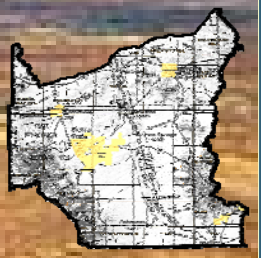
Upper San Pedro Water District



Comprehensive Water Resources Draft Plan

APPENDIX

July 27, 2009

APPENDIX A

San Pedro River, Legal and Institutional Framework

A1. Importance of San Pedro River Flow
A2. Interaction of Surface Water and Groundwater
1. Surface Waters
    a. San Pedro River
    b. Babocomari River
    c. Other Tributaries
2. Groundwater Aquifers and Recharge Conditions
3. Wells, Groundwater Depletions, and Baseflow
    a. Wells

A3. Legal Framework for Dealing with Water Rights
1. Surface Water
2. General Stream Adjudication
3. Groundwater Regulation
4. Sub-Flow Decision: Interaction of Surface Water and Groundwater Law
5. Arizona Water Settlement Act
6. Water Adequacy Rules
7. ESA and Environmental Law
8. Federal Law PL 100-696 SPRNCA
9. Federal Law PL 108-136 Section 321

A4. Institutional Framework
1. Federal Agencies
    a. United States Department of Defense
    b. The Bureau of Land Management
    c. The United States Geological Survey
    d. The Bureau of Reclamation
2. State of Arizona
    a. The Arizona Department of Water Resources
    b. The Arizona Department of Environmental Quality
    c. The Arizona Corporation Commission
3. Cochise County
    a. The Cities and Towns of Sierra Vista, Huachuca City, Tombstone, and Bisbee
    b. The Upper San Pedro Partnership
    c. Other Non-Governmental Organizations

DRAFT

A.1 Importance of San Pedro River Flows

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 proposed Upper San Pedro Water District (Proposed 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 as the first riparian national conservation area in the nation. The enabling legislation for the SPRNCA requires the Bureau of Land Management "to protect, enhance and maintain 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). The SPRNCA boundaries encompass 56,431 acres and define a corridor along the San Pedro River that extends about 35 miles north from the international boundary with Mexico, and is up to 5 miles wide. The SPRNCA also includes the lower reach of the Babocomari River. (See Figure 2)

Sixteen plant and animal species currently found in the Proposed District are at risk including 10 endangered species, 3 threatened species, and 3 candidates for federal listing. Critical habitat within the District, however, has only been designated for the Huachuca Water Umbel (See Figure 1). 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.

