacia gage indicate that the total yearly amount of water increased in the 1980's (Figure 7) while the amount of sediment has steadily decreased since 1980 (Figure 8). The concentration of suspended sediment varies significantly prior to 1978 for the San Acacia gage, ranging from 7,300 to just over 34,000 mg/l/yr (Figure 9). However, in the 1980's, the concentration of suspended sediment decreased significantly, averaging about 3,000 mg/l/yr. Since 1990, the average suspended sediment concentration at San Marcial gage is about twice the amount at the San Acacia gage indicating a source of sand-sized sediment between the two gages.

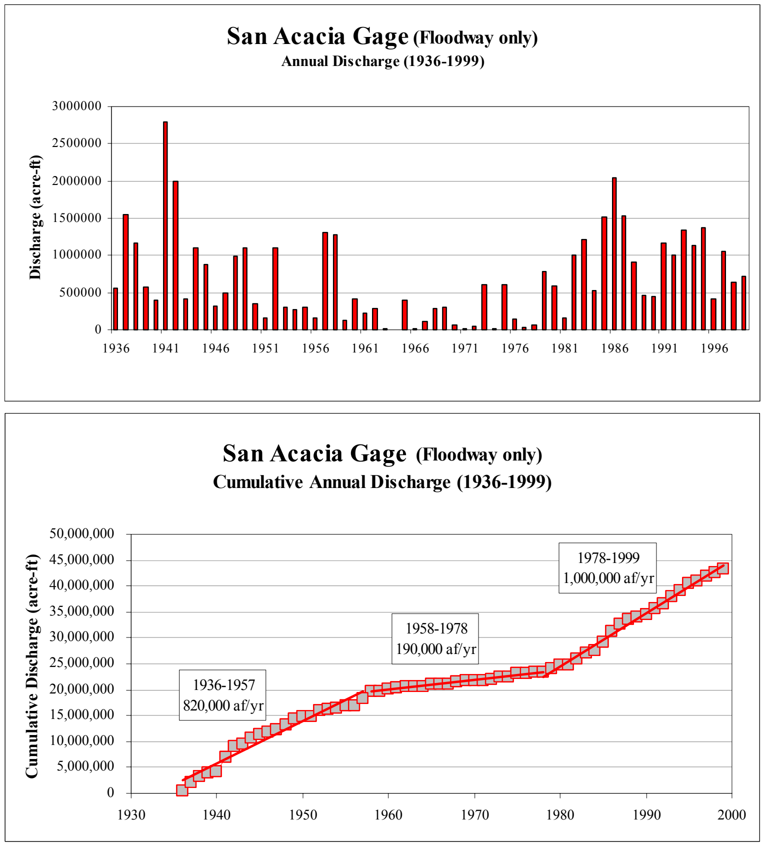


**Figure 7**: Annual discharge given in year discharge and cumulative – USGS Rio Grande gage at San Acacia, NM.

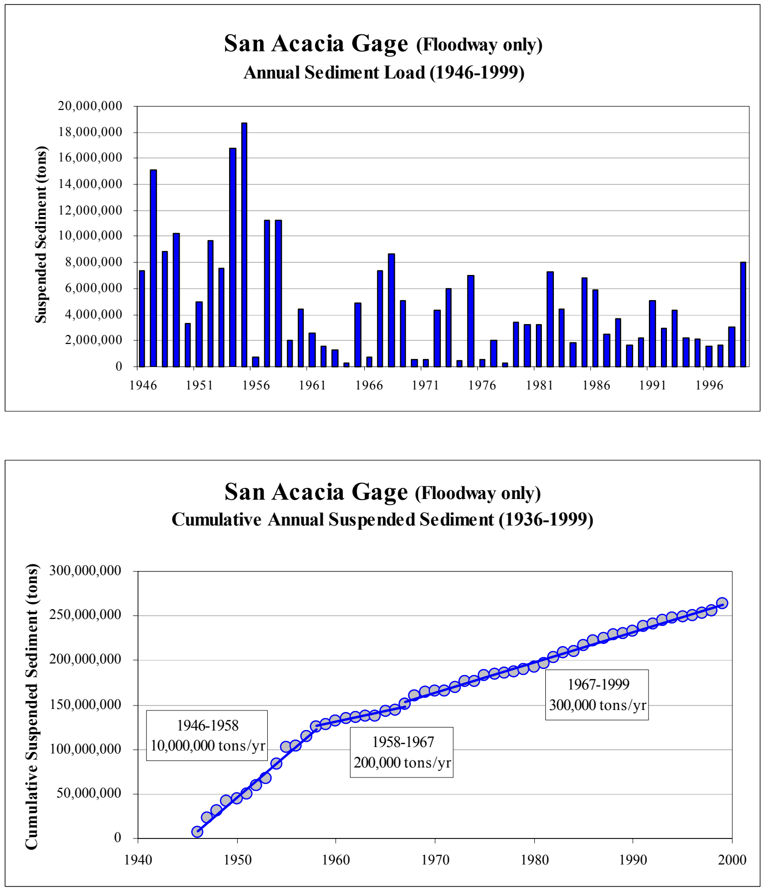


**Figure 8**: Annual sediment load given in year discharge and cumulative – USGS Rio Grande gage at San Acacia, NM.

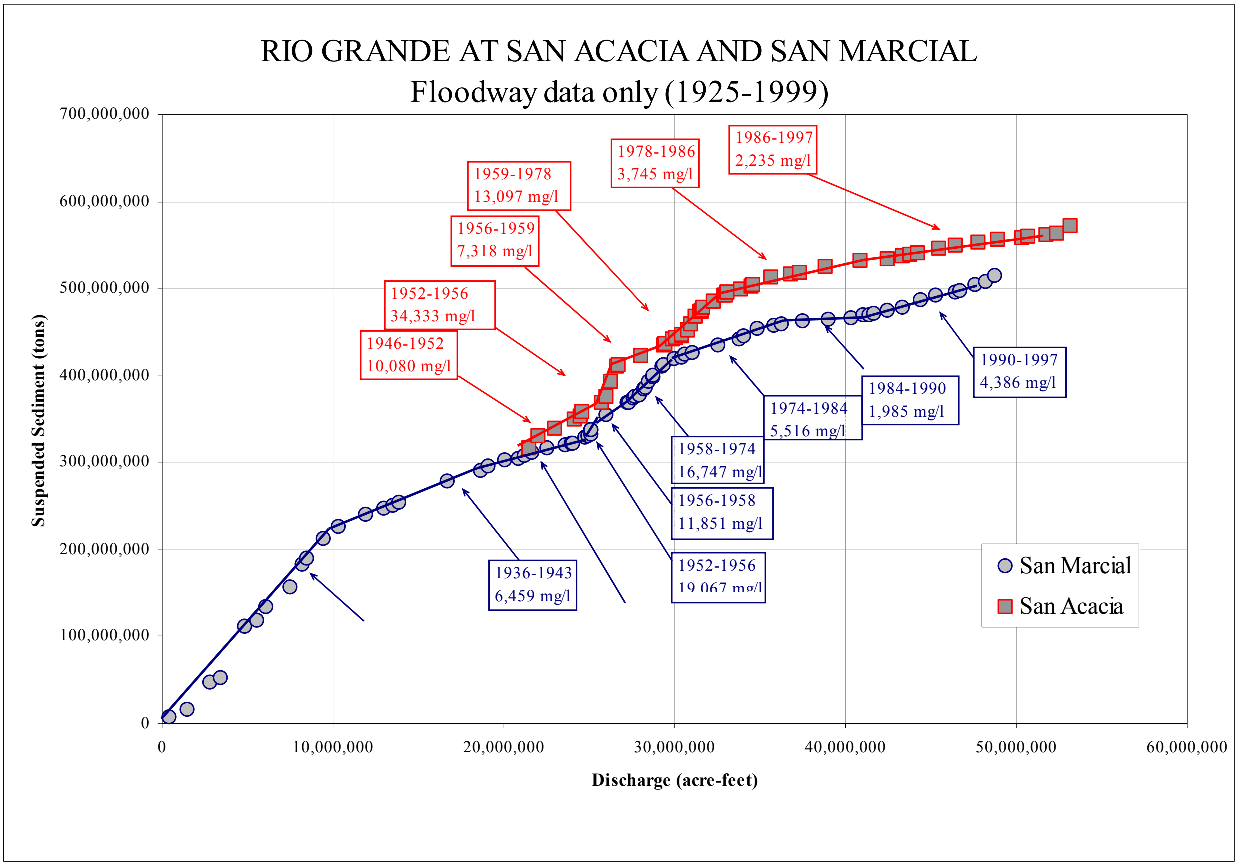


**Figure 9**: Cumulative suspended sediment and discharge – USGS Rio Grande gages at San Acacia, NM and San Marcial, NM.

### 3.3 Local Supplies of Gravel and Sand

The sediment supplied by arroyos and erosion of the channel bed/banks dominates the current local supply of sediment. Wells drilled during the building of San Acacia Diversion Dam in the 1930's and a ground water study in the early 1990's (unpublished USBR data, 1930's, and 1993) found that although sand-sized sediment dominated the channel bed and bank deposits, gravel was also present (Figures 10, 11a & 11b). The gravel measured in these logs ranged from about 13 mm to 100 mm and created distinct layers, indicating that gravel sized sediment was transported in the Rio Grande, at least episodically. Logs further downstream (RM 114.6 and 109.49) found less gravel than at the dam, which may indicate that the gravel layer was spatially isolated and mostly located near its source, the Rio Salado, rather than reach wide.

