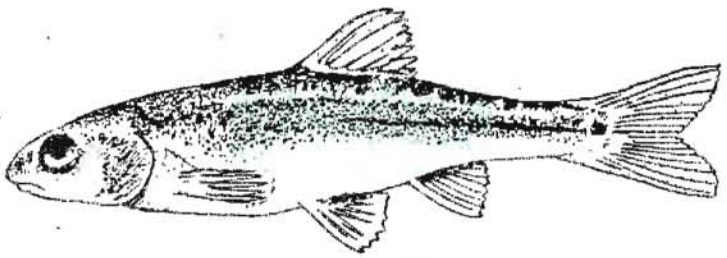
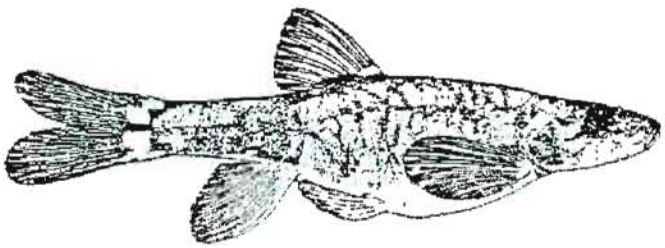
FINAL ENVIRONMENTAL ASSESSMENT

CONSTRUCTION OF FISH BARRIERS

ON

ARAVAIPA CREEK





Prepared by
U.S. Department of the Interior
Bureau of Reclamation
Phoenix Area Office
Lower Colorado Region
Phoenix, Arizona

November 1998

United States Department of the Interior
Bureau of Reclamation
Lower Colorado Region
Phoenix Area Office

FINDING OF NO SIGNIFICANT IMPACT

Construction of Fish Barriers
on Aravaipa Creek
Pinal County, Arizona

Approved: Thomas G. Burbey
Thomas G. Burbey
Area Manager, Phoenix Area Office
Bureau of Reclamation

Date: 11/5/98

FONSI No. PXAO-98-6

Pursuant to the National Environmental Policy Act (NEPA) of 1969, as amended, and based upon the analysis presented within the attached environmental assessment (EA) titled "Construction of Fish Barriers on Aravaipa Creek," we have determined that construction and operation of the fish barriers will not result in a significant impact on the human environment.

BACKGROUND

Congress passed the Colorado River Basin Project Act (Act) (PL 90-537) on September 30, 1968. The Act authorized the Secretary of the Interior, through Reclamation, to construct the Central Arizona Project (CAP). The CAP, which was declared complete in 1993, delivers Colorado River water to central and southern Arizona. During the late 1980s, concern was expressed regarding potential impact of CAP operation on protected native fishes. In 1991, we requested formal consultation with the Fish and Wildlife Service (FWS), pursuant to Section 7 of the Endangered Species Act (ESA). On April 15, 1994, the FWS issued a final biological opinion on the delivery of CAP water to the Gila River Basin. The biological opinion concluded that CAP operation would jeopardize the continued existence and adversely modify critical habitat of several threatened or endangered native fishes. Removal of jeopardy is contingent upon our implementing the reasonable and prudent alternatives of the biological opinion, including the proposed action to build two concrete fish barriers on Aravaipa Creek (Creek).

The EA describes the potential impacts to the environment resulting from construction and operation of the fish barriers. One action alternative and the no-action alternative are evaluated in the EA. Numerous other alternatives and conceptual approaches were considered during ESA Section 7 consultation, but were rejected due to technical and biological infeasibility or ineffectiveness. The no-action alternative was rejected because it would fail to implement required provisions of the biological opinion.

Public involvement for the fish barrier project included a public scoping meeting and bus tour of the project area. The draft EA was mailed to 84 individuals, agencies, and organizations on August 21, 1998, for a 31-day public comment period. In addition, public notices were published in newspapers serving the communities of Winkelman and Mammoth, Arizona, concerning the availability of the draft EA. News releases were also sent to various other news media regarding the draft EA. Twelve entities provided written comments.

FINDING OF NO SIGNIFICANT IMPACT

I have determined that construction and operation of fish barriers on the Creek will not significantly impact the environment, and that preparation of an environmental impact statement is not warranted. This decision is based upon the following considerations.

1. Placement of fish barriers on the Creek will not significantly affect surface and subsurface stream flows. The project will be designed to minimize possible floodplain impacts and resultant increases in backwater flooding. Potential effects caused by project-related flooding will be mitigated through execution of various measures specified in the EA, including acquisition of flowage easements and modification of Aravaipa Road. The biological opinion requires us to

implement the fish barrier project to avoid an ESA violation; therefore, no practicable alternative exists pursuant to Executive Order 11988 (Floodplain Management).

2. Effects of the project on aquatic and terrestrial biota are not significant. Temporary and permanent loss of Sonoran desertscrub, seepwillow/burrobrush, mesquite, and riparian habitats will be mitigated through revegetation and acquisition of conservation easements or purchase of land as described in the EA. The project will have a positive effect on spikedace and loach minnow by minimizing potential encroachment of nonnative fishes on portions of the Creek. A biological assessment of the project, issued on June 19, 1998, concluded there would be "no effect" to other federally-proposed or listed species.

3. We will continue ongoing consultation with the San Carlos Apache Tribe (SCAT) to ensure avoidance of traditional cultural properties in the project area. Consultation with the State Historic Preservation Office (SHPO) will be completed prior to implementation of the proposed action, in accordance with Section 106 of the National Historic Preservation Act. Appropriate measures will be developed in consultation with the SHPO, SCAT, and the Bureau of Indian Affairs to mitigate potential effects to cultural resources.

4. Water quality impacts will be short term and minor. Temporary increases in stream turbidity attributable to the project will cease following construction. Operation of the fish barriers will not introduce measurable long-term effects to water quality. We will obtain required Clean Water Act permits and certifications prior to project implementation.

5. No significant effect to land uses and Indian Trust Assets will result from construction and operation of the fish barriers. Potential land use impacts on Indian Trust Allotment 013736 will be mitigated through acquisition of easements and implementation of measures specified in the EA. Land use patterns on properties adjoining Allotment 013736 will not change as a result of the project.

6. The mitigation measures identified in the EA will be implemented by us as an integral part of project construction and operation.

Documents related to this action are listed below.

U.S. Bureau of Reclamation. 1972. Final Environmental Statement, Central Arizona Project.

U.S. Bureau of Reclamation. 1998. Biological Assessment for Construction of Two Fish Barriers on Aravaipa Creek.

U.S. Bureau of Reclamation. 1998. Final Environmental Assessment, Construction of Fish Barriers on Aravaipa Creek. Attached.

CONSTRUCTION OF FISH BARRIERS

ON

ARAVAIPA CREEK

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

I. PURPOSE AND NEED

This environment assessment (EA) has been prepared to evaluate the potential consequences of constructing two fish barriers on Aravaipa Creek, Arizona. The EA was prepared in accordance with the National Environmental Policy Act (NEPA), the Council on Environmental Quality regulations (40 CFR 1500-1508), and the Bureau of Reclamation (Reclamation) NEPA Handbook. Reclamation is the lead Federal agency, and the Bureau of Indian Affairs (BIA) and Fish and Wildlife Service (FWS) are cooperating Federal agencies pursuant to NEPA.

A. Background

Congress passed the Colorado River Basin Project Act (Act) (PL 90-537) on September 30, 1968. The Act authorized the Secretary of the Interior, through Reclamation, to construct the Central Arizona Project (CAP) to deliver Colorado River water for irrigation, industrial, and municipal uses in central and southern Arizona. The CAP, which was declared completed in 1993, conveys Colorado River water through a 355-mile long system of pumping plants, aqueducts, dams, and reservoirs.

During the late 1980s, the issue of introduction and spread of nonnative aquatic species through the CAP began to receive serious consideration. Concern was expressed that the CAP could accelerate the rate at which nonnative fish species invade habitats occupied by native fishes. Recognizing the CAP could potentially affect protected native fishes, Reclamation, in 1991, requested formal consultation with the FWS, pursuant to Section 7 of the Endangered Species Act (ESA). On April 15, 1994, the FWS issued a final biological opinion on the delivery of CAP water to the Gila River basin (Appendix A).

The biological opinion concluded that CAP operation would jeopardize the continued existence and adversely modify critical habitat of several threatened or endangered native fishes. Establishment of nonnative fishes within the CAP system, and their subsequent escape and invasion into habitats occupied by protected native fishes, were cited as contributing to these adverse effects. Irrigation canals using CAP-supplied water, and associated return flows to the rivers of the Gila River basin, were identified by FWS as principal routes by which nonnative fish species could move from the CAP to the Gila River and its tributaries. Transfer of nonnative fishes from the Colorado River and bait bucket releases help sustain populations of nonnative species within the CAP and the Gila River basin.

One of the reasonable and prudent alternatives FWS identified to minimize adverse impacts and avoid jeopardy was for Reclamation to construct a pair of concrete fish barriers on Aravaipa Creek. Aravaipa Creek, which is located in Graham and Pinal Counties, Arizona, supports self-sustaining populations of seven native fish species, comprising one of the largest and most intact native fish communities remaining in any stream in the State (Figure 1-1). Consequently, the creek is considered to be an important refuge for native

ARIZONA

ARAVAIPA CREEK LOCATION MAP

Figure 1-1

Consequently, the creek is considered to be an important refuge for native fishes. The special status of this canyon-bound riverine system partially results from the lack of extensive development and corresponding stream modification. Values of this aquatic ecosystem are acknowledged by Federal protection of the central canyon as the Aravaipa Canyon Wilderness Area and establishment of extensive reserves by The Nature Conservancy. Also, a portion of Aravaipa Creek was designated by FWS as critical habitat for the recovery of two federally-listed threatened native fishes - the spikedace (*Meda fulgida*) and loach minnow (*Tiaroga cobitis*) in 1994. However, critical habitat for spikedace and loach minnow was revoked on March 25, 1998 (FR 63(57):14378-14379).

B. Purpose and Need

Invasion of nonnative aquatic organisms is viewed as one of the more serious long-term threats to the status and recovery of native aquatic species. Threats include predation, competition, hybridization, and parasite and pathogen transmission. Introduction of nonnative fishes into southwestern aquatic habitats has historically resulted in the reduction or elimination of native fishes from those habitats. To minimize the cumulative effects of nonnative introductions via the CAP, Reclamation and the FWS believe that certain protective measures are appropriate. Construction of fish barriers on Aravaipa Creek would satisfy the need to protect threatened native fishes and comply with a key provision of the biological opinion.

Reclamation would build two concrete drop structures near the lower end of Aravaipa Creek. The drop structures would create a barrier to the upstream movement of nonnative fishes from the San Pedro River to portions of Aravaipa Creek populated with threatened native fishes. Specific purposes of these fish barriers are to: (1) prevent upstream incursion of exotic fishes during periods when Aravaipa Creek has sufficient flow to establish a direct water connection with downstream habitats (principally the San Pedro River) containing populations of nonnative fish species; (2) prevent return of nonnative fishes that periodically encroach on upper portions of the creek but are transported downstream during periods of flooding; and (3) create a management zone between the barriers for the purpose of detecting and removing nonnative fishes.

C. Summary of Required Permits

Table 1 lists permits, authorizations, and coordination required to implement the proposed action.

Table 1. List of permits and authorizations

Permitting Agency	Permit/Authorization
U.S. Bureau of Indian Affairs	Rights-of-entry and easements (allotted land)
U.S. Army Corps of Engineers	Section 404 Clean Water Act (CWA) permit
U.S. Environmental Protection Agency	National Pollutant Discharge Elimination System permit; Section 401 CWA Water Quality Certification
U.S. Fish and Wildlife Service	Section 7 Endangered Species Act consultation; Fish and Wildlife Coordination Act consultation
Arizona State Historic Preservation Office	Section 106 National Historic Preservation Act consultation

II. PROPOSED ACTION AND ALTERNATIVES

This chapter describes the proposed action, the no action alternative, and other alternatives considered but eliminated from detailed study.

A. Proposed Action Alternative

The proposed action is to build two fish barriers on the lower reach of Aravaipa Creek. Reclamation received rights-of-entry from the BIA to perform surveys of two potential fish barrier sites on Indian trust land allotted to members of the San Carlos Apache Tribe (Indian Trust Allotment 013736). The sites are located near the "throat" of Aravaipa Canyon, below which the channel widens, gradient lessens, and perennial flow ceases (Sites A1 and A2, Figure 2-1). Easements for the barriers, if built on allotted land, would be obtained from the BIA acting as trustee for tribal members with legal property interests in the allotment.

B. Project Design

Reclamation and the FWS believe a reinforced concrete drop structure is the best design for the proposed barrier sites (Figure 2-2). Each fish barrier would consist of four primary features: (1) a 4-foot high concrete wall extending across the stream channel and up one or two alluvial benches to tie into adjoining rock abutments, (2) a concrete apron extending about 25 feet downstream from the wall, (3) an upstream key that extends below the river channel to the depth of the natural river scour, and (4) a downstream key at the end of the apron that extends below the river channel to the depth of scour created by the barrier itself.

Figure 2-1
Indian Trust Allotments

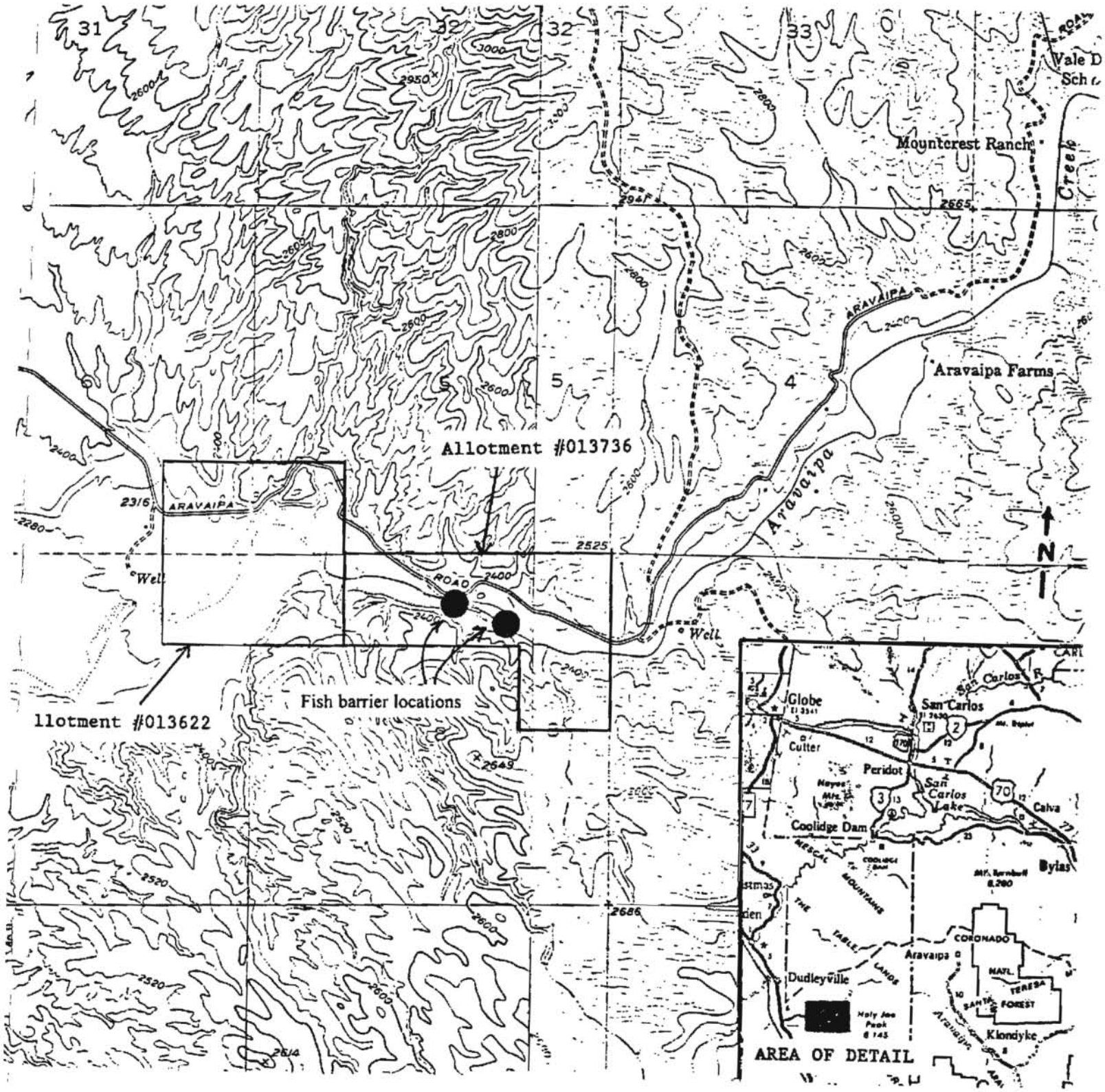
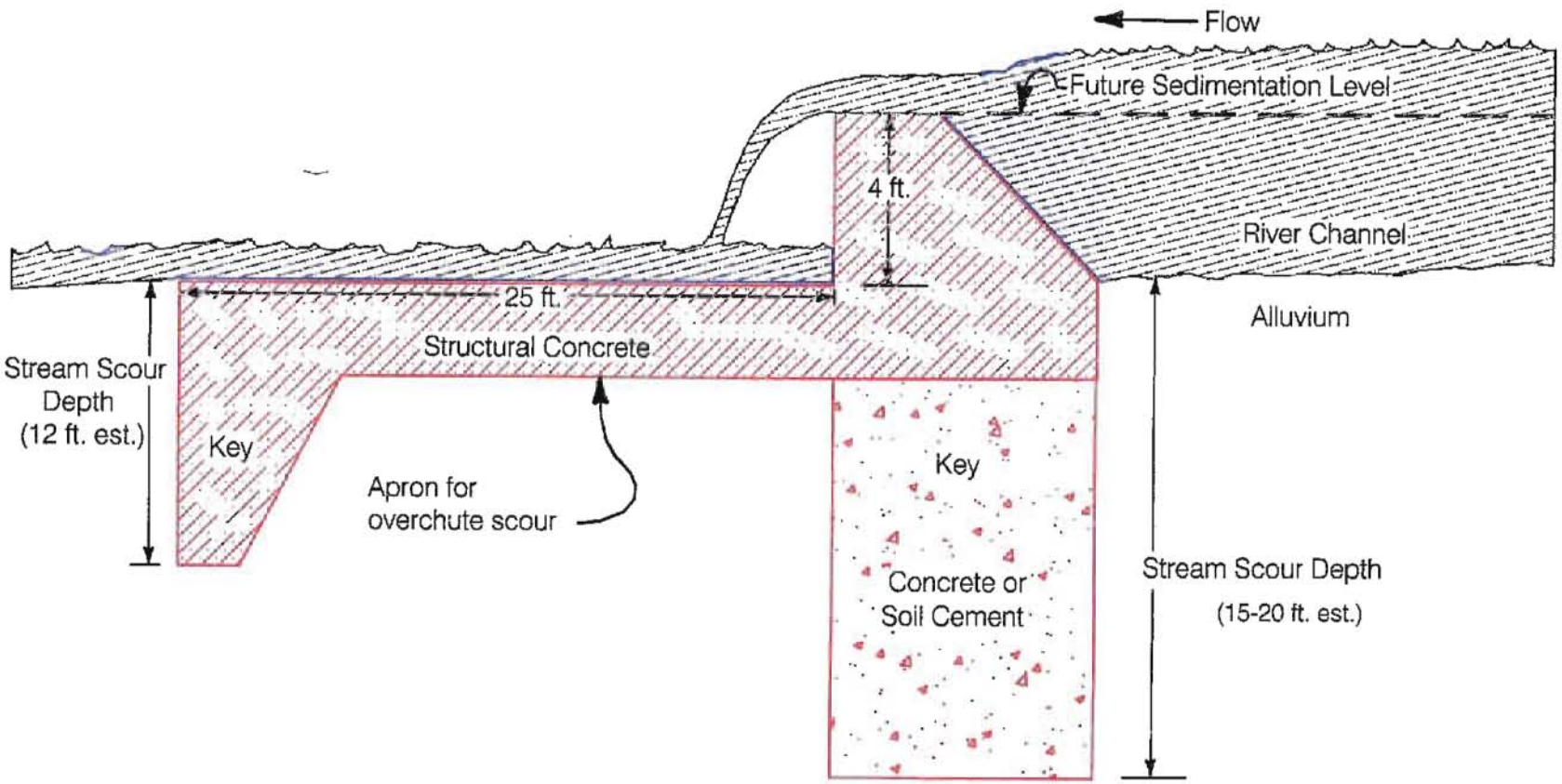


Figure 2-2



Cross Section of Conceptual Fish Barrier

The lower barrier would incorporate a water diversion feature. San Carlos Apache tribal members with property interests in allotted lands downstream of the lower barrier have requested, through the BIA, that the barrier be designed to allow for future diversion of a percentage of stream flow. The diverted water would be utilized by allottees for renewed agricultural production on previously farmed land within Indian Trust Allotments 013622 and 013736. Possible use of Aravaipa Creek water for agricultural development is not part of the proposed action for fish barrier construction and is not evaluated in this EA. Additional NEPA analysis would be completed by the BIA to evaluate the potential environmental impacts of stream water diversion, conveyance, and use prior to diverting water.

The concrete wall height of approximately 4 feet was determined by the FWS to be the minimum effective height. This height would exceed leaping abilities of fishes when combined with shallow, fast flowing water over the apron. At flow rates above 1000 cubic feet per second (cfs), the effectiveness of height is greatly reduced, but this reduction is partly compensated by higher flow velocities. Upstream movements of fishes are not expected during peak flooding because of high flow velocities and sediment loads. The wall would be designed to withstand forces experienced during a record flood (approximately 70,000 cfs) caused by flows, channel materials, and floating tree trunks.

The primary function of the apron is to prevent scouring at the base of the 4-foot wall. Scouring at the base of the wall could undercut and destabilize the structure. Secondarily, scouring would create a deep pool where undesirable fish could congregate and be easily transferred upstream of the barrier by recreationists. The apron would extend beyond the severe turbulence created by the 4-foot drop, estimated to be about 25 feet downstream, and would be designed to withstand the impact of boulders and large trees falling over the wall.

An upstream key would extend through the channel alluvium to a depth where natural scour movement would not affect the integrity of the structure. This depth, which is estimated between 15 to 20 feet, will be calculated in greater detail when geologic investigations of the barrier sites are completed. A downstream key is needed to prevent undercutting of the apron caused by scour induced by the structure. This type of scour will occur as the stream flows over the lower end of the apron. The downstream key will extend at least to the calculated depth of this scour, estimated at 12 feet.

Reclamation proposes to build a second, identical fish barrier approximately 800 feet upstream of the first. The second structure would provide an additional impediment to the upstream movement of fishes and thus reduce the probability of nonnative species successfully breeching the barrier sites. The reach between the fish barriers would be monitored closely for presence of nonnative fishes. If nonnative species are found, the reach between the barriers will be either intensively sampled and undesirable fishes physically removed, or it will

be renovated with an ichthyotoxin (fish toxin). Such actions are necessary to maintain the effectiveness of the dual barrier design, and provide the greatest likelihood that the barriers will prevent the upstream invasion of nonnative fishes.

C. Project Construction

The construction phase of the project would require the use of various kinds of equipment including:

- 2 dump trucks, 35-40 tons capacity
- 2 front end loaders, 1.3-2.6 cu yd bucket capacity
- 2 backhoes, 14.5-30 ft digging depth
- 1 grader, 145-275 HP flywheel power
- miscellaneous: air compressor, generators, pneumatic hammers, dewatering equipment
- concrete trucks (concrete delivery from commercial off-site batch plants)

Construction of the barriers is expected to take about 4 months total. Site preparation would involve excavation of stream alluvium and bank rock, followed by placement of forms, reinforcing elements, and concrete.

Excavation of the alluvial materials would be performed with standard earthmoving equipment, assuming the material can be properly dewatered. Excavation at the abutments would be done either mechanically or with controlled blasting. The depth of excavation required for the keys is contingent upon depth of scour, which is estimated at 15 to 20 feet. Excavated material would be temporarily stockpiled in the stream channel. This stockpiled material would either be returned to the excavation as backfill, or disposed of within the sedimentation zone immediately upstream of each barrier.

Above ground flows would be diverted around work areas by means of berms, dikes, and ditches. These temporary diversion features would be removed or graded into the sediment zone following construction.

Below ground flows would be intercepted upstream and downstream of the key excavations using dewatering wells. The water would be pumped through temporary piping or hoses to a location within the channel downstream of the excavations. This pumped water should be clear and have the same general characteristics of the stream water. About 1 cfs of flow would be generated by dewatering measures at each barrier.

The barriers would be constructed with reinforced concrete and anchored to rock abutments on each side of the channel. Anchor bars would extend into the rock abutments to tie the barrier ends to the bank. Approximately 1,500 cubic yards of concrete would be used to construct each barrier, with the majority of the concrete (and structural mass) going into the keys. All concrete would be commercially batched off site and trucked to the project area. Waste concrete would be disposed of off site in compliance with applicable laws and regulations. The estimated cost to construct the two barriers is approximately $2,000,000.

D. Contractor Use Area

Construction equipment and materials would be stored in a single contractor staging and use area, approximately 2.1 acres in size. Temporary fencing would be erected around this area to protect against unauthorized entry. The contractor use area would be located near the barrier sites to minimize driving distance and promote efficient use of equipment. Three alternative sites are currently under consideration for the contractor use area (Sites A, B, and C; Figure 2-3). Disturbance of native vegetation would be minimized where possible, and environmentally or culturally sensitive areas avoided. No batching or processing of materials would be conducted in the project area.

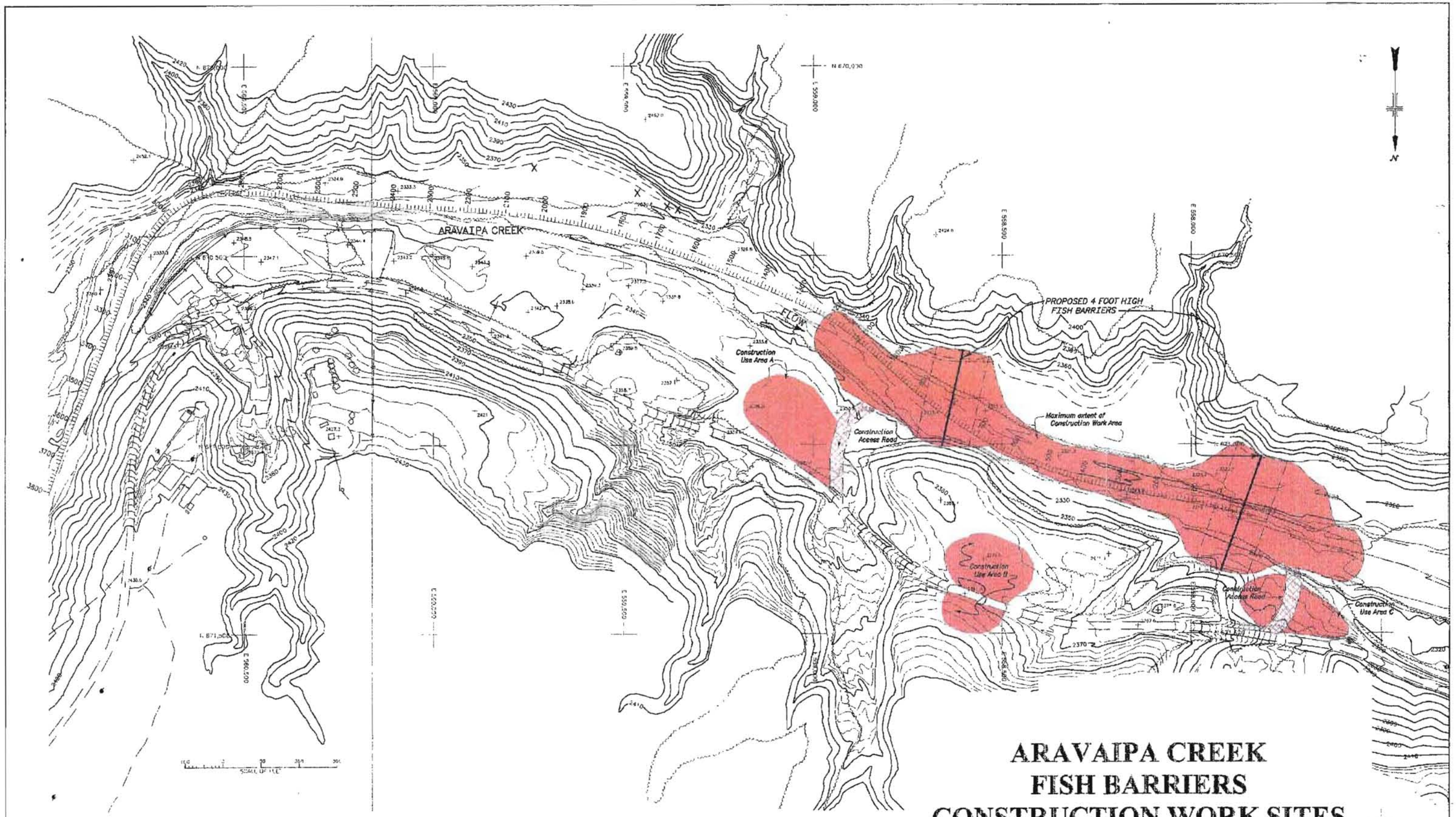
E. Construction Traffic

Construction-related traffic would use existing roads to access the project area. Improvement (minor filling, blading, and widening) of two primitive roads that connect Aravaipa Road with the stream channel would be required to accommodate construction equipment and maintain road conditions during the construction phase of the project.

Minor modification of the stream bank at two locations would be necessary to facilitate the movement of construction equipment to the stream channel and barrier sites. Construction vehicles would use existing roads and the stream channel for maneuvering between barrier sites.

F. Hazardous Materials

No hazardous waste generation would normally be expected from actions required for construction, operation, and maintenance of the fish barriers. To minimize the impact of hazardous materials (petroleum, oil, and lubricants (POLs)) used during construction, all equipment would be periodically inspected for leaks. Any significant leaks would be promptly corrected. POLs would be stored in a designated portion of the contractor use area. Lined secondary containment would be required for POL storage. The contractor would also be required to provide spill kits for equipment operating within the active stream channel.



ARAVAIPA CREEK
FISH BARRIERS
CONSTRUCTION WORK SITES

Figure 2-3

G. Operation and Maintenance

Once completed, the fish barriers would require periodic inspection and maintenance. Reclamation would contract with the Central Arizona Water Conservation District or other entity to perform all necessary inspections and repairs. Removal of flood debris from the structures would be the responsibility of the contractor.

H. No Action Alternative

Under the no action alternative, the fish barriers would not be built and existing conditions would persist. Nonnative fishes would continue to have unimpeded access to portions of Aravaipa Creek occupied by threatened native fishes. Reclamation would fail to implement the reasonable and prudent alternative specified for Aravaipa Creek in the biological opinion. To avoid an illegal "take" of species protected under the ESA, Reclamation would be required to reinitiate formal Section 7 consultation with the FWS.

I. Alternatives Eliminated from Consideration

During ESA Section 7 consultation, extensive discussions were held between the FWS and Reclamation regarding alternatives that would avoid or minimize possible adverse effects of continued CAP operation. Numerous conceptual approaches and alternative actions were evaluated and rejected (see Appendix A, pages 39-41 of the biological opinion, for a description of alternatives eliminated during Section 7 consultation). Many of the alternatives considered during consultation were rejected due to technical and biological infeasibility or ineffectiveness.

Following receipt of the biological opinion, Reclamation personnel investigated a total of eight potential sites for barrier placement between the lower boundary of the Aravaipa Canyon Wilderness Area and the confluence with San Pedro River. It was assumed no construction would be permitted within the Wilderness Area, thereby, establishing the upper boundary of the stream reach considered. Consideration of the lowermost reaches of Aravaipa Creek, where channel widths exceed 1/2 mile, was eliminated because of excessive impacts to visual aesthetics and the large area of channel potentially disturbed by siltation behind the barriers and construction activities. The eight potential sites evaluated within this reach are labeled A1 through F (Figure 2-4).

Sites E and F were dropped from further consideration because they were within the boundaries of the then designated critical habitat for spikedace and loach minnow. Construction of barriers within or near this critical habitat could fragment populations and adversely inhibit the movement of these threatened native fishes.

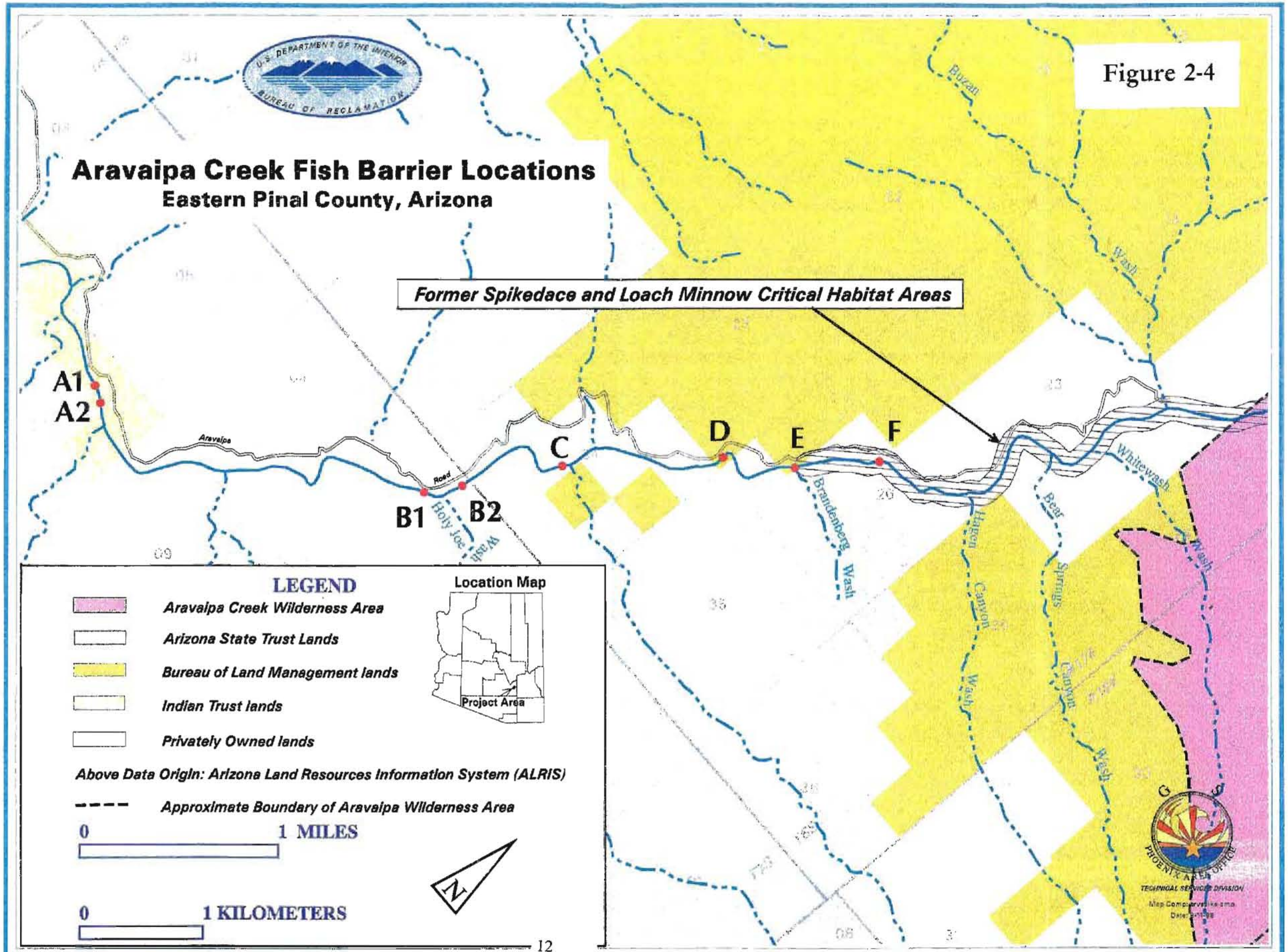


Figure 2-4
U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
Aravaipa Creek Fish Barrier Locations
Eastern Pinal County, Arizona
Former Spikedace and Loach Minnow Critical Habitat Areas
A1
A2
B1
B2
C
D
E
F
Aravaipa
Road
Holy Joe Wash
Brandenberg Wash
Hagen Canyon Wash
Bear Springs Canyon Wash
Whitewash
Buzan
Wash
LEGEND
Aravaipa Creek Wilderness Area
Arizona State Trust Lands
Bureau of Land Management lands
Indian Trust lands
Privately Owned lands
Above Data Origin: Arizona Land Resources Information System (ALRIS)
Approximate Boundary of Aravaipa Wilderness Area
0 1 MILES
0 1 KILOMETERS
N
Location Map
Project Area
PHOENIX AREA OFFICE
TECHNICAL SERVICES DIVISION

Other sites upstream of B2 were rejected due to the amount of road improvements that would be necessary to accommodate the movement of construction equipment through the narrow confines of the canyon. Access to sites C and D would require blasting of canyon walls and other extensive earthwork to allow sufficient road widening and straightening.

Rights-of-entry to sites B1 and B2 for detailed site investigations were not granted by private property owners. Due to rights-of-entry refusals, Reclamation could not adequately evaluate these potential barrier sites. Reclamation also determined that acquisition of, or rights to, sites B1 and B2 for barrier construction could not willingly be obtained from property owners, effectively eliminating these sites from further consideration. Notably, the biological opinion emphasized procurement of sites from willing sellers and discouraged condemnation of land.

III. AFFECTED ENVIRONMENT AND ENVIRONMENTAL CONSEQUENCES

This chapter describes the affected environment and analyzes the environmental consequences of the proposed action and the no action alternative. The analysis addresses the following resource topics: hydrology and geomorphology, biological resources, land use, water quality, cultural resources, environmental justice, and Indian trust assets (ITA). Potential project-related noise, air quality, and socioeconomic (except see environmental justice and ITA sections) impacts were determined by Reclamation to be negligible and thus are not analyzed in this EA. The following analysis examines possible maximum impacts of the project that are anticipated to occur.

A. Hydrology and Geomorphology

1. Affected Environment

Flow regimes within Aravaipa Creek are influenced by the size, shape, and gradient of the channel; roughness of the stream bottom; and amount of rainfall. Flows tend to be episodic, with higher volumes coinciding with runoff from storm events.

Stream gradient is generally less than 13.2 feet/mile (0.2 percent) near the source of perennial flow that begins approximately 3.7 miles northwest of the town of Klondyke. Gradient increases to greater than 132.0 feet/mile (2.5 percent) within the gorge, and again falls to near 26.4 feet/mile (0.5 percent) near the San Pedro River, where flows become ephemeral (Minckley 1981). Gradient in the proposed project area is 31.7 feet/mile (0.6 percent) (Reclamation data).

Mean channel width in the perennial reach below the gorge in 1976 was approximately 99.1 feet, mean stream width was 32.5 feet, mean depth was 3.0 inches, and mean maximum depth was 13.5 inches (Minckley 1981). These figures appear representative of the project area, except to note the local presence of a few peripheral scour pools that exceed 3 feet in depth.

Monthly mean discharges for Aravaipa Creek, measured 5.9 miles upstream from the mouth (immediately upstream from the project area), range from a low of 12 cfs in June to a high of 67 cfs in February, based on 64 years of record (U.S. Geological Survey (USGS) records). A record discharge of 70,800 cfs (300-year flood frequency) was estimated during an October 1, 1983, flood event. Flooding in 1993, which USGS records indicate peaked at 13,000 cfs, was particularly damaging because of its long duration. When floods originate in the upper Aravaipa Valley, large amounts of relatively fine-grained materials are transported downstream, often resulting in aggradation of the streambed and filling in of pools with fine material (Minckley 1981). Flood waters that are derived from higher elevation, bedrock-dominated canyon tributaries, however, have fewer sources for fine suspended loads and, therefore, have a higher probability for scour and degradation of channels downstream (Minckley 1981). Tributary floods also transport larger materials from high elevations that are often deposited in the form of alluvial fans that may temporarily block or impound mainstem flows.

Substrates in the project area range from fine sands and silts to boulders and bedrock (the latter being mudstone conglomerate along canyon walls). Erodible features potentially disturbed by the proposed action include:

- alluvial fans (silty sands, gravelly sand with gravel deposits)
- stream alluvium in active channel (sand, gravel, cobbles, and silt) and floodplains (silts, clays, and sand)
- colluvium (rock fragments and loose sand)

2. Environmental Consequences

a. Construction Impacts

Construction-related disturbances within the channel would result from site preparation (including trenching operations), equipment movement, and stockpiling of excavated alluvial material. Depending on the final design, as much as 15,000 cubic yards of material could be excavated at each barrier site for placement of structural elements such as the keys and apron. Most of the stockpiled material, however, would be returned to the excavation as backfill. Any "surplus" material would be disposed of within the sedimentation zone immediately upstream of each barrier, and eventually consolidate with sediment deposited by stream flow to form a new alluvial bed. Approximately 2 acres of soils and other geologic

features within the stream channel would be temporarily affected during construction. An additional 1.81 total acres of stream channel would fall within the permanent footprints of the barriers.

Other sites affected by construction include the contractor use area and two access roads. Preparation (blading and installation of a fence) and use of the temporary contractor yard would disturb approximately 2.1 acres of soils. The contractor use area would be revegetated with native plants following construction to stabilize disturbed soils and minimize erosion.

Access to both the upper and lower barrier sites would require utilization of two existing primitive roads. Both roads would be "improved" to accommodate the movement of construction equipment. Proposed road improvements include blading, filling, and trimming of vegetation. Approximately 0.3 acre would be disturbed by this action.

b. Surface Flows

Long-term operational impacts of the project include an incremental increase in upstream backwater flooding. The construction of barriers in the stream channel and the resulting deposition of sediment (aggradation) would raise the water surface profile upstream of the barriers. This backwater effect has been quantified in a preliminary river modeling study. The cross-sectional information for this study was obtained from aerial photogrammetry, and was mapped with 2-foot contour intervals. The hydraulic analysis was done using the U.S. Army Corps of Engineers' HEC-2 Water Surface Profile, which is an industry standard for this type of river modeling. The model estimates flow depth, flow velocity, and the width of flow for the stream channel with and without the barriers. The model accounts for channel slope, channel shape, channel roughness, and vegetation. A final river modeling analysis will be performed once all ground survey information is gathered to confirm engineering assumptions.

Frequency floods of 5, 10, 25, 50, and 100 years were run to compare the difference in the water surface profiles with the natural stream channel, and then with the barriers in place. The instantaneous peak flows associated with these frequency floods are 8.700, 13,500, 22,000, 30,000, and 40,000 cfs, respectively. Both profiles were plotted for the five frequency floods, and inundation areas were mapped (Figures 3-1, 3-2, 3-3, 3-4, and 3-5). The added backwater effects from the barriers would extend upstream a few hundred feet beyond the boundary of the allotted land onto private land. Less than 3 acres of allotted land and less than 1/4 acre of private land would be inundated by flooding attributable to the project (Table 2).

344-330-18857

Figure 3-1

KEY MAP

Sec 8, T 7S, R 17E

Estimate of 5-year flood water surface elevation without barrier.

Estimate of 5-year flood water surface elevation with barrier.

5-year flood boundary with fish barriers

5-year flood boundary without fish barriers

ARAVAIPA CREEK

FLOW

PROPOSED 4 FOOT HIGH FISH BARRIERS

PRIVATE PROPERTY

INDIAN TRUST ALLOTMENT 013736

N 670,500

N 671,000

N 671,500

E 560,000

E 559,500

E 559,000

E 558,500

SCALE OF FEET

100 0 100 200 300

NOTES

All mapping is based on Arizona State Plane Coordinate System, Eastern Zone with a North American Horizontal Datum (NAVD) 1983.

Height of barrier measured from the river channel to the top of the barrier.

Topograph; data obtained from aerial photography taken on November 21, 1994. Maps compiled at a scale of 1" = 100', with two foot contour intervals.

Water surface elevations are based on the mapped topography shown. Actual field data will be required to determine more accurate water surface information.

Water surface elevations are based on the 5-year instantaneous peak flow of 8,700 cfs.

Flood boundaries were developed using the U.S. Army Corps of Engineers' HEC-2 Steam Flow Modeling Program.

Dashed contour lines are estimated through vegetation.

Sec. 4, T.7S, R.17E | Sec. 5, T.7S, R.17E

ALWAYS THINK SAFETY

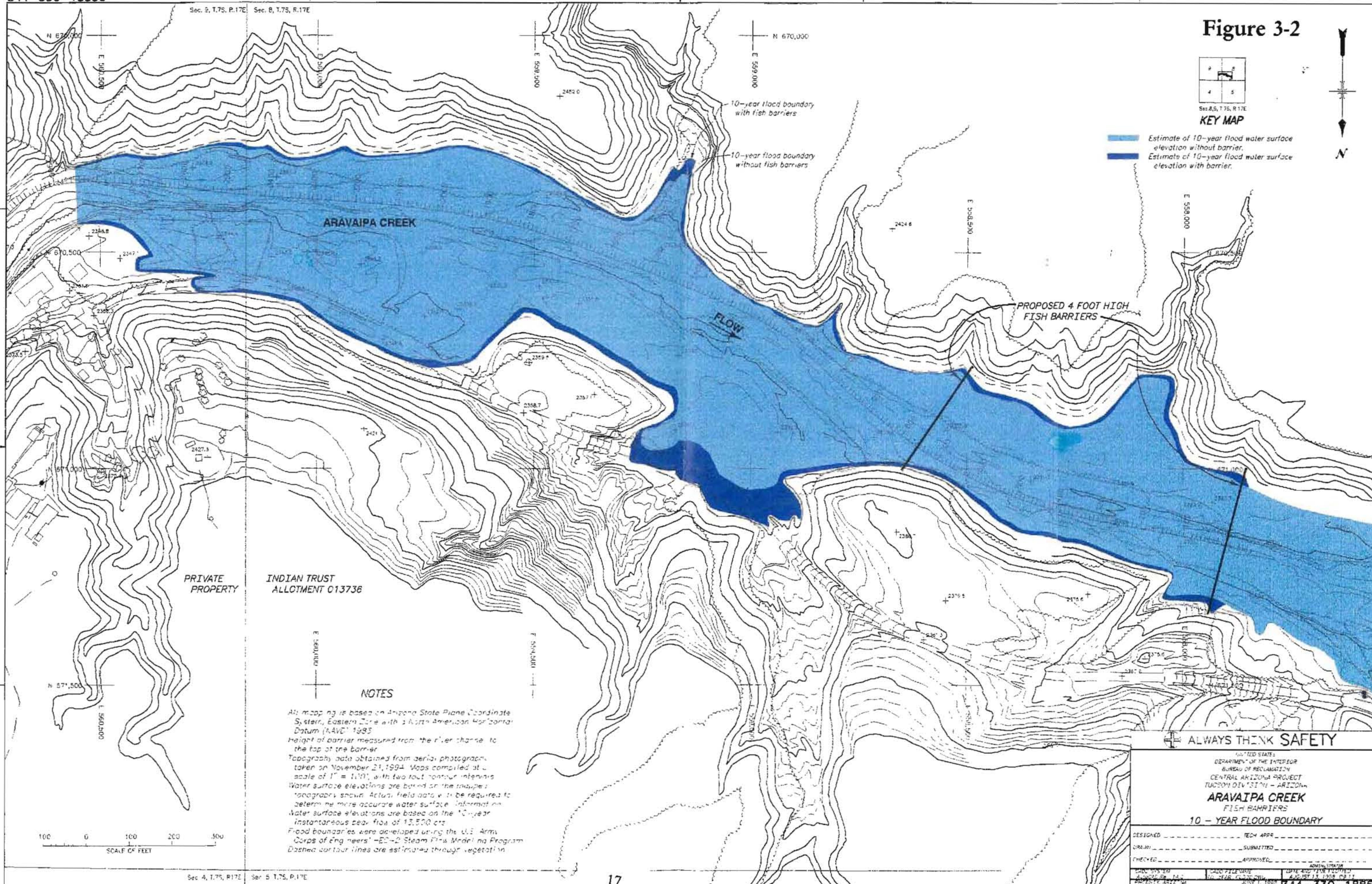
UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
CENTRAL ARIZONA PROJECT
TUCSON DIVISION – ARIZONA

ARAVAIPA CREEK
FISH BARRIERS
5 – YEAR FLOOD BOUNDARY

DESIGNED _____ TECH. APPR. _____
DRAWN _____ SUBMITTED _____
CHECKED _____ APPROVED _____
ADMINISTRATOR

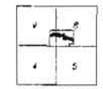
CADD SYSTEM	CADD FILENAME	DATE AND TIME PLOTTED
AutoCAD Rel. 14.0 PHOENIX, ARIZONA	5 YEAR FLOODPLAIN	AUGUST 13, 1998 08:14
	JUNE 1, 1998	344-330-18857

344-330-18856



344-330-18855

Figure 3-3



KEY MAP

Estimate of 25-year flood water surface elevation without barrier

Estimate of 25-year flood water surface elevation with barrier

N

25-year flood boundary with fish barriers

25-year flood boundary without fish barriers

ARAVAIPA CREEK

FLOW

PROPOSED 4 FOOT HIGH FISH BARRIERS

PRIVATE PROPERTY

INDIAN TRUST ALLOTMENT 013736

NOTES

All mapping is based on Arizona State Plane Coordinate System, Eastern Zone with a North American Horizontal Datum (NAVD) 1983.

Height of barrier measured from the river channel to the top of the barrier.

Topography data obtained from aerial photography, taken on November 21, 1994. Maps compiled at a scale of 1" = 100', with two foot contour intervals.

Water surface elevations are based on the mapped topography shown. Actual field data will be required to determine more accurate water surface information.

Water surface elevations are based on the 25-year instantaneous peak flow of 22,000 cfs.

Flood boundaries were developed using the U.S. Army Corps of Engineers' HEC-2 Steam Flow Modeling Program.

Dashed contour lines are estimated through vegetation.

100 0 100 200 300
SCALE OF FEET

Sec 4, T.7S, R17E | Sec 5, T.7S, R.17E

18

ALWAYS THINK SAFETY

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
CENTRAL ARIZONA PROJECT
TUCSON DIVISION - ARIZONA

ARAVAIPA CREEK
FISH BARRIERS
25 - YEAR FLOOD BOUNDARY

DESIGNED	TECH. APPR.		
DRAWN	SUBMITTED		
CHECKED	APPROVED	ADMINISTRATOR	
CADD SYSTEM AutoCAD Rel. 14.0 PHOENIX, ARIZONA	CADD FILENAME 25_YEAR_F_FOR.DWG	DATE AND TIME PLOTTED AUGUST 13, 1998 08:15	
	JUNE 1, 1998		344-330-18855

344-330-18854

Figure 3-4

Sec.8,9, T 7S, R 17E

KEY MAP

Estimate of 50-year flood water surface elevation without barrier.

