

BY CERTIFIED MAIL

**In the Office of the Director
Arizona Department of Water Resources**

San Pedro Alliance)	Petition for a Rule to
P.O. Box 492)	Designate the Upper San Pedro
Sierra Vista, AZ 85636)	River Basin an Active
)	Management Area under Title
)	45, Section 412 of the 1980
)	Groundwater Management Act

I. Introduction

The San Pedro Alliance hereby petitions the Arizona Department of Water Resources (ADWR) to designate the Upper San Pedro Basin an Active Management Area (AMA). In the Upper San Pedro River Basin, there are no designated AMAs. Therefore, there are currently no restrictions on drilling wells or withdrawing groundwater other than the requirement that the wells be registered and that the wells be drilled according to state well construction standards. There are 5,365 registered wells in the San Pedro River watershed on file with ADWR. (ADWR 1991)

The San Pedro Alliance files this petition under authority granted by Title 41, section 1033(A) of the Arizona Administrative Procedure Act. Title 41, section 1033(A) grants the right to petition an agency for adoption of a rule. Title 41 section 1033(A) also requires that "...[w]ithin sixty days after submission of a petition, the agency shall either deny the petition in writing, stating its reasons for denial, initiate rule making proceedings... or...make a rule." (A.R.S. § 41-1033)

II. Executive Summary

The San Pedro River is truly one of Arizona's, the Nation's, and the World's environmental crown jewels. The San Pedro River survives as one of the last naturally functioning desert river ecosystems in the southwestern United States.

The San Pedro River riparian area is internationally renowned for its biological diversity. Nearly 45% of the 900 total species of birds in North America utilize the San Pedro River at some point in their lives. (National Geographic Society 1999, Kingsolver 2000) In 1995, the American Bird Conservancy recognized the San Pedro River as its first "Globally Important Bird Area" in the United States. (American Birding Association 1995)

The San Pedro River is a critical "rest stop" for millions of migratory birds:

"...For millions of migratory birds traveling from winter food in Central America to their northern breeding grounds, there is one reliable passage on which life depends. Just one...the San Pedro..."
(Kingsolver 2000)

The San Pedro supports one of the highest variety of mammal species in the world:

"...PROPOSED UNIQUE ECOSYSTEM (NATIONALLY SIGNIFICANT) SAN PEDRO RIVER PINAL, PIMA, AND COCHISE COUNTIES, ARIZONA...Uniqueness - Wildlife and Habitat...The area is nationally significant, if not internationally, in regard to its mammalian diversity in that it is the richest assemblage of land mammal species in the entire United States and the second known richest in the world, exceeded only

by the diversity found in the montane cloud forests of Costa Rica..." (USFWS 1978)

In addition, 47 species of reptiles and amphibians are also found there. (BLM 1987) In 1993, Life Magazine recognized the San Pedro River as one of "America's Last Great Places". (Life 1993) Increasing local groundwater pumping, combined with past watershed abuses, provide the San Pedro with the dubious distinction of being one of the most imperiled rivers in North America.

Unfortunately, from 1990 to 1998, local water companies within the Upper San Pedro River Basin have increased the amount of groundwater sold to their customers by 23%. (Arizona Corporation Commission 1990, Arizona Corporation Commission 1998) In spite of this dramatic increase in deficit groundwater pumping, local governmental entities have implemented no significant mechanism to control deficit groundwater pumping.

AMA designation for the San Pedro River Basin offers the regulatory mechanism necessary for long-term protection of the San Pedro River against the increasing deficit groundwater pumping. AMA designation for the San Pedro River Basin is necessary to preserve the existing supply of groundwater for future needs.

III. **San Pedro Alliance**

The San Pedro Alliance is an international coalition of organizations and individuals that value the unique characteristics and priceless value of the San Pedro River. More than fifty organizations already belong to the San

Pedro Alliance. These organizations represent more than 13 million people.

The San Pedro Alliance includes: American Lands, American Rivers, Animal Defense League of Arizona, Arizona Audubon Council, Arizona Desert Tortoise and Turtle Society, Arizona Green Party, Arizona Herpetological Society, Arizona Wildlife Federation, Bear Creek Farms, Biodiversity Legal Foundation, Birdwatching Club of Arizona State University, Canadian Parks and Wilderness Society, Center for Biological Diversity, Center for Environmental Connections, Defenders of Wildlife, Desert Fishes Council, Desert Flycasters, Don't Waste Arizona, Inc., Endangered Habitats League, Environmental and Cultural Conservation Organization, Feather River Conservancy, Friends of Arizona Rivers, Friends of the Earth, Humane Society of the United States, Huachuca Audubon, International Rivers Network, Jumping Frog Research Institute, Klamath Forest Alliance, Maricopa Audubon, National Park Trust, National Turtle and Tortoise Society, National Wildlife Federation, Northern Arizona Audubon, Plumas Audubon Society, Pronatura, Republicans for Environmental Protection, San Pedro 100, Sierra Club, Sierra Club of Southern New Mexico, Sky Island Alliance, Sky Island Watch, Society for Conservation Biology, Arizona Chapter, Southeast Arizona Butterfly Association, Students for Environmental Action, Swan Lake Christmas Hill Nature Sanctuary, T & E, Inc., The Freshwater Group, The Herpetological Society, The Hiking Group, The Wild Bird Store, Trout Unlimited, Zane Grey Chapter, Tucson Audubon, Volcan Mountain Preserve Foundation, White Mountain Audubon, and Yuma Audubon. More organizations are in the process of joining or are expected to join the Alliance.

The San Pedro Alliance is a non-profit, 501c3 organization. The Board of Directors includes Mr. Al Anderson, Arizona Audubon, Mr. David Barnes, Sierra Club, Mr. Kevin Dahl, Tucson Audubon, Dr. Scott Burge, Maricopa Audubon, and Dr. Robin Silver, Center for Biological Diversity.

The San Pedro Alliance seeks long lasting protection for the San Pedro River. Long lasting protection for the San Pedro River requires recognition of the necessity to preserve the existing supply of groundwater for future needs.

IV. **Petition Organization**

This petition presents information supporting AMA designation for the San Pedro River Basin. An outline of our presentation is as follows:

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V. **Background**

The headwaters of the San Pedro River originate in the mountains and grasslands of the northeastern portion of the Mexican State of Sonora. The San Pedro River courses to the North, crossing the border in Southeast Arizona near

the City of Sierra Vista. It then flows between the Huachuca Mountains and the Mule Mountains, between the Whetstone Mountains and the Tombstone Hills, and between the Rincon Mountains and the Galiuro Mountains.

Eventually, the San Pedro joins the Gila River near Winkelman, in central Arizona. The Gila River, which is joined by the Salt River near Phoenix, ultimately joins the Colorado River near Yuma. The Colorado River enters the ocean at the Gulf of California.

At their destinations, the Gila River, the Salt River and the Colorado River are now usually dry. The Gila River rarely flows beyond the Ashurst-Hayden dam. The Salt River rarely flows past Roosevelt Dam and the Granite Reef Diversion dam. The Colorado River is now normally dry as it reaches the Gulf of California. Only the San Pedro River remains undammed and flows year-round to a significant extent.

San Pedro River base flows are the most sensitive indicator of the health of the Upper San Pedro Basin's aquifer. Base flows are stream flows during the driest time of the year. San Pedro River base flows come from water that seeps from the underground aquifer directly into the River. A direct hydrological connection exists between the water in the underground aquifer and the surface water, or actual stream flow, of the San Pedro River. Groundwater pumping in the area intercepts water that ordinarily provides the River's base flows. (Pool 1999)

In the San Pedro River watershed, ADWR has identified two groundwater basins and five sub-basins:

"...For the most part, the bedrock mountains help to identify the different groundwater basins within the watershed. Figure 2-2 shows the five groundwater

basins and their sub-basins that have been identified by the Arizona Department of Water Resources (DWR) pursuant to sections §§ 45-403 and 45-404 of the Arizona Revised Statutes (A.R.S.). The Upper and Lower San Pedro groundwater basins contain most of the groundwater and perennial surface water flows in the San Pedro River..." (ADWR 1991)

A.R.S. sections §§ 45-403 and 45-404 state:

"45-403. Designation of groundwater basins and sub-basins; hearing

A. Within eighteen months of the effective date of this section, the director shall propose boundaries for all groundwater basins and sub-basins of groundwater basins in this state not included within initial active management areas established pursuant to section 45-411...

45-404. Findings on hearing; maps; order for boundaries of groundwater basin; review and modification of boundaries

A. Within sixty days after the hearing, the director shall make and file in the director's office written findings with respect to matters considered during the hearing. For each groundwater basin, the director shall prepare and file in the director's office:

1. A map clearly identifying all lands included within the groundwater basin and its sub-basins.
2. Factual data justifying the boundaries of the groundwater basin and its sub-basins.
3. An order designating the boundaries of each groundwater basin and its sub-basins."

On February 3, 1982, in preparation for mandated public hearings ADWR defined the Upper San Pedro Basin:

"ORDER FOR HEARING

...Upper San Pedro Basin, is defined as the watershed of the San Pedro River upstream from a location known as The Narrows, approximately 10 miles north of Benson, to the Republic of Mexico border, except for the upper drainage area of Tres Alamos Wash located in Allen Flat..." (ADWR 1982)

On June 21, 1984, ADWR finalized the definition of the Upper San Pedro Basin with the issuance of "Findings and Order":

"FINDINGS AND ORDER

...41. There is an Upper San Pedro Basin located within Cochise, Graham, Pima and Santa Cruz Counties. This Basin contains the Allen Flat Sub-basin and the Sierra Vista Sub-basin...

ORDER

In consideration of the findings herein set forth, IT IS HEREBY ORDERED:

1. Outside the initial Active Management Areas established pursuant to A.R.S. § 45-411 there are forty-six (46) groundwater basins, nine of which are subdivided into a total of 27 groundwater sub-basins, which shall be designated as set forth in findings numbered 1 through 46 of this Findings and Order.

2. The boundaries of each of the groundwater basins and sub-basins are narratively described and cartographically set forth in that document entitled "Basin and Sub-basin Designations - June 1984..." (ADWR 1984a)

"Basin and Sub-basin - June 1984" states:

"GROUNDWATER BASIN AND SUB-BASIN DESIGNATIONS...

UPPER SAN PEDRO BASIN

Allen Flat Sub-Basin

Sierra Vista Sub-Basin

Basin Description

The basin in the surface watershed of the San Pedro River from the Republic of Mexico downstream to the area referred to as "The Narrows" north of Benson, and in addition, the upper drainage areas of Hot Springs and Kelsey Canyons which enters the San Pedro River north of the "The Narrows". The basin is divided into two sub-basins: Allen Flat Sub-Basin is the upper watersheds of Tres Alamos Wash, Hot Springs and Kelsey Canyons; and Sierra Vista Sub-Basin is the watershed of the San Pedro River upstream from "The Narrows" exclusive of Upper Tres Alamos Wash.

Findings

1. Groundwater primarily occurs in the alluvium deposits of the valley...Some declines in groundwater levels have occurred in the basin, the most severe of which are in the Fort Huachuca-Sierra Vista area. Depths to water in the basin varies from 0 to greater than 600 feet..." (ADWR 1984b)

The Benson "Narrows" are found roughly along a dividing line between the lower Rincon Mountains to the west and the middle of the John Lyon Mountains to the east. (ADWR 1991)

The Upper San Pedro Basin is also divided into two subwatersheds, the Sierra Vista subwatershed and the Benson subwatershed. The dividing line between the two subwatersheds is approximately three miles north of Fairbank. (ADWR 1991)

In the Sierra Vista subwatershed, water in the aquifer comes primarily from the Huachuca Mountains to the west, and from the Mule Mountains and the Tombstone Hills to the east. In the Benson subwatershed, water in the aquifer comes primarily from the Mustang and Whetstone Mountains to

the west and the Dragoon, Little Dragoon, and John Lyons Mountains to the east. (ADWR 1991)

In the Upper San Pedro Basin, groundwater pumping in excess of recharge has created declines in the water levels in the aquifer. Water levels in wells have dropped dramatically. (Putnam *et al.* 1988, Schwartzman 1990, ADWR 1994b, Corell *et al.* 1996, Wynn and Gettings 1997) Consequently, base flows in the San Pedro River have also declined dramatically. (Corell *et al.* 1996, Pool and Coes 1999, USGS 2000)

U. S. Geological Survey (USGS) hydrologist, Don Pool, confirmed this fact in a Combined Work Session of the Cochise County Board of Supervisors and the Sierra Vista City Council in Bisbee, Arizona on May 5, 1999:

"...All the recharge that enters [the aquifer] from Ramsey Canyon all the way to the Babocomari [River] is intercepted by this pumping [Sierra Vista/Fort Huachuca].

Any gallon of water that is taken out by a pumping well [in Sierra Vista/Fort Huachuca] reduces the outflow by a gallon at the river, at some point in time, at some place along the river..." (Pool 1999)

San Pedro River base flows have decreased dramatically in the last fifty years. In the Upper Basin, USGS estimates that base flows have decreased by 67% from 1943 to 1992. (USGS 2000) ADWR estimates the base flows have declined by approximately 50% from 1935 to 1991. (Correl *et al.* 1996) The Commission for Environmental Cooperation's San Pedro Expert Team concluded that groundwater discharge into the San Pedro's base flow is currently at approximately 30% of its original amount. (CEC 1999)

Just as San Pedro River base flows are the most sensitive indicator of the health of the area's aquifer, changes in streamside vegetation also reflect the health of the aquifer. Similarly, as diminished San Pedro River base flows continue to be documented, degradation of streamside vegetation is already becoming apparent:

"...Although the riparian ecosystem of the San Pedro is among the best remaining example of its type in the state, it has been reduced from its historical potential as evidenced by low abundance of wetland (cienega) vegetation and high abundance of riparian scrub (facultative riparian shrubs) in potential cottonwood-willow habitat...

...There is a relatively large group of obligate and facultative wetland plants in the San Pedro floodplain, and these have a very narrow tolerance with respect to fluctuations in depths to groundwater. Some of these wetland plants include great bulrush (*Scripus acutus*), tropical cattail (*Typha domingensis*), spikerush (*Eleocharis montevidensis*), Torrey rush (*Juncus torreyi*), horsetail (*Equisetum laevigatum*), and willow smartweed (*Polygonum lapathifolium*)...

...Loss of wetland plants already is apparent on portions of the SPRNCA where groundwater tables show seasonal groundwater declines of about 1 to 2 m (3 to 6 ft)...

