Historical Geomorphology of the Verde River

by

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Introduction

The Verde River drainage is a major river system that heads in Big Chino Valley in north-central Arizona, flows generally southeast through the rugged terrain of central Arizona, and empties into the Salt River east of the Phoenix metropolitan area. It is unusual in Arizona because much the main channel of the Verde River is perennial for much its length. Data summarized in this report were gathered to aid in the assessment of the navigability of the Verde River in February, 1912, when Arizona became a State. These investigations were conducted in cooperation with CH2MHill and were funded by the Arizona State Land Department. The purposes of this report are to (1) outline the geologic and geomorphic framework of the Verde River, (2) to describe the physical character of the channel of the Verde River, and (3) to evaluate how channel morphology and position have changed in the past century.

Physiography, Geology, and General Geomorphology of the River

The Verde River heads in and flows through the rugged highlands and valleys of central Arizona (Figure 1). The physiography and geology of the central mountain zone are transitional between the high elevation, relatively flat Colorado Plateau of northern Arizona and the lower elevation Basin and Range province of southern and western Arizona with its alternating basins and mountain ranges. The central mountain area is characterized by the most rugged relief in Arizona; large, high mountain ranges and deeply dissected alluvial basins are common. The Verde River flows from northwest to southeast through the central mountain zone of Arizona. The upper portion of the Verde drainage basin is relatively undissected. However, downstream from Big Chino Valley the Verde River is entrenched into a relatively narrow, deep canyon, and it remains entrenched well below the surrounding countryside all the way downstream to its confluence with the Salt River.

The entrenchment of the Verde River, and much of the rugged terrain along the river, reflect the dramatic downcutting of the Verde River that has occurred in the past few million years. The reasons for this downcutting are not certain. However, it is likely that the drainage in the central mountain region was generally closed during the late Miocene (5 to 10 million years ago), and has gradually become integrated as the modern regional drainage network developed in the past few million years. Broad regional uplift of the central mountain area may also have driven downcutting by the major rivers that flow through it, including the Verde, Salt, Agua Fria, Hassayampa, and Gila rivers (Péwé, 1978; Menges, 1983; Menges and Pearthree, 1989; Huckleberry, 1993).

The Verde River developed something like its modern form around 2 to 2.5 million years ago. Prior to that time, sediment was accumulating in playas or shallow lakes in Verde Valley (Bressler and Butler, 1978; Nations et al, 1981). During the time of accumulation of the Verde

Formation in Verde Valley, approximately 8 to 2 million years, drainage at the southern end of the valley was dammed or at least prevented from downcutting by a combination of volcanic activity and faulting. Dramatic downcutting of the river began in Verde Valley after 2.5 million years ago, when the natural dam was breached, and has continued to the present. The form of the Verde River upstream and downstream from Verde Valley during the past 10 million years is less clear. Upstream of Verde Valley, a closed depositional basin existed in the Perkinsville area in the late Miocene to Pliocene (about 10 to 2 million years ago; McKee and Anderson, 1971). Sometime during the late Pliocene to early Pleistocene, drainage in the Perkinsville area was captured and integrated with Verde Valley. Downstream of Verde Valley, the Verde River probably began to carve a deep valley into the landscape in the late Miocene and Pliocene, prior to integration of the Verde Valley area into the Verde River drainage system.

Long-term downcutting has continued all along the river through the Quaternary (the past 2 million years or so), leaving behind terrace deposits that record former positions of the bed of the Verde River (Figure 2; Pope and Péwé, 1973; Pope, 1974; Péwé, 1978; Pearthree, 1993; House and Pearthree, 1993). Most of these terrace deposits are thin veneers deposited on erosion surfaces carved on top of the various rock types found along the river. Verde River terraces may represent periods when the river temporarily ceased downcutting and eroded laterally and broadened its flood plain. In some cases, these terrace deposits may represent periods of aggradation and filling of the entrenched river valley (House and Pearthree, 1993). Holocene (less than 10,000 years old) terrace and channel deposits along the Verde River are quite thin, and underlying rock units are exposed at many localities in the bed of the river, implying that the long-term of trend stream downcutting has continued to the present.

Long-term downcutting and the relative erodibility of pre-Quaternary bedrock and basin-fill units effectively controls the extent and character of Quaternary alluvial deposits and the floodplain along the Verde River. The geology of the central mountain area is transitional between the relatively simple and homogeneous geology of the Colorado Plateau and the very complex, heterogenous geology of the Basin and Range. Because the geology of the central mountain area is reasonably complex and variable, the Verde River flows through a number of different types of rock units with varying susceptibility to erosion. In areas where the Verde River flows through resistant bedrock, the river valley is steep and narrow, and alluvial deposits and the floodplain are limited in extent (Figure 2B). This situation typifies nearly all of the Verde River between Paulden and the northern Verde Valley, and most of the river between southern Verde Valley and Bartlett Dam. There is little potential for substantial changes in channel position or character in these reaches. Where lithologies are less resistant to erosion, such as most of the Verde Valley and downstream from Bartlett Dam, the river valley is broad, the flood plain is relatively wide, and the potential for significant changes in channel position is much greater (Figure 2A).

Geomorphology of Verde River Channels

Even though the Verde River is entrenched in a deep valley and young alluvial deposits are thin along all of its course, most of the streambed and many of the banks of the river are formed in very young, unconsolidated alluvium. Everywhere along the river, a low-flow channel exists that conveys perennial discharges. Low-flow channels typically are shallow and 15 to 60 m wide, although the width and depth of these channels is quite variable. The bed forms of the low-flow channels are characterized by a repeating sequences of pools (deeper water areas) and riffles or rapids (shallow water areas typically dominated by cobbles and small boulders). Alternating pool-and-riffle sequences are characteristic of streams that carry coarse bedload sediment (**reference?**).

Low-flow channels of the Verde River are invariably located within a much larger channel that is shaped by large floods. These larger flood channels are typically 100 to 300 m wide, and are as wide as 1,200 m along the lower Verde River. Deposits associated with the flood channels typically are coarse gravel bars and finer sandy areas. Flood channels are evident because of freshly deposited sediment and the lack of abundant large vegetation; in many reaches, the margins of flood channels correspond with prominent banks. Young river terraces commonly exist along the margins of and slightly higher than flood channels. These terraces typically are heavily vegetated unless they have been altered by human activity. Many of these young terraces are part of the floodplain, as they are inundated during large floods. Flooding on terraces is relatively shallow and the impact of flooding on the terrace vegetation is typically is not great.

The young alluvium that forms the channel bed and low banks of the Verde River is generally composed of coarse gravelly deposits and much finer sandy overbank or slackwater deposits. This young sediment does not have much cohesion and is susceptible to scour and bank erosion during large flow events. Older river deposits typically are coarse, and underlying rock units are indurated to a greater or lesser degree. These units are much more resistant to lateral bank erosion than young stream deposits. Thus, the potential for changes in channel morphology and shifts in channel position during large floods is greatest in areas where young terraces are extensive. However, young terraces commonly have relatively dense and large vegetation, which tends to stabilize these deposits.

The geologic floodplain of the Verde River is coincident with the extent of young channel deposits and low terraces along the river. As used in this report, the geologic floodplain is the area along the river that has been subject to erosion and deposition by the Verde River in the past few thousand years. Changes in channel position that have occurred during the past few thousand years have occurred within the limits of the geologic floodplain. The geologic floodplain is bounded by older geologic units such as bedrock, basin-fill sediments, older deposits of the Verde River, or alluvial fan or terrace deposits of tributary streams. Usually, the margins of the geologic floodplain are associated with significant topographic relief that constrains lateral migration of the Verde River channel.

Data Used to Reconstruct Historical Channel Form and Position

Two sources of data were utilized to evaluate the nature of any possible changes in character or position of the channels of the Verde River. Historical aerial photographs dating from the 1980, 1972, and 1953 or 1954 were obtained for virtually all of the Verde River; aerial photographs dating to the 1946 or 1950 were available for most of Verde Valley. Data and notes from land surveys conducted in the late 1800's and early 1900's provide some information about channel form and position at times much closer to statehood. The usefulness of this cadastral survey information varies considerably from survey to survey, depending on the objective of the survey and the care taken to record observations of the river channel.

Historical aerial photographs were utilized to evaluate potential changes in channel form and position during the past four decades. Defining the extent of channels using aerial photographs is not simple or straightforward. Two main criteria that can be observed on aerial photographs were used to define the extent of channels in this study: (1) prominent, recognizable channel banks; and (2) the absence of abundant vegetation, indicating that the area had fairly recently been swept by significant flow. In ideal situations, these two criteria correspond. In general, however, the latter criterion was utilized more than the former because of the lack of definitive channel banks in many areas. In other reaches, heavily vegetated areas were included within the channel because multiple small channels flow through them. The channels defined using historical aerial photographs correspond to the flood channels discussed earlier, and almost certainly exceed the "ordinary high-water marks".