Figure 1
Huachuca Water Umbel

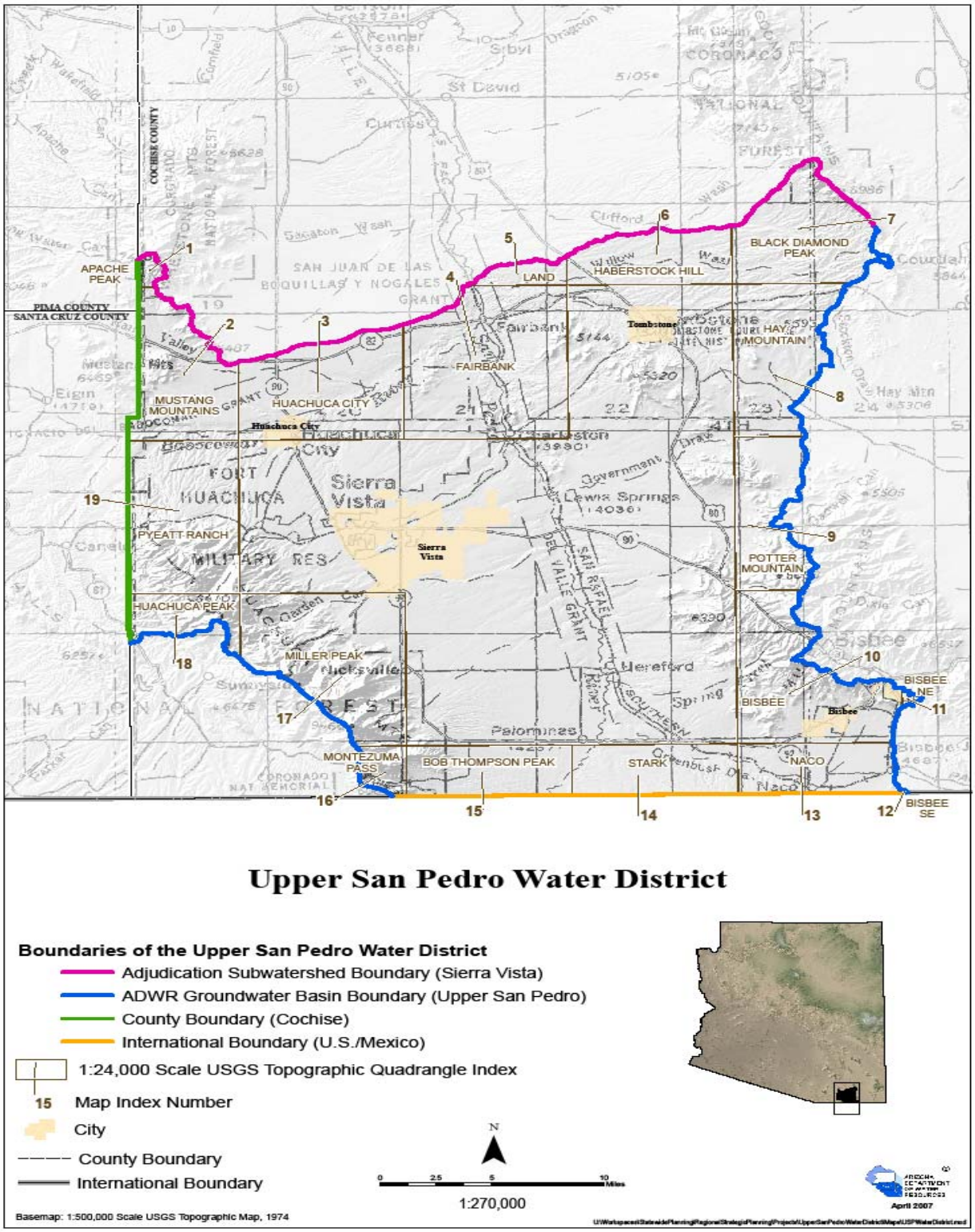


Figure 2 Proposed District Boundaries

TABLE 1. SPECIES AT RISK IN THE WATER DISTRICT

ESA STATUS	COMMON NAME	SCIENTIFIC NAME	HABITAT(S)
Endangered	California brown pelican[2]	*Pelecanus occidentalis californicus*	Riparian, wetland
	Canelo Hills ladies' tresses	*Spiranthes delitescens*	Riparian, wetland
	Colorado pikeminnow	*Ptychocheilus lucius*	Aquatic
	Desert pupfish	*Cyprinodon macularius*	Aquatic
	Gila chub	*Gila intermedia*	Aquatic
	Gila topminnow	*Poeciliopsis occidentalis occidentalis*	Aquatic
	Huachuca water umbel	*Lilaeopsis schaffneriana* var. *recurva*	Aquatic, riparian, wetland
	Jaguar	*Panthera onca*	Riparian, desert scrub to sub-alpine forest
	Lesser long-nosed bat	*Leptonycteris curasoae yerbabuenae*	Desert scrub to woodland
	Northern aplomado falcon[3]	*Falco femoralis septentrionalis*[3]	Riparian, grassland to woodland[3]
	Ocelot	*Leopardus* (=*Felis*) *pardalis*	Riparian, desert scrub to woodland
	Razorback sucker	*Xyrauchen texanus*	Aquatic
	Sonora tiger salamander	*Ambystoma tigrinum stebbinsi*	Aquatic, riparian, wetland, grassland
	Southwestern willow flycatcher	*Empidonax traillii extimus*	Riparian, wetland
Threatened	Bald Eagle	*Haliaeetus leucocephalus*	Riparian
	Chiricahua leopard frog	*Rana chiricahuensis*	Aquatic, riparian, wetland
	Loach minnow	*Tiaroga cobitis*	Aquatic
	Mexican spotted owl	*Strix occidentalis lucida*	Riparian, woodland
	Spikedace	*Meda fulgida*	Aquatic
Candidate	Huachuca springsnail	*Pyrgulopsis thompsoni*	Aquatic, riparian, wetland
	Lemmon fleabane	*Erigeron lemmonii*	Woodland
	Yellow-billed cuckoo	*Coccyzus americanus*	Riparian, desert scrub to woodland

A2. Interaction of Surface Water and Groundwater

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 rain 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 rain (See Figure 3).

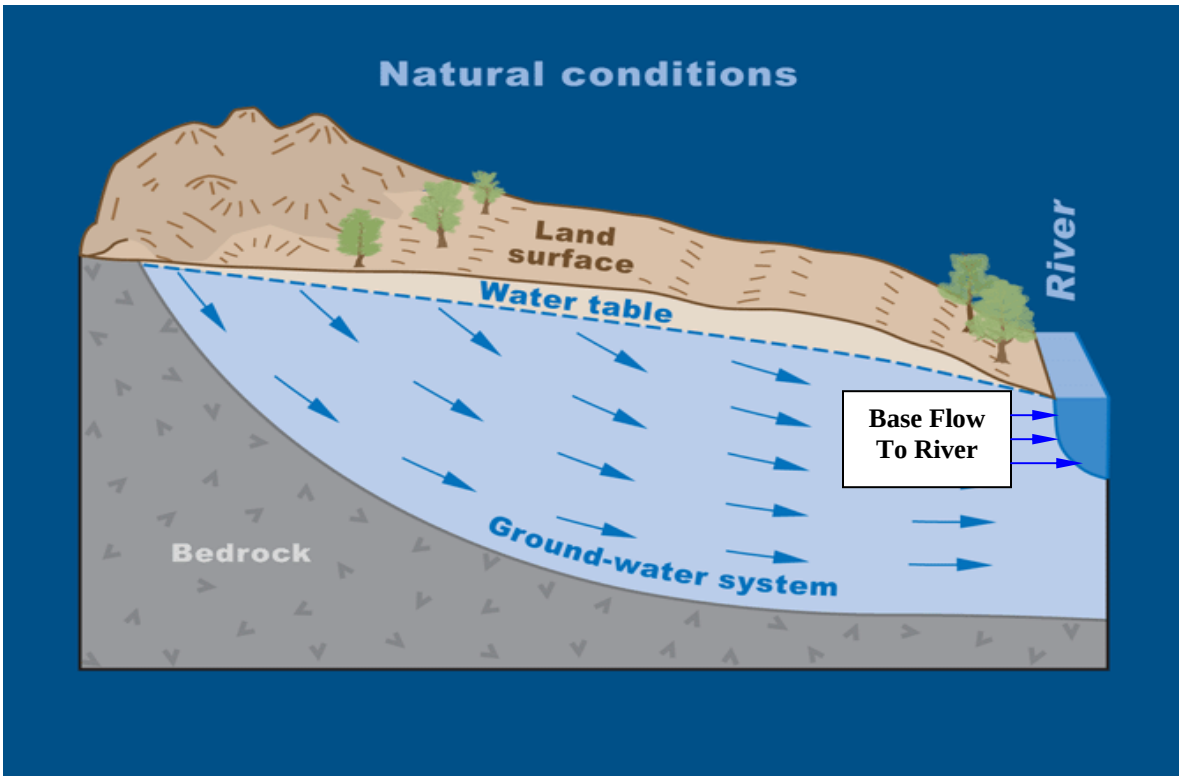


Figure 3 – Cross Section Depicting Base Flow – (USGS)

The presence and duration of baseflow and storm flows is used to characterize the streamflow in sections of a river. Perennial stream sections display baseflow throughout the year, while intermittent stream sections 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 sections are above the water table and, therefore, only flow during or shortly after storm events from runoff.

Along the San Pedro and Babocomari Rivers in the Proposed District, 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. Water from storm runoff

infiltrates the sands and gravels adjacent to the river, and then slowly drains back to the river creating a portion of the baseflow. This type of drainage back to the river has been estimated to be 55 to 80% of the baseflow. (Baillie and others, 2007). The remaining baseflow in these streams consists of water discharged from the regional, basin fill aquifer.

a. San Pedro River

Streamflow records are available from seven U.S. Geological Survey (USGS) gages located in the Proposed District along the San Pedro River (See Table 2 and Figure 4). Runoff from monsoonal storms creates most of the streamflow in this section of the river from mid-June to mid-October, while baseflow is predominantly the source of water for streamflow during the rest of the year. Baseflows are relatively constant along the Upper San Pedro River from December through March, but decrease during April through June when higher temperatures increase evapotranspiration and irrigation demands.

The San Pedro River is currently intermittent to perennial within the proposed District, with perennial sections occurring most frequently between Palominas and Charleston (See Figure 5a and 5b). Baseflows along this section 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 sections are now intermittent. In June of 2005 the streamflow of the San Pedro River measured at the USGS gaging station near Charleston ceased entirely for the first time since the gaging station had been installed in 1935. The streamflow very nearly ceased again at the USGS gaging station near Charleston when it measured a low of 0.01 cubic feet per second (cfs) on June 29, 2006 (USGS, 2007 321Report to Congress). For more information, see Appendix B5.

