ASSESSMENT OF WATER RESOURCE CONDITIONS IN SUPPORT OF INSTREAM FLOW WATER RIGHTS FOR ARAVAIPA CREEK

Bureau of Land Management
Safford District Office
October 1988

TABLE OF CONTENTS

	Page
Introduction	1
Environmental Setting	1
Specifics of the Application	2
Water Resource Values	3
Streamflow Measurement	3
East End	3
West End	3
Streamflow Data	4
West End	4
BLM Gaging Station vs USGS Gaging Station	4
Wildlife Considerations	5
Recreational Considerations	6
Summary and Conclusion	9

Literature Cited

Appendix 1 - Monthly/Semi-monthly Streamflow Measurements at East and West Aravaipa Streamgaging Stations
Appendix 2 - Streamflow Tabulation Data for BLM West Aravaipa Gaging Station, 1981-1988
Appendix 3 - List of Threatened and Endangered Species Occurring at Aravaipa Canyon
Appendix 4 - Evaluation of the Instream Flow Requirements of the Native Fishes of Aravaipa Creek, Arizona
Appendix 5 - A Preliminary Analysis of the Significance of Water to Recreational Visitors at Aravaipa Canyon Wilderness, Arizona.

List of Figures

Figure 1. Aravaipa Canyon Wilderness and BLM Streamgages
Figure 2. Comparison of BLM Instream Flow Request with 21-year USGS Average and 7-year BLM Average

ASSESSMENT OF WATER RESOURCE CONDITIONS IN SUPPORT OF INSTREAM FLOW WATER RIGHTS FOR ARAVAIPA CREEK

Introduction

During 1981, the Bureau of Land Management (BLM) submitted an Application for Permit to Appropriate Water to the Department of Water Resources (DWR). The purpose of the application was to seek and perfect a water right for the maintenance of perennial flow occurring in that portion of Aravaipa Creek located within the Primitive Area (now designated as a Wilderness Area). The application number assigned was 33-87114.

The application was initiated to protect the natural attributes of the Primitive Area. The remoteness of the area and the ecological values (i.e. flowing water, riparian vegetation, good water quality) provide ideal conditions for numerous and varied wildlife and native fish species, as well as an attraction for nature lovers and outdoor enthusiasts. People use the canyon to enjoy the recreational opportunities the area offers. The goal of the instream flow right is to protect and enhance these values by maintaining naturally occurring flows.

Two years prior to the submission of the application (in early 1979), BLM initiated in situ flow measurements, with a current meter, at the east end of the Primitive Area. During mid to late 1980, two streamgaging stations were installed to collect daily streamflow data. The BLM realized that sometime in the near future, they would have to quantify and appropriate the minimum amount of water needed to protect and maintain the flow through the canyon and the uses associated with that flow.

On August 28, 1984, the 4,044-acre Primitive Area was designated a BLM Wilderness Area, with some additional acreage along tributaries included with the new designation. The 6,699-acre wilderness area includes portions of the following tributaries: Parson's, Hell Hole, Paisano, Booger, Horse Camp, Virgus, Javelina, Hell's Half Acre, and Painted Cave Canyons. The beginning and ending points of the creek itself remained unchanged. Figure 1 shows current wilderness boundaries and locations of BLM gaging stations.

Environmental Setting

Aravaipa Creek, a tributary to the San Pedro River, is located in Pinal and Graham Counties of southeastern Arizona. Its watershed begins in the Galiuro Mountains, extending 10 to 15 miles to the central ridge of the Santa Teresa Mountains, and ends about 35 miles to the north. The watershed comprises 541 square miles and includes elevations between 2,160 and 8,441 feet (above mean sea level).

Of the approximately 17 miles of perennial surface flow, 11 1/2 miles are located within the Aravaipa Canyon Wilderness managed by the BLM. It is this stretch of flow for which instream flow is being quantified. A detailed discussion of the hydrology and geology of Aravaipa Creek is contained in Ellingson (1980).

