II. IDENTIFICATION OF PROBLEMS

II.A. IMPORTANCE OF SAN PEDRO RIVER FLOWS

A.1 SPRNCA Designation

The San Pedro River is one of the few remaining free-flowing river systems in the southwestern United States, providing habitat for numerous plant and animal species in addition to recreational opportunities, both of which depend on streamflow (Jackson and others, 1987). Within the district, the riparian and aquatic ecosystems of the San Pedro River support at least 16 fish species, approximately 47 amphibian and reptile species, up to 84 mammal species, and over 400 bird species (Jackson and others, 1987; Leenhouts and others, 2006; and BLM, 2008).

By the 1980s, development and associated water demands, as well as localized groundwater level declines, had raised concerns over potential degradation of the river and its attendant flora and fauna (Jackson and others, 1987). The San Pedro Riparian National Conservation Area (SPRNCA) was designated by Congress in 1988 "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" (16 U.S.C. 460xx). SPRNCA covers 56,431 acres and includes the upper reach of the San Pedro River within the United States and the lower reach of the Babocomari River (**Figure 1)**.

A.2 ESA Designations

Sixteen plant and animal species currently found in the district are at risk including 10 endangered species, 3 threatened species, and 3 candidates for federal listing. Another four endangered species and 2 threatened species were historically present in the area, but are not currently found there. See **Table 1.** All but two of these at-risk species depend on aquatic and/or riparian ecosystems for at least some part of their lifecycle. Critical habitat within the District has only been designated for the Huachuca Water Umbel.

II B. INTERACTION OF SURFACE WATER AND GROUNDWATER

B.1 Surface Waters

The water that flows in streams can generally be divided into two categories based on its source – storm runoff and baseflow. Storm runoff is the portion of streamflow that results directly from precipitation events, while baseflow is the portion that originates from the discharge of underground water to the stream channel. In some areas, baseflow can maintain streamflows even after prolonged periods without precipitation.

The presence and duration of baseflow is used to characterize streamflow regimes. Perennial stream reaches typically display baseflow throughout the year, while intermittent stream reaches only display baseflow on a seasonal basis, when water tables in adjacent aquifers are high enough to induce discharge to the stream channel. Channels of ephemeral stream reaches are usually above the water table and, therefore, do not typically contain baseflow.

Along the larger streams in the water district, namely the San Pedro and Babocomari Rivers, base flow originates from alluvial aquifers that underlie and are adjacent to the streams. The baseflow in these streams varies seasonally and is affected by water usage by humans and riparian vegetation, as well as by monsoonal storms. It has been estimated that from 55 to 80% of the baseflow along portions of the upper San Pedro River originates as local floodwaters that infiltrate into alluvial sediments during the monsoon and then slowly drain out (Baillie and others, 2007). The remaining baseflow in these streams consists of water discharged from the regional, basin fill aquifer.

SAN PEDRO RIVER

Streamflow records are available from seven U.S. Geological Survey (USGS) gages located in the District along the San Pedro River (**Table 2**). Runoff from monsoonal storms predominates the streamflow in this reach of the river from mid-June to mid-October, while baseflow predominates during the rest of the year. Baseflows are relatively constant along the upper San Pedro River from December through March, but decrease during April and June when higher temperatures increase evapotranspiration and irrigation demands.

The San Pedro River is currently intermittent to perennial within the District, with perennial reaches occurring most frequently between Palominas and Charleston (**Figure 2**). Baseflows along this reach of the river have generally declined over the 20th century due to natural and human-caused factors (Thomas and Pool, 2006) and as a result, some formerly perennial reaches are now intermittent. **Figure 3** illustrates the daily distribution of streamflow along the San Pedro River at Charleston and the monthly distribution of precipitation at nearby Tombstone.

BABOCOMARI RIVER

The Babocomari River is the largest tributary to the San Pedro River within the District, and streamflow has been measured since 2000 at two USGS gages located along it (**Table 2**). Although the factors affecting streamflow are similar to those of the San Pedro River, the magnitude of storm runoff and baseflow are lower along the Babocomari River due to a smaller drainage area and contributing regional aquifer. Streamflows are ephemeral over much of the river, except where shallow bedrock forces underground waters to the surface and sustains intermittent or perennial flows along its lower reaches. Like the San Pedro River, the Babocomari River has experienced reduced baseflows in some areas due to natural and human-caused factors (Thomas and Pool, 2006).

OTHER TRIBUTARIES

Other tributaries to the San Pedro River within the district are generally ephemeral, although intermittent and perennial reaches do occur in mountainous areas to the west (Pool and Coes, 1999). At higher elevations, where snowfall is a significant, sustained runoff can occur during the winter and spring as snow melts. Streamflows become increasingly ephemeral at lower elevations, as runoff infiltrates into dry sediments of alluvial fans and the basin fill that borders the San Pedro River.

Flows in six of the other tributaries to the San Pedro River have been measured by the USGS since 1959 (**Table 2**). In addition, 30 stream gages have been operated by the U.S. Department of Agriculture since 1953 within the Walnut Gulch Experimental Watershed. All stream reaches within the experimental watershed, located east of the San Pedro River, are ephemeral (Stone and others, 2008).

B.2 Groundwater Aquifers and Recharge Conditions

OVERVIEW

The district is underlain by a basin comprised of several, relatively deep troughs filled with sand, silt, and clay deposits. The bottom and sides of the basin are formed by bedrock units including granite, limestone, and sandstone (ADWR, 2005). These rocks are exposed at land surface in the mountains and hills that border the basin, but drop to depths of over 5,500 feet near the basin center (Gettings and Houser, 2000). A generalized geologic cross section through the district is shown in **Figure 4**, and a surface geology map of the region is shown in **Figure 5**.

Three aquifers have been identified in the District – alluvial, basin fill, and bedrock. Water in these aquifers generally flows from recharge areas near the mountains, through sand and gravel layers in the basin fill, and discharges into alluvium along the San Pedro and Babocomari Rivers. Discharge occurs along the rivers as baseflow, through evapotranspiration of riparian vegetation, and as springs and underflow.

ADWR (2005) estimated that there was between 19.8 million and 26.1 million acre-feet of water stored in the aquifers beneath the Sierra Vista sub-basin, a region that covers much of the same area as the district (see **Figure 1**). Water level elevations in the aquifers during 2006 are shown in **Figure 6**. The hydrogeologic units that comprise district aquifers are listed in **Table 3** including their lithologic descriptions, unit thickness, and geophysical properties.

ALLUVIAL AQUIFER

The alluvium beneath the floodplain of the San Pedro and Babocomari Rivers is relatively thin (less than 50 feet thick) and ranges in width from a few feet to nearly two miles (Pool and Coes, 1999). It consists of unconsolidated gravel, sand, and silt deposited by flood flows. Where saturated beneath perennial and intermittent stream reaches, these deposits form a prolific, but limited unconfined aquifer (ADWR, 2005).

The floodplain deposits have been divided into two hydrogeologic units - pre-entrenchment and post-entrenchment alluvium. The older, pre-entrenchment alluvium consists of clay, silt, and fine sand that were deposited during the Holocene before river channels in the area became entrenched during the late 1800s (Hereford, 1993). Compared to the post-entrenchment alluvium and underlying basin fill deposits, the pre-entrenchment alluvium has relatively low permeability (Pool and Coes, 1999). The younger, post-entrenchment alluvium consists of more permeable sand and gravel, but is generally only a few feet thick in most areas.

Most recharge to the alluvial aquifer comes from infiltration of streamflow, primarily during flood events, and through discharge from the underlying basin fill aquifer. Discharge from the alluvial aquifer occurs as baseflow, evapotranspiration, underflow that leaves the district, and from well pumpage. The aquifer can be quite productive, but is limited by the amount of water it can store. Putman and others (1988) estimated that the water stored in the alluvial aquifer totaled 421,000 acre-feet for the entire Upper San Pedro Basin, an area considerably larger than the district.