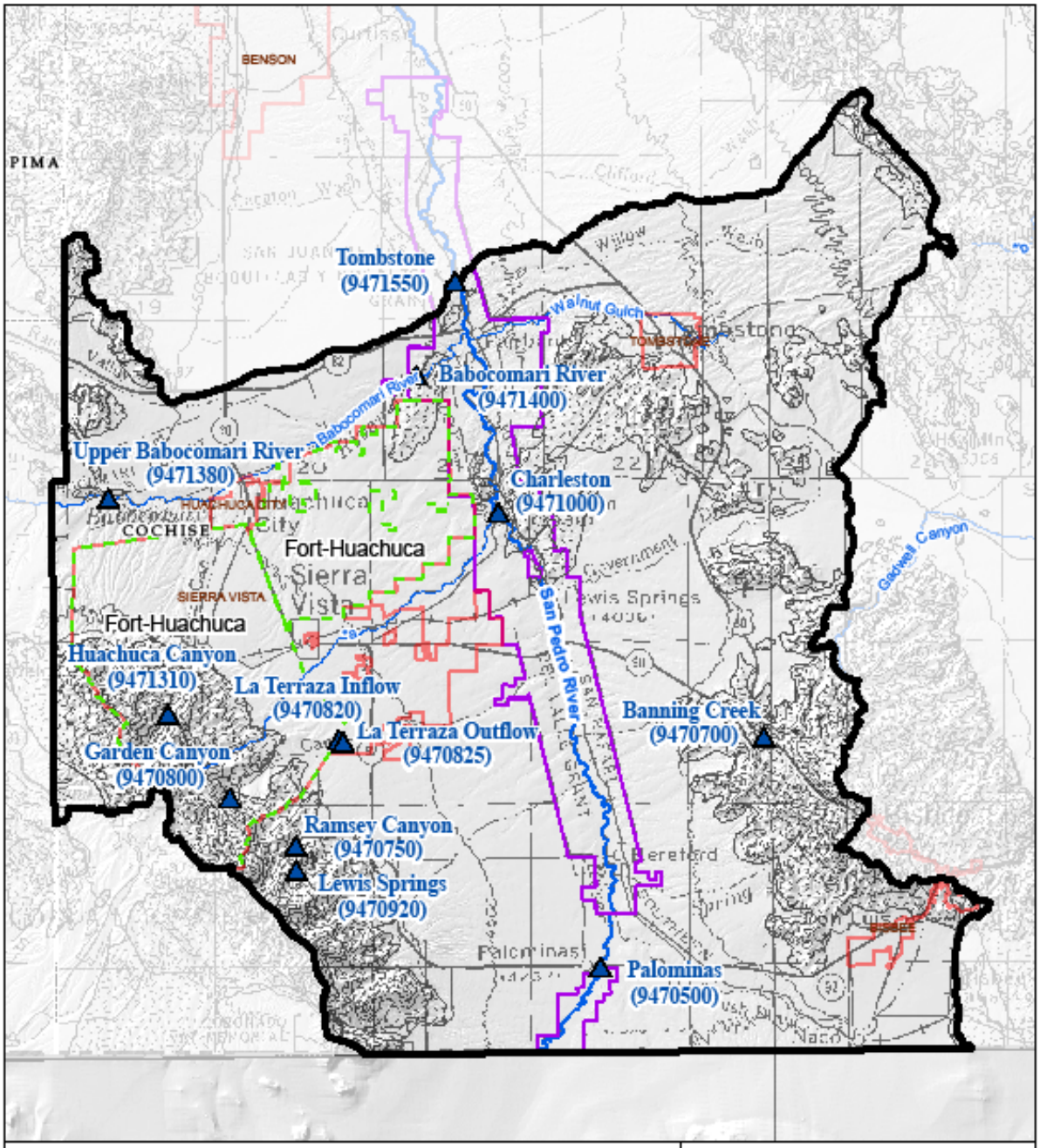
TABLE 2. U.S. GEOLOGICAL SURVEY STREAMFLOW GAGES IN THE DISTRICT

STREAM OR DRAINAGE	STATION NAME / LOCATION	STATION ID	PERIOD OF RECORD	STREAMFLOW REGIME
Babocomari River	near Huachuca City	9471380	2000-2008	Perennial
	near Tombstone	9471400	2000-2008	Intermittent
Banning Creek	near Bisbee	9470700	2001-2008	Ephemeral
Garden Canyon	near Fort Huachuca	9470800	1959-1965, 1993-2008	Intermittent
Greenbush Draw	near Palominas	9470520	2000-2004	Ephemeral
Huachuca Canyon	near Fort Huachuca	9471300	1961-1964	Intermittent
	near Fort Huachuca	9471310	2000-2008	Intermittent
Ramsey Canyon	near Sierra Vista	9470750	2000-2008	Perennial
San Pedro River	at Palominas	9470500	1930-33, 1935-41, 1950-81, 1990-91, 1995-2008	Intermittent
	at Lewis Springs[1]	94709201	1995-2006	Perennial
	at Charleston	9471000	1904-05, 1912-26, 1928-33, 1935-2008	Perennial
	at Charleston (Mesquite transect)	9471040	2001-2002	Perennial
	at Boquillas (U of A transect)	9471070	2001-2002	Perennial
	at Fairbanks	9471500	1926-1928	Perennial
	near Tombstone	9471550	1967-1986, 1996-2008	Intermittent
Walnut Gulch	near mouth[2]	63.0012	1954-2008	Ephemeral

Notes:

[1] Stage measurement only; all others listed are continuous flow gages.

[2] Operated by the USDA Agricultural Research Service, Southwest Watershed Research Center (Stone and others, 2008).