Estimate of 50-year flood water surface elevation with barrier.

N

50-year flood boundary with fish barriers

50-year flood boundary without fish barriers

ARAVAIPA CREEK

FLOW

PROPOSED 4 FOOT HIGH FISH BARRIERS

PRIVATE PROPERTY

INDIAN TRUST ALLOTMENT 013736

Sec. 9, T.7S, R.17E | Sec. 8, T.7S, R.17E

Sec. 4, T.7S, R.17E | Sec. 5, T.7S, R.17E

SCALE OF FEET

100 0 100 200 300

NOTES

All mapping is based on Arizona State Plane Coordinate System, Eastern Zone with a North American Horizontal Datum (NAVD) 1983

Height of barrier measured from the river channel to the top of the barrier

Topography data obtained from aerial photography, taken on November 21,1994. Maps compiled at a scale of 1" = 100', with two foot contour intervals

Water surface elevations are based on the mapped topography shown. Actual field data will be required to determine more accurate water surface information

Water surface elevations are based on the 50-year instantaneous peak flow of 30,000 cfs.

Flood boundaries were developed using the U.S. Army Corps of Engineers' HEC-2 Steam Flow Modeling Program

Dashed contour lines are estimated through vegetation

ALWAYS THINK SAFETY

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
CENTRAL ARIZONA PROJECT
TUCSON DIVISION - ARIZONA

ARAVAIPA CREEK

FISH BARRIERS

50 - YEAR FLOOD BOUNDARY

DESIGNED	TECH. APPR
DRAWN	SUBMITTED
TRACED	APPROVED
FILE SYSTEM: AutoCAD Rel. 14.0, Windows, Arizona	SUBJECT/FILENAME: 50 YEAR FLOOD.dwg
DATE: JUNE 1, 1998	DATE AND TIME PLOTTED: AUGUST 13, 1998 09:14

344-330-18854

344-330-18852

Figure 3-5

KEY MAP

ARAVAIPA CREEK

WELL

WELL

WELL

WELL

FLOW

PROPOSED 4 FOOT HIGH FISH BARRIERS

PRIVATE PROPERTY

INDIAN TRUST ALLOTMENT 013736

NOTES

100 0 100 200

SCALE OF FEET

ALWAYS THINK SAFETY

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
CENTRAL ARIZONA PROJECT
TUCSON DIVISION - ARIZONA

ARAVAIPA CREEK
FISH BARRIERS
100 - YEAR FLOOD BOUNDARY

DESIGNED _____ TECH. APPR. _____
DRAWN _____ SUBMITTED _____
CHECKED _____ APPROVED _____

CADD FILE/DGN
100_YEAR_FLOODLINE

DATE OF SURVEY
JUNE 1, 1998

ADDENDUM
DATE APP. THIS MODIFIED
AUGUST 17, 1998 13-06

344-330-18852

Table 2. Estimated project-related flood effects

ADDITIONAL IMPACTS (ACRES)					
Affected Property	5-Year Flood	10-Year Flood	25-Year Flood	50-Year Flood	100-Year Flood
Allotment	2.50	1.70	1.30	1.30	1.30
Private	0.04	0.16	0.13	0.16	0.19

Downstream effects beyond the barrier aprons would be relatively minor. Stream flow would return to its natural hydraulic regime within 100 feet of each barrier. Beyond 100 feet, the hydraulic effects of normal flow and flood would not be influenced by the barriers.

c. Subsurface Flows

The depth to bedrock would be determined when the right-of-entry is obtained from BIA to allow detailed geologic investigations. Examination of the alluvial base would necessitate several test drillings within the stream channel. Information derived from these field investigations would be used to develop the final project design and engineer any features that might be required to minimize possible impacts to hydrology at the barrier sites.

Currently, the depth of alluvium in the center of the channel is believed to be 60 to 80 feet. If this assumption proves to be accurate, a permeable alluvial zone with a hydraulic height of 40 to 60 feet will exist between bedrock and the concrete barrier. Assuming a height of 50 feet with a stream width of 270 feet, the permeable area is 6,750 square feet. Based on these assumptions, the barriers would interrupt approximately 0.16 cfs of subsurface flows. These flows are relatively minor and should pass below the barrier with undetectable effects on the ground-water table or above ground flows.

If the channel bedrock proves to be closer to the surface than estimated, the barriers may be tied directly to the rock or attached by means of caissons. Caissons would allow subsurface flows to pass beneath the barrier. In the case of the structure being tied to bedrock, large portals would be placed through the barrier to allow ground water to pass through the concrete.

d. Public Road Impacts

Hydraulic modeling of Aravaipa Creek shows that backwater flooding currently begins to affect Aravaipa Road at about a 12-year frequency flood. With the fish barriers in place, the same situation occurs with a 4-year flood. Reclamation would modify affected sections of Aravaipa Road to conform with the Pinal County all-weather road standards. Two low-lying sections of Aravaipa Road would be raised approximately 3 to 4 feet to improve drainage and prevent road closures caused by project-related backwater flooding. Almost 1,250 feet (500 feet and 750 feet, respectively) of Aravaipa Road above the upper barrier would be modified. Road improvements would include installation of culverts and placement of 6 inches of aggregate base course on the driving surface. Fill material would be imported from a commercial off-site source and compacted to Pinal County standards. Aravaipa Road would remain open while road construction is underway and all traffic would be accommodated, although there could be some minor traffic delays. Flagmen would be provided by the contractor if traffic volumes and construction activities warrant this additional measure to ensure safe passage through the work zone. The volume of construction traffic generated by the fish barrier project would not be expected to interfere with traffic flow on public roads.

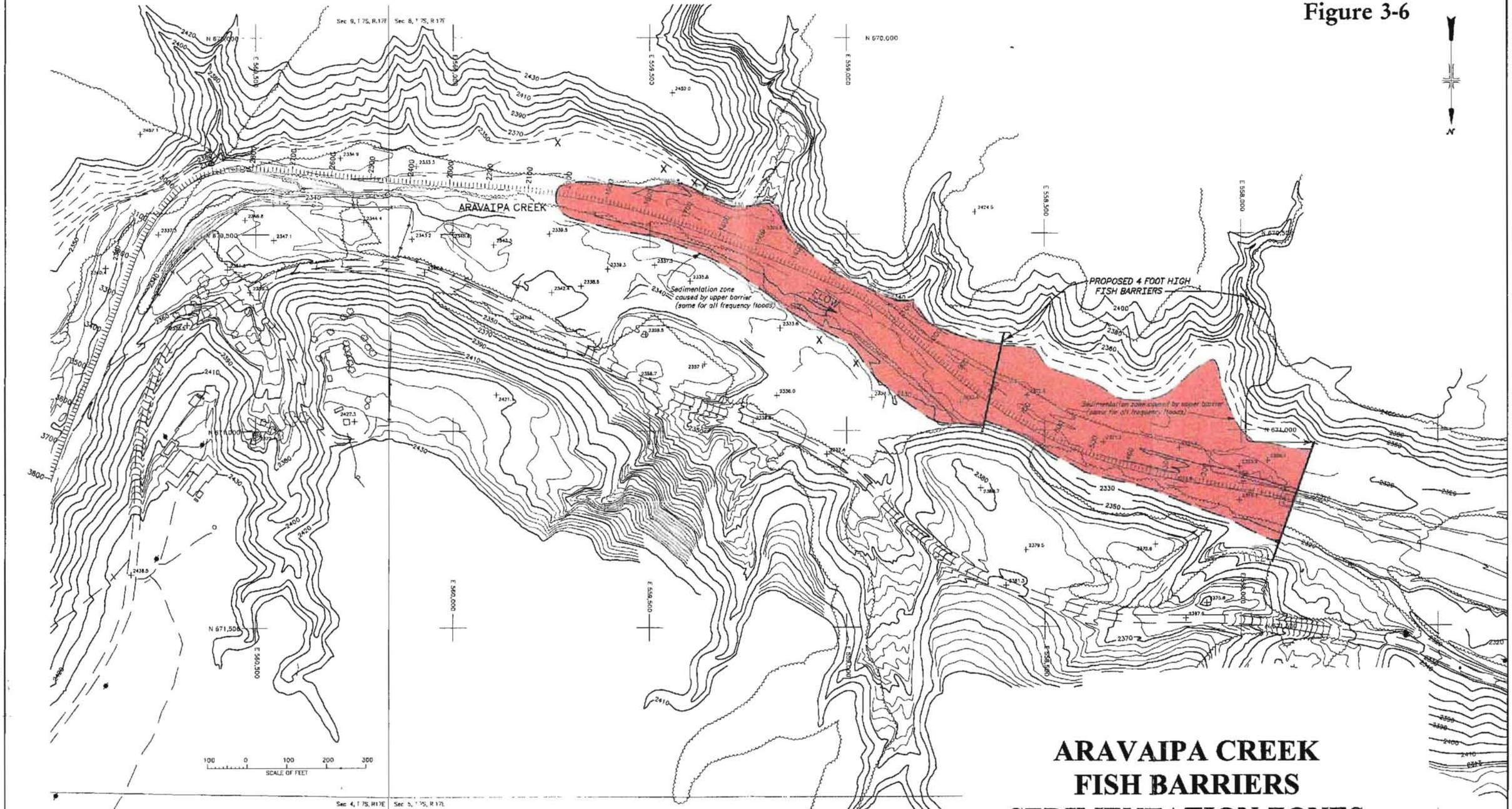
e. Sediment Deposition (Aggradation)

Any impediment placed in flowing water will momentarily disrupt flow velocity and allow opportunities for sediment deposition. This same dynamic relationship between stream velocity and sediment deposition would occur at the barrier sites. Immediately following construction, the fish barriers would become effective sediment traps. Silt transporated by normal stream flow and flood would quickly collect upstream of each barrier to form "sedimentation zones" (Figure 3-6). At the barrier's center, the sediment would accumulate (aggrade) to a depth of 4 feet, raising the stream channel to the same height as the barrier. Temporary pools formed by barrier construction would eventually fill with silt.

The extent of the sedimentation is expected to reach approximately 1,200 feet upstream of the upper barrier, where the raised stream channel would converge with the existing stream channel grade. The lower barrier would experience the same type of sedimentation, but since the barriers would be separated by about 800 feet, the sediment aggradation would be interrupted by the upper barrier. This may lead to sediment partially burying the downstream face of the upper barrier by 3 to 5 inches. Aggradation of sediment to more than a few inches at the base of the upper barrier could seriously compromise the barrier's effectiveness as an impediment to fish movement. Thus, 800 feet is the minimum acceptable distance for barrier separation.

The prevailing stream gradient through the project area is approximately 0.6 percent. For a short distance upstream of the lower barrier, stream gradient increases to almost 0.9 percent before returning to 0.6 percent near the upper barrier site. Due to

Figure 3-6



ARAVAIPA CREEK
FISH BARRIERS
SEDIMENTATION ZONES

the steeper gradient, sediment aggradation between the two barriers would be less than above the upper barrier. The acreage affected by sediment deposition is projected to be 7.5 acres (4.5 acres upstream of the upper barrier and 3.0 acres between the barriers). The volume of this sediment would be 15,000 cubic yards (10,000 cubic yards upstream of the upper barrier and 5,000 cubic yards between the barriers).

f. Scour

In the zone of sedimentation upstream of the barriers, the slope of the stream channel would become flatter as sediment accumulates. This would result in lower velocities through this section, which in turn should decrease scour and encourage additional aggradation until such time that natural sediment deposition and transport processes reach equilibrium. Upstream of the sedimentation zone, the scour should be similar to conditions without the barriers. Immediately downstream of the barriers, velocities will be higher as the water falls over the drop. Most of this turbulent scour will lose its energy at the apron. At the abutments, the higher velocities will increase erosion potential. Since the abutment rock is a soft mudstone conglomerate, it is not expected to withstand erosive flows. These high velocity areas would be armored with concrete, riprap, or gabions. Beginning approximately 100 feet downstream of the barriers, flow characteristics and scour would be unaffected by barrier operation.

Protection of the abutments from natural erosional forces is extremely important. If flows can erode around the end of a barrier, the stream will simply shift laterally and render the barrier ineffective. For this reason, the stream banks would require stabilization with riprap or other means for up to 100 yards upstream of each barrier.

g. Impacts to Wells

The possible effects of barrier construction and operation on nearby private wells were examined. First, the local drawdown due to dewatering for key trench excavation was considered. The nearest well, 1,800 feet upstream of dewatering pumping, would be the most likely affected. The analysis, however, demonstrated that recharge from the stream would confine the drawdown cone of the dewatering pumping to the immediate project area and, thus, would not impact private wells. Next, the influence of the raised stream channel was investigated. The stream channel elevation would increase as a result of sedimentation behind the barrier. The sediment zone is expected to extend 1,200 feet upstream of the upper barrier. The upper end of the sediment falls approximately 600 feet down gradient of the nearest well. This distance would preclude any measurable influence normal stream flow regimes might have on the wells.

All of the wells are within the 100-year floodplain, and are already subject to inundation from the 100-year flood event (Figure 3-5). Consequently, the well sites would be affected by slightly deeper 100-year flood flows and briefly extended flood durations. A temporary slight increase in water levels in the wells may result from the expected incremental increase in flooding.

h. Effects of Structural Failure

Once the upstream side of the barriers have filled in with sediment, very little, if any, water will be stored or backed up by the barriers. A structural failure under this condition poses no additional flooding threat to downstream property.

A structural failure of either barrier prior to sediment build-up would result in water being released downstream of the lower barrier. Prior to sediment build-up, there would be about 4.5 acre-feet and 0.5 acre-feet capacity behind the upper and lower barriers, respectively, and the maximum depth of water behind each barrier would be 4 feet. In the unlikely event of a "clear-day" failure (a failure that does not occur as a result of storm run-off), assuming a 50-foot wide section (a common jointing distance) suddenly breached for the entire hydraulic height of 4 feet of the upper barrier (the worst case scenario), an initial surge of approximately 1,100 cfs would occur. This flow would immediately begin to decrease as the ponded water elevation falls. For example, after 1 minute approximately 30 percent of the stored water would be released, and the discharge would be around 800 cfs. This flow would steadily decrease over about 20 minutes, when the stream would resume its normal flow. The leading edge of the flood wave would begin to attenuate significantly within a mile of the barrier due to infiltration, dispersion over the wide floodplain, and reduced velocity because of vegetation. As the leading edge approached the vicinity of the creek's confluence with the San Pedro River, the flow would probably range from 100 to 400 cfs. The effects of a barrier failure during normal stream flow would be confined to the stream channel and portions of the floodplain subject to recurrent flooding. The temporary flow surge immediately below the barrier would be substantially less than a 2-year frequency flood, which is estimated by USGS to be 3,790 cfs.

A more likely failure would occur during a large flood event. The catastrophic loss of a barrier during a flood would erode sediment that may have already accumulated in the sedimentation zone, returning the channel in this section of stream to its original preconstruction elevation. Loss of the barrier, and any impounded sediment, would lower the flood surface at the barrier site. The volume of water released would be proportionately small relative to the overall flood volume and would not perceptively increase flows. Because the water behind the barrier is already moving with the flood, the collapse of the

barrier would not produce a flood wave. The only anticipated adverse effect of a barrier failure during a flood would be the possible slight increase in bank erosion on allotted land immediately downstream of the barrier. No measurable impact to public roads, residences, farm production, or cultural sites is expected.

i. No Action Alternative

Geomorphic and hydrologic effects resulting from construction and operation of the fish barriers would not occur. Periodic flooding on the allotment and upstream private properties would continue without project-related influences.

B. Biological Resources

1. Affected Environment

The lower reach of Aravaipa Creek above the project area is considered one of the premier examples of high-quality riparian vegetation, as well as one of the last remaining refugia for native fish in the Sonoran Desert. The unique values of Aravaipa Creek have been recognized by active protection of the central canyon as a wilderness area managed by the Bureau of Land Management (BLM), establishment of reserves by The Nature Conservancy, and conservation efforts of the Arizona Game and Fish Department (AGFD), Forest Service, and numerous private landowners.

The head of the Aravaipa Creek channel originates below the low divide bordering Sulphur Springs Valley in Graham County, from where it flows northwest in a narrowing valley between the Pinaleño and Turnbull-Santa Teresa ranges to the north and the Galiuro Mountains to the south. After entering an upper canyon section, the stream then cuts west through a gorge in the northern flanks of the Galiuros and enters Pinal County. It then turns southwest through a lower canyon, and heads west again as it leaves the lower canyon. Aravaipa Creek joins the San Pedro River in a broad valley south of the town of Winkelman (Minckley 1981). Maximum elevations in the basin exceed 10,000 feet in headwaters of the Pinaleños, and descend to 2,150 feet at the confluence with the San Pedro River.

Vegetation in the upper portion of the creek is best characterized as desert-grassland habitat (Minckley 1981). Desert grassland habitat is often transitional between evergreen woodland or chaparral above and desertscrub habitat below (Brown 1982). The stream is perennial through the BLM Wilderness Area and for several miles downstream. However, prior to the confluence with the San Pedro River, the flow becomes subsurface and the vegetation immediately along the channel changes from a cottonwood (*Populus fremontii*) and willow

(*Salix goodingii*) gallery forest to isolated pockets of trees, and finally to riparian scrub vegetation consisting primarily of seepwillow (*Baccharis salicifolia*) and burrobrush (*Hymenoclea monogyra*).

The project area is located in the lower portion of Aravaipa Creek, approximately 10 miles downstream from the Wilderness Boundary and approximately 5.5 miles upstream from the confluence with the San Pedro River. Surface flows are perennial in the project area; however, vegetation consists of scattered pockets of Sonoran Riparian Deciduous Woodland interspersed with Sonoran Riparian Scrubland habitat.

Terrestrial Resources

1. Vegetation - Vegetation within the project area is divided into four habitat types based on the vegetation classification system described by Brown (1982). The project area was cover mapped during June 1998, and the results are presented in Figure 3-7. The four community types include: Sonoran Riparian Deciduous Woodlands (cover mapped as mixed riparian, velvet mesquite and mixed mesquite); Sonoran Riparian Scrubland (cover mapped as mixed seepwillow/burrobrush); Sonoran Interior strand (included within the seepwillow/burrobrush cover type); and paloverde, cacti-mixed scrub community (cover mapped as Sonoran desertscrub). For a list of common plant species in Aravaipa Creek see Appendix B.

Following is a more detailed description of the vegetative community in the project area. The first paragraph describes the general vegetative community, while the indented paragraphs describe the actual project conditions.

The Sonoran Riparian Deciduous Woodlands community consists primarily of streamside vegetation such as Fremont cottonwood (*Populus fremontii*) and Goodding willow (*Salix goodingii*), but also includes saltcedar (*Tamarix ramosissima*) and velvet and/or honey mesquite (*Prosopis velutina* or *P. glandulosa*).

> This habitat is the dominant association in the river corridor, but habitat quality is considered moderate at best. The habitat is scattered in small pockets along the river corridor and consists of willow, cottonwood, sycamore (*Plantanus wrightii)*, saltcedar (*Tamarix ramosissima*), velvet mesquite (*P. velutina*), soapberry (*Sapindus saponaria*), Arizona walnut (*Juglans major*), and velvet Ash (*Fraxinus velutina*). The willow/cottonwood trees are either mature or decadent with little evidence of regeneration. There is one large (300 foot by 200 foot) mesquite bosque, while the remaining mesquite (more scrubby in stature) occurs in narrow stringers adjacent to the river. Saltcedar is interspersed within the corridor.

344-330-18860

Figure 3-7

Sec. 9, T.7S, R.17E | Sec. 8, T.7S, R.17E

Sec. 4, T.7S, R17E | Sec. 5, T.7S, R.17E

ARAVAIPA CREEK

FLOW

PROPOSED 4 FOOT HIGH FISH BARRIERS

Sedimentation zone caused by upper barrier (same for all frequency floods)

Construction Use Area A

Maximum extent of Construction Work Area

Construction Access Road

Construction Use Area B

Construction Access Road

Construction Use Area C

Sedimentation zone caused by upper barrier (same for all frequency floods)

N 670,000 | E 560,500 | E 560,000 | E 559,500 | E 559,000 | E 558,500 | E 558,000

N 671,000 | N 671,500 | N 670,500

E 560,500 | E 560,000 | E 559,500 | E 559,000 | E 558,500 | E 558,000

N 671,500

E 560,500

100 0 100 200 300

SCALE OF FEET

Legend

- Private land not mapped
- Sonoran Desert Scrub
- Stream channel
- Mixed seepwillow/burrobrush
- Velvet mesquite
- Mixed mesquite (velvet mesquite, desert hackberry, elderberry, burrobrush, seepwillow, little-leaf paloverde, Arizona grape and Gooding willow)
- Mixed riparian (Fremont cottonwood, Gooding willow, Arizona ash, netleaf hackberry, soapberry and Arizona walnut)

Sec.9, T.7S, R.17E

KEY MAP

N

NOTES

All mapping is based on Arizona State Plane Coordinate System, Eastern Zone with a North American Horizontal Datum (NAVD) 1983.

Height of barrier measured from the river channel to the top of the barrier.

Topography data obtained from aerial photography, taken on November 21,1994. Maps compiled at a scale of 1" = 100', with two foot contour intervals.

Water surface elevations are based on the mapped topography shown. Actual field data will be required to determine more accurate water surface information.

Water surface are based on the 100-year instantaneous peak flow of 40,000 cfs.

Flood boundaries were developed using the U.S. Army Corps of Engineers' HEC-2 Steam Flow Modeling Program.

Dashed contour lines are estimated through vegetation.

IMPACTED AREAS IN ACRES

Upper Barrier = 3.2
Stream Channel = 1.3
Mixed Seepwillow/Burrobrush = 3.2
Velvet Mesquite = .009

Stream Channel = .71
Mixed Seepwillow/Burrobrush = 3.3
Velvet Mesquite = .18
Mixed Riparian = .007
Mixed Mesquite = 0.2

Upper Barrier = .02
Lower Barrier = .01
Upper Construction work site = .002
Middle Construction work site = .0005

Upper Barrier = 0.3
Lower Barrier = 0.1
Upper Construction work site = 0.3
Middle Construction work site = 0.5
Lower Construction work site = 0.2

Upper Barrier = 0.5
Lower Barrier = 0.9
Upper Construction work site = 0.8
Middle Construction work site = 1.6
Lower Construction work site = 1.0

Upper Barrier = .05
Middle Construction work site = .007
Lower Construction work site = .006

Upper Barrier = .02
Middle Construction work site = .006

Total area = 0.1
Mixed Mesquite = .04

Mixed Seepwillow/Burrobrush = .06
Velvet Mesquite = 0.2
Sonoran Desert Scrub = .01

Total area = 2.1

ALWAYS THINK SAFETY

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
CENTRAL ARIZONA PROJECT
TUCSON DIVISION - ARIZONA

ARAVAIPA CREEK

FISH BARRIERS

VEGETATION MAPPING

DESIGNED _____ TECH. APPR. _____

DRAWN RONALD CONWAY SUBMITTED _____

CHECKED _____ APPROVED _____

CADD SYSTEM	CADD FILENAME	DATE AND TIME PLOTTED
AutoCAD Rel. 14.0 PHOENIX, ARIZONA	344330188560.DWG JUNE 1, 1998	SEPTEMBER 29, 1998 10:30

344-330-18860

The Sonoran Riparian Scrubland community has adapted to the successional situations that occur in the flood-prone areas they inhabit (Brown 1982). Vegetation typical of this community type consists of seepwillow, desert broom (*B. sarothroides*), arrowweed (*Pluchea* sp.), as well as more upland species such as lycium (*Lycium* sp.), acacia (*Acacia* sp.) and desert hackberry (*Celtis pallida*).

This portion of the river channel is predominantly seepwillow and burrobrush adjacent to the stream channel. Although not the dominant vegetation community in the project area, it is the major habitat type impacted by the project.

The Sonoran Interior Strand community is subject to greater scouring than the Sonoran Riparian Scrubland. This habitat consists primarily of open stands of shrubs and weeds such as seepwillow, tree tobacco (*Nicotiana glauca*), and nightshade (*Solanum* sp.). Some areas subject to frequent scour may only be populated with algae (Brown 1982).

In the project area, nearly one-half of the riverine channel consists of this open community. The vegetation consists primarily of seepwillow, burrobrush, bermuda (*Cynodon dactylon*), and Mediterranean grass (*Schismus barbatus*).

The paloverde, cacti-mixed scrub community occurs on the uplands and bajadas surrounding the river corridor. Plants are mainly comprised of small-leaved desert trees, shrubs, and numerous cacti. The primary plant species in this community type include foothill paloverde (*Cercidium microphyllum*), saguaro (*Cerceus giganteus*), ocotillo (*Fouqueria splendens*), barrel cactus (*Ferocactus* sp.), brittlebush (*Encelia farinosa*), triangle-leaf bursage (*Ambrosia deltoidea*), and various cholla (*Opuntia*) species.

The project area outside of the immediate river corridor is surrounded by this community type. All the representative vegetative species are present. The "hills" along the south side of the river are more sparsely vegetated with littleleaf paloverde and acacia, while the gently sloping north side has an abundance of saguaro, mesquite, and paloverde trees.

2. Wildlife - Riparian habitat supports 60 to 75 percent of Arizona's resident wildlife (Arizona Riparian Council 1994). In recent years, riparian areas have been recognized as critical habitat for neotropical migrants such as summer tanager, Bell's vireo, yellow warbler, and yellow-billed cuckoo. Small mammals such as woodrats, skunks, and bats, as well as large mammals such as coyotes, utilize riparian areas. They are also home to a diverse array of reptiles and amphibians.

Wildlife use of riparian habitat is disproportionate to the amount of habitat available (Ohmart and Anderson 1986). In other words, although 60 - 75 percent of Arizona's resident wildlife are dependent on riparian habitats, riparian areas occupy less than 0.5 percent of the State's total land area (Arizona Riparian Council 1994).

Although the few mammal species are not distinctive, riparian habitats have greater species richness (number of species) and total small mammal biomass than upland sites (Stamp and Ohmart 1979 *in* Ohmart and Anderson 1986). The same is probably true for herpetofauna; however, there are no indepth, long-term data from riparian ecosystems to substantiate this (Ohmart and Anderson 1986). On the other hand there has been considerable information generated on avian use of riparian habitat. Numerous studies have described the strong correlation between bird species diversity and vegetation structure and density (MacArthur and MacArthur 1961, Anderson and Ohmart 1977, and Anderson et al. 1983). Healthy mature stands of cottonwood-willow vegetation provide one of the most structurally diverse habitats in the Sonoran desert (Arizona Riparian Council 1994, Rosenberg et al. 1991).

No specific wildlife inventories were conducted (outside of threatened and endangered species surveys) in the project area. Consequently the following information is taken from literature reviews of similar habitat types. This section describes the wildlife species that typically occur within the different vegetative communities. Due to the degraded habitat quality and linear, disjunct distribution of habitat in the project area, species richness and species abundance (total number of individuals) is reduced when compared to higher quality habitats. Consequently, not all the species listed may be present in the area.

The mobility of birds and mammals in conjunction with the interspersion of habitat types results in overlap of species among habitat types. Although not restricted to the community type within which they are described, the following wildlife species are primarily dependent upon that community type for breeding purposes. For a list of wildlife species in Aravaipa Creek see Appendix C.

The Sonoran Riparian Deciduous Woodlands - The mixed riparian, mixed mesquite and mesquite habitat support a wide variety of neotropical migrants (small "perching" birds that winter in central and South America) such as yellow and Lucy's warbler, summer tanager, Bell's vireo, and yellow-billed cuckoo. Other avian species include white-winged dove, Vermillion flycatcher, cardinal, Abert's towhee, Cooper's hawk, great blue heron, Bewick's wren, and verdin. Although birds make up a more visible part of the community, this habitat type is home to many species of mammals, reptiles, and amphibians.

Large mammals such as javelina, coyote, and bobcat use riparian habitat as a movement corridors. The diversity of wildlife species is directly correlated to the complexity of vegetation structure. Consequently, the riparian habitat would have greater species diversity. Small mammals include several bat species (red, hoary, and pallid bats) as well as various rats and mice: white-throated woodrat, Arizona cotton rat, cactus mouse, desert pocket mouse, and western harvest mouse. Herpetofauna include common kingsnake, desert spiny lizard, tree lizard, and western whiptail lizards.

The Sonoran Riparian Scrubland - The close proximity of the seepwillow/burrobrush habitat to "riparian" habitat allows the movement of wildlife species between habitat types. Species diversity within this habitat type would be substantially different if riparian habitat was absent. Common birds include Gambel's quail, mourning dove, white-winged dove, Abert's towhee, Say's Phoebe, and black-tailed gnatcatcher. Common mammals include coyote, bobcat, desert cottontail, cactus mouse, deer mouse, white-throated wood rat, and western harvest mouse. Herpetofauna include zebra-tailed lizard, common kingsnake, gopher snake, western whiptail lizard, and western diamondback rattlesnake.

The Sonoran Interior Strand - Because this area is more open and provides little cover, it is utilized by species which prefer open, sparsely vegetated areas. Some common avian examples include killdeer and water pipit. Habitat is limited for small mammals and herpetofauna, although the lesser earless lizard (*Holbrookia maculata*) utilizes this habitat and was seen during field visits.

Paloverde, cacti-mixed scrub - The paloverde, cacti-mixed scrub community has the richest diversity of wildlife compared to other Sonoron Desertscrub communities. Wildlife species typical of the paloverde, cacti-mixed scrub habitat include common birds such as Harris hawk, roadrunner, mourning dove, verdin, cactus wren, black-tailed gnatcatcher, phainopepla, Gambel's quail, Costa's hummingbird, brown towhee, gilded flicker, and Gila woodpecker.

Common mammals include the California leaf-nosed bat, coyote, black-tailed jackrabbit, desert cottontail, Merriams's kangaroo rat, white-throated wood rat, round-tailed ground squirrel, and cactus mouse. Common reptiles include the desert spiny lizard, patch-nosed snake, glossy snake, western diamondback, desert tortoise, Gila monster, lesser earless lizard, and side-blotched lizard. Common amphibians include the Sonora toad, Great Plains toad, Couch's spadefoot toad, and western spadefoot toad.

Aquatic Resources

1. Physical Environment

Monthly mean discharges for Aravaipa Creek measured approximately 0.5 mile upstream of the project area range from an annual low of 12 cfs in June to a high of 67 cfs in February. The largest flow recorded was 70,800 cfs, on October 1, 1983.

During floods, complex interactions among stream discharge, sediment load, sediment size, local geomorphology, and other factors determine how sediments are transported, sorted, and deposited to form aquatic habitats. Except in areas where bedrock may form the stream bottom, aquatic habitats may be completely destroyed and reformed during a flood event, and are thus highly dynamic. In 1976, lower Aravaipa Canyon (upstream from the project area) was approximately 88 percent riffles and rapids (areas of water column with fast current velocity and steep gradient, considerable surface turbulence, often with large substrates) and 12 percent pools (area of water column with low current velocity and near-zero surface gradient and little or no surface turbulence, often with small substrates) (Minckley 1981). Reclamation is unaware of more recent data that quantitatively describe aquatic habitat conditions in the lower reach of Aravaipa Creek.

The stream reach within the project area contains aquatic features regulated by the U.S. Army Corps of Engineers (COE) under the CWA. Approximately 6.3 acres of habitat are COE-delineated jurisdictional waters of the United States. The majority of jurisdictional area consists of open channel habitat (described previously under terrestrial resources) and open water habitat. Open water habitat can be described as riffles, pools or runs. The percentage of each type depends on the physical characteristics of the stream such as slope, substrate size, and sediment load among other factors.

Pools within the project area are small and shallow in depth because of the gentle slope and heavy sediment load of the stream. Riffles are relatively indistinct, have a flat gradient, and consist of variable substrate size. The existing stream bed gradient is too flat to allow development of classically-defined rifle-pool complexes. This lowered quality of instream habitats is demonstrated by the sparsity of special status fish species in the project area.

2. Reptiles and Amphibians

Aquatic habitats of Aravaipa Creek may support several aquatic and semi-aquatic reptile and amphibian species, including the Federal candidate Chiricahua leopard frog (*Rana chiricahuensis*), State-listed species Mexican garter snake (*Thamnophis equis*) and lowland leopard frog (*Rana yavapaiensis*), along with the canyon tree frog (*Hyla arenicolor*), several species of true (*Bufo* spp.) and spadefoot (*Scaphiopus* spp.) toads,

Sonoran mud turtle (*Kinosternon sonoriense*), and other species of garter snake (*Thamnophis* spp.). Bullfrog (*Rana catesbeiana*) is the most successful nonnative amphibian in Arizona. Previous studies have not thoroughly examined the potential distribution of these species within the Aravaipa Creek drainage system.

All amphibian species are tied to the aquatic environment for reproduction and rearing of gill-breathing larvae. Following transformation from larvae, most amphibians develop lungs to breathe air. Thus, eggs and larvae of all of the amphibians listed above may be found in Aravaipa Creek, but some post-larval amphibians are also highly aquatic (e.g., leopard frogs). Conversely, most reptile reproduction occurs on land, and breathing is with lungs. Sonoran mud turtle is the most highly aquatic reptile on this list, where adults are nearly exclusively found in water. Mexican garter snake is usually found within 50 feet of water (Rosen and Schwalbe 1988).

3. Fishes

A considerable amount of monitoring and research has been directed toward the fishes of Aravaipa Creek, beginning in the 1960s and continuing today (Barber and Minckley 1966, 1983, Barber et al. 1970, Minckley and Barber 1971, Siebert 1980, Minckley 1981, Schrieber and Minckley 1981, Kepner 1982, Clarkson and Minckley 1988, Rinne 1989, 1991, 1992, Vives and Minckley 1990, Williams 1991, Douglas et al. 1994, Velasco 1997). The stream supports seven native species, including two threatened forms, loach minnow (*Tiaroga cobitis*), and spikedace (*Meda fulgida*) (both monotypic genera), and a State-listed species, roundtail chub (*Gila robusta*). These species, along with longfin dace (*Agosia chrysogaster*), and speckled dace (*Rhinichthys osculus*), are members of the Family Cyprinidae (minnows). The other two species, desert sucker (*Pantosteus clarki*), and Sonora sucker (*Catostomus insignis*), are members of the Family Catostomidae (suckers).

Introduced species that permanently reside in or periodically invade Aravaipa Creek include green sunfish (*Lepomis cyanellus*), yellow bullhead (*Ameiurus natalis*), mosquitofish (*Gambusia affinis*), largemouth bass (*Micropterus salmoides*), common carp (*Cyprinus carpio*), fathead minnow (*Pimephales promelas*), and red shiner (*Cyprinella lutrensis*) (Bettaso et al 1995). A single specimen of black bullhead (*Ameiurus melas*) was taken from the lower stream in 1990 (W.L. Minckley, unpublished data). Another nonnative species collected from the lower San Pedro River but never taken from Aravaipa Creek is channel catfish (*Ictalurus punctatus*).

Only yellow bullhead and green sunfish have been consistently collected from the stream since monitoring began in 1963 (W.L. Minckley, unpublished data; Bettaso et al. 1995). The other species started appearing in collections beginning in the early 1980s (a single largemouth bass was also taken in 1963), and most are now routinely encountered in the creek below the project area. Red shiner, a species of considerable concern because of its documented negative effects on populations of spikedace and other native species (Minckley and Deacon 1968, Abarca 1989, Marsh et al. 1990, Rinne 1991, Douglas et al. 1994), first appeared in Aravaipa Creek in 1990. It disappeared in 1991 following an Aravaipa Creek flood that exceeded 3000 cfs, but reappeared in 1997 following a long period of flow stability (Clarkson 1998).

Special Status Species

The FWS utilizes a county-wide list (Table 3) to indicate listed species in a project area, consequently the majority of species do not actually occur in the project area. There is no suitable habitat in the project area for the following species: Arizona hedgehog cactus, Nichol's turk's head cactus, desert pupfish, Gila topminnow, razorback sucker, bald eagle, Mexican spotted owl, southwestern willow flycatcher, Yuma clapper rail and Acuna cactus. The AGFD has designated 17 species of wildlife of special concern in Arizona, which have been included in Table 3 (1996a).

Table 3. Federally-listed species for Pinal County, and State of Arizona wildlife of special concern.

LIST OF SPECIAL STATUS SPECIES		
STATUS	SPECIES	PRESENCE IN PROJECT AREA
E	Arizona hedgehog cactus *(Echinocereus triglochidiatus arizonicus)*	-
E	Nichol's turk's head cactus *(Echinocereus horizonthalonius* var. *nicholii)*	-
E,S	Lesser long-nosed bat (*Leptonycteris curasoae yerbabuenae*)	+
E,S	Desert pupfish *(Cyprinodon macularius)*	-
E,S	Gila topminnow (*Poeciliopsis occidentalis occidentalis)*	-
T,S	Loach minnow *(Tiaroga cobitis)*	+
E,S	Razorback sucker *(Xyrauchen texanus)*	-
T,S	Spikedace (*Meda fulgida*)	+

LIST OF SPECIAL STATUS SPECIES		
STATUS	SPECIES	PRESENCE IN PROJECT AREA
E	American peregrine falcon (*Falco peregrinus anatum*)	+
T,S	Bald eagle (*Haliaeetus leucocephalus*)	-
E,S	Cactus ferruginous pygmy-owl *(Glaucidium brasilianum cactorum)*	-
T	Mexican spotted owl (*Strix occidentalis lucida)*	-
E,S	Southwestern willow flycatcher (*Empidonax traillii extimus*)	-
E	Yuma clapper rail (*Rallus longirostris yumanensis*)	-
C	Acuna cactus (*Echinomastus erectocentrus acunensis*)	-
C,S	Chiricahua leopard frog (*Rana chiricahuensis*)	?
S	Mexican garter snake (*Thamnophis eques*)	?
S	Lowland leopard frog (*Rana yavapaiensis)*	?
S	Roundtail chub (*Gila robusta)*	+
S	Western red bat (*Lasiurus borealis)*	?
S	Greater western mastiff bat (*Eumops perotis*)	-
S	Townsends' big-eared bat (*Plecotis townsendii*)	-
S	Mesquite mouse (*Peromyscus merriami)*	-
S	Western yellow-billed cuckoo (*Coccyzus americanus occidentalis*)	-
S	Desert tortoise (*Gopherus agassizii*)	-

E=Endangered: T=Threatened; C=Candidate; S=Wildlife of special concern in the State of Arizona; -=Absent; +=Present; ?=Undetermined

Specific descriptions of special status species and known occurrences are found in Appendix D.

2. Environmental Consequences

The information presented in Tables 4 and 5 was derived from a GIS based cover map of the project area. Construction zones were overlaid onto the habitat map and the areas of impact digitized and quantified. The areas of impact represent maximum disturbance estimates.

a. Fish Barrier Sites

Terrestrial Habitat - Less than 2 acres of habitat would be permanently altered (Table 4) as a result of barrier emplacement. Approximately 1.51 acres of terrestrial habitat, predominately (93 percent) seepwillow and burrobrush, would be lost. Approximately 0.08 acre of terrestrial habitat would be impacted consisting of a mosaic of riparian species (mesquite, desert hackberry, Fremont cottonwood, Gooding willow, Arizona ash, netleaf hackberry, soapberry, and Arizona walnut). The remaining 0.03 acre consists of Sonoran desertscrub habitat. Impacts to "riparian" habitat would be limited due to the small acreage involved, and linear nature of the habitat.

The remaining 0.3 acre consists of open water habitat which will be described in the wildlife section.

Table 4. Permanent habitat impacts (acres by vegetation type) from construction of Aravaipa Creek fish barriers.

FEATURE	TOTAL IMPACT							
	TOTAL ACRES	OPEN WATER	TERRESTRIAL					
			TOTAL	seep/ burro	mes-quite	mixed riparian	mixed mes-quite	sonoran desert scrub
FISH BARRIERS	1.81	0.30	1.51	1.4	0.06	0.02	0.0	0.03
TOTAL ACRES IMPACTED	1.81	0.30	1.51	1.4	0.06	0.02	0.0	0.03

Table 5. Temporary (long/short term) habitat impacts (acres) (by vegetation type) from construction of Aravaipa Creek fish barriers.

FEATURE	TOTAL IMPACT							
	TOTAL ACRES	OPEN WATER	TERRESTRIAL					
			TOTAL	seep/ burro	mes- quite	mixed riparian	mixed mesquite	sonoran desert scrub
CONTRACTOR USE AREA B	2.10	0.00	2.10	0.00	0.00	0.00	0.00	2.10
ACCESS ROADS (Total does not include 0.16 ac of existing road)	0.30	0.00	0.30	0.05	0.20	0.00	0.04	0.01
CONSTRUCTION ZONES (exclusive of sedimentation zone)	1.30	0.20	1.10	1.08	0.01	0.010	0.00	0.002
SEDIMENTATION ZONE (exclusive of barrier overlap)	7.51	2.01	5.50	5.10	0.19	0.007	0.20	0.00
TOTAL ACRES IMPACTED	11.21	2.21	9.00	6.23	0.4	0.017	0.24	2.11

Wildlife - Due to the limited area required for placement of the barriers, minimal impacts to wildlife would occur. The barrier placement would result in minor loss of small mammal and herpetofaunal (reptile and amphibian) habitat.

Aquatic Habitat - Approximately 0.3 acre of aquatic habitat would be permanently altered by the fish barriers (Table 4). In Aravaipa Creek, the concrete fish barriers would behave as bedrock during 100-year or more-frequent floods, and the habitats they form would become highly stabilized. At lower flows, fishes and most other aquatic animals would be excluded from the shallow, swift-flowing habitats formed over the concrete aprons. Barrier faces would become waterfalls that are also unavailable to fishes and most other macroorganisms. The crests of the barriers likely would be used by species that are tolerant of swift water such as filter-feeding black fly larvae, and many forms of algae. Movements of aquatic organisms upstream past the barriers would become difficult or impossible.

There would be negligible effects to the functions and values of riffle and pool complexes resulting from the lessening of local stream slope. Classic riffle-pool complexes (which provide higher quality macroinvertebrate and fish habitat) do not exist within the project reach. The riffles in the project area consist of variable-sized substrate and extremely shallow water depths. Riffle habitat favored by the threatened loach minnow (a riffle obligate species present upstream of the project area) is composed of very uniform cobble-sized substrate. The formation of uniform cobbles within a riffle is slope dependent, meaning that the steeper slope helps to sort the substrate. The slight gradient in the project reach is insufficient to permit proper sorting of substrate. In fact, the difference in stream velocity between riffle and non-riffle areas is barely discernable within the project reach. This reach of the stream is not likely to develop high quality riffle-pool complexes due to the low gradient.

Special Status Species - No impacts to terrestrial special status species would occur from barrier placement. For aquatic species, placement of fish barriers would result in the genetic isolation of spikedace, loach minnow, and roundtail chub populations upstream of the barrier from those downstream. The length of perennial stream below the barriers lost in this manner represents only a very small percentage of the total length of the perennial waters of Aravaipa Creek. No genetic effects to the much larger upstream populations are anticipated.

In addition, habitats in the project area appear suboptimal for these species, as evidenced by their preference for upstream areas (Minckley 1981) (Bettaso, et al. 1995). For example, surveys conducted near the proposed fish barrier sites by the AGFD during 1992-1994 showed that median relative abundances of spikedace, loach minnow, and roundtail chub did not exceed 1 percent (Bettaso et al. 1995). Further, long-term (1963-1997) fish survey data from Aravaipa Creek (W.L. Minckley, Arizona State University, unpublished data) show that the presence and abundance of spikedace, loach minnow, and roundtail chub in the lower (western) reach is highly variable (Figure 3-8). When relative abundance of these species exceeds 4.5 - 5.0 percent of the total fish population in the lower reach, it is likely that some or all will be present in the vicinity of the proposed fish barriers. For loach minnow, this occurred four times in 32 years of sampling (12.5 percent of sampling years), and for spikedace, 12 times (37.5 percent). Roundtail chub relative abundance never exceeded 4.5 percent in the lower reach, and their occurrence near the project area sporadically consists of a few young-of-year individuals. Data for spikedace are strongly influenced by a surge in its relative abundance between 1983 and 1990. There is no doubt that substantial numbers of spikedace would pass over the fish barriers and be lost to the system during periods of such high abundance; numbers of loach minnow and roundtail chub would be substantially less. When the species are relatively abundant, however, such losses would have no influence on upstream populations of Aravaipa Creek, since evidence exists that the lowermost segments of the population are lost when portions of the stream naturally become isolated and dry up, or become too warm for the species to survive (W.L. Minckley, Arizona State University, personal communication).

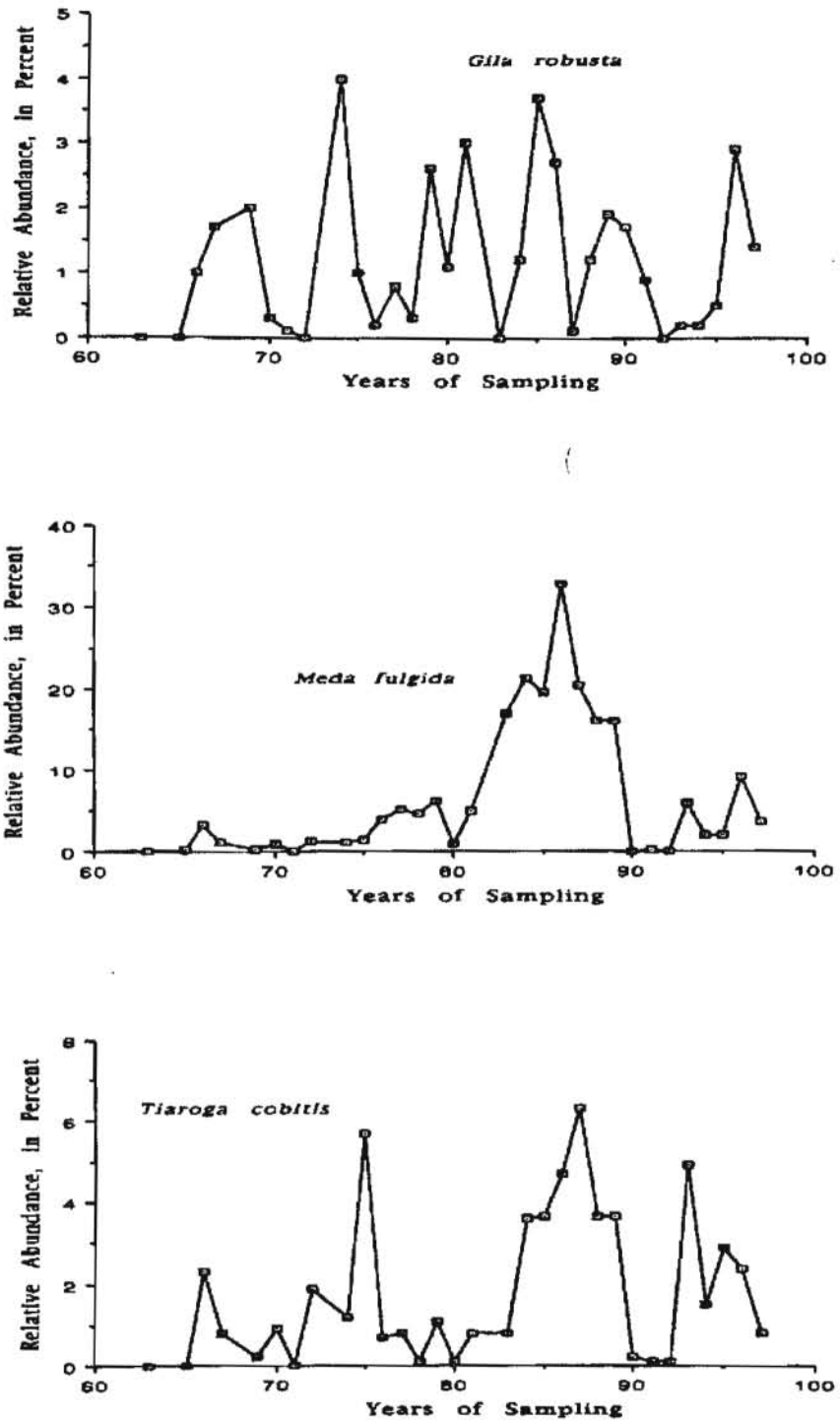


FIGURE 3-8. Relative abundance (percent) of roundtail chub (*Gila robusta*), spikedace (*Meda fulgida*), and loach minnow (*Tiaroga cobitis*) in the lower (western) segment of Aravaipa Creek, Pinal County, Arizona, 1963-1997. all sampling stations combined. Note the differences in the scale of the vertical axis.

Placement of fish barriers on Aravaipa Creek would also result in genetic isolation of the upstream populations from others in the greater Gila River basin. Over an extended period of time (perhaps hundreds or thousands of years), such isolation could result in decreased genetic variability and loss of rare alleles of Aravaipa Creek populations, and thus possibly decrease their ability to adapt to changing environments. Fragmentation of native fish populations, however, is already so extensive due to water development, presence of nonnative predators, climatic trends, and other factors, that gene flow among isolated stocks already is unlikely. The immediate protection afforded the populations by fish barriers far outweigh possible long-term genetic effects. The high probability of near-term loss of Aravaipa Creek fishes to alien competitors and predators in the absence of fish barriers further outweighs these considerations. If nonnative fishes are not brought under control in the near-term, the prognosis for persistence of native fishes, except perhaps in rare refugia, is bleak.

Downstream drift of larva of spikedace, loach minnow, and roundtail chub past the barriers would result in some losses to upstream populations, as they would be unable to move back upstream past the barriers once below. Distances drifted by spikedace, loach minnow, and roundtail chub larvae, or for that matter virtually any other native fish species, have not been determined, but two lines of evidence suggest that drift losses over the fish barriers would be negligible under the proposed project. First, drift of larval stages of these species has not been shown to be a significant feature of their life histories, and most drift that occurs is during daylight when drift distances are short (Bestgen et al. 1985). Second, spikedace, loach minnow, and roundtail chub adults only sporadically occur near the project area, and little reproduction in the lower reach is expected. Therefore, unless drift transport distances are relatively long (several kilometers or more), large losses from this avenue are not expected.

Downstream transport of older life stages of fishes during flood or by other avenues of dispersal would also result in some losses of fishes below the barriers, although native fishes in general are adapted to avoid the worst hydraulic conditions of flood events and resist downstream transport (Minckley and Meffe 1987). However, entire year classes of native fishes can be destroyed from floods that occur during larval rearing periods (Robinson et al. In press.). For reasons similar to those explained for genetic isolation impacts (above), losses of spikedace, loach minnow, and roundtail chub from flood transport are expected to be minimal and of no significance to upstream populations.

As with early life stages of native fishes, the passage of ill-timed floods that occur during larval development of Chiricahua and lowland leopard frog has the potential to decimate a given year's cohort. Such effects would occur with or without the presence of fish barriers, however. In the absence of flooding during larval development, downstream losses of larvae of Chiricahua and lowland leopard frogs over the barriers should be minor, since sites of oviposition and larval rearing are in areas of slack water with relatively little potential for entrainment in currents that could transport larvae downstream. Significant downstream drift of amphibian larvae in streams has not been noted in the literature.