BASIN FILL AQUIFER

Basin fill underlies the floodplain alluvium and was deposited during the Miocene through early Pleistocene in a structural depression formed between local mountain ranges. It forms the primary aquifer in the region and has been divided into an upper and lower hydrogeologic unit. The lower basin fill is often more consolidated than the upper unit and contains clay and silt layers that form aquifer confining layers. The upper basin fill is often less consolidated and contains more sand and gravel, but is unsaturated in parts of the basin (Pool and Coes, 1999). See **Table 3.**

Hydraulic communication between the upper and lower basin fill is generally good. The upper basin fill typically lies above a depth of 400 feet and is the primary water-bearing unit near the basin margins and near the international border with Mexico (Pool and Coes, 1999). Artesian conditions continue to exist in the lower basin fill, although they are less common now due to well pumpage that has decreased water pressures (ADWR, 2005). The saturated thickness of the basin fill aquifer is shown in **Figure 7**.

The greatest precipitation in the region occurs in the mountains that border the basin and, therefore, most natural recharge to the basin fill aquifer occurs along there at the junction between the mountains and the basin floor (Pool and Dickinson, 2007). The aquifer also receives artificial recharge at designated recharge facilities in Sierra Vista and at Fort Huachuca, and through incidental recharge from agricultural activities and septic tanks.

Most water in the basin fill aquifer flows in a direction and gradient similar to the land surface. However, flows in the aquifer become more vertical near recharge areas along the mountain fronts, along the San Pedro and Babocomari Rivers where natural discharge occurs, and near heavily pumped areas.

ADWR (2005) estimated that approximately 15.6 million acre-feet of water was stored in the basin fill and alluvial aquifers beneath the Sierra Vista sub-basin.

BEDROCK AQUIFERS

Several bedrock aquifers occur in the district. The largest is believed to be the Pantano Formation, a consolidated conglomerate that was deposited before the lower basin fill and ranges from 0 to several thousand feet thick. The Pantano Formation supplies some wells in the Sierra Vista area via fractures in the conglomerate (secondary permeability)**,** but these zones may not be widespread (Pool and Coes, 1999; Gettings and Houser, 2000). It was estimated that the

Pantano Formation may store up to 3.8 million acre-feet of water in the region, although the formation remains largely unexplored and the storage estimate is subject to re-evaluation when more data become available (ADWR, 2005).

Other bedrock aquifers consist of Mesozoic and Paleozoic sedimentary rocks and pre-Miocene granitic and volcanic rocks that outcrop in the hills and mountains that border the district (**Figure 5**). Recharge to these aquifers occurs from rain and snowmelt along the mountain fronts (Pool and Coes, 1999). Although their permeability and storage characteristics are not well known, the flow of water through these aquifers may be an important component of San Pedro hydrologic system (Pool and Dickinson, 2007).

B.3 Water Budgets

A water budget is an accounting of the inputs to, and the outputs from, a hydrologic system. A current water budget for the regional aquifer of the Sierra Vista Subwatershed is presented in **Table 4**. Components of the water budget include natural inflows and outflows (ADWR, 2005), as well as the inflows and outflows resulting from human activities (USDI, 2007). Although the boundaries of the subwatershed and district do not exactly match, they are similar enough to allow the water budget of the former to be used as an approximation of the latter.

BUDGET COMPONENTS

Inflows

Natural inflows to the regional aquifer include natural recharge, primarily infiltration of winter runoff along ephemeral channels, and underflow from Mexico (ADWR, 2005). Aquifer inflows also come from water conservation measures including the managed recharge of effluent and stormwater, and a reduction in riparian evapotranspiration from mesquite removal (USDI 2007). Other aquifer inflows from human activities are incidental and include irrigation returns, percolation from septic tanks, and urban-enhanced recharge. The latter represents the recharge to ephemeral channels that results from increased surface runoff generated in urban areas from impervious surfaces.

Outflows

Natural outflows from the regional aquifer include evapotranspiration in riparian areas, baseflow to perennial and intermittent stream reaches, and underflow to the Benson Subwatershed (ADWR 2005). Well pumpage represents most, if not all, human-caused outflows from the aquifer and includes withdrawals for municipal, military, domestic, industrial (including golf courses), and agricultural uses (USDI 2007). Well pumpage in the area has increased steadily throughout the 20^{th} century (**Figure 4**). Prior to 1960, most pumpage was for mining activities in Bisbee and Tombstone. Agricultural and municipal pumping began to increase in the 1940s and municipal use now represents the largest human water demands in the region.

RECENT BUDGETS

Inflows to the regional aquifer of the Sierra Vista Subwatershed were estimated to total 25,600 acre-feet (AF) in 2005, of which 7,600 AF were related to human activities. Outflows from the aquifer in that year were estimated to total 30,000 AF, of which 18,600 AF was well pumpage. Since total outflows exceeded total inflows, the quantity of water stored in the regional aquifer is estimated to have decreased in 2005 by 4,400 AF. Note that the quantities for several water budget components were estimated and contain uncertainties. These estimates may change in the future as more and better hydrologic data become available.

BUDGET DEFICITS

An important result from developing the water budget was quantification of a storage deficit in the regional aquifer caused by aquifer outflows exceeding inflows. As a result of water conservation measures, the annual storage deficit has decreased in recent years and is expected to be approximately 2,000 AF by 2011 (**Figure 5**). Had recent conservation measures not been employed, the annual storage deficit is estimated to have reached 13,000 AF by 2011.

WATER CONSERVATION EFFORTS

Past and Current

The Upper San Pedro Partnership (Partnership) and its members have led water conservation efforts in the district (USDI, 2005). With the goal of eliminating storage depletion in the regional aquifer by 2011, the Partnership has taken an adaptive management approach to water conservation that requires ongoing evaluation of measures and focuses on yield, cost, and community acceptance. Each member agency capable of implementing water conservation measures is expected to contribute to the effort.

The water conservation measures supported or proposed by the Partnership can be grouped into two categories – 'conservation' and 'recharge' (USDI, 2005). Conservation measures include public education, effluent reuse, code changes, and reducing irrigated agriculture. Recharge measures include effluent and stormwater recharge. **Table 5** lists recent water conservation measures taken by Partnership members and the planned and actual yields of those measures in 2005. Three measures taken by Cochise County and Sierra Vista met or exceeded their planned water yield in 2005, while two of the largest water yields that year were incidental (not resulting from member actions). The largest reduction in aquifer storage depletion was the incidental increase in ephemeral channel recharge resulting from increased urban runoff.

Water conservation measures have also been taken by community water systems in the district. State law requires that each system include conservation in their water system plans and provide ADWR an updated plan every 5 years (ADWR 2007). **Table 6** lists the community water systems in the district, their recent annual pumpage, and elements of their water conservation plan. Some, but not all, of these system are members of the Partnership.

Future

The Partnership anticipates that future water conservation measures will nearly eliminate storage depletion in the regional aquifer by 2011 (USDI, 2007). Effluent and stormwater recharge are expected to provide the greatest water yields. Other planned conservation measures, whose impacts are not currently quantified, include greater public education, building code changes, and water efficiency rebates. See **Table 7**.

II C. LEGAL FRAMEWORK FOR DEALING WITH WATER RIGHTS AND WATER USES

C.1. Surface Water

Surface water in the State of Arizona is defined in Arizona Revised Statutes § 45-141 as "waters of all sources, flowing in streams, canyons, ravines or other natural channels, or in definite underground channels, whether perennial or intermittent, floodwaters, wastewaters, or surplus water, and of lakes, ponds and springs on the surface." The key words in the definition are water from all sources flowing in natural channels. Water flowing down a paved road or on roof tops is not considered to be surface water and therefore is not appropriable.

The use of surface water in Arizona is governed by the Doctrine of Prior Appropriation. This Doctrine is based on the tenet of "First in Time First in Right" which means the person who first puts the water to a beneficial use acquires a right that is better than later appropriators of the water.

Surface water law provides that a person must apply for and obtain a permit in order to appropriate surface water unless: the water is from the mainstream of the lower Colorado River, or the person lawfully appropriated the water prior to March 17, 1995 and has filed a statement of claim for the appropriation with the state, or the water is stored in a stockpond constructed after June 12, 1919 and before August 27, 1977.

