

IN THE SUPERIOR COURT OF THE STATE OF ARIZONA
IN AND FOR THE COUNTY OF MARICOPA

IN CHAMBERS (X) IN OPEN COURT ()

SPECIAL MASTER JOHN E. THORSON
Presiding

IN RE THE GENERAL ADJUDICATION
OF ALL RIGHTS TO USE WATER IN THE
GILA RIVER SYSTEM AND SOURCE

DATE: February 23, 1995

CIVIL NO. W1-11-19
(Consolidated)

ORDER GRANTING STATE OF
ARIZONA'S MOTION FOR
RECONSIDERATION AND
MODIFYING MEMORANDUM
DECISION OF NOVEMBER 14,
1994

CONTESTED CASE NAME: *In re Sands Group of Cases (W1-11-19) and Other Related Cases (Consolidated).*

HSR INVOLVED: San Pedro River Watershed Hydrographic Survey Report.

DESCRIPTIVE SUMMARY: The Special Master grants the State of Arizona's motion to reconsider his Memorandum Decision, Findings of Fact, and Conclusions of Law for Group 1 Cases Involving Stockwatering, Stockponds, and Domestic Uses (Nov. 14, 1994) and modifies certain portions of the Memorandum Decision.

NUMBER OF PAGES - 14; Attachments - 10; Total: 24.

DATE OF FILING: Original delivered to the Clerk of the Court on February 23, 1995.

The State of Arizona has requested reconsideration of my Memorandum Decision, Findings of Fact, and Conclusions of Law for Group 1 Cases Involving Stockwatering, Stockponds, and Domestic Uses, issued November 14, 1994. The State's motion has been joined by Sands Investment Company (Dec. 20, 1994); City of Phoenix (Dec. 21, 1994); Salt River Project (Dec. 29, 1994); and Hubert & Hernandez, P.A., on behalf of claimants Bayless & Berkalew Co., Goff, Hendrickson, Mercer, Pyeatt, White, and Lunt (Dec. 28, 1994). I gave all litigants in this contested case until January 25, 1995, to file responsive pleadings to the motion. The San Carlos Apache Tribe; the Tonto Apache Tribe; and the Yavapai Apache Indian Tribe, Camp Verde Reservation (referred to collectively as the "Apache Tribes") and the Gila River Indian Community filed such pleadings.

The State's motion is GRANTED. I appreciate the State's request to reexamine my determinations about water supply at the mouth of the San Pedro River--a conclusion that is important in determining how small water uses in the upper basin will be adjudicated. After considering the arguments made by the litigants, I have corrected certain calculations in the original decision and supplemented the discussion and the findings of fact--all of which are set forth in the following.

The State's basic argument is that I erroneously derived a "mean annual flow" by multiplying the median daily flow of 6.26 cubic feet per second (cfs), a figure testified to by witness Gookin, by 365 days and then converting to produce an annual volume in acre-feet (ac-ft). The error, as I understand the State's argument, is that this calculation results in either an under-estimate or over-estimate of annual volume when there is an unequal distribution around the median value. I will respond to this argument by (1) revisiting the reason that median (middle) rather than mean (average) values were used to determine whether stockwatering, stockponds, and domestic uses are *de minimis* in the San Pedro River watershed, and (2) examining in more detail the meaning of the streamflow data about flows at the mouth of the river near Winkelman.

Use of Median Values

While mean values are commonly used in hydrology, the median is the better method for determining central tendencies when sample size is small, the distribution is asymmetrical, and extreme values are represented. See V. YEVJEVICH, PROBABILITY & STATISTICS IN HYDROLOGY 105 (1972). All three conditions are present near the mouth of the San Pedro River, as is apparent from the streamflow data appearing in Ex. No. 68. The period of record is relatively short and flood events skew the data set with very high flows for relatively few days.

The Apache Tribes' citation to the U.S. Supreme Court's decision in *Colorado v. Kansas*, 320 U.S. 383 (1943) (Roberts, J.), is indeed supportive of my reliance on median values. In that decision (rendered sixteen years after petitions were initially filed and twenty-seven years after the events complained of), the Supreme Court reviewed the special master's findings on whether Colorado had materially increased its diversions on the Arkansas River, thereby reducing flows to the substantial detriment of Kansas. After characterizing the Arkansas as a highly variable river (similar to the San Pedro River), the Court indicated that

[t]he critical matter is the amount of divertible flow at times when water is most needed for irrigation. Calculations of average annual flow, which include flood flows, are, therefore, not helpful in ascertaining the dependable supply of water usable for irrigation.

Id. at 396-97.

Similarly, confident estimates of the reliable, dependable flow of the San Pedro River are necessary to determine whether small uses in the upper basin essentially can be excluded from the adjudication through summary or *de minimis* procedures without materially harming downstream senior users. The use of median rather than mean values provides a better estimate of the reliable, dependable flow at the mouth of the San Pedro River.¹

Streamflow at River's Mouth

The exhibits introduced at trial containing information about flows at the mouth of the San Pedro River consisted of a U.S. Geological Survey (USGS) duration table of daily values for water years 1967-75 (Ex. No. 68), graphs indicating mean and median values for 1967-75 (Ex. No. 88) and the longer period of 1962-78 (Ex. No. 89), and DWR's estimates contained in its

¹See also D.R. HELSEL & R.M. HIRSCH, USGS, STATISTICAL METHODS IN WATER RESOURCES § 1.4 (1992):

Hydrologic data are typically skewed, meaning that data sets are not symmetric around the mean or median, with extreme values extending out longer in one direction. . . . When data are skewed the mean is not expected to equal the median, but is pulled toward the tail of the distribution. . . . The standard deviation is also inflated by the data in the tail. Therefore, tables of summary statistics which include only the mean and standard deviation or variance are of questionable value for water resources data, as those data often have positive skewness. The mean and standard deviation reported may not describe the majority of data very well. Both will be inflated by outlying observations.

hydrographic survey report and technical report. Ex. No. 69 (HSR Table 4-12); Ex. No. 65 at 64 (DWR Technical Report).

Both in my original decision and today, I have chosen to rely on Ex. No. 68, the USGS duration table of daily values for a nine-year period (water years² 1967-75) from the since-discontinued gage near the mouth of the San Pedro River at Winkelman (Gage No. 94735). While some of the testimony, exhibits, and pleadings have referred to a longer period of record at the same or nearby gage (the seventeen-year period of 1962-78), detailed yearly reports containing daily mean values were not introduced at trial. Also, while DWR interpolated data from other Gila River system gages to develop mean water supply values for its water budget, *see* 1 HSR App. F, records of daily flows from these other gages were not introduced to allow the calculation of median flows.

In its motion, the State has referred to USGS discharge figures for water year 1977-78 set forth in *Water Resources Data for Arizona, Water Year 1978*, USGS Water Data Report AZ-78-1 (1979). The Gila River Indian Community has attached this document to its responsive pleading. In order to reexamine my original conclusions about water supply at the river's mouth, I have obtained daily mean values reported at Gage No. 94734³ on the San Pedro River near Winkelman for water years 1962 through 1966. I have also obtained a duration table of daily mean flows for Gage No. 94735⁴ for water years 1967-78, the years the USGS apparently considers to be the official period of record.

Since litigants on both sides of this issue have alluded to these records which were not introduced at trial, I will take judicial notice of them, ARIZ. R. EVID. 201,⁵ and ORDER them marked as follows:

Ex. No. 99	USGS, Discharge, Cubic Feet Per Second, Water Year October 1961 to September 1962 (Daily Mean Values, Gage No. 94734)
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²A water year extends from October 1 to September 30. The water year beginning on October 1, 1994, is known as water year 1995.

³The USGS describes the location of this gage as latitude 32°56'35", longitude 110° 44'55".

⁴The USGS describes the location of this gage as latitude 32°58'38", longitude 110° 46'11".

⁵Rule 201, ARIZ. R. EVID., provides in relevant part that "(b) A judicially noticed fact must be one not subject to reasonable dispute in that it is either (1) generally known within the territorial jurisdiction of the trial court or (2) capable of accurate and ready determination by resort to sources whose accuracy cannot reasonably be questioned. . . . (f) Judicial notice may be taken at any stage of the proceeding."

- Ex. No. 100 USGS, Discharge, Cubic Feet Per Second, Water Year October 1962 to September 1963 (Daily Mean Values, Gage No. 94734)
- Ex. No. 101 USGS, Discharge, Cubic Feet Per Second, Water Year October 1963 to September 1964 (Daily Mean Values, Gage No. 94734)
- Ex. No. 102 USGS, Discharge, Cubic Feet Per Second, Water Year October 1964 to September 1965 (Daily Mean Values, Gage No. 94734)
- Ex. No. 103 USGS, Discharge, Cubic Feet Per Second, Water Year October 1965 to September 1966 (Daily Mean Values, Gage No. 94734)
- Ex. No. 104 USGS, Discharge, Cubic Feet Per Second, Water Year October 1975 to September 1976 (Daily Mean Values, Gage No. 94735)
- Ex. No. 105 USGS, Discharge, Cubic Feet Per Second, Water Year October 1976 to September 1977 (Daily Mean Values, Gage No. 94735)
- Ex. No. 106 USGS, Discharge, Cubic Feet Per Second, Water Year October 1977 to September 1978 (Daily Mean Values, Gage No. 94735)
- Ex. No. 107 USGS, Duration Table of Daily Mean Flow for Period of Record 1967-78, Basin Characteristics and Streamflow Statistics in Arizona as of 1989, p. 271 (Gage No. 94735)

These documents have been so marked and deposited with the Clerk of the Court. Copies are attached to this order.