No substantial impacts to later life stages (juvenile and adult metamorphs) of Chiricahua and lowland leopard frogs are expected from emplacement of fish barriers. Fish barriers should not be a complete barrier to upstream movements by terrestrially-mobile adult frogs, nor to Mexican garter snake, although movements would be hindered.

Benefits - The barriers are expected to have positive benefits to spikedace, loach minnow, roundtail chub, and other native fish populations by preventing or hindering upstream invasions of nonnative fishes and other undesirable aquatic organisms into the upper reaches of Aravaipa Creek. If Chiricahua and lowland leopard frogs persist in the area, these effects should also benefit their populations, in that they have also been shown to be negatively impacted by presence of nonnative fishes (Rosen et al. 1995). A similar benefit resulting from control of nonnative organisms should accrue to populations of Mexican garter snake (Rosen and Schwalbe 1988).

b. Bank Protection

Minor habitat loss would result from the placement of bank protection (rip-rap/concrete or gabion) upstream and downstream from each barrier. However, initial assessment indicates that bank protection may not be necessary on the south side tie-in for the upper barrier due to competency of the rock. Estimates indicate that approximately 0.30 acre of seepwillow/burrobrush, mesquite, and Sonoran desertscrub habitat would be affected. Appropriate mitigation would be included when effects are quantified during final design.

c. Temporary (Long/Short Term) Impacts

1. Alternative Contractor Use Area A

Terrestrial Habitat - This alternative use area is located east of the upper barrier between the Aravaipa Road and the creek (Figure 2-3). The habitat consists of a remnant mature mesquite bosque that has been heavily impacted by existing trails, grazing, and recreational use. Cattle utilize this area primarily for shade on a frequent basis. Numerous small mesquite bosques are located throughout Aravaipa canyon on BLM and The Nature Conservancy properties, but few bosques remain outside of these protected areas.

Although there is very little ground cover and few shrubs, development of the staging area of this habitat would result in substantial pruning of trees to provide adequate vehicular clearance as well as removal of some mature mesquite trees. It is anticipated that most of the pruned trees would survive.

Wildlife - Use of this area would result in disturbance to avian, small mammal, and herpetofaunal species. The Lucy warbler in particular prefers the mesquite habitat (Brandt 1951, Terres 1991, and Johnson et al. 1997). Other species which utilize mesquite include: Bewick's wren, Bell's vireo, northern cardinal, and yellow-breasted chat. Use of this area would result in temporary loss of 2.1 acres of small mammal and hepetofaunal habitat. Impacts to large mammals would be minimal.

Aquatic Habitat - No impacts would occur to aquatic habitat.

Special Status Species - No impacts would occur to special status species.

2. Alternative Contractor Use Area B (Preferred Site)

Terrestrial Habitat - A total of 2.10 acres of Sonoran desertscrub habitat would be disturbed for construction staging (Table 5). This site is located atop a small knoll overlooking the project area. A portion of the area has been previously disturbed, and the staging area would be centered around this location, but would extend into previously undisturbed habitat.

Wildlife - Use of the staging area would result in the temporary disturbance and/or loss to small mammal and herpetofaunal species.

Aquatic Habitat - No aquatic habitat would be impacted.

Special Status Species - No special status species would be impacted.

3. Alternative Contractor Use Area C

Terrestrial Habitat - Use of this alternate site would impact approximately 2.1 acres of mixed mesquite habitat. This site is located immediately west of the lower barrier location between Aravaipa Road and Aravaipa Creek. Habitat is generally dense with a mixture of mesquite, burrobrush, acacia, little-leaf paloverde, and desert hackberry vegetation. The mesquite ranges from scrubby trees less than 7 feet high to mature bosque type trees. The dense vegetation would require nearly complete removal of all vegetation to accommodate the staging activities. Both long and short term impacts would occur. The short term impacts would result from loss of shrubs and grasses which would recover fairly rapidly, but impacts to mature trees would require a greater length of time to restore lost values.

Wildlife - The dense vegetation supports a wider variety of wildlife than found in the upland desertscrub habitat. Clearance of vegetation would result in temporary loss of habitat for nesting birds, small mammals, and herpetofaunal species. Temporary noise disturbances from use of the area would be minimal. Impacts to large mammals would be minimal and mainly amount to noise disturbance.

Aquatic Habitat - No impacts would occur to aquatic habitat.

Special Status Species - No special status species would be impacted.

4. Construction Zones

Terrestrial Habitat - Use of construction zones would result in temporary impacts to a total of 1.3 acres of habitat (Table 5). Ninety-eight percent of these impacts would occur in the seepwillow/burrobrush habitat type. Only 0.01 acre each of mesquite and mixed riparian habitat, along with 0.002 acre of Sonoran desertscrub habitat, would be impacted. The majority of seepwillow/burrobrush habitat is distributed along the center of the river corridor and subjected to loss during flooding. Approximately 85 percent of this habitat was lost during 1993 flood events and has since reestablished. It is expected that upon completion of the construction activities this habitat would quickly reestablish with similar vegetation species and densities. In addition, a portion of the construction zones upstream of each barrier coincides with the impact area for the sedimentation zones (Figure 3-7) which will be described below.

Approximately 0.2 acre of open water habitat would be impacted (impacts will be described under aquatic section below.)

Wildlife - This portion of the river receives minimal use by wildlife species due to the frequency with which it is inundated. Avian use is sporadic, with limited nesting potential outside of killdeer and seasonal use by shorebirds. Likewise, mammalian use is limited, increasing in direct proportion to the distance from main channel (or frequently inundated area). Herpetofaunal use represents the primary terrestrial wildlife value in this habitat type. Use of this area for construction would result in a temporary loss of use for wildlife species. It is expected that vegetation (and, therefore, wildlife habitat) would begin to reestablish upon completion of construction until the next flood event eliminated it.

Aquatic Habitat - Impacts to aquatic habitat from construction zones would be overshadowed by the impacts from the sedimentation zone (with the exception of the area downstream of the lower barrier site). Impacts below the downstream barrier are expected to be minimal. Construction traffic would predominately operate on the gravel bars and habitat adjacent to the stream (with the exception of a single creek crossing site).

Special Status Species - If present in the area during construction activities, some individuals of spikedace, loach minnow, and roundtail chub might be killed when heavy equipment moves across or through the streambed. Such losses are expected to be minor. The 1994 biological opinion on the transportation and delivery of CAP water included "take" provisions for activities necessary to implement reasonable and prudent alternatives, such as the fish barrier project.

5. Access Roads

Terrestrial Habitat - Access to both the upper and lower barrier locations would utilize existing roads to the maximum extent practicable. The 0.30 acre of impact displayed in Table 5, represents the entire access area, of which almost one-half is occupied by existing roads. Impacts from construction of the lower access road would result primarily from widening of the road. Minor tree trimming on a mesquite and removal of several small desert hackberry shrubs would occur. Access to the upper barrier location would occur through the western portion of the mesquite bosque. This portion of the bosque is more open, and less vegetation clearing would be required to access the barrier site. Access would follow the existing road and then veer toward the creek through the seepwillow/burrobrush habitat. Branch removal/trimming would be required on several mature mesquite trees. Two small mesquite trees would be removed near the entrance off the county road. Complete clearance would be required for approximately 20 feet through desert hackberry, seepwillow, and burrobrush.

Wildlife - Due to the disturbed nature of the areas utilized for access, minimal impacts to wildlife species would occur

Aquatic Habitat - No impacts would occur to aquatic habitat.

Special Status Species -No impacts would occur to special status species.

6. Sedimentation Zones

Terrestrial Habitat - The majority of terrestrial habitat loss would result from the accumulation of sediment behind each barrier. Sedimentation would eliminate the development of certain instream habitats immediately upstream of the barriers.

Vegetation in the sedimentation zone is primarily (93 percent) composed of seepwillow/burrobrush habitat (Table 5). The majority of seepwillow/burrobrush habitat is located in the center of the river channel and subjected to repeated loss from flooding. Approximately 85 percent of this habitat was lost during the 1993 flood events (13,000 cfs peak flow). It is expected that upon completion of the construction activities, this habitat would reestablish with similar vegetation mimicking a regenerative process which is repeated after every flood event.

The remaining 0.40 acre of terrestrial habitat occurs in mesquite, mixed mesquite, and mixed riparian habitat. Since these areas are generally located on terraces adjacent to the channel bottom, the sedimentation impacts would be minimal. It is expected that 6 inches or less of sediment would be deposited in these habitat types, resulting in no adverse impacts.

Wildlife - This portion of the river receives minimal use by wildlife species due to the frequency of inundation and lack of cover. Avian use is sporadic, with limited nesting potential outside of killdeer and seasonal use by shorebirds. Likewise, mammalian use is limited, increasing in direct proportion to the distance from main channel (or frequently inundated area). Herpetofaunal use represents the primary terrestrial wildlife value in this habitat type. Upon completion of the barriers, this habitat would be partially inundated, forming a temporary pool that would eventually be filled with sediment. Following stabilization of the sediment zone, it is anticipated that a channel similar to preconstruction activities would become established.

The wildlife values within the sedimentation zone would change over time from the current seepwillow/burrobrush habitat to an open pool. The open pool habitat would eventually be completely filled in with sediment at which time seepwillow/burrobrush habitat would begin to reestablish. The seepwillow/burrobrush community is common along Aravaipa Creek. Loss of 5.6 acres of habitat of which nearly 50 percent is less than 3 feet high would not adversely impact wildlife in the area. There would be a short term loss of function/values between the complete sedimentation phase and the reestablishment of the habitat.

Aquatic Habitat - Instream habitats in the sedimentation zones would be altered primarily as a result of lessening of the local stream gradient. Thus, certain habitat types, such as steep-gradient riffles and rapids, would be less likely to form after construction of the barriers and resulting sedimentation. Decreases in mean sediment size, and

increases in channel sinuosity and braiding, are other possible effects associated with lower gradient. Small, shallow scour pools may form at the downstream ends of the aprons. Approximately 2.01 acres of impact would occur in the open water habitat.

At high (flood) discharges, swift current velocities and high sediment loads render most main-channel habitats largely unsuitable for aquatic organisms, which either move to lateral habitats to avoid some of the flood effects, or become entrained in the flood and either perish or get flushed downstream (Minckley and Meffe 1987). This fact would remain equally true with the presence of fish barriers.

Special Status Species - No impacts to terrestrial special status species would occur. Spikedace, loach minnow, and roundtail chub have very specific habitat preferences (flowing pools over fine substrates; shallow, well-defined riffles; and deep pools with cover, respectively), and they do not reliably inhabit the project area because of a lack of these habitats. Lessening of stream gradient in the sedimentation zones would perhaps make it less likely that habitats important for these species would ever form. These potential impacts are considered minor, however, relative to the length of unimpacted stream above the sedimentation zone.

No negative impacts to Chircahua leopard frog, lowland leopard frog, or Mexican garter snake are anticipated in the sedimentation zones.

7. Flood Inundation Effects

In addition to construction features, impacts were analyzed comparing the difference in inundation zones with and without the barriers for the following flood frequencies.

5-10 year flood impacts

Terrestrial Habitat - The difference in flood effects from the 5 and 10 year storms is predominately in the length of time low-lying portions of the county road would remain inundated. The affected areas would be limited to bare ground (dirt road), Sonoran desertscrub habitat, and a small portion of the mesquite bosque. The flow velocities would not be great enough to impact the mesquite bosque or Sonoran desertscrub habitat. No adverse impacts to any vegetation would result from the 5 - 10 year flood event.

Wildlife - The difference between impacts to wildlife with or without the barriers is negligible.

Aquatic Habitat - No aquatic habitat would be impacted.

Special Status Species - No special status species would be impacted.

25-year flood impacts

Terrestrial Habitat - Additional effects from the presence of the barriers during the 25-year flood event would be minimal. Small portions of the Sonoran desertscrub habitat would be affected along with a small portion of the road. Visual inspections of the habitat revealed no evidence of scour effects from past flood disturbances. No adverse impacts would occur to habitat.

Wildlife - No additional substantial impacts to wildlife would occur.

Aquatic Habitat - No aquatic habitat would be impacted.

Special Status Species - No special status species would be impacted.

50-100 year flood impacts

Terrestrial Habitat - Additional effects from the barriers during the 50 and 100-year flood events would be nearly undetectable. The flood flows would simply reach a few feet higher up the floodplain. On the south side of Aravaipa Creek, this habitat is a steep wall approximately 25 feet high. Slopes are gentler on the north side of the Creek and the 100-year flood zone would only inundate Sonoran desertscrub habitat. Based on visual inspections of the habitat to ascertain past flood effects, no adverse impacts to the area are expected to occur.

Wildlife - No quantifiable impacts to wildlife would occur.

Aquatic Habitat - No aquatic habitat would be impacted.

Special Status Species - No special status species would be impacted.

8. Nonnative Fishes Management

Fish populations in the stream reach between the fish barriers would be monitored at least annually, and following passage of large floods. Should undesirable nonnative fishes (or other nonnative aquatic organisms) be found in this "fish management zone," they would be aggressively removed to prevent possible transgression of the upper barrier and infestation of upstream reaches. Because this management zone would be only approximately 800 feet in length, attempts at fish removal would first consider traditional fish collection techniques using nets or electrofishing. Small losses of nontarget species (including perhaps loach minnow, spikedace, and roundtail chub) could occur from stresses associated with repeated handling and disturbance. These would be inconsequential to the larger, upstream populations, for reasons similar to those previously discussed.

Should traditional fish capture methods be considered inadequate to remove all individuals of undesirable species, chemical renovation of the management zone using an approved fish toxin would be undertaken. Prior to application of a toxin, as many native fishes as possible that were present in the management zone would first be captured, transported, and released alive above the upper barrier.

The toxin that would most likely be used to remove nonnative fish is sold under the brand name Fintrol®, with the active ingredient antimycin A. Fintrol® carries antimycin A in an acetone base, and the mixture is typically applied in streams in diluted form using multiple drip stations. Fintrol® is toxic only to aquatic animals that breathe with gills and, therefore, is not toxic to humans, domesticated animals, terrestrial wildlife, or plants. It is not a "poison" in the sense of a chemical like cyanide, but is actually an antibiotic produced in cultures of streptomycenes. It inhibits electron transport to cellular oxidative pathways, interfering with the ability of animals with gills to breathe (i.e., to uptake oxygen across a gill membrane). It kills fish rapidly and irreversibly through suffocation. Toxicity to aquatic insects with gill membranes is variable, and effects on amphibian larvae have not been reported.

Fintrol® is widely used and techniques for controlling its application are well worked out. It is applied in very small amounts - the recommended treatment level is 5-25 parts of Fintrol® to each billion parts of water. It deteriorates rapidly in water turbulence, sunlight, and warm temperatures, usually remaining active only for about 1/4 mile of stream. Although natural decay of the Fintrol® would detoxify it a short distance below the point of application, a detoxification station that would drip potassium permanganate into the stream at the lower barrier would ensure complete neutralization of the Fintrol. No adverse effect to aquatic life below the lower barrier is anticipated.

Repopulation of the management zone by aquatic invertebrates, fishes, and amphibians, following treatment would occur in a short period of time via emigration from upstream populations (fishes, amphibians, and many invertebrates) or aerial recolonization (many insects).

Human consumption of fish killed by Fintrol® is not approved by the Food and Drug Administration (FDA), although this lack of approval is due to the expense of conducting studies rather than to any suggestion of danger from human consumption. During common use over the last 20 years, no adverse effects to wildlife (or humans) have been observed from the consumption of fish killed by Fintrol®.

9. Summary of Biological Effects

Terrestrial - Construction of the Aravaipa Creek fish barriers would result in the permanent loss of less than 2 acres of terrestrial habitat (Table 6). Temporary impacts, primarily resulting from the deposition of sediments behind each barrier, would impact a total of 9 acres of terrestrial habitat. It is anticipated that after the sedimentation zones fill in, vegetation would begin to reestablish on the site.

The major impacts to wildlife species would be loss of habitat and temporary disturbances to small mammal and herpetofaunal species. Minimal impacts are expected for avian and large mammal populations.

There would be no adverse impacts to any terrestrial special status species. No federally-listed species occur in the project area on a permanent basis. No habitat for any federally-listed species occurs in the project area.

Aquatic - Specifically, 2.51 acres of aquatic resources would be impacted (0.3 acre permanent and 2.21 acres of temporary). The majority of temporary impacts would occur from the deposition of sediment. It is expected that the aquatic habitat in the sedimentation zone would reestablish once sediments levels have stabilized, although habitats characteristic of steeper gradients would be less likely to form in the lower-sloped sedimentation zone.

Approximately 0.3 acre of aquatic habitat would be permanently lost to use by fishes and other large aquatic organisms due to the presence of the fish barriers. Populations of fishes below the barriers would become reproductively (and genetically) isolated from those above, but no detrimental effects to the larger upstream populations are expected. Individuals of spikedace, loach minnow, and roundtail chub that become displaced below the barriers would likely fail to reproduce, and thus populations there would perish if they were not replaced by new immigrants from upstream.

There would be benefit to all of the special status aquatic organisms resulting from the control of invasion of new nonnative aquatic organisms.

Table 6. Summary of impacts to biological resources.

BIOLOGICAL RESOURCES	IMPACT
HABITAT	permanent loss of less than 2.0 acres of terrestrial habitat
	temporary impact to approximately 9.0 acres of terrestrial habitat
WILDLIFE	permanent loss of less than 2.0 acres of habitat for small mammals and herpetofaunal species
	loss of slow moving species (small mammals and herpetofauna) in construction zone
	temporary disturbance to wildlife species adjacent to construction areas
AQUATIC RESOURCES	permanent loss of 0.3 acre of open water habitat
	temporary impact to approximately 2.0 acres of open water habitat
	losses of drifting fish larvae and displaced juveniles and adults
	loss of fishes due to chemical or mechanical treatment of the stream between the barriers
	potential loss of certain instream habitat types in the sedimentation zones
SPECIAL STATUS SPECIES	no impacts to terrestrial special status species
	long-term beneficial impacts (increased protection) to native fishes; potential loss of individual fish during construction and periodic chemical treatment
	no adverse impacts to frogs or garter snakes

C. Mitigation

Table 7 summarizes the total acreage affected within each habitat type impacted by various construction activities and the proposed mitigation.

Table 6. Summary of impacts to biological resources.

BIOLOGICAL RESOURCES	IMPACT
HABITAT	permanent loss of less than 2.0 acres of terrestrial habitat
	temporary impact to approximately 9.0 acres of terrestrial habitat
WILDLIFE	permanent loss of less than 2.0 acres of habitat for small mammals and herpetofaunal species
	loss of slow moving species (small mammals and herpetofauna) in construction zone
	temporary disturbance to wildlife species adjacent to construction areas
AQUATIC RESOURCES	permanent loss of 0.3 acre of open water habitat
	temporary impact to approximately 2.0 acres of open water habitat
	losses of drifting fish larvae and displaced juveniles and adults
	loss of fishes due to chemical or mechanical treatment of the stream between the barriers
	potential loss of certain instream habitat types in the sedimentation zones
SPECIAL STATUS SPECIES	no impacts to terrestrial special status species
	long-term beneficial impacts (increased protection) to native fishes; potential loss of individual fish during construction and periodic chemical treatment
	no adverse impacts to frogs or garter snakes

C. Mitigation

Table 7 summarizes the total acreage affected within each habitat type impacted by various construction activities and the proposed mitigation.

Table 7. Summary of impact areas and associated mitigation

HABITAT TYPE	AC	IMPACT TYPE	IMPACT AREA	MITIGATION
SONORAN DESERTSCRUB **2.11 TEMP** **0.03 PERM** **2.14**	2.10	TEMP	STAGING AREA	REVEGETATE/NATIVE SPECIES
	0.01	TEMP	ACCESS ROAD	NO MITIGATION REQUIRED
	0.03	PERM	BARRIER	NO MITIGATION REQUIRED
STREAM CHANNEL **2.21 TEMP** **0.30 PERM** **2.51**	0.20	TEMP	CONSTRUCTION ZONE	NO MITIGATION REQUIRED
	1.86	TEMP	SEDIMENTATION ZONE	NO MITIGATION REQUIRED
	0.30	PERM	BARRIER	NO MITIGATION REQUIRED
SEEPWILLOW/BURRO BRUSH **6.23 TEMP** **1.40 PERM** **7.63**	0.05	TEMP	ACCESS ROAD	LAND ACQUISITION
	1.08	TEMP	CONSTRUCTION ZONE	LAND ACQUISITION
	5.10	TEMP	SEDIMENTATION ZONE	LAND ACQUISITION
	1.40	PERM	BARRIER	LAND ACQUISITION
MESQUITE **0.40 TEMP** **0.06 PERM** **0.46**	0.20	TEMP	ACCESS ROAD	NO MITIGATION REQUIRED
	0.01	TEMP	CONSTRUCTION ZONE	LAND ACQUISITION
	0.19	TEMP	SEDIMENTATION ZONE	NO MITIGATION REQUIRED
	0.06	PERM	BARRIER	LAND ACQUISITION
MIXED MESQUITE **0.24 TEMP** **0.00 PERM** **0.24**	0.04	TEMP	ACCESS ROAD	NO MITIGATION REQUIRED
	0.20	TEMP	SEDIMENTATION ZONE	NO MITIGATION REQUIRED
MIXED RIPARIAN **0.02 TEMP** **0.02 PERM** **0.34**	0.01	TEMP	CONSTRUCTION ZONE	LAND ACQUISITION
	0.01	TEMP	SEDIMENTATION ZONE	NO MITIGATION REQUIRED
	0.02	PERM	BARRIER	LAND ACQUISITION

Sonoran desertscrub - The Sonoran desert scrub habitat would primarily be impacted by use of the contractor staging area. This area would be revegetated at the end of construction. The two remaining impact areas only account for 0.04 acre of habitat. Due to the extensive nature of this habitat type and the negligible amount of habitat impacted, no mitigation is proposed.

Stream channel - Approximately 0.3 acre of instream habitats capable of supporting fishes would be permanently affected by construction of the barriers. Additional temporary impact to about 2 1/4 additional acres of open water (mostly between the barriers) would occur. The permanent benefit to the aquatic resources within 22 miles of stream channel upstream of the barriers that would result from this project should more than offset the temporary and permanent impacts to aquatic resources caused by construction of the barriers. Therefore, no additional in-kind on-site mitigation is proposed.

Seepwillow/burrobrush - The seepwillow/burrobrush community would sustain the majority of impacts from the proposed project. Approximately 7.63 acres of habitat would be affected (but only 1.4 acres permanently lost). The majority of acreage (82 percent) would only be affected on a short-term basis. This habitat type occurs immediately adjacent to the stream flow and receives the full impact of any flood flows. Consequently, this habitat is in a continuous state of regeneration.

After the 1993 flood, which United States Geological Survey (USGS) records indicate peaked at 13,000 cfs, nearly 85 percent of the habitat was scoured clean. Existing vegetation being considered for mitigation has developed in the subsequent 5 years. Vegetation ranges in height from 2 to 5 feet in height, indicating that lower velocity flows have rescoured the channel since 1993. USGS records indicate that two smaller flood events (8,930 and 5,260 cfs) occurred in early 1995 and were most likely responsible for the more recent growth. USGS records also indicate there has been a flow event of greater than or equal to 5,000 cfs every 3 years. Consequently, the majority of seepwillow/burrobrush habitat in the immediate channel area would be lost on a 3-year average.

Mitigation, therefore, is based on loss of function and value during the initial 3 - 5 year period following impact. Reclamation proposes to acquire land to offset the lost functions and values.

Mesquite - Less than 1/2 an acre of mesquite habitat (0.46 acre) would be impacted by this project. The temporary impacts associated with the construction access roads (0.2 acre) includes existing roads. The actual impact area is restricted to minor trimming and removal of only a few trees. No mitigation is proposed for this impact. Likewise impacts to mesquite habitat from the sedimentation zone (0.19 acre) would consist of minor amounts of sediment accumulation. No adverse impacts would occur, and no mitigation is proposed.

Construction of the fish barrier would result in permanent loss of 0.06 acre of mesquite habitat. This acreage coupled with the 0.01 acre of impact from the construction zone would be mitigated by land acquisition.

Mixed Mesquite - No permanent impacts would occur in the mixed mesquite habitat. Temporary impacts associated with the access road (0.04 acre) are considered minimal. Temporary impacts associated with the sedimentation zone (0.2) would consist of minor sediment accumulation with no adverse impact to the habitat. No mitigation is proposed.

Mixed riparian - Impacts to mixed riparian habitat from the sedimentation zone would be similar to those described for mixed mesquite and mesquite. Minor amounts of sediment accumulation in these areas would not impact the habitat.

Impacts from the construction zone (0.01 acre) and barrier footprint (0.02 acre), although minor, would be mitigated by land acquisition.

1. Mitigation Proposal

Reclamation would impact 0.10 acre of higher quality mesquite/mixed riparian habitat (Table 8). Although these habitat types rank high with respect to wildlife values, habitat in the project area has been degraded by grazing and past flood events which have reduced the vegetation to small, fragmented pockets. Impacts would also occur to 7.63 acres of seepwillow/burrobrush habitat (Table 8).

Table 8. Summary of habitat types (acres) for which mitigation is proposed

HABITAT TYPE	PERM. IMPACT (ACRES)	TEMP. IMPACT (ACRES)	MITIGATION
Sonoran desertscrub		2.10	Revegetate with native vegetation
Seepwillow/burrobrush		7.63	1) Acquire 5 acres of land along the San Pedro River or Aravaipa Cr. (OR) 2) Acquire a Conservation Easement on property along Aravaipa Creek.
Mesquite	0.07		
Mixed riparian	0.03		
TOTAL ACRES	0.10	9.73	

Anderson and Ohmart (1993) devised a ranking system for riparian habitats based on a long-term data set of avian and mammalian censusing conducted primarily in southern Arizona. The ranking system takes into account geographic location, elevation, habitat type, and structure type (vegetative layering - understory, midstory and canopy). The designed intent of this model is to allow the user to gather minimal data from a riparian community (plant species composition and structure type) and predict wildlife use values and density estimates or species richness (Anderson and Ohmart 1993).

Based on the Anderson and Ohmart (1993) scale of -3 to +3, where 0 represents the average value, wildlife values in the project area are ranked as follows:

mixed riparian habitat	+3.1
mesquite	+2.1
seepwillow/burrobrush	- 2.4
Sonoran desertscrub	not considered in study

Reclamation personnel believe that based on the minimal impacts to moderate quality mixed riparian and mesquite habitat (0.10 acre) and low quality seepwillow/ burrobrush habitat (7.63 acres), mitigation would be accomplished by land acquisition on a 1:1.7 basis for the seepwillow/burrobrush habitat and 5:1 basis for the riparian vegetation.

Because Reclamation would not retain fee title to the project area property, we are unable to control future actions and, consequently, off-site mitigation is proposed. We propose to select one of two mitigation options: (1) acquire 5 acres of riparian habitat on the San Pedro River or Aravaipa Creek which shall be managed by an appropriate agency, or (2) acquire a Conservation Easement on riparian habitat on Aravaipa Creek.

Additional Mitigation Measures

The following measures would be implemented during the construction phase of the project:

1. If any federally-listed species (other than fish) are identified in the project area, construction activities would be halted until appropriate officials from FWS and Reclamation are notified and actions taken.

2. All construction areas not required for permanent facilities would be scarified and recontoured.

3. All barrel and cholla cacti in the contractor use area would be stockpiled and replanted at the end of construction.

4. All saguaro cactus in contractor use area would be avoided, if possible, or stockpiled and replanted following construction.

5. The staging area would be scarified, recontoured, and revegetated with native species.

6. All construction personnel will be instructed not to collect, disturb, or molest wildlife species during construction.

7. Contractor will be instructed to exercise care to preserve the natural landscape and conduct operations so as to prevent unnecessary destruction, scaring, or defacing of the natural surroundings in the vicinity of the work.

8. Contractor will be directed to comply with the statutes of the Arizona Native Plant law.

9. Impacts associated with bank protection will be identified, quantified, and mitigated.

D. Scientific Monitoring

Not all impacts of the Aravaipa Creek fish barrier project on aquatic ecology are known with certainty. Reclamation would institute a scientific monitoring program of the stream biota potentially impacted by the fish barriers prior to construction of the fish barriers. Results of this monitoring would be used to more fully assess the impacts of the barriers on Aravaipa Creek, refine the design and impact analysis of future barrier projects, and provide additional scientific insight into barrier effects on the ecology of aquatic and riparian communities of Aravaipa Creek.

Specifically, existing monitoring studies of native and nonnative fish populations of Aravaipa Creek would be modified or refined into a dedicated program to evaluate their responses to the presence of fish barriers, including larval drift and emigration studies. Contingency plans for harvest of fishes from below the barriers for repatriation elsewhere within their natural ranges will be made.

In addition, routine monitoring of fish populations between the fish barriers and upstream of the upper barrier would be performed. Monitoring would likely be conducted annually and following episodes of flooding. If nonnative species are found between the barriers, they would be removed mechanically or chemically.

No Action Alternative

Existing and future environmental conditions within the project area would not be influenced by construction and operation of fish barriers. Project-related effects to aquatic and terrestrial environs, including short-term and long-term impacts to habitats, fish, wildlife, and vegetation, would not occur. The unabated incursion of nonnative fishes into upper reaches of Aravaipa Creek could threaten the existence of resident populations of native fishes. Continued recreational use and cattle grazing would impact vegetation on riparian areas.

E. Land Use

Affected Environment

Lands encompassing the project area consist of open, sparsely populated desert and low mountains, intersected by numerous drainages. Considerable agricultural production and mining exist several miles west and northwest of the project area, but would not be affected by the proposed action. Portions of Indian Trust Allotment 013622, which is downstream of the project area, have historically been cultivated.

The project area falls within part of the undeveloped floodplain of Aravaipa Creek on land allotted to members of the San Carlos Apache Tribe (Indian Trust Allotment 013736). No human habitation or permanent improvements occur on this land. A crushed rock-surface road maintained by Pinal County (Aravaipa Road) bisects the allotment and provides the only transportation corridor to upstream private properties and the BLM-managed wilderness area. Land use upstream of the allotment is predominately undeveloped open space with isolated residences, small farms, and ranches.

Portions of the project area in the mesquite bosque and near the stream channel are utilized by local residents for picnicking and camping. This casual recreational use is not sanctioned by allottees, and is, in fact, a property trespass. Several primitive roads and trails transect the mesquite bosque, encouraging continued unauthorized use. Lack of access controls have contributed to degradation of vegetation, accumulation of trash, and vehicle use in the mesquite bosque, along the streambank, and within the channel. The project area also shows evidence of trespass cattle grazing.

Environmental Consequences

Indian Trust Allotment 013736 would be most directly affected by construction and operation of the fish barriers. Construction activities would create temporary restrictions on allottee use of sites needed by the contractor for equipment access, maneuvering, and material storage during the 4-month construction period. Less than 6 acres of land in the allotment would be impacted during construction. Land use within the 1.81-acre footprints of the two barriers would be restricted during both the construction phase and the 100-year operational life of the project. Bank stabilization would limit vehicle access to the active stream channel and alter the

aesthetic quality of the stream bank near each barrier. Project operation also requires long-term access for periodic inspection of the barriers and biological monitoring, which could affect the allottees' use of a portion of the property.

Construction of the lower barrier could foreseeably create an impediment for allottees to divert stream water from an upstream source to supply potential agricultural production on historically cultivated land within allotments 013622 and 013736. Reclamation would design a diversion feature into the lower barrier to ensure that the project does not preclude tribal members from diverting water pursuant to their water rights.

Approximately 7.5 acres of stream channel would aggrade with sediment deposited upstream of the barriers. Shifts in sediment deposition and the resulting loss of vegetation within this portion of the channel would imitate effects caused by flooding. The "natural" character and aesthetic quality of the channel would quickly be restored as vegetation recolonizes the sedimentation zone.

Project-related impacts to land uses due to flooding would be low. Incremental increases in flooding would be most pronounced on allotted land immediately upstream of the barriers. Project-induced backwater flooding would impact less than 3 acres (1.9 percent) of the allotment through a 100-year flood (Figure 3-1). These temporary flood effects would be confined to undeveloped portions of the floodplain and would not change current allottee use of the land.

Increases in flooding attributable to the project would have negligible effect on upstream properties through a 5-year flood (Figure 3-1). A slight incremental increase in the extent and duration of flooding would impact three upstream properties during higher magnitude flood events (greater than 5-year frequency floods). However, less than 0.20 additional acres of private land would be affected by backwater flooding up through a 100-year frequency flood. These temporary effects would not be expected to change short-term or long-term land use patterns. Reclamation would attempt to acquire flowage easements from affected private land owners. The project would not change land use on properties downstream of allotment 013736.

The project would cause short-term inundation of two low-lying sections of Aravaipa Road during 5 and 10-year floods (Figures 3-1 and 3-2). Although this backwater flooding would be of short duration, temporary disruption of traffic flow is possible. To negate any such adverse impact, Reclamation would modify the affected sections of Aravaipa Road to conform with Pinal County's all-weather road standards. The County standards require that single access public roads, such as Aravaipa Road, be covered by no more than 8 inches of water during any 25-year frequency flood. Floods of magnitudes greater than a 12-year event already submerge the potentially affected sections of road; therefore, elevation of the road surface in conformance with County standards would be an improvement over existing conditions. Beyond a 25-year flood, the project's long-term effect would be to slightly increase the duration of flooding on the two affected sections of road.

Mitigation Measures

1. Reclamation would compensate affected tribal members for impacts caused by construction and operation of the barriers. Easements would be purchased for the barrier sites, temporary construction areas, and lands potentially affected by project-related flooding. Reclamation would also attempt to acquire flowage easements for upstream properties potentially affected by project-related flooding.

2. Reclamation would install heavy-duty gates, and fencing, to limit unauthorized vehicle access to allotted land adjacent to and upstream of the barriers. Restricting access to the property would lessen current problems associated with trespass, litter, and off-road vehicle operation.

3. Sections of Aravaipa Road on Allotment 013736 would be modified to minimize potential project-related flood impacts.

4. Reclamation would include a diversion feature in the lower barrier to ensure the allottees' ability to divert water to historically cultivated lands.

No Action Alternative

Impacts to land use attributable to the project would not ensue. Reclamation would not purchase easements or install restrictive fencing and gates. It is anticipated the area would continue to be used by recreationists, and Aravaipa Road would continue to be inundated with each 12-year frequency flood.

F. Water Quality

Affected Environment

Aravaipa Creek is a relatively pristine, mostly perennial stream. Water quality is considered generally good, with little empirical evidence of chemical contamination. Small farms and livestock grazing along the water course likely contribute minor amounts of organic and inorganic pollution. Sparse submergent aquatic vegetation, particularly filamentous algae, is indicative of acceptable nitrogen loading. Abundant and diverse populations of native fishes and aquatic insects also suggest admissible, low levels of oxygen-demanding (biodegradable) contaminants. The stream water during dry conditions is slightly turbid with extremely fine, suspended silt. Turbidity increases substantially with sediment inputs from storm water runoff.

Environmental Consequences

Disturbances to the channel during construction would cause a temporary increase in turbid conditions downstream of the project area. Excavation of alluvium, movement of equipment within the channel, and dewatering practices would contribute to elevated sediment

loading during the construction phase. Slightly elevated turbidity may persist briefly following construction as finer sediments are washed from disturbed gravel beds. These minor, short-term construction impacts would affect surface water quality only in the lowest perennial reach of Aravaipa Creek, extending from the project area to a point approximately 1-mile downstream where flow becomes subterranean. The construction phase of the project would not introduce measurable long-term water quality impacts.

Project operation would include periodic monitoring of fish populations between the barriers and mechanical (use of nets) or chemical removal of nonnative fishes, if present. If chemical control becomes necessary, a U.S. Environmental Protection Agency certified ichthyotoxin (fish toxin), such as Fintrol®, would be applied to the stream between the barriers. Fintrol®, as well as other commercially available ichthyotoxins, is toxic only to aquatic animals possessing gills (see discussion in Biological Resources chapter, section h). Use of a neutralizing agent at the lower barrier would prevent the downstream migration of the toxin. No residual toxic effect is expected in waters between the barriers due to dilution and rapid degradation of the toxin (e.g., Fintrol® completely degrades within a few hours after use). Adverse effects to aquatic biota or water quality would not occur downstream of the project area.

No Action Alternative

Existing water quality would not be affected by the project. Potential short-term increases in turbidity caused by construction would not occur.

G. Cultural Resources

Affected Environment

The project area encompasses portions of the Aravaipa Creek stream bed, floodplain and adjoining upland environs. The potential for prehistoric archeological sites in the channel and floodplain are quite low due to recurrent flooding and resultant modification of erodible landforms. Upland areas potentially affected by the project have the highest probability of containing prehistoric or historic cultural material.

Prehistoric Setting

Archaeological data on the occupation of the lower San Pedro Valley by Paleo-Indian big-game hunters and Archaic hunters and gatherers is limited, and as a consequence not much is known about these early inhabitants. More data are available on a sedentary group known as the Hohokam. Primarily farmers, the Hohokam established villages along the lower San Pedro River beginning around the 5th century A.D. Villages were often located near the mouths of major tributary drainages, because these locations offered the Hohokam not only

fertile floodplain areas for farming, but two riparian systems that could be exploited for their plant and animal resources (Masse 1980:210). The Hohokam were represented in the region until the 5th century A.D.

Beginning in the 13th century A.D., what archaeologists call the Classic Period began. Lasting until around A.D. 1400, the Classic period along the lower San Pedro Valley is associated with immigration of Indian groups from plateau and mountain areas to the north and east. The Classic period in southern Arizona is associated with platform mounds and surface structures of adobe and cobbles enclosed by walls (these walled communities are known as compounds). Recent survey along the San Pedro River (Doelle 1990a; 1990b; 1995) identified several platform mound and compound sites.

Between A.D. 1400 and 1500, the Classic period ended for reasons that remain unclear to archaeologists. Native populations along the lower San Pedro (and throughout most of southern Arizona) declined, and settlement patterns shifted to fewer and smaller villages. When the first Spanish explorers ventured into southern Arizona and down the San Pedro River, groups of native farmers resided in a string of villages located along the river. These villages lacked the platform mounds, compounds, and adobe and stone masonry architecture that marked the Classic period.

The Apache arrived in the southwest sometime in the late 15th and early 16th centuries and are related to Athapaskan groups in Alaska, Canada, and Northern California (Bronitsky and Merritt 1986:257). The lower San Pedro River and surrounding area to the east was occupied by the Aravaipa band of the San Carlos group of Western Apache, who controlled the area until eventually forced onto a reservation by the U.S Army in the late 1800s.

The Apache were farmers, who also moved frequently in search of game and wild plant foods. When they eventually acquired the horse from the Spanish, raiding also became an important subsistence pursuit. Apache settlement (for example, the lack of permanent architecture) and subsistence practices have contributed to the absence of archaeological visibility of Apache sites. Because archaeologists have had trouble identifying Apache sites, archaeological data are limited (Bronitsky and Merritt 1986:258). See Appendix E for a more extensive discussion of prehistoric and historic occupation of the project area.

Survey Methods and Results

The active stream channel where the fish barriers would be built was not surveyed due to recurrent land disturbances caused by baseline stream flow and occasional severe flooding.

A Class III survey of three proposed contractor use areas was completed in June 1998. A second more extensive Class III survey of the upland site (Site B) was performed in September 1998. The contractor use areas are adjacent to each other and are designated Sites A, B, and C (Figure 2-3). Site A is the furthermost upstream proposed contractor use area. It is located in the floodplain on the north bank of Aravaipa Creek. Site B, the desertscrub upland site, is on a terrace immediately west (downstream) of Site A. Site B is the preferred location for the contractor use area. Site C is also in the floodplain and lies immediately west and downstream of the upland site. Sites A and C are covered with a dense stand of mesquite and other riparian vegetation. Both areas have been and continue to be disturbed by vehicular activity associated with picnicking and camping along the creek. The uplands site rises above the creek and contains scattered mesquite, palo verde, ocotillo, and various cacti. It has not been as severely disturbed by recreational users as the other two sites.

The Class III surveys were conducted in accordance with the National Historic Preservation Act of 1966 (NHPA), as amended (P.L. 89-665). A Class III survey consists of an intensive on-the-ground examination of all areas to be affected by the proposed action. The survey is intended to identify all cultural resources within the project area. Survey data are used to evaluate the significance of cultural resources and to develop plans to avoid, minimize, or mitigate adverse effects to significant cultural resources from the proposed construction activity. A check of site maps at the Arizona State Museum indicated that no previous surveys had taken place in the project area, although recent surveys have been completed along the San Pedro 3 to 4 miles west of the project area (Doelle 1990a; 1990b; 1995). Farther upstream on Aravaipa Creek, a 1939 survey by Grenville Goodwin recorded 15 rock shelters (Gilman and Richards 1975).

Approximately 7 acres were surveyed. Several archeological features were noted and mapped near Site B; no features were detected on Sites A and B. A scatter of historic metal artifacts may be associated with a power line and maintenance road that run through Site B; alternatively, they may also be associated with a recent (late 19th or early 20th century) Apache occupation of the site.

The project area was visited on July 21, 1998, during which several members of the San Carlos Apache Elders Council were present. They confirmed the area as being a traditional cultural property (TCP) for the San Carlos Apache.

Environmental Consequences

There would be no impacts to cultural resources from construction of the two fish barriers. Cultural resource sites potentially eligible for National Register listing or considered sensitive by the San Carlos Apache Tribe would be avoided. The TCP could be impacted from development of the contractor use area, however.

Mitigation Measures

1. Because of the presence of a TCP in the project area, traditional elders of the San Carlos Apache Tribe will be consulted on a continuing basis regarding the specific siting of the contractor use area. The TCP would be fenced or otherwise protected from any potential disturbance from the contractor use area. Approval of any mitigation measure would be required by the allottee owners, and concurred with by tribal elders. Concurrence of the State Historic Preservation Office (SHPO) and BIA would also be obtained.

2. The TCP will be assigned an appropriate site number, and it will be accurately mapped using a total station. Surface transects will be made to identify and record all surface artifacts and features. No artifact collections will be made. A previously unsurveyed area that could provide an alternative location for a contractor use area will also be surveyed and mapped.

3. Consultation with the SHPO as required by section 106 of the NHPA will be completed prior to commencement of any land disturbing activities. Appropriate mitigation measures will be developed in consultation with the SHPO, the San Carlos Apache Tribe, and the BIA.

4. Pursuant to section 106 of the NHPA, consultation has been initiated with the San Carlos Apache Tribe regarding the presence of TCPs in the project area. The only other TCP thus far identified is the site of the Camp Grant Massacre that is located about 0.5 mile downstream from the fish barriers.

5. If previously unidentified cultural resources, especially human remains or burials, are encountered during construction, work shall cease immediately at the location, and personnel from Reclamation's Cultural Resource Branch shall be notified.

No Action Alternative

Because a contractor use area would not be required, there would be no impact to the archaeological site in the upland area. Impacts from casual recreational use of the project area would continue.

H. Environmental Justice

Executive Order (EO) 12898 requires Federal agencies to identify and address, as appropriate, disproportionately high and adverse human health or environmental effects of Federal actions on minority populations and low-income populations. Low-income populations include communities, or individuals living in close geographic proximity to one another,

identified by Bureau of Census statistical thresholds for poverty. Minority populations are identified where the percentage of minorities in the affected area exceeds 50 percent, or where the minority population percentage of the affected area is meaningfully greater than the minority population percentage of a much broader area. For the purpose of this analysis, Pinal County and the State of Arizona are selected as comparative geographic units.

Affected Environment

Pinal County is composed primarily of persons of white, Hispanic, or American Indian ethnic or racial backgrounds (96 percent of total population). County-wide populations of American Indians are further divided into several tribal affinities, with population concentrations centered on reservations. Populations of whites and Hispanics are more uniformly distributed throughout the county. Table 9 shows that percentages of minority populations are higher in Pinal County compared to the State of Arizona. Minority populations account for approximately 41 percent of the total population in Pinal County.

Table 9. Income and population statistics for Pinal County and the State of Arizona

Type of Income/Population	Pinal County	Arizona
Median household income	$21,301	$27,540
Median family income	$23,993	$32,178
Per capita income	$9,228	$13,461
Persons below poverty	23.6%	15.7%
Families below poverty	18.7%	11.4%
White (non-Hispanic)	59%	72%
Hispanic	29%	19%
Indian	8%	5%
Black	3%	3%

Source: Bureau of Census. 1990 Population and Housing Statistics

According to the 1990 census, poverty levels in Pinal County are higher than State averages. Percentages of persons and families below the poverty level are comparatively high; and household income, median family income, and per capita income are quite low. Few economic opportunities are available near the project area, and most employment is dependent on agriculture or mining.

Properties potentially affected by the project are either uninhabited or sparsely populated. Reclamation anticipates the EO 12898 effects of the proposed action are confined to minority or low-income populations that might use, or have a legal property interest in, BIA Indian Trust Allotment 013736. The allotted land, although not inhabited, is owned by members of the San Carlos Apache Tribe. San Carlos Apache tribal members belong to a minority population, as defined by EO 12898. Owners of potentially affected upstream properties do not qualify as minority or low-income "populations."

Other populations potentially affected by the project include residents from nearby communities and rural areas that use the allotted land for picnicking and camping. Since no specific demographic data exist for these users, it is assumed their race and ethnic backgrounds and income status generally conform to county-wide statistics.

Environmental Consequences

The proposed action would not result in disproportionately high, adverse health effects to low income populations or minority populations. No minority or low-income populations reside on areas affected by the project; thus direct impacts to resident EO 12898 populations would not occur. Construction and operational aspects of the project would not introduce chemical, biological, physical agents, or situations that have the potential to adversely affect the health of low-income or minority populations. The environmental effects of the project are not expected to adversely impact San Carlos Apache tribal members with legal property interests in allotment 013736.

Access to the allotted land by unauthorized persons would be restricted by the proposed action. The current casual recreational use of the property by local residents is not sanctioned by allottees and constitutes a trespass of private property. Locked gates and fencing would be erected by Reclamation to prevent unauthorized vehicle access to allotted land adjacent to, and upstream of, the barriers. Reclamation anticipates recreational use of the site would be reduced, but not eliminated. Individuals could still access the property by parking along Aravaipa Road and climbing over the fence. The installation of fencing and other restrictive barriers would not preclude any legal right to use or access the allotment.

Early in the project, Reclamation considered eight potential sites for barrier construction. All but sites A1 and A2 were rejected due to possible access constraints or unacceptable adverse biological impacts. Sites below the "throat" of Aravaipa Canyon would have been impractical due to the amount of construction necessary to span the floodplain, which broadens considerably below site A1. Reclamation finally determined that sites A1 and A2 were the only practical locations available on Aravaipa Creek for barrier placement. Construction of the barriers on allotted land would not be possible without a plurality of consent among affected allottees, their heirs, and the BIA acting as trustee for the interests of minors, deceased unprobated heirs, and unlocatable heirs.

The public involvement associated with the project included a scoping meeting near Winkelman, Arizona; numerous informational mailings to agencies, organizations, and individuals; and issuance of news releases to local and State-wide media outlets, including the *San Carlos Apache Moccasin* newspaper. San Carlos Apache tribal members with allotted land interests in the project area were specifically contacted by Reclamation and invited to comment on the proposed action. Reclamation personnel also arranged a special bus tour of the project area for allottees. Copies of the draft EA were mailed to affected allottees.

No Action Alternative

The project would not be implemented and existing conditions on, and uses of, the allotment would persist. Future use by allottees and others would not be influenced by the project. Unauthorized recreational use of the allotment would not be restricted.

I. Indian Trust Assets (ITAs)

ITAs are legal interests in property, held in trust, by the United States for Indian Tribes or for individual Indians. Examples of trust assets are lands, forage, timber, minerals, hunting and fishing rights, and water rights. ITA effects of the proposed action were examined and evaluated in consultation with the BIA and involved tribal members.

The Secretary of the Interior (Secretary) is the United States' trustee on behalf of Indian Tribes and their members. All Federal agencies have trust responsibility requiring them to take all actions reasonably necessary to protect trust assets, and avoid adverse impacts when possible. When adverse impacts cannot be avoided, appropriate mitigation or compensation must be provided, in consultation with the affected tribes and/or tribal members.

"Legal interest" means there is a primary interest for which a legal remedy may be obtained, for example compensation or injunction. ITAs do not include things in which a tribe or its members have no legal interest. For example, a tribe and its members may have no legal interest, jurisdiction, or ownership of land which may contain part of the tribe's cultural heritage, history, or affiliation. These are termed TCP's. Federal laws do pertain to the TCP's, religious, or cultural heritage sites. Such matters should be addressed whenever impacts to such properties were to occur from actions of others.

Affected Environment

Trust Indian Patent No. 741639 was granted to Elin Chiquito (a.k.a. Elin Bullis), a member of the San Carlos Apache Tribe, on March 26, 1920, and presently is owned by his heirs. The allotment (Indian Trust Allotment 013736) contains 160 acres in the N2NE4,

SE4NE4, and NE4NW4 of Section 8, T.7S., R.17E., G&S, Pinal County, Arizona. The Chiquito Allotment is a TCP, albeit formally undeclared. It also has a long well-documented history of Apache tribal cultural affiliation (Appendix E).

Immediately downstream and west along Aravaipa Creek, adjoining the Elin Chiquito Allotment, is the 160-acre trust Allotment No. 013622 of his father, Captain Chiquito, or Bullis. It occupies the SW4SW4 of Section 5, the SE4SE4 of Section 6, the NE4NE4 of Section 7, and NW4NW4 of Section 8, T.7S., R.17E., G&S and contained 26.2 acres of cultivated bottom land, part of which was irrigated by Indian Ditch No. 3 heading on the right descending bank of Aravaipa Creek within the upstream Elin Chiquito Allotment, as shown by the Arizona State Water Commissioner Survey of 1921. Minimal impact to this allotment due to construction, maintenance, or operation of the proposed fish barriers is anticipated.

Environmental Consequences

The concrete barriers and entrapped sediment would change the land contours and elevations in the stream channel. Approximately 9.3 acres (5.8 percent of the allotment acreage) would be impacted by the footprints of the two barriers and resulting sediment deposition. A minor amount of stream channel within the sedimentation zone would experience temporary inundation by water impounded by the barriers. These temporary pools would eventually be displaced by sediment.

Approximately 0.30 acre of the allotment would be affected by improvement of two existing primitive roads that connect the county-maintained Aravaipa Road to the stream channel, and by protective fencing and/or gates across the access roads. Additional disturbances to approximately 2.10 acres of land would result from construction and temporary utilization of the contractor use area. Maneuvering of construction equipment and stockpiling of excavated materials within the channel would be confined to the sedimentation zones and barrier footprints (except for a small portion of channel below the lower barrier that might be used for vehicle maneuvering).