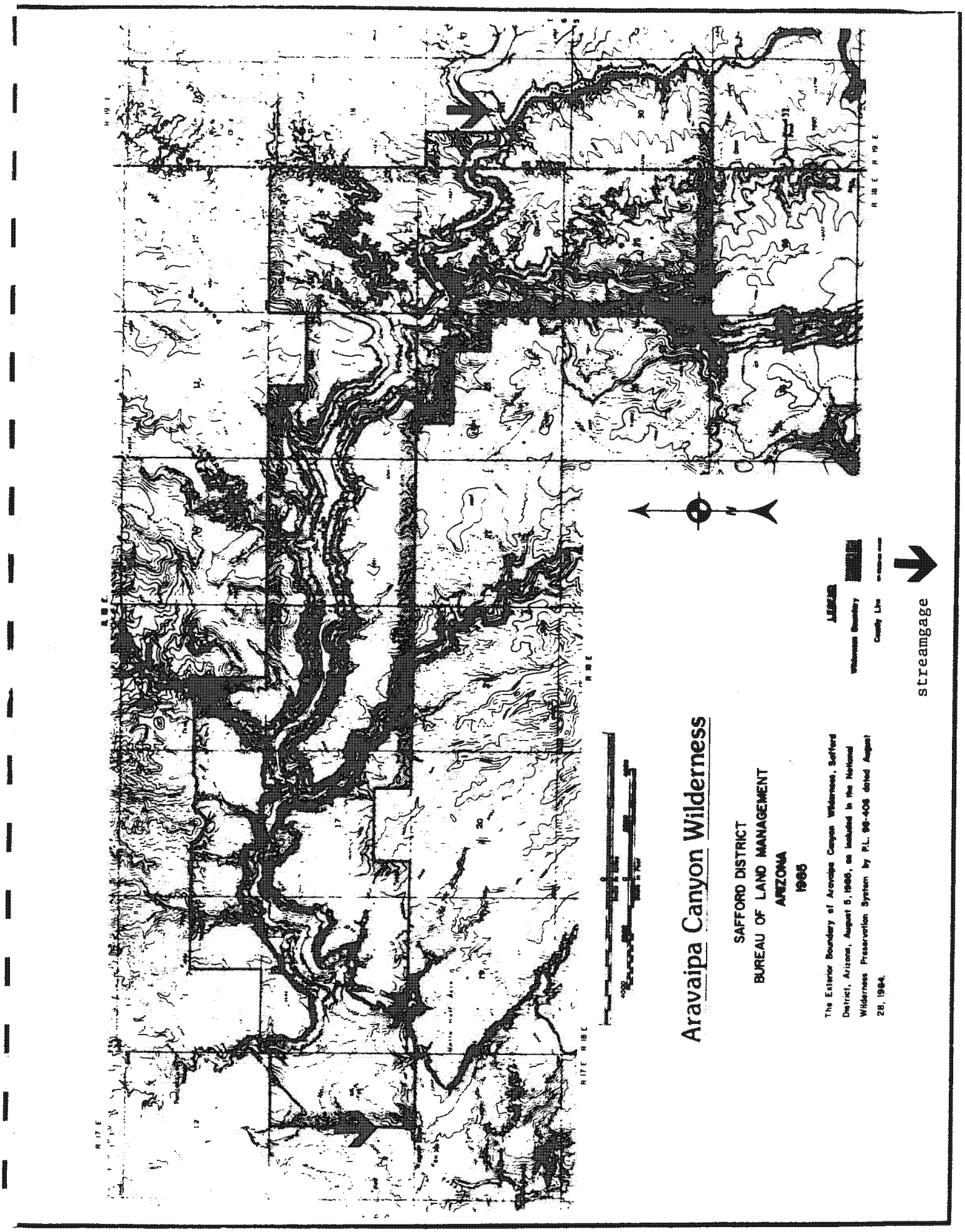


Figure 1. Aravaipa Canyon Wilderness and BLM Streamgages.

Precipitation patterns are characterized by spring droughts, summer monsoons, and regular winter rainfall. Precipitation over the watershed averages about 16" per year, or 480,000 acre-feet, of which an estimated 95% is lost to evaporation and transpiration. Of the 7,400 acre-foot base flow, another 2,400 acre-feet can be expected to be lost to evapotranspiration.