...Groundwater tables are shallowest at Hereford 1 and Moson Springs and deepest at Contention. At the Hereford 1 and Moson Springs sites, maximum groundwater decline has been 0.5 m, or 1.5 ft since 1987. These sites support several obligate wetland plants... At Palominas 10, maximum groundwater decline has been 1m [3 ft] since 1987. As a result of these moderate seasonal groundwater declines, the site supports facultative wetland plants but no obligate wetland species. At Contention (location between Tombstone and Benson), maximum groundwater decline has been 1.9 m [6 ft] since 1987. These groundwater declines have been great enough to cause loss of

obligate wetland plants and facultative wetland plants.

The dominant trees in the upper San Pedro River floodplain are Goodding willow, Fremont cottonwood, and velvet mesquite...Of all the San Pedro tree species, Goodding willow requires the shallowest groundwater. Goodding willow is an obligate wetland species...

...Lack of recent Fremont cottonwood and Goodding willow establishment already is apparent in some reaches of the San Pedro River. During 1993, for example, floods created potential conditions for cottonwood seedling establishment. Sampling of the established vegetation at this site also indicted the presence of few young cottonwoods (i.e., few saplings or "pole-sized" trees)...This contrasts with sites such as Moson Springs, at which cottonwood is abundant in many size (age) cohorts. Age structure at sites such as Moson Springs can be classified as "healthy" in the sense that there are many more young trees than old trees and many size (age) classes. At Contention, where seasonal groundwater flux is relatively high (about 2m, or 6 ft) and flow is intermittent, monitoring of seedling establishment revealed that water tables declined too rapidly in summer to allow for survivorship of Fremont cottonwood seedlings...

...Increase in Exotic Species

Another predicted consequence of lowered water tables on the San Pedro River is increased invasion of saltcedar. Saltcedar in its native land grows on mid to high floodplain terraces. It tolerates relatively deep water tables and is more drought tolerant as juveniles and adults than are Fremont cottonwood or Goodding willow. Like these two native species, however, it also is a flood-tolerant pioneer species...

Saltcedar is abundant on much of the lower San Pedro River below Benson, and is beginning to invade on hydrologically losing reaches of the downstream end of the SPRNCA where flows are intermittent and water tables show relatively high seasonal declines (i.e. between Tombstone and Benson)...The saltcedar in

this area is relatively young, but is occupying areas of the floodplain zones that typically would be occupied by cottonwood.

Contention, is a site in the downstream end of the SPRNCA in which cottonwoods are giving way to saltcedar on the young floodplains...While, at Moson Springs, in contrast, cottonwood trees are abundant in a variety of size (and age) classes, including young age classes. Should groundwater declines occur throughout the SPRNCA, saltcedar would be likely to invade the lower floodplains of much of the Upper San Pedro River, replacing one of the last strongholds of cottonwood-willow forest..." (ADWR 1994b)

Arizona has already lost more than 90% of its original riparian areas. (Arizona Commission on the Environment 1990, Krueper 1992, AGFD 1993) Dams, diversions, groundwater pumping and excessive cattle grazing are the primary culprits.

While excessive cattle grazing is slowly coming under control, dams and water diversions continue to be problematic. Deficit groundwater pumping continues increasing dramatically.

The water history of Arizona has been one of near continuous loss of river habitat. A culture of insensitivity toward water conservation perpetuates these problems. Author Marc Reisner has summarized this attitude concisely in his book Cadillac Desert:

"...One of the revelations of the postwar period was that, given the opportunity, people were happy to leave temperate climates with cold winters for desert climates with fierce summers, provided there was water to sustain them and air conditioning to keep them from perishing...Not that the migrants had bothered to ask whether there was enough water before they loaded their belongings and drove west. They simply came; no one could stop them. How they

were to fill their pools and water their lawns was Arizona's problem...

Arizona's solution was the same most other western states relied on: it began sucking up its groundwater, the legacy of many millennia, as if tomorrow would never come..." (Reisner 1986)

For the San Pedro Basin, tomorrow has arrived. Failure to control the area's deficit groundwater pumping is now not only threatening the area's future, it is resulting in conflict and litigation. More than 100 years ago, John Wesley Powell warned of this conflict and litigation that would predictably result from failure to tailor development to fit the limits of its natural resources. Also similar to today's situation, Powell's warnings were derided by water providers and local leaders:

"...Powell was invited to address the International Irrigation Congress meeting in Los Angeles...Major Powell put aside his planned speech and told them that they were mad... "I tell you gentlemen," he said into their heckling and the rising clamor of their indignation, '...you are piling up a heritage of conflict and litigation over water rights for there is not sufficient water to supply the land.'" (Stegner 1954)

For the San Pedro Basin, John Wesley Powell's words are proving prophetic. Controversy and litigation now result as calls to "tailor" development to fit natural resource limitations continue to be ignored.

In Todd Wilkinson's book, Science Under Siege, The Politicians' War on Nature and Truth, former U.S. Bureau of Land Management (BLM) hydrologist Ben Lomeli summarizes the San Pedro River situation:

"...Water runs through everything. It carries the memory of our ancestors and binds us to the land.

It courses through our blood and gives substance to our own flesh. I consider the San Pedro to be the soul of the land in the Chihuahuan Desert. The water is what makes life here possible and desirable. Those who want to abuse it are fooling themselves if they think it is expendable..." (Wilkinson 1998)

Failure to control the San Pedro Basin's groundwater-dependent development now clearly threatens the existing supply of groundwater for future needs.

VI. **The Arizona Groundwater Management Act**

The Arizona legislature passed the 1980 Groundwater Management Act (AGMA), A.R.S. § 45-401 *et seq.*, in response to evidence that the withdrawal of groundwater exceeded recharge in some of Arizona's groundwater basins. Designation of an AMA pursuant to the AGMA provides the regulatory framework to conserve, protect, and allocate the use of groundwater resources within a groundwater basin or sub-basin. [A.R.S. § 45-401 *et seq.*, ADWR 1996]

The Director of ADWR may designate a groundwater basin or sub-basin an AMA upon determination that any of the following exists:

1. Active management practices are necessary to preserve the existing supply of groundwater for future needs.
2. Land subsidence or fissuring is endangering property or potential groundwater storage capacity.
3. Use of groundwater is resulting in actual or threatened water quality degradation. (A.R.S. § 45-412)

The AGMA established four AMA groundwater basins in Arizona, in the Phoenix, Tucson, and Prescott metropolitan areas, and in Pinal County. The AGMA gave ADWR the directive to intermittently evaluate other non-AMA groundwater basins for possible AMA designation:

"...The director shall periodically review all areas which are not included within an active management area to determine whether such areas meet any of the criteria for active management areas as prescribed in this section..." [A.R.S. § 45-412 (C)]

These periodic evaluations are necessary to ensure that a secure future groundwater supply remains available to the State of Arizona.

Pursuant to A.R.S. Sections, §§ 45-403 and 45-404, ADWR has already officially defined and designated the two groundwater basins within the San Pedro watershed eligible for designation for an AMA, the Upper San Pedro Basin and the Lower San Pedro Basin.

VII. Groundwater Declines in the Upper San Pedro Basin

In the year 2000, the local population in the Sierra Vista sub-watershed will remove approximately 7,270 acre-feet of groundwater. (CEC 1999) Declining groundwater levels in the Sierra Vista sub-basin threaten the operability of existing wells. Some existing wells are already unable to reach to the depth of the depressed water levels.

In 1981, the Council on Environmental Quality (CEQ) acknowledged this problem:

"...Groundwater in the Fort Huachuca-Sierra Vista area, the Basin's major urban area, has dropped 30 feet in the past 25 years. Four wells operated by the Bella Vista Water Company, which serves part of Sierra Vista, have experienced declines ranging from 30 to 46 feet since 1973. The area faces potentially severe water supply problems. The overdraft situation 'could effectively exhaust the nearby aquifer by the year 2020...The upper San Pedro River could run dry - just as the Santa Cruz did - in the years ahead if massive groundwater overdrafting continues..." (CEQ 1981)

In 1992, the United States Army recognized this problem:

"...Due to the growing population at Fort Huachuca, Sierra Vista, and Huachuca City, increased ground water withdrawal rates will continue to result in water being extracted from the aquifer. Ground water levels in the Sierra Vista subwatershed are declining despite the apparent abundance of water in the aquifer. Further population growth, and subsequent pumpage from the aquifer in this area, will accelerate the decline of the water table and threaten the operability of existing wells in the vicinity..." (US Army 1992)

Absent dramatic regulatory change, this deficit groundwater pumping will increase to 13,000 acre-feet by the year 2020. It will result in the eventual depletion of the aquifer that feeds the San Pedro River. (CEC 1999)

Changes in the San Pedro River baseflows are already apparent. In July 1997, the San Pedro River at Charleston Narrows was nearly completely dry for the first time. (CBD 1997) Exposed bedrock at the Charleston Narrows forces the San Pedro River's entire sub-surface flow to the surface.

Wells create an area of dewatering immediately surrounding their point of extraction. This area of

depletion is called a cone of depression. As the dewatering of each well or groups of wells increases, the cone of depression increases in an expanding, circular pattern. The cone of depression represents an expanding area of lowering of the water table.

Excessive groundwater pumping in the Hereford/Palominas area has caused an expanded cone of depression that now directly captures San Pedro River surface flow. Sections of the San Pedro immediately downstream from this area now flow intermittently during the driest time of the year. (CEC 1999)

The expanding cone of depression in the Sierra Vista subwatershed threatens the aquifer, as well as the base flows of the San Pedro River. The decreasing base flows of the San Pedro River in the Sierra Vista subwatershed are due, in most part, to the excessive groundwater pumping of the Sierra Vista/Fort Huachuca population center.

The City of Benson is also growing dramatically. The San Pedro River now flows intermittently through the City. In the City of Benson, just like in Sierra Vista, vulnerability of the aquifer to depletion and decreased water quality is becoming an increasing concern.

VIII. Need for AMA Designation in the Upper San Pedro Basin

a. Threats to Groundwater

The increasing recharge deficit in the Sierra Vista sub-basin threatens the groundwater supply for future use. (Maddock and Lord 1993, CEC 1999) The following factors are primarily responsible for the increasing groundwater deficit in the Sierra Vista sub-basin:

1. Population growth associated with Fort Huachuca and local Department of Defense activities,

2. The City of Sierra Vista's plan for groundwater-dependent growth,
3. The Cochise County Comprehensive Plan for groundwater-dependent growth,
4. The City of Benson's plan for groundwater-dependent growth,
5. Assertion of Federal water rights,
6. Increasing agricultural groundwater pumping, and
7. Drought.

VIII. Need for AMA Designation in the Upper San Pedro Basin

a. Threats to Groundwater

1. Population growth associated with Fort Huachuca and local Department of Defense contracts

The size and economic influence of Fort Huachuca contribute dramatically to the San Pedro Basin's groundwater-dependent growth. As the "principle economic engine and employer in the region," Fort Huachuca "accounts for 38 percent of all employment in Cochise County." (CEC 1999) Ft. Huachuca is the fifth largest employer in the State of Arizona. This translates into a local presence of more than 30,000 troops, dependents, and associated personnel. (CEC 1999, ASL 1995)

The fact that Ft. Huachuca's activities result in the local presence of more than 30,000 groundwater-dependent people is also confirmed by the Ft. Huachuca commander:

"...Boardman (Ft. Huachuca Garrison Commander Col. Michael Boardman) said the military impact to the

area includes 34,341 people - 5,159 are active duty people, 5,247 civilian employees including contractors, 9,348 military family members and 14,587 military retirees and their family members..." (Sierra Vista Herald 1999e)

Fort Huachuca's payments to local business for contract work have increased by 39%, from \$467.7 million in 1991 to \$649.7 million in 1997. (Ft. Huachuca 1991, Ft. Huachuca 1997) These contracts support a groundwater-dependent population that would not be a factor without the contracts. These contracts continue increasing:

"High-tech business boom

SIERRA VISTA - The high-tech business is booming here, bolstered by a highly-skilled labor force, and defense contracts through Fort Huachuca, a local economic expert says.

"Seventy-five percent of industries here are in the high-tech field because of defense contractors," Economic Development Foundation Executive Director Barry Albrecht said. 'And that's a conservative number...' (Sierra Vista Herald 1998b)

"Downsizing of military will hit Fort Huachuca, Outside contract work expected to increase

...Col. Corlis Berry, the commander of the Electronic Proving Ground, said his organization has 120 civil service employees and 159 soldiers.

By the year 2000 almost all the soldiers will be gone, he said.

Berry said he expects the number of contractor personnel to increase beyond the current 600.

Col. Alfred Estrella, who heads the Information Systems Engineering Command, said his military contingent is down to 40 from 119 and he too expects most of them to be gone.

He said the slack will probably be made up by hiring more contractor people...

Dr. (Col.) William Tucker IV, commander of the Raymond W. Bliss Army Health Center said he expects his 450-strong staff to remain steady.

He said there will be a plus for medical providers off post as he spends more money for services.

Last year Tucker said he spent \$7.1 million for off-post services and supplies and this year he expects that to increase by 30 percent and next year by another 20 percent." (Sierra Vista Herald 1998c)

"Fort, city: New ties that bind

SIERRA VISTA - ...Chopin [Ft. Huachuca Garrison Commander] said as the military [is] reducing its personnel levels and budgets, he expects there will be more reaching out to the local communities for support especially in the form of contracts.

He said he is looking for ways to enter into agreements with Sierra Vista to provide services, ranging from recreational to operating the post's wastewater treatment plant.

While Sierra Vista was almost totally dependent on the fort, now the post is becoming more dependent on the city and other communities in Cochise County, Chopin said..." (Sierra Vista Herald 1998d)

"Merger helps fort firm

FORT HUACHUCA - Last summer BDM merged with TRW and the result gives the military a stronger contractor for the Joint Interoperability Test Command on post, a company vice president said...He [Vice president and general manager for TRW's Logistics, Support, Test and Evaluation Division, and former director of the Department of Defense's Command, Control, Communications and Computers, James S. Cassity Jr.] said even though the military continues to downsize he does not expect the same to be true of the contractor community. In fact he expects more contracts which could lead to increase in the company's work force." (Sierra Vista Herald 1998e)

"SV firms try to lure Tucson's high-tech workers

SIERRA VISTA - Sierra Vista's high-tech businesses need qualified computer and electrical engineers to meet an ever growing workload, and they went to Tucson this week to get them...

There is an increasing gap between the number of positions opening up and the number of qualified engineers across the country, Black [ILEX Systems company program director John Black] said. He estimated there may be as many as 100,000 unfillable computer and electrical engineering jobs nationwide. That makes the competition in the labor market extremely tight.