Historical surveys of township and range section boundaries provide abundant information regarding low-flow channels of the Verde River in Verde Valley, but provide limited information regarding the nature and positions of flood channels. Surveyors in the 1870's typically noted the width and sometimes the depth and general character of channels containing water as they crossed them (Foster, 1873, 1877). They did not provide sufficiently detailed description of the areas adjacent to the low-flow channels to permit evaluation of the character and extent of flood channels. However, a resurvey conducted in the Camp Verde area in 1892 following the large flood of 1891 (Drummond, 1892) documented the existence of a flood channel that is comparable to the modern flood channel. Most of the lower Verde River was surveyed in 1911 (Farmer, 1911), very close to the time of statehood. The channel of the Verde River that was documented in this survey was also clearly the flood channel, because it has very similar dimensions as flood channels interpreted from aerial photographs.

Historical Changes in Channel Position and Form

Aerial photographs from the 1950's and 1980's along the Verde River from Perkinsville to the confluence with the Salt River reveal no dramatic shifts in flood-channel position nor changes in general flood-channel form during this period. Positions of flood channels at various times were plotted at 1:24,000-scale in the Verde Valley and along the lower Verde River downstream from Bartlett Dam in order to investigate in more detail whether lateral bank erosion and shifts in channel position had occurred (Figures 7 and 8). In the Camp Verde area and along much of the lower Verde River, positions of flood channels in the late 1800's and early 1900's were documented using land survey data. In the sections below I discuss the evolution flood channels in Verde Valley and along the lower Verde River, and consider the character of low-flow channels through time.

Flood Channels. The character of flood channels of the Verde River has changed little during the period of photographic record (since about 1950), but locally there have been substantial changes in channel width during this time. In the Verde Valley, the general tendency was for channels to become narrower between 1950 and 1972 (Figure 3; Tables 5 and 6). During this interval there was a fairly large flood on the Verde River in 1952, but none thereafter (Figure 4). Between 1972 and 1980, channels widened considerably in many places (typically outer sides of meander bends); in a few places, however, channels were narrower in 1980 than they were in 1972. Channel widening most likely occurred during the large floods on the Verde River in 1978 (2 floods) and 1980.

There was a slight tendency for net channel widening between 1950 and 1980. Channel width increased at eight (8) section-line crossings, with a maximum widening of 100 m (Table 1). Channel width decreased at four (4) section-line crossings during this same interval, with a maximum narrowing of 165 m. The most extreme increases and decreases in channel width in Verde Valley between 1954 and 1980 were 220 m and 130 m, respectively (Table 2). Along much of the Verde River in Verde Valley, however, there was little or no change in channel width between 1950 and 1980 (Plate 1). More than 50 percent of the section-line crossings (16) exhibited no net change in channel width during this period.

The history of the flood channel of the Verde River is more complete and interesting in the Camp Verde area because of the land survey conducted there 1892 (Drummond, 1892). In addition, aerial photographs from 1946, 1954, 1972, and 1980 cover this area. The flood of 1891 was the largest during the historical period, and probably was one of the largest floods on the Verde River during the past 1,000 years (Ely and Baker, 1985; House and others, 1995). The flood channel that existed immediately after the flood had dimensions similar to the modern channel. The 1891 flood probably caused a considerable amount of change in flood-channel position and possibly morphology. The survey of 1892 specifically recorded the new positions of "meanders" of the Verde River in the Camp Verde area, and several hundred acres of "fine bottomland" were washed away in the flood and replaced by channel gravel (Drummond, 1892).

The position of the flood channel changed somewhat between 1892 and 1946, but there were no dramatic shifts in channel position. The channel widened in some places and narrowed in others, but on balance it did not change very much (Table 1; Figure 3a). There were several large floods during the period between 1892 and 1946 (Figure 4), and they evidently maintained or renewed the flood channel of the Verde River. The width of the channel generally decreased between 1946 and 1954; some of the decreases in channel width were fairly dramatic (Figure 3b). A fairly large flood was recorded downstream on the Verde River in 1952, but it evidently did not dramatically impact the flood channels in the Camp Verde area. Human encroachment on the flood channel probably caused much of the channel narrowing. By 1980, the flood channel was generally wider than in 1954 (Figure 3c). It is likely that the Verde River effectively reclaimed much of its flood channel during the floods of 1978 and 1980. The Verde River generally followed the same course in 1980 as it had in 1892, although the position of the flood channel changed somewhat during this interval (Figure 3d). The width of the flood channel in 1980 generally was somewhat narrower than in 1892 (Table 1; Table 2).

Changes in channel width during this century were more dramatic along the lower Verde River. The land survey of 1911 (Farmer, 1911) shows a wide flood channel (Figure 5; Table 3). The flood channel narrowed somewhat between 1911 and 1953 and locations of channel margins shifted in a few localities (Figure 5a). By 1972, however, after an interval of 20 years without large floods, the flood channel was 1000 m or more narrower at a number of localities (Figure 5b). The floods of 1978 and 1980 almost invariably reoccupied the same flood channels that existed in 1953, so the net changes in channel widths between 1953 and 1980 were not great (Table 3). The net changes in channel width between 1911 and 1980 generally were modest, although the 1911 channel was somewhat wider on balance. At several localities, such as at the confluence with Sycamore Creek and in Section 31, T4N, R7E, fairly significant changes in channel position have occurred since the time of statehood.

Low-Flow Channels. Cadastral surveys from the 1870's record evidence of a continuous low-flow channel throughout Verde Valley that was very similar to the modern low-flow channel of the Verde River. Surveys conducted by Foster in 1873 and 1877 documented a through-going stream about 0.5 m deep and 15 to 30 m wide with a sandy bottom. It is not clear from the survey notes whether this low-flow channel was within a well-defined flood channel. The Verde River of the 1870's was described as "a beautiful stream of clear, pure water with an average width of 100 links (66 ft) and an average depth of 3 feet" (Foster, 1877; see Table 4). The banks of the low-flow channel were estimated to be 3 ft (consistent with the depth estimate). Cottonwoods, willows, and mesquite lined much of the river bank. The low-flow channel clearly existed within a much broader geologic floodplain, described in the survey as bottomland with large amounts of fine farming and grazing land (Foster, 1873). A significant amount of irrigated farming was underway in the bottomlands by 1873-77. The land surveys of the 1870's did not describe marshy land adjacent to the Verde River, nor did they document any areas where the low-flow channel was ill-defined. A resurvey conducted in 1916 in the Camp Verde area records wetted channels about 60 to 120 m wide, and in a number of places the surveying team could not directly survey across the river because it was too swift and deep (Richards, 1916). It may be that 1916 was an unusually wet winter, resulting in increased flow in the Verde River relative to 1873 and 1877.

The low-flow channel along the lower Verde River documented in 1911 was shallow and somewhat wider than the low-flow channel in Verde Valley. The land survey of 1911 recorded wetted channel ranging from about 3 to 6 chains (180 to 360 ft) wide and 1 to 4 ft deep (Farmer, 1911). This low-flow channel was within a much larger flood channel. The flood channel evidently was quite obvious, as it was the primary channel noted in the survey data and notes. The banks of the flood channel were fringed with cottonwoods and mesquite.

Positions of low-flow channels clearly have changed substantially through the past century. Substantial changes in the positions of the banks of flood channels have dictated changes in the areas within which the low-flow channels can flow. In addition, the positions of low-flow channels have changed after floods in reaches where the flood channel has remained fairly stable. An example of the extent of change in low-flow channel positions in Verde Valley is shown in Figure 6. In this area, many substantial changes in channel position occurred between the original survey in 1877 and 1950. Several large floods occurred during this period, as was noted above, and substantial changes in flood-channel positions probably occurred as well. In the Clarkdale area, human activity likely significantly altered the position of the low-flow channel as well. Changes in position of low-flow channels between 1950 and 1970 were very limited, but the floods of 1978 and 1980 evidently caused some substantial changes in channel position.

Conclusions

Regional physiography and the long-term evolution of the Verde River exert a strong influence on the extent and character of its floodplain. The Verde River flows through some of the most rugged country in Arizona. During the past several million years, the Verde River has downcut hundreds of feet, occasionally leaving terrace deposits behind as a record of former valley floors. Because of this long-term downcutting, the Verde River is confined within a steep, narrow valley along much of its length. In these confined reaches, the floodplain is limited in extent, and the potential for changes in channel positions is also limited. The potential for changes in channel form and position is greater in Verde Valley and along the lower Verde River below Bartlett Dam, where the floodplain is relatively broad.