Legend

- Surface Water Gaging Station
- Fort Huachuca
- State Boundary
- Upper San Pedro Water District
- Hardrock
- City
- County

0 2 4 6 8 10 Miles

Figure 4

Upper San Pedro Water District
Water Resources Plan

05/11/2009, \\adwrsas1-phx01.azwater.gov\gis-vns, s:\workspaces\statewideplanning\regionsdistrategicplanning\projects\upperanpedrowaterdistrict\maps\uspwd_report_figures\mxd\fig4_SWGagingStations.mxd

1

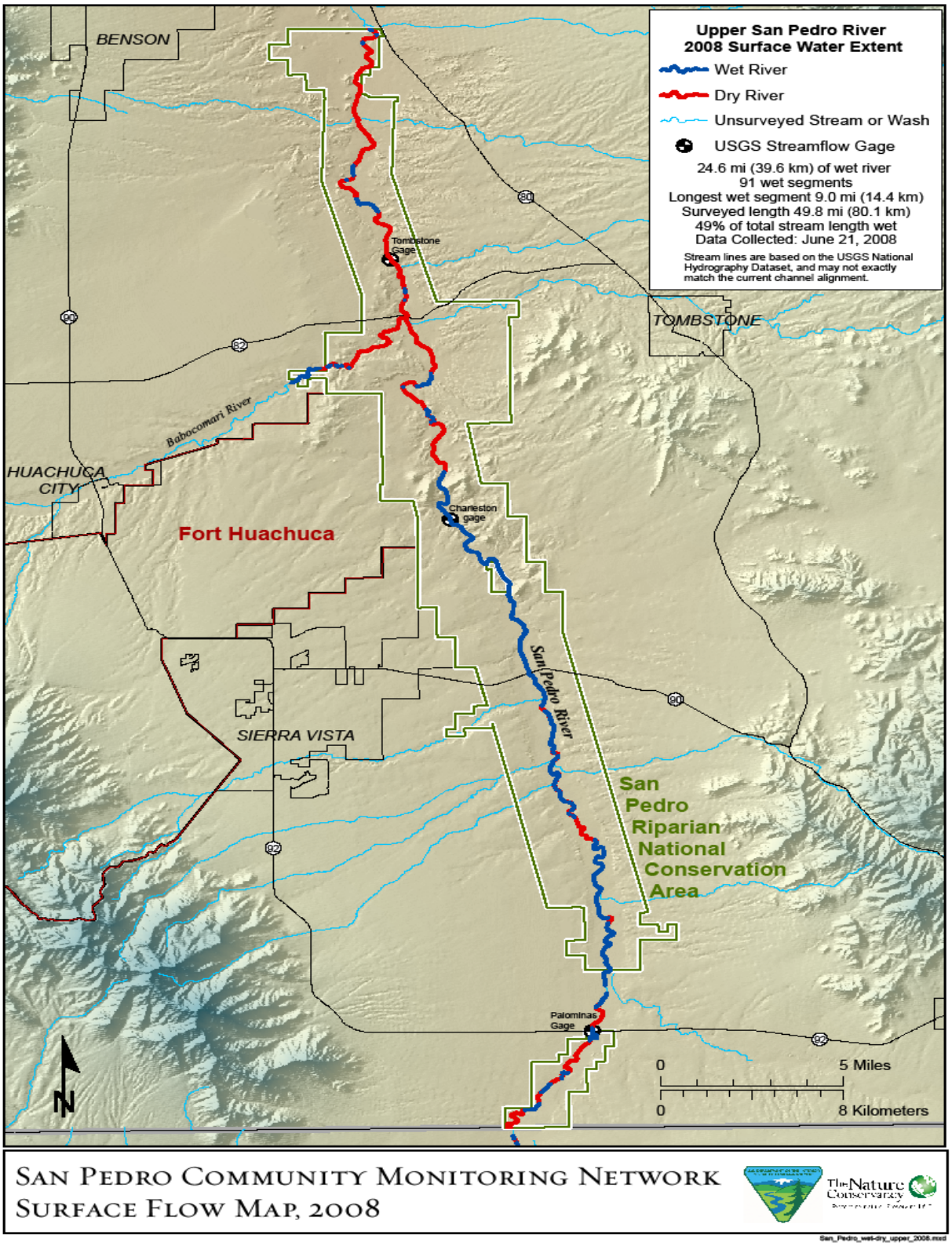


Figure 5a Survey of Wet and Dry Stream Reaches for the San Pedro and Babocamari Rivers within the Sierra Vista Subwatershed (data source: TNC 2008).

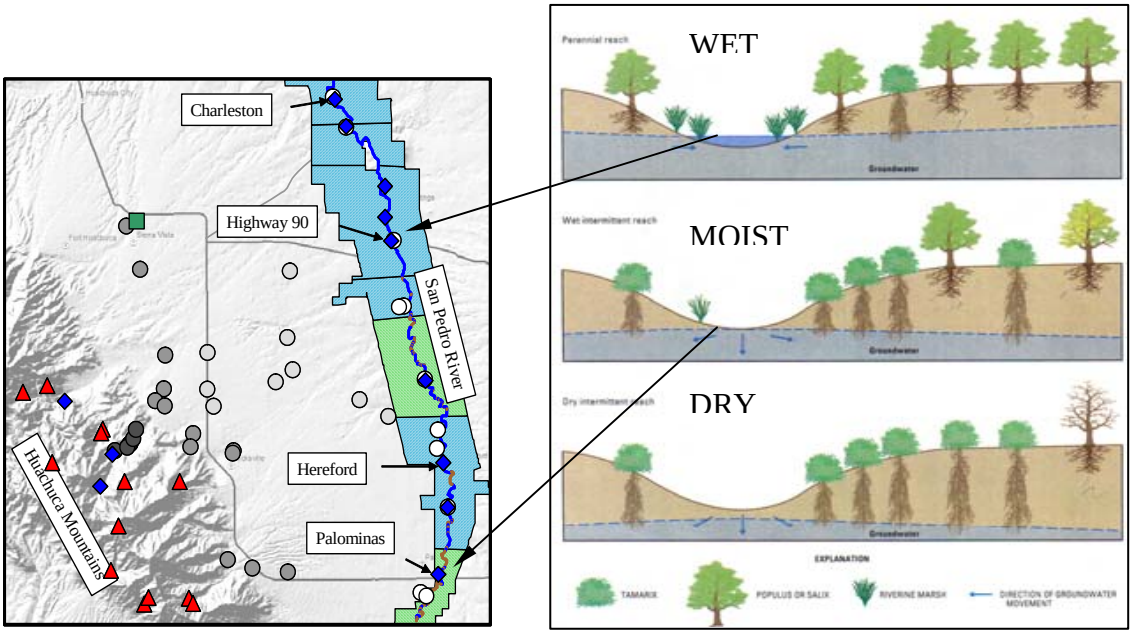


Figure 5b
Schematic Diagram Showing Types of Stream Conditions

b. Babocomari River

The Babocomari River is the largest tributary to the San Pedro River within the Proposed District. Since 2000 streamflow has been measured at two USGS gages (Table 2 and Figure 4). 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 smaller aquifer that contribute to the flow. 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 sections. Like the San Pedro River, the Babocomari River has experienced reduced baseflows in some areas due to natural and human-caused factors.

c. Other Tributaries

Other tributaries to the San Pedro River within the Proposed 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 significant, sustained runoff can occur during the winter and spring as snow melt. Streamflows become increasingly ephemeral at lower elevations, as runoff infiltrates into dry washesl that border the San Pedro River.