Couple that with an increasing amount of business pouring out of Fort Huachuca every day, and Black said Sierra Vista companies may need as many as 300 new engineers this year alone.

"I said two months ago that I could put 30 (engineers) to work today," Black said. "Today I'm saying could put 50 to work today."...

Albrecht [Sierra Vista Economic Development Foundation Executive Director Barry Albrecht] said the fair was the first step in a much larger marketing campaign to draw engineers to the area..." (Sierra Vista Herald 2000b)

"\$47.3 million deal for SV

SIERRA VISTA - A \$47.3 million information technology support contract awarded by the Army this week could mean up to \$1 billion for a local information technology provider and could create as many as 400 new jobs over a five-year period...

The contract, awarded to OAO Corp. Tuesday, is also spurring the construction of an approximately \$5 million state-of-the-art technology research facility in town...

...Under the contract, OAO will provide all of the hardware, software and technical service needed to run the Army's Information Systems Engineering Command operations around the world.

The one-year contract is for \$47.3 million and has a clause that allows it to be renewed annually for four years. If those options are exercised, the contract is expected to be worth approximately \$246 million, but could go as high as \$1 billion, Molina

[Edward Molina, an OAO senior technical representative] said.

In order to support the operation, the Sierra Vista Economic Foundation is building a 45,000 square-foot technology research center off of Highway 90, which it will then lease to OAO and its subcontractors...

"This a great relationship between the city, the Economic Development Foundation and the private sector to service the needs of the Army," he said, "This is real economic development."

Molina said OAO officials intend to house their operations in Sierra Vista in a number of temporary sites until the new building is completed. (Sierra Vista Herald 2000c)

"High-tech company moves to Sierra Vista, SIGNAL Corp. opens Wilcox Drive office after receiving post contract

...After landing a major contract with Fort Huachuca, the SIGNAL Corp. has opened an office here.

SIGNAL has hired about 40 employees for the local office, and the company eventually plans to reach 125 employees, said Cass Panciocco, executive vice president for SIGNAL.

In April, SIGNAL was awarded a \$298 million contract with the fort's Information Systems Engineering Command, Panciocco said. The Total Engineering and Integration Services, or TEIS, contract has a spending cap of \$1 billion...

...'As opportunities come up out of the fort - with us being here locally - (the goal is) to go after more work, and expand our base here,' he [Panciocco] said.

Other local companies are already reaping the benefits of SIGNAL's presence in Sierra Vista. The company purchased computers from another local retailer.

'We try to keep it (business) local, in terms of supporting the community,' Panciocco said..." (Sierra Vista Herald 2000h)

The CEC San Pedro Expert Study Team estimates 9,400 acre-feet per year of deficit groundwater pumping in the subwatershed for the year 2000. (CEC Report 1999) In a recently released Biological Opinion from the U.S. Fish and Wildlife Service on Ft. Huachuca activities, Ft. Huachuca admits to groundwater pumping totaling 5,121 acre-feet per year. (USFWS 1999b) This represents 54% of the groundwater pumping in the upper San Pedro Basin based on US Army figures and calculations, and on a letter to the editor by City of Sierra Vista councilman, Casey Jones. (Jones 1999)

In the Biological Opinion, the U.S. Fish & Wildlife Service assigns 62% of all groundwater pumping in the subwatershed to Ft. Huachuca (5,802 acre-feet). (USFWS 1999b) These figures also assume 150 gallons per day for per capita use (based in large part on Sierra Vista councilman Jones' letter to the editor [Jones 1999]). This is less than the per capita use of 164 gallons per day determined by the City of Sierra Vista's own consultants. (ASL 1995) Utilizing the City of Sierra Vista consultant's figure of 164 gallons per day per capita use, Ft. Huachuca is responsible for 67% (6,343 acre-feet per year) of the year 2000 groundwater pumping deficit of 9400 acre-feet per year.

In the Biological Opinion, Ft. Huachuca commits to one significant quantifiable action of recharging 600 acre-feet per year over the next ten years:

"...Specific projects to which the Fort is committed (parts V and VI of Appendix A of the MOA - Appendix 1 herein) would reduce water use by a minimum of 600 acre-feet per year within 10 years..." (USFWS 1999b)

Ft. Huachuca claims water rights for 10,522 acre-feet per year of groundwater pumped:

"...Fort Huachuca has filed two statements of claimant, 39-10774 and 39-10775, which claim twenty-five wells, thirty-nine springs, and seventy-four ponds...Total amount of annual water use claimed by the Fort is 10,522 acre-feet per year (10,087 acre-feet per year claimed on 39-20774 and 435 acre-feet per year on 39-10775). The Fort based these claims on federal water rights, and legitimate and authorized federal activities..." (ADWR 1991)

VIII. Need for AMA Designation in the Upper San Pedro Basin

a. Threats to Groundwater

2. The City of Sierra Vista's plan for groundwater-dependent growth

The City of Sierra Vista has plans for groundwater-dependent expansion that include the addition of thousands of new single family homes, new industries, an airport business park expansion, and a satellite campus of the University of Arizona. The leadership of the City of Sierra Vista remains dedicated to excessive, groundwater-dependent growth, no matter the future consequence:

"Council Members Urge IDA [Sierra Vista Industrial Development Authority] to Boost Growth

...Sierra Vista City Council members Casey Jones and Harold Vangilder on Monday urged the Industrial Development Authority to become more aggressively involved with the city's growth and development..."It's got to be a labor of love," Vangilder said. 'You've got to be aggressive about it'..." (Sierra Vista Herald 1997)

"A conversation with the Sierra Vista Mayor Pro Tem

...There is not anything in, on or around the San Pedro River that is worth a single job of a single citizen in Sierra Vista..." (Mountain View News 1995)

"Science Under Siege, The Politicians' War on Nature and Truth

...In Sierra Vista today, there are those such as Harold Vangilder who have grand plans for the little municipality... "All right, there may be five hundred species of wildlife found along the San Pedro. My response is, so what?"...he says... "...Nature has been selecting for species for a long time. It's called evolution, and part of the process is survival of the fittest. We're the ones who rule supreme, and if a plant or animal can't adapt to our needs, then it's too bad.'"... (Wilkinson 1988)

Attempts at encouraging moderation of the rate of deficit groundwater-dependent growth have been met with hostility:

"City officials declare war on enviro 'enemy'

...At a hastily called news conference Friday, officials from Sierra Vista and Cochise County said they have sat silently on the sidelines for too long and vowed to take on environmentalists hoping to stop growth in the area...

"...We've been silent too long. Them days are gone." Sierra Vista Mayor Pro Tem Harold Vangilder said at the beginning of the city's news conference..." (Sierra Vista Herald 1995)

"...On Friday, Sept 23, the Sierra Vista City Council took a courageous action...they declared they would fight any attack on the viability of their economy by fighting the listing as endangered species two noxious weeds and a member of the fish-bait community. I'm talking about the water umbel, the ladies tresses and the tiger salamander...It is

incomprehensible that laws passed by Congress, the regulation and policies of federal agencies and the rulings of federal judges would declare the needs of owls, squirrels, noxious weeds and fish bait have more value than the future we seek to build for our children. It is a sad thing to note that the environmental community can apparently lay down on the graves of our children and cry for the owls..." (Vangilder 1995)

"Report is minimized by Sierra Vista councilman

...A Sierra Vista official is minimizing the importance of a state document which asserts that declining groundwater levels in the Sierra Vista area are reducing the flow in the San Pedro River.

"It has the import of the tag on your mattress," said Sierra Vista City Councilman Harold Vangilder of the document which local homeowners have signed..." (Sierra Vista Herald 1994b)

Sierra Vista planning and zoning decisions reflect this zeal for the promotion and accommodation of excessive, local groundwater-dependent growth. More than 12,000 new homes are planned.

The development firm Castle & Cooke Arizona, Inc. plans to build over 7,000 homes if it can convince the City to enter into a 20-year financing agreement for the expansion of sewer lines. (Sierra Vista Herald 1999b) Bella Vista Ranches and Water Company already has secured approval for a master development plan that includes the construction of over 5,000 new homes in and adjacent to the City of Sierra Vista. This development translates into a forecasted 50% increase in population by the year 2025. (Ft. Huachuca 1998)

The groundwater-dependent building boom is not a nebulous future plan. The boom is happening now:

"Sierra Vista building boom? Pace ahead of 1998 rate

SIERRA VISTA - More homes are being built in the city limits during the first seven months of this year compared to the same period in 1998, according to a report from the city's building administrator...

...There also was an increase in commercial permits so far this year..." (Sierra Vista Herald 1999d)

A proposed expansion of the Sierra Vista airport will also contribute directly and indirectly to the demise of the San Pedro River. The expansion will bring 500 new jobs to the area, according to the former Mayor of Sierra Vista:

"...The mayor said 200 acres of Fort Huachuca land could be used to expand the airport. He said an airport expansion would bring 500 jobs to the area and make moving freight possible..." (Sierra Vista Herald 1999c)

Following U.S. Army Corps of Engineers Construction Engineering Research Laboratory' local job and household size multipliers, 500 new jobs translates into over 2,400 additional groundwater-dependent people that will remain or relocate to the area. The expansion will also create indirect growth related to the attractiveness of a larger and more efficient airport facility.

The proposed expansion of the University of Arizona (UA) satellite campus in Sierra Vista will further increase deficit groundwater pumping. The UA Sierra Vista Campus Strategic Plan succinctly expresses its mission of economic development and expansion:

"The University of Arizona Sierra Vista Campus (UASV) will play a pivotal role in... enhancing and

expanding opportunities for economic development...Upon completion, the 99,164 sq. ft. campus will accommodate approximately 3,000 to 4,000 students." (Arizona Board of Regents 1995)

Growth of the City of Sierra Vista has increased to the point that the City is out of capacity of sewage and wastewater processing ability. A new wastewater treatment and recharge project is planned to solve this dilemma. The proposed wastewater treatment project claims to be able to recharge 30% of the groundwater removed by the City, in addition to processing increasing amounts of sewage and wastewater. The net effect of the project on the aquifer will be increased deficit groundwater pumping as the result of the increasing groundwater-dependent growth the wastewater plant accommodates. (CEC Report 1999)

The City has claimed that recharge from the wastewater treatment plant will allow the City to grow to 107,000 groundwater-dependent people without further damage to the San Pedro River. In April 1996, City of Sierra Vista Mayor Richard Archer wrote to the US Army:

"...The City of Sierra Vista has embarked on a Wastewater Recharge project. This recharge project, by refreshing the aquifer between Sierra Vista And the San Pedro River, will protect the San Pedro River until the total population of Sierra Vista/Fort Huachuca reaches 107,000 people..." (Archer 1996)

The City of Sierra Vista claims that the recharge project will "protect" the San Pedro River by creating a "mound" of recharged water between the increasing Sierra Vista/Fort Huachuca cone of depression and the San Pedro

River. This protection is supposed to last for twenty years:

"...A study, completed in the mid80's, indicated that the combined Sierra Vista/Fort Huachuca pumping was creating a deepening cone of depression, which could eventually impact the flows of the San Pedro River. The city began looking at ways that it could clean up the water at the treatment facility to augment the water supply. It was concluded that the water could be cleaned further and recharged between the city and the river. This process would, in effect, create an underground mound of water that would protect the river base flows from the effects of the cone of depression under the city...The whole purpose of these projects is to protect the San Pedro River from any adverse effects of groundwater pumping in the Sierra Vista/Fort Huachuca area. The current plan is projected to mitigate any impact to the river over the next 20 years..." (City of Sierra Vista 1998)

The implication by the City of Sierra Vista that the effluent recharge project is expected to delay the effects the river beyond an area immediately down aquifer is not accurate. On January 25, 1999, the Fish and Wildlife Service acknowledged that, at best, base flows in the river may only be supplemented from Lewis Springs (immediately down-aquifer from the wastewater treatment plant site) northward to Fairbank:

"...the proposed action is expected to affect an increase in river baseflow over a no project scenario during the period 2000-2040 (ASL 1998). This effect is expected to occur primarily in the reach from Lewis Springs to Fairbank..." (USFWS 1999a)

The fact that, at best, base flows may only be supplemented from Lewis Springs northward to Fairbank is also supported by the City of Sierra Vista's own

consultants in both 1995 and 1999. (ASL 1995, Fluid Solutions/Bureau of Reclamation 1999)

The U.S. Bureau of Reclamation also agrees that the expansion of the wastewater treatment plant may offer temporary protection to a portion of the San Pedro River. Bureau of Reclamation, however, is also more cautious about the City of Sierra Vista's expansive claims:

"...The recharge project is not intended, and should not be considered, as solving the long-term water supply problems the community faces, nor the potential impacts of other ground-water uses within the subwatershed. It does not balance ground-water withdrawals and recharge in the subwatershed. Based on the ground-water models, recharge at the WRF would result in mounding of water within the aquifer between the cone of depression and the San Pedro River. The mound would create an effective hydrological barrier between the pumping that serves the City, Fort Huachuca, and the river. According to the models, this mounding would continue for a minimum of 20 years (term of Reclamation's agreement with the City), or as long the recharge occurs..." (Fluid Solutions/Bureau of Reclamation 1999)

Initially, the wastewater treatment plant may provide a protective "mound" of water for a short section of the San Pedro River immediately downstream from the facility. Unfortunately, the rate of local groundwater pumping continues to increase more than the rate of wastewater treatment plant recharge. If this local groundwater pumping is not controlled, the cone of depression resulting from the increasing local groundwater pumping will eventually drain the wastewater treatment plant's protective "mound" as well as the River. At this point, there will no longer be enough water seeping from the aquifer to maintain base flows in the River.

Controversy still exists concerning whether or not recharge at the current site will actually occur as proposed. A clay layer of low transmissivity exists underneath the proposed recharge site.

Concerns about whether or not recharge at the proposed wastewater treatment plant will occur as planned was first noted at a Combined Work Session of the Cochise County Board of Supervisors and the Sierra Vista City Council. This meeting occurred on May 5, 1999 in Bisbee.

At the Bisbee meeting, U.S. Geological Survey hydrologist Don Pool presented data that the area of proposed recharge might be located improperly:

"How does the river flow? Study gives new insight

...Don Pool [a hydrologist for the federal agency] ...said the proposed Sierra Vista recharge project may be sited in the wrong area..."