Mining

There is no recorded history of mining or current mining on Allotment No. 013736, nor any known plans to set up mining activities in the future. Potential mining activities on land at or near the fish barriers would be precluded for the life of the project.

Use of Water

Many uses of water on Indian lands are not covered either by decree or by State permit. Aravaipa Creek and San Pedro River Apache Indian public domain allotments are among these, including both the Elin and Captain Chiquito Allotments. Undecreed water right

claims under the Winters Doctrine do exist for these allotments. Those rights derive from *Winters v. United States* (1908), 207 U.S. 564, and are referred to as "federally-reserved water rights." They are not merely for present uses, but for future uses as well. As to the quantity of waters reserved, that matter was directly passed upon in *Conrad Investment Co. v. United States*, 9 Cir., 161 F. 829, decided shortly after the Winters decision. The Conrad decision stated (page 832): "What amount of water will be required for these purposes may not be determined with absolute accuracy at this time, but the policy of the government 'to reserve whatever water of Birch Creek may be reasonably necessary' not only for present uses, but for future requirements, is clearly within the terms of the treaties as construed by the Supreme Court in the Winters case."

A limited adjudication of the waters of the Gila River, under Globe Equity No. 59, was decided on June 29, 1935, in *United States v. Gila Valley Irrigation District*. That case was reopened and currently is before the court. Water rights in the San Pedro River and Aravaipa Creek tributaries of the Gila River are being determined in the State Court Gila River System and Source general stream adjudication. The State adjudication process is under Revised Statutes §§§ 45-251 to 45-260 and is being conducted in the State Superior Court. The general adjudication of the Gila River System and Source has been assigned to the Superior Court for Maricopa County. Water rights claims have been entered for these Indian allotments in this proceeding.

Exactly what impact construction of the proposed fish barriers might have on these water rights, beneficial uses, duty of water, season of use, and points of use have not been studied or determined. The barriers, however, are not intended, by design or function, to impound water, divert flow from allotted lands, or otherwise limit potential water use by allottees. The lower barrier would include a water diversion capability to ensure the Indian allottees would continue to be able to divert by gravity flow from Aravaipa Creek in accordance with their water rights.

Trust Income

Allotment 013736 currently is not being used to provide any income to the owners. Previously it was leased for grazing and as a buffer zone to public encroachment on adjoining private land immediately upstream of the allotment, and some control fencing was erected between the adjoining properties. Project operation requires periodic access of the property for barrier inspection and biological monitoring, which could affect future land use and income-generating potential. Allottees would be compensated by Reclamation for project-related usage of allotment 013736.

Privacy

It will be necessary for Reclamation employees or their contractors to inspect the condition of the barriers, and to monitor the effects of the barriers on native and nonnative fishes. Consequently, there would be a potential loss of privacy and seclusion for the original allottee heirs on their land.

Fishing

Aravaipa Creek is presently closed to fishing by order of the AGFD. A consequence of the project would be the elimination of any potential recreational or subsistence fisheries on the reach of Aravaipa Creek above the lower barrier. Aravaipa Creek, however, has never supported a "quality" sport fisheries. Only two species of game fish (green sunfish and yellow bullhead) routinely invade portions of the stream potentially affected by the project. Once the barriers are operational, populations of game fish in Aravaipa Creek would likely be limited to waters below the lower barrier. Although allottees have not frequently used the allotment for fishing in the past, the project would negatively affect any such future use above the lower barrier, if and when the current prohibition on fishing is cancelled.

Mitigation

See mitigation measures under "Land Use."

No Action Alternative

Without project implementation, no allotted land would be required for barrier construction and operation. Project-related construction and operation effects would not occur. Allottees with property interests in the allotment would not be compensated for potential project-related impacts.

J. Cumulative Impacts

Cumulative impacts result from the incremental effect of the proposed action when added to other past, present, and reasonably foreseeable future actions. The most influential action related to the project is the gradual displacement of native fishes by nonnative fishes throughout Arizona. Construction of the barriers on Aravaipa Creek, combined with other management strategies, could conceivably prevent localized extirpation and permanent endangerment of loach minnow and spikedace. Conversely, the project could prevent the dispersion of nonnative and native fishes into habitats upstream of barrier sites, thus restricting their ranges.

Land-disturbing activities in Arizona irrevocably and incrementally destroy a portion of the State-wide cultural resource base each year. Project-related construction could permanently impact scattered cultural material on approximately 2 acres of the allotment. Loss of cultural material resulting from actions associated with the project represents a small, but irretrievable, fraction of the regional cultural resource base.

K. Irreversible and Irretrievable Commitment of Resources

The term irreversible describes the loss of future options and applies to the effects of use of nonrenewable resources. Irreversible commitments cannot be reversed, except perhaps in the long term. Irretrievable refers to the loss of production, harvest or use of natural resources for a period of time. Loss of production or resources can be irretrievable, while the action may not be irreversible.

Construction activities associated with the project would require irreversible and irretrievable commitment of labor, fossil fuels, water, raw material, and financial expenditures.

Minor losses of "in situ" cultural resources are an anticipated consequence of the project. Loss of cultural material due to construction impacts are considered irreversible and irretrievable. The losses would be mitigated through surveys and data recovery.

Allottee use of the barrier sites on Indian Trust Allotment 013736 would be irretrievable and irreversibly lost. Due to the project's 100-year life span, the barriers are considered permanent features of the land.

Irretrievable losses of existing desert and riparian wildlife habitat would be attributable to construction-related disturbances and the long-term presence of the barriers. The displacement of habitat is not irreversible as mitigation efforts and natural processes would revegetate disturbed sites.

L. Mitigation Measures

The following section is a comprehensive listing of the mitigation measures incorporated into this EA. These mitigation measures will be implemented as part of the proposed action.

Biological Resources

1. Reclamation would select one of two mitigation options to compensate for impacts to riparian areas: (a) acquire 5 acres of riparian habitat on the San Pedro River or Aravaipa Creek which shall be managed by an appropriate agency, or (b) acquire a Conservation Easement on riparian habitat on Aravaipa Creek.

2. If any federally-listed species (other than fish) are identified in the project area, construction activities would be halted until appropriate officials from FWS and Reclamation are notified and actions taken.

3. All construction areas not required for permanent facilities would be scarified and recontoured to facilitate natural revegetation.

4. All barrel and cholla cacti in the contractor use area would be stockpiled and replanted at the end of construction.

5. All saguaro cactus in contractor use area would be avoided.

6. The staging area would be scarified, recontoured, and revegetated with native species.

7. All construction personnel will be instructed not to collect, disturb, or molest wildlife species during construction.

8. Contractor will be instructed to exercise care to preserve the natural landscape and conduct operations so as to prevent unnecessary destruction, scaring, or defacing of the natural surroundings in the vicinity of the work.

9. Contractor will be directed to comply with the statutes of the Arizona Native Plant law.

Land Use

1. Reclamation would compensate affected tribal members for impacts caused by construction and operation of the barriers. Easements would be purchased for the barrier sites, temporary construction areas, and lands potentially affected by project-related flooding. Reclamation would also attempt to acquire flowage easements for upstream properties potentially affected by project-related flooding.

2. Reclamation would install heavy-duty gates, and other barriers as deemed necessary, to limit unauthorized vehicle access to allotted land adjacent to and upstream of the barriers.

3. Sections of Aravaipa Road on Allotment 013736 would be modified to minimize potential project-related flood impacts.

4. Reclamation would include a diversion feature in the lower barrier to allow for diversion of a percentage of stream flow by tribal members.

Cultural Resources

1. Because of the presence of a TCP in the project area, traditional elders of the San Carlos Apache Tribe will be consulted on a continuing basis regarding the specific siting of the contractor use area. The TCP would be fenced or otherwise protected from any potential disturbance from the contractor use area. Approval of any mitigation measure would be required by the allottee owners, and concurred with by tribal elders. Concurrence of the State Historic Preservation Office (SHPO) and BIA would also be obtained.

2. The TCP will be assigned an appropriate site number, and it will be accurately mapped using a total station. Surface transects will be made to identify and record all surface artifacts and features. No artifact collections will be made. A previously unsurveyed area that could provide an alternative location for a contractor use area will also be surveyed and mapped.

3. Consultation with the SHPO as required by section 106 of the NHPA will be completed prior to commencement of any land disturbing activities. Appropriate mitigation measures will be developed in consultation with the SHPO, the San Carlos Apache Tribe, and the BIA.

4. If previously unidentified cultural resources, especially human remains or burials, are encountered during construction, work shall cease immediately at the location, and personnel from Reclamation's Cultural Resource Branch would be notified.

Project Design

1. The final project design will be reviewed by an independent architect engineer as promised during the scoping meeting in Winkelman on June 27, 1998.

M. List of Related Environmental and Cultural Resources Laws and Directives

National Environmental Policy Act (42 U.S.C 4321,et seq.) - This law requires Federal agencies to evaluate the potential environmental consequences of major Federal actions. NEPA also requires full public disclosure about the proposed action, accompanying alternatives, impacts, and mitigation.

This draft EA was prepared in accordance with the requirements of NEPA. The EA addresses the potential environmental impacts of implementing the proposed construction and operation of two fish barriers on Aravaipa Creek, Arizona. Public involvement associated with development of this EA included a public scoping meeting and bus tour of the project area. The draft EA was mailed to 84 individuals, agencies, and organizations for a 31-day public review period. In addition, public notices were published in newspapers serving the

communities of Winkelman and Mammoth, Arizona regarding the availability of the draft EA. News releases were also sent to various other news media regarding the draft EA. Twelve entities provided written comments (see Appendix F).

Endangered Species Act of 1973 (P.L.93-205) - The ESA provides protection for plants and animals that are currently in danger of extinction (endangered) and those that may become so in the foreseeable future (threatened). Section 7 of this law requires Federal agencies to ensure that all federally- associated activities do not have adverse impacts on the continued existence of threatened or endangered species or designated areas (critical habitat) that are important in conserving those species.

A biological assessment (BA) was prepared by Reclamation to evaluate the direct and indirect effects of the project on federally-listed and candidate species (excluding fish), as required by the ESA. The BA was submitted to the FWS on June 19, 1998, and concluded with "no effect" to any proposed or listed species. Native fishes were considered in the final biological opinion on the delivery and use of CAP water to the Gila River Basin, dated April 15, 1994, and no additional consultation was necessary according to Ms. Sally Stefferud, FWS, May, 26, 1998. Some native fishes may indirectly be lost due to the project; however, the 1994 biological opinion included "take" provisions for activities necessary to implement the reasonable and prudent alternatives. No cumulative effects of the project were noted in the BA.

Fish and Wildlife Coordination Act of 1958 (FWCA) (P.L. 85-624) - The objective of this law is to provide that wildlife conservation receive equal consideration and be coordinated with other features of water resource development programs. A Federal agency must consult and coordinate its actions and projects with the FWS and the affected State fish and game agency on any impoundment, diversion, or other water control facility.

Because the fish barrier project is a product of a Section 7 consultation, intensive coordination with the FWS has been ongoing since the project's inception. The FWS, which is also a cooperating agency in the development of this EA, concluded in a letter dated July 27, 1998, "The current level of coordination is sufficient to meet any regulatory needs required by the FWCA and a specific report should not be required."

Clean Water Act (33 U.S.C. 1251 et seq.) - The CWA strives to restore and maintain the chemical, physical, and biological integrity of the nation's waters by controlling discharge of pollutants. The basic means to achieve the goals of the CWA is through a system of water quality standards, discharge limitations, and permits.

Consultation with the COE on the delineation of "jurisdictional" waters within the project area is complete. An individual permit application and mitigation plan was submitted to the COE in September 1998. The COE has requested additional information. It is anticipated a public notice will be issued by the COE before the end of 1998. A CWA Section 404 (dredge

and fill) permit and CWA Section 401 water quality certification will need to be obtained prior to project implementation. Because the project would disturb more than 5 acres of land, a CWA Section 402 NPDES general permit for construction activities would also be required.

National Historic Preservation Act (P.L. 89-665) - This law establishes as Federal policy the protection of historic sites and values in cooperation with states and local governments.

Consultation with SHPO, as required by section 106 of the NHPA, would be completed prior to project implementation. Appropriate mitigation measures would be developed by Reclamation in consultation with the SHPO, the San Carlos Apache Tribe, and the BIA.

Wilderness Act of 1964 (P.L. 88-577) - This Act formally recognizes the values of wilderness and affords protection of wilderness areas through establishment of the National Wilderness Preservation System.

No wilderness areas are immediately proximal to the project area. Aravaipa Canyon Wilderness Area, which is managed by the BLM, is approximately 9 miles upgrade of the proposed upper barrier site. Reclamation anticipates the effects of the project would be confined to Indian Trust Allotment 013736 and three upstream private properties. Project-related impacts to Aravaipa Canyon Wilderness Area are not expected.

Executive Order 11988 (Floodplain Management) - This Presidential directive encourages Federal agencies to avoid, where practicable alternatives exist, the short- and long-term adverse impacts associated with floodplain development. Federal agencies are required to reduce the risk of flood loss, minimize the impacts of floods on human safety, health and welfare, and restore and preserve the natural and beneficial values served by floodplains in carrying out agency responsibility.

The fish barriers would be engineered to minimize possible project-related flood impacts. Adverse effects to properties and natural resources would be mitigated through the execution of measures specified in this EA. Placement of fish barriers on Aravaipa Creek by Reclamation is a required provision of the 1994 biological opinion to avoid jeopardizing the continued existence of spikedace and loach minnow. Therefore, no practicable alternative to the proposed action exists.

Executive Order 12898 (Environmental Justice) - This directive requires that each Federal agency identify and address, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-income populations.

The effects of barrier construction and operation on EJ 12898 populations are discussed in the Environmental Justice section of this EA.

Executive Order 11990 (Wetlands) - EO 11990 requires Federal agencies, in carrying out their land management responsibilities, take action that will minimize the destruction, loss, or degradation of wetlands, and take action to preserve and enhance the natural and beneficial values of wetlands.

No jurisdictional wetlands are present in the project area and no impact is anticipated.

IV. LIST OF PREPARERS

Pierre Cantou, Paralegal, Bureau of Indian Affairs
Rob Clarkson, Fishery Biologist, Bureau of Reclamation
Jon Czaplicki, Archeologist, Bureau of Reclamation
Diane Laush, General Biologist, Bureau of Reclamation
John McGlothlen, NEPA Compliance Specialist, Bureau of Reclamation
Bobbie Ohler, Civil Engineer, Bureau of Indian Affairs
Jeff Riley, Civil Engineer, Bureau of Reclamation

The following list summarizes persons and agencies contacted for consultation and coordination:

Roger Baumann, Civil Engineer, Pinal County Department of Civil Works
Marjorie Blaine, Regulatory Branch, U.S. Army Corps of Engineers
Robert Clark, Jr., San Carlos Agency, Bureau of Indian Affairs
W.L. Minckley, Professor of Zoology, Arizona State University
Sabra Schwartz, Nongame Biologist, Arizona Game and Fish Department
Mike Smith, Superintendent, San Carlos Agency, Bureau of Indian Affairs
Sally Stefferud, Biologist, Fish and Wildlife Service
Mike Sredl, Nongame Biologist, Arizona Game and Fish Department

V. REFERENCES

Abarca, F.J. 1989. Potential food habit overlap between spikedace (*Meda fulgida*) and red shiner (*Cyprinella lotrensis*). Unpublished Master's Thesis, Arizona State University, Tempe.

Anderson, B.W., and R.D. Ohmart. 1977. Vegetation structure and bird use in the lower Colorado River Valley. Pp. 23-24 *in* R.R. Johnson and D.A. Jones, technical coordinators, Importance, preservation and management of riparian habitat: A symposium. USDA Forest Service General Technical report RM-43. Rocky Mountain Forest and Range Experiment Station. Fort Collins, Colorado.

Anderson, B.W., R.D. Ohmart, and J. Rice. 1983. Avian and vegetation community structure and their seasonal relationships in the lower Colorado River Valley. Condor 85:392-405.

Anderson, B.W. and R.D. Ohmart. 1993. The development of an Arizona riparian habitat evaluation model with wildlife values. Submitted to Arizona Game and Fish Department. Contract No. G30025-B. Phoenix, Arizona. 34pp.

Arizona Game and Fish Department. 1992. Special status bats of southwestern Arizona (workshop manual). AGFD Phoenix, Arizona.

Arizona Game and Fish Department. 1996. Cactus ferruginous pygmy-owl surveys and nest monitoring in the Tucson Basin, Arizona 1996. AGFD. 35 pp.

Arizona Game and Fish Department. 1996a. Wildlife of special concern in Arizona (draft). Arizona Game and Fish Department. Phoenix, Arizona. 40 pp.

Arizona Riparian Council. 1994. Riparian. Fact Sheet Number 1.

Bagley, B.E. 1991. The updated status of the Sonoran topminnow (*Poeciliopsis occidentalis*) and desert pupfish (*Cyprinodon macularius*) in Arizona. Proceedings of the Desert fishes Council XXI:231 (abstract).

Barber, W.E., and W.L. Minckley. 1966. Fishes of Aravaipa Creek, Graham and Pinal counties, Arizona. The Southwestern Naturalist 11:313-324.

Barber, W.E., and W.L. Minckley. 1983. Feeding ecology of a southwestern cyprinid fish, the spikedace, *Meda fulgida* Girard. The Southwestern Naturalist 28:33-40.

Barber, W.E., D.C. Williams, and W.L. Minckley. 1970. Biology of the Gila spikedace, *Meda fulgida*, in Arizona. Copeia 1970:9-18.

Barrett, S. L. 1990. Home range and habitat of the desert tortoise (*Xerobates agassizii*) in the Picacho Mountains of Arizona. Herpetologica 46:202-206.

Barrett, S.L and T.B. Johnson. 1990. Status summary for the desert tortoise in the Sonoran desert. Unpublished report to the U.S. Fish and Wildlife Service, Albuquerque, New Mexico. 115 pp.

Bestgen, K.R., D.L. Propst, and C.W. Painter. 1985. Transport ecology of larval fishes in the Gila River, New Mexico. Proceedings of the Desert Fishes Council XVII:174 (abstract).

Bettaso, R.H., D.B. Dorum, and K.L. Young. 1995. Results of the 1992-1994 Aravaipa Creek fish monitoring project. Nongame and Endangered Wildlife Program Technical Report 73, Arizona Game and Fish Department, Phoenix.

Brandt, H. 1951. Arizona and its bird life. The Bird Research Foundation. Cleveland, OH. 723 pp.

Bronitsky, Gordon, and James D. Merritt 1986 The Archaeology of Southeast Arizona: A Class I Cultural Resource Inventory. Bureau of Land Management Cultural Resources Series Monograph 2. Phoenix: Arizona State Office, Bureau of Land Management.

Brown, D.E. 1982. Biotic communities of the American Southwest-United Statesand Mexico. Desert Plants Vol. 4, Numbers 1-4. University of Arizona. Tucson, Arizona 342pp.

Brown, M. and F.A. Abarca. 1992. An Update Status Report of the Sonoran Topminnow (*Poeciliopsis occidentalis*) and Desert Pupfish (*Cyprinodon macularius*) in Arizona. Arizona Game and Fish Department. Phoenix, Az. 39 Pp.

Clarkson, R.W. 1998. Results of fish monitoring of selected waters of the Gila River Basin, 1995-1996. Final Report to U.S. Fish and Wildlife Service and Arizona Game and Fish Department. U.S. Bureau of Reclamation, Phoenix, Az.

Clarkson, R.W., and J.C. Rorabaugh. 1989. Status of leopard frogs (*Rana pipiens* complex: Ranidae) in Arizona and southeastern California. The Southwestern Naturalist 34:531-538.

Clarkson, R.W., and W.L. Minckley. 1988. Morphology and foods of Arizona catostomid fishes: *Catostomus insignis*, *Pantosteus clarki*, and their putative hybrids. Copeia 1988:422-433.

Conway, C.J., W.R. Eddleman, S.H. Anderson and L.R. Haneburry. 1993.Seasonal changes in Yuma clapper rail vocalizations rate and habitat use. Journal of Wildlife Management 57(2): 282-290.

Doelle, William H. 1990a "San Pedro River Prehistory." Archaeology in Tucson 4(1):1-3.

Doelle, William H. 1990b "San Pedro Survey Continues." Archaeology in Tucson 4(3):6.

Doelle, William H. 1995 "The Centuries before Coronado: The Classic Period on the San Pedro River." Archaeology in Tucson 9(2):1-6.

Douglas, M.E., P.C. Marsh, and W.L. Minckley. 1994. Indigenous fishes of western North American and the hypothesis of competitive displacement: *Meda fulgida* (Cyprinidae) as a case study. Copeia 1994:365-372.

Eddleman, W.R. 1989. Biology of the Yuma clapper rail in the southwestern U.S. and northwestern Mexico. USBR. IA No.4-AA-30-020060. 127 pp.

Fish and Wildlife Service. 1984. American peregrine falcon recovery plan (Rocky Mountain/Southwest Population). Prepared in cooperation with American peregrine falcon recovery team. Fish and Wildlife Service. Denver, Colorado. 105 pp.

Fish and Wildlife Service. 1991. Endangered and threatened species of Arizona summer 1991. Fish and Wildlife Service. Arizona State Office. Phoenix, Arizona. 106 pp.

Fish and Wildlife Service. 1995. Endangered and threatened wildlife and plants; Final rule determining endangered status for the southwestern willow flycatcher. Federal Register Vol. 60., No. 38: 10694-10715

Frost, J.S., and J. E. Platz. 1983. Comparative assessment of modes of reproductive isolation among four species of leopard frogs (*Rana pipiens* complex). Evolution 37:66-78.

Gaines, D. 1974. Review of the status of the yellow-billed cuckoo in California: Sacramento Valley population. Condor 76:204-209.

Gilman, P. and B. Richards. 1975. An Archaeological Survey in Aravaipa Canyon Primitive Area. Arizona State Museum Archaeological Series 77. Tucson: The University of Arizona.

Hendrickson, D.A., and J.E. Brooks. 1991. Transplanting short-live fishes in North American deserts: review, assessment, and recommendations. Pages 283-298 *in*: W.L. Minckley and J.E. Deacon, editors. Battle Against Extinction: Native Fish Management in the American West. The University of Arizona Press, Tucson.

Hoffmeister, D.F. 1986. Mammals of Arizona. University of Arizona Press. Tucson, Arizona. 602 pp.

Johnson, R., H.Yard and B.Brown. 1997. Lucy's Warbler (*Vermivora luciae*) *in* the Birds of North America. L No. 318, (A.Poole and F.Gill, Eds). The Academy of Natural Sciences of Philadelphia. The American Ornithologists' Union. Washington, D.C. 20 pp.

Kepner, W.G. 1982. Reproductive biology of longfin dace (*Agosia chrysogaster*) in a Sonoran Desert stream. Unpublished Master's Thesis, Arizona State University, Tempe.

Laymon, S.A. and M.D. Halterman. 1989. A proposed habitat management plan for yellow-billed cuckoos in California *in* Proceedings of the California Riparian Systems Conference September 22-24: Davis, CA. General Technical Report PSW-110. Berkeley, CA. USDA Forest Service, Pacific Southwest Forest Range Experiment Station. 544 pp.

MacArthur, R.H. and J.W. MacArthur. 1961. On bird species diversity. Ecology 42:594-598.

Marsh, P.C. 1997. Status of loach minnow in the Black River drainage, Arizona. Final Report to Bureau of Reclamation, Phoenix, Arizona. Federal Grant No. 6-FG-32-00710. Arizona State University Center for Environmental Studies, Tempe.

Marsh, P.C., J.E. Brooks, D.A. Hendrickson, and W.L. Minckley. 1990. Fishes of Eagle Creek, Arizona, with records for threatened spikedace and loach minnow (Cyprinidae). Journal of the Arizona-Nevada Academy of Science 23:107-116.

Marsh, P.C., and W.L. Minckley. 1990. Management of endangered Sonoran topminnow at Bylas Springs, Arizona: description, critique, and recommendations. Great Basin Naturalist 50:265-272.

Masse, W. Bruce 1980. The Hohokam of the Lower San Pedro Valley and the Northern Papagueria: Continuity and Variability in Two Regional Populations. *In* "Current issues in Hohokam Prehistory," pgs. 205-223. Arizona State University Anthropological Research Papers No. 23. Tempe: Arizona State University.

Masse, W. Bruce 1981. A Reappraisal of the Protohistoric Sobaipuri Indians of Southeastern Arizona. *In* "The Protohistoric Period in the North American Southwest, AD 1450-1700," pgs. 28-56. Arizona State University Anthropological Research Papers No. 24. Tempe: Arizona State University.

Meffe, G.K., D.A. Hendrickson, and W.L. Minckley. 1983. Factors resulting in decline of the endangered Sonoran topminnow *Poeciliopsis occidentalis* (Atheriniformes: Poeciliidae) in the United States. Biological Conservation 25:135-159.

Milsap, B.A. and R.R. Johnson. 1988. Ferruginous pygmy-owl. Pages 137-139 in R.L. Glinski et al. (Eds.) Proceedings of the southwestern raptor management symposium and workshop. National Wildlife Federation. Washington D.C. 395 pp.

Minckley, W.L. 1973. Fishes of Arizona. Arizona Game and Fish Department, Phoenix.

Minckley, W.L. 1981. Ecological studies of Aravaipa Creek, central Arizona, relative to past, present, and future uses. Final Report to U.S. Bureau of Land Management, Safford District Office, Arizona, Contract No. YA-512-CT6-98. 362 pages.

Minckley, W.L., and W.E. Barber. 1971. Some aspects of the biology of the longfin dace, a cyprinid fish characteristic of streams in the Sonoran Desert. The Southwestern Naturalist 15:459-464.

Minckley, W.L., and J.E. Deacon. 1968. Southwestern fishes and the enigma of "endangered species." Science 159:1424-1433.

Minckley, W.L., and G.K. Meffe. 1987. Differential selection for native fishes by flooding in streams of the arid American Southwest. Pages 93-104 *in* W.J. Matthews and D.C. Heins, editors. Ecology and Evolution of North American Stream Fish Communities. University of Oklahoma Press, Norman.

Muiznieks, B.D., T.E. Corman, S.J. Sferra, M.K. Sogge, and T.J. Tibbitts. 1994. Arizona Partners in Flight 1993 southwestern willow flycatcher survey. Nongame and Endangered Wildlife Program Technical Report 52. AGFD. Phoenix, Arizona

Ohmart, R.D. and B.W. Anderson. 1986. *in* A.Y. Cooperrider, R.J. Boyd and H.R. Stuart (ed). Inventory and Monitoring of Wildlife Habitat. USDI. BLM Service Center. Denver, Colorado 858 pp.

Phillips, A.R., J. Marshall, and G. Monson. 1964. The birds of Arizona. University of Arizona Press, Tucson, Arizona. 212 pp.

Platz, J.E., R.W. Clarkson, J.C. Rorabaugh, and D.M. Hillis. 1990. Rana berlandieri: recently introduced populations in Arizona and southeastern California. Copeia 1990:324-333.

Platz, J.E., and J.S. Frost. 1984. *Rana yavapaiensis*, a new species of leopard frog (*Rana pipiens* complex). Copeia 1984:940-948.

Platz, J.E., and J.S. Mecham. 1979. *Rana chiricahuensis*, a new species of leopard frog (*Rana pipiens* complex) from Arizona. Copeia 1979:383-390.

Rea, Amadeo. 1983. Once a River. University of Arizona Press. Tucson, Arizona. 285 pp.

Rinne, J.N. 1989. Physical habitat use by loach minnow, *Tiaroga cobitis* (Pisces: Cyprinidae), in southwestern desert streams. The Southwestern Naturalist 34:109-117.

Rinne, J.N. 1991. Habitat use by spikedace, *Meda fulgida* (Pisces: Cyprinidae) in southwestern streams with reference to probable habitat competition by red shiner, Notropis lutrensis (Pisces: Cyprinidae). The Southwestern Naturalist 36:7-13.

Rinne, J.N. 1992. Physical habitat utilization of fish in a Sonoran Desert stream, Arizona, southwestern United States. Ecology of Freshwater Fish 1:35-41.

Robinson, A.T., R.W. Clarkson, and R.E. Forest. In Press. Dispersal of larval fishes in a regulated river tributary. Transactions of the American Fisheries Society 127.

Rosen, P.C., and C.R. Schwalbe. 1988. Status of the Mexican and narrow-headed garter snakes (*Thamnophis euqes megalops* and *Thamnophis rufipunctatus rufipunctatus*) in Arizona. Final Report to U.S. Fish and Wildlife Service, Albuquerque, New Mexico. Arizona Game and Fish Department, Phoenix.

Rosen, P.C., C.R. Schwalbe, D.A. Parizek, Jr., P.A. Holm, and C.H. Lowe. 1995. Introduced aquatic vertebrates in the Chiricahua region: effects on declining native ranid frogs. USDA Forest Service General Technical Report RM-GTR-264:251-261.

Rosenberg, K.V., R.D. Ohmart, W.C. Hunter, and B.W. Anderson. 1991. Birds of the Lower Colorado River Valley. University of Arizona Press, Tucson, Arizona. 416 pp.

Schrieber, D.C. 1978. Feeding interrelationships of fishes of Aravaipa Creek, Arizona. Unpublished Master's Thesis, Arizona State University, Tempe.

Schrieber, D.C., and W.L. Minckley. 1981. Feeding interrelationships of native fishes in a Sonoran Desert stream. Great Basin Naturalist 41:409-426.

Sferra, S.J., R.A. Meyer, T.E. Corman. 1995. Arizona Partners in Flight 1994 southwestern willow flycatcher survey. Nongame and Endangered Wildlife Program Technical Report 69. AGFD. Phoenix, Arizona

Sferra, S.J., T.E. Corman, C.E. Paradzick, J.W.Rourke, J.A. Spencer, and M.W. Sumner. Arizona Partners in Flight southwestern willow flycatcher survey 1993-1996 Summary Report. 1997. Nongame and Endangered Wildlife Program Technical Report 113. AGFD. Phoenix, Arizona

Siebert, D.J. 1980. Movements of fish in Aravaipa Creek, Arizona. Unpublished Master's Thesis, Arizona State University, Tempe.

Spencer, J.A., S.J. Sferra, T.E. Corman, J.W.Rourke, M.W. Sumner. Arizona Partners in Flight 1995 southwestern willow flycatcher survey. 1996. Nongame and Endangered Wildlife Program Technical Report 97. AGFD. Phoenix, Arizona.

Stebbins, R.C. 1985. A field guide to western reptiles and amphibians. Houghton Mifflin Company, Boston, Massachusetts.

Stefferud, S.E. 1984. Sonoran topminnow (Gila and Yaqui) recovery plan. U.S. Fish and Wildlife Service, Region 2, Albuquerque, NM. 67 pages.

Terres, J.K. 1991. Encyclopedia of North American birds. Wings Books. New York, New York. 1109 pp.

Tibbitts, T.J., M.K. Sogge and S.J. Sferra. 1994. A survey protocol for the southwestern willow flycatcher (*Empidonax traillii extimus*). Technical report NPS/NAUCPRS/NTRT-94-04. Flagstaff, Arizona. 24 pp.

Todd R.L. 1986. A saltwater marsh hen in Arizona: a history of the Yuma clapper rail (Rallus longirostris yumanensis). Arizona Game and Fish Dept., Fed. Aid Proj. W-95-R. Completion Rept. 290 pp.

U.S. Fish and Wildlife Service. 1990a. Loach Minnow Recovery Plan. Albuquerque, New Mexico. 38 pp.

U.S. Fish and Wildlife Service. 1990b. Spikedace Recovery Plan. Albuquerque, New Mexico. 38 pp.

Velasco, A.L. 1997. Fish population response to variance in stream discharge, Aravaipa Creek, Arizona. Unpublished Master's Thesis, Arizona Statue University, Tempe.

Vives, S.P., and W.L. Minckley. 1990. Autumn spawning and other reproductive notes on loach minnow, a threatened cyprinid fish of the American southwest. The Southwestern Naturalist 35:451-454.

Williams, C.M. 1991. Fish movement relative to physical environment in a Sonoran Desert stream. Unpublished Master's Thesis, Arizona State University, Tempe.

APPENDIX A. BIOLOGICAL OPINION

United States Department of the Interior

FISH AND WILDLIFE SERVICE
P.O. Box 1306
Albuquerque, New Mexico 87103

In Reply Refer To:
R2/ES-SE
2-21-90-F-119

APR 29 1994

MEMORANDUM

To: Regional Director, Bureau of Reclamation, Boulder City, Nevada

From: Regional Director, Region 2

Subject: Final Biological Opinion on the Transportation and Delivery of Central Arizona Project Water to the Gila River Basin (Hassayampa, Agua Fria, Salt, Verde, San Pedro, middle and upper Gila Rivers, and associated tributaries) in Arizona and New Mexico

Attached is the Fish and Wildlife Service's final biological opinion on the subject formal consultation under section 7 of the Endangered Species Act of 1973, as amended. This opinion finds that the action would jeopardize the continued existence of the spikedace (Meda fulgida), loach minnow (Tiaroga cobitis), Gila topminnow (Poeciliopsis occidentalis), and razorback sucker (Xyrauchen texanus) and would adversely modify the critical habitat of the spikedace, loach minnow, and razorback sucker. The reasonable and prudent alternative given in this opinion is the product of over 3 years' of negotiation between the Fish and Wildlife Service and the Bureau of Reclamation (BR). We appreciate the efforts of BR to finding a way to conserve the listed species and look forward to working with you on implementation of this opinion. If we can be of further assistance, please contact Sally Stefferud or Tom Gatz in the Arizona Ecological Service State Office, at (602) 379-4720.

John G. Rogers

Attachment

cc:
Project Manager, Bureau of Reclamation, Phoenix, AZ
Director, U.S. Fish and Wildlife Service, Washington, D.C. (DES)
State Supervisors, Ecological Services State Offices, Arizona and New Mexico
Project Leader, U.S. Fish and Wildlife Service, Pinetop, AZ
Assistant Regional Director - Endangered Species, Region 2

2-21-90-F-119

SUMMARY
BIOLOGICAL OPINION ON TRANSPORTATION AND DELIVERY OF
CENTRAL ARIZONA PROJECT WATER TO THE GILA RIVER BASIN
IN ARIZONA AND NEW MEXICO

Date of the opinion: April 15, 1994

Action agency: Bureau of Reclamation

Project: Transportation and delivery of Colorado River water through the Central Arizona Project (CAP) to various water users in the Gila River basin (excluding the Santa Cruz River subbasin). This biological opinion addresses only the potential of this project to introduce and spread non-native aquatic species. The Santa Cruz subbasin will be the subject of additional formal consultation.

Listed species and critical habitats: Spikedace (Meda fulgida), loach minnow (Tiaroga cobitis), Gila topminnow (Poeciliopsis occidentalis occidentalis), razorback sucker (Xyrauchen texanus), desert pupfish (Cyprinodon macularius), Colorado River squawfish (Ptychocheilus lucius), and bald eagle (Haliaeetus leucocephalus). Critical habitats for spikedace, loach minnow, and razorback sucker.

Biological opinion: Jeopardy for spikedace, loach minnow, Gila topminnow, and razorback sucker. Adverse modification of critical habitat for spikedace, loach minnow, and razorback sucker. (page 1)

Reasonable and prudent alternative (RPA): Implementation of the RPA is *necessary to remove the threat of jeopardy* from the proposed action. Construction of 4 drop-structure barriers (2 on Aravaipa Creek, 2 on San Pedro River), continued operation of 3 existing electrical barriers on canals, monitoring of non-native fish in specific areas of middle Gila basin and canals, transfer of $500,000 annually to FWS for conservation of Gila basin native fishes and research and non-native fish control, development and implementation of an information and education program about the adverse effects of non-native fish. (pages 26 to 29)

Incidental take statement:

Level of take anticipated: Anticipated take is unquantifiable, but will be assumed to have been exceeded if proposed action, as modified by RPA, is altered or not carried out. If the anticipated incidental take is exceeded, consultation must be reinitiated. (pages 29-30)

Reasonable and prudent measures and terms and conditions: Implementation of the RPA. Terms and conditions are *mandatory requirements*. (page 30)

Conservation recommendations: Implementation of conservation recommendations is *discretionary*. Construction of 4 drop-structure barriers, encouraging dry-up of CAP connected irrigation canals and other features and management of non-native fishes in those not appropriate for dry-up, organization and facilitation of multi-agency efforts to address conflicts between sport fishing and native fish conservation, and opposition to introduction of additional non-native aquatic species in the lower Colorado River basin. (page 31)

Additional section 7 consultation needs: Further consultation will be required for effects the Santa Cruz River basin (excluding the Santa Rosa Canal system.

2-21-90-F-119

U.S. FISH AND WILDLIFE SERVICE
ENDANGERED SPECIES ACT SECTION 7 BIOLOGICAL OPINION

TRANSPORTATION AND DELIVERY OF CENTRAL ARIZONA PROJECT WATER TO THE GILA RIVER BASIN (HASSAYAMPA, AGUA FRIA, SALT, VERDE, SAN PEDRO, MIDDLE AND UPPER GILA RIVERS AND ASSOCIATED TRIBUTARIES) IN ARIZONA AND NEW MEXICO

April 15, 1994

This biological opinion has been prepared in response to the February 12, 1991, request by the Bureau of Reclamation (BR) for formal consultation with the Fish and Wildlife Service (FWS) pursuant to section 7 of the Endangered Species Act (Act) of 1973, as amended, on the proposal to provide Central Arizona Project (CAP) water to Indian and non-Indian water users in central Arizona. For the purposes of this consultation, the Gila River basin does not include the Santa Cruz River or its tributaries but does include the Santa Rosa Canal system. Formal section 7 consultation on the Santa Cruz River basin will be conducted separately from the rest of the Gila River basin consultation.

The species of concern in this opinion are the threatened spikedace (Meda fulgida) and loach minnow (Tiaroga cobitis); and the endangered Gila topminnow (Poeciliopsis occidentalis occidentalis), desert pupfish (Cyprinodon macularius), Colorado River squawfish (Ptychocheilus lucius), razorback sucker (Xyrauchen texanus), and bald eagle (Haliaeetus leucocephalus). The consultation began on February 12, 1991, the date the BR request was received by the FWS. A draft biological opinion was delivered to BR on May 30, 1991, for review of the technological and economical feasibility of the reasonable and prudent alternative. The consultation was extended six times to allow for development of a complex reasonable and prudent alternative. On March 2, 1994, BR notified the FWS of their acceptance of the reasonable and prudent alternative and requested a final opinion.

The following biological opinion is based on information contained in the biological assessment prepared by the BR, project data from BR, data in our files, and other sources of information.

BIOLOGICAL OPINION

It is the FWS's biological opinion that the proposed delivery of CAP water to water users in central Arizona is likely to jeopardize the continued existence of the threatened spikedace and loach minnow and the endangered Gila topminnow and razorback sucker and is likely to adversely modify the critical habitat of the spikedace, loach minnow, and razorback sucker. It is the FWS's biological opinion that the proposed delivery of CAP water to water users in central Arizona is not likely to jeopardize the continued existence of the endangered desert pupfish, Colorado River squawfish, or bald eagle. This opinion concerns only the transport and delivery of water, not the construction of new facilities to convey the water or the development of new agricultural lands.

BACKGROUND INFORMATION

Species Descriptions

Spikedace

The spikedace was listed as a threatened species on July 1, 1986. Critical habitat was designated for the spikedace on March 8, 1994, and includes portions of the Verde and Gila Rivers and Aravaipa Creek. The spikedace is a small silvery fish, with the common name alluding to the well-developed spine on the dorsal fin (Minckley 1973). Spikedace originally existed throughout much of the Gila River drainage above Phoenix, but is currently known only from Aravaipa Creek (Graham and Pinal Counties, Arizona), the upper Gila River (Grant and Catron Counties, New Mexico), the Verde River (Yavapai County, Arizona), and Eagle Creek (Greenlee County, Arizona). A recent record of the spikedace also exists from the middle Gila River upstream from Ashurst-Hayden Dam (USDI BR 1992). Habitat destruction and competition and predation from introduced non-native fish species are the primary causes of the species' decline (Propst et al. 1986, Rinne 1991).

Loach Minnow

The loach minnow was listed as threatened on October 28, 1986. Critical habitat was designated for the loach minnow on March 8, 1994, and includes portions of the Gila, San Francisco, Blue and Tularosa Rivers and Aravaipa, Campbell Blue, and Dry Blue Creeks. A small, elongated fish, the loach minnow is olive-colored with small white or orange spots at the base of the dorsal and caudal fins (Minckley 1973). Loach minnow were once common in the Gila River above Phoenix but are now found in only six locations: Aravaipa Creek (Graham and Pinal Counties, Arizona), upper Gila, San Francisco and Tularosa Rivers (Catron and Grant Counties, New Mexico), the White River (Navajo and Gila Counties, Arizona) and the Blue River (Greenlee County, Arizona). Habitat destruction and competition and predation from introduced non-native fish species are the primary causes of the species' decline (Propst et al. 1988, Propst and Bestgen 1991).

Gila Topminnow

The Gila topminnow was listed as endangered on March 11, 1967. No critical habitat has been designated for this species. The Gila topminnow is a small, livebearing fish found in the Gila, Sonora, and de la Concepcion River drainages in Arizona, New Mexico, and Sonora, Mexico (Minckley 1973, Vrijenhoek et al. 1985). It was once among the most common species of the Gila River and its tributaries (Hubbs and Miller 1941). Destruction and alteration of its habitat plus competition with and predation by non-native fish species have resulted in extirpation of the Gila topminnow throughout most of its range (USDI FWS 1984, Meffe et al. 1983). Nine naturally occurring populations of Gila topminnow remain, all but one located in the Santa Cruz River basin. One naturally occurring population is found in three small adjacent spring systems just off the Gila River on the San Carlos Indian Reservation near Bylas, Graham County, Arizona. Stocked populations of Gila topminnow are found throughout the Gila River basin in Arizona, primarily in isolated springs and spatially intermittent streams.

Desert Pupfish

The desert pupfish was listed as endangered on March 31, 1986. Critical habitat for this species was designated at Quitobaquito Spring, Organ Pipe Cactus National Monument, Pima County, Arizona, and at three locations in Imperial County, California. The desert pupfish is a small fish historically

common throughout much of the lower Gila, lower Colorado, and Sonoyta River systems in Arizona, California, and Sonora, Mexico (Minckley 1973). Decline of the desert pupfish is due to destruction and alteration of its habitat and introduction of predatory and competitive non-native fishes. Natural populations of desert pupfish now exist in three Imperial County, California locations; Quitobaquito Spring, Pima County, Arizona; Rio Sonoyta, Sonora, Mexico, and scattered sites in the lower Colorado River delta in Baja California and Sonora, Mexico (Black 1980, Miller and Fuiman 1987, Schoenherr 1988, Hendrickson and Varela-Romero 1989). Stocked populations of the desert pupfish are found in isolated springs and spatially intermittent streams scattered throughout the Gila River basin in Arizona and the Salton basin in California.

Razorback Sucker

The razorback sucker was listed as endangered on October 23, 1991. Critical habitat was designated for this species on March 21, 1994. Within the Gila River basin, the critical habitat includes portions of the Verde, Gila, and Salt Rivers. The razorback sucker grows to over two feet in length and has a distinctive abrupt, sharp-edged, dorsal ridge behind the head (Minckley 1973). It was once common throughout the Colorado River basin, but now exists sporadically in only about 750 miles of the upper basin. In the lower basin a substantial population exists only in Lake Mohave, but they do occur upstream in Lake Mead and the Grand Canyon and downstream sporadically on the mainstem and associated impoundments and canals (USDI FWS 1991a). Habitat alteration and destruction, along with competition and predation from introduced non-native fish species, are responsible for the species' decline (Marsh and Brooks 1989, Bestgen 1990). Razorback suckers have been stocked into numerous locations in the Gila, Salt, and Verde River basins in a attempt to recover the species.

Colorado Squawfish

The Colorado squawfish was listed as endangered on March 11, 1967. No critical habitat has been designated for this species. On July 24, 1985, the Salt River from Roosevelt Dam upstream to U.S. Highway 60 bridge, and the Verde River from Horseshoe Dam upstream to Perkinsville were designated as locations for experimental, non-essential populations of Colorado squawfish. Those areas were subsequently stocked with that species. The Colorado squawfish is a large, silvery minnow which grows up to six feet long (Minckley 1973). It was once common throughout the Colorado River system, including the Gila River basin, but natural populations are now found only in scattered areas of the upper Colorado River system in Utah, Colorado, and New Mexico (USDI FWS 1991b). The decline of the species is due to habitat alteration and destruction and to introduction of predacious and competitive non-native fish (USDI FWS 1991b).

Bald Eagle

The bald eagle was listed as endangered on March 11, 1967, and no critical habitat has been designated for this species. The desert-nesting population of this large, fish-eating eagle breeds earlier than its more northern-dwelling counterparts. Loss of riparian forests, some of the impacts created by reservoirs, and drying of rivers contributed to the decline of this species. Bioaccumulation of pesticides and other toxic substances adversely affected reproduction. Currently, bald eagles nest along the Bill Williams, Agua Fria, Verde, Salt, and Gila Rivers and their tributaries in central Arizona.

Project Description

The CAP was constructed to provide a long term, non-groundwater, water source for municipal, industrial, and non-Indian and Indian agricultural users in Arizona. The water provided through the CAP aqueduct system represents Arizona's allocation of the flow of the Colorado River. The water is taken from the Colorado River at Lake Havasu and is conveyed across the state in a series of large open aqueducts (Figure 1). A storage option for CAP water became available December 1992 following enlargement of Lake Pleasant, an existing reservoir on the Agua Fria River north of Phoenix. Water is pumped into the reservoir when the aqueduct is carrying more than the demand requires and pumped out to make up demands during other times of the year.

The CAP system was declared completed in October of 1993 and its expected project life is 100 years. Water deliveries are currently ongoing to supply agricultural, municipal, and industrial users listed in Tables 1 and 2. Figure 2 shows the general location of the entities receiving water through the CAP.

The issue under discussion in this opinion is the transfer of non-native fish species from the Colorado River and other sources of introduction along the aqueduct system into the waters of the Gila River basin in Arizona and portions of western New Mexico. The CAP aqueduct has been in operation long enough that field collection data support initial hypotheses that fish populations are able to exist in the aqueducts. At present, fish largely originate from Lake Havasu, although reproduction of some species has been documented in the aqueduct and another source of fish became available with storage of CAP water in Lake Pleasant (Grabowski et al. 1984, USDI BR 1987, USDI BR 1988, Matter 1991).

We have identified several tributaries to the Gila River that, because of the proximity to either the CAP aqueduct or users of CAP water, may have the potential for non-native fish species to be introduced to them via the CAP.

Hassayampa River

The Hassayampa River is crossed by the CAP aqueduct approximately 24 miles upstream of its confluence with the Gila River. Several irrigation districts are in the vicinity of the river; the Harquahala Valley and Tonopah, both of which drain to Centennial Wash, and the Buckeye and Roosevelt which are adjacent to the Gila River at and above its confluence with the Hassayampa. The Gila River at the Hassayampa confluence often has water year round due to treated effluent outflows from the Phoenix metropolitan area and irrigation returns from the agricultural fields. The Hassayampa is usually dry throughout the reach of interest, although permanent water is found upstream near Wickenberg.

Agua Fria River

The CAP aqueduct crosses the Aqua Fria downstream of Lake Pleasant's New Waddell Dam. Beginning in December 1992 CAP water has been stored in the Lake Pleasant. Although the Agua Fria is seasonally dry above Lake Pleasant, water flows into the lake occurs over a several month period in winter and spring and monsoon generated flash floods are common summer occurrences. Water is occasionally spilled downstream from Lake Pleasant, such as during the flooding in January-February 1993.

TABLE 1. CENTRAL ARIZONA PROJECT WATER DELIVERIES FOR AGRICULTURAL USES IN 1993.

AG USERS
MONTHLY DELIVERIES
CALENDER YEAR 1993
Table #1

SUBCONTRACT CUSTOMERS	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
CAIDD/CMA →# :	0	436	4,669	8,514	9,094	12,026	14,479	10,590	2,229	386	75	426	63,024
CAIDD/SRD →# :	0	133	2,529	3,200	2,147	3,878	4,721	3,984	204	55	0	321	21,172
CAIDD/SHA →# :	0	143	1,468	1,863	1,504	3,015	2,631	2,136	775	129	15	19	13,698
Chandler Hts → :	0	0	229	69	223	198	204	188	148	0	0	0	1,259
Hohd/CS Ext. → :	0	1,174	4,321	3,005	4,593	7,371	8,927	7,291	445	657	251	1,661	39,705
Hohd/Kleck → :	25	199	619	454	596	485	334	172	22	0	18	200	3,025
MSIDD →# :	0	1,228	22,224	14,204	13,383	20,115	26,255	17,146	1,755	52	104	4,049	120,535
New Magma →# :	0	480	2,808	9,813	7,653	6,823	14,324	13,580	4,535	413	199	0	59,434
Queen Creek →#:	22	346	2,887	4,039	3,956	5,155	6,383	6,162	2,263	154	14	19	31,400
San Tan → :	0	0	265	601	693	607	1,362	744	803	0	0	0	5,276
Toltec → :	0	0	306	1,375	1,489	2,216	2,968	2,311	772	0	0	0	11,037
Sub Total	47	4,139	42,236	43,757	45,331	64,090	82,488	64,304	13,962	1,851	686	6,695	369,586

NON-SUBCONTRACT CUSTOMERS	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
B.K.W. Farms :	0	0	0	0	0	0	0	250	0	0	0	0	250
Cort-Harana → :	0	0	0	0	0	294	1,548	791	17	0	0	0	2,650
Great W. Dajoda:	0	0	0	0	0	0	0	0	0	0	0	0	0
Harq. Valley G :	16	222	1,211	4,203	3,676	4,452	5,427	4,576	1,990	615	85	854	27,329
James M. Jones :	0	0	0	36	39	0	0	0	0	0	0	0	75
MWD :	0	0	0	0	0	0	0	0	0	0	0	0	0
Roosevelt → :	0	0	0	0	0	7,259	8,107	5,482	4,541	0	0	0	25,389
San Carlos IDD :	0	0	0	0	0	0	0	0	0	0	0	0	0
Semilla Farms :	0	0	0	0	0	0	0	0	0	0	0	0	0
Sub Total	16	222	1,211	4,239	3,715	12,005	15,082	12,079	6,548	615	85	854	55,573

INDIANS	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
Ak-Chin Farms :	44	1,876	6,697	9,969	9,908	10,902	12,081	11,152	5,430	4,283	755	2,604	76,701
Gila River Ind.:	0	0	0	0	0	0	0	0	0	0	0	0	0
Sub Total	44	1,876	6,697	9,969	9,908	10,902	12,081	11,152	5,430	4,283	755	2,604	76,701
TOTAL (AG)	109	6,237	50,144	57,965	58,954	86,997	110,651	87,535	25,940	6,749	1,526	10,153	502,960

TABLE 2. CENTRAL ARIZONA PROJECT WATER DELIVERIES FOR MUNICIPAL AND INDUSTRIAL USES IN 1993.