Temperatures in the canyon consist of hot summers with mild winters. Mean maximum temperatures range from 90 to 100 degrees Fahrenheit from June through September, while mean minimums are between 30 and 40 degrees from November to February.

Vegetation varies from open woodland and chaparral communities in the upper watershed to grassland, desert-scrub, and riparian in the lower portions. Approximately 300 species have been recorded on the watershed, half of which occur in the wilderness. A list of species can be found in Appendix A of Minckley (1981).

Specifics of the Application

The application requested a quantity of in situ surface flow in the amount of 10,860 acre-feet, or 15 cubic feet per second (cfs), per annum. The given legal description, as amended, includes the entire length of the surface flow contained within the then Primitive Area, as follows:

T. 6 S., R. 19 E.	Sec. 19, W½
T. 6 S., R. 18 E.	Sec. 24, N½
	Sec. 23, NE
	Sec. 14
	Sec. 15, N½
	Sec. 16, N½
	Sec. 17, N½
	Sec. 18
	Sec. 8, SW
	Sec. 7, SE
T. 6 S., R. 17 E.,	Sec. 13, E½

The quantity of flow claimed on the application was broken into two separate use categories. The first category claimed 10 cfs (7,240 acre-feet) yearlong for wildlife and fisheries consumptive and non-consumptive use. The rest of the Explanatory section listed the threatened and endangered fish and wildlife species found in or adjacent to the main channel. The second category claimed an additional five cfs yearlong (3,620 acre-feet) for riparian ecosystem maintenance and aesthetic recreational values.

The separation of the quantities of flow into two different beneficial uses should not be construed as two separate and distinct requests for instream flow, but should be considered as a single request for a quantity of water to fulfill each and all of the stated uses. Initially, the reasoning was that separate flows should be distinguished according to the beneficial uses applicable under state law. In retrospect, the uses should not have been separated but should have been combined to avoid the belief that the quantities were indeed separate.

Water Resource Values

The natural values of Aravaipa Canyon are inextricably linked to the water resource. The riparian habitat created by the perennial water flow is unique from the surrounding Lower Sonoran desert-shrub. Without the water, many plant and animal species would disappear. The biological diversity would be reduced as the existing riparian community was eliminated. Instream values and recreational experiences are also dependent upon instream flow (including floods and related groundwater conditions). Baseflows and riparian zone water tables are maintained almost entirely by inflows from the upstream Aravaipa Valley watershed. Depletion of the streamflow from upstream diversions could reduce instream flows, eventually affecting the riparian habitat and fish populations within the canyon.

Perennial water in the southwestern United States draws people for numerous water-based recreational activities. Aravaipa Canyon provides the user with a chance to be closely associated with nature through immediate contact with the surface flow and all of the water-dependent attributes or qualities.

The existing natural resources and the quality of the recreational experience are totally dependent upon a sufficient quantity of flow through the canyon. Very low flows (less than 10 cfs) could be tolerated by the entire system for short periods of time. But, extensive low flows (in excess of two months) coupled with high summer temperatures may cause stresses on the flora and fauna from which they could never recover. Long duration low flows would certainly affect the quality of the recreational users' experience.

Streamflow Measurement

East End

In March of 1979, the District initiated streamflow measurements at the east boundary of Aravaipa Primitive Area. These measurements provided the base data prior to the installation of a streamgaging station. The streamgaging station was installed in late July of 1980, and became fully operational by August 1, 1980.

Due to problems with this station over the years, this flow data will not be used for analyzing instream flows. Only the monthly/semi-monthly flow measurement will be inserted for a comparison with the monthly/semi-monthly measurements collected at the west end (see Appendix 2). Flow has been continuously measured at this site nearly every month, and more often twice a month (see Appendix 1). All measurements are in accordance with U.S. Geological Survey (USGS) standards.

West End

In September, 1980, the District installed a streamgaging station at the west end of Aravaipa Canyon, where the flow exits from the wilderness area; the station became fully operational in December.