...Sierra Vista Public Works Director George Michael said the proposed site for the recharge portion of an \$8 million wastewater treatment plant may have to be revised based on Pool's contention the area is on one side of a silt and clay deposit, which is higher than the river, and the water will not make it to the river..." (Sierra Vista Herald 1999a)

In 1997, Huachuca Audubon had expressed similar concerns regarding the impermeability of the proposed recharge site to the City of Sierra Vista and the Bureau of Reclamation. (Huachuca Audubon 1997):

"...In 1976 the U.S. Department of Agriculture's Soil Conservation Service completed a soil and water resources study in the proposed effluent recharge project area prior to construction of the current effluent treatment facility. The agency found that the area's soils were of three basic types: Pinaleno, Sonoita, and Whitehouse-Continental

series. The 1976 study titled, Evaluation Of Irrigation Potential For Two Selected Sites by B. E. Ambrose, District Conservationist, USDA - CCS, Douglas Arizona, stated: "Cuts of 8 inches or more on the Pinaleno soils may expose clay or clay loam materials with slow intake rates. Clay strata may be exposed in the Sonoita soils below 40 inches. The Pinaleno soils may yield excessive runoff under slope irrigation due to slow intake rates. Stratified clay lenses could cause lateral drainage of irrigation water through the sub-soil. They [Whitehouse-Continental series soils] have loamy and gravelly loam surface textures with clay and clay loam sub-surface textures. These soils will yield excessive runoff under slope irrigation."

This finding was reaffirmed with data presented in the July, 20, 1979 report titled: Soil Engineering Report, Sierra Vista Sewer Improvements Wastewater Treatment Facility [Engineers Testing Laboratories, prepared for John S. Collins & Associates, Tucson]. This document states that core drillings show the predominant soil type in the area is clayey sand (SC). The clayey sands had varying degrees of calcite cementation and have low permeability. The report states that because the native clayey sand is "virtually impermeable" it would be a suitable material to use to build the pond berms. A statement indicating the lack of permeability is found on page seven: 'Field percolation tests were performed according to the specifications prescribed by the Arizona State Department of Health, except for use of a smaller hole size than specified. This smaller hole size was used since it was not possible to drill larger diameter borings due to the heavy cementation of some of the site soils.'" (Huachuca Audubon 1997)

These potential problems were subsequently discussed in a multi-agency meeting on June 28, 1999. The discussion was summarized in a August 13, 1999, Bureau of Reclamation Memorandum:

"Subject: Underlying Geology at the Sierra Vista Wastewater Treatment Plant

...A meeting was held on June 28, 1999, at Reclamation's Phoenix Area Office to discuss possible impacts to the recharge operation by the presence of a clay and silt body near the proposed Sierra vista Water Reclamation Facility (WRF)...The data showed the eastern extent of the clay layer is well defined and occurs between the WRF and the San Pedro River. There is sufficient data from driller's logs, soil borings, and geophysical surveys to suggest that the silt and clay layer exists beneath the recharge site. Adequate data, however, is not available to define the western, or north-south extent of this layer...

...some of the percolating water that would otherwise flow subsurface toward the river may actually be intercepted by the clay layer, flow easterly over the top of the layer, and daylight at Murray Springs, or create new springs between the recharge site and the river..." (Bureau of Reclamation 1999a)

The U.S. Fish and Wildlife Service also summarized the controversy surrounding impermeability of the proposed recharge site:

"...The clay deposit also has the potential to alter the effluent flow path, possibly increasing or decreasing the amount of recharge that flows to the river. According to a newspaper article, (former) Sierra Vista Public Works Director George Michael said that the City would consider Pool's findings and may relocate the proposed recharge facility if needed. (USFWS 1999b)

In spite of this uncertainty, further studies were not undertaken prior to approval of funding from the Bureau of Reclamation and ADWR for the wastewater treatment plant expansion. Bureau of Reclamation ultimately concluded:

"...The evidence to date, however, supports the ground-water models and does not preclude benefits

from accruing to the San Pedro River should this occur..." (Fluid Solutions/Bureau of Reclamation 1999)

Even if the wastewater treatment plant expansion does protect a short section of the San Pedro River for the next twenty years as proposed, in twenty years, any attempts to control local deficit groundwater pumping will be impossible. The current window of opportunity to save the San Pedro River will be lost. In twenty years, the deficit groundwater pumping of the much larger local groundwater-dependent population will be too massive to mitigate, much less control.

The proposed wastewater treatment plant expansion will not solve the increasing problem of deficit groundwater pumping. At best it, is a temporizing measure for a short stretch of the River:

"...The recharge project is not intended, and should not be considered, as solving the long-term water supply problems the community faces, nor the potential impacts of other ground-water uses within the subwatershed. It does not balance ground-water withdrawals and recharge in the subwatershed."
(Bureau of Reclamation 1999b)

Meanwhile, the Sierra Vista housing market keeps "rolling" along with housing sales greater than 18% for the second year in a row:

"SV housing market kept rolling in 1999

...In the Sierra Vista area stretching between Huachuca City and Hereford, 926 existing homes were sold in 1999 compared with the 784 housing units sold in 1998...This past year's sales are up 18.1 percent more than 1998, making 1999 the second year in a row for sales gains of more than 18 percent...The city issued 273 permits for new residential

construction in 1999. During 1998, 253 permits were issued.

The total number of permits issued in 1998 exceeded the total for 1997 by 44 units..." (Sierra Vista Herald 2000a)

VIII. Need for AMA Designation in the Upper San Pedro Basin

a. Threats to Groundwater

3. The Cochise County Comprehensive Plan promotes groundwater-dependent growth

Cochise County leaders display no less zeal than City of Sierra Vista officials in promoting excessive groundwater-dependent growth:

"RV park plan approved; city annexation bid next

...I am concerned about water," Thompson (Cochise County Board of Supervisor Les Thompson) said. "Everybody in Arizona better be concerned about water but at the cost of stopping development? You'll never get this supervisor to stop development for water..." (Sierra Vista Herald 1998a)

"Supervisors OK for development, Split vote clears way for homes, golf course

...Thompson (Cochise County Board of Supervisor Les Thompson) also said the riparian area should be a reason to promote development in the area, not prevent it..." (Sierra Vista Herald 1998f)

Like in Sierra Vista, Cochise County leaders' rhetoric continues to be transformed into objective actions. Cochise County leaders have also established that they will not control the increasing amount of deficit groundwater pumping under their jurisdiction. In fact, the Cochise

County Comprehensive Plan is designed to promote increasing deficit groundwater pumping:

"...GOALS AND POLICIES...Overall Plan Goal...The overall goal of the Cochise County Comprehensive Plan is to promote the future growth of Cochise County in an orderly, harmonious, environmentally and economically responsible manner. Free enterprise market dynamics shall be allowed to determine land use activity patterns to the maximum extent feasible within the public's legitimate interests of health, safety, welfare, conservation and convenience...

...This policy does not preclude any specific types of land use due to level and type of water use. Instead it allows the developer the flexibility to address water conservation, rainwater detention, erosion control and the conservation and enhancement of natural recharge areas using their choice of best management practices..."
(Cochise County 1996)

VIII. Need for AMA Designation in the Upper San Pedro Basin

a. Threats to Groundwater

4. The City of Benson's plan for groundwater-dependent growth

The same attitude toward uncontrolled growth supported by deficit groundwater pumping displayed by City of Sierra Vista and Cochise County officials applies to City of Benson officials:

"Arizona cities, including Benson, 'neck and neck' for yarn factory

BENSON (AP) - This southeastern Arizona community is "neck and neck" with Yuma as a potential site for a yarn manufacturing company, a Benson official says...

"Tucson was too expensive and Casa Grande had problems with water consumption," Kreps [City of

Benson Community Development Director Larry Kreps] said. The company is expected to use 200,000 gallons of water per day.

"We've got a well that can pump 220 gallons per minute," Kreps said. "We don't have a water problem..." (Sierra Vista Herald 2000g)

The City of Benson, like the City of Sierra Vista, is also promoting and experiencing rapid growth in spite of being completely dependent on deficit groundwater pumping. Benson will triple in size over the next ten years (currently there are 5,136 people in Benson). (CEC 1999)

Some of the specifics of Benson's rapid growth are described in recent correspondence from the City of Benson Community Development Director:

"...Benson has annexed the 24 square mile Whetstone Ranch property and the two square miles of the Sands Ranch. The Sands Ranch developers plan to sell large parcels to housing developers around a golf course center-piece. Two separate, 3,000-acre parcels of the Whetstone Ranch are currently in escrow for master planned communities. All of these properties are along SR-90 leading from I-10 to Kartchner Caverns..." (City of Benson 2000)

The recent development and opening of Kartchner Caverns State Park will continue contributing to the City of Benson's deficit groundwater-dependent growth:

"Crowds swamp caverns staff, Kartchner proving boon to businesses in nearby Benson..."

TUCSON - Three months after its opening, Kartchner Caverns State Park is cruising at capacity.

Five hundred visitors tour its underground geological splendors daily and state parks officials are elated - as are area merchants...

The development of the caverns has spurred economic growth nearby, particularly in Benson, 12 miles north. In the past four years, four motels have been built within its city limits - increasing the number of rooms in town from about 150 to nearly 400.

The town also boasts three new sit-down and three fast-food restaurants, as well as five new RV parks.

"It has been nothing but good" because of Kartchner Caverns, said Larry Kreps, Benson's economic-development coordinator...

From Kreps' point of view...the opening of Kartchner Caverns "just couldn't get any better."

"Benson was the bedroom community for Tucson for so many years, nothing was happening here. It's hard to believe that Benson is actually the mouse that roared now," he said..." (Arizona Republic 2000a)

"Boost for Benson - Caverns provide economic lift in jobs, tourism

...Kartchner Caverns State Park, with about 13,000 visitors a month, has helped boost employment and brought more cash into Benson's stores and restaurants, officials say..."The full impact of Kartchner Caverns has not been seen yet," [said Benson Community Development Director Larry Krebs]...

"...Data compiled by Cochise College's Center for Economic Research in Douglas on the cavern's economic impact show restaurant and bar sales in Benson, the nearest city, increased by 18.3 percent, to \$4.52 million, from January through May, compared with the same period in 1999.

Lodging sales revenues increased by 18.4% percent during the first five months, compared with the same period last year..." (Arizona Republic 2000b)

The Benson subwatershed contains the two major surface water irrigation water providers found within the San Pedro River watershed. Surface water irrigators in the subwatershed pump groundwater when surface water is not available.

The St. David Irrigation District (SDID) is located in and around the community of St. David south of Benson. The Pomerene Water Users Association (PWUA) is located just northeast of Benson in and around the small town of Pomerene.

The SDID irrigates just over 1,087 acres within and south of the community of St. David. The district diverts water whenever flows in the river are sufficient for irrigation. (ADWR 1991) The PWUA irrigates approximately 1,052 acres of land. (ADWR 1991)

The SDID pumps groundwater during the dry season when surface water diversion is not possible. Individual irrigators in both districts pump groundwater as they deem necessary. The SDID claims water rights registration of 2000 acre-feet per year from wells and 6,000 acre-feet per year from the San Pedro River. (ADWR 1991)

The PWUA claims water rights registration from the San Pedro River of 16,130 acre-feet per year. (ADWR 1991) ADWR reports:

"...No records of the amount of water used by the shareholders of the PWUA have been kept..." (ADWR 1991)

The fact that PWUA refuses to record amounts of surface or groundwater pumped was expressed publicly during the Gila River water rights adjudication hearings:

"Water users make claims to San Pedro

...We've been fighting with the Indians since the beginning, only now they have lawyers," said Eldon Barney, president of the Pomerene Water Users Association...

...The Pomerene group pumps water for irrigation out of the San Pedro River, much like settlers did

more than a century ago, Barney said - and the Indians don't like it.

Barney said no one in the association knows how much water is being diverted from the San Pedro into the Pomerene Canal north of St. David. He said the amount varies from year to year.

"We don't keep a record of how much water is running. We take all we can get," said Barney..." (Sierra Vista Herald 1994a)

VIII. Need for AMA Designation in the Upper San Pedro Basin

a. Threats to Groundwater

5. Assertion of Federal Water Rights

In 1988, recognizing that the San Pedro River supported a diverse riparian ecosystem, Congress created the National Riparian Conservation Area. The Arizona-Idaho Conservation Act established the San Pedro Riparian National Conservation Area (SPRNCA):

"LAWS OF 100th CONG. - 2nd SESS.

PUBLIC LAW 100-696 [S. 2840]; November 18, 1988

ARIZONA-IDAHO CONSERVATION ACT OF 1988

TITLE I...ESTABLISHMENT OF SAN PEDRO RIPARIAN NATIONAL CONSERVATION AREA SEC. 101. (a) ESTABLISHMENT. - In order to protect the riparian area and the aquatic, wildlife, archeological, paleontological, scientific, cultural, educational, and recreational resources of the public lands surrounding the San Pedro River in Cochise County, Arizona, there is hereby established the San Pedro Riparian National Conservation Area..." [16 U.S.C. § 460 (1988)]

The Department of Interior and BLM became the federal land managers. AICA reserves a quantity of water necessary to protect SPRNCA. [16 U.S.C. § 460 (1988)] Unfortunately,

designation of the SPRNCA has not reversed the downward trend in base flows as increasing deficit groundwater pumping threatens the area. (Vandana et al. 1997)

Seven years ago, on September 29, 1993, in order to accommodate and promote the uncontrolled development of housing subdivisions in the Upper San Pedro River Basin, ADWR removed the requirement to warn housing buyers of potential future water problems:

"...Current groundwater modeling studies indicate that with continued pumping at the current rate of withdrawal for 100 years, the cone of depression in the groundwater aquifer will not directly or appreciably affect the San Pedro River..." (ADWR 1993a)

In spite of multiple Public Records Law (A.R.S. Title 39-121) requests, ADWR has not been able to establish an objective basis for this decision to remove the requirement to warn housing buyers of potential future water problems. (ADWR 1993b, ADWR 1994a) Subsequently, the Federal government threatened to protect its federally reserved rights in the SPRNCA:

"...There is no doubt that pumping in the Sierra Vista already has a significant indirect impact on the flow of the San Pedro, and as we understand it your own hydrologists agree with this conclusion. Even though the cumulative cone of depression has not intercepted the stream, the cumulative cone of depression in that area is intercepting underground recharge which historically augmented and supported the stream. The new uses to be allowed under your revised policy will only exacerbate this problem and accelerate the time when there is a direct and catastrophic effect on the San Pedro River...