Prior to capturing or diverting surface water for use in the State of Arizona an individual must first obtain a surface water permit, right or claim from the Arizona Department of Water Resources (Department). Surface water can only be appropriated for beneficial use and beneficial use shall be the basis, measure and limit to the use of water. The beneficial uses as defined in statute are domestic, municipal, irrigation, stock-watering, water power, recreation, wildlife including fish, mining, and non-recoverable water storage. Flood and sediment control are not recognized beneficial uses. Surface water is appurtenant to the land to which it has been certificated and may not be used elsewhere without going through a sever and transfer process.

All streams within Arizona are over appropriated making it very difficult to obtain a new right to the use of surface water. Applications to appropriate surface water are generally protested and as such must go to a hearing if the protest cannot be resolved. Some of the larger protesters to any applications to appropriate water in the Upper San Pedro Groundwater Basin are the Gila Indian Tribe, San Carlos Indian Tribe, Salt River Project, Freeport McMoran and others.

C.2. Adjudcation

A general stream adjudication is a judicial proceeding to determine or establish the relative priority and extent of surface water rights. Two general stream adjudications are currently underway in the State of Arizona, the Gila River System and Source (Gila Adjudication) and the Little Colorado River System and Source. The Upper San Pedro Water District is located within the Gila Adjudication.

The Gila Adjudication came about as a result of numerous petitions being filed in the 1970's to determine the water rights for a number of streams within the Gila River System and Source. Salt River Valley Water Users (SRP) filed the first petitions on the Salt and Verde Rivers, Phelps Dodge filed on the Gila System and Source, ASARCO filed on the San Pedro River and Buckeye Irrigation Company filed to expand the previous filings to include the Agua Fria River. In November of 1981, the Arizona Supreme Court consolidated all of these adjudications into one proceeding assigned to the Maricopa County Superior Court.

Any person or entity who uses surface water or who has made a claim to use surface water, on property within the Gila River System and Source, potentially may be affected. The legislature has charged the Arizona Superior Court with quantifying and prioritizing validly existing water rights claimed in the this watershed. The final court decree will establish the existence and ownership of claimed water rights, as well as important characteristics of the water rights, including location of water uses, quantity of water used, and date of priority of the water.

More than 83,500 Statement of Claimant filed by more than 28,000 parties are currently joined in these proceedings that will result in the Superior Court issuing a comprehensive final decree of water rights. Parties to this proceeding include irrigators, cities, business and numerous Indian Tribes Thousands. The largest of these claims was from Gila River Indian Community (about 1.5 million acre-feet).

In 2004, Congress passed the Arizona Water Rights Settlement Act. The passage of this Act requires non-Indian parties, the U.S. and the State to provide water resources and money to the Gila River Indian Community in exchange for a waiver of the tribe's claim to water. By agreeing to a settlement all parties involved obtained certainty and finality to their established water rights and the Gila River Indian Community stopped all litigation in the Gila River Adjudication. All other parties will continue with the adjudication process in the court, but the Gila River Indian Community has dropped its claims to the river altogether

C.3. Groundwater Regulation

Groundwater is Arizona's most abundant water resource and Arizona has some of the largest and most productive aquifers in the southwest. The regulation of groundwater in Arizona is dependent upon whether or not you are located inside or outside of an Active Management Area (AMA). There are currently five AMAs in Arizona known as the Phoenix, Pinal, Tucson, Santa Cruz, and Prescott AMAs. The San Pedro Water District is not located within an AMA.

Inside AMAs there are certificated groundwater rights and the use and management of groundwater is strictly regulated. Outside of AMAs there are no certificated groundwater rights and the use of groundwater is based on the doctrine of reasonable and beneficial use. Outside of AMAs a landowner may drill a well on their property and put the water to beneficial use with the only restrictions being that they own the property where the well will be drilled, the well is drilled by a licensed well driller who has received a drill card from the Department authorizing the driller to drill the well, and the water will be put to beneficial use. The only other regulation on the use of groundwater is a statewide prohibition on the interbasin transfer of groundwater. There are a few exceptions to the prohibition of interbasin transfers, but they are explicitly stated in statute and the only one that is applicable to the Upper San Pedro Water District area is the provision that allows a city, town, or private water company whose service area is located in two adjoining groundwater basins and was transferring water between basins prior to September 1, 1993, to continue and even expand that transfer to meet the demands of their service area.

There have been two studies conducted to determine whether or not the Upper San Pedro Groundwater Basin should be designated as an AMA with the most recent occurring in 2004. Both studies concluded that the Upper San Pedro Groundwater Basin did not meet the statutory requirements to be designated as an AMA.

C.4. Sub-Flow Decision – Interaction of Surface Water and Groundwater Law

As a part of the adjudication effort the Court has recognized the interconnectivity between surface water and groundwater and directed the Department to develop a methodology for determining which wells may be potentially pumping appropriable Sub-flow rather than groundwater. The Report submitted to the Court by the Department in 2002 recommended that all wells located within the geologic zone known as the Holocene Alluvium be considered as potentially pumping appropriable sub-flow.

The Department is currently directed to provide a technical report to the Court by March 2009 that includes a map developed by the Department, which delineates the Holocene Alluvium. The Department has contracted with the Arizona Geologic Survey to establish where the Holocene Alluvium is located along the San Pedro River. The Department will then use this information to develop a final map, which incorporates the setbacks established by the Court for connecting tributary aquifers and basin fill deposits.

All claimants in the Gila Adjudication along with the Court's approved list of contacts will have 180 days to file objections to the technical report. The Court will ultimately approve a map that delineates the Sub-flow zone. Two additional issues that are still pending before the Court deal with the de-minimus standard and the cone of depression tests.

The ramifications of a final Decision and Order from the Court pertaining to the Sub-flow decision are not fully known, but it is anticipated that one of the impacts would be the potential limitation on the development of new wells within the Holocene Alluvium. A final Decision and Order would also lay the ground work for moving the adjudication forward. The adjudication would ultimately establish the relative priority and extent of surface water rights. Wells deemed to be pumping appropriable sub-flow would now have a priority date established that would coincide with when the well was drilled. As an example, all wells identified to be pumping appropriable sub-flow that were drilled after creation of the SPRNCA (1987) would have a junior right to the SPRNCA claims currently being considered before the court.

C.5. Arizona Water Settlements Act

In 2004, Congress passed the Arizona Water Rights Settlement Act. This Act stipulates that the Gila Indian Community will receive water resources and money from non-Indian parties, the U.S. and the State in exchange for a waiver of the tribe's claim to water. Additionally, the Act established the Gila River Maintenance Area with restrictions on the development of new surface and groundwater, agriculture, and dams. With the exception of two provisions, all of the lands within the District are exempt from any of the restrictions required by the Act. For the lands within the District, the Settlement Act explicitly prohibits the construction of any new dams and requires new non-exempt wells that pump more than 500 gallons per minute notify the Department.

INSERT MAP

C.6. Water Adequacy Rules

In 1973 the Legislature passed the Adequate Water Supply Program Legislation. The Adequate Water Supply Program was intended to serve as a consumer advisory program, ensuring that potential real estate buyers are informed about any water supply limitations.

Under the statutes governing the Adequate Water Supply Program all proposed subdivisions outside of AMA's must demonstrate that water is physically, legally, and continuously available to the proposed subdivision for at least 100 years. The developer must also demonstrate the water is of sufficient quality and that the developer has the financial capability to construct any necessary water storage, treatment and delivery system. In order to demonstrate the physical availability of water for subdivisions that will use groundwater, the Developer must demonstrate that the depth-to-groundwater will not exceed 1,200 feet below the surface of the land 100 years.

INSERT GRAPHIC

Because the Adequate Water Supply Program was intended as a consumer advisory program no provisions were made to require the subdivision meet all five criteria in order for the subdivision to receive a public report from the Department of Real Estate. In other words lots could still be sold even if the subdivision received an inadequate water supply determination from the Department and the disclosure of the inadequacy was only required for the first buyer of the property and not to subsequent buyers.

In 2007 the legislature passed SB 1575 that provides clear authority for cities and town or counties to adopt an ordinance requiring new subdivisions to obtain from the Arizona Department of Water Resources a determination of the existence of an adequate 100-year water supply in order to obtain final plat approval from the local platting authority. If adopted, the Department of Real Estate also cannot approve a public report without an adequate water supply determination.