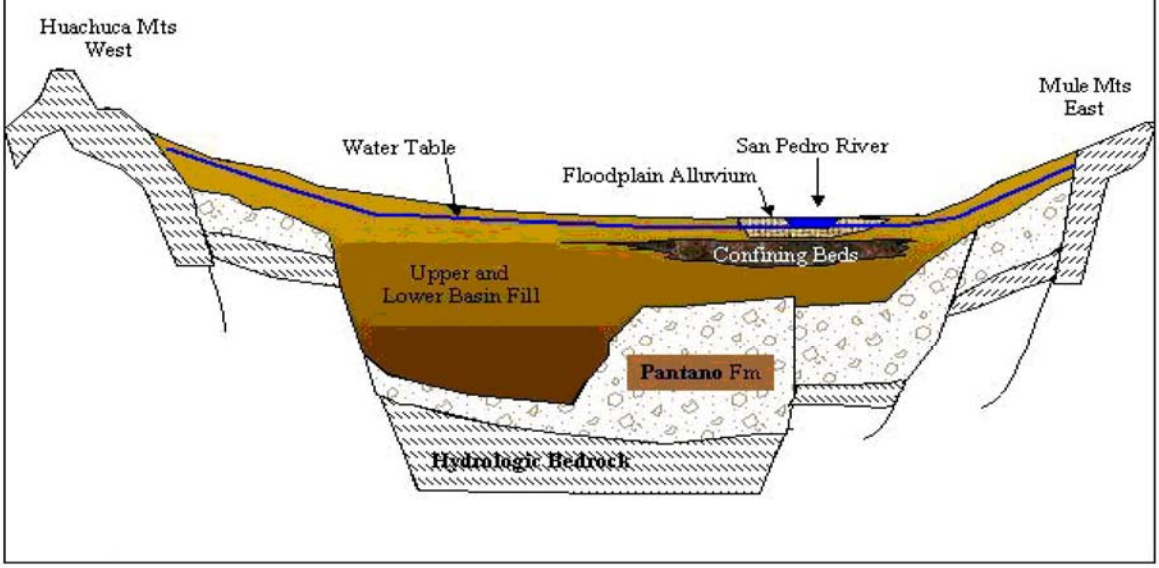
Flows in six of the other tributaries to the San Pedro River have been measured by the USGS since as early as 1959 (Table 2). In addition, 30 stream gages have been operated by the U.S. Department of Agriculture since 1953 within the Walnut Gulch

Experimental Watershed. All stream reaches within the experimental watershed, located east of the San Pedro River, are ephemeral (Stone and others, 2008).

2. Groundwater Aquifers and Recharge Conditions

Three aquifers have been identified in the Proposed District – alluvial, basin fill and bedrock. The alluvial aquifer is composed of recent sands and gravels deposited by the River. The basin fill aquifer is composed of various types of soil, or unconsolidated material, that fills the valley between the mountains. The bed rock underlies the basin fill and may have small amounts of water in fractures. These aquifers have been filled over centuries by mountain front recharge. Figure 6 shows a schematic of a cross section of the Upper San Pedro Valley that depicts the aquifers.

Figure 6: Generalized Geologic cross-section of the Upper San Pedro Water District area



Most recharge to the alluvial aquifer comes from infiltration of streamflow, primarily during storm runoff, and through movement of water from the underlying basin fill aquifer. Some of the water in the alluvial aquifer discharges as baseflow to the river. Some water is also withdrawn by wells for human uses, including stock watering and irrigation. The shallow groundwater aquifer along the river also supports natural vegetation.

The basin fill aquifer underlies the alluvial aquifer. Most natural recharge to the basin fill aquifer occurs along the junction between the mountains and the basin floor (mountain front recharge). The basin fill aquifer also receives artificial recharge from 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 similar to the land surface.

ADWR estimated in 2005 that there was between 19.8 million and 26.1 million acre-feet of water in storage beneath the Sierra Vista subwatershed, a region that covers much of the same area as the proposed District.

3. Wells, Groundwater Depletions and Base Flow

a. Well Permits

The number of wells in the Sierra Vista Proposed District has increased substantially in the last 20 years. The number of small domestic or stock wells (<35 gpm) has increased by over 65% to about 3,480. The number of larger wells (>35 gpm) for municipal and industrial uses has increased by 18% to about 560. In spite of this increase in the number of wells, the conservation programs and effluent recharge and reuse programs initiated by Fort Huachuca, cities, towns, county and others have reduced the overall overdraft.

More water is pumped from the aquifer than is replaced by recharge every year. As a result, the groundwater supplies are being overdrafted. The groundwater overdraft has caused the water levels in parts of the Proposed District to decline, which indicates that the groundwater in storage is being depleted. The depletion is most apparent to the south of Sierra Vista near the mountain front. If the groundwater levels continue to decline in the cone of depression near Sierra Vista, the cone will spread towards the River eventually causing the groundwater levels near the River to decline, which will impact the base flow in the River. Figure 7 illustrates the groundwater declines and the lateral extent of the declines between 2001 and 2006. These declines have been observed for several decades and were documented in the 2005 Upper San Pedro Basin Active Management Area Review Report (ADWR 2005). Figure 8 illustrates the change in groundwater elevations from 1990 to 2004 for specific wells throughout the Proposed District. Figures 9, 10, and 11 are hydrographs that show the change in groundwater elevations over the last 30 years for specific wells designated as J, K, L, N, and R on Figure 8.

Currently, groundwater levels along the River are stable or have risen between 2000 and 2006. Figure 7 illustrates this observation. Also, Figure 7 shows substantial groundwater level rises between the River and Sierra Vista where the City recharges its effluent. These water level rises serve to increase flows to offset and delay some of the long-term impacts of the regional groundwater overdraft.

Figure 12 illustrates the groundwater elevation contours for water level data collected in 2001. Located on Figure 12 are three transects identified as A – A', B – B', and C – C'. Figures 13 (A–A'), 14 (B–B'), and 15 (C–C') depict the groundwater elevation changes for years 1978, 1999, and 2001 along each transect line. It also identifies actual wells measured during those years and their location in proximity to the River.