The general form of low-flow channels of the Verde River is quite similar along its length. Low-flow channels typically are 15 to 60 m wide, and they wind through a much larger flood channel. The flood channel has well-defined banks in some places but no obvious banks in other areas. The width of flood channels varies substantially, from about 60 to 1000 m wide. The width of the flood channel depends in large part on the character and width of the geologic flood plain, which is controlled by the erodibility of underlying rock units. Areas inundated during large floods typically include low terraces and vegetated slackwater areas. In confined canyon reaches, the entire canyon bottom (channel and low terraces) is inundated during large floods.

The character and position of Verde River channels during the historical period was investigated in Verde Valley and along the lower Verde River. Several generations of historical aerial photographs indicate that low-flow channels have shifted positions in many reaches, but the larger-scale features of the flood channel are fairly consistent. Modest changes in positions of flood-channel banks and total widths have occurred in many places, but other reaches exhibit little or no change during the past few decades. In most areas, the large floods of 1978 or 1980 occupied the same flood channels that were evident in 1953-54. Historical land surveys in the Camp Verde area and along the lower Verde River reveal that the general form of the flood channels of the Verde River have not changed substantially since the time of statehood. Low-flow channels have shifted position to a greater degree than the larger flood channels. The size and general form of low-flow channels in Verde Valley, however, was about the same in the 1870's as it is today.

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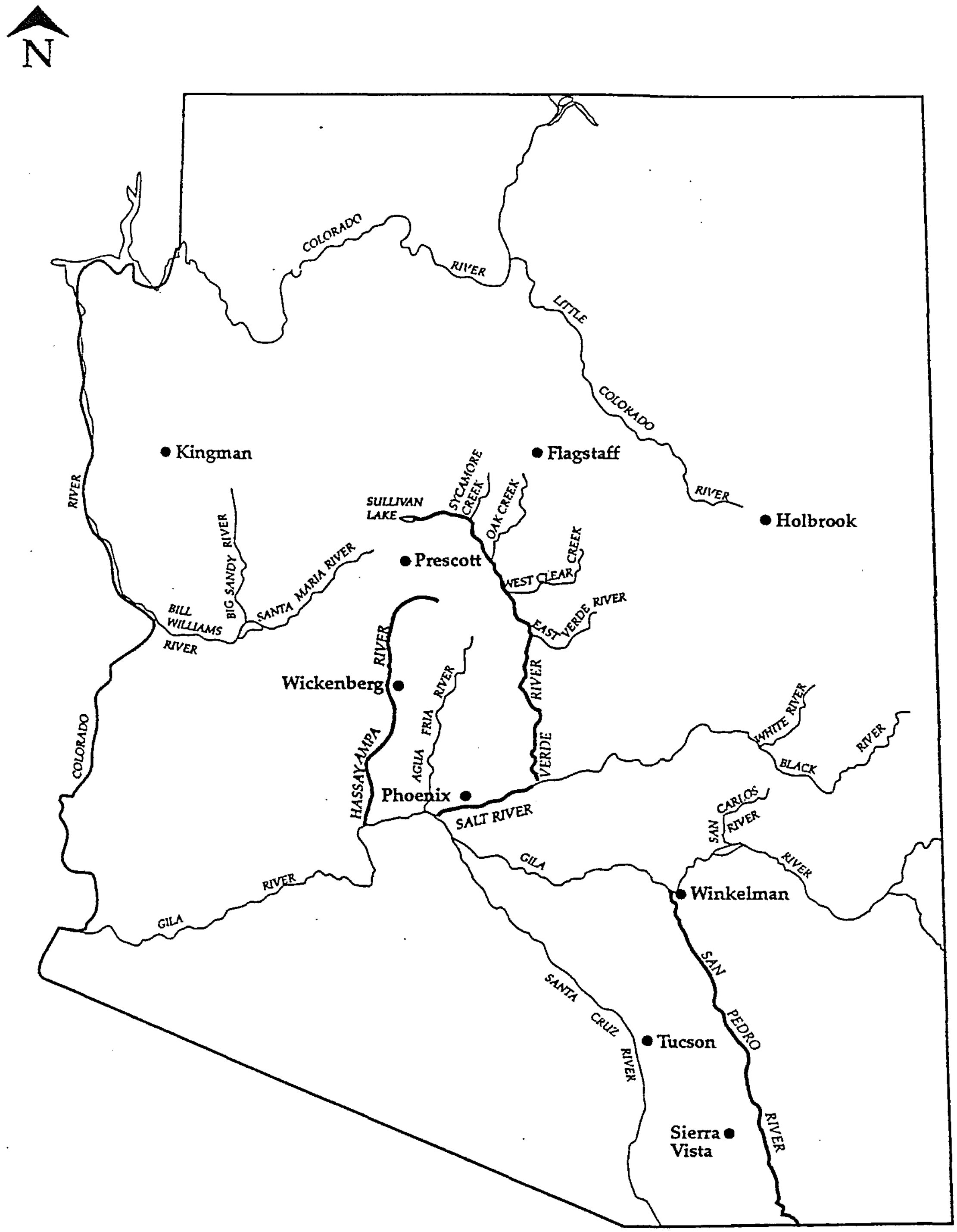


Figure 1. Location map for the Verde River and other major rivers of Arizona. The Verde River, shown by a bold line in this figure, heads in and flows through the rugged mountain region of central Arizona. The Verde River is deeply entrenched into the landscape and the channel and floodplain of the river are limited in extent and confined by canyon walls along much of its course.

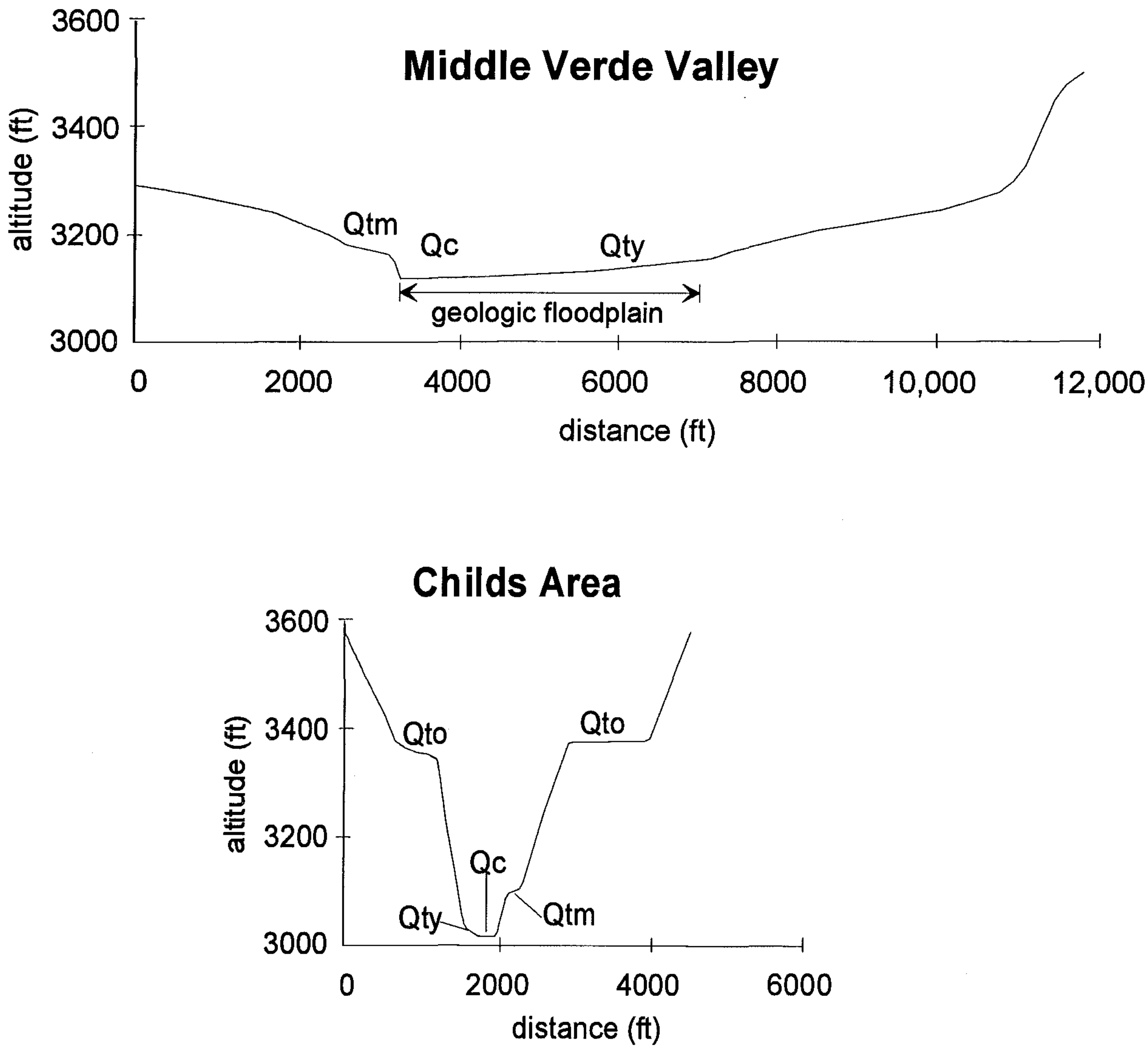


Figure 2. Topographic cross sections of the Verde River valley illustrating differences in the topographic confinement of the river. The Verde River has been confined to areas shown as Qc (active channels) and Qty (young terraces) during the past 10,000 years or so. Older river deposits dating to the middle (Qtm) and early (Qto) Pleistocene record former positions of the valley floor left behind as the river continued to downcut. The potential for changes in channel position is much greater in reaches where the floodplain is broad, such as the middle Verde Valley area. The position of the channel cannot change substantially and the entire valley bottom may be inundated during large floods in reaches where the river is topographically confined, such as the Childs area.