In March of 2008, Cochise County adopted the authority granted in SB 1575 now making it mandatory for a proposed subdivision within Cochise County to obtain an adequate water supply determination from the Department before a subdivision can receive a public report from the Department of Real Estate.

If the Upper San Pedro Water District is established by a vote of the registered voters within the District's boundaries, the Department must take into consideration a sixth criteria for all proposed subdivision within the District's boundaries. Upon the establishment of the District the Department will initiate the process of adopting rules to ensure that the projected water use of any proposed subdivision within the District is also consistent with the Goal of the District and the District's ability to meet the measurable objectives as defined in the District's comprehensive plan.

C.6. ESA and Environmental Laws

The Endangered Species Act (ESA) was signed into law in 1973 (Pub. L. 93-205). The stated purpose of the ESA at the time of its passage was to protect species and also the ecosystems upon which they depend. It encompasses plants and invertebrates as well as vertebrates.

The United States Fish and Wildlife Service (FWS) and the National Oceanic and Atmospheric Administration (NOAA) oversee the administration of the ESA. The ESA only protects species which are officially listed as "endangered" or "threatened". There is a third status, which is "candidate species". The FWS has concluded that listing "candidate species" is probably warranted but immediate listing is precluded due to other priorities.

Section 11 of the Endangered Species Act describes the violations and penalties that may be enforced under law. As habitat loss is the primary threat to most imperiled species, the original ESA of 1973 allowed the FWS and NOAA Fisheries to designate specific areas as protected "critical habitat" zones. Critical habitats are required to contain all areas essential to the conservation of the target species. (Section 3(5) (A)). Such lands may be private or public. Federal agencies are prohibited from authorizing, funding or carrying out actions that destroy or adversely modify critical habitats (Section 7(a) (2)).

Sixteen at-risk species have been identified within the Upper San Pedro Groundwater Basin. All but two depend on aquatic and/or riparian ecosystems for at least some part of their lifecycle. Only one at-risk species, the Huachuca Water Umbel, has critical habitat designated for it within the District's boundaries.

The base flow of the River and the aquifer near the River are considered critical habitat for the support of the Huachuca Water Umbel. The physical and biological habitat features essential to the conservation and restoration of the Huachuca Water Umbel include a riparian plant community that is fairly stable over time and not dominated by nonnative plant species, a stream channel that is relatively stable but subject to periodic flooding, refugial sites (sites safe from catastrophic flooding), and a substrate (soil) that is permanently wet or nearly so, for growth and reproduction.

Excessive groundwater pumping to supply Ft. Huachuca and the surrounding communities has been considered a threat and jeopardy to the Huachuca Water Umbel, which is dependant on the riparian habitat and base flow of the river. Ft Huachuca has responded with unprecedented water conservation programs to reduce its impact to the aquifer. However, the future of the River is expected to be a continuing consideration by the Base Relocation and Closure Committee. Without adequate protection for the River, Ft. Huachuca may be recommended for closure.

The closing of Fort Huachuca would result in the loss of more than $750 million to the local economy and more than $2 billion to the economy of the State of Arizona. The direct economic and social impacts to the Sierra Vista area would be severe.

An area encompassing a large reach of the River is also designated as a National Riparian Conservation Area. All federal agencies, including the U.S. Defense Department, must take appropriate actions if the agency activities will cause jeopardy to endangered species.

C.7. Conclusions

The Upper San Pedro Water District is limited in what it can do by regulatory restrictions imposed upon it by both State and Federal statutes. The obtainment and use of additional water supplies by the District in the future from local sources will also be limited by the goals and objectives established by the District.

Surface Water

The diversion, capture or use of surface water requires a right or claim. Obtaining a surface water right is highly improbable in the Upper San Pedro Groundwater Basin. Enhancing recharge through the management of surface water and sheet flow from storm events is an option that is available to the District. This can be accomplished by strategically locating storm-water detention basins throughout the District. Managing storm-water through the installation of detention basins does not require a certificate of water right. This option, however, is not without some potential obstacles as well. Periodic flood flows are considered to be essential to the health of a river's ecology. Reducing and/or eliminating periodic flood flows from storm events may result in unacceptable impacts to the River. The likely-hood of the District being able to introduce legislation that would allow for the greater use of surface water over and above what they are currently able too is extremely unlikely. Several attempts have been made to initiate legislation that would allow for greater flexibility in the use of surface water that has been met with extreme opposition.

Groundwater

The development of additional groundwater within the Upper San Pedro Groundwater Basin is limited only by the volume of groundwater in storage. Extensive pumping overtime, however, will impact groundwater elevations at the SPRNCA boundary and ultimately the base flow of the River. With the establishment of a permanent District, the District will take into consideration potential impacts on the groundwater elevations encompassing the SPRNCA when selecting locations to develop groundwater for future use. Augmentation and recharge are tools the District will employ to mitigate potential impacts to the elevation of the groundwater.

The District will play a significant role in the management of the groundwater through the adoption of goals.

<u>Sub-Flow</u>

A final decision and order by Superior Court regarding Sub-flow will limit where new wells may be developed within the District. The development of new wells in close proximity to the River may no longer be allowed without first obtaining a surface water right or claim, which as stated previously is highly improbable. The exact timing of the Court decision and order is unknown, but most feel it will happen within the next two to three years.

<u>Water Adequacy</u>

The Adoption of SB 1575 by Cochise County requires all newly proposed subdivisions demonstrate they have an adequate water supply for 100 years in order to obtain final platting approval. The establishment of a permanent District will require the Department to adopt rules that takes into consideration the Goal of the District. The Department will have to include in its analysis a determination of the effects on the current groundwater elevations at the SPRNCA boundaries from the proposed subdivision's projected pumping. The District has the capability through its goal setting to play a significant role in water adequacy requirements for newly proposed subdivisions. Although this may be viewed as restricting new development, the District also has the capability through augmentation and recharge to assist new development in mitigating potential impacts to the River and/or by providing an alternative source of water other than groundwater.

<u>ESA</u>

ESA issues are and will continue to have an affect on the long-term management of water within the District. Excessive groundwater pumping will threaten the baseflow and riparian habitat of the San Pedro River. Loss of riparian habitat and baseflow will result in unacceptable impacts to numerous threatened species. Impacts to threatened and endangered species may result in Ft. Huachuca not being reauthorized during the next round of Base Realignment and Closure proceedings. The District has already adopted the goal of maintaining the current groundwater elevations at the boundary of the SPRNCA in order to maintain sufficient baseflow and riparian habitat for the maintenance of the threatened and endangered species.

III. FUTURE RISKS AND UNCERTAINTIES

III. A. IMPACTS OF INCREASED MUNICIPAL, INDUSTRIAL OR AGRICULTURAL GROUNDWATER WITHDRAWALS

A.1. Projected Growth Rates

The 2000 Census population of the Sierra Vista subwatershed was estimated at 68,122. Of this total approximately 85% of the residents were served by a water provider and 15% were served by domestic wells. Shown in Table III-1 are population estimates and projections that assume the current percentages of residents served by a water provider and by domestic wells will reflect future conditions.

Table III-1 Sierra Vista Subwatershed population estimates and projections

	2000	2005	2010	2020	2030
Population served by a water provider	57,548	65,404	73,149	85,989	95,755
Population served by a domestic well	10,574	12,018	13,441	15,800	17,594
Total population	**68,122**	**77,422**	**86,590**	**101,789**	**113,349**

Source: ADWR, 2005; USGS, 2007; ADES, 2006

Shown in Table III-2 is the estimated volume of water withdrawn or diverted to meet current and projected demand, and the amount of water that returns to the aquifer. Figure III-1 shows water sector use from 2000 to 2003. The estimated water demand by municipal, industrial and agricultural users was approximately 19,000 acre-feet in 2005. Demand dropped slightly in 2005 because 500 acres of agricultural irrigation were taken out of production.