This station continued to record data until October, 1983, when all of the instrumentation and flow measuring equipment was lost during that flood. Included in the loss were three months of chart data. Flow measurements were not taken until May 1984 when new equipment was obtained. The gaging station was restored to operational status and has been functional since. Consistency in measurement has been maintained since 1982 by using the permanent Park Ranger who lives near the site.

Streamflow Data

West End

Earlier problems with the data have been resolved due to the development of a new rating curve. The original computations were taken from one early-developed rating curve even though the staff gage had been lost and replaced several times. Steps have been taken to ensure that the data conforms to USGS standards. A minimum of two flow measurements are taken each month and routine station maintenance is carried out at least three times a month.

Nearly six years of flow data is tabulated for the West Aravaipa gaging station (Appendix 2). Of the six years of data, the lowest flow (a discharge of 7.0 cfs) occurred during July of 1982. Unfortunately the chart data for July 1983 was lost preventing an examination for comparative flow. Since the 1983 flood, the lowest discharge, 18.2 cfs, occurred on July 23, 1987.

A quick examination of the tabulated flow data reveals that, in portions of the columns there are no numbers for daily cfs. This lack of data occurred because very few flow measurements were taken during, or after periods of flooding. Most flow measurements occurred during lower flows. Although data in excess of 100 cfs is lacking, the range of flows of primary concern to BLM is 10-100 cfs. Therefore, lacking actual high flow data, the rating curve for this station is projected. The projection line allows a "best guess" for flows above 100 cfs.

Since BLM's application is for naturally occurring flows in the range of 10 to 40 cfs, the greatest emphasis in accuracy is placed on measurements in this range.

BLM Gaging Station vs USGS Gaging Station

The use of the BLM gaging station to measure the Aravaipa streamflow has advantages over using the USGS gaging station located downstream. The advantages are enumerated as follows:

1. The BLM gaging station measures the flow as it exits from the canyon, while the USGS station is located 5.75 air miles further downstream.

2. The BLM station is maintained two to four times a month while the USGS station is usually serviced once a month.

3. Flow is usually measured twice a month at the BLM station.

4. A number of domestic residences exist between the two stations. Many of the residences use irrigation from the creek for their gardens, orchards, and fields. This use would have to affect the quantity of flow occurring at the lower gaging station.

5. The USGS rates the data from Station No. 09473000 as fair due to irrigation occurring upstream.

Although the BLM gage provides measurement of flow exiting directly from the canyon, only seven years of data are available for the station. Most of this was collected in wet years and does not accurately reflect long-term averages.

Due to upstream irrigation withdrawals, the USGS gaging station records lower flows than the BLM gage. This affects the months of April through September but is especially apparent in the data between April and June. The USGS gage provides a long-term view of flow trends, and may provide a better overall average since it includes data from both wet and dry years. For this reason, the 21 years of USGS flow data summarized by Minckley was considered along with the BLM data for purposes of comparison.

The following chart summarizes mean monthly flows for both stations:

Month	J	F	M	A	M	J	J	A	S	O	N	D
USGS 21-yr. avg.	25	58	43	14	10	9	21	30	23	28	15	39
BLM, West 7-yr. avg.	34	40	49	29	24	21	26	29	28	24	26	35

Wildlife Considerations

Aravaipa Canyon supports a wide variety of wildlife species, many of which are dependent on the perennial water and adjacent riparian habitat provided by the creek. A total of seven native fish, eight amphibian, 47 reptile, 237 bird, and 46 mammal species have been reported in the canyon; of these 305 species, 20 receive federal or state protection (Appendix 3).

No group of animals is as susceptible to changes in water quantity and quality as the fishes. For this reason, biological resource analysis is based on flows needed to maintain the native fish population. Three of the seven species of fish in Aravaipa are protected by federal and state regulations. The loach minnow (*Tiaroga cobitis*) and spikedace (*Meda fulgida*) are Federally Threatened, while the Gila roundtail chub (*Gila robusta grahami*) is a Federal Category 2 Candidate species. All three are listed as Group 3 Threatened by the State of Arizona.