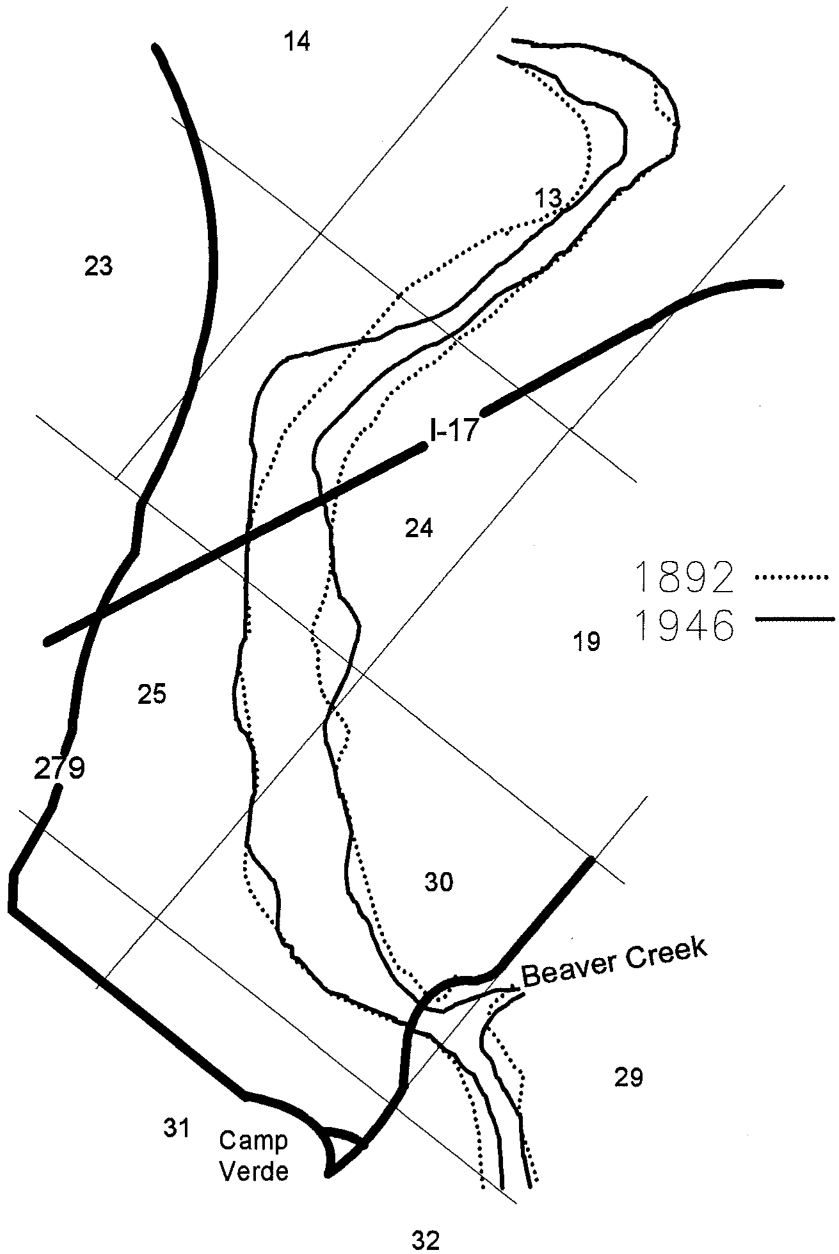


Figure 3a. Changes in the position and width of the flood channel of the Verde River in the Camp Verde area between 1892 and 1946. Channel positions in 1892 were surveyed by Drummond (BLM archives). Channel positions in 1946 were interpreted from aerial photographs.

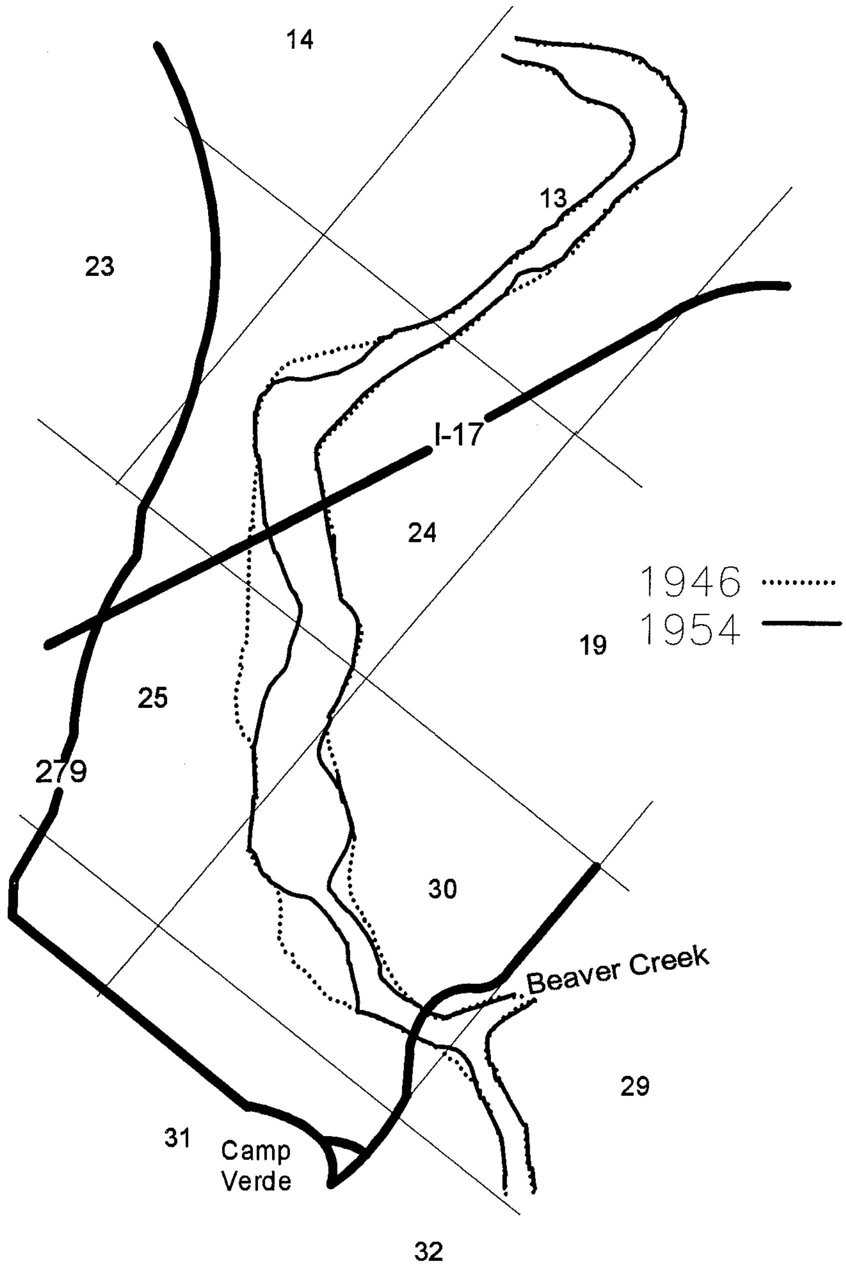


Figure 3b. Changes in the position and width of the flood channel of the Verde River in the Camp Verde area between 1946 and 1954. Channel positions were interpreted from aerial photographs.