M&I USERS
MONTHLY DELIVERIES
CALENDER YEAR 1993
Table #2

SUBCONTRACT CUSTOMERS	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
Az. Water Co.	0	0	0	0	0	117	137	135	131	135	127	43	825
Carefree	0	0	0	11	30	36	41	32	34	18	0	0	202
Cave Creek	14	10	10	20	19	25	24	38	19	22	18	15	232
Chandler *	117	239	177	12	88	93	63	43	44	135	155	0	1,166
Chaparral	83	99	0	0	69	158	159	164	160	163	154	207	1,416
Eloy	0	6	19	25	25	69	52	44	31	31	10	28	340
Gilbert	0	0	0	0	0	0	0	0	0	0	4	5	9
Glendale	836	275	25	558	548	926	1,088	1,012	991	1,441	569	641	8,916
Maricopa County	8	13	25	47	52	77	72	64	58	35	23	19	493
Mesa	675	570	1,558	1,030	1,568	2,074	2,697	2,360	2,136	1,912	1,841	778	19,247
Phoenix *	7,722	134	782	1,326	4,755	7,375	8,984	9,297	8,835	8,199	5,072	5,488	80,969
Queen Creek	0	0	0	0	0	0	0	0	0	0	6	19	25
Rio Verde *	0	0	0	250	0	0	0	0	0	0	0	0	250
Scottsdale *	1,200	1,170	1,496	1,705	1,892	2,179	2,391	2,296	2,222	2,402	1,891	1,719	22,663
Tempe *	0	0	0	933	0	0	0	0	0	714	780	0	2,427
Tucson	2,786	2,795	4,016	4,755	5,026	5,149	5,228	4,421	4,944	3,423	1,849	1,924	46,315
Sub Total	13,441	5,315	8,118	10,680	14,101	18,280	20,936	17,005	15,605	18,630	12,497	10,886	185,495

NON-SUBCONTRACT CUSTOMERS	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
Ancala	3	6	18	29	53	48	49	33	37	44	16	18	353
C.S. McCrossan	0	5	6	1	4	5	0	0	0	0	0	0	21
Dragoez	0	0	0	0	0	7	4	7	7	0	0	7	32
J.W.J. Contr Co.	0	1	7	12	24	25	1	1	14	15	9	2	112
Mazatzal Farm	0	1	1	2	3	3	4	4	4	3	1	2	28
PCL Civil Const.	0	0	0	0	0	11	11	1	11	4	3	5	46
Picacho School	0	0	0	1	3	6	3	4	0	0	0	0	17
Red Mt. Ranch	2	6	25	42	62	66	68	51	51	75	22	19	491
Sonoran Lnd Grp.	0	0	0	0	0	0	0	0	0	0	0	0	0
Viewpoint	2	2	5	12	19	18	18	12	14	18	5	6	131
Sub Total	7	23	62	98	168	190	156	113	138	159	56	59	1,231
TOTAL (M&I)	13,448	5,338	8,180	10,778	14,269	18,470	21,094	17,119	15,743	18,789	12,553	10,945	186,726
GRAND TOTAL	13,557	11,575	58,324	68,743	73,223	105,467	131,745	104,654	41,603	25,538	14,079	21,098	669,686

* Customer is able to take deliveries thru SRP interconnect.
\# Oct.- Dec deliveries were made to individual farmers under excess contracts.
+ Deliveries may include recharge/exchange water.
@ Oct - Nov deliveries were purchased from Honokam.
! Dec deliveries were made to individual farmers under excess contracts.

FIGURE 1. OVERVIEW OF THE CENTRAL ARIZONA PROJECT.

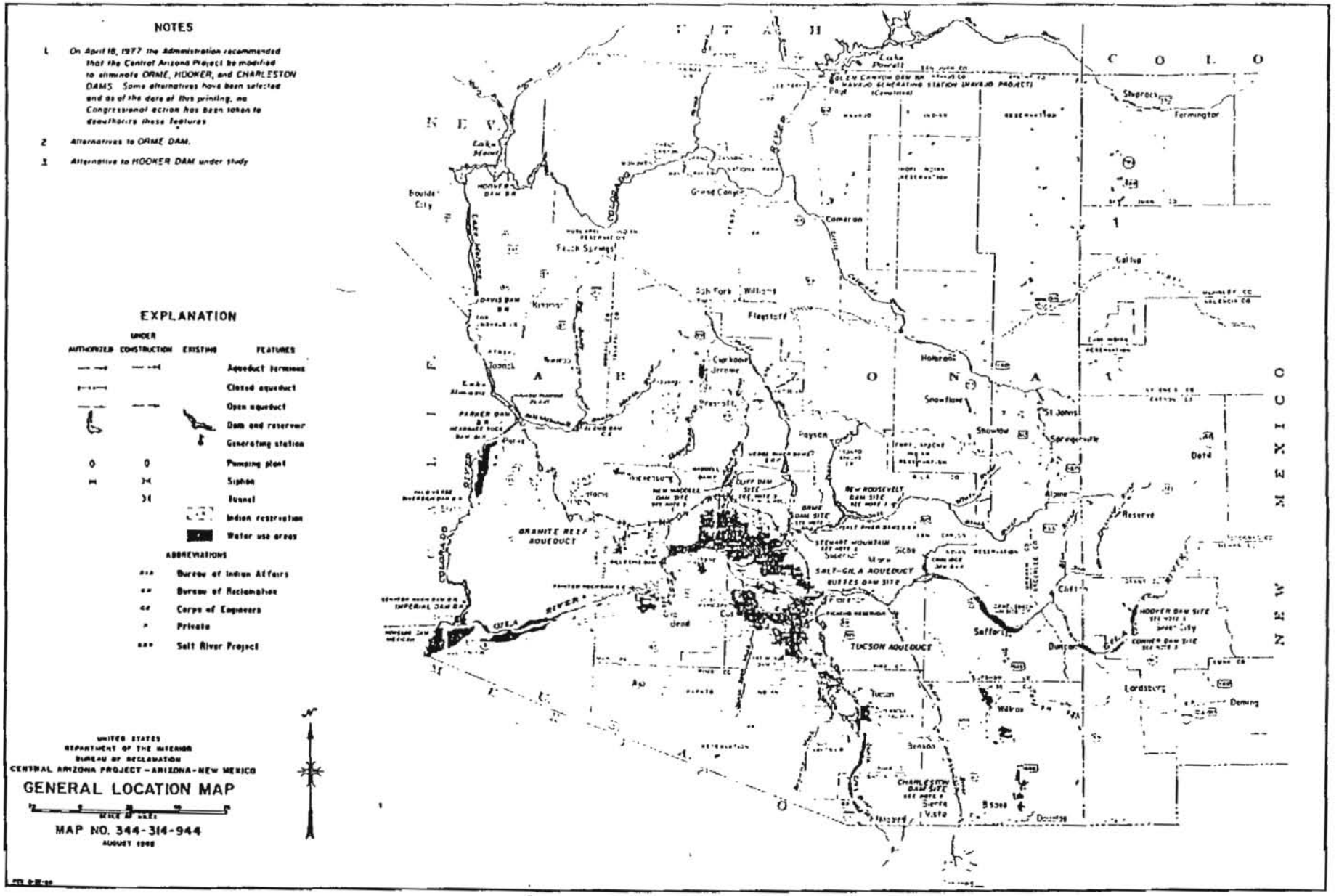
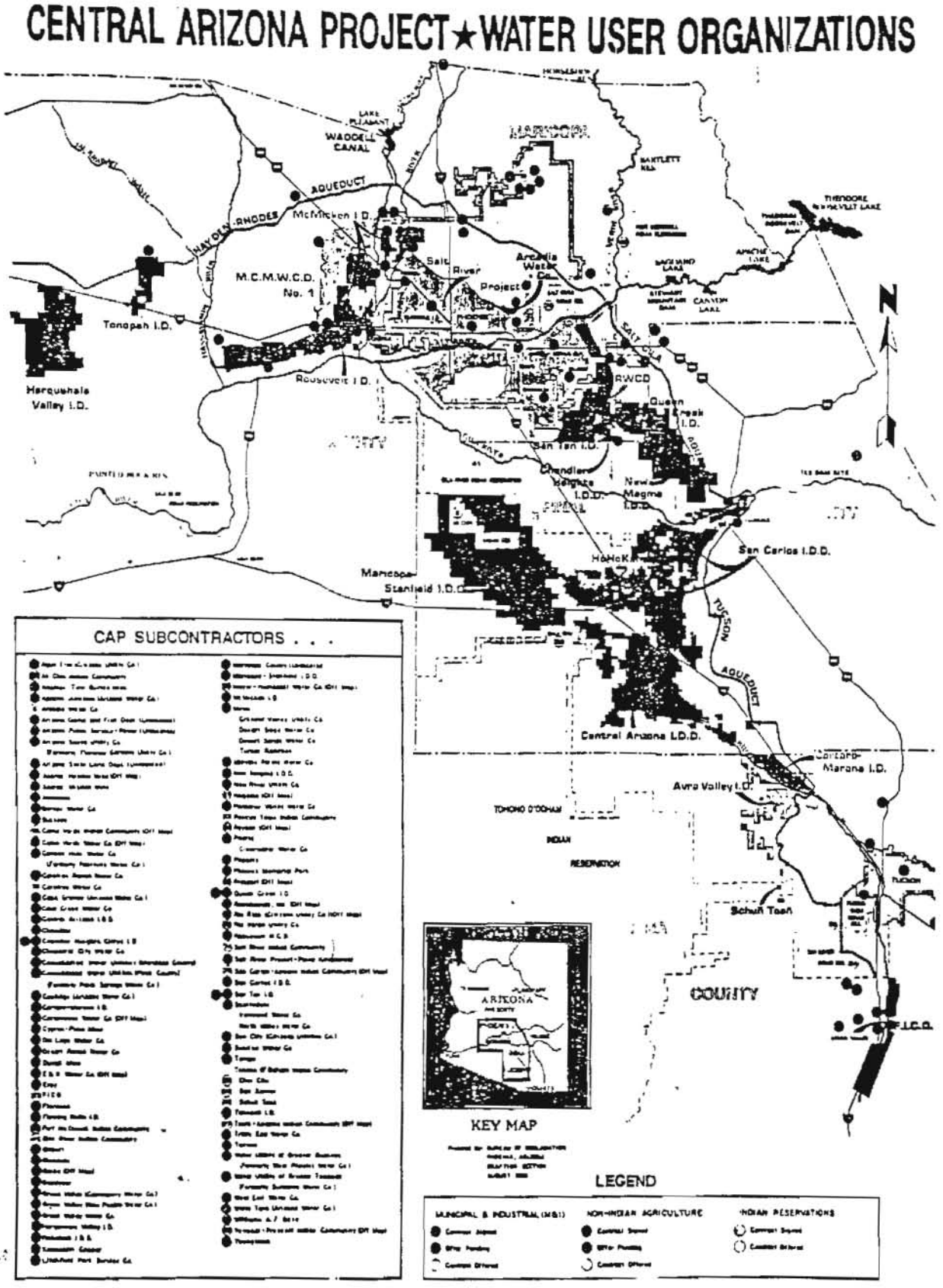


FIGURE 2. LOCATION OF CENTRAL ARIZONA PROJECT WATER USERS IN CENTRAL ARIZONA.



Salt and Verde Rivers

The CAP aqueduct crosses the Salt River below Granite Reef Dam which is below the confluence of the Salt and Verde Rivers.The two major Salt River Project (SRP) canals receive Salt and Verde River water from Granite Reef Dam and the diversion from CAP into those canals is located in the same general area (Figure 3). This water is for both municipal and agricultural uses. There are electric fish barriers on both the SRP canals upstream of the CAP delivery point to deter fish passage upstream into the Salt River above Granite Reef Dam. Upstream of Granite Reef are two large dams on the Verde River and four on the Salt River that provide further deterrence.

Gila River

Water deliveries to the affected area from the CAP will be made from turnouts off the CAP aqueduct to the various irrigation districts and other users. There are 21 CAP water delivery turnouts on the CAP aqueduct between the Salt River siphon in Maricopa County and the Picacho Pumping Plant near Eloy in Pinal County. These turnouts serve water users in the area of the Gila River. Five of the turnouts are in the East Salt River Valley for delivery to primarily municipal water users.

For some of the irrigation districts, the connections to the Gila River channel are limited to return flows from their distribution systems that may reach the river channel, siphon crossings of the canals under the Gila River, or from canals or sumps that are in the 100 to 500 year floodplain of the Gila or smaller tributary streams. Some irrigation districts, such as Maricopa-Stanfield, Hohokam and Central Arizona, do not currently have a surface water source for their crops and use groundwater exclusively.

The presence of CAP water in the canals of the irrigation systems, coupled with the opportunity to reach the channel of the Gila River between its confluence with the Salt River and Ashurst-Hayden Diversion Dam, provides the potential for CAP transferred non-native fish species to move from the CAP to the Gila River channel. Although the Gila River is usually dry throughout this reach, there is water often enough in part or all of the channel to allow for the movement of fish upstream.

In addition to this indirect route, the San Carlos Irrigation Project (SCIP) also has a direct route for the transfer of fish species. Coolidge Dam, on the Gila River upstream of the CAP aqueduct crossing, is a water storage dam that supplies surface water from the Gila River to the two entities that comprise SCIP; the Gila River Indian Community (GRIC) and the San Carlos Irrigation and Drainage District (SCIDD). There are some farmers in SCIDD that are not within the SCIP portion of the district. Figure 4 shows the pertinent physical features of the existing irrigation system. Water is released from Coolidge Dam and flows past the confluence with the San Pedro to the Ashurst-Hayden Diversion Dam approximately 40 miles downstream. There the released flow is diverted south into the Florence-Casa Grande Canal. With the long irrigation season in Arizona, combined with bank storage in the Gila and natural flows from the San Pedro, the Gila River between Coolidge and Ashurst-Hayden Dams is largely perennial. Unless there has been a rainfall event or natural flows exceed the capacity of the Florence-Casa Grande Canal, the Gila River below Ashurst-Hayden is usually dry. In the winter when the SCIP is not irrigating, the inflow from the San Pedro River and runoff from rainfall

FIGURE 3. CENTRAL ARIZONA PROJECT/SALT RIVER PROJECT INTERCONNECTION

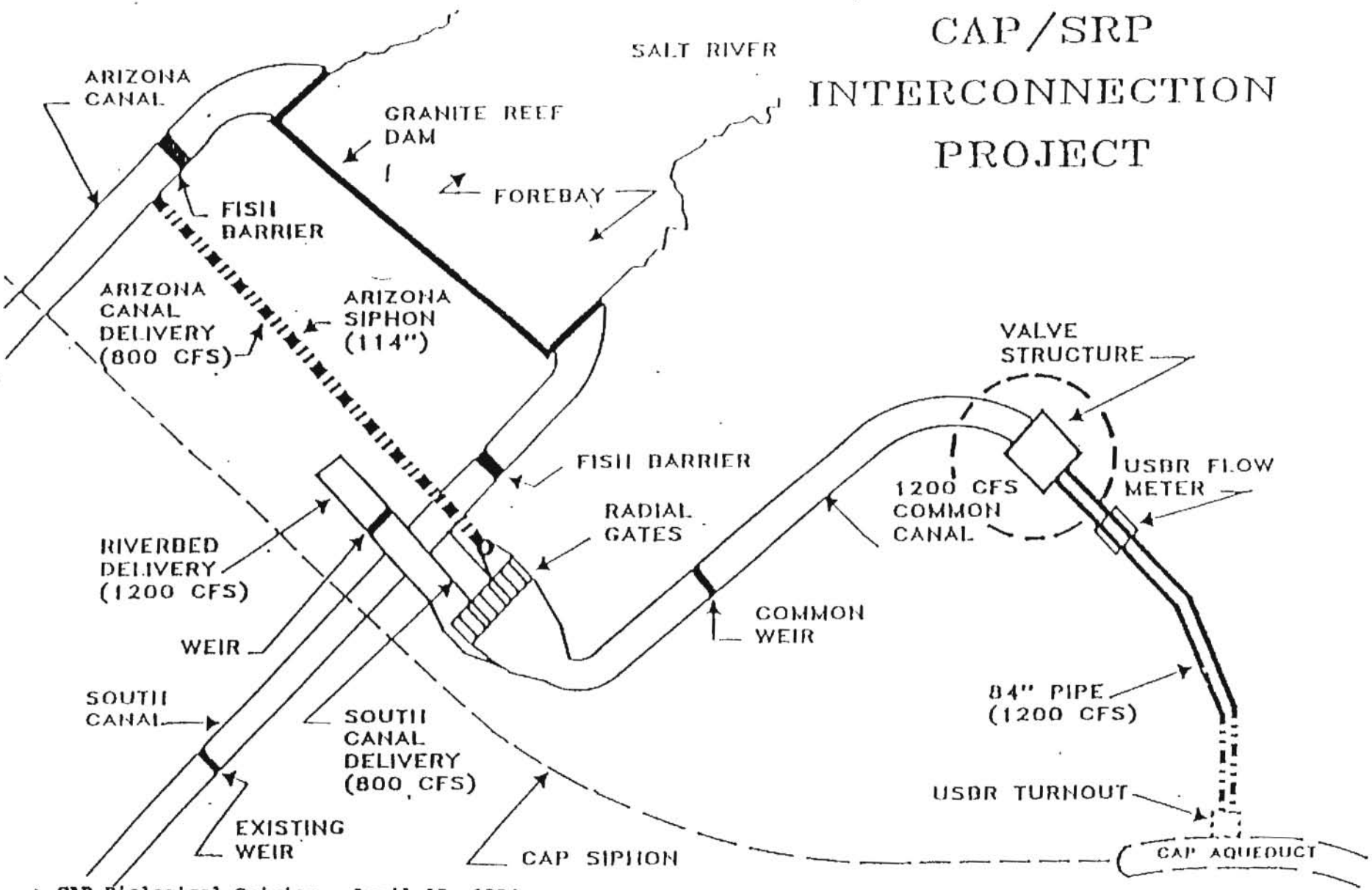
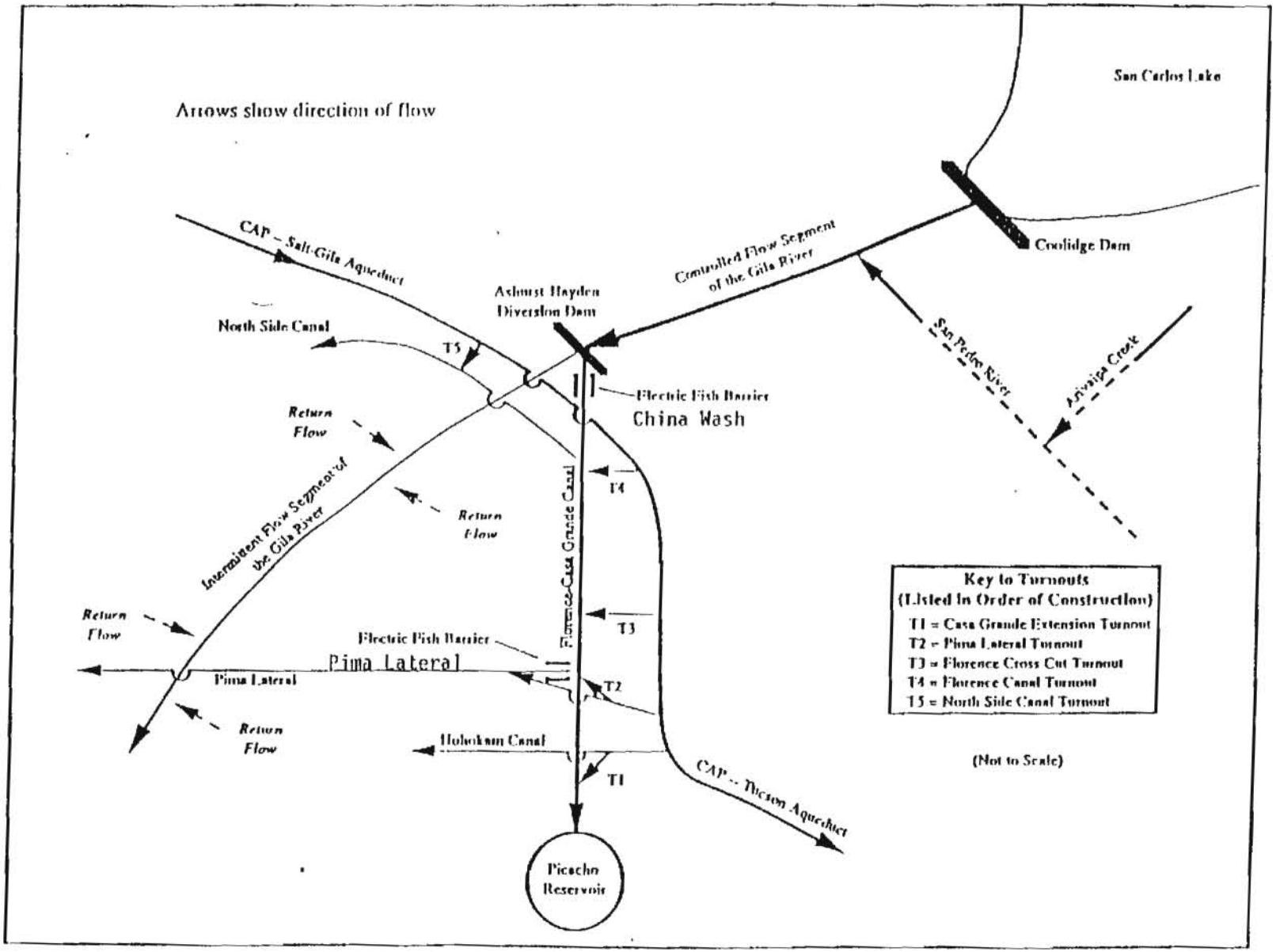


FIGURE 4. SAN CARLOS IRRIGATION PROJECT WATER DELIVERY SYSTEM (Essential Components).



events may result in flow in the Gila River below Ashurst-Hayden since there would be no diversion of flow into the Florence-Casa Grande Canal.

The delivery of CAP water to SCIP is via a series of turnouts to the Florence-Casa Grande Canal to serve SCIDD lands or via the Pima Lateral Feeder Canal to serve GRIC lands. The first of the turnouts, the Pima Lateral Feeder Canal was constructed in 1989 to deliver CAP water into the existing Pima Lateral Canal (which connects to the Florence-Casa Grande Canal) in exchange for GRIC leaving 30,000 acre-feet of their SCIP water in San Carlos Reservoir to provide a minimum pool for the fishery. In 1990, other turnouts were proposed, and some constructed, from the CAP aqueduct and the Florence-Casa Grande Canal to serve SCIDD. There are, then, existing direct water connections from the CAP aqueduct to the Gila River above Ashurst-Hayden Dam via the Florence-Casa Grande Canal. There may also be instances where other irrigation districts canal systems are connected to the SCIDD system, thus providing an additional introduction point for CAP water and fish to reach the Florence-Casa Grande Canal.

Unlike the other irrigation districts in the area, the first water to SCIP entities was in 1990. The GRIC received 47,548 acre-feet of CAP water, up to 30,000 for their SCIP water left in San Carlos Reservoir, and the rest under an interim contract. The SCIDD received 10,301 acre-feet and SCIP as a separate entity received 24,483 acre-feet. In May 1991 an additional 5,020 acre-feet were delivered and no water has been delivered to these entities since that time. To protect against CAP fish introductions, two electric fish barriers were constructed to deter fish from moving upstream beyond the diversion at Ashurst-Hayden. The first was placed on the Pima Lateral to deter fish from accessing the Florence-Casa Grande Canal and was part of the GRIC exchange program. The second was placed on the Florence-Casa Grande Canal at the U.S. Geological Survey gaging station at China Wash, upstream of any CAP turnout to the Florence-Casa Grande Canal.

Summary

The waters conveyed by the CAP can connect both directly, via existing canals and reservoirs, or indirectly, via return flows, to the rivers of the Gila River basin. This connection opens potential conduits for the transfer of non-native species of fish to the lower Gila River basin tributaries and to the middle and upper Gila River basin above Ashurst-Hayden Dam. The Hassayampa, Agua Fria, Salt and Verde Rivers, as tributaries of the Gila, will also enable any fish species introduced into their waters from the CAP to reach the Gila River and eventually move upstream to the base of Ashurst-Hayden. Ashurst-Hayden Dam is not an effective fish barrier for several reasons, both structural and operational, and any fish species that reaches the base of the dam would have the opportunity to move beyond it to the middle Gila and San Pedro Rivers. The presence of the CAP connection creates a perennial waterway from the Colorado River to the major streams of the Gila River basin, connecting rivers and canal systems currently more isolated by dams and intermittent stream reaches.

EFFECTS OF THE ACTION

The introduction and spread of non-native fishes and other aquatic organisms have been identified as major factors in the decline of native fishes throughout North America and particularly in the southwest (Miller 1961, Lachner et al. 1970, Moyle 1976, Courtenay and Stauffer 1984, Williams et al. 1985). Miller et al. (1989) report that non-native species were the second most common causal factor in recent extinctions of North American fishes. Although not always the primary factor, non-native species played a part in 68

percent of the 40 known North American fish taxon extinctions in the past 100 years.

Interbasin water transfers have been implicated in the transfer of species and the fostering of non-native establishment (USDI BR 1990, Meador 1992). Although the CAP does moves water only within the Colorado River basin, it connects two disparate portions of that basin, which presently support different non-native fish faunas. The CAP provides increased access for non-native fish species in the Colorado River and upper basin into the Gila River basin.

In addition to direct transfer of non-native species from the Colorado River, the CAP provides a "highway" for the movement of non-native species within the Gila River basin. Historically, the rivers and streams of the Gila basin were perennially or intermittently connected by surface flow, allowing movement of fish throughout the system. With the advent of European settlement, water development and watershed use severed those connections with dams, reservoirs, and loss of surface flows. Although this fragmentation of their populations was detrimental to the survival of the native Gila basin fishes, it provided some benefits by inhibiting the spread of non-native species. With the completion of the CAP, the Gila basin rivers and streams will be reconnected by surface flow, once again increasing the opportunity for movement of fish throughout the system, this time with non-native species being a major component in the fish community of the basin.

Probabilities on which non-native species will be introduced via CAP and the timing of their introduction cannot be predicted; however, over the 100-year life of the CAP, the probability is high that one or more non-native fish species will use the CAP as an avenue to colonize habitats now occupied by listed fish species, and either alone, or in concert with other species or physical situations, have major adverse consequences to the listed fish. Critical habitats for spikedace and loach minnow in Aravaipa Creek, the upper Gila River, the upper Verde River, and the Blue and San Francisco Rivers will be adversely affected, as will critical habitats for the razorback sucker in the Verde, Salt, and Gila Rivers.

Environmental Baseline

Impact analysis for the proposed project must consider the already seriously deteriorated condition of the aquatic habitats and native fish community of the Gila River basin. Several native fish species have already been extirpated from the basin and others now occupy only limited areas. Of the 14 native fishes that remain in, or have been restocked into the Gila River basin, 86 percent are Federally-listed as endangered or threatened (8 species) or are Federal candidates (4 species). Only 2 species have no special status, although the paperwork is being processed to add both to the candidate list. Minckley and Douglas (1991) believe that the pattern of decline and extinction in western river basins is rapidly moving beyond the loss of individual fish species to a pattern of collapse of entire aquatic faunas.

The decline of the Gila River basin native fish community has resulted primarily from impoundment, diversion, channelization and other manipulations and alterations of the rivers, streams, and watersheds. Impoundments such as San Carlos, Roosevelt, and Horseshoe Reservoirs all directly removed habitat for most native species and modified or dried flows in long stretches downstream. Major portions of the Gila River system now flow only intermittently; e.g., the San Pedro River, the lower Salt River, and the Gila River near Virden, New Mexico, near Safford, Arizona, and below Ashurst-Hayden Dam. Habitat alteration has greatly reduced the complexity of the aquatic system. Alterations to the river system have created new types of habitats

more favorable to non-native species than to native species (Minckley 1983, Bestgen and Propst 1986, Bestgen and Propst 1989, Rinne 1991).

Introduction and spread of non-native fish species has also been a major factor in the decline of the Gila River basin fish community (Minckley and Deacon 1968, Meffe 1985, Minckley 1985, Propst et al. 1986, Propst et al. 1988, Propst and Bestgen 1991, Rinne 1991). The Gila River basin presently supports several non-native fish species. Some of these, such as rainbow trout (Oncorhynchus mykiss) (USDI FWS 1983, Propst et al. 1992), channel catfish (Ictalurus punctatus)(Bestgen and Propst 1989, Marsh and Brooks 1989), mosquitofish (Gambusia affinis) (Meffe et al. 1983, Meffe 1985), and smallmouth bass (Micropterus dolomieui) (Propst et al. 1986), have had substantial adverse impacts to the native fish species. A few, such as fathead minnow (Pimephales promelas), appear to have had little effect upon native fishes.

Thus, the pre-project baseline is a deteriorated system where native fishes persist in isolated stream sections which have not yet undergone sufficient perturbation to cause extirpation of those species. Non-native species already present exert continuing competitive and predatory pressure on native fishes. Fragmentation of aquatic habitats has disrupted historic patterns of recolonization or augmentation of damaged or destroyed native fish populations from intact up-stream or downstream populations. Additional impacts to these systems and the listed fish from the proposed project will be cumulative to the existing baseline. Therefore, project effects are of more consequence to the species than if the baseline was a pristine condition.

Analysis of Effects

1. **Non-native Species Which Might be Introduced Through CAP**

In an attempt to define the extent of the potential problem, the striped bass (Morone saxatilis), white bass (Morone chrysops), blue tilapia (Tilapia aurea), rainbow smelt (Osmerus mordax), and the triploid grass carp (Ctenopharyngodon idella) were identified in early planning for CAP water deliveries as being non-native fish that were likely be transported by CAP and to adversely impact the native fish species of the Gila drainage.

Matter (1991) evaluated the five species for their likelihood of entry and survival in the Gila River above Ashurst-Hayden Dam. These five species are not currently found in the Gila River basin above Ashurst-Hayden, but all are currently found in the Colorado River system. All five are believed to have adverse effects on native southwestern fishes (Taylor et al. 1984; Evans and Loftus 1987; Miller and Fuiman 1987; W.L. Minckley, Arizona State University, pers. com., April 1991).

In addition to those five species, we are also concerned about other non-native fish which already inhabit the Colorado and Gila Rivers and the CAP aqueduct system, or which may at some time be introduced into those systems. Such species fall into three categories: those already known and perhaps established in the Colorado River or CAP systems, but not yet in the middle or upper Gila River basin; those not yet found in the Colorado River system, including the Gila River basin; and those already found throughout most of the Colorado and Gila River basins. The CAP and interconnecting canal systems provide enhanced opportunities for such non-natives to colonize, recolonize, or augment existing populations in the Gila River basin. Because of the size and habitat characteristics of the streams of the Gila River basin, it is likely that the primary threat from non-native fish incursion may come from some of the smaller non-native fish species, rather than the larger species included in Matter's study.

Non-native fishes already known and perhaps established in the Colorado River system, but which have not yet successfully invaded the middle or upper areas of the Gila River basin, include the guppy (Poecilia reticulata), golden shiner (Notemigonus crysoleucas), sailfin molly (Poecilia latipinna), redside shiner (Richardsonius balteatus), and plains killifish (Fundulus zebrinus) (Minckley 1973, Hughes 1981, Haynes et al. 1982) Non-native fishes which have been reported from the CAP and interconnected Salt River Project (SRP) canals include: threadfin shad (Dorosoma petenense), rainbow trout, brook trout (Salvelinus fontinalis), goldfish (Carassius auratus), common carp (Cyprinus carpio), grass carp-bighead carp hybrids (Ctenopharyngodon idella x Aristichthys nobilis), golden shiner, red shiner (Cyprinella lutrensis), beautiful shiner (Cyprinella formosa), fathead minnow, black bullhead (Ameiurus melas), yellow bullhead (Ameiurus natalis), channel catfish, flathead catfish (Pylodictis olivaris), mosquitofish, sailfin molly, guppy, shortfin molly (Poecilia mexicana), swordtail (Xiphophorus variatus), yellow bass (Morone mississippiensis), striped bass, green sunfish (Lepomis cyanellus), bluegill (Lepomis macrochirus), redear sunfish (Lepomis microlophus), convict cichlid (Cichlasoma nigrofasciatum), firemouth cichlid (Cichlasoma meeki), Rio Grande cichlid (Cichlasoma cyanoguttattum), largemouth bass (Micropterus salmoides), black crappie (Pomoxis nigromaculatus), walleye (Stizostedion vitreum), blue tilapia, Mozambique tilapia (Tilapia mossambica), and redbelly tilapia (Tilapia zilli) (Marsh and Minckley 1982, Mueller 1989, Matter 1991). The thriving non-native fish fauna of these canals illustrates their potential as a source from which non-native fish could move into the Gila River system.

Predicting the species of non-native fishes not presently established in the Colorado River system that will be introduced via CAP, and their potential for threat to native species, is, of course, impossible. However, certain groups or species have a higher probability than others of entering that category. Examples of fish species which are expanding their ranges in the United States, either by migration or human transfer, and which have some likelihood of spreading into the Colorado and Gila River systems include the rudd (Scardinius erythrophthalmus), sheepshead minnow (Cyprinodon variegatus), gizzard shad (Dorosoma cepedianum), bigscale logperch (Percina macrolepida), tench (Tinca tinca), silver carp (Hypophthalmichthys molitrix), bighead carp (Aristichthys nobilis), and pacu (Colossoma sp.) (Moyle 1976; Robins et al. 1980; Courtenay et al. 1984; Platania 1990; Howells et al. 1991; J. Brooks, U.S. FWS, Dexter, NM pers. com. April 1991; J. Williams, U.S. FWS, Gainesville, FL, pers. com. April 1991; Univ. of Arizona 1993). A thorough literature search would likely turn up more, most of which can be expected to have some adverse impacts to native fish species. Various aquarium fishes have been documented as causing adverse effects to native southwestern fish species (Courtenay and Deacon 1983, Courtenay et al. 1985, Deacon et al. 1964). Unauthorized dumping of unwanted aquarium fish into canals, springs, and rivers is a continuing source of non-native introductions and is the likely source of a number of the small non-native fishes in the Phoenix-area canals (Lachner et al. 1970, Marsh and Minckley 1982, Williams and Sada 1985, Courtenay and Meffe 1989). It is likely that common aquarium species in the families Poeciliidae, Characidae, Loricariidae, Cobitidae, and Cichlidae would pose threats to most of the small native fishes and to young of the larger natives.

Augmentation, through CAP, of populations of non-native species already introduced into the Gila River basin may increase the adverse effects those species exert on the native fishes. Continuing introduction of additional individuals of a non-native species may help that population reach higher levels and buffer it against the effects of natural events such as flooding and drought. Controlling non-native populations through management becomes

increasingly difficult when the population is continuously augmented from outside.

Although non-native fish are the primary concern in this analysis, the proposed project will also provide an avenue for introduction of other non-native aquatic organisms into the Gila River basin. Various insects, molluscs, crustaceans, plants, and parasitic and disease organisms may be transported into the Gila River basin via the CAP and may have adverse effects on the ecosystem as a whole as well as on the listed fishes specifically. While effects of past non-native invertebrate introductions on native southwestern fishes and invertebrates are poorly documented, such species as the Asian clam (Corbicula manilensis) and the crayfish (Procamberus clarkii) have been implicated in declines of native species (Pister 1979, Wells et al. 1983). Asian tapeworm (Bothriocephalus acheilognathi) contributed to recent declines of the woundfin (Plagopterus argentissimus) in the Virgin River. The tapeworm is thought to have entered the Virgin River with invading red shiner (Heckmann et al. 1986). It is anticipated that other invertebrate non-natives currently expanding their range, such as the zebra mussel (Dreissena polymorpha) and giant rams-horn snail (Marisa cornuarietis) would have adverse effects to native fishes and invertebrates (USDI BR 1990, Horne et al. 1992).

2. The Time Frame of Project Effects

It is important to understand that the CAP is not a project whose impact can be measured over a short span of years. Once constructed and operational, the aqueduct system will be bringing water from the Colorado River into the Gila River basin for at least 100 years. Delivery of that water to users gives any species which enters the aqueduct during the period of operation continuous access into the Gila River basin. Once established in the Gila basin, the effects of non-native species on native species will continue far beyond the life of the project. Proper analysis of the potential impacts of the proposed project must include a long-term view since the longer CAP is in operation, the higher the risk of undesirable non-native species entering the system. With the aqueduct and the proposed and ongoing water deliveries, the risks of non-native species reaching the habitat of the listed species are clearly increased and continue long past the construction phase of any feature of the CAP.

3. Potential Sources of CAP-associated Non-native Introductions

There are several avenues by which non-native species may enter the CAP aqueduct. The most direct entry point for non-native species into the CAP aqueduct is from Lake Havasu at the aqueduct head on the Colorado River. This route has been documented as the source of nine species of non-native fish currently present in the CAP aqueduct (Mueller 1989). Non-native species will also be able to enter the aqueduct through Lake Pleasant. Tilapia and white bass are both likely to enter the aqueduct from Lake Pleasant (Matter 1991). Other points of entry are discussed in the project description section above.

Non-native species may also enter the CAP through accidental or intentional release by private citizens without authorization; also known as "bait bucket" introductions. The increasing interconnection of waters of the Colorado River basin through canals and aqueducts adds increasing opportunities for this type of introduction. Increased opportunity for bait bucket introductions was also noted as an important concern in environmental analyses for the Garrison Diversion Unit in North Dakota, an interbasin water transfer project similar to CAP (USDI BR 1990a). CAP provides increased opportunity for spread of bait bucket introductions through much larger portions of the basin than would be possible via the natural stream systems. Bait bucket introductions are made for many reasons: stocking of favorite sport fish, escape or dumping of bait,

dumping of unwanted aquarium or pet fish, or escape of aquaculture species. The proximity of CAP and interconnected SRP canals to high-density human populations in the Phoenix-Tucson area and the easy availability of CAP and SRP canals to anglers and other people, all combine to make CAP and SRP waters a prime source for bait bucket introductions. Several species already found in the CAP aqueduct are thought to have entered via bait bucket transfer (Mueller 1989). The CAP aqueduct also passes close to Picacho Reservoir, a heavily used fishing site between Phoenix and Tucson. Picacho Reservoir is fed by Gila River water via the Florence-Casa Grande Canal. Sites such as this with close proximity to Gila River and Colorado River (CAP) water, both offering legal or illegal fishing opportunities, tempt anglers to stock one with fish from the other or to dump bait obtained from one into the other. Anglers are often involved in the transport and introduction of fish species from one water to another, either deliberately or through casual release of bait fish (Minckley 1973, Bestgen et al. 1989). While bait bucket introductions will occur with or without the CAP, CAP will provide an increased opportunity for such introductions and will allow introduced species a much greater opportunity to spread throughout the Gila River basin.

4. Sub-basins - Potential Effects

A. Hassayampa River. The potential route from CAP into listed fish habitats in the Hassayampa River is through irrigation diversions in the Harquahala Valley, lower Hassayampa River basin, and Gila River near the mouth of the Hassayampa River. Species released into the Harquahala Valley could move downstream in Centennial Wash into the Gila River and upstream into the Hassayampa River. The Gila River normally has flowing water in this area due to effluent from Phoenix. Painted Rock Reservoir, a few miles downstream from Centennial Wash and the Hassayampa River mouths, is a likely harbor for invading CAP non-natives. Non-native species which become established in Painted Rock Reservoir serve as a constant source for upstream movement during periods of flow in the rivers.

The listed fish present in the Hassayampa River basin include stocked populations of desert pupfish, Gila topminnow, and Colorado squawfish in springs and ponds at The Nature Conservancy Hassayampa Preserve and stocked populations of Gila topminnow in isolated springs in the upper watershed. In addition, a reach of the Hassayampa River near Wagoner has been designated as habitat for establishment of an experimental, nonessential population of woundfin.

The probability of CAP introduction of non-native species into the Hassayampa River basin is moderate to high and the consequences to listed species will be moderately adverse. The probability is moderated by long, normally dry, stream stretches. Although the populations of listed species in the Hassayampa River basin are small, the perennial waters of the Hassayampa basin are important recovery habitat.

B. Agua Fria River. Fish movement from the CAP aqueduct into Lake Pleasant and up into the Agua Fria River will be unrestricted. Prior to the first CAP water entering Lake Pleasant in December 1992, striped bass were present in the CAP aqueduct, but were not known from the lake. In November 1993, less than a year later, the first recorded striped bass were caught in the lake. Lake Pleasant will periodically spill excess flood water downstream, thus allowing non-native species to move downstream to the Gila River.

As a result of an earlier biological opinion, a barrier has been constructed by BR on Tule Creek, a tributary of the Agua Fria which supports a large stocked population of Gila topminnow. Several other stocked Gila topminnow

populations are present in the basin and a bald eagle nest is located at Lake Pleasant.

Introduction of non-native species into the Agua Fria River basin via CAP is virtually certain and the consequences to listed species will be moderate. The planned fish barrier on Tule Creek will provide some protection to the Tule Creek Gila topminnow population, although the presence of non-native species near the downstream side of the barrier will raise the probability of bait bucket transfer above the barrier. Cow Creek and Humbug Creek, both of which have stocked Gila topminnow populations, already support several non-native species. The Gila topminnow populations in those creeks will probably succumb to increased non-native pressure over the life of the CAP.

C. Salt and Verde Rivers. Because the entry point for CAP-assisted non-native species is below the confluence of the Salt and Verde Rivers, the effects on these two river basins are closely related. The potential entry point is at the interconnection of the CAP and SRP systems near Granite Reef Dam on the Salt River (Figure 3). The two major SRP canals head in the pool behind Granite Reef Dam (the forebay). CAP water is transferred from the aqueduct into the canals just downstream from their head. Non-native species could move out of the CAP aqueduct into the SRP canals and from there move upstream into the Salt River above Granite Reef Dam.

The listed species present in the Verde and Salt River basins include bald eagle, spikedace, loach minnow, stocked razorback sucker, stocked Colorado squawfish, and numerous stocked Gila topminnow populations, mostly in isolated springs and small streams. Critical habitat for spikedace is located in the Verde River between Sullivan Dam and Sycamore Creek. Critical habitat for razorback sucker is located in the Verde River between Perkinsville and Horseshoe Dam. In the Salt River, critical habitat for razorback sucker is located between U.S. Highway 60/State Route 77 and the Roosevelt Diversion Dam.

The probability of CAP introduction of non-native species into habitats of the listed species in the Salt and Verde River basins is low, but the consequences of such introductions to the listed species are severe. The probability of upstream movement of fish or other aquatic organisms is limited by several structures. On the Salt River, these structures include the two electric barriers on the SRP canals, which prevent or hinder upstream movement from the canals; Granite Reef Dam, which serves as a barrier to upstream movement in the Salt River bed; and Stewart Mountain, Mormon Flat, Horse Mesa, and Roosevelt Dams, which block fish movement on the Salt River between Granite Reef Dam and the native fish habitat in the upper basin. On the Verde River, fish which surmount Granite Reef Dam are then blocked by Bartlett and Horseshoe Dams from reaching the portions of the river occupied by listed fish.

Despite these barriers, non-native species continue to spread upstream, most likely by bait bucket transport. The presence of CAP introduced non-natives at the base of any given dam increases the risk of those non-natives being transported upstream into the reservoir and river. The electric fish barriers, both on the SRP canals and the Florence-Casa Grande and Pima Lateral Canals (see D. below), are not totally effective at preventing upstream fish movement. Little data exist to support the assumption that these electric barriers totally block upstream fish movement and some ichthyologists have expressed the belief that fish can move upstream through the barriers under certain conditions. In addition, electric barriers are subject to periodic operational failures, such as the one occurring at the SRP barriers on December 23, 1993 (SRP 1994). Following that barrier outage, two grass carp, formerly found only below the barrier, were captured upstream of the barrier.

It is not known how many other individuals of this and other fish species may also have crossed the barrier during the outage. An outage also occurred at the Pima Lateral electric barrier in June 1990 (USDI BR 1990b).

The importance of the listed fish populations in the Salt and Verde River is high. One-third of the known remaining occupied spikedace habitat is in the upper Verde River. One of five remaining loach minnow populations is found in the White River in the upper Salt River basin. Loss of these populations will seriously damage the survival potential of either species. The reestablishment of razorback sucker and Colorado squawfish in the Salt and Verde River basins have had only limited success due to non-native fish predation (Marsh and Brooks 1989). Addition of more species of non-natives could preclude recovery of both listed fish in these rivers.

D. Gila River below Coolidge Dam and San Pedro River. There are numerous entry points into the Gila River itself, as discussed in the project description. The entry point of highest concern is the Florence-Casa Grande Canal, which begins at the pool behind Ashurst-Hayden Dam. Due to various structural features, Ashurst-Hayden Dam is not an effective barrier to upstream fish movement, and ceases to be a barrier at all when the river-level gate is open. No barrier to upstream fish movement exists in the Gila River above Ashurst-Hayden and below Coolidge Dam. Non-native species which enter the Gila River in that area also have open access to the San Pedro River system, including Aravaipa and Redfield Creeks, and the Babocomari River. Matter (1991) has concluded that four of the five non-native fishes considered in his study would likely spread into those areas given the proposed project, even with the existing electric barriers on the Pima Lateral and Florence-Casa Grande Canals.

The portion of the Gila River basin where native fish species are most at risk is the Gila River between Ashurst-Hayden and Coolidge Dams and the San Pedro River and its tributaries. The potential consequences of those introductions to the listed species are severe. This area includes a bald eagle nest at Coolidge Dam and spikedace and loach minnow in Aravaipa Creek. A recent spikedace record in the Gila River near Cochran (about 7 miles above Ashurst-Hayden Dam) suggests that spikedace may also still inhabit portions of the Gila River between Ashurst-Hayden and Coolidge Dams (USDI BR 1992). Important recovery habitat for spikedace, loach minnow, razorback sucker, desert pupfish, Gila topminnow, and other native fish exists in the upper San Pedro River basin (Stefferud and Stefferud 1989).

Matter (1991) specifically analyzed the potential of five species of non-native fish which might be introduced by CAP into the Gila River basin below Coolidge Dam. He concluded that although four of the five non-natives are likely to move throughout the Gila and San Pedro Rivers, all have a low probability of reproducing in habitats currently occupied by spikedace, loach minnow, and razorback sucker. Only the blue tilapia is considered likely to be able to reproduce in the San Pedro River or its tributaries, including Aravaipa Creek. Blue tilapia are mouthbrooders and utilize a variety of food resources including both phyto- and zooplankton, benthic invertebrates, detritus, and algae (Drenner et al. 1984 In Matter 1991). This diet overlaps with the insect diet of both spikedace and loach minnow (Minckley 1973, Propst et al. 1986, Propst et al. 1988, Marsh et al. 1989) and in juvenile fish there may be more of an overlap due to the small sizes of prey required. Some authors found that eggs and larvae are also possibly part of the diet of blue tilapia (Shaflund and Pestrak 1983 In Matter 1991). While blue tilapia do not nest, they have been known to harass other fish and interfere with native fish reproduction. Harassment may be a less significant factor for spikedace than for loach minnow. Spikedace releases eggs into the water column (Barber et al. 1970). Loach minnow males may provide some care of the eggs (Propst et

al. 1988). We know of no data on the effects of blue tilapia on native Gila River basin fishes, but redbelly tilapia have been shown to replace desert pupfish in areas of the lower Colorado River basin (Schoenherr 1981).

Matter (1991) did not consider rainbow smelt likely to spread into the Gila River above Ashurst-Hayden Dam, and therefore not likely to affect native fishes in the middle and upper Gila basin. He believed grass carp may reach the Gila River above Ashurst-Hayden but did not consider them likely to move into the San Pedro or the smaller tributaries. Therefore, he believed them unlikely to pose any significant problems for the listed fish.

With the proposed project, both white and striped bass will likely become a part of the fish fauna in the Gila and San Pedro Rivers and their tributaries (Matter 1991). Although not likely to reproduce in the Ashurst-Hayden to Coolidge Dam reach, these species are likely to prey on native and non-native fish species in those areas. The effects of these predators, contingent upon their density, could be significant upon the prey populations which would include spikedace, loach minnow, and razorback sucker.

E. Gila River above Coolidge Dam. There is less likelihood of CAP-mediated non-native introductions into the Gila River and its tributaries above Coolidge Dam. However, the consequences of introductions into that area are the most severe. The largest remaining populations of spikedace and loach minnow are found in the upper Gila, San Francisco, and Blue Rivers along with the largest portions of their critical habitat. Spikedace are also found in Eagle Creek. Several stocked razorback sucker populations are located in this portion of the basin and critical habitat for razorback sucker includes the area between the Arizona-New Mexico border and Coolidge Dam. Natural Gila topminnow populations are found in three springs on the Gila River alluvial plain near the town of Bylas, and stocked populations of Gila topminnow and desert pupfish are scattered throughout the basin. The Gila River between the mouth of the San Francisco River and the Safford Valley is considered to be of high value for recovery of razorback sucker, loach minnow, spikedace, and bonytail chub (Gila elegans) (Minckley 1985). The Gila River between San Carlos Reservoir and the Arizona-New Mexico border and the San Francisco River from its mouth to the Arizona-New Mexico border have been designated as habitat for establishment of experimental, non-essential populations of woundfin.

Transfer of non-natives over Coolidge Dam would not result directly from CAP, but, in conjunction with bait bucket transfer, will become substantially more likely as a result of the CAP introduction of non-natives into the Gila River below the dam. Coolidge Dam impounds San Carlos Reservoir which supports a warm water sport fishery that is heavily used by local and visiting anglers. A likely scenario for transport of fish from the dam base into the reservoir would be an angler driving to the river just below the dam to collect bait fish for use in the reservoir, then dumping excess bait into the reservoir. Once released into the reservoir, the risk of those non-native species spreading into the upper Gila, San Francisco, and Blue Rivers and their tributaries becomes quite high.

5. Listed Species - Potential Effects

For all non-native introductions, some common principles hold. Aquatic systems can support only a finite biologic resource. With each new species, regardless of the size of its population in the system, there are fewer resources to divide among the other species present. Long-term interactions of introduced and native fish populations are not simple to model or predict, but the record clearly indicates that introduction of non-native fishes into southwestern aquatic habitats coincides with reduction or elimination of

native fishes from those habitats. The mechanisms of this replacement are poorly understood and may include competition, predation, harassment, hybridization, usurpation of habitat, or alteration of habitat by the non-natives. Other factors, such as human-caused alteration in aquatic habitat from conditions more suitable to native fishes to conditions more favorable to non-native species, may also play an important role (Meffe 1983, Meffe 1985, Bestgen and Propst 1986, Marsh et al. 1989, Marsh and Brooks 1989, Baltz and Moyle 1993). Many existing Gila River basin native fish populations now coexist with one or more non-native fish species (Minckley 1973, Minckley 1983, Propst et al. 1986, Propst et al. 1988, Propst and Bestgen 1991, Rinne 1991). However, the long-term stability and eventual outcome of those situations are not yet known and may be altered by the cumulative impacts of additional non-natives.