In determining whether upper basin water uses such as stockwatering, stockponds, and domestic uses can be considered *de minimis*, I remain

concerned about having confident estimates of the amount of water that can normally be expected at the mouth of the river. Ex. No. 68, the duration table of daily values, remains the most helpful evidence on this question because it is based on actual daily flows measured at the river's mouth. This duration table simply indicates for the nine-year period of 1967-75 the number of days the river was flowing at a certain volume (using daily mean values)--ranging from no flow at all to more than 8,200 cfs.

A slight rearrangement of the data presented in Ex. No. 68 better illustrates the information for our purposes. In Table 1, I have reordered the data to show the number of days during the nine-year period (3,287 days) when the river flowed at a certain rate (cfs), the volume (ac-ft) equivalent of each flow for a single day, and the cumulative volume (ac-ft) for the number of days the river flowed *at a specified rate or less*.

The results of this presentation are no less than startling. As can be seen from Table 1, the median value for this nine-year period is less than 4.3 cfs--which is less than the 6.26 cfs estimate I subscribed to in my earlier opinion. The State is correct in maintaining that the annualized volume cannot be calculated by simply multiplying 4.3 or 6.26 cfs by 365 days and converting into acre-feet. This calculation would not produce an accurate result unless the distribution of data points was equal around the median.

However, I believe I am correct in the following interpretation: Table 1 indicates that for almost one-half of the nine-year period of record (1,598 days or almost 4.5 years), the flows at Winkelman were less than 4.3 cfs. The total volume of water passing this point during one-half of this nine-year period was only between 2,563 and 3,735 ac-ft or, on the average, not less than 570 and not more than 830 ac-ft/yr.

Similarly, for 2,305 days (approximately 70 percent of the nine-year period of record), flows at the mouth were less than 12.0 cfs. Thus, the cumulative volume of flows at less than 12.0 cfs, for a period that is the equivalent of almost seven years, is only 15,262 ac-ft (which, if allocated over that six and one-third year period is only 2,419 ac-ft/yr).

Table 1:
Flows and Associated Volumes (1967-75) -- San Pedro River at Winkelman, Arizona
Adapted from Ex. No. 68

CFS	# Days	Total Days	% of Days	AF Σ Days (lower limit)	Cum Q Σ Days (lower limit)	AF Σ Days (upper limit)	Cum Q Σ Days (upper limit)
0.00	739	739	22	0	0	146.322	146
0.10	76	815	25	15	15	30.096	176
0.20	55	870	26	22	37	32.67	209
0.30	28	898	27	17	54	22.176	231
0.40	67	965	29	53	107	79.596	311
0.60	50	1,015	31	59	166	79.2	390
0.80	52	1,067	32	82	249	113.256	503
1.10	80	1,147	35	175	423	253.44	756
1.60	98	1,245	38	311	734	426.888	1,183
2.20	191	1,436	44	833	1,567	1172.358	2,356
3.10	162	1,598	49	996	2,563	1379.268	3,735
4.30	283	1,881	57	2,413	4,976	3418.074	7,153
6.10	292	2,173	66	3,532	8,508	4972.176	12,125
8.60	132	2,305	70	2,251	10,760	3136.32	15,262
12.00	207	2,512	76	4,926	15,685	6967.62	22,229
17.00	212	2,724	83	7,147	22,832	10074.24	32,303
24.00	145	2,869	87	6,901	29,733	9761.4	42,065
34.00	72	2,941	89	4,854	34,587	6842.88	48,908
48.00	83	3,024	92	7,900	42,488	11175.12	60,083
68.00	50	3,074	94	6,742	49,230	9405	69,488
95.00	31	3,105	94	5,840	55,070	7979.4	77,467
130.00	39	3,144	96	10,054	65,124	14671.8	92,139
190.00	32	3,176	97	12,057	77,180	17107.2	109,246
270.00	30	3,206	98	16,062	93,242	22572	131,818
380.00	26	3,232	98	19,592	112,834	27284.4	159,103
530.00	15	3,247	99	15,765	128,599	22275	181,378
750.00	18	3,265	99	26,771	155,370	39204	220,582
1100.00	7	3,272	100	15,269	170,639	20790	241,372
1500.00	6	3,278	100	17,847	188,486	24948	266,320
2100.00	5	3,283	100	20,822	209,307	28710	295,030
2900.00	1	3,284	100	5,751	215,058	8118	303,148
4100.00	1	3,285	100	8,130	223,188	16236	319,384
8200.00	2	3,287	100	32,521	255,710	0	

Notes to Table 1:
Flows and Associated Volumes (1967-75) -- San Pedro River at Winkelman, Arizona
Adapted from Ex. No. 68

"CFS" means cubic feet per second.

"AF Σ Days" means the volume (ac-ft) that results for the specified number of days at that flow (cfs).

"Cum Q Σ Days" means the cumulative volume (ac-ft) that results for the total number of days at that flow (cfs) or less.

Because the categories present definite limits, such as flows greater than 3.1 cfs but less than 4.3 cfs, the number of days for that category and all preceding categories must necessarily represent lower flows than the next higher flow category. However, upper and lower limits cumulative volumes must be calculated for each category. One accomplishes this in the following way for each category:

Volume (lower limit) = category flow rate * the number of days of that category

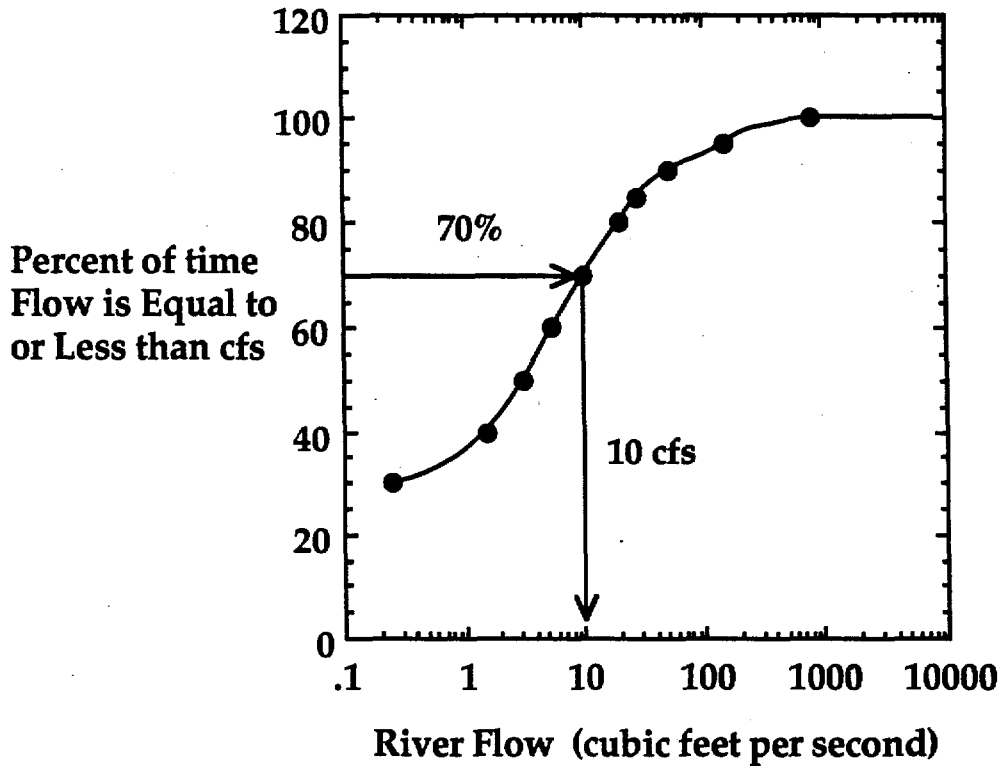
Volume (upper limit) = next higher flow rate category * the no. of days of the lower limit category

Lower limit volumes can then be summed to determine the lower limit cumulative volumes. Similarly, upper limit volumes can be summed to determine upper limit cumulative volumes.

For roughly this same period, the USGS reports that the "median of yearly mean discharges" is 35 cfs or 25,400 ac-ft/yr. Ex. 106. The reason that the median of yearly discharges varies so considerably from the median of daily discharges is the great amount of water produced by a very few but strong flood events each year. For instance, Ex. No. 68 reports flows of 8,200 cfs or more on each of two days during the nine-year period of record. A flow of this rate produces more than 16,236 ac-ft in one day, which is more than the cumulative volume produced by low flows on 2,305 other days (almost 6.3 years) during the period of record.