The bottom line is that your letter reflects, in our view, an insensitivity as to the significant

tension which presently exists in that area of Arizona, and a disrespect for the property rights of the United States. We sincerely believe that your decision is misguided and will likely lead to confrontations which could be avoided." (Department of the Interior 1993)

Seven years later, the Federal government has still done nothing to make good on these earlier threats to protect its water rights. Efforts to encourage the Federal government to make good on its earlier threats are underway as the U.S. Supreme Court has already resolved this issue in favor of protecting Federal water rights. [Cappaert v. United States (426 U.S. 128 (1976))]

This case, Cappaert v. United States (426 U.S. 128 (1976)), has been examined in detail by Professor Robert Glennon, Morris K. Udall Professor of Law and Public Policy at the University of Arizona College of Law and Dr. Thomas Maddock, III, Professor of Hydrology at the University of Arizona College of Engineering and Mines, in a 1997, publication from the Rocky Mountain Mineral Law Institute:

"...in Cappaert v. United States (426 U.S. 128 (1976)), the U.S. Supreme Court considered federal reserved rights in Devil's Hole National Monument in Nevada which had been set aside by executive proclamation for the purpose of preserving a pool of water that contained the desert pupfish, an unusual species, and that had other scientific and educational interests. In 1968, local farmers began pumping groundwater from a well approximately two and on-half miles from Devil's Hole. The groundwater pumping captured water from the pool, thus lowering the water level in the pool and exposing a rock shelf which decreased the desert pupfish's spawning area and increased the likelihood of its extinction. The farmers had a permit from the state engineer under Nevada law for their wells. In 1971, the United States filed suit. Both sides conceded that the water pumped by the farmers was

hydrologically connected to the water in the pool in Devil's Hole. The farmers claimed that the reserved rights doctrine required federal courts to balance competing interests, a claim rejected by the U.S. Supreme Court. (426 U.S. 138.) The court decided that the government intended to reserve unappropriated water in order to maintain the level of the pool. (See *id.* At 147.) The court approved an injunction that reserved the amount of water that would be necessary to preserve the water level in the pool in order to implement the original objectives of reserving the land. "[T]he United States can protect its [reserved] water from subsequent diversion, whether the diversion is of surface or ground water." (*Id.* at 143.) Nor did the federal government need to perfect its reserved water rights according to state law. "Federal water rights are not dependent upon state law or state procedures..." (*Id.* at 145.)

We may draw several lessons from Cappaert. First, the priority date of federal reserved rights is the date of the federal reservation. Second, the purpose of the reservation will determine the scope of the federal reserved rights. Third the amount of water reserved in that which is "necessary" to accomplish the federal purposes. Fourth, the federal reserved rights doctrine will protect against harm to these purposes from subsequent groundwater pumping that captures surface water..." (Glennon and Maddock 1997)

The case, Cappaert v. United States (426 U.S. 128 (1976)), has also been reviewed in another article by Professors Glennon and Maddock. In "In Search of Subflow," Professors Glennon and Maddock looked at the case specifically in terms of the Upper San Pedro Basin situation:

"...In Cappaert v. United States [426 U.S. 128 (1976)], the United States Supreme Court rejected the state claim that the reserved rights doctrine required a balancing of competing interests. When the Federal Government sets aside land for a particular federal purpose, its purpose is not

balanced against competing state interests. A combination of Commerce Clause (U.S. Const. Art. I, § 8, cl. 3.), the Property Clause (U.S. Const. Art. IV, § 3, cl. 2.), and the Supremacy Clause (U.S. Const. Art. VI, cl. 2.). means that when there is a dispute the federal interests prevail...

...the Court held that "the United States can protect its [reserved] water from subsequent diversion, whether the diversion is of surface of groundwater." (426 U.S. at 143)

"...Federal water rights are not dependent upon state law or state procedures..." (426 U.S. at 145)

...Several implications flow from the Cappaert ruling. First, the reserved rights doctrine will apply to the San Pedro Riparian National Conservation Area. Second, the reserved rights adhere as of the date of the federal reservation. Third, the purpose of the reservation determines the scope of federal water rights. Fourth, the Federal Government obtains rights to the quantity of water that is "necessary" to accomplish its purpose. Fifth, the reserved rights doctrine will protect against harm from subsequent groundwater pumping of hydrologically-connected water..." (Glennon and Maddock 1994)

Inevitable implementation and exercise of Federal water rights will increase competition for groundwater within the Upper San Pedro Basin. This will heighten the necessity for AMA creation.

VIII. Need for AMA Designation in the Upper San Pedro Basin

a. Threats to Groundwater

6. Increasing agricultural groundwater pumping

Agriculture continues to be one of the largest sources of groundwater consumption in the Upper San Pedro River

Basin. (ADWR 1991, Glennon 1999) Most of this groundwater removed comes from the regional and floodplain aquifer within two miles of the River. This groundwater would otherwise flow directly into the River sustaining San Pedro River baseflows. (Glennon and Maddock 1997)

While BLM and Nature Conservancy attempts to purchase and retire irrigation water rights were initially successful, new groundwater irrigation operations are increasing:

"...When the SPRNCA was designated, the Bureau of Land Management purchased and retired the then existing 10,000-20,000 acre-feet of irrigation pumping within the conservation area. A purchase by the Nature Conservancy of the last remaining 200 hectares (500 acres) of irrigated lands completed the buyout of agricultural use. This reduction in pumping has had a beneficial impact on base flows within the SPRNCA. Recently, however, this trend has started to reverse. The same farmer who was paid by the Nature Conservancy to cease pumping on one parcel is now reported to have opened up three new pivot sprinkler systems on another 200 hectares a short distance away in the Hereford and Palominas area where the effects on the Riparian Conservation Area are likely to be most pronounced. This new irrigation accounts for most or all of the 200-360 hectares (500-900 acres, although estimates vary) of irrigated land on the US side of the basin (pumping about 1,500-1,800 acre-feet of water)...Alfalfa and pasture crops typically take about three feet of water per acre..." (CEC 1999)

As of December 1999, this newly increasing irrigation in the Palominas/Hereford area now totals five center-pivot groundwater-pumping operations of 160 acres each, and approximately 115 acres of groundwater/flood-irrigated fields.

This totals approximately 915 acres of newly groundwater-irrigated agricultural fields. Alfalfa and pasture crops require a minimum of three acre-feet of water per acre for alfalfa and pasture crops. This equates to new groundwater-irrigated agricultural operations using approximately 2745 acre-feet of groundwater per year. More new groundwater-dependent agricultural operations are expected as new operators anticipate escalating future buyouts compensation.

VIII. Need for AMA Designation in the Upper San Pedro Basin

a. Threats to Groundwater

7. Drought

Many climatology and tree ring experts are predicting drought conditions anywhere from the present to several decades into the future. As population in the Upper San Pedro Basin continues increasing, drought conditions will exacerbate overdraft conditions. As a harbinger, with temporary drought-type conditions this summer, some wells in the Upper San Pedro Basin went dry:

"Small water companies feeling pinch of supply and demand

SIERRA VISTA - Nearly 900 connections of three small water companies are experiencing some quantity problems due to lack of winter snows and rains, the manager of the companies said this morning.

It is not only the large companies having problems but small ones too, said Nathan Watkins, who manages the Antelope Run, East Slope and Indiada water companies.

Judy Gignac, manager of the Bella Vista Water Co. that has 6,600 connections, said Thursday that

wells in the higher elevations were having problems. She urged conservation.

Watkins too, said, "We are asking our customers to reduce use,"

Of the three small companies' 12 wells, three are dry, Watkins said.

Two of the four wells serving 47 Indiada connections and one of two supporting 90 connections on the Antelope Run system are dry, Watkins said. The eight wells of the East Slope system, serving 750 connections, are not having as many problems.

Most of the wells are in the higher elevations, fed by mountain front recharge that depends on snow and rain.

"Ever since Easter demand has outpaced supply," he said. The major problem is not enough pumping capabilities..." (Sierra Vista Herald 2000e)

Even before the problem with wells going dry became public, one of the Upper San Pedro Basin's largest water companies was already calling for conservation measures to combat the drought conditions:

"Drought conditions prompt water conservation request

"SIERRA VISTA - One of the area's biggest water companies is calling for customers to conserve water, especially in the mountains and foothills.

A lack of heavy snow and winter rains has caused some wells in the higher elevations to suffer from a reduced mountain front recharge, according to Judy Gignac, the general manager of the Bella vista Water Co.

Gignac said some people who live in the higher elevations and have private wells also are experiencing water problems and they are asking to tie into the water company system, increasing the stress on the wells.

Nearly 325 customers served by six wells - five in the Nicksville system and one in the Rail Oaks system - could experience problems and need to especially conserve water, Gignac said. Customers in the foothill area of the Huachuca Mountains will

receive individual letter advising them of the problems and recommendations for conserving water.

...The Arizona Water Co. In Bisbee also is asking customers to use less water.

...Gignac said people have to recognize Mother Nature has not been cooperative for the past several years and that has impacted on the shallow wells in the higher elevations. "The problem is that without mountain recharge there is no water to get into the cracks and crevices which serve some of our wells."

...Gignac said people have to recognize Mother Nature has not been cooperative for the past several years and that has impacted on the shallow wells in the higher elevations. The problem is that without mountain recharge there is no water to get into the cracks and crevices which serve some of our wells.

...People also should not expect the summer monsoons to make the situation better because those heavy rains have a tendency to quickly run off and not soak into the ground. Without a good soaking, the shallow wells won't be helped, Gignac said..."
(Sierra Vista Herald 2000d)

By the end of May this year, the Upper San Pedro Basin's largest water companies were considering requesting authority to curtail water use. The companies were considering this request at the same time that National Weather Service meteorologists were warning that the drought may be lasting "for years":

"City, water companies to talk drought

SIERRA VISTA - The areas drought conditions may lead the three water companies serving Sierra Vista and the city government to ask the Arizona Corporation Commission for authority to curtail water use, said Judy Gignac, the general manager of the Bella Vista Water Co.

This morning, Erik Pytlak, a National Weather Service meteorologist said Southeastern Arizona may be heading into a winter dry period which could last for years and any plans to conserve water are important. ...

...The city cannot impose mandatory ordinances because the water companies will not have to comply and the city would have a hard time enforcing them, he [City Manager Chuck Potucek] said...

...Drought conditions have existed for the past couple of years and it appears it may continue, Pytlak said, adding dry winters may be the rule for the next 20 year period because of a change in the weather cycle in the Pacific Ocean.

Pytlak said parts of Southeastern Arizona are experiencing the driest period since Oct. 1 to date in the past 100 years of weather record keeping...

...For the past two years, La Nina has been controlling the weather patterns and that has led to dry winters, he said.

Although La Nina is weakening and the result could be more rain and snow this winter, the long-term forecast is for less than normal winter precipitation, Pytlak said.

What people do not understand is that although there may be heavy summer rains, the precipitation rapidly runs off, whereas winter rains and snow have more of a tendency to soak into the ground and get to wells. ...(Sierra Vista Herald 2000f)

These warnings of future drought conditions are being repeated by multiple other experts:

"American Southwest Could Be Facing 10-Year Drought

CLIMAS [University of Arizona's Climate Assessment Project for the Southwest] researchers have analyzed how a drought similar to the Southwestern drought of the 1950s would affect Phoenix and Tucson water supplies in the year 2025.

The Pacific Decadal Oscillation [PDO] is a fairly regular pattern of high and low pressure systems over the northern Pacific Ocean, off the coast of Alaska and Canada. The PDO operates on a 20- to 30-year time scale -- much longer than the better-known but short-term El Niño and La Niña events. Shifts in the PDO regime occurred in 1925, 1947 and 1977. Some climatologists believe that the PDO shifted again around 1995.

Researchers know that the PDO correlates with relatively wetter and drier periods in western North America, Morehouse [Barbara Morehouse, Director of the CLIMAS] said. And new research by University of Washington climate researchers suggests that the PDO enhances El Niño and weakens La Niña conditions in one phase, then weakens El Niño and enhances La Niña conditions in its alternate phase.

Since 1977, as the new research would predict, the American Southwest has been blessed with wetter winters during El Niño years and not-so-dry winters in La Niña years.

Winter precipitation is nature's major means of watering this region. So if the PDO did indeed shift to its alternate phase in 1995, Morehouse notes, the Southwest may be short on renewable water for the next several decades.

How severe that drought will be and how long it will last still is not clear.

Most of the Southwest experienced a prolonged and severe drought during the 1950s, Morehouse noted. If a drought of that magnitude and duration occurred today, "the consequences could be at least as severe," she said.

CLIMAS scientists have modeled the effects of prolonged drought on urban water supplies in Phoenix and Tucson based on the 10-year drought conditions that occurred in the 1950s and the Arizona Department of Water Resources estimates of Phoenix and Tucson water needs in 2025...

"The Tucson/Phoenix area has experienced considerable growth and change in the past several decades, a time when conditions have been relatively wet. Assuming that these conditions will continue into the indefinite future flies in the face of everything we have learned about the ancient and recent climate history of the Southwest.

"We all should begin thinking seriously about the impacts of extended dry conditions, about what viable alternatives exist for coping and what contingency plans we need," Morehouse said." (Daily University Sciences News 2000)

"Scientists fear ocean shift may mean drought

Shifting water temperatures in the Pacific Ocean may leave Arizona and California with drought conditions for the next 20-30 years...El Nino and La Nina conditions have wreaked havoc across the United States in recent years.

But scientists say there is a more destructive monster lurking in the Pacific Ocean that could negatively affect Tucson's weather for the next 30 years...

A negative cycle of the PDO [Pacific Decadal Oscillation], which scientists predict is setting up in the Pacific currently, shifts storm systems to a more northerly track.

If predictions hold true, California and Arizona could be high and dry, while Washington and Oregon could be drenched for the next 20 to 30 years.

In a positive PDO cycle, El Nino conditions rule the waters off the West Coast, which lead to above normal rainfall in the Southwest and drier than normal conditions in the Northwest.

According to Pytlak [National Weather Service meteorologist and UA public administration graduate student Erik Pytlak], the PDO probably last shifted in 1995, which means drought conditions could persist in the Southwest until 2025..." (Arizona Daily Wildcat 2000)

"Tree rings indicate 20-year drought

ALBUQUERQUE - Researchers studying tree ring patterns say the patterns suggest that Arizona and the rest of the Southwestern United States could be facing serious drought conditions over the next two decades.

University of New Mexico scientist Louis Scuderi says climate patterns inscribed in the trees over the past 700 years indicate a recurring 72-year pattern of droughts.

Scuderi, who analyzed the rings of hundreds of trees in Arizona, New Mexico, Colorado and Utah, says the last drought spanned the 1950s, suggesting that the next serious drought would begin around 2020 if the pattern holds...