In 1980-81, the USFWS financed a study of flows in Aravaipa Creek (Turner and Tafanelli, 1983) required for the Federally Threatened *Meda* and *Tiaroga*. They concluded that ... "a discharge of 20 cfs provided the most available habitat for adult *Meda* and *Tiaroga*." Habitat ... "rapidly decreases at discharges less than 10 cfs for both species. A minimum discharge of 13 cfs at

BLM's East Aravaipa gaging station would be an acceptable minimum flow for adult Meda and Tiaroga during low-flow periods in the summer and fall."

The USFWS study (Appendix 4) discusses yearlong flow requirements for the two species of fish. While it concludes that scouring flows during winter probably are necessary to clean silt and sand from cobble sites used for spawning, no recommendations were made for these flows.

The BLM study by ASU (Minckley 1981) analyzes 21 years of monthly average flows from the USGS gaging. It also discusses the relationship between flows and fish and riparian habitat.

Dr. Minckley commented on some ecological principles to consider for instream flow. He believes that high winter and summer flows are necessary to clean gravel, scour pools, and recharge the riparian zone. Based on his 25 years of experience in Aravaipa, a stable flow of 15 cfs would probably be disasterous. He recommended that flows vary in a pattern following the natural, unregulated flow regime. His estimation for the low flow for April-May-June should be approximately 10 cfs, and a similar low flow in the October-November period. The difference between 10 and 15 cfs for these months should be added to winter and summer months. He pointed out a deficiency acknowledged in the USFWS report: The flow recommendations were for adult fishes only; there are no data for the needs of egg or fry.

Generally, the population of the seven species of native fish vary in absolute numbers and in proportion with each other. The environmental factors that allow seven species to coexist in a relatively small stream are created at least in part by a complex pattern of discharge amounts. Complex environments allow species diversity to increase as no single species can specialize for all the conditions present. No other stream in Arizona supports more than five native fish species. Aravaipa Creek is unique in its diversity.

Based on this input, fisheries needs in Aravaipa would best be accommodated with a varying flow regime while maintaining a 15 cfs average as follows:

Month	J	F	M	A	M	J	J	A	S	O	N	D
cfs	20	25	20	10	10	10	15	20	10	10	10	20

Recreational Considerations

The water of Aravaipa Creek and its tributaries is extremely important to the recreational experiences of visitors to Aravaipa Canyon. Nearly every recreational opportunity found in Aravaipa Canyon is enhanced by or focused on the water of Aravaipa Creek. The presence of a perennial stream in a desert setting attracts many people from Arizona and throughout the world, not only for hiking, wading and swimming activities, but for birdwatching and viewing other wildlife that the water of Aravaipa Creek supports directly or by providing riparian habitat.

These conclusions are based upon verbal comments by visitors to Aravaipa rangers and other BLM employees, written comments on visitor register sheets at the wilderness trailheads, letters and articles. Comments received during the preparation of the Aravaipa Canyon Wilderness Management Plan also recognized the importance of maintaining necessary and adequate streamflow in Aravaipa Creek.

An Aravaipa Canyon Wilderness (ACW) recreation visitor survey was conducted by the University of Arizona during a 12-month period in 1987-88 to obtain information about visitor preference regarding a variety of factors that affect experience in the wilderness. A total of 665 responses (83% response rate) were received and evaluated. Data from that survey has been used to prepare A Preliminary Analysis of the Significance of Water to Recreational Visitors at Aravaipa Canyon Wilderness, Arizona, a copy of which is attached as Appendix 5.

The analysis showed that water and water-related recreational activities in Aravaipa Canyon Wilderness are highly valued by people visiting the area. Of 13 Aravaipa Canyon elements listed, water was ranked most frequently as the most important element in the canyon. Water was ranked among the top five of those Aravaipa Canyon elements by 82% of the respondents. Other elements ranking highly included peace and quiet, solitude and wildlife.

Two activities, hiking in the creek and swimming, were highly rated by visitors. The survey showed that 95% of the respondents liked or strongly liked hiking in the creek. Considering a more common assumption that people would rather hike with dry feet, that response is significant with respect to the importance of Aravaipa Creek to ACW visitors. About 78% responded that they would like or strongly like to swim during future wilderness visits.