The new exhibits, of which I take judicial notice, only buttress these conclusions. First, Ex. No. 107 (the duration table for 1967-78) indicates that for the entire period of record at Gage No. 94735, flows were less than 3.1 cfs for 50 percent of the time and less than 10 cfs for 70 percent of the time. See Figure 1 which also illustrates this relationship. These results closely correspond to the interpretations I have made from Table 1.

Figure 1:
 Percent of Time of River Discharge (1967-78)
 San Pedro River at Winkelman, Arizona
 Adapted from Ex. No. 107



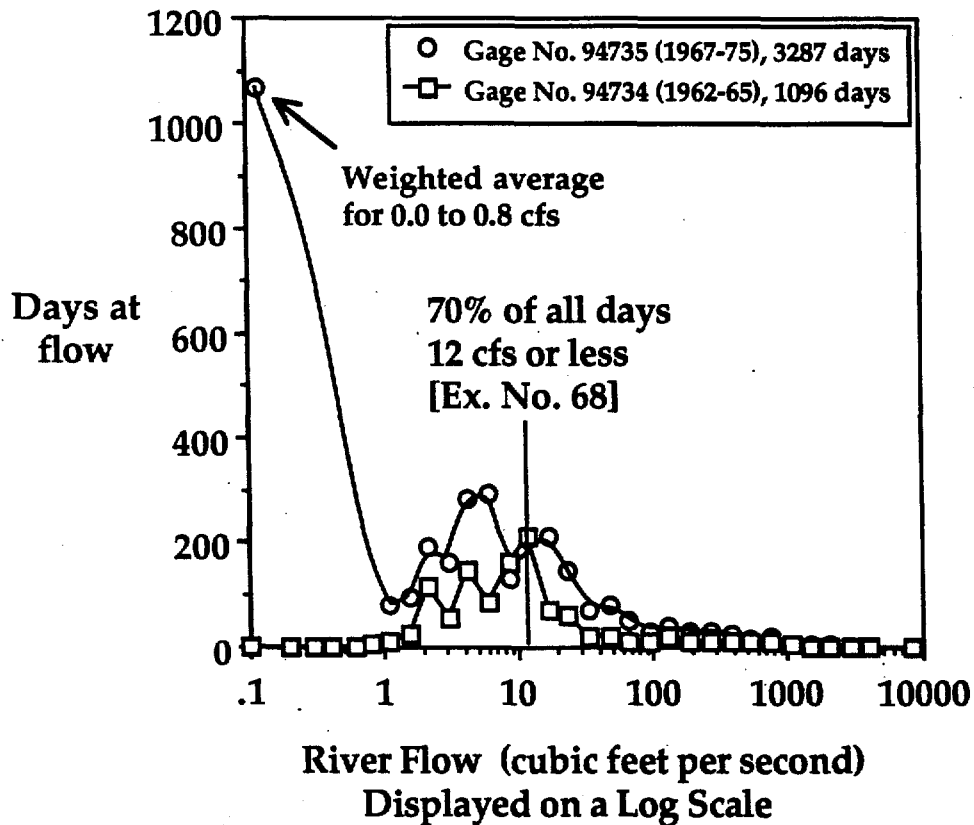
Second, even Ex. Nos. 99 through 103, while not considered as part of the period of record, also indicate a high occurrence of low flows during the 1962-66 period.⁶ If a table of duration of daily values is prepared for these years (not considering 1961-62, Ex. No. 99, and 1965-66, Ex. 103, which are incomplete years), it shows that for 64 percent of the days in that period (700 days total), flows at the river's mouth were 12.0 cfs or less (resulting in a cumulative volume of less than 6,703 ac-ft or 3,495 ac-ft per year). Once

⁶There appear to be several problems with the 1962-66 data which may render it less reliable than the reports for later years. Only partial year records are available for 1961-62 and 1965-66. In Ex. No. 101, the USGS remarks: "Records fair except for those periods of doubtful gage-height record, which are poor. Flow at Leroy Springs at point 2 miles upstream, was measured at 2.48 cfs on Oct. 21, 3.36 cfs on Apr. 1 and 2.22 cfs on June 18." On these same three days, flows at Gage No. 94734 were reported as 5.4 cfs, 14 cfs, and 2.7 cfs, respectively, leaving a suspicion that some of the records during this period may overstate flows.

again, the results reinforce rather than contradict the interpretations made from Table 1.

This extraordinary variability of the San Pedro River flows is apparent from Figure 2 which, by using some of the information from Table 1, displays the number of days by river flow categories. The river flow is plotted on a logarithmic scale because the flow categories vary by more than six orders of magnitude (0.0 to 8,200 cfs). A weighted average was also used so the flows of 0.0 cfs could be plotted.⁷

Figure 2:
 Number of Days at Indicated Flows (1967-75)
 San Pedro River at Winkelman, Arizona
 Adapted from Ex. Nos. 68, 101-103



⁷Weighted average (cfs) = total volume (0.0 to 0.8 cfs)/total days (0.0 to 0.8 cfs).

Conclusion

I continue to adhere to my conclusion "that the amount of water reliably available at the mouth of the San Pedro River watershed is not of the magnitude estimated by DWR" nor in the magnitude suggested by the State in its motion for reconsideration. The daily data for the 1967-78 period of record indicates that, for almost 70 percent of the time, flows at the mouth are at rates that produce only 2,419 ac-ft on an annualized basis. I am left even more convinced that the litigants arguing for a type of *de minimis* adjudication of stockponds and domestic uses that would effectively exclude these uses from the Gila River adjudication have not met their burden of proof. They have not demonstrated the insignificance of stockpond depletions in the amount of 2,000 ac-ft/yr, *see* Finding of Fact No. 63, and domestic depletions in the amount of 550 ac-ft/yr, *see* Finding of Fact No. 64, when compared to these prevalent low flows and volumes.

Having thus reviewed the evidence, I make the following modifications to the discussion and findings of fact set forth in the original decision:

Modifications to Page 17 (Amending Findings of Fact Nos. 5-7; adding Findings of Fact Nos. 7A, 7B, 7C)

"Finding of Fact No. 5. The median surface water flow at the mouth of the San Pedro River, for the period of 1962-77, is no more than 6.2 cfs. Ex. No. 89 (graph and data). Thus, the cumulative volume resulting from flows of 6.2 cfs or less during one-half of the period of record is less than 33,605 ac-ft or 4,480 ac-ft on an annualized basis.

"Finding of Fact No. 6. Based on the nine-year (1967-75) period of record at the U.S. Geological Survey's Winkelman gage at the mouth of the San Pedro River (Gage No. 94735), the median surface water flow at the mouth of the San Pedro River is between 3.1 and 4.3 cfs. Ex. No. 68.

"Finding of Fact No. 7. Based on the nine-year (1967-75) period of record at the U.S. Geological Survey's Winkelman gage at the mouth of the San Pedro River (Gage No. 94735), streamflow could be expected to be less than 4.3 cfs for 49 percent of the time (1,598 days). At a flow rate less than 4.3 cfs, the cumulative volume that would be expected for these days during the nine-year period is less than 3,735 ac-ft.

"Finding of Fact No. 7A. Based on the nine-year (1967-75) period of record at the U.S. Geological Survey's Winkelman gage at the mouth of the San Pedro River (Gage No. 94735), streamflow could be expected to be less than 12 cfs for 70 percent of the time (2,305 days). At a flow rate of less than 12

cfs, the cumulative volume that would be expected for these days during the nine-year period is less than 15,262 ac-ft.

"Finding of Fact No. 7B. Based on the twelve-year (1967-78) period of record at the U.S. Geological Survey's Winkelman gage at the mouth of the San Pedro River (Gage No. 94735), streamflow could be expected to be 3.1 cfs or less for 50 percent of the time (2,192 days). Ex. No. 107. At a flow rate of 3.1 cfs or less, the cumulative volume that would be expected for these days during the twelve-year period is less than 4,643 ac-ft.

"Finding of Fact No. 7C. Based on the twelve-year (1967-78) period of record at the U.S. Geological Survey's Winkelman gage at the mouth of the San Pedro River (Gage No. 94735), streamflow could be expected to be less than 10 cfs for 70 percent of the time (3,068 days). Ex. No. 107. At a flow rate of less than 10 cfs, the cumulative volume that would be expected for these days during the twelve-year period is less than 18,094 ac-ft. "

These modified findings of fact also lead to revisions in other parts of the memorandum decision. They are as follows:

Modifications to Pages 29-30

(Amending the last paragraph on page 29,
which continues on page 30, and the first
full paragraph on page 30)

"The case is more difficult for stockponds and domestic uses. While these uses are even more numerous and the individual amounts of water consumed are *de minimis*, the evidence does not support a finding that stockponds as a group or domestic uses as a group have a *de minimis* impact on the Gila River system. If the annual outflow of the San Pedro River is 56,540 ac-ft/yr, based on mean values and as reported by DWR, then depletion by stockponds in the amount of 2,000 ac-ft/yr or 3.5 percent (based on undepleted flow analysis) would be *de minimis*. The Master has determined that median flows (for 50 percent of the time during the 1967-75 period of record), are less than 4.3 cfs, yielding less than 830 ac-ft/yr on the average. Thus, the depletion by stockponds of 2,000 ac-ft/yr exceeds the amount of water that would be expected to flow at the river's mouth. This is not a *de minimis* impact.