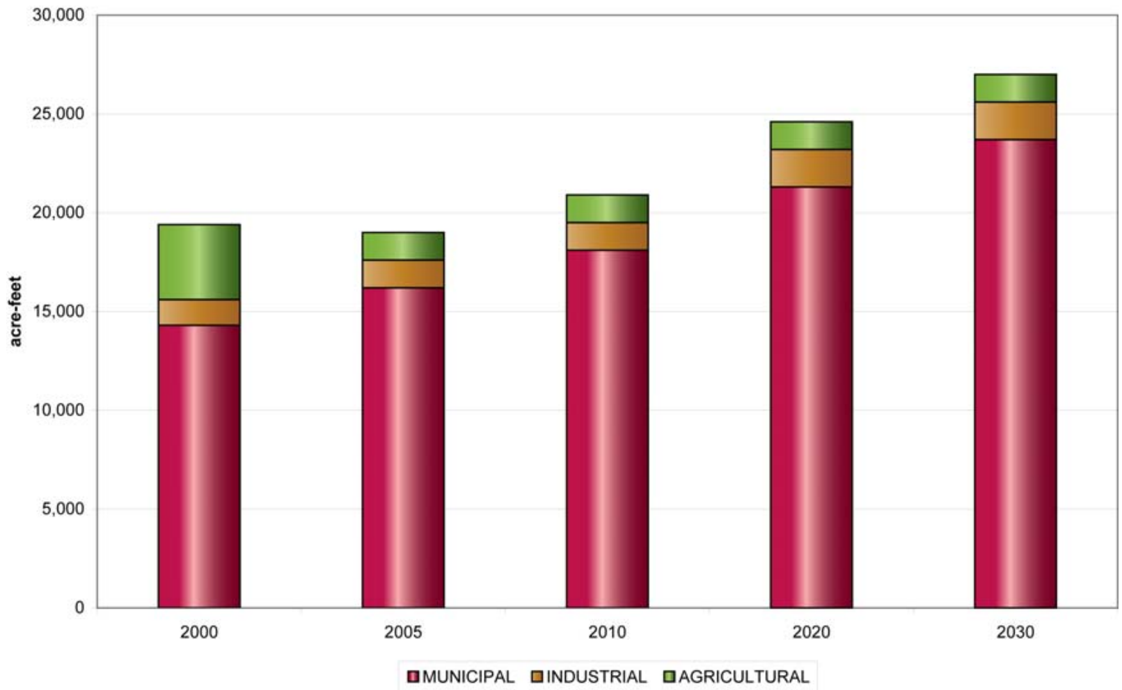
Demand is met almost entirely by groundwater. As population growth continues, municipal and industrial demand will increase. Total water demand is expected to increase to approximately 27,000 acre-feet in 2030 assuming that current per capita rates will remain unchanged in the future, industrial sector demand increases slightly and agricultural irrigation remains at 2005 levels.

Table III-2 Sierra Vista Subwatershed water demand and supply by sector (in acre-feet)

	2000	2005	2010	2020	2030
MUNICIPAL					
DEMAND	**14,300**	**16,200**	**18,100**	**21,300**	**23,700**
Water Provider	10,600	12,000	13,400	15,800	17,600
Domestic Well	3,700	4,200	4,700	5,500	6,100
SUPPLY	14,300	16,200	18,100	21,300	23,700
Surface Water	160	160	160	160	160
Effluent	420	370	370	370	370
Groundwater	13,720	15,670	17,570	20,770	23.170
(Less) Incidental Recharge	*(1,900)*	*(2,240)*	*(2,430)*	*(2,760)*	*(3,040)*
(Less) Artificial Recharge	*0*	*(2,380)*	*(3,900)*	*(4,500)*	*(5,100)*
Groundwater net use	*11,820*	*11,050*	*11,240*	*14,040*	*15,560*
INDUSTRIAL					
DEMAND	**1,300**	**1,400**	**1,400**	**1,900**	**1,900**
SUPPLY	1,300	1,400	1,400	1,900	1,900
Effluent	0	0	100	100	100
Groundwater	1,300	1,400	1,300	1,800	1,800
(Less) Incidental Recharge	*(50)*	*(50)*	*(50)*	*(80)*	*(80)*
Groundwater net use	*1,250*	*1,350*	*1,350*	*1,820*	*1,820*
AGRICULTURAL					
DEMAND	**3,800**	**1,400**	**1,400**	**1,400**	**1,400**
SUPPLY-Groundwater	3,800	1,400	1,400	1,400	1,400
(Less) Incidental Recharge	*(1,220)*	*(450)*	*(450)*	*(450)*	*(450)*
Groundwater net use	*2,580*	*950*	*950*	*950*	*950*
TOTAL					
Total Water Demand	**19,400**	**19,000**	**20,900**	**24,600**	**27,000**
Groundwater net use	*15,650*	*13,350*	*13,540*	*16,810*	*18,330*

Note: Demand estimates based on assumptions in ADWR, 2005. Agricultural demand adjusted from ADWR, 2005 using USGS acre-foot/acre demand assumptions and assumed 32% incidental recharge.

Figure III-1 Sierra Vista Subwatershed Demand by Sector 2000-2030

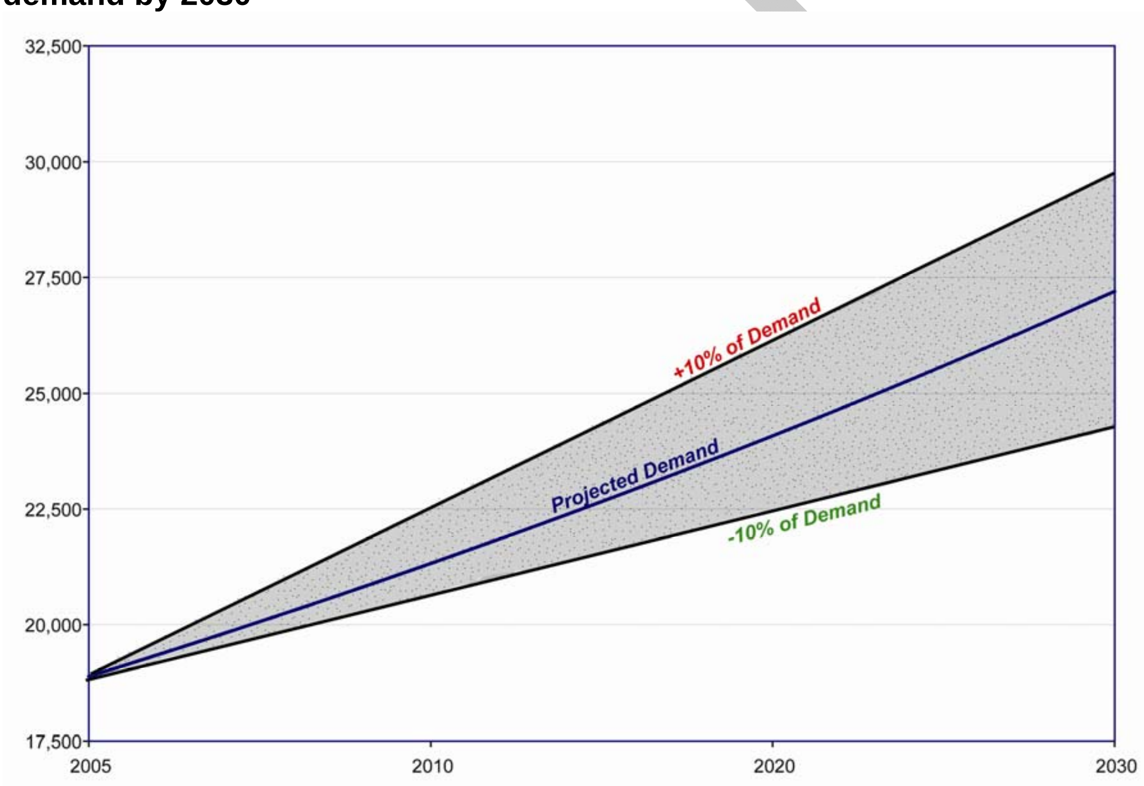


Water returns to the aquifer after use, primarily from septic systems, golf course and park irrigation and from effluent discharge from wastewater treatment plants. This return to the aquifer is referred to as incidental recharge. Artificial recharge is water that returns to the aquifer through an underground storage facility, usually through a specially constructed recharge basin. Almost all water that returns to the aquifer through incidental and artificial recharge originates from groundwater withdrawal and use and offsets some of the groundwater demand. The groundwater demand that is not offset is referred to as “net use” groundwater in Table III-2.