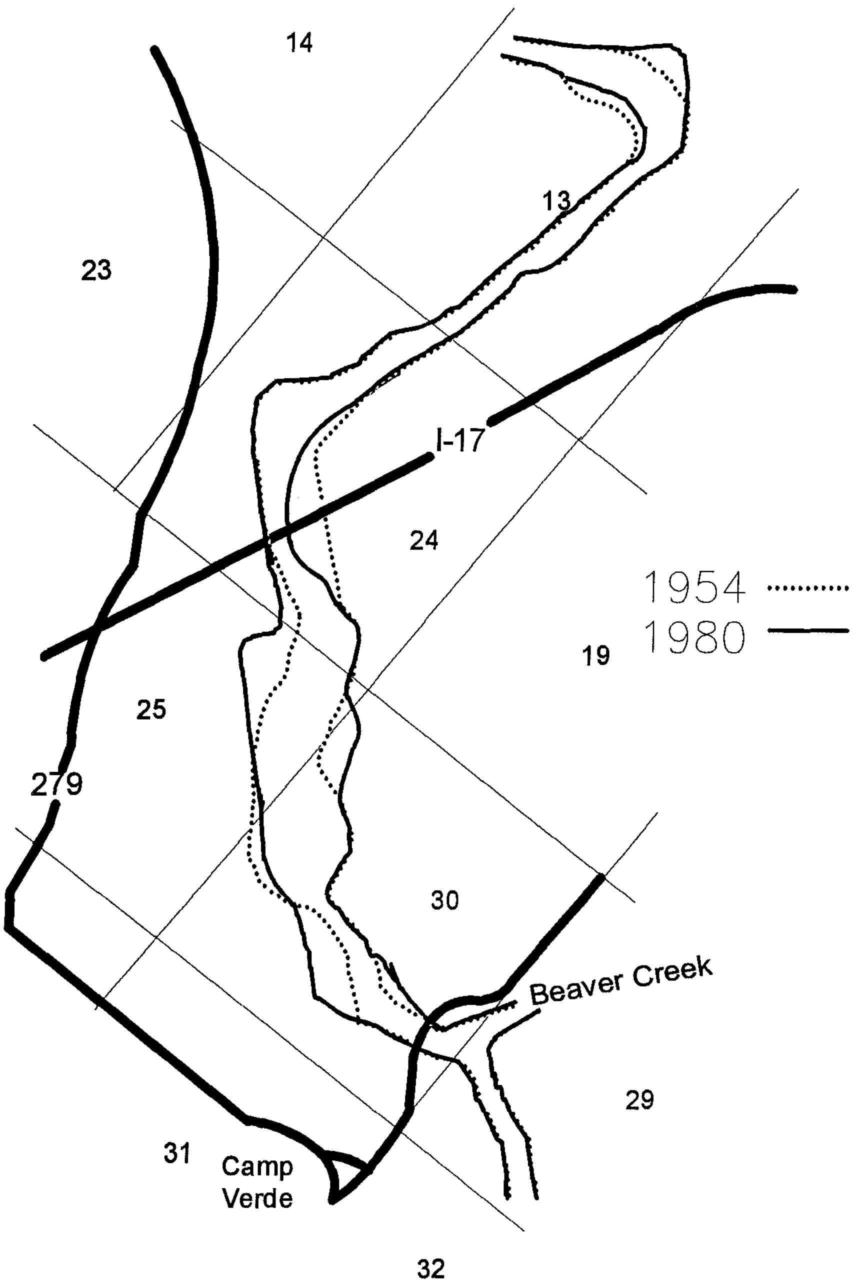


Figure 3c. Changes in the position and width of the flood channel of the Verde River in the Camp Verde area between 1954 and 1980. Channel positions were interpreted from aerial photographs.

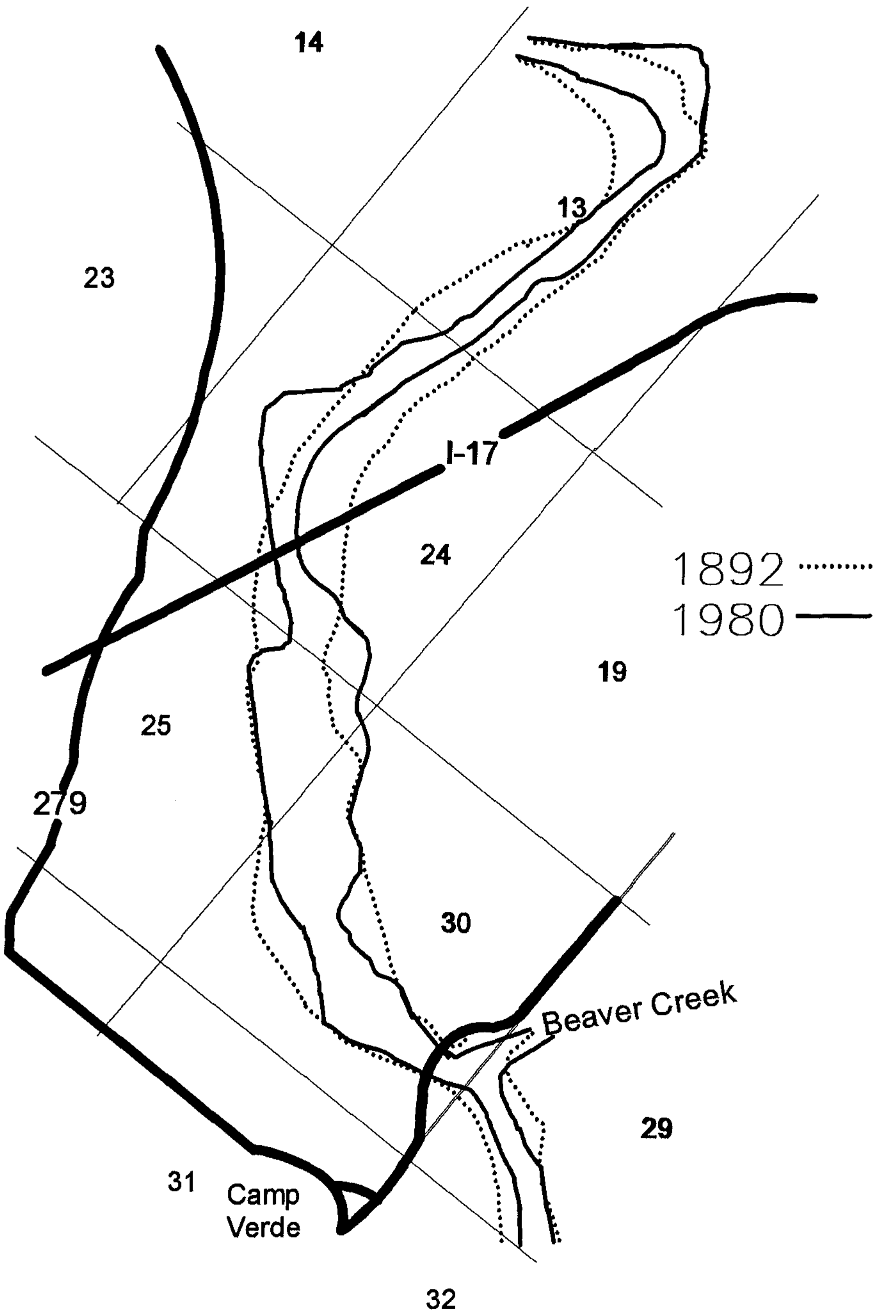


Figure 3d. Net changes in the position and width of the flood channel of the Verde River in the Camp Verde area between 1892 and 1980.

Figure 4a. **Annual Maximum Flood Series: Verde River at Clarkdale**

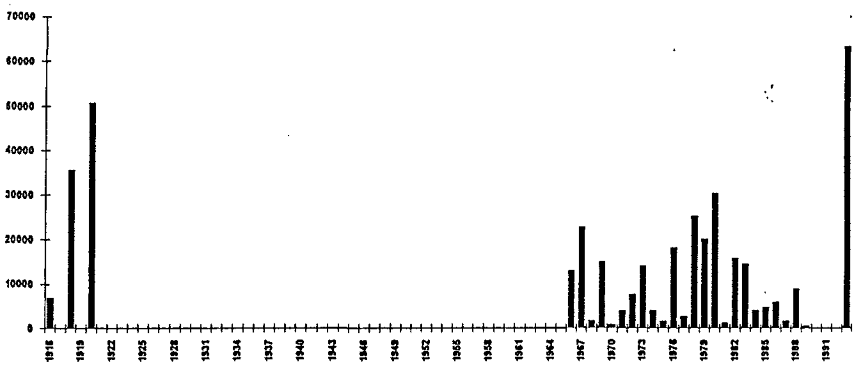


Figure 4b. **Annual Maximum Flood Series: Verde River Near (1934-1945, 1989-1993) and Below (1970-1980) Camp Verde**