"Since the Master also has determined that flows are 12.0 cfs or less for 70 percent of the time during the same nine-year period, yielding 2,419 ac-ft/yr on the average, then the depletion by stockponds of 2,000 ac-ft/yr results in an impact of almost 83 percent which is not *de minimis*.

"Similarly, the depletion by domestic uses in the amount of 550 ac-ft/yr produces one percent impact if annual flow is considered to be 56,540 ac-ft/yr.

When compared to median flows of 4.3 cfs, yielding less than 830 ac-ft/yr on the average, the impact is 66 percent which is not *de minimis*. When compared with the more probable flow of 12 cfs or less (for 70 percent of the time), producing watershed outflow of 2,419 ac-ft/yr, the impact is 23 percent--again not *de minimis*."

Modifications to Page 31
(Amending Findings of Fact Nos. 63-64)

"**Finding of Fact No. 63.** Depletion by San Pedro River watershed stockponds, based on undepleted flow analysis, is 2,000 ac-ft/yr. Ex. No. 65 at 64 (Table 3-5) (DWR Technical Report). When compared to flows of 12.0 cfs or less, which are present for 70 percent of the time and yield 2,419 ac-ft/yr on the average, then the depletion by stockponds of 2,000 ac-ft/yr results in an impact of almost 83 percent. Ex. No. 68; Table 1 (this Order).

"**Finding of Fact No. 64.** Depletion by San Pedro River watershed domestic uses, based on undepleted flow analysis, is 550 ac-ft/yr. Ex. No. 65 at 59 (Table 2) (DWR Technical Report). When compared to flows of 12.0 cfs or less, which are present for 70 percent of the time and yield 2,419 ac-ft/yr on the average, then the depletion by domestic uses of 550 ac-ft/yr results in an impact of 23 percent. Ex. No. 68; Table 1 (this Order)."

DATED this 23rd day of February 1995.



JOHN E. THORSON
Special Master

The original of the foregoing delivered on February 23, 1995, to the Clerk of Maricopa County Superior Court for filing, copying, and distribution to those parties who appear on the Court-approved mailing list for Case No. W1-11-19 (Consolidated) dated March 11, 1994. There is no service by fax of this document.



Kathy Dolge

STATION NUMBER 09473400 SAN PEDRO RIVER NEAR WINKELMAN, A2. STREAM SOURCE AGENCY USGS
 LATITUDE 325635 LONGITUDE 1104655 DRAINAGE AREA 4630.00 DATUM STATE 04 COUNTY 021

DISCHARGE, CUBIC FEET PER SECOND, WATER YEAR OCTOBER 1961 TO SEPTEMBER 1962
 DAILY MEAN VALUES

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	8.0	3.7	5.0	82	.40
2	7.4	3.5	4.0	82	.30
3	6.4	3.5	2.2	35	.40
4	6.1	3.5	2.2	11	.30
5	6.4	3.5	2.2	7.2	54
6	6.4	3.5	2.2	4.0	34
7	6.4	3.5	2.0	3.1	7.0
8	6.1	3.0	1.8	2.4	3.0
9	5.2	3.0	1.5	2.4	26
10	4.7	3.0	1.5	2.4	46
11	4.5	3.0	1.3	2.2	4.0
12	8.6	4.5	2.5	1.4	2.0
13	8.6	4.5	2.5	1.4	58
14	8.9	4.5	2.5	1.4	10
15	8.9	4.5	2.5	1.5	2.2
16	9.2	4.5	2.5	1.6	1.4
17	9.2	4.5	2.5	1.6	1.2
18	9.2	4.3	2.0	1.6	1.0
19	9.5	4.0	2.0	1.6	1.0
20	9.8	4.0	2.0	1.5	.90
21	8.9	4.0	2.0	1.5	1.8
22	8.9	4.0	2.0	75	1.2
23	8.9	4.0	2.0	15	1.4
24	8.9	4.0	2.0	10	2.0
25	8.6	3.7	2.0	4.7	52
26	8.6	3.7	2.0	12	434
27	8.6	3.7	2.0	29	274
28	8.6	3.7	2.0	41	12
29	8.3	3.7	12	251	6.3
30	8.0	3.7	7.0	282	5.9
31	3.7	...	73	.70	...
TOTAL	148.8	92.7	833.7	267.70	1042.70
MEAN	4.80	3.09	26.9	8.64	34.8
MAX	8.0	12	282	82	434
MIN	3.7	2.0	1.3	.60	.30
AC-FT	295	184	1650	531	2070

Ex. No. 99

STATION NUMBER 09473400 SAN PEDRO RIVER NEAR WINKELMAN, AZ. STREAM SOURCE AGENCY USGS
 LATITUDE 325635 LONGITUDE 1104455 DRAINAGE AREA 4430.00 DATUM STATE 04 COUNTY 021

DISCHARGE, CUBIC FEET PER SECOND, WATER YEAR OCTOBER 1962 TO SEPTEMBER 1963
 DAILY MEAN VALUES

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	4.7	3.7	6.7	9.3	8.0	13	10	8.0	4.3	2.3	422	455
2	3.4	4.0	6.7	9.3	8.0	13	9.0	8.0	4.0	2.3	540	186
3	3.7	4.4	5.9	10	8.0	15	9.0	8.0	3.7	2.3	1030	198
4	3.4	4.4	5.9	64	8.0	14	9.0	8.0	3.4	2.3	386	1090
5	3.4	4.4	5.9	14	8.0	12	10	8.0	3.4	2.3	151	631
6	3.1	4.4	5.9	11	8.0	12	9.0	7.0	3.4	2.3	161	198
7	3.1	4.4	6.3	11	9.0	11	10	7.0	3.1	2.3	135	105
8	3.1	4.4	6.3	10	8.8	12	10	6.0	3.1	2.3	59	192
9	3.1	4.0	6.3	9.3	8.8	13	10	6.0	3.1	2.3	182	175
10	2.9	4.0	5.9	9.3	121	11	10	6.4	3.1	2.3	20	65
11	2.9	4.0	5.5	10	1080	10	11	5.5	3.1	2.3	16	62
12	2.4	4.0	5.5	9.3	2500	9.0	10	5.1	2.8	2.3	61	34
13	2.2	4.0	6.0	8.8	170	9.0	11	5.9	2.8	2.3	169	22
14	2.0	4.4	5.3	8.8	25	9.0	10	5.1	2.8	2.0	165	19
15	2.2	5.9	5.9	8.2	20	9.0	10	5.1	2.8	2.3	194	18
16	2.6	5.1	3.4	7.7	16	9.0	10	5.1	2.8	2.3	464	14
17	4.8	5.1	4.0	8.2	17	9.0	10	4.7	2.5	2.3	1200	12
18	8.2	5.1	7.0	7.7	16	12	10	4.7	2.5	2.3	298	11
19	9.7	5.5	6.7	7.7	16	12	10	4.7	2.3	2.5	156	10
20	5.1	5.5	5.1	7.7	15	12	10	4.3	2.3	13	347	9.6
21	4.0	5.5	5.1	7.7	14	12	10	4.3	2.3	5.0	317	9.0
22	4.0	5.5	5.5	8.2	14	12	10	4.3	2.3	2.3	425	8.4
23	4.4	5.9	5.5	9.3	13	12	10	4.3	2.3	2.0	374	7.4
24	4.0	5.9	3.5	9.3	13	12	10	4.0	2.3	2.3	248	6.8
25	4.0	5.9	5.1	9.3	13	12	10	4.0	2.3	1.8	115	7.8
26	4.0	5.9	12	11	13	11	10	4.0	2.3	1.6	991	6.4
27	3.7	5.9	10	10	13	11	10	4.0	2.3	7.2	513	6.4
28	3.4	5.9	97	10	15	11	10	4.3	2.3	271	418	6.4
29	3.4	6.3	15	8.2	---	11	10	4.3	2.3	72	205	5.9
30	3.4	6.3	10	7.7	---	11	8.0	4.3	2.3	100	325	5.9
31	3.4	---	10	8.0	---	11	---	4.3	---	759	623	---
TOTAL	117.7	149.7	342.8	340.0	4178.6	352.0	296.0	168.3	84.3	1280.8	10710	3577.0
MEAN	3.80	4.99	11.1	11.0	149	11.4	9.87	5.43	2.81	41.3	345	119
MAX	9.7	6.3	97	64	2500	15	11	8.0	4.3	759	1200	1090
MIN	2.0	3.7	3.4	7.7	8.0	9.0	8.0	4.0	2.3	1.6	16	5.9
AC-FT	233	297	680	674	8290	698	587	334	167	2540	21240	7090

WTR YR 1963 TOTAL 21597.2 MEAN 59.2 MAX 2500 MIN 1.6 AC-FT 42840

Ex. No. 100

GILA RIVER BASIN

9-4734. San Pedro River near Winkelman, Ariz.