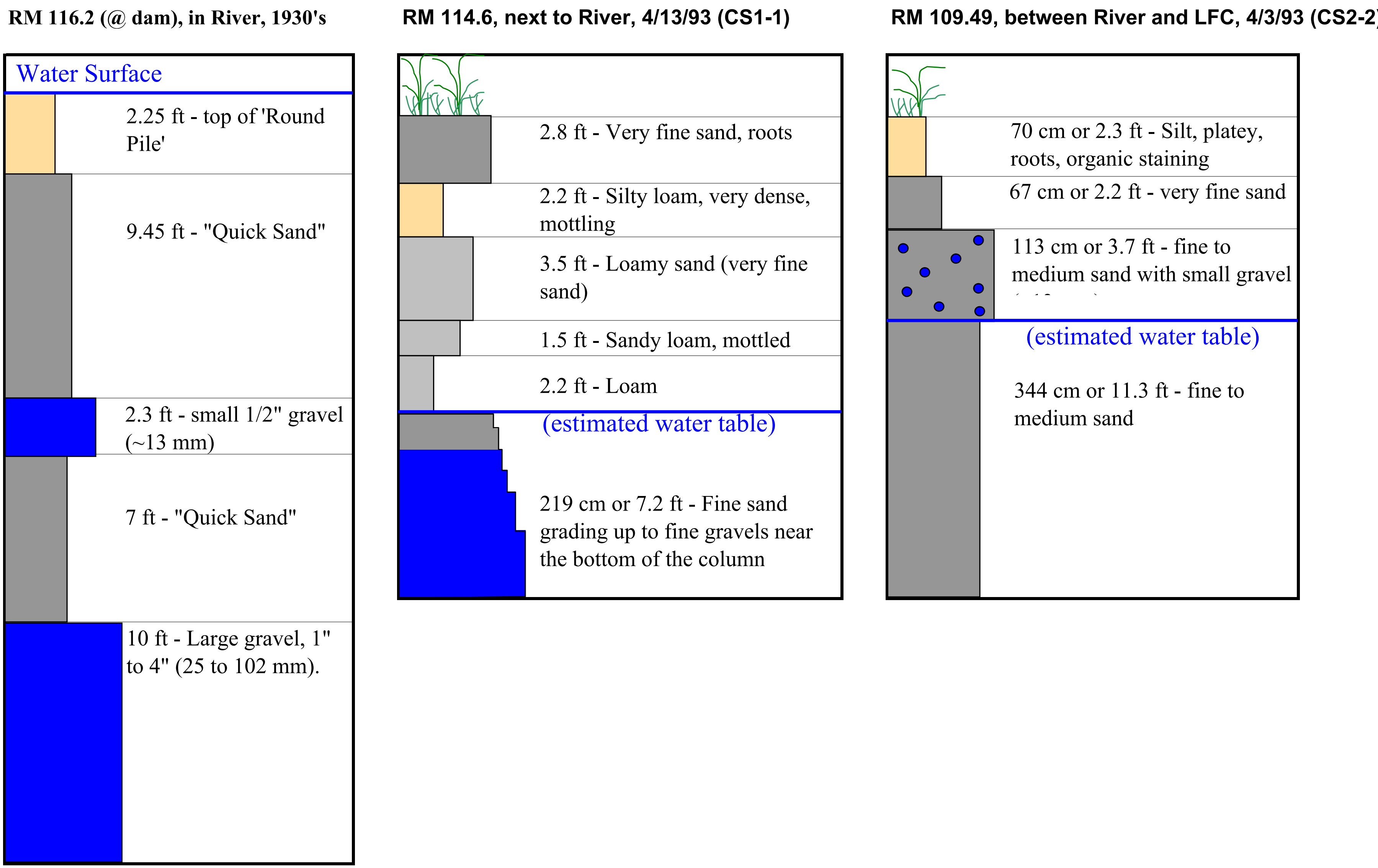


Figure 10: Historic Well Log data in the San Acacia Reach.