As population increases, the volume of incidental recharge will increase. Effluent production will also increase with population growth. The volume of effluent recharged to the aquifer is planned to increase to over 5,000 acre-feet a year by 2030. Effluent is recharged to the aquifer at two facilities in the subwatershed. In 2005, approximately 2,380 acre-feet of effluent was recharged at Fort Huachuca and at the Sierra Vista Recharge Facility (USGS, 2007). Fort Huachuca has entered into an agreement with Huachuca City to receive and treat its wastewater, which will then be recharged at the Fort’s recharge ponds. The proportion of water returned to the aquifer as either incidental recharge or artificial recharge increases through 2010, so that net use groundwater in 2010 is almost the same as in 2005 even though total demand increases.

There is a degree of uncertainty in population and water demand estimates and projections which must be considered in water resource planning. U.S. Census counts provide an accurate population estimate every ten years, but growth in intercensal years must be estimated, and projections may vary widely from actual growth. In addition, projections are adjusted each year based on current conditions. For example, when the Department conducted its review of the Upper San Pedro Basin to determine if it met the statutory criteria to designate the basin as an active management area (AMA) (ADWR, 2005), the Arizona Department of Economic Security (ADES) official population projections predicted that in 2010 the population of the Sierra Vista subwatershed would be approximately 76,500 residents. As shown in Table III-1, by 2005 the estimated population of the area had already exceeded the 2010 projection. New ADES population projections predict 20% more residents in 2020 and 24% more residents in 2030 than the projections used in the ADWR (2005) report. Since population drives the municipal, and to some extent the industrial, demand estimates, it is important to consider a range of possible outcomes. Figure III-2 illustrates two possible demand scenarios: one at 110% of the baseline projection by 2030 and another at 90% of the baseline projection.

Figure III-2. Sierra Vista Subwatershed projected demand and 10% variations on demand by 2030



<u>*a. Water Provider demands and withdrawals*</u>

Municipal demand served by a water provider accounted for approximately 74% of the total municipal demand in 2005. It is assumed that the proportion of the population served by a water provider will remain the same in the future. The proportion could change if future growth occurs primarily in more densely zoned areas served by a water provider compared to large lot subdivisions where individual domestic (exempt) wells are the typical source of water.

There are a number of water systems in the subwatershed, but only eight serve over 250 acre-feet of water a year and only two, Huachuca City and Tombstone, are public systems. Water providers are required to report annual water use information to the Department. Water provider demand was approximately 12,000 acre-feet in 2005 and is projected to increase to 17,600 acre-feet in 2030 assuming a constant use rate of 164 gallons per capita per day. Almost all municipal demand is met with groundwater. Approximately 160 acre-feet of surface water is diverted annually from springs in the Huachuca Mountains and conveyed through a gravity feed pipeline to the City of Tombstone. Approximately 400 acre-feet of effluent is used by Fort Huachuca for turf irrigation.

Much of the water provider service areas located within incorporated areas are served by a centralized sewer system. In unincorporated areas, septic tanks are the norm and contribute to incidental recharge.

<u>*b. Exempt well demands and withdrawals*</u>

Exempt (domestic) wells typically serve one or several large residential lots and account for approximately 26% of the municipal water demand in the subwatershed. These wells are equipped with relatively small pumps that withdraw water for household, irrigation and stock watering purposes. Within the state's AMAs, exempt wells are defined as those equipped with pumps that pump 35 gpm or less and are exempt from regulations that apply to larger wells. The term "exempt well" is commonly used statewide.

Regardless of their location in the state, owners of exempt wells are not required to meter or report water pumpage, so exempt well demand and withdrawals must be estimated. Reported exempt well estimates vary widely and may include assumptions about indoor use, outdoor watering, pasture irrigation and stock use. Some of the annual estimates that have been used in Arizona vary from 0.17 acre-feet/person (ADWR, 1991) to 1 acre-foot per well (Ten Eyck, 1994). ADWR (2005) assumed .35 acre-feet/person per year for the Sierra Vista subwatershed. This use rate was applied to the estimated population not served by a water provider, resulting in an estimated demand of 4,200 acre-feet in 2005, increasing to 6,100 acre-feet in 2030. This estimate includes an assumption that the same proportion of the population will be served by exempt wells as were served in 2000 and a constant water use rate.

Lots served by exempt wells are typically one-acre in size or larger and lack sewer service. Incidental recharge from septic systems serving these lots accounts for approximately 40% of the total municipal incidental recharge.

A.2. Land Use and Zoning Impacts

In the Sierra Vista Subwatershed land use regulation can be delineated into three categories; unincorporated areas, incorporated areas and federal land. Subwatershed local governments have approved a number of ordinances and plans that influence water use.

On March 21, 2006 the Cochise County Board of Supervisors adopted the Sierra Vista Sub-watershed Water Conservation and Management Policy Plan (Plan) to guide development in the unincorporated areas of the subwatershed.[1] According to the Plan, development density will be no greater than one unit per acre unless the subdivider incorporates water saving measures that mitigate any increase in usage over the current zoning, and effluent is recharged or densities are transferred from elsewhere in the sub-basin. The Plan also prohibits increasing densities within two miles of the SPRNCA. (USGS, 2007)

Many of the Plan's policies are carried out through the Sierra Vista Sub-watershed Overlay District and other changes to the code that went into effect on January 5, 2007. The overlay district provides water use restrictions, in addition to those already required in the county, on new development within the subwatershed; it does not change the underlying zoning.[2] (Cochise County Code § 1802.2) Concurrent with the passage of the overlay district, the Cochise County zoning regulations were amended to encourage transfer of development rights from the area within two miles of the SPRNCA boundary and one mile of the Babocomari River to other portions of Cochise County. (Cochise County Code § 2208.3)

In addition to the Plan there are two area plans that may influence land use; Southern San Pedro Valley Area Plan (SSPVA) adopted in 2001, and the Babocomari Area Plan (BAP) adopted in 2005. (See Figure III-3) The SSPVAP does not include additional water restrictions. It does indicate a preference for large (four-plus acre) lots for residential development except in areas where a higher density is already present. (Cochise County, 2001) The BAP indicates that future upzoning should not increase groundwater withdrawals beyond the current assumed impact of one unit per four acres. The plan also discourages new wells in the 100-year floodplain of the Babocomari River. (Cochise County, 2005)

Water use restrictions in the incorporated areas of the subwatershed are similar to those in Cochise County. The City of Sierra Vista first incorporated water conservation into their zoning code in 1985 and its current code is more restrictive than the Sierra Vista Sub-watershed Overlay District. The City of Bisbee also incorporates water conservation into its zoning code. Bisbee's restrictions are comparable to that of Cochise County.