Location.--Lat 32°56'35", long 110°44'55", in SW¼NE¼ sec.6, T.6 S., R.16 E., on right bank, ¾ miles southeast of Winkelman, and 4 miles upstream from mouth.

Drainage area.--4,449 sq mi, of which 696 sq mi is in Mexico.

Records available.--April 1962 to September 1964.

Gage.--Water-stage recorder and remains of concrete control (control washed out Feb. 12, 1963). Altitude of gage is 1,990 ft (from topographic map). Prior to Feb. 12, 1963, at datum 2.05 ft higher. Feb. 12 to Sept. 30, 1963, at datum 1.00 ft higher.

Extremes.--Maximum discharge during year, 6,460 cfs Aug. 15 (gage height, 7.7 ft); minimum daily, 0.5 cfs July 12, 13. 1962-64: Maximum discharge, that of Aug. 15, 1964; minimum daily, 0.3 cfs Sept. 3, 1962.

Remarks.--Records fair except those for periods of doubtful gage-height record, which are poor. Flow of Leroy Springs at point 2 miles upstream, was measured at 2.48 cfs on Oct. 21, 3.36 cfs on Apr. 1 and 2.22 cfs on June 18.

Discharge, in cubic feet per second, water year October 1963 to September 1964

Day	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.
1	5.8	5.1	12	13	11	11	*11	7.3	3.6	+1.8	d1200	25
2	*g 5.8	5.1	12	13	11	*12	11	7.3	*3.2	1.6	d1680	19
3	g 5.8	5.1	12	13	11	15	11	7.3	3.2	1.4	748	14
4	g 5.8	5.4	12	13	*11	16	11	6.9	2.9	1.2	*d227	13
5	g 5.8	5.1	12	12	11	15	11	6.5	2.9	1.0	d130	12
6	g 5.8	5.4	12	12	11	15	11	7.3	3.2	1.0	*d1280	18
7	g 5.4	8.9	11	*13	11	15	11	7.3	2.9	1.0	204	25
8	5.4	15	11	12	11	14	10	6.9	2.9	1.0	40	25
9	5.4	14	11	12	11	14	9.4	6.9	2.7	11	d60	498
10	5.4	13	12	12	11	14	7.6	6.9	2.9	d2.8	d40	1010
11	*5.4	12	12	12	11	14	7.3	*6.5	2.7	d1.0	402	1960
12	5.4	12	12	12	11	14	6.9	5.4	2.5	d.5	d981	571
13	5.4	11	12	12	11	*14	6.9	5.4	2.5	d.5	d292	758
14	5.4	11	12	12	12	14	6.5	5.4	2.3	17	d302	553
15	5.4	11	12	12	12	12	6.1	5.4	2.1	73	*d4050	2580
16	5.4	11	12	11	12	11	6.5	5.4	2.3	7.0	L270	266
17	5.4	11	12	10	13	11	5.8	5.4	2.7	2.0	515	36
18	5.1	12	12	11	*12	11	6.1	5.8	2.7	.7	803	20
19	5.4	12	*12	12	12	11	6.1	5.4	2.7	d18	180	42
20	5.4	12	12	*12	12	11	6.5	5.1	2.7	d47	*70	56
21	5.4	14	12	12	12	11	5.8	5.1	2.5	*d55	52	*75
22	5.4	18	12	12	12	11	5.8	5.1	2.5	d25	44	64
23	5.1	15	12	12	12	11	*5.6	5.4	2.3	d246	31	88
24	5.1	13	11	11	12	11	5.8	5.4	2.3	*d879	23	1120
25	5.1	12	11	11	12	12	5.8	4.5	2.1	d844	19	155
26	5.1	*11	11	11	12	12	6.1	4.5	1.9	d102	d967	106
27	5.1	11	11	11	12	12	6.5	3.9	1.9	**d32	86	69
28	5.1	11	11	11	11	12	6.5	3.6	1.7	14	44	44
29	5.1	11	12	11	11	12	*6.9	3.6	1.7	11	66	37
30	*5.1	11	12	11	-----	11	6.9	3.6	1.7	d546	66	32
31	5.1	-----	12	11	-----	11	-----	3.6	-----	d700	40	-----
Total	166.8	324.1	364	365	334	390	230.4	174.1	76.2	3,644.5	15,912	10,291
Mean	5.38	10.8	11.7	11.8	11.5	12.6	7.68	5.62	2.54	118	513	343
Ac-ft	331	643	722	724	662	774	457	345	151	7,230	31,560	20,410

Calendar year 1963: Max 2,500 Min 1.6 Mean 59.8 Ac-ft 43,320
 Water year 1963-64: Max 4,050 Min 0.5 Mean 86.2 Ac-ft 64,010

Peak discharge (base, 4,000 cfs, revised)

Date	Time	Gage height	Discharge	Date	Time	Gage height	Discharge
7-30	0230	6.7	4,580	8-26	0500	7.0	5,000
8-2	0800	6.6	4,440	9-10	2200	+6.9	4,860
8-15	1400	7.7	6,460	9-15	1330	7.15	5,080

* Discharge measurement made on this day.
 † About.
 ** Field estimate made on this day.
 d Doubtful gage-height record.
 g Computed from once daily staff gage readings.

STATION NUMBER 09473400 SAN PEDRO RIVER NEAR WINKELMAN, AZ. STREAM SOURCE AGENCY USGS
 LATITUDE 325635 LONGITUDE 1104455 DRAINAGE AREA 4430.00 DATUM STATE 04 COUNTY 021

DISCHARGE, CUBIC FEET PER SECOND, WATER YEAR OCTOBER 1964 TO SEPTEMBER 1965
 DAILY MEAN VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	25	12	17	24	21	17	11	11	2.6	1.8	6.0	2.2
2	22	11	20	25	21	16	11	9.4	2.6	1.8	18	2.4
3	21	12	26	25	19	14	11	8.0	2.6	1.8	4.5	614
4	20	13	31	25	17	14	14	6.5	2.6	1.8	5.5	17
5	17	13	25	25	19	14	18	6.0	2.6	1.8	5.0	150
6	17	13	23	25	21	13	12	5.0	2.8	1.8	4.0	96
7	15	13	20	25	542	12	10	5.0	2.4	1.6	3.5	16
8	15	14	18	130	150	12	9.4	5.0	2.6	1.4	2.8	11
9	14	14	19	40	52	11	8.7	5.0	2.8	1.4	44	12
10	12	14	19	30	118	9.4	10	5.0	2.8	1.2	26	6.5
11	12	14	20	25	150	12	58	5.0	3.0	2.0	7.0	8.1
12	9.4	13	20	25	84	26	30	5.0	3.0	1.8	4.0	29
13	8.0	13	21	25	63	22	22	5.0	2.6	1.4	3.0	183
14	7.5	14	21	26	46	17	20	5.0	2.4	1.2	69	6.7
15	7.5	14	22	26	42	16	18	5.0	2.4	1.2	35	9.4
16	8.7	14	22	24	36	15	14	4.5	2.4	39	10	7.5
17	196	14	23	21	34	19	14	4.0	2.6	37	37	7.0
18	147	14	30	20	31	19	14	3.5	2.6	15	23	6.5
19	69	14	30	21	25	16	14	3.0	2.6	34	24	6.5
20	36	14	25	24	23	15	14	3.5	2.6	27	8.7	6.0
21	28	15	25	117	21	15	14	3.5	2.6	9.4	6.0	5.5
22	23	15	25	48	20	15	14	3.0	2.6	5.0	5.5	5.5
23	20	15	24	30	20	15	13	3.0	2.8	14	5.0	4.5
24	18	16	24	28	20	14	12	2.8	3.0	58	12	4.0
25	15	16	24	26	20	14	13	2.6	2.8	7.0	11	3.0
26	15	16	24	26	19	14	13	2.6	2.6	18	5.0	3.0
27	15	16	24	28	19	14	12	2.6	2.2	118	4.5	2.8
28	15	16	24	30	20	13	12	2.6	2.0	28	2.8	2.6
29	15	17	24	26	---	12	12	2.6	2.0	201	2.4	2.4
30	13	17	24	25	---	11	12	2.6	1.8	60	2.6	2.4
31	13	---	24	24	---	12	---	2.6	---	23	6.9	---
TOTAL	869.1	426	718	1019	1673	458.4	460.1	139.9	77.0	717.4	403.7	1232.5
MEAN	28.0	14.2	23.2	32.9	59.7	14.8	15.3	4.51	2.57	23.1	13.0	41.1
MAX	196	17	31	130	542	26	58	11	3.0	201	69	614
MIN	7.5	11	17	20	17	9.4	8.7	2.6	1.8	1.2	2.4	2.2
AC-FT	1720	845	1420	2020	3320	909	913	277	153	1420	801	2440
CAL YR 1964	TOTAL 33430.30	MEAN 91.3	MAX 4050	MIN .50	AC-FT 66310							
WTR YR 1965	TOTAL 8194.1	MEAN 22.4	MAX 614	MIN 1.2	AC-FT 16250							