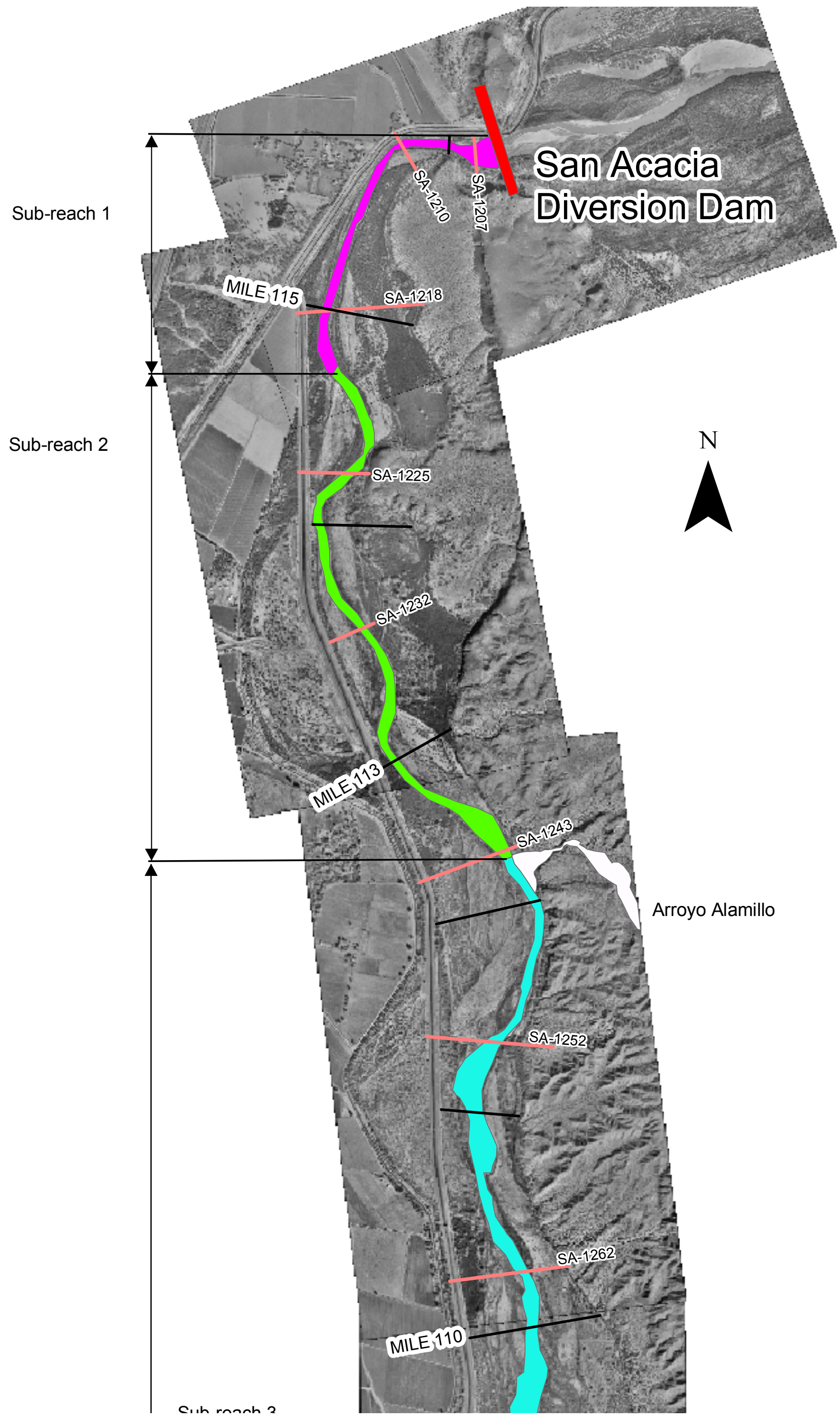


**Figure 11a**: Sub-Reach location map showing Sub-reaches 1, 2 and the northern portion of sub-reach 3, Rio Grande – San Acacia Reach.