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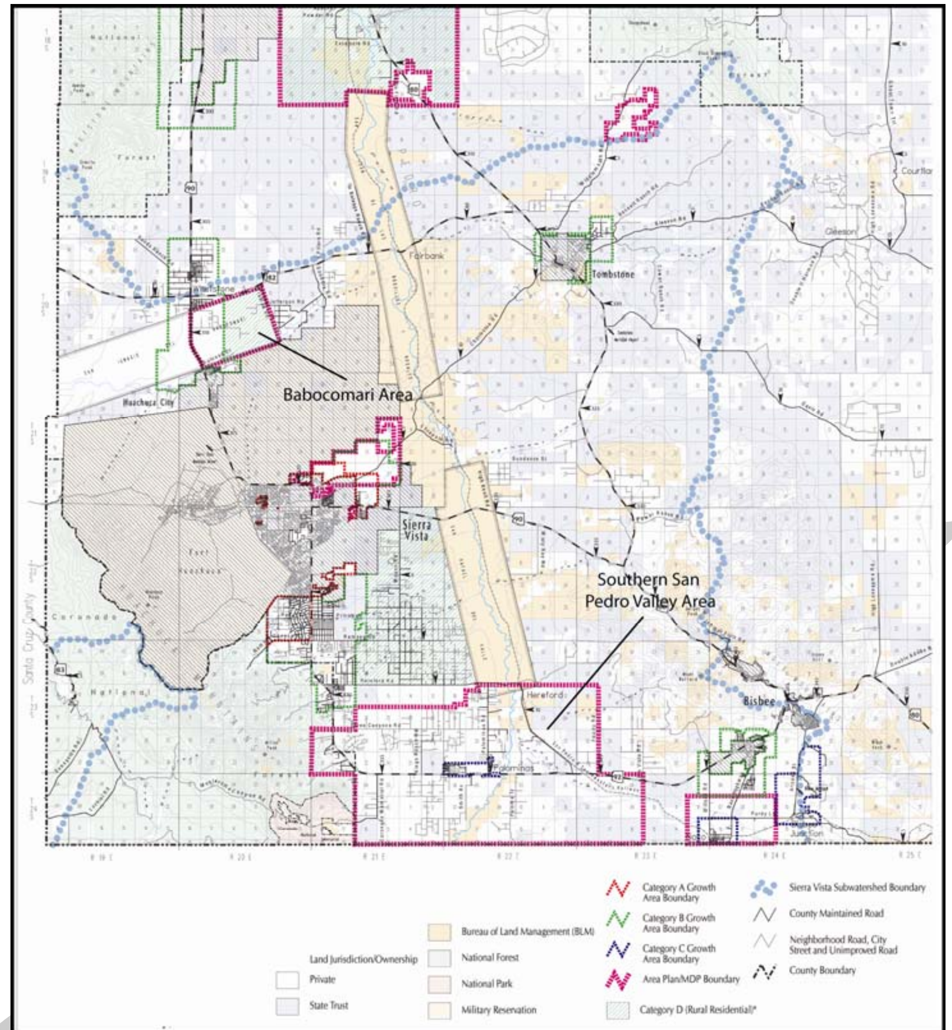
[1] The Cochise County Comprehensive Plan also includes a Water Conservation Goal and Policies section. This portion of the Comprehensive Plan is almost identical to elements within the Sierra Vista Sub-watershed Water Conservation and Management Policy Plan, however, the Comprehensive Plan applies to all Cochise County.

[2] Examples of the overlay conservation requirements include: gray water plumbing in all new construction, humidity sensors on any new installation or replacement of outdoor sprinkler systems and a moratorium on decorative water features not fed solely by rainwater.

Principal federal land holders within the subwatershed are the United States Department of Defense (DOD) and the Bureau of Land Management (BLM). The majority of the BLM land in the subwatershed is within the SPRNCA and must be managed to protect and enhance the desert riparian ecosystem. DOD lands are within Fort Huachuca, which in order to maintain its viability as a military installation has implemented strict water conservation policies and reduced water use by almost 45% since 1993. (ADWR, 2005)

Although existing land use code and policy may serve to limit impacts to the San Pedro River within the subwatershed, uncertainties remain. Current land use controls are limited to conservation measures and lower densities, which do not prevent growth and concomitant water use; they only decrease the impact of future growth. Furthermore, many of the most progressive policies, such as the prohibition of increased densities within two miles of the SPRNCA boundary, are part of the county's Comprehensive Plan, which does not change underlining zoning but serves as a guide for making decisions on land use changes. A shift in political and/or economic climate could weaken the influence of such plans on land use decisions. Looking forward it is more likely that polices and regulations will become more, not less, stringent. For example, a survey conducted as part of Cochise County's Comprehensive Plan update found that one-half of all respondents identified water availability as one of the biggest challenges in the next decade. In this same study 48% of respondents indicated that not enough is being done in Cochise County to protect water resources. (FMR Associates Inc., 2007)

Figure III-3 Excerpt from the Cochise County Comprehensive Plan Map



Source: Cochise County Comprehensive Plan, 2006

Another element of uncertainty is how much growth will occur on lands near the river. At this time the majority of land within four miles of the San Pedro River is zoned one unit per four acres in the unincorporated areas and one unit per acre in Sierra Vista. Although these areas would have relatively low density development, the combined impact on water use at build out could be significant.

A.3. Projected Industrial Demands

Industrial demand is primarily from sand and gravel operations and golf courses not served from municipal wells. Industrial demand is a relatively small component, 7%, of the total demand in the subwatershed. Historically, the industrial sector used groundwater exclusively. Beginning in 2009, the Turquoise Valley Golf Course will begin receiving approximately 100 acre-feet of effluent annually from the City of Bisbee San Jose Wastewater Treatment Facility. Industrial demand is likely to increase with the anticipated construction of an additional golf course and increased activity at sand and gravel facilities to support construction of housing and roads. Recent increases in copper prices spurred interest in evaluating the feasibility of reactivating the Bisbee mine, but increased metal mining demand was not assumed in the demand projections.

A.4. Projected Agricultural Demands

By 2008, much of the irrigated lands in the subwatershed had been retired, leaving about 300 actively irrigated acres. Farming activities are small, family-run operations and crops are typically pasture and orchards. Irrigation of wine grapes occurs in the Elgin area, with modest increases in planted acres. However, while this area is inside the subwatershed, it is outside the proposed District boundaries. While there are no restrictions on agricultural irrigation in the subwatershed, current growth is within the municipal sector and agricultural demand is anticipated to remain limited in the future, declining to about 5% of the total demand by 2030.

III.B. IMPACTS OF ADJUDICATION ON GROUNDWATER WITHDRAWALS

The Gila River Adjudication, which includes the San Pedro River Watershed, is a legal proceeding to determine the nature, extent, and relative priority of surface water rights within the river system. An important adjudication issue is whether the water withdrawn from wells is appropriable subflow. The Department is currently developing subflow zone maps for the watershed, including the area of Upper San Pedro Water District that will be used by the adjudication court to determine which wells are within its jurisdiction. Once this jurisdiction is established, the court may need to regulate the amount of water pumped from some wells to protect existing surface water uses.

III.C. IMPACTS OF DROUGHT AND CORRESPONDING NATURAL RECHARGE

Natural recharge to the subwatershed is from mountain front recharge, stream channel recharge and cross-border flux from Sonora to Arizona. Mountain front recharge includes baseflow and underflow into the subwatershed. The total estimated natural recharge is approximately 18,000 acre-feet per year (Corell and others, 1996).

Precipitation generally occurs during two periods. Summer precipitation (June-October) is typically several inches greater than the winter season (November-February). The snow fraction is usually a relatively insignificant contribution of the total annual precipitation (ADWR, 2005). Pool and Coes (1999) noted that trends in seasonal precipitation at four stations in the subwatershed showed a general trend of increasing winter precipitation and decreasing wet-season (summer) precipitation during the period 1956-1997. Winter precipitation is more hydrologically efficient because there is less runoff, less evaporation and greater gain to streams. However, recent investigations suggest that flood flows from summer rainfall may be a larger contributor to recharge than previously thought.

Annual precipitation decreased by 13% and summer precipitation decreased by 26% during the period 1913-2002 (Thomas and Pool, 2006). Summer streamflow decreased by 85% during this period but factors other than precipitation, particularly changes in riparian vegetation, were likely major factors in decreasing trends.

In early July of 2005, the San Pedro River ran dry at the Charleston gage for the first time; a condition that persisted for 10 days. The gage has been in continuous operation since 1935. This area typically has perennial flow due to impervious bedrock close to the land surface. Possible causes were delayed onset of the monsoon (the second latest in recorded history), ongoing drought, riparian demand and groundwater pumping. Flow at this gage almost ceased in both 2006 and 2007 prior to the onset of the monsoon.