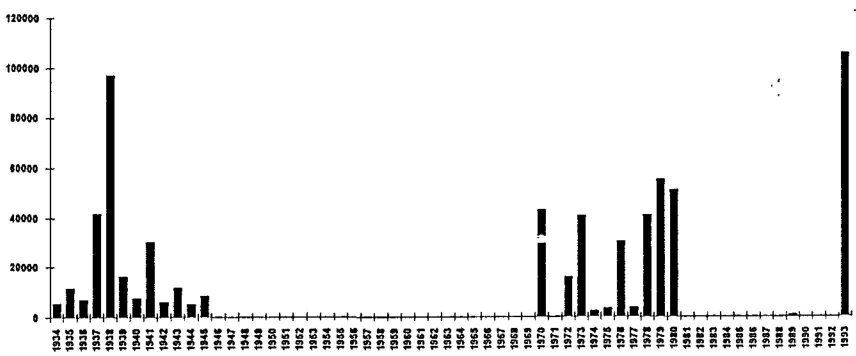
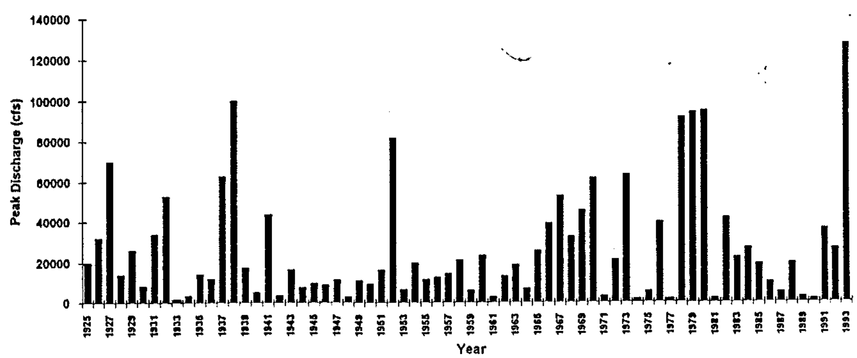


Figure 4c. **Verde River Below Tangle Creek: Annual Maximum Flood Series 1925-1993**



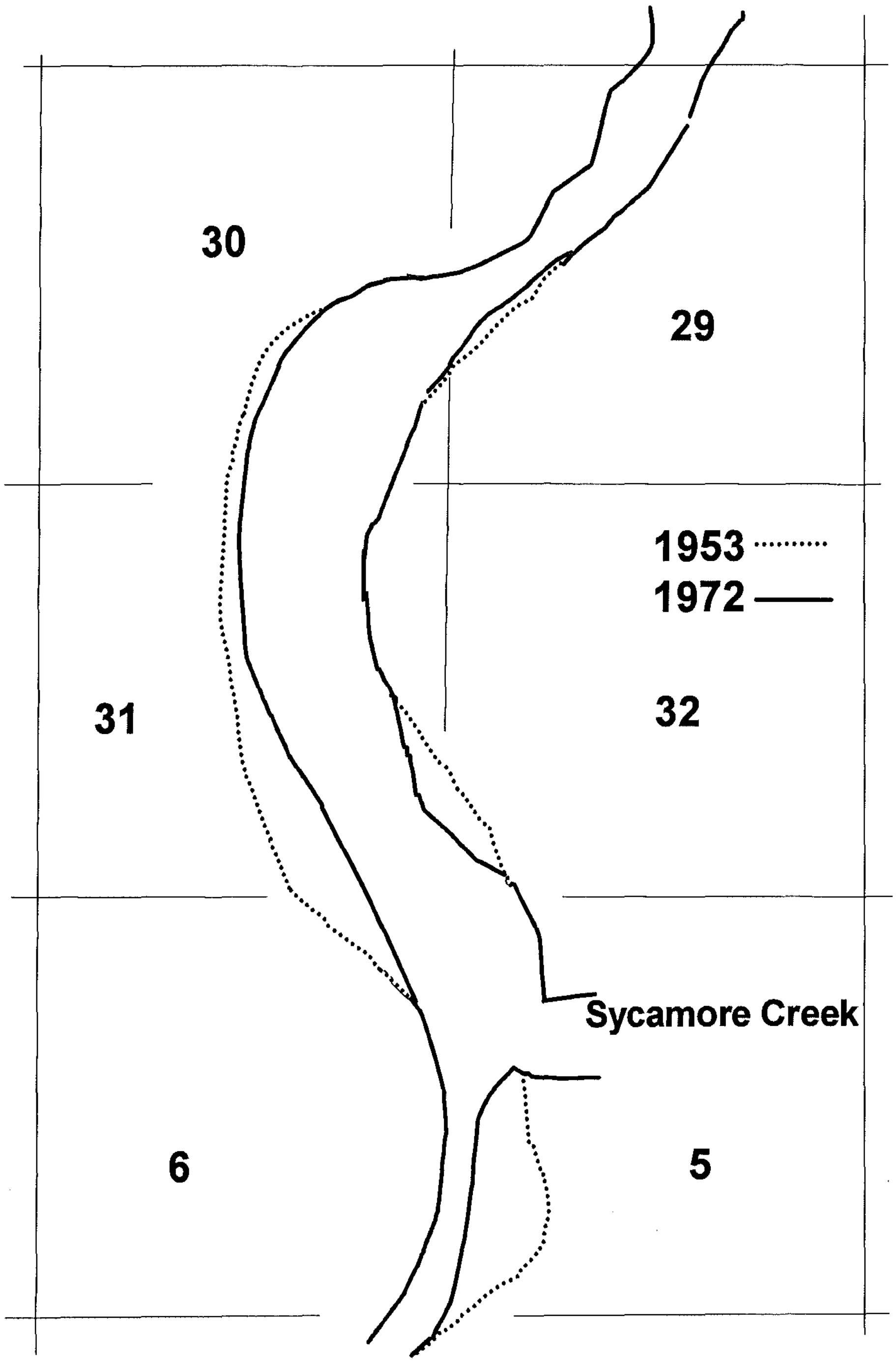


Figure 5b. Changes in the position and width of the flood channel of the lower Verde River near Sycamore Creek between 1953 and 1972.

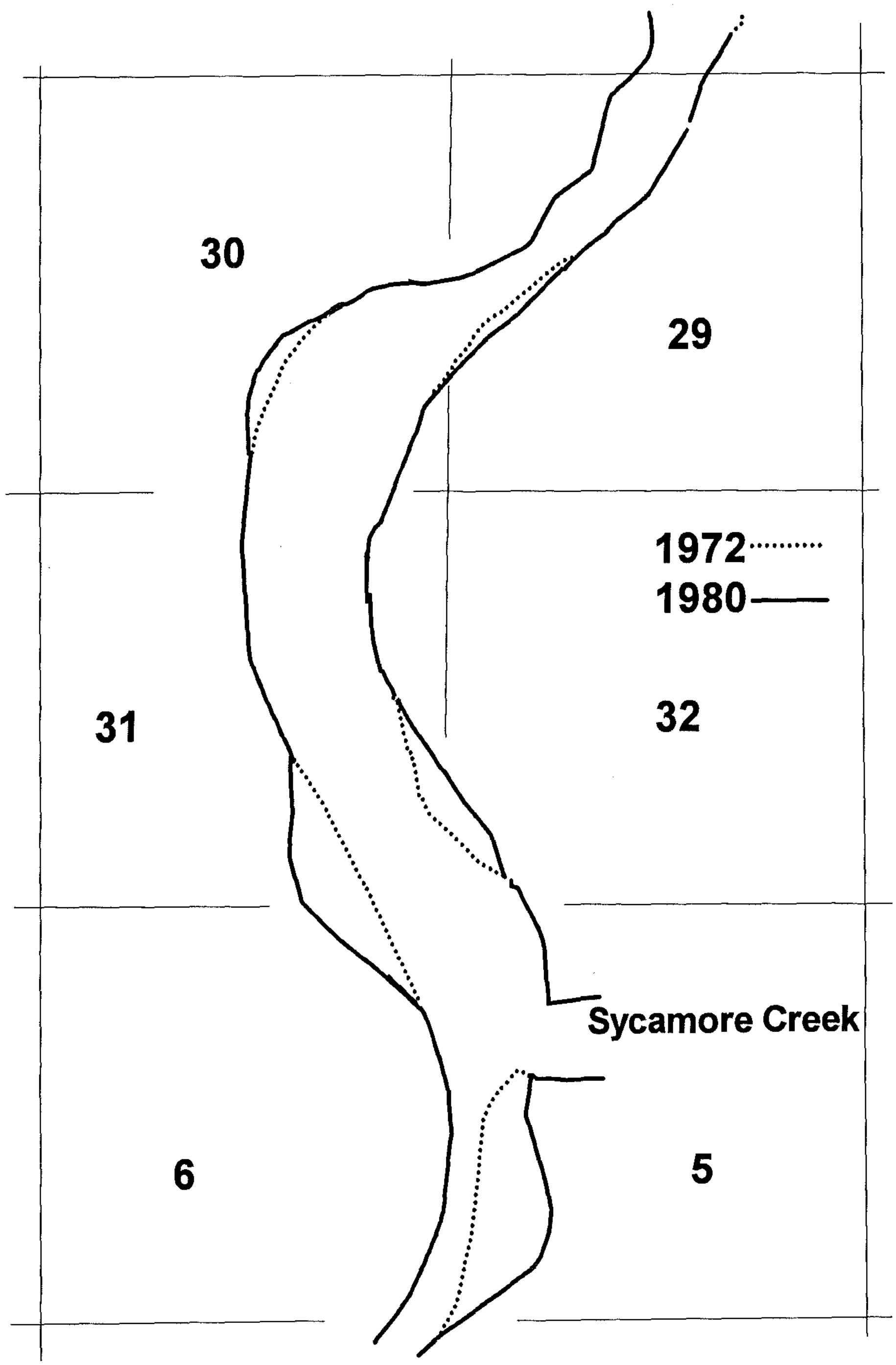


Figure 5c. Changes in the position and width of the flood channel of the lower Verde River near Sycamore Creek between 1972 and 1980.