Species-specific analysis of the likelihood of non-native species entering and successfully establishing in the Gila River basin, and the potential for impacts to each listed species, would be lengthy, complex, and largely non-productive. Too many unknown variables exist: which species, where they will enter, how many successive introductions will occur and what the short-term water conditions (i.e. drought, flood) will be at the time of introduction. In addition, species introduced into habitats outside their native range often act in ways quite different than within their native range. Once released from limiting pressures under which they evolved, species may adapt to conditions which had previously been thought to be unsuitable for them (Stauffer 1984, Brown and Coon 1991).

Most of the species which we have identified as having potential for introduction into the Gila River basin via the CAP connection have never co-occurred with the listed species of concern in this opinion. Therefore, no data exist on their interactions. However, many of those non-natives have been identified as being detrimental to other native southwestern fishes. Sailfin mollies have been identified as causing adverse impacts to desert pupfish (Matsui 1981, Schoenherr 1988), golden shiner to Little Colorado spinedace (Lepidomeda vittata) (Minckley and Carufel 1967), shortfin mollies to Hiko White River springfish (Crenichthys baileyi grandis) (Courtenay et al. 1985), redbelly tilapia to desert pupfish (Matsui 1981, Schoenherr 1988), sheepshead minnow to Pecos pupfish (Cyprinodon pecosensis) (Echelle and Connor 1989), redside shiner to woundfin (Minckley 1973), and grass carp to aquatic habitats in general (Taylor et al. 1984).

The cumulative aspect of effects of non-native introductions via CAP is an important factor in this analysis. Introduction of a non-native species through the CAP connection will likely not be a one-time-only event. Over the life of the project multiple "stockings" of each non-native species into the river basin will likely occur, thus substantially raising the probability of establishment. The multiple or continuous introduction of individuals of each non-native species into the Gila River system will not be the only long-term cumulative effect. Impacts to native fish from non-natives which make their way into the Gila River and its tributaries, whether via CAP or another route, may be additive, multiplicative, or synergistic. The effects of any given non-native fish on the listed fish may be tolerable in the absence of other non-natives. However, in the presence of other non-natives, those effects may result in serious losses to the listed species. Analyses of potential effects of a non-native species on native species must not be limited to one-on-one interactions, but must also consider community interactions.

Because of the continuous opportunity for movement of non-natives from the aqueduct into the river system, adverse effects to native species would not even necessarily require successful reproduction of the non-natives in the Gila River or its tributaries. Successful reproduction of a non-native

species in the CAP aqueduct or irrigation canals, combined with continuous movement into the river system, may give the non-native species an advantage over native species by insulating the non-native from the effects of limiting natural events, such as drought and floods.

A. Spikedace and Loach Minnow. Analysis of the effects of non-native introductions via CAP on spikedace and loach minnow must take into account the short life span of these fish; both survive only about two years. This makes both of these species particularly vulnerable to short-lived, high-intensity impacts. Loss of two consecutive years of reproduction in either spikedace or loach minnow would result in extirpation of the population. Both could sustain serious adverse impacts from invasion of their habitat by a non-native species even if the non-native fails to become established in the long-term.

Introduction of non-natives via CAP has the potential to affect all remaining populations of spikedace and loach minnow. The threat to the Verde River population of spikedace and the White Mountain population of loach minnow is low, due to protection provided by intervening dams. The Aravaipa Creek population of both loach minnow and spikedace will be at high risk and will probably be extirpated by cumulative impacts of non-native introductions over the life of the project. The upper Gila River and Eagle Creek populations of spikedace and San Francisco, Blue, and upper Gila River populations of loach minnow will probably suffer substantial losses due to CAP-mediated non-native introductions over the life of the project.

Proposed critical habitat for both spikedace and loach minnow includes Aravaipa Creek in Pinal and Graham Counties, Arizona and portions of the upper Gila River in Grant and Catron Counties, New Mexico. For loach minnow, proposed critical habitat also includes the Blue River and the San Francisco River for a stretch downstream from the mouth of the Blue in Greenlee County, Arizona, as well as portions of the San Francisco and Tularosa Rivers in Catron County, New Mexico. For spikedace, proposed critical habitat also includes the upper Verde River in Yavapai County, Arizona. Of these areas, Aravaipa Creek will clearly be affected by non-native introductions resulting from the CAP aqueduct. The Blue, San Francisco, Tularosa, and upper Gila Rivers will be affected by non-native species which may be transported over the dam into San Carlos Reservoir. The upper Verde may be affected by non-natives which eventually are transported above both mainstem dams on that river. Adverse modification of critical habitat is defined as a direct or indirect alteration that appreciably diminishes the value of the critical habitat for both survival and recovery of the listed species. The introduction of additional non-native fish species into the already degraded habitat of the spikedace and loach minnow will appreciably diminish the survival and recovery value of their critical habitats.

B. Gila Topminnow. Gila topminnow are particularly vulnerable to adverse impacts from non-native fish (Meffe et al. 1983). The springs near Bylas which support natural populations of Gila topminnow are separated from the Gila River only by short, dry, stream stretches. Mosquitofish have invaded those springs from the Gila River during periods of high flow. Barriers which have been constructed to exclude non-native fish from the springs are only partially successful and are too low to prevent invasion by some species. Introduction of additional non-native species into the Gila River above Coolidge Dam will substantially increase the threat of loss of these Gila topminnow populations.

The Cow Creek and Humbug Creek stocked Gila topminnow populations will probably be extirpated by cumulative non-native introductions over the life of the CAP. The Tule Creek population may survive if the barrier being constructed on that creek successfully prevents upstream movement of non-

native fishes. Other Gila topminnow stocked populations are in isolated springs or small perennial stream segments separated from the mainstreams by extensive areas of dry streambed. Some effects to these populations may occur through some upstream movement of non-natives and through increased opportunity for bait bucket introductions.

C. Desert Pupfish. Desert pupfish populations which may be affected by CAP non-native introductions into the Gila River basin (excluding the Santa Cruz River basin) are small, stocked populations, most of which are located in springs or short perennial portions of small streams generally isolated from the mainstream rivers. Effects on the desert pupfish from this project are expected to be minor.

D. Razorback Sucker. The 1991 listing of the razorback sucker extended the protection of the Act to all populations of the species, including those restocked into the Gila River basin. The success of that stocking effort has not been fully determined; however, monitoring of the ten year stocking effort indicates that the razorback suckers do not survive well in the presence of non-native fish populations (Marsh and Brooks 1989, Minckley et al. 1991). The combined effects of existing non-native fishes in the Gila River basin and non-native species which will be introduced via the CAP will most likely prevent successful reestablishment of razorback sucker in the Verde, Salt, and Gila Rivers.

Critical habitat for the razorback sucker includes the following areas in the Gila River basin: the Gila River from the Arizona-New Mexico border to Coolidge Dam in Graham, Greenlee, and Pinal Counties, Arizona; the Salt River from the old U.S. Highway 60/State Route 77 bridge to the Roosevelt Diversion Dam in Gila County; and the Verde River from Perkinsville to Horseshoe Dam in Yavapai County. These areas may be affected by non-natives which are eventually transported above the dams on those rivers. Introduction of non-native fish species into these habitats has already had a substantial adverse impact on the razorback sucker and additional introductions would appreciably diminish the value of the critical habitat for survival and recovery of the razorback sucker.

E. Colorado Squawfish. The stocked populations of Colorado squawfish in the Salt and Verde River basins are designated as experimental, nonessential. As such, loss of those populations cannot, by definition, result in jeopardy to the survival of the species. As with razorback sucker, the combined effects of existing and additional non-native species are expected to severely limit the successful reestablishment of Colorado squawfish in the Gila River basin.

F. Bald Eagle. The bald eagle feeds primarily on fish, utilizing suckers, catfish, and carp, as well as other available species in its daily diet (USDI FWS 1982). The introduction of non-native fish via the CAP has the potential to change the fish fauna of the Gila River basin, and thus the forage base for the southwestern population of the bald eagle.

The five fish species studied by Matter (1991) are, except for the rainbow smelt, hypothesized to be able to survive in the Gila River below Coolidge Dam. Only the blue tilapia was thought likely to reproduce and become a significant part of the fish fauna. If they become established, tilapia may force out some of the existing fish population, but their intolerance to cold may make them susceptible to bald eagle foraging as they concentrate in warmer, shallower waters. Small to moderate size grass carp may also be taken by bald eagles. Both white bass and striped bass prey on other fish and may thus have an adverse impact on the prey base of the bald eagle. The extent to which this is likely to affect the hunting opportunities for the bald eagle

nesting territory at Coolidge Dam is unclear. Matter (1991) believed all five species could live and all but grass carp reproduce in San Carlos Reservoir and from there could move further upstream on the Gila River. No bald eagle nests are known from the Gila River above San Carlos Reservoir. Effects to the bald eagle from introduction of non-native fishes into San Carlos Reservoir will be confined to the Coolidge nest. The degree of effects on the hunting territory will depend on the extent of change in fish species composition.

Introductions and survival of exotic or non-native fish species over the life of the project and beyond will alter fish species compositions in the area of bald eagle nests throughout the Gila River basin. Evidence suggests that bald eagles are not prey specific and will take whatever fish species are available to them, including a large number of non-native species (Biosystems Analysis, Inc. 1991). Unless the newly introduced fish species eliminate significant portions of the forage base presently available for eagles and are themselves not available as prey for some reason, effects to the nesting territories may not be significant.

For the bald eagle, the change in fish fauna over the life of the project may or may not have significant effects to the prey base these birds rely on. Changes to the prey base that still result in abundant, easily catchable prey, albeit of a different species, might not be significant to the maintenance of a nesting territory. Expansion of the newly introduced fish species into a wider range in the Gila River will affect the bald eagle only so far as the individual species posed a concern due to their effects on the prey base.

6. Recovery - Potential Effects

The long-term survival of an endangered or threatened species may require implementation of recovery actions as well as basic protection. Preclusion of recovery opportunities may jeopardize survival. The purposes of Congress in setting forth the Endangered Species Act are very clear. Section 2(b) of the Act states:

> "The purposes of this Act are to provide a means whereby the ecosystems upon which endangered species and threatened species depend may be conserved..."

Conserve is defined in section 3(3) to mean:

> "...to use and the use of all methods and procedures which are necessary to bring any endangered species or threatened species to the point at which the measures provided pursuant to this Act are no longer necessary..."

Thus, the conservation of any threatened or endangered species under the Act clearly requires recovery of that species and protection of ecosystems which would support that recovery. Loss of significant portions of recovery habitat would then be contrary to the purposes of the Act.

A major recovery strategy for endangered and threatened southwestern fishes is their reestablishment within historic range. Since the decline of these species has resulted from the destruction and alteration of their habitat and the introduction of non-native fishes into that habitat, suitable reestablishment sites are rare. Attempts at restoring destroyed or damaged habitat and removing non-native fish have met with limited success (Meffe 1983, Carothers et al. 1989). Therefore, unoccupied streams which appear to still have suitable habitat, or which have a potential for restoration and few or no non-native fishes, are critical to the recovery of these species.

Ongoing recovery programs of native fish reestablishment illustrate the difficulties of that recovery technique, particularly in relation to the problems caused by non-native species. Success of reestablishment efforts for Gila topminnow have been limited due to the difficulty in finding waters where non-native fish are not present. Because non-native fish are widespread in the Gila River basin, Gila topminnow reestablishment has been restricted to small isolated springs and streams, or stock tanks and artificial ponds. These waters are not representative of what is known to be natural topminnow habitat. Because of the small, isolated nature of most of the reestablishment sites, they are vulnerable to drought, flooding, failure of human-constructed elements, non-native introductions, and numerous other perturbations. Stocked Gila topminnow populations are commonly lost and restocking is required (Brooks 1986, Simons 1987, Bagley et al. 1991, Brown and Abarca 1992).

The reestablishment effort for razorback sucker in the Gila River basin has also met with limited success due to the ubiquitous presence of non-native fishes (Marsh and Brooks 1989, Minckley et al. 1991). Predation from non-natives, primarily ictalurid catfishes, has resulted in little or no success in stocking of small razorbacks despite the large numbers of fish stocked. Stockings have been shifted to larger individual razorback sucker placed into tributary streams, rather than the mainstream, in an effort to reduce losses to predation. Introduction and establishment of additional predatory non-natives would likely negate those efforts.

We believe the upper San Pedro River basin (above Saint David) is among the most promising recovery habitat for native Gila River fishes, including the Gila topminnow, desert pupfish, spikedace, loach minnow, and razorback sucker. Due to extensive habitat degradation in the past, 11 of the original 13 fishes native to the upper San Pedro River have been extirpated. Several species of non-native fish are now present within the system, although fewer occur there than in other areas of the Gila River basin. Severe fish kills have occurred in the past when mine spills in the upper watershed in Sonora, Mexico dropped pH levels in the river to 3.1 (Eberhardt 1981). However, 36 miles of the upper portion of the San Pedro River corridor, including about 4 miles of the lower Babocomari River, are now protected by the Bureau of Land Management as the San Pedro Riparian National Conservation Area. That protection, plus protective diking of mine tailings in Mexico, and cessation of many earlier human activities in the area, such as the Tombstone mines, the town and ore mills at Charleston, and livestock grazing in the riparian zone, have resulted in an improving aquatic and riparian system and a high potential for native fish recovery. The proposed CAP connection will substantially increase the likelihood of additional non-native fish becoming established in the upper San Pedro River basin. The probability that the upper San Pedro River basin may become so contaminated with non-native fish species that successful reestablishment of native fishes is no longer feasible increases substantially with the CAP water transfers.

The Hassayampa River in the area of The Nature Conservancy's preserve near Wickenburg and further upstream near Wagoner is also considered to be important recovery habitat for several listed fishes.

The Gila River between the mouth of the San Francisco and the upper end of the Safford Valley has recently been designated as a Riparian National Conservation Area. This portion of the river has high potential as recovery habitat for several listed and native fishes, including spikedace, loach minnow, woundfin, razorback sucker, Colorado squawfish, and bonytail chub. Introduction of additional non-native fishes into these areas will likely reduce or eliminate the use of these areas for recovery of the native fishes.

7. Cumulative Impacts

Cumulative effects are those effects of future non-Federal (State, local government, or private) activities on endangered or threatened species or that are reasonably certain to occur during the course of the Federal activity subject to consultation. Future Federal actions are subject to the consultation requirements established in section 7 and therefore, are not considered cumulative in the proposed action.

Various State, private, and local actions will be cumulative to the effects of non-native species introductions via the CAP. The States will continue to introduce sport fish and fish for sport fish prey into waters of the Gila River basin, including species already being stocked and additional species which become desirable for sport fishing. State, private, and local entities will continue to introduce non-native fish and other organisms into waters of the Gila River basin for various purposes, such as insect and weed control. Private individuals will continue to introduce non-native fish through release of live bait fish. Both the States of New Mexico and Arizona permit live bait use in the Gila River basin. Private individuals will continue to make unauthorized stockings of fish and other organisms for a variety of reasons including stocking of sport fish and release of unwanted aquarium and aquaculture fish. Non-native species being raised in aquaculture operations will continue to escape into waters of the Gila River basin.

These State, local, and private introductions of non-native species will have a strong adverse effect on the listed species being addressed here. Cumulatively, these non-Federal impacts may result in severe losses or extirpation of populations of the listed fish. In combination with introductions through CAP, such losses and extirpations pose a severe threat to the survival of all native fishes in the Gila River basin.

REASONABLE AND PRUDENT ALTERNATIVES

Regulations that implement section 7 define reasonable and prudent alternatives (RPA's) as alternative actions, identified during formal consultation, that:

(1) can be implemented in a manner consistent with the intended purpose of the action,

(2) can be implemented consistent with the scope of the Federal agency's legal authority and jurisdiction,

(3) are economically and technologically feasible, and

(4) would, FWS believes, avoid the likelihood of jeopardizing the continued existence of listed species or the destruction or adverse modification of critical habitat.

Many RPA's have been considered in this consultation but were rejected for various reasons during the course of consultation (see Appendix). The following RPA has evolved during the section 7 consultation process.

This RPA contains five primary elements: 1) construction and operation of upstream barriers to fish movement from the CAP aqueduct into native fish habitats, 2) monitoring for non-native fish, 3) transfer of funding to FWS for recovery and protection of listed and candidate Gila basin fishes as mitigation for adverse project effects which cannot feasibly be alleviated below the jeopardy threshold, 4) transfer of funding to the FWS for management

against non-native fish and research to support that management, and 5) implementation of an information and education program regarding non-native aquatic fishes. Implementation of all of these elements, as delineated below, is required to result in an effective removal of jeopardy.

Implementation of the RPA will extend throughout the 100-year life of the project. Delivery of CAP water within the Gila River basin or to the Santa Rosa Canal system may begin as of the date of this biological opinion.

1.1 BR shall construct physical drop structures that act as barriers to upstream fish movement at the following locations:

Aravaipa Creek - between the Aravaipa Canyon Wilderness and the mouth (2 barriers in close proximity)
San Pedro River - between Redington and Fairbank (2 barriers in close proximity)

The barriers on Aravaipa Creek shall be completed within three and one-half years of the date of this biological opinion. The barriers on the San Pedro Rivers shall be completed within six years of the date of this biological opinion.

Using the best available information, the design of the barriers shall be mutually agreed upon by BR, FWS, and Arizona Game and Fish Department (AGFD), with appropriate input from experts on southwestern U.S. fishes, hydrology, and exotic fish problems. These barriers are anticipated to rise 4 to 10 feet above the stream bottom and may not provide 100 percent probability of blocking upstream fish movement at all flows. The barriers will function in conjunction with management, as provided for in the following items, to reduce the probability of non-native fish upstream movement to a very low level.

Barrier site locations shall be subject to review by BR, FWS, and AGFD and by the land owner(s) or land management agency(s). If site acquisition is necessary, acquisition from willing sellers shall be emphasized. Condemnation of barrier sites shall be used only after all other avenues are exhausted and after review and approval by FWS and AGFD. If the necessary acquisition or rights to appropriate barrier sites cannot be obtained in the areas specified above, then formal section 7 consultation shall be reinitiated by BR.

BR or their designee shall maintain the barriers throughout the life of the project.

1.2 BR or their designee shall maintain and operate the existing electrical barriers on the Salt River Project canals between the CAP turnout and the Salt River throughout the life of the project, unless replaced by barriers mutually agreed upon by BR, FWS, and AGFD. The effectiveness of the maintenance and operation and the effectiveness of the barriers in preventing upstream fish movement will be reviewed by BR, FWS, and AGFD at intervals not exceeding 10 years. Any changes in operating protocols shall be subject to approval by FWS and AGFD.

If changes in water deliveries, usage, or other factors alter the potential for movement of fish through and between CAP, SRP, and interconnecting canals, then formal section 7 consultation may be reinitiated and the need for continued operation of the electrical barriers may be reevaluated.

1.3 BR or their designee shall maintain and operate the existing electrical barrier on the Florence-Casa Grande Canal near China Wash throughout the life of the project, unless replaced by one of the following:

a. A drop structure at the juncture of the Florence-Casa Grande Canal and the Gila River that would form a barrier (with a probability of effectiveness mutually agreeable to FWS, AGFD, and BR) to upstream fish movement from the canal into the river; or

b. A pump system for transferring Gila River water into the Florence-Casa Grande Canal which would preclude upstream movement of fish from the canal into the river.

c. Or other measures agreed upon by BR, FWS, and AGFD.

The effectiveness of the maintenance and operation and the effectiveness of the barriers in preventing upstream fish movement will be reviewed by BR, FWS, and AGFD at intervals not to exceed 10 years. Any changes in operating protocols shall be subject to approval by FWS and AGFD.

If changes in water deliveries, usage, or other factors alter the potential for movement of fish through and between CAP, Florence-Casa Grande, and interconnecting canals, then formal section 7 consultation may be reinitiated and the need for continued operation of the electrical barriers may be reevaluated.

1.4 The existing electrical barrier on the Pima Lateral Canal may be discontinued at the discretion of BR.

2. BR shall, in cooperation with AGFD and FWS, develop and implement a baseline study and long-term monitoring of the presence and distribution of non-native fish in the following areas:

CAP aqueduct
SRP canals
Florence-Casa Grande Canal
Other water delivery canals, as appropriate
Salt River between Stewart Mountain Dam and Granite Reef Dam and the electrical barriers
Gila River below Coolidge Dam
San Pedro River downstream of the U.S./Mexico border

The purpose of this effort shall be to establish baseline data on the presence and distribution of non-native fishes in the target reaches and to detect changes in the species composition or distribution.

Data collection protocols shall be cooperatively formulated by BR, FWS, and AGFD, with the final protocol requiring consensus by all three agencies. This monitoring shall begin no later than 6 months after the date of this biological opinion, and shall continue throughout the life of the project. BR shall submit reports on this sampling to FWS and AGFD on an annual basis throughout the life of the project. Comprehensive reports compiling all previous data collected under this sampling shall be prepared by BR and submitted to FWS and AGFD at the end of every 5 years following initiation of the monitoring. If a non-native fish species is found in an area where they have not previously been found, the FWS and AGFD shall be informed of the finding by telephone within 5 days of the collection.

3. BR shall deposit into an escrow-type account in the name of the FWS the sum of $250,000 annually for 25 years from the date of the first funding transfer. The first funding transfer shall occur no later than three months after the date of this biological opinion and the amount shall be prorated to

reflect the percent of the current fiscal year remaining. In all future fiscal years, funding transfer shall occur within the first two months of the fiscal year. These funds shall be used by FWS for conservation actions (recovery and protection) for the spikedace, loach minnow, Gila topminnow, razorback sucker, or other Gila River basin listed or candidate fish species. These monies shall not be subject to FWS or BR overhead charges.

Expenditure of these funds shall be jointly agreed upon by the FWS and BR in consultation with AGFD and New Mexico Department of Game and Fish (NMGF). FWS shall submit an annual report to BR detailing the expenditure of these funds and how the expenditures contribute to the removal of jeopardy from the proposed delivery of CAP water in the Gila River basin. A briefing of fund expenditures, accomplishments, and upcoming work items shall be presented by FWS at the annual joint meeting of the regional offices of BR and FWS.

4. BR shall deposit into an escrow-type account in the name of the FWS the amount of $250,000 annually for 25 years from the date of the first funding transfer. The first funding transfer shall occur no later than three months after the date of this biological opinion and the amount shall be prorated to reflect the percent of the current fiscal year remaining. In all future fiscal years, funding transfer shall occur within the first two months of the fiscal year. These funds shall be used by FWS for research on, and control of, non-native aquatic species. Research may include, but is not limited to, the status, biology, ecology, habitat, and life history of spikedace, loach minnow, Gila topminnow, razorback sucker, and other Gila River basin listed or candidate fish species; status, biology, ecology, habitat, and life history of invading or already present non-native aquatic species; toxicology of various fish toxicants to native or non-native aquatic species; and community ecology of Gila River basin fish communities with focus on interactions of native and non-native species. This fund shall not be subject to FWS or BR overhead charges.

Expenditure of these funds shall be jointly agreed upon by FWS and BR in consultation with AGFD, and NMGF. FWS shall submit an annual report to BR detailing the expenditure of these funds and how the expenditures contribute to the removal of jeopardy from the proposed delivery of CAP water in the Gila River basin. A briefing of fund expenditures, accomplishments, and upcoming work items shall be presented by FWS at the annual joint meeting of the regional offices of BR and FWS.

5. BR shall develop and implement an information and education program directed to conservation of native fish and their habitats. Emphasis shall be placed on problems caused by bait-bucket transfer, dumping of pet aquarium fish, and other forms of transport by private individuals. This program shall be implemented no later than 2 years after finalization of this Biological Opinion, and shall continue for a minimum of 5 years. Annual reports of this program shall be submitted to FWS.

Because this biological opinion has found jeopardy to the continued existence of four listed species, BR is required to notify the FWS of its final decision on the implementation of the reasonable and prudent alternative.

INCIDENTAL TAKE

Section 9 of the Act, as amended, prohibits any taking (harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or attempt to engage in any such conduct) of listed species of fish and wildlife without a special

exemption. Harm is further defined to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing behavioral patterns such as breeding, feeding, or sheltering. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to, and not intended as part of, the agency action is not considered a prohibited taking provided that such taking is in compliance with the incidental take statement. **The measures described below are nondiscretionary, and must be undertaken by the agency or made a binding condition of any grant or permit issued to the applicant, as appropriate.**

The FWS anticipates that the proposed transfer of CAP water into the Gila River Basin via irrigation systems under the terms of the reasonable and prudent alternative in this opinion will result in incidental take of spikedace, loach minnow, Gila topminnow, razorback sucker, and Colorado squawfish through habitat modification causing impairment of breeding, feeding, and sheltering.

The anticipated amount of taking due to implementation of this proposed action cannot be quantified. Several species involved are short-lived, have high rates of reproduction, and experience great population fluctuations, thus making population estimates difficult to obtain and interpret. The non-native species which may invade cannot be identified and the timing of the invasions are unknown. Implementation of the RPA is expected to minimize take of the listed fish. Therefore, the level of incidental take anticipated as a result of the proposed action will be assumed to have been exceeded if the proposed action, as modified by the reasonable and prudent alternative, is altered or not carried out as set forth in this biological opinion. If this should occur, the BR must reinitiate consultation with the FWS immediately to avoid violation of section 9. If it is determined that the impact of the additional taking will cause an irreversible and adverse impact on the species, operations must be stopped in the interim period between the initiation and completion of the new consultation.

It is unlikely that any incidental take of desert pupfish or bald eagle will occur as a result of implementation of the proposed action. Accordingly, no incidental take is authorized. Should any take occur, BR must reinitiate formal consultation with the FWS and provide a description of the circumstances surrounding the take.

Reasonable and Prudent Measures

The FWS believes that the RPA given in this biological opinion includes all measures necessary and appropriate to minimize the incidental taking authorized by this biological opinion.

Terms and Conditions for Implementation

In order to be exempt from the prohibitions of section 9 of the Act, the BR is responsible for compliance with the following terms and conditions, which implement the reasonable and prudent measures described above. Implementation of the RPA in the biological opinion will constitute the terms and conditions for this action.

The incidental take statement provided in this opinion satisfies the requirements of the Endangered Species Act, as amended. This statement does not constitute an authorization for take of listed migratory birds under the Migratory Bird Treaty Act, the Bald and Golden Eagle Protection Act or any other Federal statute.

CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of the Act directs Federal agencies to utilize their authorities to further the purposes of the Act by carrying out conservation programs for the benefit of endangered and threatened species. The term conservation recommendations has been defined as FWS suggestions regarding discretionary agency activities to minimize or avoid adverse effects of a proposed action on listed species or regarding the development of information. The recommendations provided here relate only to the proposed action and do not necessarily represent complete fulfillment of the agency's 7(a)(1) responsibility for these species.

1. Construct physical drop structure barriers to upstream fish movement at the following locations:

Redfield Canyon,
Babocomari River - above Huachuca City,
Hassayampa River - between CAP aqueduct and The Nature Conservancy Preserve, and
Agua Fria River - above Lake Pleasant.

Appropriate barrier design for each site should be agreed upon by BR, FWS, and AGFD using the best available information on fish movement capabilities. Site location should be reviewed by those three agencies and by the land owner or land management agency.

2. Unless they are shown at some future date to be needed for the recovery and survival of native fish, and if the actions are not at odds with national wetlands policy, encourage annual dryup of all canals, ditches, siphon, sumps, and other open water storage and conveyance features of CAP and of all entities receiving CAP water. This does not include the CAP Aqueduct itself, Picacho Reservoir, any reservoirs located on natural stream systems, or any natural rivers or streams. For other open water features which cannot be dried annually, management plans to control non-native fish should be encouraged and assisted. Acceptable alternatives to drying may include use of fish toxicants, structural modification to allow dryup, structural modification to avoid flood inundation, and/or physical barriers to fish movement out of areas which cannot be dried into other portions of the system. The management plans should be mutually acceptable to BR, FWS, and AGFD.

3. Organize and facilitate a multi-agency effort to address conflicts between sport fishing (including use of live bait) and native fish conservation in Arizona and possibly New Mexico. The primary goal of this effort would be to find solutions which would provide protection to native fishes and still provide adequate sport fishing opportunities.

4. Oppose all introductions of any non-native aquatic species not already established in the Colorado River basin, into waters of the lower Colorado River basin over which BR has partial or total control. Support efforts to prevent purposeful introduction of additional non-native species into the waters of the lower Colorado River basin.

In order for the FWS to be kept informed of actions that either minimize or avoid adverse effects or that benefit listed species or their habitats, the FWS requests notification of the implementation of any conservation recommendations.

SUMMARY

This concludes formal consultation on the transportation and delivery of CAP water to the Gila River basin (Hassayampa, Agua Fria, Salt, Verde, San Pedro, middle and upper Gila Rivers and associated tributaries) in Arizona and New Mexico. As required by 50 CFR 402.16, reinitiation of formal consultation is required if: (1) the amount or extent of incidental take is exceeded; (2) new information reveals effects of the agency action that may impact listed species or critical habitats in a manner or to an extent not considered in this opinion; (3) the agency action is subsequently modified in a manner that causes an effect to the listed species or critical habitat that was not considered in this opinion; or (4) a new species is listed or critical habitat designated that may be affected by this action.

LITERATURE CITED

Bagley, B.A, D.A. Hendrickson, F.J. Abarca, and S.D. Hart. 1991. Status of the Sonoran topminnow (Poeciliopsis occidentalis) and desert pupfish (Cyprinodon macularius) in Arizona. Arizona Game and Fish Department, Phoenix, Arizona. 64 pp.

Baltz, D.M. and P.B. Moyle. 1993. Invasion resistance to introduced species by a native assemblage of California stream fishes. Ecological Applications 3(2):246-255.

Barber, W.E., D.C. Williams, and W.L. Minckley. 1970. Biology of the Gila spikedace, Meda fulgida, in Arizona. Copeia 1970(1):9-18.

Bestgen, K.R. 1990. Status review of the razorback sucker, Xyrauchen texanus. Contribution 44, Colorado State University Larval Fish Laboratory, Ft. Collins, Colorado. 92 pp.

Bestgen, K.R., S.P. Platania, J.E. Brooks, D.L. Brooks. 1989. Dispersal and life history traits of Notropis girardi (Cypriniformes: Cyprinidae), introduced into the Pecos River, New Mexico. American Midland Naturalist 122:228-235.

Bestgen, K.R., and D.L. Propst. 1986. Red shiner vs. native fishes: replacement or displacement? Proceedings of the Eighteenth Annual Symposium of the Desert Fishes Council. November 20-22, 1986.

Bestgen, K.R., and D.L. Propst. 1989. Distribution, status, and notes on the ecology of Gila robusta (Cyprinidae) in the Gila River drainage, New Mexico. The Southwestern Naturalist 34(3):402-412.

Biosystems Analysis, Inc. 1990. Ecology of bald eagles in Arizona, 1991 draft report. Report to the U.S. Dept. of Interior, Bureau of Reclamation. Boulder City, Nevada.

Black, G.F. 1980. Status of the desert pupfish, Cyprinodon macularius (Baird and Girard), in California. California Dept. of Fish and Game. Sacramento, California. 42 pp.

Brooks, J.E. 1986. Status of natural and introduced Sonoran topminnow (Poeciliopsis o. occidentalis) populations in Arizona through 1985. U.S. Fish and Wildlife Service, Albuquerque, New Mexico. 34 pp.

Brown, D.J. and T.G. Coon. 1991. Grass carp larvae in the lower Missouri River and its tributaries. North American Journal of Fisheries Management 11:62-66.

Brown, M. and F.J. Abarca. 1992. An update status report of the Sonoran topminnow (Poeciliopsis occidentalis) and desert pupfish (Cyprinodon macularius) in Arizona. Arizona Game and Fish Department, Phoenix, Arizona. 39 pp.

Carothers, S.W., G.S. Mills, and R.R. Johnson. 1989. The creation and restoration of riparian habitat in the southwestern arid and semi-arid regions. Pp. 359-371 In: Wetland creation and restoration: the status of the science. Vol. 1. U.S. Environmental Protection Agency, Corvallis, Oregon.

Courtenay, W.R., Jr., and J.E. Deacon. 1983. Fish introductions in the American southwest: a case history of Rogers Spring, Nevada. The Southwestern Naturalist 28(2):221-224.

Courtenay, W.R., Jr., J.E. Deacon, D.W. Sada, R.C. Allan, and G.L. Vinyard. 1985. Comparative status of fishes along the course of the pluvial White River, Nevada. The Southwestern Naturalist 30(4):503-524

Courtenay, W.R., Jr., D.A. Hensley, J.N. Taylor, and J.A. McCann. 1984. Distribution of exotic fishes in the continental United States. Pp. 41-77 In: Distribution, biology, and management of exotic fishes. W.R. Courtenay, Jr. and J.R. Stauffer, Jr., eds. Johns Hopkins Univ. Press. Baltimore and London.

Courtenay, W.R., Jr., and G.K. Meffe. 1989. Small fishes in strange places: a review of introduced Poeciliids. Pp. 319-331 In: Ecology and evolution of livebearing fishes (Poeciliidae). G.K. Meffe and F.F. Snelson, Jr., eds. Prentice Hall. Englewood Cliffs, New Jersey.

Courtenay, W.R., Jr., and J.R. Stauffer, Jr. 1984. Distribution, biology, and management of exotic fishes. Johns Hopkins Univ. Press. Baltimore and London. 430 pp.

Deacon, J.E., C. Hubbs, and B.J. Zahuranec. 1964. Some effects of introduced fishes on the native fish fauna of southern Nevada. Copeia 1964(2):384-388.

Drenner, R.W., S.B. Taylor, X. Lazzaro, and D. Kettle. 1984. Particle-grazing and plankton community impact of an omnivorous cichlid. Transactions of the American Fisheries Society 113:397-402.

Eberhardt, S. 1981. San Pedro River basin water quality status report for period 1973-1979. Report of Bureau of Water Quality Control, Arizona Dept. of Health Services, Phoenix.

Echelle, A.A., and P.J. Connor. 1989. Rapid geographically extensive genetic introgression after secondary contact between two pupfish (Cyprinodon, Cyprinodontidae). Evolution 43:717-727.

Evans, D.O. and D.H. Loftus. 1987. Colonization of inland lakes in the Great Lakes region by rainbow smelt, Osmerus mordax: their freshwater niche and effects on indigenous fishes. Canadian Journal of Fisheries and Aquatic Sciences 44(Supp. 2):249-266.

Grabowski, S.J., S.D. Hiebert, and D.M. Lieberman. 1984. Potential for introduction of three species of non-native fishes into Central Arizona via the Central Arizona Project- A literature review and analysis. U.S. Bureau of Reclamation, Denver, Colorado. 225 pp.

Haynes, C.M., R.T. Muth, and L.C. Wycoff. 1982. Range extension for the redside shiner, Richardsonius balteatus (Richardson), in the upper Colorado River drainage. The Southwestern Naturalist 27(2):223.

Heckmann, R.A., J.E. Deacon, and P.D. Greger. 1986. Parasites of the woundfin minnow, Plagopterus argentissimus, and other endemic fishes from the Virgin River, Utah. Great Basin Naturalist 46(4):662-675.

Hendrickson, D.A. and A. Varela-Romero. 1989. Conservation status of desert pupfish, Cyprinodon macularius, in Mexico and Arizona. Copeia 1989(2):478-483.

Horne, F.R., T.L. Arsuffi, and R.W. Neck. 1992. Recent introduction and potential botanical impact of the giant rams-horn snail, Marisa cornuarietis (Pilidae), in the Comal Springs ecosystem of central Texas. The Southwestern Naturalist 37(2):194-214.

Howells, R.G., R.W. Luebke, B.T. Hysmith, and J.H. Moczygemba. 1991. Field collections of rudd, Scardinius erythrophthalmus (Cyprinidae), in Texas. The Southwestern Naturalist 36(2):244-254.

Hubbs, C.L., and R.R. Miller. 1941. Studies of the fishes of the order Cyprinodontes. IVII -- Genera and species of the Colorado River System. Occasional Papers of the Museum of Zoology, University of Michigan 433:1-9.

Hughes, R.M. 1981. The plains killifish, Fundulus zebrinus (Cyprinodontidae), in the Colorado River basin of western North America. The Southwestern Naturalist 26(3):321-325.

Lachner, E.A., C.R. Robins, and W.R. Courtenay, Jr. 1970. Exotic fishes and other aquatic organisms introduced into North America. Smithsonian Contributions to Zoology No. 59. 29 pp.

Marsh, P.C., F.J. Abarca, M.E. Douglas, and W.L. Minckley. 1989. Spikedace (Meda fulgida) and loach minnow (Tiaroga cobitis) relative to introduced red shiner (Cyprinella lutrensis). Report to Arizona Game and Fish Department, Phoenix. 116 pp.

Marsh, P.C., and J.E. Brooks. 1989. Predation by ictalurid catfishes as a deterrent to re-establishment of hatchery-reared razorback suckers. The Southwestern Naturalist 34(2):188-195.

Marsh, P.C. and W.L. Minckley. 1982. Fishes of the Phoenix metropolitan area in central Arizona. North American Journal of Fisheries Management. 4:395-402.

Matsui, M.L. 1981. Thé effects of introduced teleost species on the social behavior of Cyprinodon macularius californiensis. MS thesis. Occidental College, Los Angeles, California. 61 pp.

Matter, W.J. 1991. Potential for transfer of non-native fish in Central Arizona Project canal waters to the Gila River system. Bureau of Reclamation, Phoenix, Arizona. 83 pp.

Meador, M.R. 1992. Inter-basin water transfer: ecological concerns. Fisheries 17(2):17-22.

Meffe, G.K. 1983. Attempted chemical renovation of an Arizona springbrook for management of the endangered Sonoran topminnow. North American Journal of Fisheries Management 3:315-321.

Meffe, G.K. 1985. Predation and species replacement in American southwestern fishes: a case study. Southwestern Naturalist 30(2):173-187.

Meffe, G.K., D.A. Hendrickson, W.L. Minckley, and J.N. Rinne. 1983. Factors resulting in decline of the endangered Sonoran topminnow Poeciliopsis occidentalis (Atheriniformes:Poeciliidae) in the United States. Biological Conservation 25(1983):135-159.

Miller, R.R. 1961. Man and the changing fish fauna of the American southwest. Papers of the Michigan Academy of Science, Arts,and Letters 46:365-404.

Miller, R.R., and L.A. Fuiman. 1987. Description and conservation status of Cyprinodon macularius eremus, a new subspecies of pupfish from Organ Pipe Cactus National Monument, Arizona. Copeia 1987(3):593-609.

Miller, R.R., J.D. Williams, and J.E. Williams. 1989. Extinctions of North American fishes during the past century. Fisheries 14:22-38.

Minckley, W.L. 1973. Fishes of Arizona. Arizona Game and Fish Department. Phoenix, Arizona. 293 pp.

Minckley, W.L. 1983. Status of the razorback sucker, Xyrauchen texanus (Abbott) in the lower Colorado River basin. Southwestern Naturalist 28(2):165-187

Minckley, W.L. 1985. Native fishes and natural aquatic habitats in U.S. Fish and Wildlife Service Region II west of the continental divide. Report to the U.S. Fish and Wildlife Service, Albuquerque, New Mexico. Dept. of Zoology, Arizona State Univ., Tempe, Arizona. 158 pp.

Minckley, W.L. and L.H. Carufel. 1967. The little Colorado River spinedace, Lepidomeda vittata, in Arizona. Southwestern Naturalist 13:291-302.

Minckley, W.L., and J.E. Deacon. 1968. Southwestern fishes and the enigma of "endangered species". Science 159:1424-1432.

Minckley, W.L., and M.E. Douglas. 1991. Discovery and extinction of western fishes: a blink of the eye in geologic time. Pp. 7-17 In: Battle against extinction: Native fish management in the American west. W.L. Minckley and J.E. Deacon, eds. Univ. of Arizona Press, Tucson.

Minckley, W.L., P.C. Marsh, J.E. Brooks, J.E. Johnson, and B.L. Jensen. 1991. Management toward recovery of razorback sucker (Xyrauchen texanus). Pp. 303-357 In: Battle against extinction: Native fish management in the American west. W.L. Minckley and J.E. Deacon, eds. Univ. of Arizona Press, Tucson.

Moyle, P.B. 1976. Inland fishes of California. Univ. of California Press. Berkeley, California. 405 pp.

Mueller, G. 1989. Fisheries investigations in the Central Arizona Project canal system. Final Report 1986-1989. U.S. Bureau of Reclamation, Boulder City, Nevada. 114 pp.

Pister, E.P. 1979. Report of the Death Valley System Committee of the Desert Fishes Council. Proceedings of the Eleventh Annual Symposium, Desert Fishes Council. Nov. 15-17, 1979.

Platania, S.P. 1990. Reports and verified occurrence of logperches (Percina caprodes and Percina macrolepida) in Colorado. The Southwestern Naturalist 34(1): 87-88.

Propst, D.L. and K.R. Bestgen. 1991. Habitat and biology of the loach minnow, Tiaroga cobitis, in New Mexico. Copeia 1991(1):29-38.

Propst, D.L., K.R. Bestgen, and C.W. Painter. 1986. Distribution, status, biology, and conservation of the spikedace (Meda fulgida) in New Mexico. U.S. Fish and Wildlife Service Endangered Species Report No. 15. 93 pp.

Propst, D.L., K.R. Bestgen, and C.W. Painter. 1988. Distribution, status, biology, and conservation of the loach minnow, Tiaroga cobitis, Girard, in New Mexico. U.S. Fish and Wildlife, Albuquerque, New Mexico. Endangered Species Report Number 17. 75 pp.

Propst, D.L., J.A. Stefferud, and P.R. Turner. 1992. Status and conservation of Gila trout Oncorhynchus gilae Miller. The Southwestern Naturalist. 37(2):117-125.

Rinne, J.N. 1991. Habitat use by spikedace, Meda fulgida (Pisces:Cyprinidae) in southwestern streams with reference to probable habitat competition by red shiner, Notropis lutrensis (Pisces:Cyprinidae). The Southwestern Naturalist 36(1):7-13.

Robins, C.R., R.M. Bailey, C.E. Bond, J.R. Brooker, E.A. Lachner, R.N. Lea, and W.B. Scott. 1980. A list of common and scientific names of fishes from the United States and Canada. American Fisheries Society Special Publication No. 12. 174 pp.

Salt River Project. 1994. Letter to Arizona Game and Fish Department re electric barrier outage and white amur movement. February 11, 1994. Phoenix, Arizona. 2 pp.

Schoenherr, A.A. 1981. The role of competition in the replacement of native fishes by introduced species. Pp. 173-203 In: Fishes in North American deserts. R.J. Naiman and D.L. Soltz, eds. Wiley-Interscience Pub., New York, New York.

Schoenherr, A.A. 1988. A review of the life history and status of the desert pupfish, Cyprinodon macularius. Bulletin of the Southern California Academy of Science 87(3):104-134.

Shaflund, P.L., and J.M. Pestrak. 1983. Suppression of largemouth bass production by blue tilapia in ponds. Proceedings of the Annual Conference of the Southeastern Association of Fish and Wildlife Agencies 37:441-446.

Simons, L.H. 1987. Status of the Gila topminnow (Poeciliopsis occidentalis occidentalis) in the United States. Special Report on Project E-1. Arizona Game and Fish Department. Phoenix. 36 pp.

Stauffer, J.R., Jr. 1984. Colonization theory relative to introduced populations. Pp. 8-21. In: Distribution, biology, and management of exotic fishes. W.R. Courtenay, Jr. and J.R. Stauffer, Jr., eds. Johns Hopkins Univ. Press. Baltimore and London.

Stefferud, S.E., and J.A. Stefferud. 1989. A brief sampling of fish and aquatic habitat in the upper San Pedro River, March 24-26, 1989. Report to Bureau of Land Management, Huachuca City, Arizona. 11 pp.

Taylor, J.N., W.R. Courtenay, Jr., and J.A. McCann. 1984. Known impacts of exotic fishes in the continental United States. Pp. 322-373. In: Distribution, biology, and management of exotic fishes. W.R. Courtenay, Jr. and J.R. Stauffer, Jr., eds. Johns Hopkins Univ. Press. Baltimore and London.

University of Arizona. 1993. Game-plan at Maricopa Agricultural Center. Arid Lands Fish Production, Jan./Feb. 1993 II(1):1.

U.S. Department of the Interior, Bureau of Reclamation. 1987. Central Arizona Project Canal System Fishery Investigations Progress Report. Bureau of Reclamation, Boulder City, Nevada. 60 pp.

U.S. Department of the Interior, Bureau of Reclamation. 1988. Central Arizona Project Canal System Fishery Investigations Progress Report. Bureau of Reclamation, Boulder City, Nevada. 59 pp.

U.S. Department of the Interior, Bureau of Reclamation. 1990a. Garrison Diversion Unit joint technical committee report to the United States-Canada consultative group (including the Biology Task Force report). November 1990. Bureau of Reclamation, Billings, Montana. 57 + 73 pp.

U.S. Department of the Interior, Bureau of Reclamation. 1990b. Memorandum to San Carlos Irrigation Project re electric barrier outage. July 9, 1990. Bureau of Reclamation, Phoenix, AZ. 2 pp.

U.S. Department of the Interior, Bureau of Reclamation. 1992. Summary of fish and water quality sampling along the San Pedro River from Dudleyville to Hughes Ranch near Cascabel, Arizona, October 24 and 25, 1991, and the Gila River from Coolidge Dam to Ashurst/Hayden Diversion Dam, October 28-31, 1991. February 26, 1992. Bureau of Reclamation, Phoenix, Arizona. 11 pp.

U.S. Department of the Interior, Fish and Wildlife Service. 1982. Southwestern bald eagle recovery plan. U.S. Fish and Wildlife Service, Albuquerque, New Mexico. 65 pp.

U.S. Department of the Interior, Fish and Wildlife Service. 1983. Arizona trout recovery plan. U.S. Fish and Wildlife Service, Albuquerque, New Mexico. 37 pp.

U.S. Department of the Interior, Fish and Wildlife Service. 1984. Gila and Yaqui topminnow recovery plan. U.S. Fish and Wildlife Service, Albuquerque, New Mexico 56 pp.

U.S. Department of the Interior, Fish and Wildlife Service. 1991a. Endangered and threatened wildlife; the razorback sucker (Xyrauchen texanus) determined to be an endangered species. Federal Register 56(205):54957-54967.

U.S. Department of the Interior, Fish and Wildlife Service. 1991b. Colorado squawfish revised recovery plan. U.S. Fish and Wildlife Service, Denver, Colorado. 56 pp.

Vrijenhoek, R.C., M.E. Douglas, and G.K. Meffe. 1985. Conservation genetics of endangered fish populations in Arizona. Science 229:400-402.

Wells, S.M., R.M. Pyle, and N.M. Collins. 1983. The IUCN invertebrate red data book. International Union for the Conservation of Nature and Natural Resources, Gland, Switzerland. 301 pp.

Williams, J.E., D.B. Bowman, J.E. Brooks, A.A. Echelle, R.J. Edwards, D.A. Hendrickson, and J.J. Landye. 1985. Endangered aquatic ecosystems in North American deserts with a list of vanishing fishes of the region. Journal of the Arizona-Nevada Academy of Science 20(1):1-62.

Williams, J.E., and D.W. Sada. 1985. Status of two endangered fishes, Cyprinodon nevadensis mionectes and Rhinichthys osculus nevadensis, from two springs in Ash Meadows, Nevada. The Southwestern Naturalist 30(4):475-484.

APPENDIX

REJECTED REASONABLE AND PRUDENT ALTERNATIVES BIOLOGICAL OPINION ON THE TRANSPORTATION AND DELIVERY OF CENTRAL ARIZONA PROJECT WATER TO THE GILA RIVER BASIN

During the extensive discussions in the development of the final reasonable and prudent alternative (RPA) several quite different conceptual approaches to removal of jeopardy were considered and rejected along with a wide variety of actions to implement those approaches. The rejected RPA's listed below include conceptual approaches, specific actions, and various combinations of all or part of the actions found in the final RPA.

1. Conceptual approaches:

   a. RPA actions should focus on preventing non-native species from entering the CAP aqueduct. The basic line of defense should be at the intake of CAP at Lake Havasu with secondary defenses to prevent those species that get into the CAP aqueduct from getting out into the Gila basin, and tertiary defenses to prevent those species which get into the Gila basin from entering important listed species habitats. This approach was rejected because successful exclusion of non-native species from the CAP aqueduct is unlikely and not considered vital to protection of listed species.

   b. RPA actions should focus on preventing non-native species from entering the Gila basin from the CAP aqueduct. The basic line of defense should be to prevent non-native species from moving out of the CAP aqueduct into the Gila basin. A secondary line of defense should be to prevent those non-native species which get into the Gila basin from entering important listed species habitats. This approach was rejected because of technological and economic considerations and was replaced by a concept in which RPA actions focus on preventing non-native species from entering important native fish habitats. No secondary line of defense exists with this approach.

2. Use of screens, bar racks, and/or pumps on turnouts from CAP; rejected due to technical infeasibility.

3. Treatment of CAP water with ozone or other chemicals to kill fish, larvae, and eggs; rejected due to economic infeasibility of ozonation, and unacceptable environmental consequences of other chemicals.

4. Closure of the Gila River at the base of Coolidge Dam to fishing and public access; rejected because it is outside the authority of BR.

5. Creation of a fund for contingency management as a proportion of water receipts, with BR implementation of contingency management; rejected in favor of direct BR funding to FWS using existing species conservation infrastructure.

6. Additional electrical barriers; rejected due to lack of data on electrical barrier effectiveness.

7. Evaluation of measures to make Ashurst-Hayden Dam a fish barrier and implementation of only those measures that are cost-effective; rejected due to lack of relationship between removal of jeopardy and cost-effectiveness.

8. Modification of Ashurst-Hayden Dam to form a compete fish barrier; rejected as part of concept 1(b).

9. Assist in treatment of Aravaipa Creek with rotenone; rejected due to need for extensive evaluation of environmental consequences including take and possible jeopardy of the listed fish.

10. Request all agencies to stop stocking non-native fish in the Gila River drainage; rejected as unenforceable and therefore ineffective in relieving jeopardy. Incorporated into a more comprehensive Conservation Recommendation.

11. Request the Game and Fish Departments of Arizona and New Mexico to stop live bait use in the Gila River basin; rejected due to high probability of ineffectiveness. Incorporated into a more comprehensive Conservation Recommendation.

12. Continuation of funding for the bald eagle nest watch program; rejected because the finding for bald eagle is non-jeopardy and this element is not effective in relieving jeopardy for listed fish.