Analysis of data from the survey also indicates that visitors are sensitive to changes in Aravaipa Creek streamflow. Approximately 88% of the respondents found streamflow at preferable levels. Further analysis of the data showed that visitors to the wilderness prefer some streamflow levels over others. Through that analysis, it was possible to determine at what streamflow volumes respondents were more likely to indicate that they saw less water than they prefer, as much water as they prefer or more water than they prefer.

The researchers postulated that declines in streamflow increased the likelihood that respondents would report they found less water than they preferred. Since visitors appear to be highly satisfied with current flows, declines to less than those experienced are likely to cause dissatisfaction. The availability of swimming and other water-related activities is decreased as deep pools and swimming holes disappear at low flows. The aesthetic character of the canyon is also changed, with dying vegetation and stagnant pools increasing due to lessened flow.

Many Aravaipa Canyon Wilderness visitors have been to the canyon before. The recreation visitor survey showed that over 51% of the respondents had previously visited ACW. These repeat visitors are more likely to be accustomed to average flows and thus more likely to be dissatisfied with flows that vary from the natural flow regime. If flows were to decline below the requested

quantities some visitors might seek other locations with water-related qualities they desire. The attraction of Aravaipa Canyon for recreation could be diminished.

Without a sufficient flow of water in Aravaipa Creek, the uncommon, and in some cases, unique recreation opportunities present in Aravaipa Canyon would not exist. The chances of seeing a rare bird or viewing desert bighorn sheep in the canyon are greatly improved by the presence of a perennial stream and the vegetation and habitat it supports. Other recreational activities possible in a desert wilderness setting are made more enjoyable by the flowing stream. In the opinion of many visitors, the water of Aravaipa Creek and its tributaries is the single most important element of Aravaipa Canyon Wilderness.

Aravaipa Canyon is a wilderness area and must be managed to maintain its wilderness character, including natural conditions and outstanding opportunities for primitive recreation. The maintenance of the natural ecosystem requires flows to follow their natural cycles. Adequate flows are also necessary to perpetuate recreational opportunities and the aesthetic attraction of Aravaipa Canyon. For this reason, a range of flows that would satisfy visitor expectations without varying from the natural flow pattern is requested.

SUMMARY AND CONCLUSION

An application for an instream flow water right in Aravaipa Creek was filed by the BLM on June 1, 1981. This request for 15 cfs was based on a "best guess" of the minimum needs for the recreational and wildlife uses. Since that time, three studies of particular concern were conducted in the canyon. Minckley (1981) summarized the physical and biological characteristics of the creek, and included USGS statistics on flow data for a 21-year period, with monthly averages. Turner and Tafanelli (1983) evaluated the instream flow requirements of native fishes in Aravaipa Creek. These reports, coupled with recent discussions with Minckley, resulted in a recommendation for varying monthly flow amounts, while maintaining an average flow request of 15 cfs over the year.

Moore and Brickler (1988) analyzed visitor satisfaction at Aravaipa Canyon Wilderness, and attempted to correlate this with stream discharge. They found that visitors were sensitive to changes in streamflow, and suggest that below average flows would result in some visitor dissatisfaction.

Seven years of flow data from BLM's West Aravaipa gaging station and 21 years of flow data from the USGS station downstream (Minckley, 1981) were compared for streamflow trends. The long-term monthly flows of the creek vary on a seasonal basis. In most months, flows are higher than the 15 cfs requested in the original application; for three months flows are lower. The USGS data for April-June suggest that there may be insufficient flow during those months to support the original 15 cfs request during these months; the 7-year BLM average indicates otherwise.

High flows are needed to scour silt to produce sites for fish egg-laying. They also tend to wash out mats of aquatic vegetation, making a more pleasant recreational experience for hikers. To account for the seasonal fluctuations in flows, BLM proposes to modify the original application according to the 21-year average. The monthly requests for flow follow the natural flow pattern of the creek, as established by the West End gage. Flows were also selected not to exceed average flows occurring at the USGS gage downstream. Figure 2 compares these three flow patterns.