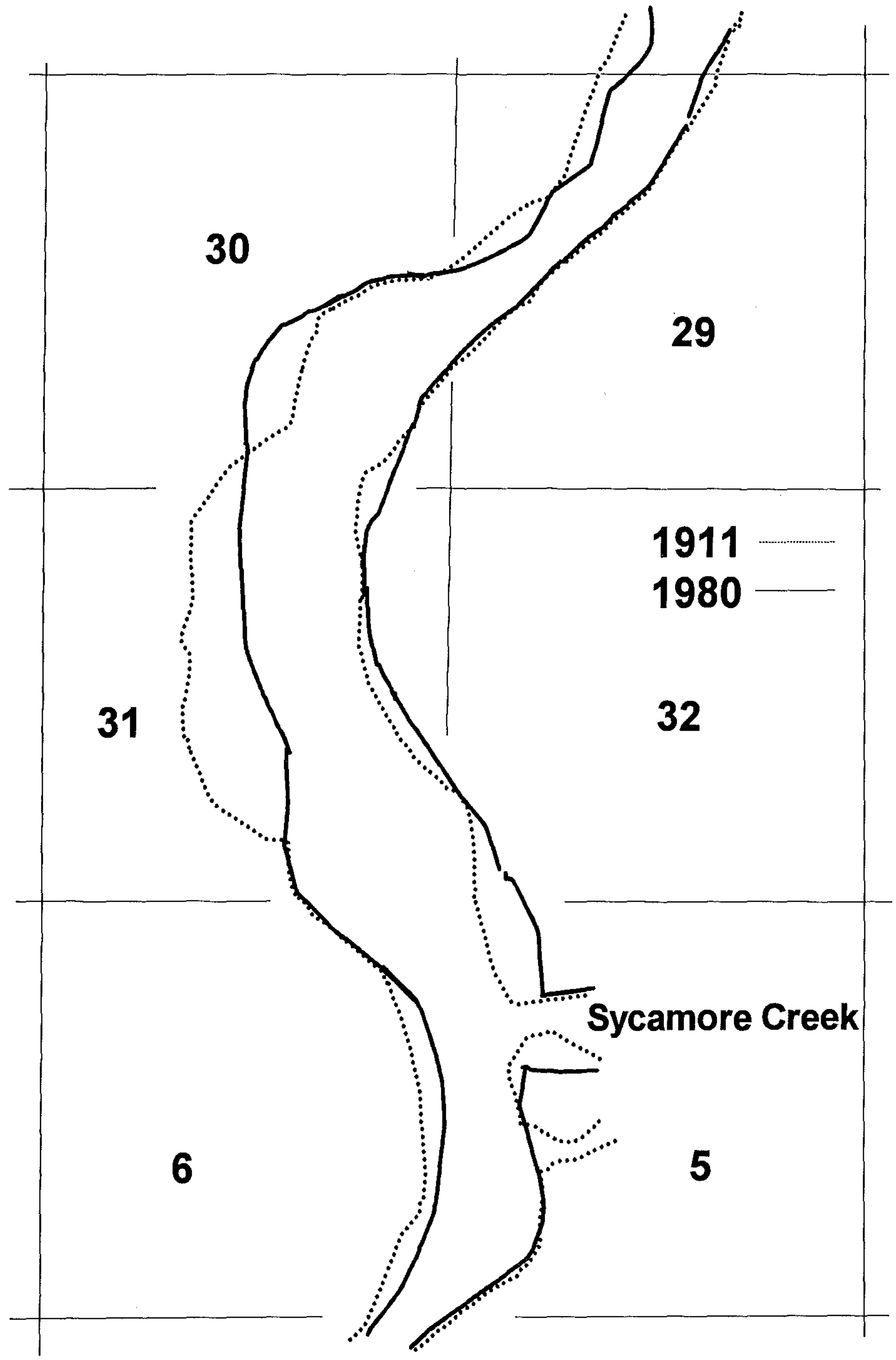


Figure 5d. Net changes in the position and width of the flood channel of the lower Verde River near Sycamore Creek between 1911 and 1980.

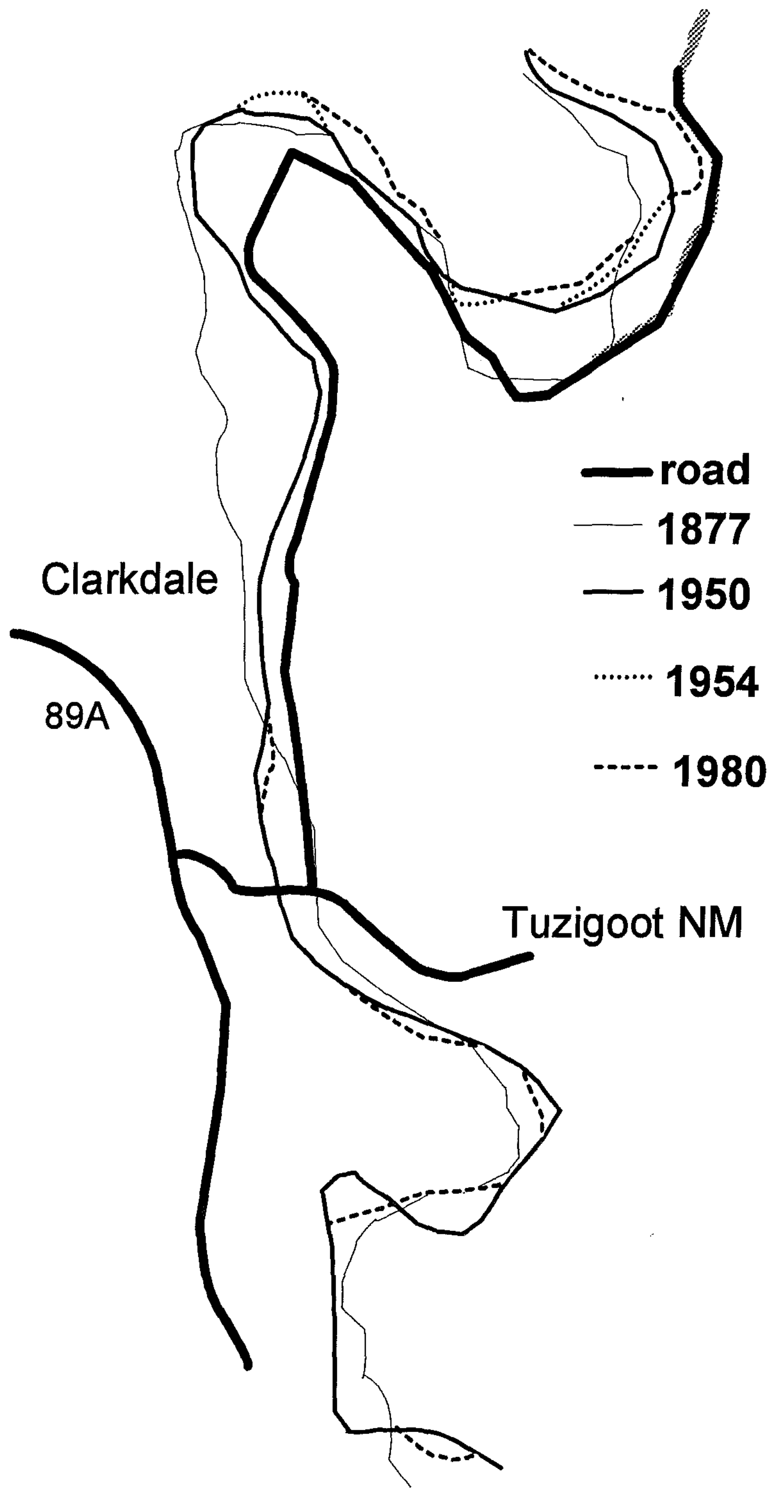


Figure 6. Historical changes in low-flow channel positions in the Clarkdale-Tuzigoot area.