13. Various locations and combinations of physical and electrical barriers, particularly on the Gila River; rejected as parts of concepts 1(a) and (b).

14. Construction of sets of barriers on the Gila and lower San Pedro Rivers to form management zones between barriers that could be managed to control or remove non-native species; rejected as part of concept 1(b).

15. Require annual dryup or non-native fish management in all canals, ditches, siphons, sumps, and other open water sources and conveyances of CAP and entities receiving CAP water; this was part of a an approach which included preventing access of non-natives to the CAP aqueduct which was rejected as part of concept 1(a). Specific actions were moved into the Conservation Recommendations.

16. Modification of points of discharge into the Gila River downstream from canals and ditches to prevent pooled year-round water; rejected as part of concept 1(a).

17. Conduct a program of test applications of piscicide to the Gila River between Coolidge and Ashurst-Hayden Dams and possibly the San Pedro River to refine techniques for non-native fish removal and native fish reestablishment; rejected because existing techniques and expertise are adequately developed for contingency purposes and due to the need to conduct extensive analysis of the potential need for and impacts of such an effort.

18. Maintenance of the existing Pima Lateral electrical barrier; rejected as unnecessary due to other actions in RPA.

19. Study the effectiveness of the existing electrical fish barriers at preventing upstream fish movement; replaced by transfer of funding to FWS for research to support non-native fish management.

20. Prohibit fishing and public access in the CAP; rejected as part of concepts 1(a) and (b).

21. Oppose the introduction of additional non-native aquatic species into waters of the Colorado River basin; rejected as part of concepts 1(a) and (b) and placed into the Conservation Recommendations.

22. Preparation and implementation by BR of management plans for controlling or removing invading non-native fish species; replaced by transfer of funding to FWS for these actions.

23. Development of methods for assessing the probability that an invading non-native fish species came from the CAP; rejected as part of concepts 1(a) and (b).

24. Funding and oversight by BR of research on listed and non-native fishes; rejected in favor of transfer of such funding to FWS for implementation.

25. Transfer of recovery and management of Gila basin native fishes to BR under the oversight of a multi-party team; rejected because of questions regarding legality, because of potential conflicts with Arizona and New Mexico Game and Fish Departments, and because existing infrastructure for recovery and management already exist in the FWS and States.

26. Monitoring of non-native fish in the lower Verde River and Aravaipa Creek; rejected as not required for removal of jeopardy.

27. Geohydrologic study of the Bylas Springs complex; rejected in favor of transfer of funding to FWS for implementation of recovery and protection.

28. Study of the fluvial geomorphology of Aravaipa Creek in relation to human uses and watershed stability; rejected in favor of transfer of funding to FWS for implementation of recovery and protection.

29. Installation and operation of 15 stream flow gages and 4 water quality monitoring stations in the Gila River basin; rejected in favor of transfer of funding to FWS for implementation of recovery and protection.

30. Devising solutions to the groundwater mining and depletion in the upper San Pedro River basin to protect surface flow in the river; rejected in favor of transfer of funding to FWS for implementation of recovery and protection.

31. Devising methods for modernizing irrigation diversions in the Cottonwood and Camp Verde areas of the middle Verde River basin to increase instream flow; rejected in favor of transfer of funding to FWS for implementation of recovery and protection.

APPENDIX B

COMMON WILDLIFE SPECIES IN ARAVAIPA CREEK

APPENDIX B. COMMON WILDLIFE SPECIES IN ARAVAIPA CREEK

BIRDS

Great Blue Heron	*Ardea herodias*
Mallard	*Anas platyrhynchos*
Gadwall	*Anas strepera*
American Wigeon	*Anas americana*
Green-winged Teal	*Anas crecca*
Cinnamon Teal	*Anas cyanoptera*
Turkey Vulture	*Cathartes aura*
Cooper's Hawk	*Accipiter cooperii*
Northern Harrier	*Circus cyaneus*
Harris' Hawk	*Parabuteo unicinctus*
Red-tailed Hawk	*Buteo jamaicensis*
American Kestrel	*Falco sparverius*
Gambel's Quail	*Callipepla gambelii*
Killdeer	*Charadrius vociferus*
Spotted Sandpiper	*Actitis macularia*
Least Sandpiper	*Calidris minutilla*
White-winged Dove	*Zenaida asiatica*
Mourning Dove	*Zenaida macroura*
Greater Roadrunner	*Geococcyx californianus*
Great Horned Owl	*Bubo virginianus*
Barn Owl	*Tyto alba*
Western Screech Owl	*Otus kennicottii*
Lesser Nighthawk	*Chordeiles acutipennis*
Anna's Hummingbird	*Calypte anna*
Black-chinned Hummingbird	*Archilochus alexandri*
Northern Flicker	*Colaptes auratus*
Gila Woodpecker	*Melanerpes uropygialis*
Ladder-backed Woodpecker	*Picoides scalaris*
Vermilion Flycatcher	*Pyrocephalus rubinus*
Western Kingbird	*Tyrannus verticalis*
Black Phoebe	*Sayornis nigricans*
Northern Rough-winged Swallow	*Stelgidopteryx serripennis*
Common Raven	*Corvus corax*
Verdin	*Auriparus flaviceps*
Bewick's Wren	*Thryomanes bewickii*
Cactus Wren	*Campylorhynchus brunneicapillus*
Northern Mockingbird	*Mimus polyglottos*
Black-tailed Gnatcatcher	*Polioptila melanura*
Ruby-crowned Kinglet	*Regulus calendula*

BIRDS (Cont.)

Phainopepla	*Phainopepla nitens*
Loggerhead Shrike	*Lanius ludovicianus*
European Starling	*Sturnus vulgaris*
Bell's Vireo	*Vireo bellii*
Yellow-rumped Warbler	*Dendroica coronata*
Brown-headed Cowbird	*Molothrus ater*
Hooded Oriole	*Icterus cucullatus*
Bullock's Oriole	*Icterus bullockii*
Summer Tanager	*Piranga rubra*
Northern Cardinal	*Cardinalis cardinalis*
Pyrrhuloxia	*Cardinalis sinuatus*
Blue Grosbeak	*Guiraca caerulea*
Black-headed Grosbeak	*Pheucticus melanocephalus*
House Finch	*Carpodacus mexicanus*
Lesser Goldfinch	*Carduelis psaltria*
Abert's Towhee	*Pipilo aberti*
White-crowned Sparrow	*Zonotrichia leucophrys*
Lincoln's Sparrow	*Melospiza lincolnii*
Song Sparrow	*Melospiza melodia*

MAMMALS

Coyote	*Canis latrans*
Gray Fox	*Urocyon cinereoargenteus*
Raccoon	*Procyon lotor*
Striped Skunk	*Mephitis mephitis*
Cactus Mouse	*Peromyscus eremicus*
Deer Mouse	*Peromyscus maniculatus*
Southern Grasshopper Mouse	*Onychomys torridus*
White-throated Woodrat	*Neotoma albigula*
Arizona Cotton Rat	*Sigmodon arizonae*
Arizona Pocket Mouse	*Pergonathus amplus*
Desert Cottontail	*Sylvilagus audubonii*
Black-tailed Jackrabbit	*Lepus californicus*
Western Pipistrelle	*Pipistrellus hesperus*
Big Brown Bat	*Eptesicus fuscus*
Cave Myotis	*Myotis velifer*
Mexican free-tail bat	*Tadarida brasiliensis*
Pallid bat	*Antrozous pallidus*

AMPHIBIANS

Tree Frog	*Hyla arenicoler*
Sonoran Desert Toad	*Bufo alvarius*
Great Plains Toad	*Bufo cognatus*
Western Spadefoot Toad	*Scaphiopus hammondi*
Lowland Leopard Frog	*Rana yavapaiensis*
Chiricahua Leopard Frog	*Rana chiricahuaensis*
Bullfrog	*Rana catesbiana*

REPTILES

Sonora Mud Turtle	*Kinosternon sonoriense*
Spiny Softshell	*Trionyx spiniferus*
Banded Gecko	*Coleonyx variegatus*
Lesser Earless Lizard	*Holbrookia maculata*
Greater Earless Lizard	*Holbrookia texana*
Long-tailed Brush Lizard	*Urosaurus graciosus*
Tree Lizard	*Urosaurus ornatus*
Side-blotched Lizard	*Uta stansburiana*
Regal Horned Lizard	*Phrynosoma solare*
Western Whiptail	*Cnemidophorus tigris*
Coachwhip	*Masticophis flagellum*
Sonora Gopher Snake	*Pituophis melonaleucus*
Common Kingsnake	*Lampropeltis getulus*
Checkered Garter Snake	*Thamnophis marcianus*
Black-necked Garter Snake	*Thamnophis cyrtopsis*
Western Diamondback Rattlesnake	*Crotalus atrox*

FISH

Spikdace	*Meda fulgida*
Loach Minnow	*Tiaroga cobitis*
Roundtail Chub	*Gila robusta*
Desert Sucker	*Catostomus clarki*
Sonora Sucker	*Catostomus insignis*
Speckled Dace	*Rhinichthys osculus*
Longfin Dace	*Agosia chrysogaster*
Carp	*Cyprinus carpio*
Red Shiner	*Notropis lutrensis*
Channel Catfish	*Ictalurus punctatus*
Largemouth Bass	*Micropterus salmoides*
Green Sunfish	*Chaenobryttus cyanellus*
Blue Tilapia	*Tilapia aurea*
Yellow Bullhead	*Ameiurus natalus*
Mosquitofish	*Gambusia affinis*

APPENDIX C

COMMON PLANT SPECIES IN ARAVAIPA CREEK

APPENDIX C. COMMON PLANT SPECIES IN ARAVAIPA CREEK

Common Name	Scientific name
Red Brome	*Bromus rubens*
Bermuda Grass	*Cynodon dactylon*
Century Plant	*Agave chrysantha*
Desert Spoon	*Dasylirion wheeleri*
Fremont Cottonwood	*Populus fremonti*
Gooding Willow	*Salix goodingii*
Arizona Walnut	*Juglans major*
Desert Hackberry	*Celtis pallida*
Net-leaf Hackberry	*Celtis reticulata*
Arizona Sycamore	*Plantanus wrightii*
Water-cress	*Rorippa nasturtium-aquaticum*
Four-wing Saltbush	*Atriplex canescens*
White-thorn Acacia	*Acacia constricta*
Desert Senna	*Cassia covesii*
Blue Paloverde	*Cercidium floridum*
Little-leaf Paloverde	*Cerdicium microphyllum*
Heron-bill	*Erodium cicutarium*
Creosotebush	*Larea divaricata*
Western Soapberry	*Sapindos sapanaria*
Graythorn	*Zizyphus obtusifolia*
Canyon Grape	*Vitis arizonica*
Saltcedar	*Tamarix ramosissima*
Hedgehog	*Echinocereus* Spp
Pincushion	*Mammillaria* Spp
Buckhorn Cholla	*Opuntia acanthocarpa*
Ocotillo	*Fouquieria splendens*
Velvet Ash	*Fraxinus pennsylvanica*
Sacred Datura	*Datura meteloides*
Wolfberry	*Lycium pallidum*
Tree Tobacco	*Nicotiana glauca*
Water Speedwell	*Veronica anagallis-aquatica*
Buttonbush	*Cephalanthus occidentalis*
Canyon Ragweed	*Ambrosia ambrosioides*
Triangle-leaf bursage	*Ambrosia deltoidea*
Desert Broom	*Baccharis sarothroides*
Seepwillow	*Baccharis salicifolia*
Desert Marigold	*Baileya multiradiata*
Brittlebush	*Encelia farinosa*
Burroweed	*Haplopappus tenuisectus*
Burobrush	*Hymenoclea monogyra*
Cocklebur	*Xanthium strumarium*

APPENDIX D

SPECIAL STATUS SPECIES

APPENDIX D. SPECIAL STATUS SPECIES

Lesser long-nosed bat (*Leptonycteris curasoae yerbabuenae*) - The lesser long-nosed bat (formerly Sanborn's long-nosed bat) is one of three leaf-nosed bats in Arizona (Hoffmeister 1986). This species was listed as endangered on September 30, 1988 (Federal Register Vol. 53 No. 190). The current range of the lesser long-nosed bat extends from southern Maricopa County through Pinal, Pima, Cochise, and Santa Cruz Counties and into Mexico.

This species is found mainly in desertscrub habitat dotted with agaves (*Agave* sp.), mesquite, creosotebush (*Larrea tridentata*), and columnar cacti. Daytime and maternity roosts are located in caves and abandoned mines. The bats feed on nectar and pollen from saguaros and agaves forming a mutualistic relationship with these plants (FWS 1991). They cannot tolerate prolonged exposure to cold, do not hibernate and spend winters in Mexico.

The project area is surrounded by Sonoran Desertscrub habitat which includes saguaros. It is most likely utilized by lesser long-nosed bats on a transient basis. The closest roosting colonies to the project area are in the Santa Catalina, Galiuro and Pinaleno Mountains with the closest site being over 30 miles away (Sabra Schwartz, AGFD, personal communication, 13 March 1998).

Bald Eagle (*Haliaeetus leucocephalus*) - In 1978 all bald eagles in 43 of the 48 contiguous United States, including Arizona, were classified as endangered (43 FR 6233, February 14, 1978), and those in Minnesota, Wisconsin, Michigan, Oregon, and Washington were classified as threatened. On July 12, 1995, the bald eagle was downlisted to threatened in all 48 States (Fed Register Vol 60, No. 133, page 36000-36010).

In Arizona, the number of known bald eagle nesting areas has steadily increased from 1 or 2 in 1970, to 38 in 1998. This increase may have resulted from the establishment of new territories as well as from increased nest search efforts.

There have been no recorded bald eagle nests in the project area. The nearest nest is located approximately 20 miles north of the project area, near the confluence of the San Pedro and Gila Rivers. The Winkelman nest territory was first active in 1995 but no nesting was attempted. In 1996, 2 eggs were laid but failed to hatch. The nest also failed in 1997 and has been classified as unoccupied in 1998.

Yuma clapper rail (*Rallus longirostrus yumanensis*) - The Yuma clapper rail is a chicken-shaped marsh bird with a long, down-curved beak. This subspecies is found along the Colorado River from Needles, California, to the Gulf, at the Salton Sea and other localities in the Imperial Valley, California, along the Gila River from Yuma to at least Tacna, Arizona, and several areas in central Arizona, including Picacho Reservoir (Todd 1986; Rosenberg et al. 1991).

Yuma clapper rails are found in emergent wetland vegetation such as dense or moderately dense stands of cattails (*Typha latifolia* and *T. domingensis*) and bulrush (*Scirpus californicus*) (Eddleman 1989; Todd 1986). They can also occur, in lesser numbers, in sparse cattail-bulrush stands or in dense reed (*Phragmites australis*) stands (Rosenberg et al. 1991). The most productive clapper rail areas consist of a mosaic of uneven-aged marsh vegetation interspersed with open water of variable depths (Conway et al. 1993). Annual fluctuation in water depth and residual marsh vegetation are important factors in determining habitat use by Yuma clapper rails (Eddleman 1989).

The nearest population of clapper rails is located at Picacho Reservoir, approximately 40 miles west of the project area (Sabra Schwartz, AGFD, personal communication, 13 March 1998).

Peregrine falcon (*Falco peregrinus anatum*) - The historic breeding range for the peregrine falcon extended from Canada and Alaska south into Baja, California, central Mexican highlands and northwest Mexico, including continental United States (U.S.) with the exception of the southeast part of the country. In Arizona, both resident and migrant peregrine falcons are found over the entire state.

Peregrine falcons in the southwest inhabit cliffs and river gorges near water. Eyries occur on cliffs which generally exceed 61 m in height. Eyries are situated on open ledges and a preference for a southern exposure increases with latitude (FWS 1984). There are approximately 188 breeding pairs of peregrine falcons in Arizona (Sabra Schwartz, AGFD, personal communication, March 13, 1997).

The peregrine falcon (*Falco peregrinus anatum*), occurs in the project area on a transient basis. The closest nesting population is approximately 20 miles to the east in Aravaipa Canyon (Sabra Schwartz, AGFD, personal communication, 13 March 1998).

Cactus ferruginous pygmy-owl (*Glaucidium brasiliarum cactorum*) - The subspecies of cactus ferruginous pygmy-owl (pygmy-owl) which is found in Arizona was listed as endangered on March 10, 1997 (Vol 62, No. 46, 10730-10747).

Little is known of this species' life history in Arizona. The pygmy-owl is similar in appearance to its congener, the northern pygmy-owl, which is also found in the State. This small (17 cm) owl can be distinguished from other small owls in the State by its long tail and round earless head. It can be identified from the similar northern pygmy-owl by the dark versus light barring in the tail. However, the best criteria for identification is its call.

Historically, the species was more common and widespread in the State. Records have shown this species utilized cottonwoods (*Populus fremontii*) and willows (*Salix goodingii*) for nesting in riparian woodlands (Rea 1983). Records prior to 1971 indicate this species was found as far north in the State as the Blue Point Cottonwoods near the confluence of the Salt and Verde Rivers (Millsap and Johnson 1988). Today confirmed reports of pygmy-owls in Arizona are

exclusively from Sonoran desertscrub below 3000 ft (914 m) in elevation and south of Picacho Peak (AGFD 1996). The habitat contains foothill paloverde (*Cercidium microphyllum*) and saguaro cacti (*Cereus giganteus*) in large numbers, but it is the presence of medium and large ironwood trees (*Olnea tesota*) in varying densities that predominate all detection areas (AGFD 1996).

No record for pygmy-owl (*Glaucidium brasilianum cactorum*) is known for the site. The last verified sightings on the lower San Pedro River were in 1985 and 1986 at Dudleyville, Arizona where two birds were seen each year (Sabra Schwartz, AGFD, personal communication, 13 March 1998). The closest nesting population is in northwest Tucson, 40 air miles away. Reclamation conducted surveys for the cactus ferruginous pygmy-owl (according to AGFD protocol) on evening of May 20 and the morning of May 21, 1998. No pygmy-owls response was elicited.

Southwestern willow flycatcher (*Empidonax extimus traillii*) - The southwestern willow flycatcher was listed as endangered in Federal Register Vol. 60, No. 38, February 27, 1995 (FWS 1995). The southwestern willow flycatcher is difficult to distinguish from other members of the genus *Empidonax*. Identification is more easily verified by its call, a sneezy "fitz-bew."

The southwestern willow flycatcher is one of four subspecies of the willow flycatcher most commonly recognized in North America (Tibbitts et al. 1994). The four subspecies have subtle differences in color and morphology and occupy distinct breeding ranges. The breeding range of *E. t. extimus* includes southern California, Arizona, New Mexico, the extreme southern portions of Nevada, Utah, and western Texas.

No southwestern willow flycatcher surveys have been conducted on Aravaipa Creek due to lack of suitable habitat (Muiznieks et al. 1994, Sferra et al. 1995, Spencer et al 1996, Sferra et al. 1997, and AGFD in press). The closest breeding territories occur on the San Pedro River near the confluence with Aravaipa Creek. In 1998, additional flycatcher territories have been located immediately upstream of the confluence on the San Pedro River.

Chiricahua leopard frog (*Rana chiricahuensis*) - The Chiricahua leopard frog, *Rana chiricahuensis*, described in 1979 by Platz and Mecham (1979), had already suffered serious reduction in geographic range in Arizona by 1987 (Clarkson and Rorabaugh 1989). The species was afforded Candidate status under the Endangered Species Act listing process in 1996 (FR 61(40):7600). The Chiricahua leopard frog was reported from both the headwaters (23 km northeast of Bonita) and lower reach (9 km east of Highway 77) of Aravaipa Creek by Frost and Platz (1983), while Platz and Frost (1984) reported the lowland leopard frog (*R. yavapaiensis*)

from the same lower site. There are more recent records of lowland leopard frog from upper Aravaipa Creek (M. Sredl, AGFD, personal communication, June 10, 1998), but no sightings of *R. chiricahuensis* have been recorded along the stream since the records of Frost and Platz (1983).

Reclamation conducted surveys for the Chiricahua leopard frog in the project area on the evening of May 20, 1998. No leopard frogs of any species or life stage were definitely encountered during the survey. *Bufo* spp. were seen and captured (eggs, larvae, and metamorphs), as were adult canyon tree frogs, (*Hyla arenicolor*).

Gila topminnow (*Poeciliopsis occidentalis occidentalis*) - The species Sonora topminnow *Poeciliopsis occidentalis* includes two subspecies: Gila topminnow *P. o. occidentalis*, distributed in the Gila River Basin of Arizona and New Mexico and the Ríos Gila, Concepción, and Sonora basins of Sonora, Mexico; and Yaquí topminnow *P. o. sonoriensis*, distributed in the Río Yaquí Basin of northern Mexico and extreme southeastern Arizona. Both of these poeciliids (livebearers) were listed as federally endangered in 1967 without designation of critical habitat. Gila topminnow was formerly distributed widely throughout lower (<4920 ft) elevations in the Gila River Basin among springs, streams, and marshes, but populations continue to dwindle (Bagley et al. 1991, Hendrickson and Brooks 1991). Loss of habitat due to declining water tables, arroyo cutting, and introduction of nonnative fishes, especially mosquitofish *Gambusia affinis*, are primary reasons for its decline (Meffe et al. 1983, Stefferud 1984, Marsh and Minckley 1990).

Today, less than a dozen natural populations of Gila topminnow remain in Arizona, with most occurring within the Santa Cruz River Basin (Stefferud 1984, Brown and Abarca 1992). The two historic collection localities in the San Pedro River Basin (San Pedro River 4 mi N of Feldman, artesian spring 8 mi SE of Mammoth) no longer support populations of Gila topminnow. Extensive repatriation efforts have been undertaken in Arizona since the 1960s, but relatively few have had long-term success (Bagley 1991, Hendrickson and Brooks 1991). Three attempts to stock Gila topminnow into Aravaipa Creek (two in 1967 and one in 1977) failed (David Weedman, Arizona Game and Fish Department, personal communication).

Loach minnow *(Tiaroga cobitis)* - Loach minnow is a small, short-lived fish endemic to streams of the Gila River Basin. The species has been extirpated from most of its historic range, surviving as a relatively large population only in Aravaipa Creek (Minckley 1981). In Arizona, smaller populations inhabit the East Fork Black River (Marsh 1997), Blue River, Campbell Blue River, White River, San Francisco River, and Eagle Creek. In New Mexico, loach minnow is found along portions of the Gila, Tularosa, and San Francisco rivers, and in Dry Blue Creek (USFWS 1990a). Loach minnow was listed as threatened on October 28, 1986 (Federal Register Vol. 51 No. 208).

Loach minnow is a current-loving species, inhabiting interstices of gravel and rubble in shallow, well-defined, stream riffles (USFWS 1990a), similar to the habits of darters in the Mississippi River drainage. In Aravaipa Creek, loach minnow is consistently rare compared to most other species (Minckley 1981). Numbers are greatest within the gorge area, and it is infrequently collected below that reach (Minckley 1981). Apparently summer water temperatures in the lowermost canyon preclude year-round habitation by this species there (W.L. Minckley, Arizona State University, personal communication). Foods in Aravaipa Creek were predominantly ephemeropteran nymphs and black fly (Family Simuliidae) larvae (Schrieber and Minckley 1981).

Spikedace *(Meda fulgida)* - Spikedace is another small-bodied, short-lived fish endemic to the Gila River Basin that has been extirpated from most of its historic range. In Arizona, spikedace remains only in Aravaipa Creek, a portion of the upper Verde River, and in Eagle Creek, and also inhabits the upper Gila River in New Mexico (USFWS 1990b). Spikedace was listed as threatened on July 1, 1986 (Federal Register Vol. 51 No. 126).

Spikedace occupies flowing pools generally less than a meter deep over sand, gravel, or mud bottoms below riffles or in eddies (Minckley 1981). Foods in Aravaipa Creek are primarily ephemeropteran nymphs and dipteran larvae, but substantial numbers of winged adults of these groups and caddis flies are taken (Schrieber and Minckley 1982). Spikedace is more frequently encountered in the lower canyon of Aravaipa Creek than loach minnow, and standing crops are relatively high there compared to above the gorge (Minckley 1981).

Desert Tortoise (*Gopherus agassizii*) - The desert tortoise is a long-lived terrestrial reptile that inhabits desert regions in the southwestern U.S. The Sonoran population is isolated from the Mojave population by the Colorado River. Arizona's Sonoran population of desert tortoise occurs discontinuously south and east of the Colorado River, from Lake Mead National Recreation Area through the southwestern, west-central, and south-central parts of the State. The precise range limits are generally not well known, and there are frequent information gaps within the known or suspected limits (Barrett and Johnson 1990).

The desert tortoise occupies a variety of habitats throughout its range. In Arizona's Sonoran desert, the desert tortoise typically occurs in the paloverde-cacti-mixed scrub series (Barrett 1990). Rangewide, the desert tortoise is typically found at elevations of 300 m to 1067 m. In Arizona, it has been found as low as 158 m (Mohave Valley, Mohave County) and as high as 1615 m (east slope of the Santa Catalina Mountains, Pima County) (Barrett and Johnson 1990).

Sonoran desert tortoise sheltersites (dens, pallets, etc.,) are usually found on rocky bajadas and slopes, or in washes that dissect the desertscrub. Tortoises will use more than one den and reuse previously occupied dens (Barrett and Johnson 1990). They appear to avoid the deep, fine-soiled valley situations favored by the Mohave desert tortoise.

There is no habitat for this species in the immediate project area. Potential habitat is located

upslope on the bajadas.

Western yellow-billed cuckoo (*Coccyzus americanus occidentalis*) - In Arizona, the western yellow-billed cuckoo is an uncommon to fairly common breeder in riparian habitats, primarily below the Mogollon Rim in the Colorado and Gila River drainages (Phillips et al. 1964). The largest concentrations are in the Upper Santa Cruz, San Pedro, Verde, Bill Williams and Gila River drainages of central and southeastern Arizona (Krueper, in press).

A riparian obligate species found in highest occurrences and density on cottonwood/willow associations Yellow-billed cuckoos require a minimum of 10 hectares (ha) of broad-leafed forest at least 100 m wide (Gaines 1974) and at least 1 ha of dense nesting habitat per pair (Laymon and Halterman 1989). Marginal habitat is described as "a minimum of 4 ha of broad-leafed forest at least 50 m wide, and at least 0.5 ha of dense nesting habitat" (Laymon and Halterman 1989). Multiple pairs of cuckoos can be found in wider strips (>100 m wide and > 265 ha patches) of habitat versus narrow strips, where pairs are distributed more widely (Laymon, personal communication).

The project area does not provide suitable habitat for the western yellow-billed cuckoo.

Greater western mastiff bat (*Eumops perotis californicus*) - The greater western mastiff bat belongs to the Mollossidae family (free-tailed bats) (AGFD 1992). It is one of only six North American species of *Eumops*, of which only two species are found in Arizona (AGFD 1992). The greater western mastiff bat is the largest bat in the U.S.

In Arizona, the greater western mastiff bat is considered a year round resident based on collections or calls heard in every month except January. Unlike other species, the greater western mastiff bat makes a distinctive, piercing, high pitched "cheep" every 2 to 3 seconds during flight. The call is louder than that of any other U.S. bat and, unlike other bats, it is emitted almost continuously while flying (AGFD 1992).

Greater western mastiff bats roost in crevices and shallow caves on the sides of cliffs and rock walls (Hoffmeister 1986). The habitat is primarily lower and upper Sonoran desertscrub (AGFD 1992). They need a roost site with a vertical drop of 3 m or more because their large body size and narrow wings make ground launching difficult (AGFD 1992). These bats prefer to crowd into tight crevices 0.3 m or more deep and 5 cm or more wide (AGFD 1992). They will roost singly or in groups of two, but usually in colonies of up to 100 individuals (AGFD 1992). Threats to this species include disturbances at roost sites (AGFD 1992).

There is no roosting habitat for this species in the project area.

Mexican garter snake (*Thamnophis eques*) - Mexican garter snake is a large (up to 39 inches), highly aquatic species tied to the presence of perennial water, and is found in riparian and marsh

habitats in east-central and southeastern Arizona and southward to Oaxaca, Mexico. Its known distribution includes the upper San Pedro River drainage, but it is unknown if the species inhabits the lower drainage and Aravaipa Creek. The species has generally disappeared from lowland habitats in Arizona (Stebbins 1985). Nonnative species introductions, especially bullfrog *Rana catesbeiana* and predatory fishes, have negatively impacted this species (Rosen and Schwalbe 1988). Cattle overgrazing also has impacted habitats of Mexican garter snake through elimination of ground cover. The species has been extirpated from several localities since 1950, and has completely disappeared from the Tucson area, where it formerly had been abundant (Rosen and Schwalbe 1988).

Mexican garter snakes feed primarily on fishes and amphibians, and supplement their diet with mice and lizards (Rosen and Schwalbe 1988). Young are born alive in early June to early July. Although body and clutch sizes of Mexican garter snake are relatively large for garter snakes, reproduction apparently occurs only once every two years, and reproductive output is therefore low (Rosen and Schwalbe 1988). Long adult lifespan and apparent low juvenile survivorship are other life history features of this species.

Lowland leopard frog (*Rana yavapaiensis*) - Lowland leopard frog is one of the several species of leopard frog described from Arizona in recent decades that has escaped widespread population losses from the interior of Arizona, although it has been lost from the lower Colorado River, Arizona-California, and Imperial County, California (Clarkson and Rorabaugh 1987). Introduction of bullfrogs and nonnative predatory fishes is the most serious known threat, and invasion of the nonnative Rio Grande leopard frog is cause for concern to some populations (Platz et al. 1990). Specific causes of recent declines of this and other amphibian species in Arizona and elsewhere are largely undetermined.

Lowland leopard frog is distinguished from Chiricahua leopard frog by a mottled network of dark blotches on the rear thighs (Chiricahua leopard frog has white spots) and smaller body proportions. Populations may hybridize with Chiricahua leopard frog where ranges overlap (Stebbins 1985). Platz and Frost (1984) reported lowland leopard frog from lower Aravaipa Creek, and there are more recent records of lowland leopard frog from upper Aravaipa Creek (M. Sredl, AGFD, personal communication, June 10, 1998).

Roundtail chub (*Gila robusta*) - Roundtail chub was historically widespread in larger streams and rivers and their tributaries in the Colorado River Basin. In the Gila River Basin, it is now largely found only in smaller, less impacted, tributary streams. The subspecies in Aravaipa Creek has been designated as *G. r. grahami*, one of four subspecific forms variously recognized within the species complex (Minckley 1973). The species inhabits pools and eddies and the relatively swift waters below rapids. Roundtail chub can readily be caught on hook and line, and is classified as a sport fish in Arizona.
In Aravaipa Creek, roundtail chub consumes larger invertebrates, small lizards, and other fishes, occupying the position of "top carnivore" when large (Minckley 1973, Schrieber and Minckley 1981). It is highly secretive, mostly inhabiting deeper pools as adults (Minckley 1973). Chubs

have been shown to move long distances in Aravaipa Creek, possibly a response to seasonal temperature changes (Siebert 1980, Williams 1991). Relatively little information on other aspects of its life history is known.

Mexican garter snake is a large, highly aquatic species found in riparian and marsh habitats in east-central and southeastern Arizona and southward to Oaxaca, Mexico. Its distribution includes the San Pedro River drainage, but it is unknown if the species inhabits Aravaipa Creek. Nonnative species introductions, especially bullfrog, have negatively impacted this species through predation (Rosen and Schwalbe 1988), and the species has been extirpated from several localities since 1950. Mexican garter snakes feed primarily on fishes and amphibians, and bear live young in early June to early July.

Townsend's big-eared bat (*Plecotus townsendii*) - Townsend's big-eard bat is one of only 5 species in the genus (*Plecotus*); three species occur in the U.S. and only one in Arizona. Within Arizona, Townsend's big-eared bat has a widespread distribution, but is not common anywere and is least common in northeastern grasslands and southwestern desert areas (AGFD 1992).

Townsends big-eared bats utilize caves and mine tunnels during the day but often rest in abonadoned buildings at night (Hoffmeister 1986). They prefer to hang from open ceilings at roost sites and do not use cracks or crevices (AGFD 1992). At maternity roosts thesse bats prefer dim light near the edge of the lighted zone (AGFD 1992). Townsend's big-eared bats can be found from low elevation desertscrub to coniferous forests (Hoffmeister 1986). Wintering habitat is in cold caves and mines in the upper elevations, from the Grand Canyon to southeastern Arizona.

Although general populations trends indicate that population losses are occurring, no specific therets were identified (AGFD 1992).

There are no caves to provide night roosts in the immediate project area.

Western red bat (*Lasiursu borealis*) - The western red bat is a summer resident of Arizona (AGFD 1992). The preferred habitat is riparian and oter wooded areas where they roost in trees by day. They are often found in fruit orchards but also roost in saguaro boots and occasionally in cave-like situations (E.L. Cockrum, personal communication *in* AGFD 1992). Although they generally avoid caves and buildings during both summer and winter. Western red bats range from 2400 to 7200 feet in elevation. They have been found upstream on Aravaipa Creek on The Nature Conservancy property (AGFD 1992).

There is limited but potential habitat in the project area. The few trees removed would not be expected to adversely impact this species.

Mesquite Mouse (*Peromyscus merriami*) - The mesquite mouse, like name implies, is restricted to mesquite bosques (forests). They are found in south central Arizona (Hoffmeister 1986). Little information has been recorded for this species. The demise of most of the major mesquite bosques in southern Arizona has most likely significantly impacted this species (Hoffmeister 1986).

Although there is a remnant mesquite bosque in the project area it is unknown whether the mesquite mouse would be present. It apears that the project area may actually be just outside of the range for this species.

APPENDIX E

PREHISTORIC AND HISTORIC HABITATION

APPENDIX E. PREHISTORIC AND HISTORIC HABITATION

Archaeological data on the occupation of the lower San Pedro Valley by Paleo-Indian big-game hunters and Archaic hunters and gatherers is limited, and as a consequence not much is known about these early inhabitants. Significantly more data are available on the Hohokam. Primarily farmers, the Hohokam established villages along the lower San Pedro River beginning around the 5th century A.D. Villages were often located near the mouths of major tributary drainages because these locations offered the Hohokam not only fertile floodplain areas for farming, but two riparian systems that could be exploited for their plant and animal resources (Masse 1980:210). During the next several centuries, Hohokam occupation along the lower San Pedro and its tributaries continued and even expanded. Large and small villages grew in number to accommodate a growing population. Some of the large major villages contained one or more ballcourts that served as gathering places for rituals and games for people from surrounding smaller sites. The smaller sites were often situated on terraces and were associated rock piles, check dams, and other water control and water harvesting features necessary for dry farming (Masse 1980.216).

Beginning in the 13th century A.D., what archaeologists call the Classic Period began. Lasting until around A.D. 1400, the Classic period along the lower San Pedro Valley is associated with immigration of Indian groups from plateau and mountain areas to the north and east. Whereas the Preclassic period is noted for its ballcourts, the Classic period in southern Arizona is associated with platform mounds and surface structures of adobe and cobbles enclosed by walls (these walled villages are known as compounds). Recent survey along the San Pedro River (Doelle 1990a; 1990b; 1995) identified several platform mound and compound village sites. Platform mounds were probably used for ritual observation, and platform mound sites are often located at regular intervals along the river as if identifying distinct boundaries (Doelle 1995:2). Farming continued to be the primary subsistence pursuit of the Classic period occupants of the lower San Pedro Valley.

Between A.D. 1400 and 1500, the Classic period ended for reasons that remain unclear to archaeologists. Native populations along the lower San Pedro (and throughout most of southern Arizona) declined, and settlement patterns shifted into fewer and smaller villages. When the first Spanish explorers ventured into southern Arizona and down the San Pedro River, groups of native farmers resided in a string of villages located along the river. These villages lacked the platform mounds, compounds, and adobe and stone masonry architecture that marked the Classic period. These farmers, known as the Sobaipuri, apparently were well established in southern Arizona when the Spanish arrived in the mid-16th century A.D. (Masse 1981:28). Archaeological data for the Sobaipuri is limited and somewhat confusing. Sites definitely identified as Sobaipuri are few, and the limited archaeological data conflict with the documentary evidence provided by the Jesuit priest Eusebio Francisco Kino and other Spanish explores in the

17th and 18th centuries (Masse 1981:28,44). According to Spanish reports, the Sobaipuri were successful irrigation farmers who lived in oval, brush-covered structures along the San Pedro and Santa Cruz rivers. Limited archaeological data suggest they were primarily hunter-gatherers, with farming playing a minor subsistence role (Masse 1981:44).

Regardless, Spanish documents indicate that beginning in the latter part of the 17th century Sobaipuri living on the San Pedro River were being pushed west into the Santa Cruz River Basin by Apache raiders. By 1762 Apache raids had effectively forced the Sobaipuri to abandon the San Pedro River basin (Masse 1981:28-30).

The Apache arrived in the southwest sometime in the late 15th and early 16th centuries and are related to Athapaskan groups in Alaska, Canada, and Northern California (Bronitsky and Merritt 1986:257). The lower San Pedro River and surrounding area to the east was occupied by the Aravaipa band of the San Carlos group of Western Apache, who controlled the area until eventually forced onto a reservation by the American army in the late 1800s.

The Apache were farmers, who also moved frequently in search of game and wild plant foods. When they eventually acquired the horse from the Spanish, raiding also became an important subsistence pursuit. Apache settlement (for example, the lack of permanent architecture) and subsistence practices have contributed to the absence of archaeological visibility of Apache sites. Because archaeologists have had trouble identifying Apache sites, archaeological data are limited (Bronitsky and Merritt 1986:258).

Indian Trust Allotment 013736, also historically known as the Chiquito Allotment, has a long well-documented history of Apache tribal cultural affiliation and an incredibly sad history. In 1871 Chief Eskiminzin and his band of 150 Aravaipa (Creek) Apaches lived around the outer limits of the Camp Grant Military Reservation, just two miles downstream from this allotment, near the confluence of Aravaipa Creek with the San Pedro River. To avenge the death of four Anglos reportedly at the hands of Indians, in April that year, a mob of angry whites from Tucson entered the Indian settlement near Camp Grant and murdered 118 of the band. Only a handful of the Aravaipa Apaches managed to escape with their lives and none of their possessions save what they wore. Eventually, out of dire necessity, they gravitated back to their homeland base. Their descendants, 12 in number, applied for and received 800 acres of trust allotments along Aravaipa Creek and the San Pedro River and upon which they reestablished themselves, cultivated garden tracts by gravity diversions of their own labors and managed to remain relatively self sufficient by their diligence and to eke out an existence there. The vigilantes never were convicted in a court of law in Arizona Territory. In time, history proved the Aravaipa Apaches were innocent victims in this thirst-for-revenge case of "mistaken identity."

In the entire state of Arizona 7,846 patents for trust Indian allotments, aggregating 179,868 acres were granted by the Federal Government. Chiquito's Allotment is one of the most extraordinary and rarist of all Arizona Indian allotments, for it is one of but 18 which possessed and still possesses a perennial stream upon it, from which gravity water was diverted by Indian

occupant owners for agricultural subsistence gardens. It was the presence of perennial water upon and within these several allotments that was and yet is so vital as a trust asset of the Indian owners, and the principal reason for the selection of these lands initially and subsequently again by the Indian owners as trust allotments.

APPENDIX F

COMMENT LETTERS AND RESPONSES TO COMMENTS

United States Department of the Interior

BUREAU OF INDIAN AFFAIRS
PHOENIX AREA OFFICE
P.O. BOX 10
PHOENIX, ARIZONA 85001

TAKE PRIDE IN AMERICA

IN REPLY REFER TO:
Land and Water Resources
(602) 379-4511

OCT 13 '98

OCT 05 1998

DATE		INITIALS
10/13	1000	JSB
10/13	1015	
	1500	

Mr. Thomas G. Burbey, Area Manager
Bureau of Reclamation
Phoenix Area Office
P. O. Box 9980
Phoenix, Arizona 85068-0980

Subject: Comments to Draft Environmental Assessment - Construction of Fish Barriers on Aravaipa Creek - August 1998

Dear Mr. Burbey:

We have the following comments to the subject draft environmental assessment:

1. Has this document been provided to the allottees for their review and comment? **1-1**

2. Page 4, Table 1: Blasting permits required by the county should probably be included in this table, in case blasting is necessary. **1-2**

3. Page 6, Figure 2-2: "Overshute" should be "Overchute." **1-3**

4. Page 7, 1st ¶, 5th line: Should add "and 013736." to end of sentence. Land was farmed on both allotments. **1-4**

5. Page 7, last ¶: How frequently will the reach be monitored? **1-5**

6. Page 8, 4th ¶: Don't understand "...provided the material is properly drained." **1-6**

7. Page 8, Section C: Should add paragraph to summarize construction activities required for raising road in two locations. **1-7**

8. Page 9, Section F: Will Contractor be prohibited from storing any hazardous materials including petroleum products on site? **1-8**

9. Page 9, Section G: How frequent will the monitoring be? Annually? After floods? **1-9**

10. Page 15, subsection b, last sentence: At the public meeting it was suggested that an outside contractor be hired to review BOR's results - is this still being considered? Will road improvements be included in the final river model? **1-10**

11. Page 15, Table 2: Checking the figures in the table and the inundation map, it seems there is more of a difference between the higher floods than 1.3 acres. Using overlays it appears there is more of a spread for the 100 year than the 50 year, than indicated by the table. **1-11**

12. Page 21, 2nd ¶: How did you get the 0.16 cfs from the 6,750 square feet? Needs more information. **1-12**

13. Page 21, 3rd ¶: Is it possible/likely that all water will go underground at the barrier site, due to the new restriction? **1-13**

14. Page 21, subsection d: Define "momentary traffic delays" - will you require Contractor to keep the roadway open (at least one lane) at all times with no more than brief delays limited to 5 to 10 minutes? Will Contractor be required to provide signing/flag people? **1-14**

15. Page 21, subsection d, 5th line: Delete "or BIA requirements (BIA is the agency of jurisdiction for those portions of Aravaipa Road that are located on allotted land)."

    As it relates to the road surface, design standards, construction, and maintenance, the BIA is not the "agency of jurisdiction." The road is not on the BIA (IRR) road system and BIA does not have right-of-way. The road should be constructed to Pinal County standards. Pinal County has "implied authority" on the roadway surface as the maintaining entity. **1-15**

16. Page 21, subsection d, Public Road impacts: Add information in the report as to total length of road that would have to be constructed, to what height, additional width, to be to County standards with the barriers in place. **1-16**

17. Page 22, last ¶, 3rd line: Should "may" be "would"? Is it definitely known at this time that some stabilization will be necessary? **1-17**

18. Page4 24, last ¶, 3rd line: Is 0.5 acre-ft correct? Seems like both barriers would store about the same amount of sediment. **1-18**

19. Page 25, 2nd ¶, 9th line: Delete "momentary" - if erosion is increased for a short time it will still be an increase in overall erosion. **1-19**

20. Figure 3-7: Text is difficult to read - suggest changing text to black print. **1-20**

21. Page 36, 2nd ¶, 2nd line: Where is Table 3-3? **1-21**

22. Page 36, last ¶: Is it possible/likely that listed species will travel downstream of the barriers and be trapped in pools that will eventually dry up? Isn't this a take? Could this be included in the monitoring program, and trapped listed species be transported back upstream? **1-22**

23. Page 37, 3rd ¶: I can envision all of a listed species being washed downstream of the barriers during a flood - is this possible? Please expand on last sentence. **1-23**

24. Page 47, Table 6, Aquatic Resources, 4th row: Delete "native." **1-24**

25. Page 52, Section D: It should provide more details of monitoring, including frequency. **1-25**

26. Page 53, Environmental Consequences: There should be further discussion on riprap impacts here. **1-26**

27. Page 53, 4th ¶, 1st line: Change "foreseeable" to "foreseeably"; 3rd line: add "and 013736." after 013622. **1-27**

28. Page 54, 2nd ¶, 5th line: Delete "or the requirements of the BIA (BIA is the agency of jurisdiction for the segments of Aravaipa Road located on allotted lands)."

    As it relates to the road surface, design standards, construction, and maintenance, the BIA is not the "agency of jurisdiction." The road is not on the BIA (IRR) road system and BIA does not have right-of-way. The road should be constructed to Pinal County standards. **1-28**

29. Page 54, Item 2: Allotment No. 013622 is currently fenced along the west and south sides. If a fence was added beginning at the west fence and following the roadway east past the fish barriers, it would probably be a great benefit to keeping the public away from the fish barriers (provided the fences are not damaged/destroyed by vandalism). This is a suggestion that might be beneficial for everyone - would need to ensure the allottees want such a fence. **1-29**

30. Page 61, 2nd ¶, 7th line: Change "the county road" to "Aravaipa Road." **1-30**

31. Page 63, 4th ¶, 5th line: Change "referred to as "implied rights"" to "federally reserved water rights." **1-31**

32. Page 64, 1st ¶, 2nd line: After "adjudication," insert "The state adjudication process is under Arizona Revised Statutes §45-251 to 45-260 and is being conducted in the State Superior Court. The general adjudication of the Gila River System and Source has been assigned to the Superior Court for Maricopa County." 1-32

33. Appendix E, page E-1, 3rd line: Change "area" to "are." 1-33

Our realty staff have provided comments concerning right-of-way procurement that do not appear to have direct bearing on the EA. The comments are attached for your information (Memorandum dated September 24, 1998).

Please call Bobbie Ohler at (602) 379-4511 if you have questions concerning the comments.

Sincerely,

John Phillips

Acting Area Director

Response to Letter of Comment from the Bureau of Indian Affairs

1-1. The draft EA was provided to allottees with property interests in Indian Trust Allotments 013736 and 013622.

1-2. A County blasting permit is not required according to the Pinal County Department of Civil Works.

1-3. This correction has been made in final EA.

1-4. The reference to "013736" has been added to the final EA.

1-5. The frequency of monitoring is undetermined at this time. We anticipate monitoring will be performed annually and following episodes of flooding. The final EA has been revised to reflect this information.

1-6. Dewatered alluvium would be more stable and easier to excavate than alluvium that is saturated with water.

1-7. A description of modifications to Aravaipa Road has been included in the final EA.

1-8. Fuel and lubricants would be stored in the contractor use area. Reclamation requires secondary containment with an impermeable lining for fuel storage areas on all construction projects.

1-9. See response 1-5.

1-10. Reclamation will have the final project design reviewed by an independent architect engineer as promised during the June 27, 1998, scoping meeting in Winkelman. The final EA includes this commitment as a mitigation measure (see chapter III, section L). Proposed road modifications will be included in the final river model.

1-11. The added flood effects listed in Table 2 were quantified from GIS data layers. These estimates, however, do not reflect the results of final river modeling which will be performed once all pertinent field data have been collected.

1-12. The depth to bedrock will be determined when the right-of-entry is obtained from the BIA to allow geologic investigations. Until the depth of alluvium is measured, we are assuming the center of the channel is 60 to 80 feet deep. If this assumption proves to be accurate, a permeable alluvial zone with a hydraulic height of 40 to 60 feet will exist between bedrock and the concrete barrier. Assuming a height of 50 feet with a stream width of 270 feet, the permeable area is 6,750 square feet. Using the standard formula for flow through a porous medium

Q = KiA where: Q = flow
K = coefficient of permeability, assume 0.3 cu ft/sq ft/min for clean sand and gravel
I = average hydraulic gradient
A = area normal to direction of flow

Q = (0.3 cu ft/sq ft/min)(0.006)(6,750 sq ft) = 12.15 cubic feet/minute
Q = 0.2 cfs

Applying the same method to determine how much flow the barrier affects yields:

Q = (0.3)(0.0006)(5,400) = 0.16 cfs

1-13. We anticipate the geomorphic and hydrologic characteristics of the project area will preclude flow from becoming entirely subterranean. The barrier sites are located on a reach of stream that is narrowly constricted by the mudstone walls of Aravaipa Canyon. Depth of alluvium is probably not much more than 80 feet (and possibly much less), and the alluvial bed is likely saturated due to confinement by surrounding bedrock. Normal monthly mean discharges of 12 cfs to 67 cfs should be sufficient to support surface flows through the project area. More will be known of the alluvial deposit once geologic investigations are completed.

1-14. At least one lane of travel will remain open. Flagmen will be provided by the contractor if traffic volumes and construction activities warrant additional measures to ensure safe passage through the work zone. The final EA has been revised to clarify this issue.

1-15. The final EA has been modified to reflect the current understanding of road status.

1-16. The final EA includes a description of anticipated road improvements.

1-17. The final EA has been changed to reflect stabilization will be necessary.

1-18. The correct amount is 0.5 acre-feet. The prevailing channel gradient through the project area is 0.6 percent, except for a section of stream above the lower barrier that approaches 0.9 percent. The portion of channel with the higher gradient would aggrade less.

1-19. Reclamation believes the added erosive potential resulting from a barrier collapse during a flood would be momentary and slight relative to the overall flood volume.

1-20. Figure 3-7 will be revised in the final EA.

1-21. Table 3-3 is actually Table 4. This reference was overlooked during a change in the table numbering format. The final EA has been corrected.

1-22. Loss of spikedace and loach minnow already occurs as downstream pools and backwaters periodically become isolated and dry up. The fish barrier project would not change this phenomenon. During periods of extreme drought, the lineal extent of active stream below the lower barrier will be reduced as flow volumes diminish. Consequently, fish mortality downstream of the lower barrier will increase as suitable habitat shrinks. However, impact to loach minnow and spikedace would not be significant because this reach of stream is well below their optimal habitat and population concentrations. The 1994 biological opinion included "take" provisions for activities necessary to implement the reasonable and prudent alternatives, such as the fish barrier project (see chapter III, section M of the final EA).

1-23. As noted in the EA's discussion regarding genetic isolation, these species are adapted to episodic flooding within Aravaipa Canyon and tend to persist even during conditions of extreme flood. The fish apparently seek shelter among the eddies and quieter waters of the rock strewn canyon walls.

1-24. This change has been included in final EA.

1-25. Monitoring protocol is not yet established; see response 1-5.

1-26. A discussion on bank stabilization has been added to the final EA.

1-27. This change has been included in final EA.

1-28. The road will be modified according to Pinal County road standards. The final EA includes a description of the proposed road modifications.

1-29. Reclamation will consider extending the fence beyond the lower barrier. We agree that allottees must concur with the fencing proposal before any permanent fence is installed.

1-30. This change has been included in final EA.

1-31. This change has been included in final EA.

1-32. This change has been included in final EA.

1-33. This change has been included in final EA.

ARIZONA

P.O. BOX 4637
HUACHUCA CITY, ARIZONA 85616
520-456-1008

People for the USA

September 12, 1998

U.S. Bureau of Reclamation
PXAO-1500
P.O. Box 81169
Phoenix, AZ 85096

Reference the Draft Environmental Impact Statement (EIS) pertaining to the installation of fish barriers on Aravaipa Creek/San Pedro River. Request a 60 to 90 day extension of the comment period, a copy of the Draft EIS and Federal Register notice announcing the availability of the Draft EIS. 2-1

I have received no notice or information on this current proposed action, even though I contacted your agency in January 1997 indicating my interest and desire to be informed on this project. At that time you did provide me several documents, but I have not had any information in over a year. 2-2

The following comments are based on the information in the September 13 article in the Arizona Daily Star.