Although the reasons for the drought cycles remain unclear, one key difference between now and the past, Scuderi said, is the rapid growth in human population and its effect on the water supply..." (Associated Press 2000)

In December 1999, scientists from the Climate Assessment for the Southwest Project at the University of Arizona summarized the potential for conflict exacerbated in the Upper San Pedro Basin by the drought being predicted:

"...For Sierra Vista, lack of readily available alternative supplies poses similar challenges [to vulnerability to deep drought, multi-year events]. Here, a deep multi-year drought could trigger tensions over maintaining flows in the San Pedro River, an internationally recognized and nationally protected riparian ecosystem versus supplying water for urban and agricultural use..." (CLIMAS 1999)

Drought conditions will dramatically exacerbate an already deteriorating situation by diminishing aquifer recharge threatened by excessive deficit groundwater pumping.

VIII. Need for AMA designation in the San Pedro Basin

b. Binational issues

1. Threats to San Pedro River streamflow

Palominas is just north of the International Border. Streamflow at the Palominas gauge has shown declines in flow:

"...Currently the models of the Upper San Pedro groundwater system include a net annual input of 3,000 acre-feet of groundwater flow to the Sierra Vista aquifer from Mexico. Today, the transborder surface flows are intermittent at the Palominas gauge. The median flow (50 percent exceedance) has declined from seven cubic feet-per-second in 1940 to two cubic feet-per-second in 1965, where it has remained. This decline reflects substantial groundwater development for irrigation in Mexico in the reach between the Ejido José María Morales and the border. A 1992 satellite image shows some 3,400 hectares (8,000 acres) of irrigated agriculture in this region. Much of the irrigation in Mexico is in the flood plain of the river, within two to three miles of the stream. Based on observations made during the expert team's site visit in January 1998, the irrigation water is drawn from wells driven by large electric pumps supplied from the Mexican rural power grid. Estimating the consumptive water use at 2 acre-feet per acre (probably an underestimate), this irrigation is extracting some 16,000 acre-feet per year from the aquifer. (CEC 1999)

Groundwater extraction for mining already takes significant water from the San Pedro River. This will most likely become an increasing factor. The Mexican de Cobre mine in Cananea pumped 12,500 acre-feet per year in 1995. (CEC 1999)

Another mine, the Mina Mariquita, has recently opened. Opening of this new mine is most likely a harbinger of new mining activity with increasing impact on the watershed. Not only will this increasing activity affect the San Pedro River, it will undoubtedly affect the aquifer as well. As the population and as mining activity increase on the Mexican side of the International Border, deficit groundwater pumping will inevitably continue increasing.

VIII. Need for AMA designation in the San Pedro Basin

b. Binational issues

2. Pollution in the Upper San Pedro Basin

Growing local industrial activities, as well as increasing wastewater recharge, will increasingly threaten water quality in the Upper San Pedro Basin, both within the San Pedro River and the aquifer. Lowering of the water table heightens the effects of this inevitably increasing groundwater contamination.

In 1977, a breach in the effluent containment dikes in Cananea contaminated the San Pedro River in the U.S.:

"...Extreme pollutional conditions in the San Pedro River in 1977-1979 were attributed to overflow or leakage of improperly located leaching ponds associated with excessive runoff in Mexico (Eberhardt 1981). The most detail was obtained during a spill in 1979, when water was brick-red in color, pH as low as 3.1 and dissolved oxygen as low as 2.0 mg/l were recorded, along with high iron, copper, manganese, zinc, and suspended solids. Concentrations of copper and zinc alone and in combination far exceeded those lethal to longfin dace (Lewis 1997). Aquatic life was killed for at least 100 km north of the International Boundary (AGFD 1979, AGFD 1980), and water quality for irrigation, livestock, and wildlife was impaired both in the stream and potentially in the area ground water. Similar pollutional events were noted in December 1977 and January through March 1978 (Eberhardt 1981). Longer-term pollution from seepage or minor release of mine wastes almost certainly occurred prior to 1977 (University of Arizona 1978), but was not evident in samples from 1973 (U.R.S. Company et al. 1976)..." (BLM 1987)

"...Existence of potentially severe pollution of the upper San Pedro River nonetheless remains a major concern, and merits additional discussion. As

already noted, major impacts may especially be expected if pollutants enter the system during low flow when dilution potential is minimal and toxicity can quickly develop. Such a situation will result in decimation of aquatic life, and, as noted in the 1979 incident, in possible loss of terrestrial wildlife and other values of the system. Spills of chemical or physical pollutants diluted during high discharge should pass quickly through the presently incised San Pedro River and have minimal local influence. On the other hand, if incision can be reversed in the San Pedro River and cienega conditions re-created, floods will pass far more slowly and sedimentation will be far greater in pools and in a roughened, heterogeneous channel. Toxic or sedimenting wastes would be retained and their impacts exacerbated by longer exposure times and greater local concentrations in both the longer and shorter term. If foreign materials in toxic quantities enter ground waters, then pass to the stream or into wells, another problem will be created. Greater storage of ground water might be paralleled by greater storage of waste materials, a trend that would be somewhat countered by dilution and complexation by organic and inorganic materials..." (BLM 1987)

Recently, prolonged labor unrest at the Cananea mine highlights these and other environmental threats once again:

"...The uprising began November 19, after Grupo Mexico announced a brutal restructuring at Cananea. The plan included layoffs of up to 1,000 of the mine's 2,070 employees, closure of groundwater protection operations, severe limitation of retirement benefits and the hatcheting of production bonuses. As some 2,000 enraged workers walked off the job, they also raised critical pollution and healthcare concerns at the facility, which remains a major regional polluter. Among the oldest mines in the hemisphere, Cananea's nearby streams are filled with incredibly toxic water, its hillsides barren of any plant life..." (Tucson Weekly 1999)

IX. Previous petition to designate an AMA for the Upper San Pedro River Basin

In 1988, the Sierra Club filed a petition with ADWR to designate the Upper San Pedro Basin as an AMA. (Sierra Club 1988) The Sierra Club filed their petition due to concerns about overdraft conditions within the Upper San Pedro River Basin. The Sierra Club hoped to enlist help to remedy the situation.

ADWR concluded that AMA designation was not necessary at that time. (ADWR 1988b) ADWR did, however, express concern about groundwater withdrawals and recognized the need to monitor the situation:

"...Water use patterns in the Upper San Pedro basin are in a state of flux with agricultural pumping being reduced, and municipal and industrial pumping increasing as growth of the Sierra Vista area occurs..." (ADWR 1988b)

X. State of Arizona policy for riparian areas

State of Arizona policy acknowledges "that the protection and restoration of riparian areas are of critical importance to the State." (State of Arizona 1991) Executive Order No. 91-6, "Protection of Riparian Areas," requires protective advocacy for riparian areas from all State of Arizona agencies.

Executive Order No. 91-6 states:

"...WHEREAS, riparian areas contribute to the well-being and quality of life of the citizens of Arizona; and...

...WHEREAS, desert streams, such as the Gila, Salt, and Santa Cruz Rivers that once flowed year round, now flow intermittently or not at all; and

WHEREAS, five of the 32 native fish species found in Arizona at the turn of the century no longer occur here and 21 of the remaining 27 are either listed by the State as endangered, threatened, or are under study for listing; and

WHEREAS, it is estimated that 75% or more of Arizona's wildlife is dependent upon riparian areas for some portion of its life cycle, and healthy riparian habitats are critical for the survival of the majority of Arizona's fish and wildlife species; and

WHEREAS, riparian areas are not closed ecosystems, but are dynamically interrelated with the entire surrounding watershed, and being typically associated with high water tables, they are particularly rare in the Southwest; and

WHEREAS, it is estimated that over 90% of the native riparian areas along our major desert watercourses has been lost, altered, or degraded; and it is recognized that past changes in these areas, particularly the alteration and loss of the State's surface water flows, have been detrimental to Arizona's riparian areas; and

WHEREAS, these dramatic changes in our riparian areas continue today as rapid population growth brings ever-increasing pressures and demands on the State's riparian resources; and it is essential to achieve and maintain a balance among the competing uses of the State's riparian resources to ensure that these areas are protected and enhanced for the benefit of present and future generations; and...

WHEREAS, it is in the public interest to protect the functions and values of riparian areas:

NOW, THEREFORE, I, Rose Mofford, Governor of the State of Arizona, by virtue of the power vested in me, do hereby order that all applicable state

agencies cooperate and seek funding to carry out the provisions below and that:

(1) In recognition of the critical importance of riparian areas to the State, it is hereby determined that the policy of the State of Arizona shall be:

- (a) To recognize that the protection and restoration of riparian areas are of critical importance to the State;
- (b) To actively encourage and develop management practices that will result in maintenance of existing riparian areas and restoration of degraded riparian areas;...
- (e) To actively encourage the preservation, maintenance and restoration of instream flows throughout the State;
- (f) That any loss of degradation of riparian areas will be balanced by restoration or enhancement of other riparian areas of equal values and functions.

(2) All state agencies shall rigorously enforce their existing authorities to assure riparian protection, maintenance and restoration..." (State of Arizona 1991)

XI. ADWR recommendations for protection of the San Pedro River

ADWR has offered recommendations for protection of the San Pedro River. (ADWR 1991) Since base flows are the most sensitive indicator of the health of the aquifer, application of these recommendations are critical to

preserve the existing supply of groundwater for future needs.

In order to maintain or improve the San Pedro riparian ecosystem, ADWR states:

"Recommendations

To maintain or improve the condition of the San Pedro riparian ecosystems, the following hydrologic conditions should be met:

Cienegas are a rare riparian/wetland community type that presently occur on reaches of the San Pedro where: (1) flow is perennial, (2) the river gains water from the groundwater (gaining reaches), (3) the water table in portions of the floodplain is above or only about 0.5 m (1 or 2 ft) below the ground surface, and (4) the water table fluctuates on a seasonal basis by less than 0.5 m (1.5 ft). To maintain these existing cienegas, these conditions must continue to be met in the future. To restore cienegas throughout the SPRNCA, these same conditions must occur on reaches in the north and south ends of the SPRNCA where flow is now intermittent, reaches lose surface flow to the groundwater, and water tables seasonally fluctuate by 1 m (3 ft) or more.

Fremont cottonwood-Goodding willow forests are an ecologically important riparian forest type that are in degraded condition along many rivers in the state. This forest type occurs throughout the SPRNCA but in many areas is intermixed with extensive stands of riparian scrub and in the south end of the SPRNCA is being replaced by salt cedar. To maintain the existing cottonwood-willow forests, water table should remain less than 3 m (10 ft) below the floodplain surface. To allow for new generations of these "pioneering" riparian trees, water tables during winter flood years should remain less than 1 m (3 ft) below the surface of seedling establishment zones and floods should be allowed to occur..." (ADWR 1991)

XIII. Arizona Auditor General's 1999 Report on ADWR

According to the ADWR Website Homepage:

"ADWR works to secure long-term water supplies for Arizona's communities. The Department administers state water laws (except those related to water quality), explores methods of augmenting water supplies to meet future demands, and develops policies that promote conservation and equitable distribution of water." (ADWR 2000)

Similarly, the State of Arizona Auditor General finds that:

"...the Department developed a mission statement as follows:

To ensure a long-term sufficient and secure water supply for the state; to develop public policy which promotes efficient use and equitable distribution of water in an environmentally and economically sound manner..." (Arizona Auditor General 1999)

In April 1999, the State of Arizona Auditor General evaluated and reported to the Arizona Legislature concerning ADWR efforts to ensure a long-term water supply for the State:

"The Office of Auditor General has conducted a performance audit and Sunset review of the Arizona Department Water Resources...(Department)...The purpose of this audit was to evaluate the Department's efforts to ensure a long-term water supply for the State..." (Arizona Auditor General 1999)

The Auditor General faulted ADWR poor efforts to ensure long-term water supply outside of AMAs:

"...Groundwater Depletion Is Likely to Continue...Regulatory Limitations May Create Water Supply Problems As the Population Increases...The

populations outside of the AMAs [Active Management Area's] is projected to grow by an additional 500,000 persons by 225,000. However, limited consumer protections outside AMAs provide current and future residents with less assurance about future water supply than their counterparts in the AMAs. Specifically, the adequate water supply provision, applicable to areas outside of the AMAs, requires only that the original purchaser of a new subdivision lot receive notification of the sufficiency of the water supply. The provision does not prohibit new subdivisions from being developed or sold in the absence of sufficient water, and does not require that subsequent purchasers receive notification regarding insufficient water...well spacing in the non-AMAs is not regulated...

The lack of an assured water supply provision in areas outside of the AMAs allows the development and sale of new subdivisions that do not have sufficient water. Therefore, new residents may be using an insufficient water supply, and may deplete the water upon which existing residents rely...

...The Department has not sought legislative changes to better enable subsequent purchasers to know the sufficiency of the water supply or to require areas outside of AMAs to demonstrate an assured water supply before building new subdivisions, and to regulate well spacing..." (Arizona Auditor General 1999)

The deteriorating situation in the Upper San Pedro Basin is specifically mentioned in the report:

"REGULATORY LIMITATIONS MAY CREATE WATER SUPPLY PROBLEMS AS THE POPULATION INCREASES...Since water in the State is a limited resource, shortages may develop or become more pervasive. For example, the Sierra Vista area is currently experiencing groundwater depletion..."

Unfortunately, the Auditor General fails to examine ADWR's September 29, 1993, removal of the requirement to warn housing buyers of potential future water problems.

ADWR's response to the Auditor General's report does, however, offer insight into the rationale of the ADWR's September 29, 1993 decision:

"This letter is the Department's response to the performance audit of the Arizona Department of Water Resources by the Office of the Auditor General...The recommendations of the audit will require significant study to determine the economic cost benefit of amending A.R.S. § 45-576 to extend the assured water supply requirements to areas outside of the AMAs and to amend A.R.S. § 45-598 to provide the Department with limited authority to establish well spacing requirements in areas of the State outside of the AMAs..." (ADWR 1999)

XIII. The Lower Santa Cruz River Basin AMA designation addresses problems similar to those threatening the Upper San Pedro River Basin.

Creation of the Santa Cruz AMA demonstrates the importance of AMA designation to manage challenges similar to those plaguing the Upper San Pedro River Basin. The similarity of the problems in the upper Santa Cruz River basin and the San Pedro River basin are obvious: threats to groundwater, preservation of the riparian area, maintenance of surface flows, and binational issues, including pollution and degradation of water quality.