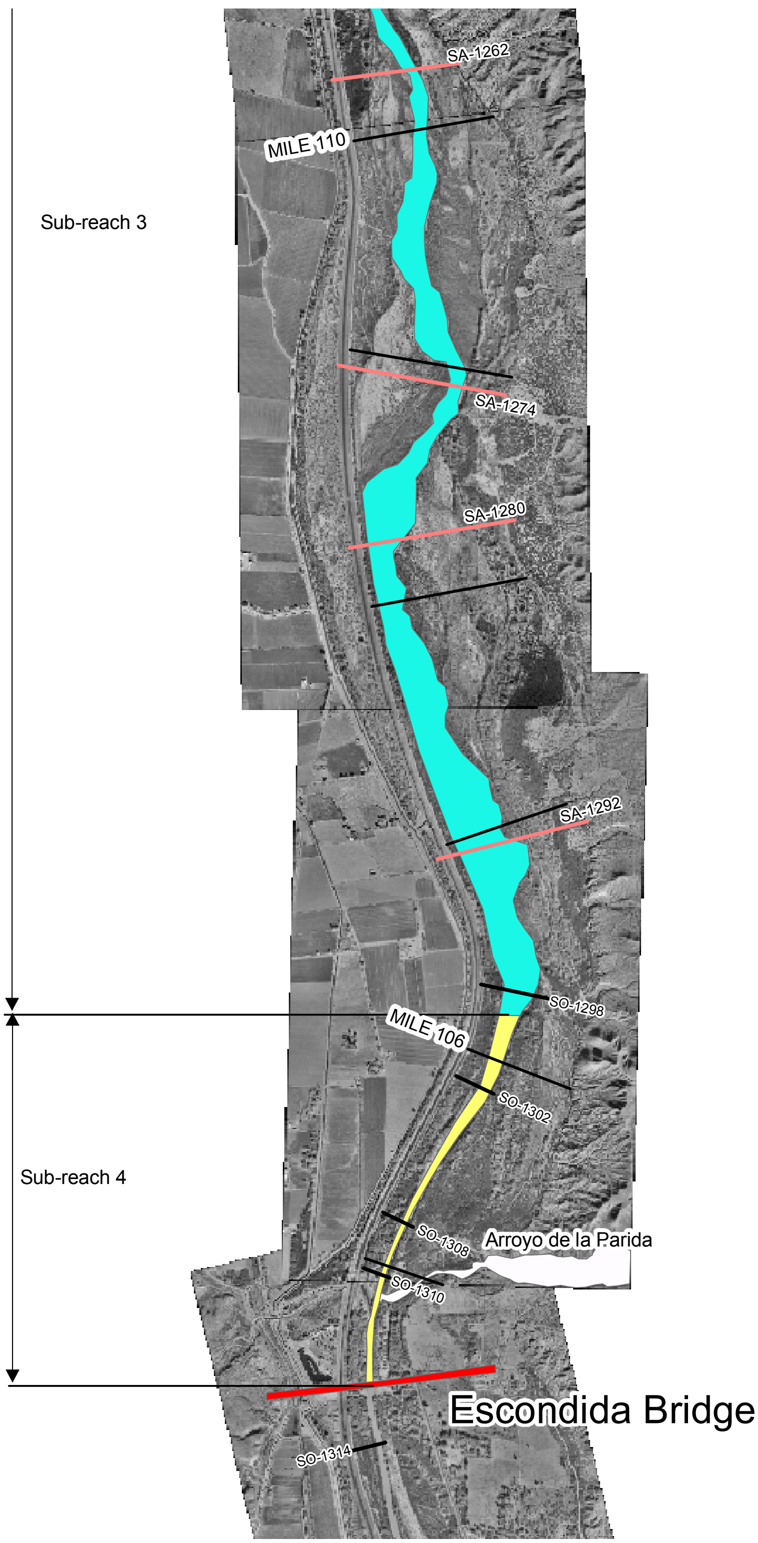


**Figure 11b**: Sub-Reach location map showing the southern portion of sub-reach 3 and sub-reach 4, Rio Grande – San Acacia Reach.

Large arroyos currently supplying sand and gravel sized sediment include the Rio Salado, Arroyo Alamillo and Arroyo de la Parida. Although the Rio Salado enters the Rio Grande just upstream of the study reach gravel transports to the mainstem are currently transported downstream of San Acacia diversion dam. Although historic levels of Rio Salado sediment supply are unknown, the size and present extent of the Rio Salado alluvial fan is similar to that found in earlier photos (1935 photos), indicating that the supply of sediment may have been similar throughout the 1900s. Current sediment sizes found in the Rio Salado alluvial fan consists dominantly of sand and gravel (Table 1), however cobble sized sediment from the Rio Salado were found in the Rio Grande channel immediately downstream of the confluence. Two medium-sized arroyos, Arroyo Alamillo (at RM 112) and Arroyo De La Parida (at RM 105), currently enter into the Rio Grande in this study reach (Figure 11). Both these arroyos transport sand, gravel and larger sized particles (Table 1) to the Rio Grande. San Lorenzo Arroyo, which historically meets the Rio Grande at approximately RM 113.5, was disconnected from the Rio Grande when the LFCC channel was built in the 1950s/1960s. These tributaries and relic sediment deposits in the channel bed/banks are important local sediment sources for the Rio Grande, but especially important as local sources of gravel.

**Table 1**: Samples of bed material from tributaries within or near the San Acacia Reach.

| Tributary | Sampling method | $d_{84}$ (mm) | $d_{50}$ (mm) | $d_{35}$ (mm) |
|---|---|---|---|---|
| Rio Salado | dry sieve | 35 | 12 | 9 |
| Arroyo Alamillo | dry sieve | 16 | 7 | 4 |
| Arroyo de la Parida | dry sieve | 22 | 8 | 6 |
| Arroyo de la Parida | surface count | 148 | 93 | 85 |