Where is the science? Apparently there is a requirement to install two fish barriers, but it does not matter which river/creek they go on. The initial plan was to place them on the San Pedro River, now the requirement is for Aravaipa Creek. What is the impact is converting water from Aravaipa Creek to the Apache Indian Farm Land? 2-3

What is the date of the Biological Opinion which you are using for your information? When was it made available to the public for review and comments? The Biological Opinion I am aware of is over four years old. Nature and things change, so how can decisions be made on information in an outdated document if that is the document being used? 2-4

What is the proposed total cost of this project? 2-5

Sincerely

Rachel Thomas

Rachel Thomas, President

cc: Senator Jon Kyl
Senator John McCain
Congressman Jim Kolbe

Response to Letter of Comment from Arizona People For the USA

2-1. The draft EA was distributed on August 21, 1998, for a 31-day public review and comment period. Reclamation believes the comment period was sufficient. The draft EA was mailed to 84 individuals, agencies, and organizations. In addition, public notices were published in newspapers serving the communities of Winkelman and Mammoth, Arizona, which are located near the project area. News releases were also sent to various other news media, including the two major daily newspapers in Tucson. Federal Register notices are not required for EAs, and Reclamation did not prepare a notice for the Aravaipa Creek fish barriers EA.

2-2. We apologize for the oversight. A copy of the draft EA was mailed to your organization immediately following receipt of the letter dated September 12, 1998.

2-3. The draft EA analyzed the potential environmental impacts of the fish barrier project. The analysis was prepared and reviewed by an interdisciplinary team of engineers, archeologists, biologists, and other environmental professionals. Requirement for two fish barriers on Aravaipa Creek was stipulated in the 1994 "Biological Opinion on Transportation and Delivery of Central Arizona Project Water to the Gila River Basin." The biological opinion requires additional barriers be constructed on the San Pedro River. The San Pedro River barriers, if built, would be constructed sometime after completion of the Aravaipa Creek barriers. Additional NEPA analysis will be completed by the BIA to evaluate the potential environmental impacts of stream water diversion, conveyance, and use should the Indian allottees decide to divert water.

2-4. The final biological opinion is dated April 15, 1994. Biological opinions are issued by the FWS on the possible impacts of Federal actions on listed species and designated critical habitat pursuant to Section 7 of the Endangered Species Act. Draft biological opinions are not distributed for public review and comment. The FWS believes the issues addressed in the 1994 biological opinion are still contemporary and valid.

2-5. The estimated cost for construction of the Aravaipa Creek fish barriers is $2,000,000.

Wheeler
AND ASSOCIATES, INC.

Terence O. Wheeler
P.O. Box 2792
Globe, Arizona 85501
USA

Phone 520-425-3017
Fax 520-425-3017

3

SEP 21 '98

September 17, 1998

U.S. Bureau of Reclamation
PXAO-1500
P.O. Box 81169
Phoenix, Arizona 85096

To Whom it may concern,

In regards to your proposal to build barriers in Aravaipa Creek to prevent exotic species from entering the channel. I would like you to know that "you are out of your mind". First of all the exotics are already there. Secondly you don't have a clue as to the dynamics of watersheds and their corresponding riparian areas or of the communities of plants, animals, and fish that live in them. **3-1** **3-2**

These so called rare and endangered species have survived thousands of years of changes in geologic, physical and climate conditions. So called exotics have been a part of this process for all of these years as well. These species are still here only because they have adapted to the conditions that prevail. **3-3**

By this blocking this drainage you will change the dynamics of this creek that these endangered species have adapted to. If they cannot readapt to the changes you bring, they will be lost. **3-4**

Don't screw with Mother nature.

Sincerely,

Terence O. Wheeler
Ecologist, Range/Watershed specialist

cc: J.D. Hayworth
J. Hull
J. Shadegg
J. Kyle
J. McCain
J. Flake
D. Brimhall

Response to Letter of Comment from Wheeler and Associates, Inc.

3-1. Seven species of nonnative fishes are known to permanently reside or periodically invade Aravaipa Creek. One species in particular, the red shiner, is of considerable concern because of its documented adverse effects on spikedace and other native fishes. Red shiner first occupied Aravaipa Creek in 1991 but was removed from the stream by flooding the following year. Red shiner reappeared in 1997 (see page 34 of the final EA). Reclamation believes that barrier operation combined with periodic flooding and the nonnative fishes management activities described on page 48 of the final EA will prevent the permanent establishment of most nonnative fishes in Aravaipa Creek above the project area.

3-2. The project would be built within the lower end of Aravaipa Canyon. The floodplain in this area is relatively narrow and subject to recurrent and sometimes severe flooding. The plants and animals that occupy this riparian zone are adapted to repeated flood-induced disturbances. The aquatic biota, particularly fishes, of Aravaipa Creek have been studied since the early 1960s.

3-3. Your assertion that native and nonnative species have survived changes in geologic, physical, and climatic conditions for thousands of years is accurate. An important point that you overlook, however, is these native and nonnative species did not survive the last several millennia together. The exotics referred to in your letter are native to other regions of North America and were translocated to Arizona in an attempt to create new sport fisheries within the State. Over the last several decades, releases of nonnative game fishes (mostly predatory species) and bait species have created new competitive relationships. In many instances, introductions of nonnative fishes have depressed native fish populations, often causing serious decline or disappearance. Generally, native fish population declines are attributable to three environmental influences: loss of suitable habitat, exposure to environmental contamination, or interaction with nonnative species. These influences (and resultant population declines) mostly stem from human-induced activities and development rather than natural change. The purpose of the Endangered Species Act is to provide for the protection and recovery of species threatened or endangered by human activity.

3-4. The fish barriers are not intended by design or function to block surface or subsurface flow. Measurable hydrological effects will be confined to the immediate project area and a relatively short distance upstream and downstream of the barrier sites. The project will be located on the lower reach of Aravaipa Creek, well below optimal habitat of the threatened native fishes (see page 38 of the EA). Reclamation, the FWS, and the AGFD believe the project will have a positive effect on populations of threatened native fishes inhabiting Aravaipa Creek.

HORSEPLAY
TACK & STUFF

Arizona's Largest Riding Equipment Inventory

Web Page • www.the river.com/horseplay

7809 E. Wrightstown Rd. • Tucson, AZ 85715
(520) 886-1499 • FAX (520) 886-1556

WINNERS CIRCLE SADDLERY

1703 E. Ft. Lowell Rd. • Tucson, AZ 85719
(520) 327-2744 • FAX (520) 325-1664

9/17/98

ARE YOU NUTS?? $2,000,000.00 ??

PLEASE?? LET THE WORLD EVOLVE NATURALLY!! 4-1

I LEFT CALIFORNIA FOR ARIZONA 6 YEARS AGO BECAUSE OF ENVIRONMENTAL AND ENDANGERED SPECIES INSANITY!! I WAS PREVENTED FROM DEVELOPING A 19 ACRE INDUSTRIAL PARK BECAUSE OF THE LONG TOED SALAMANDER, A HOUSE BECAUSE OF A BLUE WINGED BUTTERFLY, ANOTHER HOUSE BECAUSE OF THE SANTA CRUZ TAR PLANT. I WAS FORCED TO SELL A BUSINESS OF 25 YEARS OVER 2 QTS OF SALAD OIL IN 35,000 GAL OF WATER. MY ARTICLES APPEARED IN SEVEN NEWSPAPERS AND ON THE ROSH LIMBAUGH SHOW TO NO AVAIL. 4-2

AN REAL ENDANGERED SPECIES IS ONE WITHOUT A RADIO COLLAR, EAR TAG, AND TATOO.

$2,000,000 TO SAVE MINNOWS ??
+ $5,000,000 TO RETURN 10 WOLVES TO N. ARIZ ??
$7,000,000 WOULD BUILD A LIBRARY OR SCHOOL!!

MARK ME DOWN AS OPPOSED!!

Response to Letter of Comment from Horseplay Tack & Stuff

4-1. Reclamation is legally obligated to comply with all Federal laws, including the Endangered Species Act. See also response 3-3.

4-2. Your other comments are noted.

9/16/98

TO WHOM IT MAY CONCERN,
I AM DROPPING YOU THIS NOTE TO LET YOU KNOW THAT I AM ADAMANTLY OPPOSED TO CONSTRUCTING THE FISH BARRIERS IN ARAVAIPA CANYON. THIS IS A HUGE WASTE OF TAX PAYERS MONEY.
I THINK MOST PEOPLE WOULD RATHER SEE THE CREEK STOCKED WITH BASS & OTHER MORE DESIREABLE FISH! SCREW THE NATIVE SPECIES!
I HAVE ALSO CALLED & WRITTEN MY SENATORS & CONGRESSMEN. THANK YOU.
BRIAN MORTON
[redacted]

5-1

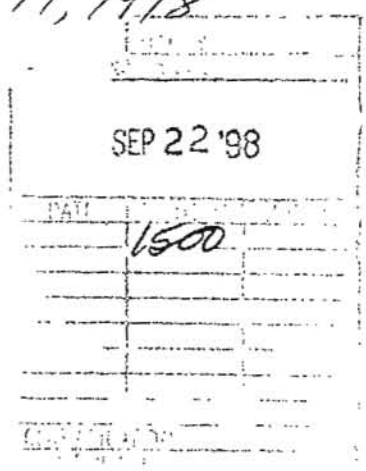
Response to Letter of Comment from Morton

5-1. Your comments are noted.

[redacted]

Sept. 19, 1998

U.S. Bureau of Reclamation
PXAO-1500
P.O. Box 81169
Phoenix, Arizona 85096



Dear Sirs:

Attn: Barriers on Aravaipa Canyon

I strongly regret your idea of barriers and destroying farm land & meadows. 6-1

There is a limited amount of farmland & it should be protected. Fish have managed over the years & they should be left alone. 6-2

I'm very familiar with the area having lived in Safford a long time & visited with residents in the canyon & enjoyed the canyon in the Klondyke area. More recently the other end of the Creek flowing into the San Pedro River, so I do not want any barriers. 6-3

It's also, too costly — My husband joins me!

Yours truly,

Frances J. Mooberry
(Mrs. Dana M. Mooberry)

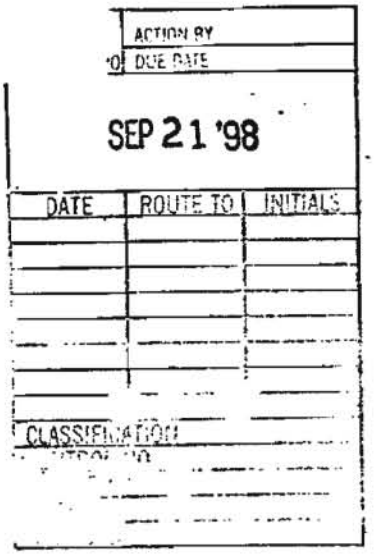
Response to Letter of Comment from Mooberry

6-1. The project will be located within the lower portion of Aravaipa Canyon. Effects of the project will be confined to parts of the stream channel, floodplain, and less than 2.5 acres of upland desert. There are no farmlands or meadows within the project area that would be affected by the project. The project provides the opportunity to restore retired farmland on the allotted lands downstream of the lower barrier site.

6-2. See response 3-3.

6-3. Your other comments are noted.

7



September 7, 1998

Bureau of Reclamation
Phoenix Area Office
ATTN: PXAO-1500
P.O. Box 81169
Phoenix, AZ. 85069-1169

Mr. John McGlothlen:

As provided through the Draft Environmental Assessment (EA) on the construction of fish barriers on Aravaipa Creek, Pinal, County Arizona.

On September 30, 1968 Congress authorized the Secretary of the Interior through Reclamation to construct the Central Arizona Project (CAP) for irrigation, industrial and municipal uses in central and southern Arizona. The CAP was declared complete in 1993, conveying Colorado River water through a 355 mile long system of pumping plants, aqueducts, dams and reservoirs. The total cost of the CAP was $4,695,000,000.00 tax payer dollars.

During the late 1980's issues of nonnative aquatic species introduced through the CAP began to receive serious consideration. On April 15, 1994, some 26 years after the Secretary of the Interior approved this project, the U.S. Fish & Wildlife Service (FWS) concluded that CAP operation would jeopardize the continued existence, and adversely modify critical habitat of several threatened or endangered native fishes. Establishment of nonnative fishes within the CAP system and their subsequent escape and invasion into habitats occupied by native fishes, were cited as contributing to these adverse effects.

One reasonable and prudent alternative identified by FWS to **minimize** adverse impacts and avoid jeopardy was for Reclamation to construct a pair of concrete fish barriers on Aravaipa Creek. Aravaipa Creek supports **self sustaining** populations of seven native fish species. Consequently, the creek is considered by the FWS to be an important refuge for native fishes. This special status is **partially** a result of the remote location of the stream and rugged terrain encompassing this watershed.

In my previous response to the BR dated July 7, 1998, I asked many questions that weren't answered regarding the literature provided at the June 27,1998 scoping meeting. The information provided in this EA doesn't contain the pertinent information regarding the answers I'm seeking in relation to the construction of the FWS fish barrier project on the Aravaipa Creek.

Through recent investigation (August 28,1998), I learned that the FWS has already directed the BR to proceed with the Aravaipa Creek project. The directive to proceed has come well in advance of the distribution of this lengthy and costly $119,240.00 draft to all interested parties. What reasons did the BR and FWS have for initiating the previous two meetings (February 1,1997/June 27,1998), other than pacifying the American public through legal formalities required by the federal government? As an end result, will this or any other opposing response to the construction of the proposed FWS fish barriers on the Aravaipa Creek matter? **Apparently Not!** 7-1

As I reviewed this EA, which includes three decades of data collected by astute and documented wildlife biologists, along with many of their esteemed colleagues having distinguished titles, as well as references from cooperating agencies, I found two (2) alternatives. One is the construction of the costly $2.756 million fish barriers and the other is the No Action Alternative. Surely in the course of thirty (30) years of painstaking, time consuming, tax dollar eating research, the BR, FWS and other cooperating agencies have been able to come up with more than two contingency plans, one of which is a do nothing. After reading this draft and the other literature provided at the two (2) previously insignificant (at least from a public viewpoint) appointed BR and FWS meetings, I favor the **No Action Alternative** as my choice. 7-2

Why would the Secretary of the Department of the Interior, in conjunction with the FWS and other cooperating agencies support the construction of the CAP? This project has created a 355 mile long $4,695,000,000.00 tax paid super-highway providing unlimited access for nonnative fishes and other aquatic species to readily invade all of Arizona's rivers, streams, creeks and their tributaries! Wasn't any research done prior to the construction? If not, why? If so, was the data collected wrong? If the collected data and research pertaining to the CAP was correct, did these cooperating agencies willingly proceed, therefore knowingly endanger the very existence of the spikedace and loach minnows, as well as every other native fish and aquatic species known to exist in Arizona's watersheds? 7-3

The Department of the Interior, FWS and cooperating agencies approval of the CAP equates to approximately $13,225,352.11 per mile to deliberately contaminate every watershed in Arizona with nonnative fishes and aquatic species. Now, the same assembly of agencies wants to spend another $2,750,000.00 to build two (2) fish barriers in approximately eight hundred feet on the Aravaipa Creek in Pinal, County Arizona. This proposed fish barrier project equates to approximately $3,437.50 per **foot** to hinder **NOT PREVENT** the cumulative destructive effects of nonnative introductions via the federally funded and approved CAP. 7-4

This EA states that several preferred sites were pursued unsuccessfully prior to the selection of allotted land belonging to San Carlos Apache tribal members, for the use of **NOT PURCHASE OF** the proposed FWS fish barriers.

In addition, the BR is currently and privately negotiating with the Bureau of Indian Affairs (BIA), on an acceptable amount of money (tax dollars) to be paid to San Carlos Apache tribal members for this acquisition. Upon requesting information regarding the amount being negotiated by the two (2) government agencies, I was politely informed, that this information was confidential and unavailable to the tax paying public. Now there's something very wrong with this picture! Tax paying citizens of the United States of America, supporting their government agencies through withheld taxes, are denied the right to know how many of their tax dollars are being spent to pay citizens of a different sovereign nation for the use of, not purchase of property to provide rights of entry and liability flood insurance for a proposed costly project, attempting to protect native fishes and aquatic species from nonnative fishes and aquatic species introduced through previous projects federally funded and approved by the BR, FWS and other cooperating agencies. 7-5

Recap of Proposed Project:

1. The Secretary of the Department of the Interior in conjunction with the FWS and cooperating agencies have approved a $4,695,000,000.00 CAP, that has introduced nonnative fishes and aquatic species to all of Arizona's watersheds. 7-6

2. Thirty (30) years of research provided by representatives of the BR, FWS and cooperating agencies have identified, that there is now a threat to native fishes and aquatic species from nonnative fishes and aquatic species introduced through the federally funded and approved CAP.

3. In order to hinder the adverse effects of the BR, FWS and cooperating agencies previous decision to predestine the demise of all native fishes and aquatic species through the federally funded and approved construction of the CAP, it is now necessary to spend an additional $2.756 million in effort to save the remaining native fishes and aquatic species in Aravaipa Creek, Pinal, County Arizona for an undetermined, but finite period of time. 7-7

4. FWS stated, that a $2.756 million is reasonable and prudent in attempting to hinder adverse impacts caused by the introduction of nonnative fishes and aquatic species through the the federally funded and approved CAP. The realistic end result of the FWS fish barrier project will provide little more than short term relief from the inevitable? 7-8

Recap Continued:

5. Through data provided by the BR and FWS in this EA as well as in the two (2) previous meeting, three (3) decades of research have produced evidence that self sustaining native fishes and aquatic species have survived quite well in conjunction with natural deterrents, therefore preventing permanent strongholds of nonnative fishes and aquatic species for more than short spans of time. Only green sunfish and yellow bullhead have been collected on more than one (1) occasion from the stream since monitoring in 1963. Red shiner minnows first appeared in 1990 and disappeared in 1991 after floods exceeded 3,000 cfs, which they commonly do. **7-9**

6. The special status of this watershed is partially due as an end result of it's remote location and rugged terrain. It is also true, that many other factors potentially provide for this special status such as, canyon bound system, periodic flooding, natural flow velocities and sediment load. All of these factors cumulatively provide natural deterrents, rather than costly inadequate man made structural deterrents. **7-10**

7. The BR and BIA are privately negotiating an acceptable price to pay the San Carlos Apache tribal members for the use of, **not purchase of** property to provide the FWS and cooperating agencies rights of entry and liability flood insurance for the proposed $2.756 million FWS fish barrier project on the Aravaipa Creek.

8. Several other more suitable sites were identified as preferred, but were unobtainable for various reasons.

7-11

Isn't it interesting, that not one (1) resident landowner of the Aravaipa Creek was willing to sell rights of entry to the BR/FWS? Were all land acquisition proposals presented to resident landowners of the Aravaipa Creek equal to, what is privately being negotiated by the BR and BIA on the San Carlos Apache tribal members behalf? Who knows? Certainly not the tax paying American public!

Below is a list of some questions previously submitted (July 7, 1998), that were not answered:

1. If natural deterrents have worked since the beginning of creation, or at least for the last thirty (30) years monitored by the FWS, why won't they continue to work without the costly intervention of the FWS and the construction of their fish barrier project? **7-12**

2. If, after thirty (30) years of monitoring by the FWS, nonnative fishes have been unable to secure permanent strongholds for more than short spans of time, what other than man made structures will promote such abilities? **7-13**

3. According to literature provide by the FWS in June 27,1998 meeting, a yet-to-be exotic species better able to adapt to Aravaipa Creek may be introduced. Again, is the FWS waiting for this super yet-to-be exotic species to evolve? If so, please provide an example of it's development and where this will occur. **7-14**

4. The purpose of the FWS fish barrier project on the Aravaipa Creek is to minimize or **hinder** the upstream incursion of nonnative fishes during periods when there is sufficient flow to establish a direct water connection with downstream habitats. How will these costly FWS fish barriers prevent or **hinder** nonnative fishes from being deposited and/or carried to the upper reaches of the Aravaipa Creek by terrestrial wildlife and/or humans? **7-15**

5. The design of the costly FWS fish barriers are supposed to exceed the swimming and leaping abilities of nonnative fishes. Who measured the swimming and leaping abilities of nonnative fishes, and how do they compare with the swimming and leaping abilities of native fishes? What tools were used to obtain this data? By what means will the FWS remove the pesky nonnative fishes that do swim faster and leap higher than anticipated? **7-16**

6. Isn't the unsuccessful FWS Virgin River fish barrier project costing tax payers millions of dollars indicative of the proposed FWS fish barrier project on the Aravaipa Creek? If the fish barriers are built on the Aravaipa Creek, how many efforts will be unsuccessfully attempted by the FWS and other cooperating agencies trying to remove nonnative fishes, and how much more will this cost the tax paying public? **7-17**

7. In the February 1, 1997 meeting the FWS stated that many unsuccessful attempts at colonization by nonnative fishes must occur before becoming successful. Again, how many unsuccessful attempts are required before becoming successful, and what data will substantiate this answer? **7-18**

8. Before one (1) of the floods in the 1980's, there was at least one (1) resident landowner on the Aravaipa Creek having nonnative fishes contained in an earth structure continuously fed by the natural flow of the creek itself. After the flood, the earth structure was damaged severely and nonnative fishes were released readily into the natural flow of the Aravaipa Creek. How have the FWS and other cooperating agencies determined, that most if not all nonnative fishes found in the creek are not remnants of the ones unintentionally released during this period of time? How does the FWS and other cooperating agencies know, that there weren't other residents unknowingly harboring pesky nonnatives that eventually escaped into the natural flow of the Aravaipa Creek? **7-19**

9. As an end result, will the predators that consume spikedace and loach minnows cease to exist if their diets are changed to red shiner and fathead minnows? Will the natural flow of the Aravaipa Creek be any less natural if spikedace and loach minnows are forced to live in the presence of nonnative fishes introduced through the federally funded and approved CAP? **7-20**

10. NEPA: National Environmental Policy Act, was established in the early 1970's by the federal government through an overwhelming response by the American public in order to create and ensure policies pertaining to specifically identified endangered and threatened species. Isn't it time for the American public to re-establish control of the authority given to the FWS and their freedom to take charge in any manner they dictate? **I THINK SO!** **7-21**

In addition to all of the current and proposed expenditure for the construction of the FWS fish barrier project on the Aravaipa Creek, the BR is required to compensate the FWS in the amount of $250,000.00 a year for twenty five (25) years from the date of the first funding transfer. The first funding transfer shall occur no later than three (3) months after the date of this biological opinion and the amount shall be prorated to the reflect the percent of the current fiscal year remaining. This money will be used by the FWS at their discretion for uses of but not limited to the status, biology, ecology, habitat and life history of the spikedace and loach minnows, gila topminnow, razorback sucker and other Gila River Basin listed or candidate fish species. This equates to approximately $6,250,000.00 tax dollars in addition to the proposed $2,750,000.00 construction of the FWS fish barriers on the Aravaipa Creek. 7-22

This is just another perfect example of our government agencies totally out of control! How many individuals, departments and/or agencies have been held accountable for the destruction caused by the approval of the CAP? Many agricultural users prefer sources other than CAP (when possible), because of the cost per acre feet. Even more preposterous is the fact, that the city of Tucson, Arizona (primary user) upon receipt of the water provided by the CAP, has declined to use it for it's intended purpose and now discharges it into the ground attempting to replenish their own natural aquifer. **The whole thing is absolutely ludicrous!**

How much longer will the tax paying citizens of the United States of America stand for such foolishness? I'm fed up with the FWS and cooperating agencies radical viewpoints and nonsense like this being imposed on the American public!

Finally, I present you with the two (2) way street concerning the issue of incidental take. During the flood of 1993, the FWS denied Jep O. White, long time resident of Aravaipa Creek permission to access the creek with a single piece of heavy equipment, attempting to save a large portion of his property. This decision was solely made by FWS representative Sally Stefferud, who feared that a spikedace or loach minnow may be harmed during Mr. White's attempt to save his property. Sally Stefferud is identified in this EA, as promoting the use of multiple pieces of heavy equipment in the creek to construct the fish barrier project. Her stand, as well as all the other individual supporters and cooperating agencies also identified in this EA is based on the premise, that incidental take during the construction of the fish barrier project, which as an end result, will only hinder **NOT PREVENT** the encroachment of nonnative fishes and aquatic species is permissible and acceptable.

Where do we draw the line, and who do we hold accountable for such blatant disregard for the veritable needs of American citizens, and the abuse of the our tax dollars? I say we draw the line **HERE**, and revoke the abused authority given to the FWS by the American public **NOW**, and in so doing, establish new and practical guidelines with reasonable priorities and practices, carried out by less radical and more responsible representatives of our government agencies.

In closing I submit to you, that if an animal (bird, fish or mammal) has been elevated to higher status in today's society than a man, who's home and property are being threatened by and act of God, there is something terribly wrong! It is time to remove those few, who are dictating such ridiculous and radical views to the many, who are financially supporting something less than their best interests. Once again, how can any of the government agencies (federal/state) identified in this EA, deny a tax paying American citizen the use of reasonable means and access in a time of disaster, for fear of accidental death to a threatened species, when these same government agencies are knowingly and willingly planning the intentional extermination of a countless number of the same threatened species, in attempt to hinder a problem they have created?

Not only do I oppose this project, **I ADAMANTLY OPPOSE** it and any other recommended FWS proposal identified in this EA.

Sincerely,

Bobby R. Blake
Resident of Aravaipa Creek
Tax Payer, Registered Voter and Citizen of the United States of America

cc: Senator John McCain
Senator Jon Kyl
Congressman J.D. Hayworth
Congressman Jim Kolbe

Response to Letter of Comment from Blake

7-1. Although Reclamation must construct fish barriers on Aravaipa Creek pursuant to the Endangered Species Act, compliance with the National Environmental Policy Act (NEPA) is still required. In this situation, the NEPA process serves to allow public input regarding discretionary aspects of the project such as location, design, and mitigation of construction and operation impacts. The two meetings you refer to were conducted to gather information and identify issues of public importance regarding the fish barrier project. The June 27, 1998, meeting was held to formally scope issues that should be addressed in the EA. Public scoping meetings are intended to gather information to focus the analysis; they are not intended to tally support or opposition. No attempt to pacify attendees was intended.

7-2. Numerous conceptual approaches and alternative actions were considered during ESA Section 7 consultation. These alternatives are referred to on page 11 of the EA and discussed in greater length in Appendix A.

7-3. In 1968, Congress passed the Colorado River Basin Project Act, which authorized construction of the CAP to convey Colorado River water to central and southern Arizona. Reclamation was directed by Congress to build the CAP. The "cooperating agencies" you refer to did not necessarily support (or oppose) construction of the CAP. They were identified as cooperating agencies in the draft Aravaipa Creek fish barriers EA because they possess special expertise or jurisdiction by law over issues relevant to the fish barrier project. Cooperating agency status under NEPA does not imply support for a proposed action. An environmental statement on the consequences of construction and operation of the CAP was completed by Reclamation in 1972. The environmental statement was finalized one year before Congress enacted the ESA; therefore, the analysis did not address impacts to threatened and endangered species or the consequence of fish movement through the CAP. Numerous agencies and organizations, including the FWS, commented on the adequacy of the 1972 analysis. Comments focused on issues considered important at that time. The FWS did not state support for or opposition to the CAP in their comments.

7-4. Construction of the CAP was formally authorized by Congress and was not subject to approval by Federal agencies. The purpose of the CAP is to provide a renewable water supply to municipal, industrial, agricultural users who otherwise would be dependent on diminishing supplies of groundwater. Conveyance of fish has never been an objective of the CAP. The possible effects of fish movement through the CAP were not fully recognized or analyzed until the 1990s. Your other comments are noted.

7-5. The negotiation for this acquisition is between Reclamation and the BIA as Trustee for certain members of the San Carlos Apache tribe. An appraisal has been prepared by Reclamation and is under review by the BIA. The appraisal is confidential until the offer is accepted. Under the provisions of the Freedom of Information Act (FOIA), Exemption 5, Privileged Information,

Reclamation cannot reveal to the public the amount of compensation disclosed by the appraisal, which, if approved, will be the amount offered to tribal members for the acquisition. Once an agreement is reached and the appropriate documents are signed, public disclosure of the settlement amount is permissible.

7-6. The 1994 biological opinion addresses only the potential movement of nonnative aquatic species through the CAP to the Gila River basin. The CAP is not interconnected to all the riverine systems of Arizona.

7-7. The more than 30 years of research cited in the EA and referenced in your letter examined only the aquatic biota of Aravaipa Creek. This research did not address the possible effects of CAP operation. Your suggestion that the CAP will "predestine the demise of all native fishes and aquatic species" is overstated and inaccurate.

7-8. As far as we know, the FWS has not commented on the reasonableness of costs incurred to implement provisions of the 1994 biological opinion. The biological opinion identified the fish barrier project as a reasonable and prudent measure to protect loach minnow and spikedace, two species listed as threatened under the authority of the Endangered Species Act. Estimated project costs are not discussed in the biological opinion. The fish barrier project would not have received serious consideration during Section 7 consultation if there was little chance of it having a positive effect on spikedace and loach minnow recovery. Assuming appropriate recovery measures are implemented, extirpation of spikedace and loach minnow from Aravaipa Creek, or their total extinction, is not inevitable.

7-9. Your assertion that only green sunfish and yellow bullhead have been collected on more than one occasion is not accurate. Several species are now routinely encountered below the proposed project area (see page 33 of the EA). The recent appearance of red shiner in Aravaipa Creek is particularly troublesome. Red shiner first appeared in Aravaipa Creek in 1990, were removed by flooding the following year, then reappeared in 1997. Red shiner is an aggressive competitor that is also known to feed on the larva of spikedace and other native species. Displacement of native fishes (including spikedace) by red shiner has been documented in other riverine systems. Red shiner prefers silty, sandy, rocky pools, and occasionally riffles of creeks and small to medium-sized rivers (conditions quite evident on Aravaipa Creek). Permanent establishment of red shiner in the upper and middle reaches of Aravaipa Creek could seriously threaten resident populations of spikedace and loach minnow.

7-10. The rugged terrain and remote location of Aravaipa Creek have little causal relationship with the possible spread of nonnative fishes through the Gila River basin to Aravaipa Creek. The isolation of Aravaipa canyon, however, has limited the extent of development along the creek. Habitat alteration and fragmentation caused by human developments have had an adverse effect on native fishes in other streams and rivers in Arizona. Periodic flooding does appear to have deterred nonnative fish incursion and permanent establishment in the canyon reaches of Aravaipa Creek thus far. However, the invasion of Aravaipa Creek by nonnative fishes is only a recent

phenomenon. Most of the nonnative species currently encroaching on Aravaipa Creek first appeared in the creek during the 1980s (see page 34 of the EA). Other nonnative species inhabiting the Colorado River, CAP, and parts of the Gila River basin could spread to Aravaipa Creek in the future. See response 7-9 regarding red shiner.

7-11. Your comments are noted. See also response to comment 7-6.

7-12. See response 3-3.

7-13. Researchers from several organizations including Arizona State University have studied Aravaipa Creek since the early 1960s. The FWS has not monitored fishes in the creek for 30 years, as your letter asserts. See response 7-14.

7-14. Several species of nonnative fishes found in the Colorado River system and Gila River below Ashurst-Hayden Dam have not yet spread to Aravaipa Creek. Other species of fish are expanding their ranges in North America and could be introduced to the Colorado River and Gila River Basin by human transfer (see Appendix A of EA, page 14). Many of these species could eventually spread to Aravaipa Creek. The immigration of additional nonnative fish species to Aravaipa Creek could adversely affect the survival of native fishes.

7-15. You are correct in pointing out the barriers are designed to impede only the upstream movement of fishes in Aravaipa Creek. Other methods of conveyance are possible, including human transfer. Page 1 of the EA identified bait bucket transfers as a means by which nonnative species are sustained in the Gila River basin. Problems associated with human transfer of nonnative species are also discussed in Appendix A of the EA. The transfer of fishes Reclamation proposes to install fencing between Aravaipa Road and the barriers to restrict access and reduce the possible human transfer of fish at the barrier sites.

7-16. Reclamation contracted with Arizona State University to conduct a literature review of what was known of the swimming and leaping abilities of nonnative fishes. Various researchers conducted these studies using methodologies that are generally too complex to describe in the EA. Reclamation can provide a copy of this report upon request. No research has been specifically conducted on maximum swimming and leaping abilities of native fishes. As stated in the EA, the zone between the barriers will be periodically surveyed and nonnative fishes that transgress the lower barrier will be removed by either mechanical means (nets) or by use of a fish toxin.

7-17. It is impossible to predict how many nonnative fish transgressions past the barriers may occur by natural means, but the expectation is that they will be rare, if they occur at all. As noted in the EA, human transfer of nonnative fishes is possible and likely occurs elsewhere in the Gila River basin. Unauthorized human transfer of fishes cannot be predicted or effectively controlled. The Virgin River fish barriers (not a Reclamation project) was not successful because nonnative fish species had already become established in the river by the time the project was implemented.

7-18. Reclamation's responses to questions posed by Aravaipa Creek property owners at the February 1, 1997, meeting included an explanation of how nonnative fish invasions often follow a pattern of several unsuccessful attempts before colonization is achieved. It is not, however, a matter of unsuccessful attempts being necessary before an invasion is deemed "successful." It is certain that numerous successful invasions have occurred from a single attempt, as evidenced by the many new species that have established themselves in Arizona waters through intentional stockings to improve sport fisheries. Many biologists familiar with the 1990 red shiner invasion of Aravaipa Creek consider it extremely lucky that it was unsuccessful.

7-19. Reclamation does not have information on the composition of fish species in private impoundments affected by flooding in the 1980s. The nonnative fishes present in Aravaipa Creek also occur elsewhere in the Gila River basin, including the San Pedro River. These fishes are capable of directly accessing Aravaipa Creek during periods when flow volumes are sufficient to establish a connection with the San Pedro River (usually several times per year). As noted in the EA, human transfers are also possible.

7-20. In addition to predation, the EA describes other threats to native fishes posed by interaction with nonnatives. See also response 7-10 regarding red shiner. Flow characteristics of Aravaipa Creek are not affected by fish. However, species composition would not be "natural" if natives are displaced by nonnatives.

7-21. Your comment appears to confuse the National Environmental Policy Act with the Endangered Species Act. Please see page 71-72 of the final EA for brief descriptions of these two Acts. Your other comment is noted for the record.

7-22. Your other comments are noted.

THE STATE OF ARIZONA

GAME & FISH DEPARTMENT

2221 West Greenway Road, Phoenix, Arizona 85023-4399 (602) 942-3000
www.gf.state.az.us

Governor
Jane Dee Hull

Commissioners:
Chairman, Herb Guenther, Tacna
Michael M. Golightly, Flagstaff
William Berlat, Tucson
M. Jean Hassell, Scottsdale
Dennis D. Manning, Alpine

Director
Duane L. Shroufe

Deputy Director
Thomas W. Spalding

ACTION BY

SEP 23 '98

DATE	ROUTE TO	INIT
9/24	1000	JHB
9/28	1015	
	1500	

CLASSIFICATION CONTROL NO.

September 21, 1998

Mr. Thomas Burbey, Area Manager
Bureau of Reclamation
Phoenix Area Office
P.O. Box 81169
Phoenix, AZ 85069-1169

Re: Draft "Environmental Assessment on Construction of Fish Barriers on Aravaipa Creek, Pinal County, Arizona"

Dear Mr. Burbey:

The Arizona Game and Fish Department has reviewed the draft "Environmental Assessment on Construction of Fish Barriers on Aravaipa Creek, Pinal County, Arizona" and we submit the following comments.

Game and Fish has been involved with this project since the time of issuance of the "Biological Opinion on Transportation and Delivery of Central Arizona Project Water to the Gila River Basin (Hassayampa, Agua Fria, Salt, Verde, San Pedro, middle and upper Gila Rivers and associated tributaries) in Arizona and New Mexico" in 1994. We note that a variety of site alternatives were investigated in the process of selecting the proposed sites. Issues including effective barrier height following aggradation and effects of the barrier on stream gradient have been discussed during the process. Effects of these and other factors on effectiveness of the structures as fish barriers, and associated tradeoffs, have been discussed as well. Recognizing this past analysis, we ask, however, that information on aggradation be verified.

We note on page 22, paragraph 2, that "The extent of the sedimentation is expected to reach approximately 1200 feet upstream of the upper barrier, where the raised stream channel would converge with the existing channel grade." Also we note discussion of similar sedimentation above the lower barrier, which could result in sediment build up 3-5 inches up the lower face of the upper barrier. Several reviewers inferred a gradient of 0.3% above the upper barrier based on the discussion of sedimentation noted above. 8-1

Based on this inference, the sediment build up would exceed 3-5 inches on the downstream side of the upper barrier. Clarification

to us of the relationship between the grade and sedimentation would be beneficial to our complete understanding of the issue of continuing effectiveness of the barriers and maintenance requirements.

Game and Fish supports the concept of the mitigation proposal for impacts to riparian habitat on page 50 and 51 and inclusion of the "Additional Mitigation Measures."

8-2

Thank you for the opportunity to review this draft document. If you have any questions feel free to contact me at 602-789-3607.

Sincerely,

WE Werner

William E. Werner
Aquatic Habitat Coordinator
Habitat Branch

WW

CC: Sally Stefferud, USFWS, Phoenix
John McGlothlen, USBR, Phoenix

Response to Letter of Comment from the AGFD

8-1. The prevailing stream gradient through the project area is approximately 0.6 percent. For a short distance upstream of the lower barrier, stream gradient increases to almost 0.9 percent before returning to 0.6 percent near the upper barrier site. Sediment aggradation between the two barrier would be less due to the steeper gradient (see page 22 of the final EA).

8-2. Your other comment is noted.

9

FAX TRANSMITTAL BLM
Safford Field Office Phone (520) 348-4400
711 14th Ave., Safford AZ 85546 # of pages

To: John McGlothlin	From: Tom Terry
Fax #	Fax # (520) 348-4450
Dept/Agency	Date 10-6-98

September 16, 1998

To: Tom Terry, Mike McQueen

From: Steve Knox, ORP

Subject: Review of Draft EA for Construction of Fish Barriers on Aravaipa Creek - Comments

I have reviewed the draft EA and offer the following comments for consideration in the final document.

General Comments

1. While this project is a number of miles downstream of Aravaipa Canyon Wilderness, the EA does not address if there will be any effects on wilderness resources. It seems from reading the analysis of impacts to other natural and cultural resources there will be no impacts to the wilderness, but the document does not say. 9-1

Wilderness is an issue that should be addressed in the EA. If there are no anticipated impacts to wilderness, then that should be stated in the EA, and no further analysis needed. If there are impacts, then obviously they should be addressed in the appropriate level of detail in the EA.

I am specifically interested in knowing that the barrier structures will not impact the hydrology of Aravaipa Creek back into the wilderness. For example, will raising the stream bed 8 feet at the project site (once the barriers silt in) affect the water flow, stream bed, pools, riffles, etc. in the wilderness? It doesn't appear that the effects will occur much distance either upstream or downstream of the project area, but we need to make certain we are not affecting the wilderness resources. 9-2

2. Same comment for wild and scenic river resources. Aravaipa Creek, in the wilderness, has been recommended for designation under the Wild and Scenic Rivers Act.

3. Will there be a temporary pool of water behind the upper barrier, until it silts in? If so, there should be a discussion of that pool, and potential environmental consequences. For example, how long will it take for the pool to silt in? In the interim, will the pool provide habitat for non-native species. Will people camping near the barrier transport non-native fish to the pool, providing an avenue to non-native fish into Aravaipa Creek above the barriers? Will presence of the pool attract further unauthorized recreation use? Etc.? 9-3

Specific Comments

1. page 9, E. - what is the anticipated construction schedule? Is their any potential it would overlap with our West Aravaipa Ranger Station construction schedule this fall and winter? If so, there might be issues to coordinate (construction traffic, etc.). 9-4

2. page 21, d. - same construction schedule comment as above.

3. page 21, e., and page 22 - how long will the temporary pool remain behind the barriers? The EA never says. Also, will sedimentation affect the hydrology of Aravaipa Creek upstream of the 1,200 foot sedimentation zone? Could it affect the wilderness and wild and scenic river resources? 9-5

4. page 25, B. 1. - the document refers to "The upper reaches of Aravaipa Creek is considered one of the premier examples of high-quality riparian vegetation, as well as one of the last remaining refugia for native fish in the Sonoran Desert." While this portion of Aravaipa Creek is above the project area, it is actually in the lower reaches of the watershed. 9-6

5. page 26, second line - "Winkleman" should be "Winkelman".

6. page 43, Aquatic Habitat - would the effects to instream habitats be limited to the sedimentation zone, or would they extend upstream above the project area (to the wilderness)? See General Comment 1. 9-7

7. page 45, h. - how long will there be a temporary pool behind the upper barrier (before it silts in)? Won't that pool need to be monitored as well? 9-8

If you have any questions, let's visit.

Steve Knuf

Response to Letter of Comment from the BLM

9-1. Project-related impacts to Aravaipa Canyon Wilderness Area are not expected. As you have noted, the wilderness area is several miles upstream of the fish barrier project area. The anticipated environmental effects of the project are confined to small portions of Indian Trust Allotment 013736 and three upstream private properties. The EA examines these possible impacts, none of which affect the wilderness area. Reference to the Wilderness Act of 1964 was inadvertently omitted from section M of chapter III, List of Related Environmental and Cultural Resource Laws and Directives. This information has been added to the final EA

9-2. The project would raise the stream bed 4 feet at each barrier. The extent of aggradation upstream of the upper barrier is approximately 1200 feet. The aggraded sedimentation zones, as described in the EA, also generally delineate upstream hydrologic effects of the project under conditions of normal stream flow. Potential project-induced flood effects are also discussed in the EA. The upstream distance and higher elevation of the wilderness area relative to the barrier sites would preclude any foreseeable hydrologic effect to stream resources in the Aravaipa Canyon Wilderness Area.

9-3. Partial backfilling of the barriers will be accomplished during the project's construction phase to facilitate natural aggradation of sediment and minimize potential pooling. Nevertheless, some water will temporarily be impounded on the upstream side of the barriers following construction. These pools will gradually fill with sediment deposited by normal stream flow and may totally disappear with the first flood. USGS records indicate a flow event of 5,000 cfs or greater is possible every three years, which may be sufficient to fully aggrade the stream channel and eliminate pooled water. The EA also describes measures (installation of fencing and locked gates) that would eliminate unauthorized vehicle access to and reduce trespass recreational use of the project area from the lower barrier to the first upstream private property. These access restrictions will reduce the possible human transfer of fishes at the barrier sites.

9-4. Construction would begin around mid to late summer 1999 and last 4 to 8 months.

9-5. See response 9-1 and 9-2.

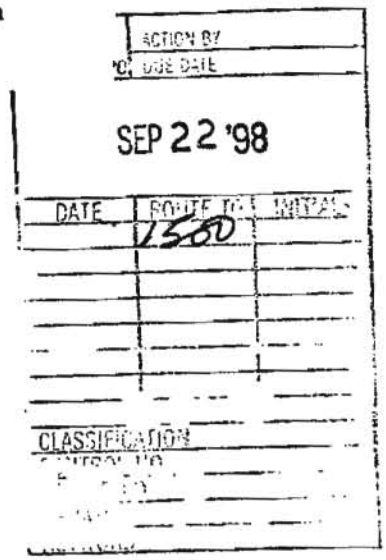
9-6. Corrections have been made in the final EA.

9-7. Effects to aquatic habitats would be confined to the barrier sites and sedimentation zones.

9-8. See response 9-3. Reclamation will perform periodic fishery surveys above both barriers on Indian Trust Allotment 013736. Reclamation does not have permission to access private properties upstream of the allotment.

CENTRAL ARIZONA PROJECT

P.O. Box 43020 • Phoenix, Arizona 85080-3020 • 23636 North Seventh Street (85024)
(602) 869-2333 • www.cap-az.com



September 18, 1998

John McGlothlen
U.S. Bureau of Reclamation
Attn: PXAO-1500
P.O. Box 81169
Phoenix, Arizona 85069-1169

Subject: Comments on Draft Environmental Assessment for Construction of Fish Barriers on Aravaipa Creek

Dear Mr. McGlothlen:

The Central Arizona Water Conservation District (CAWCD) submits the following comments on the Bureau of Reclamation's (Reclamation) draft environmental assessment regarding the construction of fish barriers on Aravaipa Creek.

CAWCD continues to oppose the use of Central Arizona Project (CAP) funds to construct these fish barriers. Reclamation's only reason for building the barriers is that they were identified as one component of a reasonable and prudent alternative in a 1994 biological opinion (BO) on CAP water deliveries issued by the U.S. Fish and Wildlife Service. CAWCD has demonstrated, however, that the BO is arbitrary and capricious because it contradicts previous consultations and biological opinions on the CAP, ignores readily available data, and applies a discriminatory standard. Two lawsuits challenging the validity of the BO are currently pending in U.S. District Court.

10-1

If Reclamation builds the fish barriers and the BO is subsequently overturned, then Reclamation will have wasted significant effort and funds. Delaying construction, on the other hand, causes no harm because the barriers are intended to protect against a long-term, rather than immediate, threat. Therefore, the only prudent course of action for Reclamation to take would be to suspend all work on the barriers until the legal challenges to the BO are resolved.

In addition, for the past two years Congress has expressly denied Reclamation's request for appropriations to construct these fish barriers. Thus, any expenditure by Reclamation

10-2

for barrier construction is in violation of appropriations laws.

We appreciate the opportunity to provide these comments.

Very truly yours,

Thomas W. McCann
Attorney

lo
twm\mcglothlen.ltr

Response to Letter of Comment from the Central Arizona Project

10-1. The Aravaipa Creek fish barrier project is a required element of the 1994 biological opinion. Reclamation must complete the project by December 31, 1999, to avoid a violation of the Endangered Species Act. The biological opinion is the product of more than 3 years' extensive negotiation between Reclamation and FWS. Both Reclamation and FWS believe the biological opinion is legally adequate. Your other comments are noted.

10-2. Past Congressional Conference Reports do contain language prohibiting the expenditure of funds on fish protection activities, such as the fish barrier project. However, this prohibition has not been included in an appropriations bill enacted by the full Congress and signed into law by the President. Reclamation must comply with the binding obligations of Federal law, including the Endangered Species Act. According to the Department of Interior solicitor's office, the Conference Report language does not dispense Reclamation from meeting its legal obligations.

11

United States Department of the Interior
Fish and Wildlife Service
Arizona Ecological Services Field Office
2321 W. Royal Palm Road, Suite 103
Phoenix, Arizona 85021-4951
(602) 640-2720 Fax (602) 640-2730

In Reply Refer To:
AESO/SE
2-21-90-F-119

September 22, 1998

MEMORANDUM

TO: Area Manager, U.S. Bureau of Reclamation, Phoenix, Arizona

FROM: Acting Field Supervisor

SUBJECT: Comments on Draft Environmental Assessment on the Construction of Fish Barriers on Aravaipa Creek, Pinal, County, Arizona

The Fish and Wildlife Service has reviewed the draft environmental assessment (EA) on the construction of fish barriers on Aravaipa Creek and finds it to be complete and well written. After reviewing the information in the EA, the Service believes the proposed action does not significantly affect the quality of the human environment and recommends that Reclamation make a Finding of No Significant Impact. **11-1**

On page 9, item F, please require that all heavy equipment operating near the river carry an oil spill kit or spill blanket at all times and that the operator be trained in the use of such spill containment equipment. **11-2**

On page 64, there is a discussion of the effects to fishing. This discussion needs to mention that Aravaipa Creek is closed to fishing by order of the Arizona Game and Fish Commission. **11-3**

Thank you for the opportunity to review this document. The Service appreciates the efforts of Reclamation in obtaining this important protection for native and listed fishes. If we can be of further assistance, please contact Sally Stefferud or me.

Thomas A. Gatz

cc: Director, Arizona Game and Fish Department, Phoenix, AZ

Response to Letter of Comment from the FWS

11-1. Your comment regarding the absence of significant impacts is noted.

11-2. The contractor will be required to provide spill kits for equipment operated in the active stream channel.

11-3. The final EA has been revised to acknowledge the existing fishing prohibition on Aravaipa Creek.

12

DEPARTMENT OF THE ARMY
LOS ANGELES DISTRICT, CORPS OF ENGINEERS
TUCSON PROJECT OFFICE, REGULATORY BRANCH
5205 EAST COMANCHE STREET
DAVIS-MONTHAN AFB, ARIZONA 85707-5000

ACTION BY
OFFICE DUE DATE
SEP 15 '98

DATE	ROUTE TO	INITIALS
	1500	

CLASSIFICATION

REPLY TO
ATTENTION OF:

September 14, 1998

Office of the Chief
Regulatory Branch

Bureau of Reclamation
Phoenix Area Office
ATTN: Mr. John McGlothlen
PO Box 81169
Phoenix, Arizona 85069-1169

File Number: 954-0517-MB

Dear Mr. McGlothlen:

This letter provides comments to the draft environmental assessment (DEA) dated August, 1998 for the proposed fish barriers in Aravaipa Creek (Section 3, T7S, R17E), Pinal County, Arizona.

Review of the DEA indicates an individual permit (IP) under Section 404 of the Clean Water Act will most likely be required for this activity. A detailed alternatives analysis in accordance with the Section 404(b)(1) guidelines will be necessary to determine the least environmentally damaging, practicable alternative to accomplish your purpose and need. 12-1

While our comments to the DEA are limited, we would suggest that mention of the jurisdictional waters determination is made within the description of the affected environment rather than on page 69 under related laws. In addition, the discussion of impacts to aquatic resources should specifically mention the types of waters of the U. S. impacted. For example, there are special aquatic sites (riffles) within the project area which will be impacted during construction. These should be specifically mentioned and perhaps a figure included to demonstrate their location. Finally, while the Bureau mentioned there would be no mitigation for stream channel impacts, the Corps shall require mitigation for impacts to special aquatic sites. 12-2 12-3

We appreciate the opportunity to provide comments on your DEA. We look forward to working with the Bureau during the permitting of this action. If you have questions, please contact me at (520) 670-5021.

Sincerely,

Marjorie E. Blaine
Senior Project Manager
Arizona Section, Regulatory Branch

Response to Letter of Comment from the COE

12-1. An individual Clean Water Act Section 404 permit application for the fish barrier project was submitted to the COE on September 17, 1998.

12-2. The affected environment and environmental consequences sections of the final EA were revised to include a discussion of the jurisdictional waters determination and presence of riffles within the project area.

12-3. Mitigation for impacts to riffles is being addressed under the Section 404 permit application process. The final Section 404 permit will identify any special conditions that are required by the COE to mitigate for impacts to riffles.