The management goal for the Santa Cruz AMA is to prevent local water tables from declining:

"The management goal for the Santa Cruz AMA is:

To maintain a safe yield condition and to prevent local water tables from experiencing long-term declines" (ADWR 1996)

Preservation of the riparian area of the upper Santa Cruz River was a "primary" consideration:

"...Preservation of the rich riparian area in the Upper Santa Cruz River between Nogales and Tubac was a primary consideration in the establishment of the Santa Cruz AMA. Fundamental differences between Arizona's groundwater and surface water laws may allow water levels to decline due to groundwater pumpage even if it diminishes surface water supplies. This condition has led to the impairment or elimination of riparian habitats in several parts of the state. The statutory goal of the Santa Cruz AMA is an initial attempt to address this concern for riparian damage..." (ADWR 1996)

Ensuring surface water availability for holders of surface water rights also influenced creation of the Santa Cruz AMA:

"...The need to assure continued availability of surface water for riparian habitats is also coincident with the desire to ensure surface water availability for holders of surface water rights. The City of Nogales and Rio Rico hold claims to very senior surface water rights which are intended for supplying municipal growth. Consequently ensuring the physical availability of surface water supplies by preventing water level declines, is important for their ability to exercise these claims..." (ADWR 1996)

Designation of the Santa Cruz AMA highlights the importance of addressing water quality, well as water quantity issues, using the AMA mechanism. The Santa Cruz

AMA recognizes the intricate linkage between these two issues:

"...Water quantity and quality are intricately linked in the Santa Cruz AMA...In order to optimize current and long term beneficial water use within the AMA, it is vital to address both water quality and quantity issues in an interrelated fashion..." (ADWR 1996)

The Santa Cruz AMA recognizes the importance of addressing water quality issues exacerbated by regional growth and industrialization:

"...Water quality issues in the Santa Cruz AMA may be exacerbated by regional growth and industrialization..." (ADWR 1996)

Attention to binational issues also played a key role in creation of the Santa Cruz AMA:

"...A final prime consideration for establishment of the Santa Cruz AMA lies in the region's proximity to Sonora, Mexico. Water use and water supplies for Arizona and Sonora are intricately linked as explained in subsequent sections of this report. To better address these interrelated issues, the legislation which created the Santa Cruz AMA also authorized the Director of ADWR to coordinate and cooperate with Mexican governmental agencies regarding planning and exchange of hydrological information. The creation of the Santa Cruz AMA facilitated adequate focus on these binational issues from the perspective of the region which is most significantly impacted..." (ADWR 1996)

XIV. Conclusion

In 1988, ADWR examined the issue of designating the Upper San Pedro Basin as an AMA. ADWR concluded that AMA designation was not necessary at that time. (ADWR 1988a) ADWR did recommend a reassessment of the decision "in 10 to 15 years":

"RECOMMENDATIONS...In our opinion, active management practices are not necessary because our studies indicate that up to the year 2000 no significant impacts will occur and that benefits of mandatory water conservation will be minimal...We believe that the benefits derived from an AMA do not justify the additional regulations an AMA will impose on the users. We would recommend, however, that the Department reassess this decision in 10 to 15 years...." (1988a)

Much has changed since 1988. AMA designation for the San Pedro River Basin is now absolutely necessary to preserve the existing supply of groundwater for future needs. In the absence of AMA designation for the Upper San Pedro River Basin, uncontrolled, deficit groundwater pumping will continue:

"...The upper Sierra Vista Basin region is undergoing rapid growth in population, which can be expected to increase demand for groundwater in the upper basin..." (CEC 1999)

Unregulated deficit groundwater pumping will ultimately harm the area's population centers, the future viability of Fort Huachuca, as well as the riparian corridor along the San Pedro River. Population studies project continued increasing groundwater-dependent growth

throughout the Upper San Pedro River Basin. This growing population will ultimately compete for groundwater resources amongst itself, as well as with local agricultural users and with the Federal government's reserved water rights.

In March 1999, the Commission for Environmental Cooperation tallied proposed mitigation measures. These proposed mitigation measures are designed to reduce extractions and increase recharge. Even if fully implemented, however, they will still leave a deficit of 6,770 acre-feet per year given projected population growth. (CEC 1999)

"...If this deficit is allowed to grow, as growth trends suggest it will in the absence of remedial steps, it will eventually dewater the river and convert the riparian vegetation to types and species more typical of the upland desert conditions of the arid southwest. These are conditions that simply will not sustain the avian biodiversity that makes the upper San Pedro a special and essential place in the North American landscape. This would represent a profound loss not only to global biodiversity, but to the quality of life and economic potential of the basin itself.

Ironically, as one scientist has commented, the threat to the SPRNCA is not that water is scarce in the upper San Pedro basin, but that it is abundant. Because the regional aquifer holds so much water, new wells are readily and inexpensively developed. It is hard to convince local water users that there is a water supply problem requiring restrictions on land uses. Yet, as noted above, the basin is in deficit by several thousand acre-feet of water per year. The "water user" that will first experience the consequences of this deficit is the baseflow of the San Pedro River on which the vitality of the riparian vegetation depends. Like the proverbial canary in the mine, other water users will know they have a problem when this habitat expires. By then,

it will be too late to take the measures necessary to preserve it. Indeed, by then, the necessary measures will have become draconian, because they will entail dramatic reductions in the intervening extractions from the aquifer. Limiting aquifer development is merely difficult; reversing development may be impossible.

As the analysis in this report shows, the major threats to the viability of the riparian resource are the creeping incremental demands on the groundwater that sustains it. But the problem to be addressed is not just tomorrow's development of the aquifer. Even the current level of development of the aquifer will not sustain the riparian resource, but will eventually bring it to grief, unless measures are taken. As the water budget analysis in this report suggests, the aquifer probably cannot be brought into balance even at the current level of development without importing water into the basin. We hesitate to raise this option because it merely transfers the hydrologic deficit to the basin of origin. It may also fuel new growth in water demands. It would be a perverse outcome if strategies to maintain baseflows in the near term undermine efforts to bring the basin into hydrologic balance over the long term. This would merely bequeath the burden to future generations and make the solutions ever more difficult and costly..." (CEC 1999)

The U.S. Fish and Wildlife Service agrees:

"...In conclusion, we agree with the San Pedro Expert Study Team (1999) that, in the absence of a concerted effort to reverse current trends, the most likely future scenario is one of continued water use in excess of supply, continued enlargement of the cone of depression under Fort Huachuca and Sierra Vista, and in time, dewatering of portions of all of the San Pedro River in the Sierra Vista subwatershed..." (USFWS 1999b)

Secretary of the Interior Bruce Babbitt has been Arizona Governor and Attorney General. He helped create the Arizona Groundwater Management Act. He also helped lay the groundwork for formation of the San Pedro River National Conservation Area.

On November 9, 1999, at the binational San Pedro Conference in Bisbee, Arizona, Secretary Babbitt criticized the State of Arizona for not having created an AMA in the Upper San Pedro Basin:

"Babbitt scolds state over river: Water consumption along San Pedro 'unsustainable'"

BISBEE - Upset over what he says is unsustainable consumption of water in the San Pedro River basin, Interior Secretary Bruce Babbitt scolded Arizona on Wednesday for not having a management plan for the fragile river.

The state needs a legal framework in which to create an active groundwater-management area - similar to those in Tucson, Phoenix, and Prescott - to conserve the river's resources, Babbitt told reporters after addressing a binational conference on the San Pedro...

...the state is not doing enough, he told a group of about 150 people at the conference.

"The state of Arizona in Phoenix has abdicated its responsibility to lead in the management of this resource," he said...

Babbitt said if the state is unwilling to step in, the federal government eventually could find itself having to resort to the courts.

"We really are at the 11th hour, and we need to accelerate our efforts," he said. "There's time, but there's not much."

While governor of Arizona, Babbitt helped lay the groundwork for turning a 40-mile stretch of the river into what Congress eventually designated the San Pedro Riparian National Conservation Area. Now, his responsibility is to advocate for and defend its integrity, he said.

"Capital water consumption in this valley is unsustainable. It's Phoenix-style consumption -

and I say that in the negative possible way," Babbitt said. "Nobody wants to emulate the ecological destruction that took place up there."

Babbitt said he learned Tuesday of "an unimaginable abuse of this resource" - agricultural expansion occurring in Cochise County, where much of the river runs. Farm irrigation from groundwater is considered one of the heaviest drain on San Pedro water.

"We cannot destroy this river by standing idly by while land speculators go out and start expanding irrigation on the Arizona side of the border," he said. "It's an outrage, pure and simple."
(Associated Press 1999)

"Raise your voices and ask, where is the state of Arizona?" Babbitt demanded... (Sierra Vista Herald 1999f)

Five months later, after addressing this binational conference on the San Pedro River, Secretary Babbitt returned to Arizona to visit Kartchner Caverns State Park. Upon leaving the Caverns, Secretary Babbitt was deeply moved by the beauty of the vista across the Upper San Pedro Basin. He was also frustrated by the knowledge that little of significance is being done to save the integrity of the Basin and the San Pedro River.

In a subsequent Op-Ed to the Arizona Republic, Secretary Babbitt captures some of the frustration motivating the San Pedro Alliance to file this petition:

"...As we headed down to the parking lot [after a tour of Kartchner Caverns State Park], I looked out at the San Pedro Valley. There is no place in Arizona or anywhere else quite like this; across the valley, the Dragoon Mountains are glowing purple in the sunset, to the south I can see the blue peak of Santo Thomas clear down in Mexico and off to the rights, the ramparts of Huachucas.

But down in the valley along the San Pedro River, it may not last. The desert floor is being bulldozed to dust for wildcat subdivisions. The lush forest of cottonwood and willow along the San Pedro River are threatened by excessive groundwater pumping. How ironic that the state of Arizona can set a world standard for cave development, yet do so little to manage development on top." (Babbitt 2000)

Federal, County, City and local interests have proven unwilling and unable to offer and implement objectively functional, long-term solutions to actually control deficit groundwater pumping in the San Pedro River basin. Only the State of Arizona, through creation of an AMA, can provide the unity, guidance, and regulatory mechanism necessary to effectively manage the diverse and conflicting interests of water users in the Upper San Pedro River Basin.

AMA designation for the San Pedro River Basin offers the regulatory mechanism necessary for long term protection of the San Pedro River against the increasing deficit groundwater pumping. AMA designation for the San Pedro River Basin is necessary to preserve the existing supply of groundwater for future needs.

BIBLIOGRAPHY for the San Pedro Alliance AMA Petition

American Birding Association 1995. American Birding Association, Inc., "Winging It", Volume 7, Number 10, October 1995.

Arizona Corporation Commission 1990. Arizona Corporation Commission Utilities Division Annual Reports for Year Ending December 31, 1990.

Arizona Corporation Commission 1998. Arizona Corporation Commission Utilities Division Annual Reports for Year Ending December 31, 1998.

ADWR 1982. Arizona Department of Water Resources, Order for Hearing B-82-05-COCH in the matter of the designation of groundwater basins and sub-basins in the state of Arizona, pursuant to sections 45-403 and 45-404, Arizona Revised Statutes, February 3, 1982.

ADWR 1984a. Arizona Department of Water Resources, Findings and Order #41 in the matter of the designation of groundwater basins and sub-basins in the state of Arizona, pursuant to Sections 45-403 and 45-404, Arizona Revised Statutes, June 21, 1984.

ADWR 1984b. Arizona Department of Water Resources, Groundwater Basin and Sub-basin Designations, June 1984.

ADWR 1988a. Memorandum, Doug Toy and Herb Dishlip, ADWR, "AMA Recommendations for the Upper San Pedro (USP) Basin," to Alan P. Kleinman, ADWR, March 31, 1988.

ADWR 1988b. Correspondence, C. Laurence Linser, Director, ADWR, to the Sierra Club, June 16, 1988.

ADWR 1991. Arizona Department of Water Resources, "Hydrographic Survey Report for the San Pedro River Watershed, Volume 1: General Assessment, In Re The General Adjudication of the Gila river System and Source, November 20, 1991.

ADWR 1993a. Correspondence, C. Laurence Linser, Deputy Director, ADWR, to William P. Sullivan, Martinez & Curtis, P.C., Attorneys for Bella Vista Land and Water Co., September 29, 1993.

ADWR 1993b. Public Records Law response, C. Laurence Linser, Deputy Director, Engineering and Adjudication, ADWR, to Robin Silver, M.D., Conservation Committee, Maricopa Audubon Society, December 7, 1993.

ADWR 1994a. Public Records Law response, T.C. Richmond, Chief Counsel, ADWR, to Robin Silver, M.D., Conservation Committee, Maricopa Audubon Society, March 28, 1994.

ADWR 1994b. Arizona Department of Water Resources, Upper San Pedro River case study. Pages 147-208 in Arizona Riparian Protection Program, Legislative Report, July 1994.

ADWR 1996. Arizona Department of Water Resources, State of the AMA: Santa Cruz Active Management Area, July 1996.

ADWR 1999. Correspondence, Rita P. Pearson, Director, Arizona Department of Water Resources, to Douglas R. Norton, Auditor General, April 19, 1999.

ADWR 2000. ADWR Home Page
(<http://www.water.az.gov/default.htm>), October 7, 2000

AGFD 1979. Arizona Game and Fish Department, Statewide Fishery Investigations, 1978, Fed. Aid fish. Prj. F-7-R-21, Phoenix, 1979.

AGFD 1980. Arizona Game and Fish Department, Statewide Fishery Investigations, 1979, Fed. Aid fish. Prj. F-7-R-21, Phoenix, 1980.

AGFD 1993. Arizona Game and Fish Department, Arizona Riparian Inventory and Mapping Project, Phoenix, December 1, 1993.

Archer 1996. Correspondence, Richard Archer, City of Sierra Vista Mayor, to General William W. Hartzog, U.S. Army Training and Doctrine Command, Ft. Monroe, VA, April 5, 1996.

Arizona Auditor General 1999. Douglas R. Norton, Auditor General, "State of Arizona Office of the Auditor General Performance Audit Arizona Department of Water Resources, Report to the Arizona Legislature, Report No. 99-8," April 1999.

Arizona Daily Wildcat 2000. Blake Smith, "Scientists fear ocean shift may mean drought," Arizona Daily Wildcat, February 15, 2000.

Arizona Board of Regents 1995. Minutes, Arizona Board of Regents Meeting, March 9-10, 1995.

Arizona Commission on the Environment 1990. Arizona Commission on the Environment, Sue Lofgren, Chair, "Final report and recommendations of the governor's riparian habitat task force (Executive Order 89-16, Streams and Riparian Resources), Report submitted to the Honorable Rose Mofford, Governor of the State of Arizona, 1990.

Arizona Republic 2000a. Arthur H. Rotstein, "Crowds swamp caverns staff, Kartchner proving boon to businesses in nearby Benson," Associated Press/Arizona Republic, February 29, 2000.

Arizona Republic 2000b. Arthur H. Rotstein, "Boost for Benson - Caverns provide economic lift in jobs, tourism", Associated Press, Arizona Republic, August 26, 2000.