Ex. No. 102

STATION NUMBER 09473400 SAN PEDRO RIVER NEAR WINKELMAN, AZ. STREAM SOURCE AGENCY USGS
 LATITUDE 325635 LONGITUDE 1104455 DRAINAGE AREA 4430.00 DATUM STATE 04 COUNTY 021

DISCHARGE, CUBIC FEET PER SECOND, WATER YEAR OCTOBER 1965 TO SEPTEMBER 1966
 DAILY MEAN VALUES

LY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	2.8	2.2	8.0	---	---	---	---	---	---	---	---	---
2	2.8	2.2	7.0	---	---	---	---	---	---	---	---	---
3	2.8	2.2	6.5	---	---	---	---	---	---	---	---	---
4	2.6	2.2	6.0	---	---	---	---	---	---	---	---	---
5	2.6	2.2	5.5	---	---	---	---	---	---	---	---	---
6	2.4	2.4	5.5	---	---	---	---	---	---	---	---	---
7	2.4	2.4	5.5	---	---	---	---	---	---	---	---	---
8	2.4	2.4	5.5	---	---	---	---	---	---	---	---	---
9	2.4	2.4	6.5	---	---	---	---	---	---	---	---	---
10	2.4	2.4	1150	---	---	---	---	---	---	---	---	---
11	2.4	2.4	2590	---	---	---	---	---	---	---	---	---
12	2.4	2.4	188	---	---	---	---	---	---	---	---	---
13	2.4	2.4	20	---	---	---	---	---	---	---	---	---
14	2.4	2.4	15	---	---	---	---	---	---	---	---	---
15	2.4	2.6	800	---	---	---	---	---	---	---	---	---
16	2.4	2.6	700	---	---	---	---	---	---	---	---	---
17	2.4	2.6	1200	---	---	---	---	---	---	---	---	---
18	2.4	2.6	1200	---	---	---	---	---	---	---	---	---
19	2.4	2.8	500	---	---	---	---	---	---	---	---	---
20	2.4	3.0	150	---	---	---	---	---	---	---	---	---
21	2.4	3.5	100	---	---	---	---	---	---	---	---	---
22	2.4	3.5	8000	---	---	---	---	---	---	---	---	---
23	2.2	3.5	10000	---	---	---	---	---	---	---	---	---
24	2.2	4.0	2000	---	---	---	---	---	---	---	---	---
25	2.2	5.0	1000	---	---	---	---	---	---	---	---	---
26	2.2	26	450	---	---	---	---	---	---	---	---	---
27	2.2	6.0	200	---	---	---	---	---	---	---	---	---
28	2.2	6.5	100	---	---	---	---	---	---	---	---	---
29	2.2	7.0	100	---	---	---	---	---	---	---	---	---
30	2.2	7.5	350	---	---	---	---	---	---	---	---	---
31	2.2	---	1300	---	---	---	---	---	---	---	---	---
TOTAL	74.2	121.3	32169.0	---	---	---	---	---	---	---	---	---
MEAN	2.39	4.04	1038	---	---	---	---	---	---	---	---	---
MAX	2.8	26	10000	---	---	---	---	---	---	---	---	---
MIN	2.2	2.2	5.5	---	---	---	---	---	---	---	---	---
AC-FT	147	241	63810	---	---	---	---	---	---	---	---	---

CAL YR 1965 TOTAL 38545.5 MEAN 106 MAX 10000 MIN 1.2 AC-FT 76450

Ex. No. 103

GILA RIVER BASIN

09473500. SAN PEDRO RIVER AT WINKELMAN, ARIZ.

LOCATION.--Lat 32°58'38", long 110°46'11", in SE¼SW¼ sec.24, T.5 S., R.15 E., Pinal County, on right bank 0.7 mi (1.1 km) south of Winkelman, and 1.0 mi (1.6 km) upstream from mouth.

DRAINAGE AREA.--4,471 mi² (11,580 km²); of which 696 mi² (1,803 km²) is in Mexico.

PERIOD OF RECORD.--May to August 1890 (monthly discharge only), January 1966 to current year.

GAGE.--Water-stage recorder. Altitude of gage is 1,925 ft (587 m), from topographic map. Apr. 8 to Aug. 31, 1890, nonrecording gage at site about 1,000 ft (300 m) upstream at different datum. Jan. 1, 1966, to Sept. 30, 1968, water-stage recorder at present site at datum 0.27 ft (0.082 m) lower.

AVERAGE DISCHARGE.--10 years, 40.7 ft³/s (1.153 m³/s), 29,490 acre-ft/yr (36.4 hm³/yr); median of yearly mean discharges, 34 ft³/s (0.96 m³/s) 24,600 acre-ft/yr (30 hm³/yr).

EXTREMES.--Current year: Maximum discharge, 4,300 ft³/s (122 m³/s) July 28 (gage height, 9.30 ft or 2.835 m); no flow for many days. Period of record: Maximum discharge, about 15,000 ft³/s (425 m³/s) Dec. 20, 1967 (gage height, 11.95 ft or 3.642 m), from rating curve extended above 2,600 ft³/s (74 m³/s) and comparison with slope-area measurement for flood of Dec. 22-23, 1965, at site 3.5 mi (5.6 km) upstream; no flow at times each year.

Flood of Dec. 22-23, 1965, reached a stage of 12.2 ft (3.72 m), from floodmarks, present site, datum used Jan. 1, 1966, to Sept. 30, 1968—discharge, 16,800 ft³/s (476 m³/s) at site 3.5 mi (5.6 km) upstream—by slope-area measurement of peak flow.

REMARKS.--Records fair. Diversions above station, mostly by pumping from ground water, for municipal and industrial use, and for irrigation of about 12,700 acres (51.4 km²). Records of water temperatures and suspended-sediment loads for the current water year are published on following pages.

DISCHARGE, IN CUBIC FEET PER SECOND, WATER YEAR OCTOBER 1975 TO SEPTEMBER 1976
MEAN VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	0	0	2.4	3.9	1.9	1.9	0	0		19	23	1.0
2	.90	0	2.7	3.9	2.4	1.5	0	0		10	8.7	.30
3	.10	0	2.4	3.9	2.7	1.7	0	0		1.0	4.4	.10
4	0	0	1.9	2.9	2.9	2.2	0	0		.50	1.5	.40
5	0	0	1.9	2.7	2.7	2.2	0	0		0	.40	.29
6	0	0	1.9	2.4	1.9	1.9	0	0		0	.40	405
7	0	0	1.9	2.4	1.7	1.9	0	0		0	.30	484
8	0	0	1.5	2.4	1.7	1.7	0	0		0	0	49
9	0	0	1.2	2.7	1.7	1.5	0	0		0	0	1.0
10	0	0	1.0	2.4	1.5	1.2	0	0		0	2.1	.40
11	0	0	.70	2.4	1.7	1.0	0	0		0	77	.30
12	0	0	.40	2.4	1.7	1.0	0	0		0	30	0
13	0	0	.70	2.4	1.9	1.0	0	0		50	3.0	0
14	0	0	1.0	2.2	1.7	.70	0	0		2.9	2.0	0
15	0	0	1.2	1.9	1.7	.40	0	0		.40	.50	0
16	0	0	1.5	2.2	1.7	.40	.70	0		.20	2.9	0
17	0	0	1.5	2.2	1.7	.30	11	0		.10	6.4	0
18	0	0	1.7	2.2	1.7	.10	2.0	0		110	2.4	0
19	0	0	1.5	2.4	1.9	.20	.60	7.0		102	1.0	0
20	0	0	1.7	2.2	1.7	.20	.30	0		36	4.6	0
21	0	0	2.9	2.2	1.7	.20	.10	0		10	.10	0
22	0	0	3.4	2.2	1.7	.10	.10	0		96	4.9	0
23	0	0	3.4	2.4	1.7	0	.10	0		674	442	.50
24	0	0	4.4	2.7	1.7	0	.10	0		450	38	82
25	0	0	4.4	2.4	1.7	.10	.10	0		615	14	50
26	0	0	3.9	2.4	1.7	0	.10	0		117	6.4	36
27	0	0	4.4	2.2	1.7	0	.10	0		68	33	8.7
28	0	0	4.4	2.2	1.7	0	0	0		1550	42	4.4
29	0	3.1	3.4	1.9	1.7	0	0	0		682	33	1.2
30	0	3.4	2.9	2.2	---	0	0	0		807	10	.40
31	0	---	3.4	1.9	---	0	---	0		119	5.0	---
TOTAL	1.00	6.5	71.60	76.8	53.8	23.40	15.30	7.0	0	5520.10	799.00	1153.70
MEAN	.032	.22	2.31	2.48	1.86	.75	.51	.23	0	178	25.8	38.5
MAX	.90	3.4	4.4	3.9	2.9	2.2	11	7.0	0	1550	442	484
MIN	0	0	.40	1.9	1.5	0	0	0	0	0	0	0
AC-FT	2.0	13	142	152	107	46	30	14	0	10950	1580	2290
CAL YR 1975 TOTAL	4334.45											
MEAN 11.9												
MAX 898												
MIN 0												
AC-FT 8600												
WTR YR 1976 TOTAL	7728.20											
MEAN 21.1												
MAX 1550												
MIN 0												
AC-FT 15330												

PEAK DISCHARGE (BASE, 4,000 CFS).--July 28 (1800) 4,300 cfs (9.30 ft).