Although recent studies indicate that flows greater than 15 cfs would be beneficial for some periods, we have attempted to reconcile all beneficial uses while staying within the 15 cfs average of our 1981 application. Overall, the instream flow request accounts for less than half of the average monthly flow measured at the West End gage.

Month	J	F	M	A	M	J	J	A	S	O	N	D
Instream Flow Nomination	20	25	20	10	10	9	10	20	11	15	10	20

The instream flow requested above, which averages to the 15 cfs in the original application, is compared to USGS and GLM averages in Figures 2a and 2b.

Figure 2a.

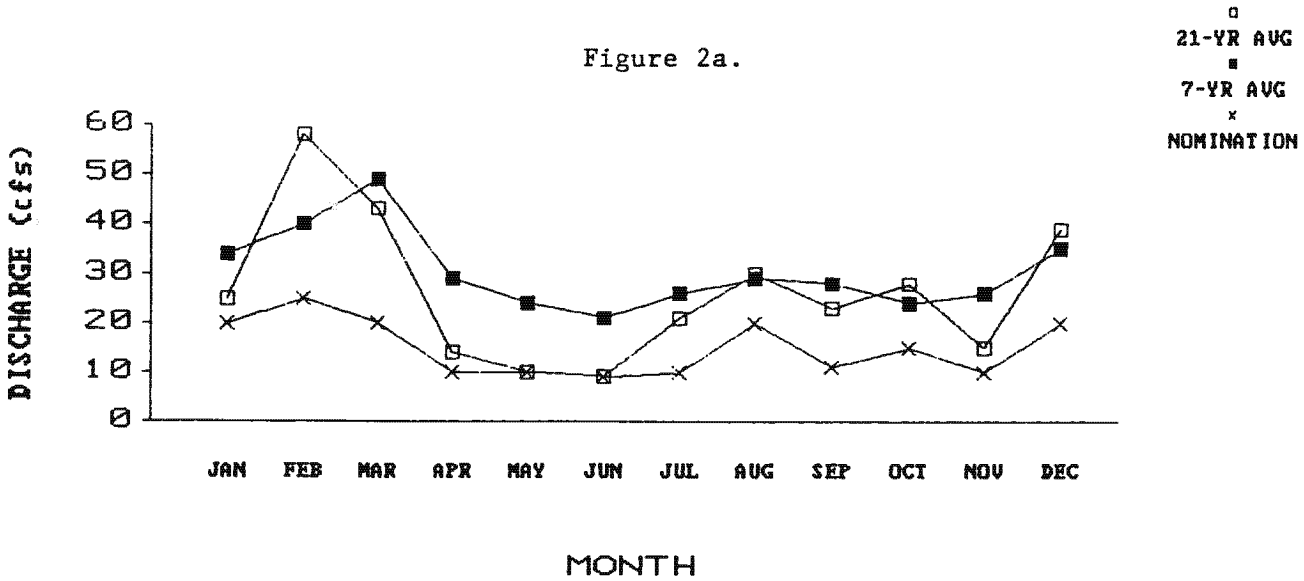
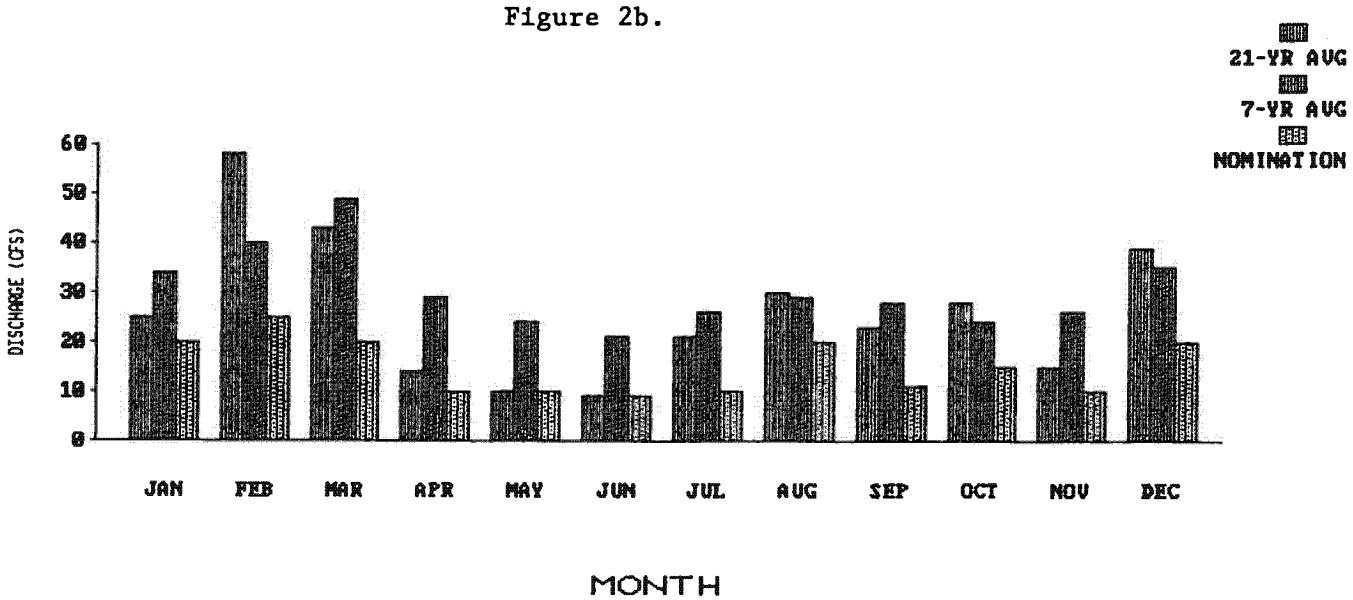