ASL 1995. A.S.L. Hydrologic & Environmental Services, Report on Feasibility of Groundwater Recharge and Sewage Effluent Reuse in the Sierra Vista Subwatershed, prepared for City of Sierra Vista and U.S. Department of Interior Bureau of Reclamation, Phoenix, June 30, 1995.

ASL 1998. A.S.L. Hydrologic & Environmental Services, Monitoring program and design report and groundwater modeling evaluation for Sierra Vista Water Reclamation facility. Report to the City of Sierra Vista, Arizona, Phoenix, 1998.

Associated Press 1999. Art Rotstein, Associated Press, "Babbitt scolds state over river: Water consumption along San Pedro 'unsustainable'", Arizona Republic, November 11, 1999.

Associated Press 2000. "Tree rings indicate 20-year drought," Arizona Republic, April 30, 2000.

Babbitt 2000. Bruce Babbitt, "Arizona preserved magic of caverns," Op-Ed, Arizona Republic, April 17, 2000.

BLM 1987. William Jackson, *et al.*, "Assessment of Water Conditions and Management Opportunities in Support of Riparian Values: BLM San Pedro River Properties, Arizona, Project Completion Report, Bureau of Land Management, U.S. Department of the Interior, Denver, CO, May 1987.

Bureau of Reclamation 1999a. Bruce D. Ellis, Chief, Environmental Resource Management Division, U.S. Bureau of Reclamation, Phoenix, MEMORANDUM, August 13, 1999.

Bureau of Reclamation 1999b. U.S. Bureau of Reclamation, "Finding of No Significant Impact," City of Sierra vista Water Reclamation Facility Effluent Recharge Project, Cochise County, Arizona, November 15, 1999.

CBD 1997. Correspondence, Robin Silver, M.D., Conservation Chair, Center for Biological Diversity, to Greg Block, Esq., Director, Commission for Environmental Cooperation, July 27, 1997.

CEC 1999. Commission for Environmental Cooperation San Pedro Expert Team, Sustaining and Enhancing Riparian Migratory Bird Habitation on the Upper San Pedro River, Final Draft, March 1999.

City of Sierra Vista 1998. City of Sierra Vista, "A Walk Along the San Pedro", 1998.

City of Benson 2000. Correspondence, Mr. Larry Kreps, Community Development Director, City of Benson, to Ms. Lisa Force, February 2, 2000.

CLIMAS 1999. CLIMAS Update, Newsletter of the Climate Assessment for the Southwest, Volume 2, Number 3-4, The University of Arizona, Tucson, December 1999.

Cochise County 1996. Cochise County Comprehensive Plan, Amended 1996; Resolution No. 84-72, Amended Ordinance No. 06-02 & Resolution No. 96-34, 1996.

Corell *et al.* 1996. Corell, S.W., F. Corkhill, D. Lovvik, and F. Putman, "A groundwater flow model of the Sierra Vista subwatershed of the upper San Pedro basin-southeastern Arizona," Arizona Department of Water Resources, Hydrology Division, Phoenix, AZ., Modeling Report No. 10., 1996.

Daily University Sciences News 2000. "American Southwest Could Be Facing 10-Year Drought," Daily University Sciences News, February 6, 2000.

Department of the Interior 1993. Correspondence, Fritz L. Goreham, Office of the Solicitor, U.S. Department of the Interior, to Larry Linser, Deputy Director, ADWR, November 17, 1993.

Eberhardt 1981. S. Eberhardt, "San Pedro River basin water quality status report for period 1973-1979", Rept. Bur. Wat. Qual. Contr., Ariz. Dept. Health Serv., Phoenix, 1981.

Fluid Solutions/Bureau of Reclamation 1999. Fluid Solutions and the U.S. Bureau of Reclamation, "Final Environmental assessment for the Sierra Vista Water Reclamation Facility Effluent Recharge Project, Cochise County, Arizona," Phoenix, Arizona, November 1999.

Ft. Huachuca 1991. Directorate of Resource Management, U.S. Army Garrison Fort Huachuca, Arizona, Impact Statements for Fiscal Year 1991 for Fort Huachuca, 1991.

Ft. Huachuca 1997. Directorate of Resource Management, U.S. Army Garrison Fort Huachuca, Arizona, Impact Statements for Fiscal Year 1997 for Fort Huachuca, 1997.

Ft. Huachuca 1998. Fort Huachuca Draft Environmental Impact Statement, p. 3-54, April 1998.

Glennon 1999. Correspondence, Robert J. Glennon, Esq., Morris K. Udall Professor of Law and Public Policy, University of Arizona College of Law, to Mr. Mike Ferguson, Deputy State Director, Arizona State Office, BLM, Phoenix, March 26, 1999.

Glennon and Maddock 1994. Robert Jerome Glennon and Thomas Maddock, III, "In Search of Subflow: Arizona's Futile Effort to Separate Groundwater from Surface Water," 36 Ariz. L. Rev. 567, 1994.

Glennon and Maddock 1997. Robert Jerome Glennon and Thomas Maddock, III, The Concept of Capture: The Hydrology and Law of Stream/Aquifer Interactions, 43 Rocky Mtn. Min. Law Inst. 22-1; 1997.

Huachuca Audubon 1997. Correspondence, Huachuca Audubon Society, to A.S.L. Hydrologic & Environmental Services and the U.S. Bureau of Reclamation, November 24, 1997.

Jones 1999. Casey Jones, City of Sierra Vista City Council, Letter to the Editor, Sierra Vista Herald, September 5, 1999.

Kingsolver 2000. Kingsolver, Barbara, "The Patience of a Saint: San Pedro River," National Geographic Magazine, Washington, D.C., April 2000.

Krueper 1992. Krueper, D.J., Effects of land use practices on western riparian ecosystems in status and management of neotropical migratory birds (Finch and Stangel, eds.), September 21-23, 1992, Estes Park, CO. Symposia Proceedings, in Gen. Tech. Rep. RM-229, Fort Collins, CO. U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest And Range Experiment Station, 422 pp., 1993.

Lewis 1997. M.A. Lewis, "Influence of an Open-pit Copper Mine on the Ecology of an Upper Sonoran Intermittent Stream", Unpubl. Ph.D. Dissert., Ariz. St. Univ., Tempe, 1977.

Life 1993. Life Magazine, "This Land Is Our Land, America's Last Great Places - and How They Might Be Saved Forever," October 1993.

Maddock and Lord 1993. Correspondence, Thomas Maddock III & William B. Lord, University of Arizona Department of Hydrology and Water Resources, to, U.S. Army, May 14, 1993.

Mountain View News 1995. Mountain View News, "A conversation with the Sierra Vista Mayor Pro Tem", October 11, 1995.

National Geographic Society 1999. National Geographic Society, Field Guide to the Birds of North America, Third Edition, Mary B. Dickinson, Editor, Washington, D.C., 1999.

Pool 1999. Pool, Don, U. S. Geological Survey hydrologist, to the Combined Work Session of the Cochise County Board of Supervisors and the Sierra Vista City Council, Bisbee, Arizona, May 5, 1999.

Pool and Coes 1999. Pool, D.R., and Alissa L. Coes, "Hydrogeologic Investigations of the Sierra Vista Subwatershed of the Upper San Pedro Basin, Cochise County, Southeast Arizona, Water-Resources Investigations Report 99-4197," U.S. Geological Survey, 1999.

Putnam et al. 1988. Putnam, F., K. Mitchell, and G. Bushner, "Water resources of the upper San Pedro basin, Arizona," Arizona Department of Water Resources, Hydrology Division, Phoenix, 1988.

Reisner 1986. Reisner, Marc, Cadillac Desert, Penguin Books, New York, 1986.

Schwartzman 1990. Schwartzman, P.N., "A hydrogeologic resource assessment of the lower Babocomari watershed, Arizona," Masters Thesis, Department of Hydrology and Water Resources, University of Arizona, Tucson, AZ., 1990.

Sierra Club 1988. Sierra Club, Petition to Designate the Upper San Pedro Basin as an Active Management Area, 1988.

Sierra Vista Herald 1994a. Diane Dolak, "Water users make claims to San Pedro," Sierra Vista Herald/Review, March 11, 1994.

Sierra Vista Herald 1994b. Diane Dolak, "Report is minimized by Sierra Vista councilman," Sierra Vista Herald, March 27, 1994.

Sierra Vista Herald 1995. Colleen Chandler, "City officials declare war on enviro 'enemy'", Sierra Vista Herald, September 23, 1995.

Sierra Vista Herald 1997. Amy Fredette, "Council Members Urge IDA [Sierra Vista Industrial Development Authority] to Boost Growth," Sierra Vista Herald, July 9, 1997.

Sierra Vista Herald 1998a. John Graber, "RV park plan approved; city annexation bid next," Sierra Vista Herald February 3, 1998.

Sierra Vista Herald 1998b. Margie Cady, "High-tech business boom," Sierra Vista Herald, February 25, 1998.

Sierra Vista Herald 1998c. Bill Hess, "Downsizing of military will hit Fort Huachuca, Outside contract work expected to increase," Sierra Vista Herald, March 23, 1998.

Sierra Vista Herald 1998d. Bill Hess, "Fort, city: New ties that bind," Sierra Vista Herald, May 1, 1998.

Sierra Vista Herald 1998e. Bill Hess, "Merger helps fort firm," Sierra Vista Herald, June 7, 1998.

Sierra Vista Herald 1998f. John Graber, "Supervisors OK for development, Split vote clears way for homes, golf course," Sierra Vista Herald, August 4, 1998.

Sierra Vista Herald 1999a. Bill Hess, "How does the river flow? Study gives new insight", Sierra Vista Herald, May 11, 1999.

Sierra Vista Herald 1999b. Diane Saunders, "Proposal may take 25 years to build," Sierra Vista Herald, June 3, 1999.

Sierra Vista Herald 1999c. Julie Stevens, "Saracino pushes for safer roads; Wants state transportation to help pay more of the bill," Sierra Vista Herald, June 6, 1999.

Sierra Vista Herald 1999d. Bill Hess, "Sierra Vista building boom? Pace ahead of 1998 rate," Sierra Vista Herald, August 8, 1999.

Sierra Vista Herald 1999e. Bill Hess, "Commander sees success by working in partnerships," Sierra Vista Herald, October 3, 1999.

Sierra Vista Herald 1999f. Bill Hess, "Arizonans must do more to protect San Pedro, Babbitt says," Sierra Vista Herald, November 11, 1999.

Sierra Vista Herald 2000a. Ken Jones, "SV housing market kept rolling in 1999," Sierra Vista Herald, February 6, 2000.

Sierra Vista Herald 2000b. John Graber, "SV firms try to lure Tucson's high-tech workers," Sierra Vista Herald, March 31, 2000.

Sierra Vista Herald 2000c. John Graber, "\$47.3 million deal for SV," Sierra Vista Herald, April 2, 2000.

Sierra Vista Herald 2000d. Bill Hess, "Drought conditions prompt water conservation request," Sierra Vista Herald, May 4, 2000.

Sierra Vista Herald 2000e. Bill Hess, "Small water companies feeling pinch of supply and demand," Sierra Vista Herald, May 7, 2000.

Sierra Vista Herald 2000f. Bill Hess. "City, water companies to talk drought," Sierra Vista Herald, May 30, 2000.

Sierra Vista Herald 2000g. Associated Press, "Arizona cities, including Benson, 'neck and neck' for yarn factory," Sierra Vista Herald, August 8, 2000.

Sierra Vista Herald 2000h. Margie Cady, "High-tech company moves to Sierra Vista, SIGNAL Corp. opens Wilcox Drive office after receiving post contract", Sierra Vista Herald, August 20, 2000.

State of Arizona 1991. Governor Rose Mofford, Executive Order No. 91-6, "Protection of Riparian Areas", February 14, 1991.

Stegner 1954. Wallace Stegner, Beyond the Hundredth Meridian, John Wesley Powell and the Second Opening of the West, Penguin Books, 1954, p. 342-3.

Tucson Weekly 1999. Tim Vanderpool and Darrin Mortenson, "Cheap Labor, Cheap Lives?", Tucson Weekly, April 8, 1999.

University of Arizona 1978. University of Arizona Water Resources Research Center, "Surface water quality monitoring: San Pedro River basin, Arizona, October 1977, Rept. Ariz. Dept. Health Serv., Phoenix., Univ. Ariz. Wat. Resour. Res. Cent., Tucson. Ariz., 1978.

U.R.S. Company et al. 1976. U.R.S. Company, W.R. Booth, and Associates, "Water Quality Management plan for the upper Gila and San Pedro River Basins Rept., Ariz. Dept. Health Serv., Phoenix. U.R.S. Co., W.R. Booth, and Assoc., Phoenix, 1976.

US Army 1992. U.S. Army, Final Supplemental Environmental Impact Statement for Base Realignment at Fort Huachuca, Arizona, August 1992.

USFWS 1978. U.S. Fish and Wildlife Service, U.S. Department of the Interior, "Unique Wildlife Ecosystems, Arizona." Washington, D.C., November 6, 1978.

USFWS 1999a. Memorandum, U.S. Fish and Wildlife Service Field Supervisor, Arizona Ecological Services Field Office, "Subject: Informal Section 7 Consultation - Request for Concurrence on San Pedro River Watershed Effluent Recharge Project, Cochise County, Arizona, to Bureau of Reclamation Area Manager, Phoenix Field Office," January 25, 1999.

USFWS 1999b. U.S. Fish and Wildlife Service, Biological Opinion AESO/ES 2-21-98-F-266 on impacts that may result from activities authorized, carried out, or funded by the Department of the Army at and near Fort Huachuca (Fort), Arizona, October 27, 1999.

USGS 2000. U.S. Geological Survey (USGS) Website, <http://waterdata.usgs.gov/nwis-w/AZ/data.components/hist.cgi?statnum=09471000>.

Vandana *et al.* 1997. Sharma Vandana, R.D. MacNish, and T. Maddock III, Analysis of Hydrologic Data Collected by the U.S. Bureau of Land Management 1987-95, University of Arizona Research Laboratory for Riparian Research, HWR No. 97-060, University of Arizona, 1997.

Vangilder 1995. Harold Vangilder, "Greater Arizona Journal," The Weekly Bulletin, October 4, 1995.

Wilkinson 1988. Todd Wilkinson, Science Under Siege, The Politicians' War on Nature and Truth, Johnson Printing, 1988.

Wynn and Gettings 1997. Wynn, J., and M. Gettings, "A preliminary interpretation of the 1997 airborne electromagnetic survey over Fort Huachuca, Arizona, and the upper San Pedro River basin (draft)," U. S. Geological Survey, U.S. Department of the Interior, Reston, VA., 1997.