LOCATION		CHANNEL WIDTH (ft)				NET CHANGE (ft)			
Township	**Section Line**	**1892**	**1946, 1950**	**1954**	**1980**	**1892 to1950**	**1950 to1954**	**1954 to1980**	**total change**
T13NR5E	6/7	1040	1040	800	1040	0	-240	240	0
	5/6	1520	n.d.	960	960		-560*	-560	
T14NR5E	32/5	1280	n.d.	720	720		-560*	0	-560
	29/32	1200	720	720	880	-480	0	160	-320
	30/29	720	400	320	320	-320	-80	0	-400
T14NR4E	25/30	2240	1920	1600	2240	-320	-320	640	0
	24/25	1440	2160	1200	1520	720	-960	320	80
	13/24	1280	480	480	480	-800	0	0	-800
	14/13	240	240	240	240	0	0	0	0
	11/14	n.d.	640	480	640		-160	160	0
	2/11		640	640	800		0	160	160
	3/2		640	640	640		0	0	0
	4/3		1280	1280	1280		0	0	0
T15NR4E	33/4		1040	960	960		-80	0	-80
	29/28/32/33		640	640	640		0	0	0
	20/21/29/28		0	720	720			0	0
	19/20		480	480	800		0	320	320
	18/19		320	320	320		0	0	0
	7/18		560	560	560		0	0	0
T15NR3E	12/7		880	880	1040		0	160	160
	1/12		240	240	240		0	0	0
	2/1		640	640	640		0	0	0
T16NR3E	35/2		400	240	400		-160	160	0
	26/35		720	640	800		-80	160	80
	27/26		560	400	400		-160	0	-160
	28/27		1200	1200	1200		0	0	0
	27/28		400	400	400		0	0	0
	22/27		320	320	480		0	160	160
	21/22		240	240	320		0	80	80
	20/21		240	240	240		0	0	0
	17/20		480	480	480		0	0	0

Table 1. Changes in widths of flood channels of the Verde River since 1892 in the Verde Valley. Channel widths were measured along section lines, and generally are not perpendicular to the trend of the river and are greater than true channel widths. Channel widths were surveyed by Drummond (1892), shortly after the large flood of 1891. Subsequent channel widths were interpreted from historical aerial photographs.

Location	Channel Width (ft)				Change in Width (ft)			
Verde Valley	**1892**	**1954**	**1972**	**1980**	**1892 to 1954**	**1954 1972**	**1972 1980**	**net change**
T13NR5E								
SEC 26	n.d.	240	240	800	n.d.	0	560	560
SEC 22	n.d.	360	360	800	n.d.	0	440	440
SEC 6	1360	640	640	1040	-720	0	400	-320
T14NR5E								
SEC 30	1680	320	1200	880	-1360	880	-320	-800
T14NR4E								
SEC 25	1680	1040	1760	1760	-640	720	0	80
SEC 24	1040	1280	960	1120	240	-320	160	80
SEC 2	n.d.	880	320	880	n.d.	-560	560	0
T15NR4E								
SEC 19	n.d.	320	320	800	n.d.	0	480	480
T16NR3E								
SEC 35	n.d.	480	680	960	n.d.	200	280	480
SEC 28	n.d.	640	800	960	n.d.	160	160	320
SEC 21	n.d.	640	420	480	n.d.	-220	60	-160
SEC 8	n.d.	1200	320	800	n.d.	-880	480	-400
SEC 8/7	n.d.	880	240	450	n.d.	-640	210	-430
Lower Verde River	**1911**	**1953**	**1972**	**1980**	**1911 to 1953**	**1953 to 1972**	**1972 to 1980**	**net change**
T3NR7E								
SEC 19	1840	1200	1200	1840	-640	0	640	0
SEC 18	2640	2400	1040	2400	-240	-1360	1360	-240
SEC 5/6	1600	1280	400	1280	-320	-880	880	-320
T4NR7E								
SEC 31	2640	2240	1040	1600	-400	-1200	560	-1040
SEC 18/17	2560	2400	900	2400	-160	-1500	1500	-160
SEC 5		1000	400	1000		-600	600	0
T5N R7E								
SEC 30/29		3200	560	3200		-2640	2640	0
~SEC 8		320	400	640		80	240	320

Table 2. Extreme changes in flood channel width on the Verde River. "Net change" refers to the difference in channel width between the earliest record and 1980 for any particular site. Channels were generally widest around 1900 (shortly after the large flood of 1891), and narrowed through 1972 at most localities. Channel widths increased again during the floods of 1978 and/or 1980.

LOCATION		CHANNEL WIDTH (ft)				NET CHANGE (ft)			
Township	**Section Line**	**1911**	**1953**	**1972**	**1980**	**1911 to 1953**	**1953 to 1972**	**1972 to 1980**	**net change**
T3NR7E	32/5	n.d.	800	800	1040			240	240
	31/32	n.d.	1200	1200	1680			480	480
	30/29/31/32	1280	1840	1840	1840	560	0	0	560
	20/19/30/29	1680	1520	1520	1520	-160	0	0	-160
	18/19	1920	1920	1920	2160	0	0	240	240
	7 to 18	2400	2400	960	2400	0	-1440	1440	0
	6/5/7/8	1280	1040	720	1120	-240	-320	400	-160
T4NR7E	31/32/6/5	2320	2880	2000	2880	560	-880	880	560
	30/31	1920	1920	1920	1920	0	0	0	0
	29/30	1360	1120	1120	1120	-240	0	0	-240
	20/29	1520	960	960	960	-560	0	0	-560
	17/20	1920	2160	1520	2160	240	-640	640	240
	7/8/18/17	2480	2480	1200	2480	0	-1280	1280	0
	5 to 8	1040	1040	880	1040	0	-160	160	0
T5NR7E	32/5	n.d.	800	800	800		0	0	0
	29/32	n.d.	1280	1280	1280		0	0	0
	19/20/30/29	n.d.	4800	1760	4800		-3040	3040	0

Table 3. Changes in widths of flood channels of the lower Verde River below Bartlett Dam. Channel widths were measured along section lines, and generally are perpendicular to the trend of the river and are not true channel widths. Channel widths were surveyed by Farmer (1911). Subsequent channel widths were interpreted from historical aerial photographs.

Quadrangle	Township	Section Line	Channel Width		
			1873-76		modern
			Chains	(ft)	(ft)
Horner Mtn. (1967)	T13NR5E	36S	1.10	73	80
		35/36	1.00	66	120
		35S E	1.00	66	160
		35S W	1.00	66	80
		26/35	1.00	66	160
		27/26	1.20	79	200
		34/27	1.20	79	120
		27/34	1.20	79	200
		22/27	1.00	66	120
Camp Verde (1969)		21/22	1.10	73	160
		20/21	1.00	66	160
		17/20	0.75	50	120
		16/17	0.60	40	200
		9/16	0.75	50	120
		8/9	0.80	53	120
		7/8	1.00	66	120
		6/7	1.00	66	80
		5/6	1.50	99	120
	T14NR5E	32/5	1.20	79	80
		14/13	1.00	66	160
		11/14	1.10	73	120

Table 4. Low-flow channel widths of the Verde River in the 1870's and around 1970. Channel widths from the 1870's were documented by the original cadastral surveys of the area. Surveys noted channel conveying water at the time of the survey, most likely equivalent to the modern low-flow or base-flow channels. Low-flow channel widths from around 1970 were obtained from 1:24,000-scale U.S. Geological Survey topographic quadrangles. Publication dates for the quadrangles are indicated in parentheses.

Quadrangle	Township	Section Line	Channel Width		
			1873-76		modern
			Chains	(ft)	(ft)
Cornville (1968)	T14NR4E	2/11	0.90	59	120
		3/2	0.90	59	80
		4/3	1.20	79	80
	T15NR4E	33/4	1.00	66	80
		21/28	1.00	66	80
		20/21	1.25	83	120
		19/20	0.70	46	80
		18/19	0.70	46	80
		17/18	0.80	53	80
		18/17	0.65	43	80
		7/18	0.75	50	60
	T15NR3E	1/12	0.90	59	20
		2/1	1.00	66	80
	T16NR3E	35/2	1.00	66	80
		26/35	1.10	73	60
Clarkdale (1973)		28/27	0.65	43	100
		22/27	1.10	73	80
		21/22	2.00	132	80
		20/21	1.10	73	240
		17/20	1.00	66	80
		17/7	1.10	73	120
		7/8	0.90	59	60
		8/9	1.00	66	80
		8N	0.80	53	80

Table 4. (Continued).