GILA RIVER BASIN

265

09473500 SAN PEDRO RIVER AT WINKELMAN, AZ
(National stream-quality accounting network station)

LOCATION.--Lat 32°58'38", long 110°46'11", in SEkSWk sec.24, T.5 S., R.15 E., Pinal County, Hydrologic Unit 15050203, on right bank 0.7 mi (1.1 km) south of Winkelman, and 1.0 mi (1.6 km) upstream from mouth.

DRAINAGE AREA.--4,471 mi² (11,580 km²); of which 696 mi² (1,803 km²) is in Mexico.

WATER-DISCHARGE RECORDS

PERIOD OF RECORD.--May to August 1890 (monthly discharge only), January 1966 to current year.

GAGE.--Water-stage recorder. Altitude of gage is 1,925 ft (587 m), from topographic map. Apr. 8 to Aug. 31, 1890, nonrecording gage at site about 1,000 ft (300 m) upstream at different datum. Jan. 1, 1966, to Sept. 30, 1968, water-stage recorder at present site at datum 0.27 ft (0.082 m) lower.

REMARKS.--Records good except those June 1 to July 28, which are poor. Diversions above station, mostly by pumping from ground water, for municipal and industrial use, and for irrigation of about 13,300 acres (53.8 km²) in 1974, excluding an unknown amount in Mexico.

AVERAGE DISCHARGE.--11 years, 38.6 ft³/s (1.093 m³/s), 27,970 acre-ft/yr (34.5 hm³/yr); median of yearly mean discharges, 32 ft³/s (0.91 m³/s) 23,200 acre-ft/yr (29 hm³/yr).

EXTREMES FOR PERIOD OF RECORD.--Maximum discharge, about 15,000 ft³/s (425 m³/s) Dec. 20, 1967 (gage height, 11.95 ft or 3.642 m), from rating curve extended above 2,600 ft³/s (74 m³/s) and comparison with slope-area measurement for Flood of Dec. 22-23, 1965, at site 3.5 mi (5.6 km) upstream; no flow at times each year.

EXTREMES OUTSIDE PERIOD OF RECORD.--Flood of Dec. 22-23, 1965, reached a stage of 12.2 ft (3.72 m), from floodmarks, present site, datum used Jan. 1, 1966, to Sept. 30, 1968—discharge, 16,800 ft³/s (476 m³/s) at site 3.5 mi (5.6 km) upstream—by slope-area measurement of peak flow.

EXTREMES FOR CURRENT YEAR.--Maximum discharge, 4,900 ft³/s (139 m³/s) Sept. 11, gage height, 9.50 ft (2.896 m), base discharge, 4,000 ft³/s (110 m³/s); no flow for many days.

DISCHARGE, IN CUBIC FEET PER SECOND, WATER YEAR OCTOBER 1976 TO SEPTEMBER 1977
MEAN VALUES

SEP	DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1.2													
7.6													
4.0	1	.20	.00	.20	8.1	3.4	.00	.00	.00	.00	.00	343	.00
3.8	2	.40	.00	.20	2.7	2.0	.00	.00	.00	.00	.00	300	.00
3	3	.40	.00	.30	.50	1.7	.00	.00	.00	.00	.00	103	16
	4	.20	.00	.40	1.0	1.2	.00	.00	.00	.00	.00	50	16
33	5	.10	.00	.40	2.7	1.2	.00	.00	.00	.00	.00	20	6.4
5.0	6	.00	.00	.30	.50	1.5	.00	.00	.00	.00	.00	10	43
4.0	7	.00	.00	.20	.40	1.2	.00	.00	.00	.00	.00	5.0	80
4.0	8	.00	.00	.30	.40	1.0	.00	.00	.00	.00	.00	3.0	15
132	9	.00	.00	.20	1.5	1.0	.00	.00	.00	.00	.00	160	6.9
70	10	.00	.00	.30	1.2	.70	.00	.00	.00	.00	.00	167	250
10	11	.00	.00	.20	.70	.50	.00	.00	.00	.00	.00	138	1180
5.0	12	.00	.00	.20	.40	.40	.00	.00	.00	.00	.00	507	46
5.0	13	.00	.00	.20	.40	.50	.00	.00	.00	.00	150	192	1.9
5.0	14	.30	.00	.20	.40	.50	.00	.00	.00	.00	30	173	1.0
	15	.00	.00	.30	.40	.40	.00	.00	.00	.00	25	169	.50
5.0	16	.00	.00	.30	.40	.40	.00	.00	.00	.00	20	257	1.2
5.0	17	.00	.00	.40	.40	.40	.00	.00	.00	.00	16	432	1.2
5.0	18	.00	.00	.40	.40	.40	.00	.00	.00	.00	100	100	.70
5.0	19	.00	.00	.40	.40	.40	.00	.00	.00	.00	20	73	.40
	20	.00	.00	.30	.40	.40	.00	.00	.00	.00	5.0	122	.40
4.7	21	.00	.00	.30	.40	.40	.00	.00	.00	.00	3.0	25	.40
5.4	22	.00	.00	.40	1.0	.30	.00	.00	.00	.00	1.0	82	.20
3.7	23	.00	.00	.50	33	.30	.00	.00	.00	.00	100	118	.20
2.1	24	5.1	.00	.50	5.4	.20	.00	.00	.00	.00	20	288	.20
	25	.00	.00	.50	2.2	.20	.00	.00	.00	.00	60	140	.00
2.7	26	.00	.00	.50	1.9	.30	.00	.00	.00	.00	80	40	.00
3.0	27	.00	.00	.50	1.2	.30	.00	.00	.00	.00	30	10	.00
3.3	28	.00	.10	.40	1.0	.20	.00	.00	.00	.00	18	5.0	96
3.0	29	.00	.10	.40	1.0	---	.00	.00	.00	.00	24	2.0	78
4.4	30	.00	.10	.40	1.0	---	.00	.00	.00	.00	17	.00	5.0
---	31	.00	---	.50	1.2	---	.00	---	.00	---	21	.00	---
355.8	TOTAL	6.70	.30	10.60	72.60	21.40	.00	.00	.00	.00	740.00	4014.00	1804.60
11.9	MEAN	.22	.010	.34	2.34	.76	.000	.000	.000	.000	23.9	129	60.2
132	MAX	5.1	.10	.50	33	3.4	.00	.00	.00	.00	150	507	1180
1.2	MIN	.00	.00	.20	.40	.20	.00	.00	.00	.00	.00	.00	.00
706	AC-FT	13	.6	21	144	82	.00	.00	.00	.00	1470	7960	3580
	CAL YR 1976	TOTAL	7666.70	MEAN	20.9	MAX	1550	MIN	.00	AC-FT	15210		
	WTR YR 1977	TOTAL	6670.20	MEAN	18.3	MAX	1180	MIN	.00	AC-FT	13230		

GILA RIVER BASIN

09473500 SAN PEDRO RIVER AT WINKELMAN, AZ
(National stream-quality accounting network station)

LOCATION.--Lat 32°58'38", long 110°46'11", in SE4SW4 sec.24, T.5 S., R.15 E., Pinal County, Hydrologic Unit 15050203, on right bank 0.7 mi (1.1 km) south of Winkelman, and 1.0 mi (1.6 km) upstream from mouth.

DRAINAGE AREA.--4,471 mi² (11,580 km²); of which 696 mi² (1,803 km²) is in Mexico.

WATER-DISCHARGE RECORDS

PERIOD OF RECORD.--May to August 1890 (monthly discharge only), January 1966 to current year.

GAGE.--Water-stage recorder. Altitude of gage is 1,925 ft (587 m), from topographic map. Apr. 8 to Aug. 31, 1890, nonrecording gage at site about 1,000 ft (300 m) upstream at different datum. Jan. 1, 1966, to Sept. 30, 1968, water-stage recorder at present site at datum 0.27 ft (0.082 m) lower.

REMARKS.--Records poor. Diversions above station, mostly by pumping from ground water, for municipal and industrial use, and for irrigation of about 13,300 acres (53.8 km²) in 1974, excluding an unknown amount in Mexico.

AVERAGE DISCHARGE.--12 years, 44.1 ft³/s (1,249 m³/s), 31,950 acre-ft/yr (39.4 km³/yr); median of yearly mean discharges, 35 ft³/s (0.99 m³/s) 25,400 acre-ft/yr (31 km³/yr).

EXTREMES FOR PERIOD OF RECORD.--Maximum discharge, 16,000 ft³/s (453 m³/s) Oct. 10, 1977, gage height, 14.0 ft (4.267 m); no flow at times each year.