Figure 2. Comparison of Instream Flow Request with USGS and BLM monthly streamflow averages.

Figure 2b.



Subject to valid existing rights, the BLM regards this flow regime as a valid representation of current instream, non-consumptive uses in Aravaipa Creek. As such, this regime represents the minimum amounts of flow needed to maintain and preserve the character of water-dependent values in the Aravaipa Canyon Wilderness. Any diversions of stream flow from Aravaipa Creek which would result in a net depletion of streamflow at the east entrance to the area will diminish the water dependent values within the wilderness. Therefore, these flows are not considered average monthly flows, but, rather, average daily flows. In other words, we cannot tolerate some days of 30 cfs and some of 0 cfs even though they average to 15 cfs.

This flow regime results in a 10,840 acre-feet per year request, compared to the 10,860 acre-feet per year calculated at the 15 cfs per month rate of flow. BLM will continue to measure flow through the canyon, and will use the West End gage to monitor flows granted through this application.

LITERATURE CITED

Arizona Game and Fish Commission. 1982. Threatened Native Wildlife in Arizona. Arizona Game and Fish Department Publication, 12 pp.

Ellingson, Charles T. 1980. The Hydrology of Aravaipa Creek, Southeastern Arizona. University of Arizona, Master's Thesis.

Minckley, W.L. 1981. Ecological Studies of Aravaipa Creek, Central Arizona, Relative to Past, Present and Future Uses. Final Report, Contract No. YA-512-CT6-98. U.S. Bureau of Land Management, Safford, Arizona.

Moore, Steven D., and Stanley K. Brickler. 1988. A Preliminary Analysis of the Significance of Water to Recreation Visitors at Aravaipa Canyon Wilderness, Arizona. U.S. Bureau of Land Management, Safford, Arizona.

Turner, Paul R., and Robert J. Tafanelli. 1983. Evaluation of the Instream Flow Requirements of the Native Fishes of Aravaipa Creek, Arizona by the Incremental Methodology. Final Report. U.S. Fish and Wildlife Service, Albuquerque, New Mexico.

U.S. Fish and Wildlife Service. 1987. Listed, Proposed and Candidate Species Under the Endangered Species Act Found in the State of Arizona. Unpublished USFWS Memo of 2 pages with 22 pages of Appendices, dated June 8, 1987.