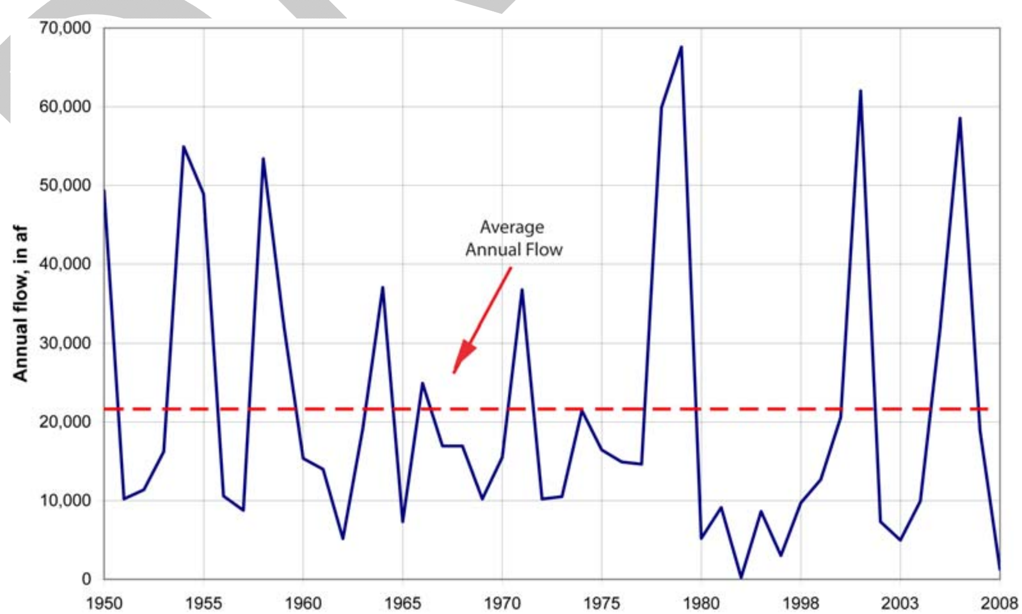
During the 2002-2005 time-period when drought conditions were extreme, there were reports of water level declines in some shallow, drought-sensitive domestic wells located along the base of the Huachuca mountains.

[Waiting for additional drought impact information from CLIMAS]

III.D. IMPACTS OF REDUCED UNDERFLOW FROM MEXICO

Cross border groundwater flux into the subwatershed is estimated to be approximately 3,000 acre-feet a year (Corell and others, 1996). Long-term data at the Palominas gage, the streamgage on the San Pedro River closest to Mexico, shows significant declines since 1950 (see Figure III-4). The impact of Mexican water demand on inflows to the United States has been largely unquantified. A recently completed groundwater flow model of the Sierra Vista subwatershed and Sonoran portions of the Upper San Pedro Basin (Pool and Dickinson, 2007) can be used to assess the impacts of increasing groundwater withdrawals in Mexico on groundwater flow. The United States-Mexico transboundary aquifer assessment program (TAAP) being implemented as a result of Public Law 109-448 should provide additional information on transboundary aquifer conditions in the Upper San Pedro Basin.

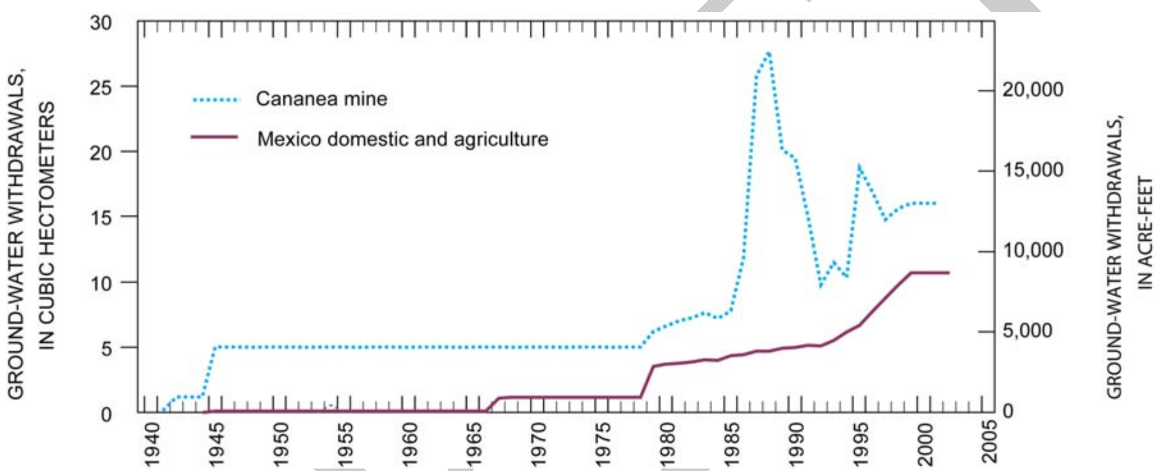
Figure III-4 Annual Flow at the San Pedro River near Palominas USGS Streamgage (#9470500)



Source: USGS, 2008

The Pool and Dickinson model uses withdrawal estimates reported by Esparza (2002) for the Mexican portion of the Upper San Pedro Basin. These estimates are reported as mine and non-mine uses as shown in Figure III-5. Mine uses in Cananea (which may include the City of Cananea) increased significantly during 1986-2002 from historic levels and ranged from 9,700 to 21,800 acre-ft/year. Recent use appears to be approximately 13,000 acre-feet/yr. Groundwater is withdrawn from numerous wells that tap the basin fill across a wide area. Agricultural and domestic groundwater use was estimated at 8,100 acre-feet per year during 1999-2002; an increase from 2,800 acre-feet/year in 1980 (Esparza, 2002).

Figure III-5 Groundwater withdrawals in the Sonoran portion of the Upper San Pedro Basin (modified from Pool and Dickinson, 2007)



The Cananea mine has been in production since the early 1900's and has the third largest copper deposit in the world. Almost 164,000 tons of copper were produced in 2006. Expansion of mine production has been proposed, which would increase well pumpage and potentially affect underflow from Mexico to the United States.

Reportedly, the municipality of Cananea, with a population of 32,000 receives most of its water supply from the Rio Sonora Basin (Liverman and others, 1997). Naco, Sonora has approximately 5,300 residents, which can increase to 7,000, counting transient workers waiting to cross into the United States (Browning-Aiken and others, 2003).

Approximately nine ejidos, or communal agricultural settlements, are dispersed across the Mexican portion of the region (Browning-Aiken and others, 2003). Liverman and others, (1997) estimated that approximately 3,460 acres were irrigated using surface water from the San Pedro River diverted through a ditch and small reservoir system. Total surface water demand was estimated at about 5,000 acre-feet a year for irrigation of cattle pastures. Trends in surface water withdrawals for agricultural use are not known.

Based on historic groundwater withdrawals, combined domestic and agricultural demand has been relatively stable in the last few years but demand is likely to increase in the future as population increases and agricultural activities continue. Increasing groundwater pumping may impact groundwater inflow to the United States.

III.E. CONCLUSIONS

Population growth will likely be the primary factor affecting future demand in the subwatershed. Demand is expected to increase by approximately 8,000 acre-feet, to 27,000 acre-feet by 2030. The magnitude of the increase will vary depending on the actual rate of population growth, implementation of conservation or zoning measures that affect demand, and unanticipated changes in the agricultural or industrial sectors. Current land use controls, while progressive, only decrease the impact of future growth and many of the most progressive policies are part of the county's Comprehensive Plan, which does not change underlining zoning. However, it is likely that future planning and zoning policies and regulations will become more, not less strict.

The amount of net use groundwater will also increase with growth by approximately 5,000 acre-feet by 2030. This volume may vary due to changes in demand, the amount of water recharged to the aquifer, or changes in effluent or surface water use. For example, if residences currently on septic systems are connected to centralized wastewater collection and treatment facilities, this resource, rather than groundwater, could be used to water parks and golf courses in the future and there would be a reduction in incidental recharge.

The location of future demand will affect groundwater levels and flows in the San Pedro River. If future groundwater pumpage is concentrated near the existing cone of depression in Sierra Vista, the cone will deepen and the rate of decline may increase. Alternatively, dispersal of pumping to multiple sites may lessen localized impacts. Much of the area immediately near the San Pedro River is closed to pumping because of the SPRNCA, but it is clear that the closer pumping is to the river, the more immediate are impacts on flow. Existing land use code and policy may limit impacts but uncertainties remain. Most land within four miles of the River is zoned for relatively low density development; however the combined impact at build out could be significant.

A relatively unknown variable is the impact of Mexican pumping on cross border flux and flows in the San Pedro River. New studies should provide more information and tools to estimate demand and impacts, but there are limited opportunities to influence demand in Mexico. Finally, drought and long-term climate change will likely impact water resources and river flow in the subwatershed. While it is not possible to control this variable, mitigation measures may be undertaken to minimize risk.