EXTREMES OUTSIDE PERIOD OF RECORD.--Flood of Dec. 22-23, 1965, reached a stage of 12.2 ft (3.72 m), from floodmarks, present site, datum used Jan. 1, 1966, to Sept. 30, 1968—discharge, 16,800 ft³/s (476 m³/s) at site 3.5 mi (5.6 km) upstream—by slope-area measurement of peak flow.

EXTREMES FOR CURRENT YEAR.--Maximum discharge (*) and peak discharges above base of 4,000 ft³/s (110 m³/s):

Date	Time	Discharge (ft ³ /s)	Discharge (m ³ /s)	Gage height (ft)	Gage height (m)
Oct. 10	1800	16,000	453	14.0	4.267
Mar. 3	1100	8,670	245	12.99	3.685

No flow for many days.

DISCHARGE, IN CUBIC FEET PER SECOND, WATER YEAR OCTOBER 1977 TO SEPTEMBER 1978
MEAN VALUES

DAY	UCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	.20	8.0	2.0	2.0	20	560	13	3.4	.00	.00	173	11
2	.20	4.0	2.0	2.0	20	4550	11	9.2	.00	.00	198	9.2
3	.00	8.0	2.0	2.0	20	4870	11	3.4	.00	.00	21	9.4
4	.00	8.0	2.0	2.0	20	1270	9.9	3.6	.00	.00	36	11
5	.30	8.0	2.0	2.0	20	491	9.2	5.7	.00	.00	130	137
6	363	30	2.0	2.0	20	732	9.9	3.0	.00	.00	42	7.0
7	313	14	2.0	2.0	20	500	9.2	.95	.00	.00	22	5.5
8	219	10	2.0	2.0	20	234	8.5	.80	.00	.00	17	4.4
9	2070	9.0	2.0	2.0	20	122	8.5	.80	.00	.00	55	2.7
10	4960	8.0	2.0	2.0	20	84	8.3	.80	.00	.00	62	1.2
11	3000	7.0	2.0	2.0	25	65	8.3	1.0	.00	.00	6.4	.82
12	558	8.0	2.0	2.0	30	62	7.1	.95	.00	.00	60	1.0
13	400	5.0	2.0	2.0	40	92	6.4	1.0	.00	.00	19	.17
14	200	4.0	2.0	50	100	97	5.7	.85	.00	3.0	80	.09
15	100	4.0	2.0	200	250	66	4.8	.65	.00	.55	86	.12
16	50	3.0	2.0	900	200	65	5.7	.85	.00	.85	61	.04
17	30	3.0	2.0	300	150	60	4.2	.65	.00	.00	58	3.2
18	20	3.0	2.0	100	100	55	4.6	.16	.00	20	51	4.8
19	15	2.0	4.0	50	60	40	5.0	.24	.00	4.6	131	1.6
20	10	2.0	2.0	30	70	35	4.2	.55	.00	.75	223	.25
21	9.0	2.0	2.0	20	60	30	5.7	.50	.00	.00	107	.00
22	9.0	2.0	2.0	15	50	25	4.6	.30	.00	.00	46	193
23	9.0	2.0	2.0	10	45	20	6.4	.09	.00	117	32	85
24	8.0	2.0	2.0	10	44	20	4.6	.00	.00	.60	32	15
25	8.0	2.0	2.0	10	55	17	5.0	.00	.00	.50	32	8.3
26	8.0	2.0	2.0	10	41	13	6.4	.00	.00	.50	23	5.9
27	8.0	2.0	2.0	10	43	18	4.2	.60	.00	.09	26	4.2
28	8.0	2.0	2.0	10	43	15	5.0	.00	.00	2.6	44	.84
29	8.0	2.0	2.0	10	---	12	6.4	.00	.55	9.4	11	.38
30	8.0	2.0	2.0	10	---	9.9	4.6	.00	.00	9.2	10	.32
31	8.0	---	2.0	15	---	11	---	.00	---	107	27	---
TOTAL	17500.00	170.0	62.0	1388.0	1628	14220.9	207.6	39.44	.55	313.64	2047.4	522.33
MEAN	565	5.47	2.00	44.7	58.1	459	6.92	1.29	.018	10.1	67.3	17.4
MAX	9980	30	2.0	500	250	4870	13	9.2	.55	117	223	193
MIN	.04	2.0	2.0	2.0	20	9.9	4.2	.00	.00	.00	6.4	.00
AC+FT	34716	337	123	2750	3250	28210	412	79	1.1	622	8140	1040

CAL YR 1977 TOTAL 24384.60 MEAN 66.6 MAX 9980 MIN .00 AC-FT 48370
WTR YR 1978 TOTAL 38138.26 MEAN 108 MAX 9980 MIN .00 AC-FT 75650

NOTE.--No gage-height record Oct. 10 to Feb. 24.

BASIN CHARACTERISTICS AND STREAMFLOW STATISTICS IN ARIZONA AS OF 1989

**U.S. GEOLOGICAL SURVEY
Water-Resources Investigations Report 91 - 4041**

**Prepared in cooperation with the
ARIZONA DEPARTMENT OF WATER RESOURCES and
FLOOD CONTROL DISTRICT OF MARICOPA COUNTY**



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GILA RIVER BASIN

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09473500 SAN PEDRO RIVER AT WINKELMAN, AZ--Continued

MEAN MONTHLY AND ANNUAL DISCHARGES 1967-78

MONTH	MAXIMUM (FT ³ /S)	MINIMUM (FT ³ /S)	MEAN (FT ³ /S)	STAN- DARD DEVI- ATION (FT ³ /S)	COEFFI- CIENT OF VARI- ATION	PERCENT OF ANNUAL RUNOFF
OCTOBER	565	0.00	80	174	2.2	15.2
NOVEMBER	25	0.01	6.9	7.6	1.1	1.3
DECEMBER	538	0.34	55	153	2.8	10.5
JANUARY	48	2.3	15	17	1.1	2.9
FEBRUARY	206	0.76	43	73	1.7	8.1
MARCH	459	0.00	74	133	1.8	14.1
APRIL	35	0.00	8.2	11	1.4	1.6
MAY	7.2	0.00	1.6	2.2	1.4	0.3
JUNE	16	0.00	2.3	5.4	2.3	0.4
JULY	184	10	66	59	0.89	12.5
AUGUST	586	3.4	134	156	1.2	25.6
SEPTEMBER	81	0.13	39	27	0.68	7.5
ANNUAL	104	13	44	30	0.67	100

MAGNITUDE AND PROBABILITY OF ANNUAL LOW FLOW
BASED ON PERIOD OF RECORD 1967-78

PERIOD (CON- SECU- TIVE DAYS)	DISCHARGE, IN FT ³ /S, FOR INDICATED RECURRENCE INTERVAL, IN YEARS, AND NON-EXCEEDANCE PROBABILITY, IN PERCENT					
	2 50%	5 20%	10 10%	25 5%	50 2%	100 1%
1						
3						
7						
14						
30						
60	0.02	0.00	0.00	0.00	0.00	0.00
90	0.49	0.05	0.00	0.00	0.00	0.00
120	4.9	1.6	0.82	0.44	0.23	0.14
183	9.4	2.6	1.2	0.63	0.29	0.17

MAGNITUDE AND PROBABILITY OF INSTANTANEOUS PEAK FLOW
BASED ON PERIOD OF RECORD 1963-84

DISCHARGE, IN FT ³ /S, FOR INDICATED RECURRENCE INTERVAL IN YEARS, AND EXCEEDANCE PROBABILITY, IN PERCENT						
2 50%	5 20%	10 10%	25 4%	50 2%	100 1%	
6,390	12,800	19,500	31,600	44,300	60,900	
WEIGHTED SKEW (LOGS)= 0.68						
MEAN (LOGS)= 3.84						
STANDARD DEV. (LOGS)= 0.33						

MAGNITUDE AND PROBABILITY OF ANNUAL HIGH FLOW
BASED ON PERIOD OF RECORD 1967-78

PERIOD (CON- SECU- TIVE DAYS)	DISCHARGE, IN FT ³ /S, FOR INDICATED RECURRENCE INTERVAL, IN YEARS, AND EXCEEDANCE PROBABILITY, IN PERCENT					
	2 50%	5 20%	10 10%	25 4%	50 2%	100 1%
1	2,000	4,460	7,020	11,700	16,600	22,900
3	1,130	2,380	3,650	5,950	8,290	11,300
7	587	1,230	1,880	3,050	4,230	5,750
15	362	715	1,040	1,590	2,100	2,720
30	236	425	578	802	993	1,200
60	147	244	323	439	539	650
90	105	173	228	309	379	456

DURATION TABLE OF DAILY MEAN FLOW FOR PERIOD OF RECORD 1967-78

DISCHARGE, IN FT ³ /S, WHICH WAS EQUALED OR EXCEEDED FOR INDICATED PERCENT OF TIME																
1%	5%	10%	15%	20%	30%	40%	50%	60%	70%	80%	90%	95%	98%	99%	99.5%	99.9%
810	148	52	28	20	10	5.5	3.1	1.5	0.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00

† Reliability of data in column is uncertain, and potential errors are large.

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