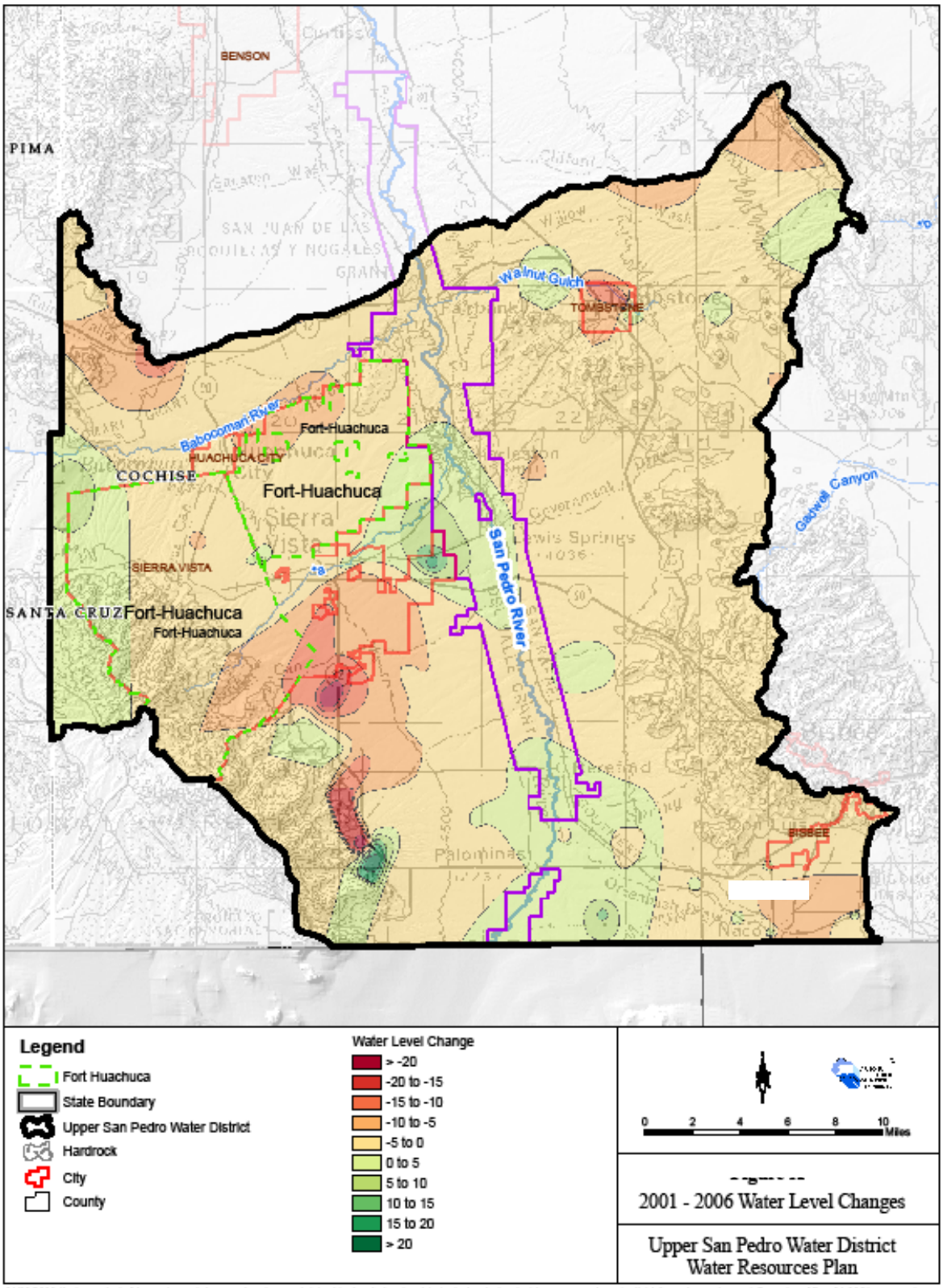


Figure 7 – Water Level Change 2001 - 2006

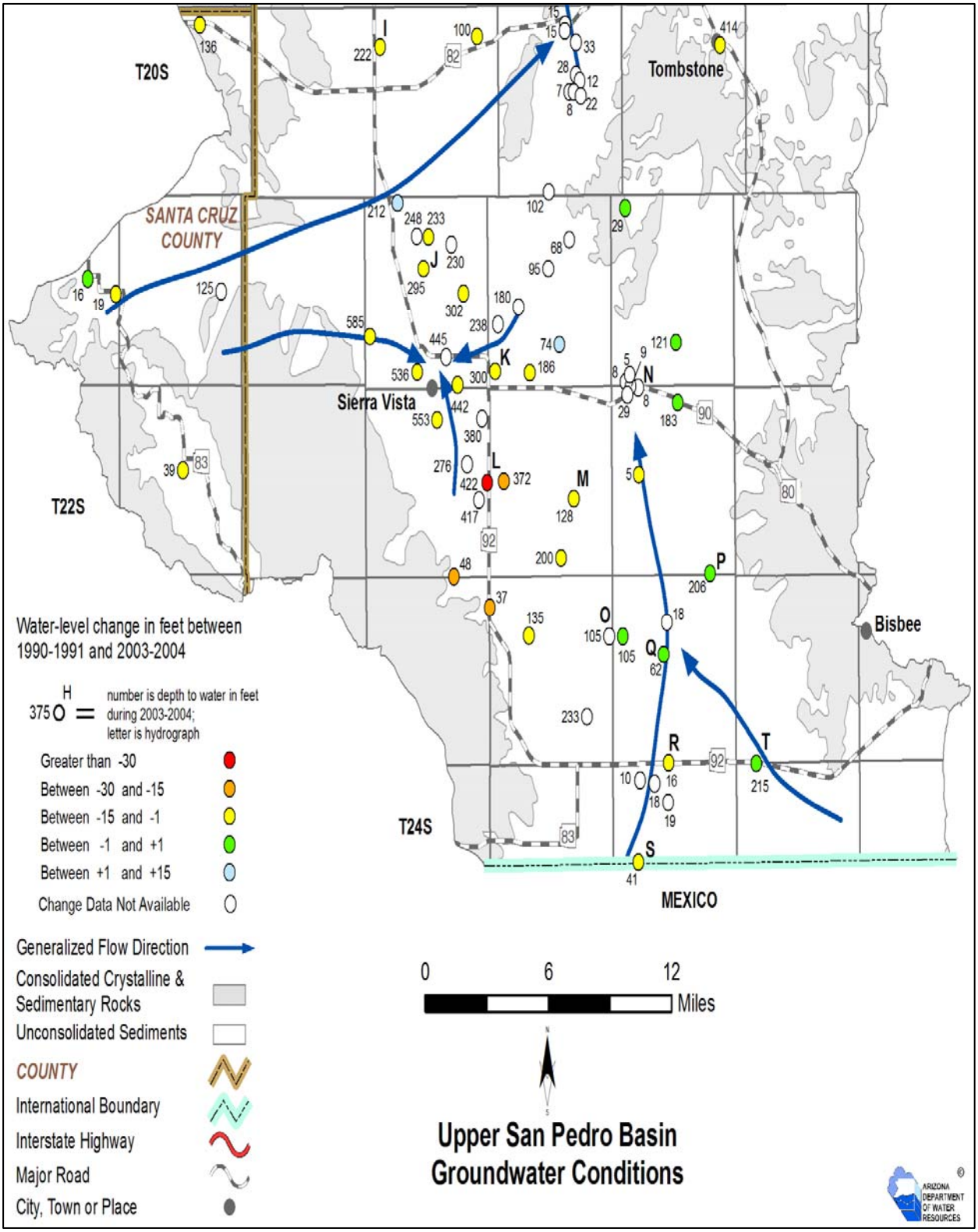


Figure 8 – Water Level Change for Specific Wells 1990 - 2004

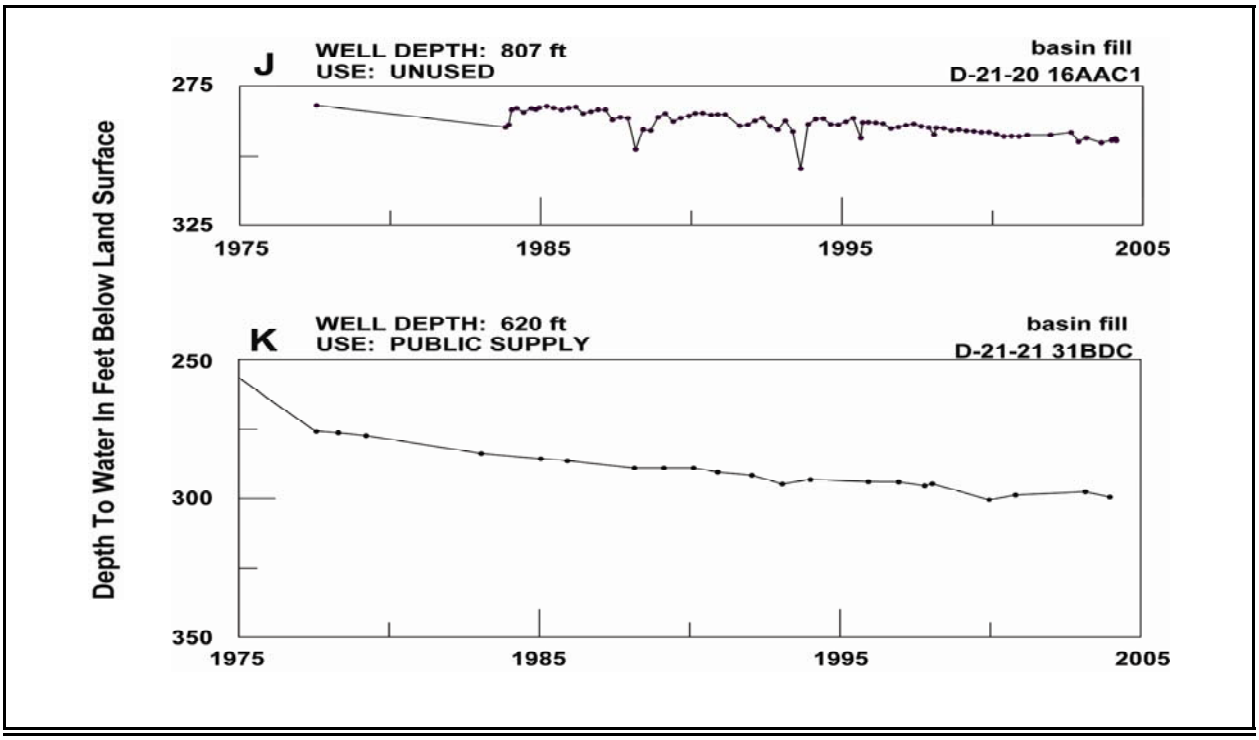


Figure 9 – Hydrographs for Wells Designated as J and K on Figure 8

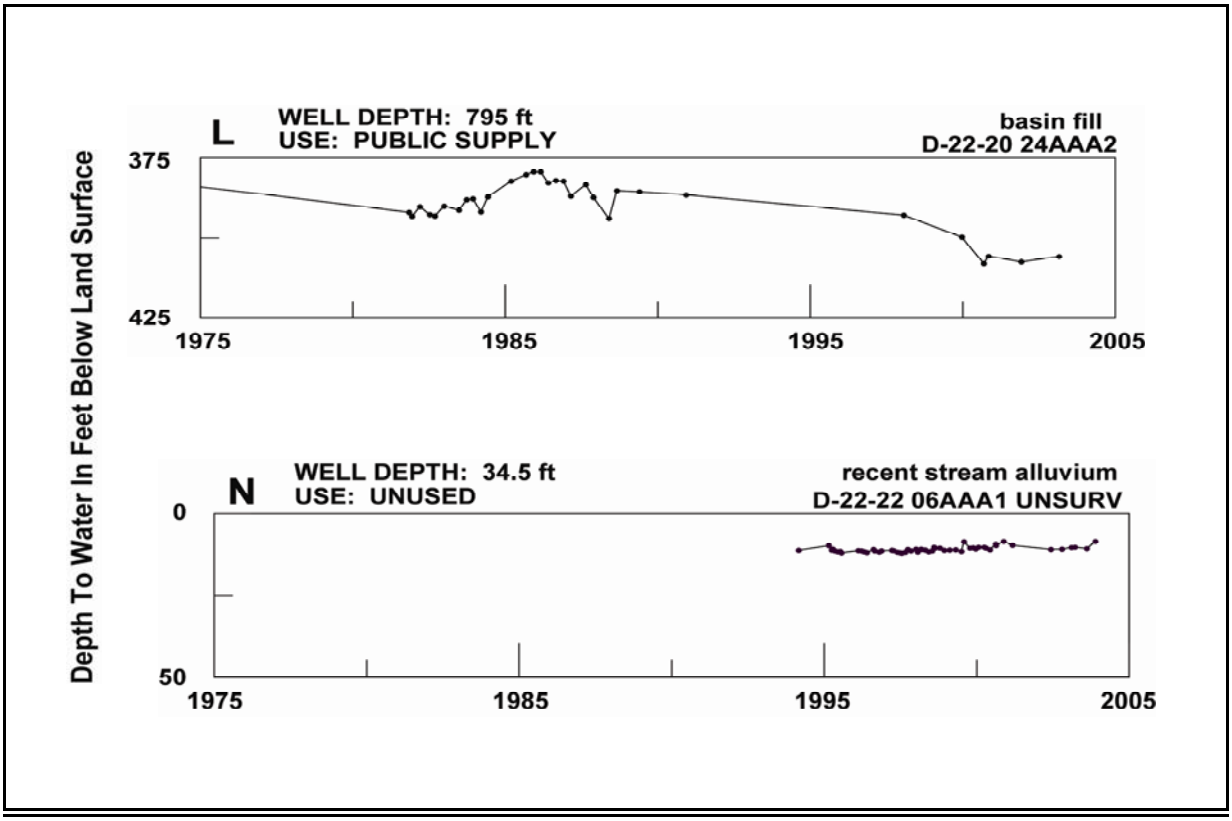


Figure 10 - Hydrographs for Wells Designated as L and N on Figure 8

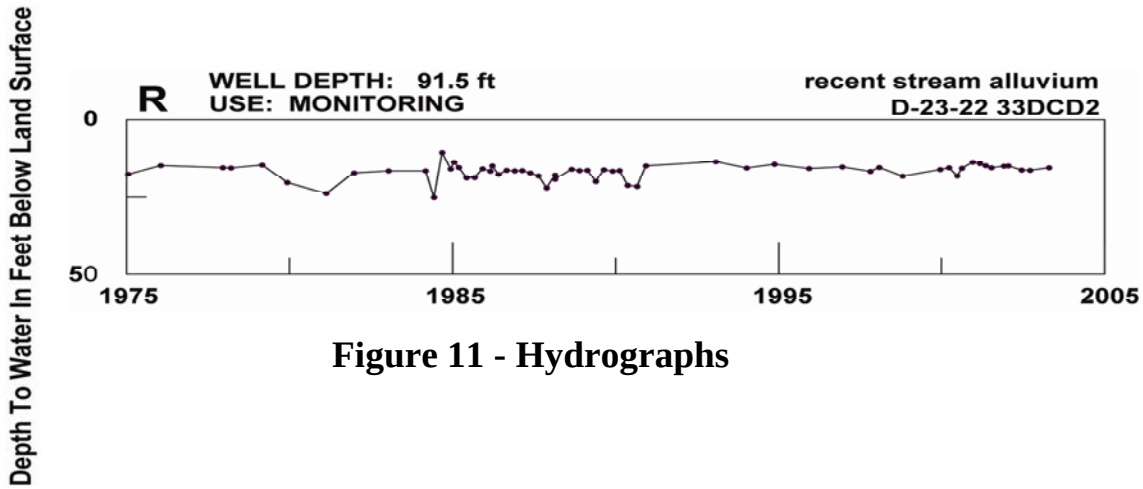


Figure 11 - Hydrographs

Figure 11 - Hydrograph for Well Designated as R on Figure 8

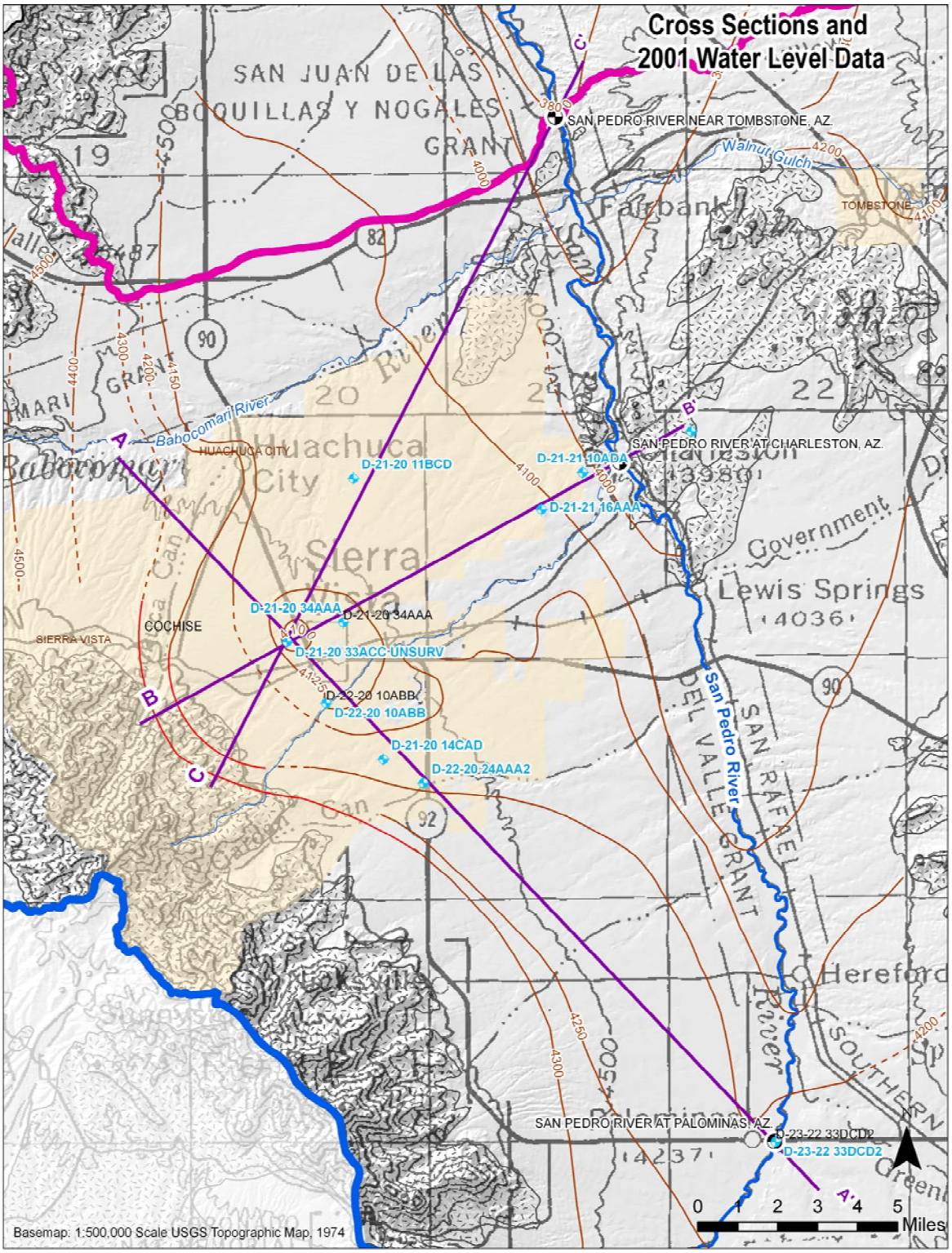


Figure 12 – 2001 Groundwater Elevation Contours and Transects

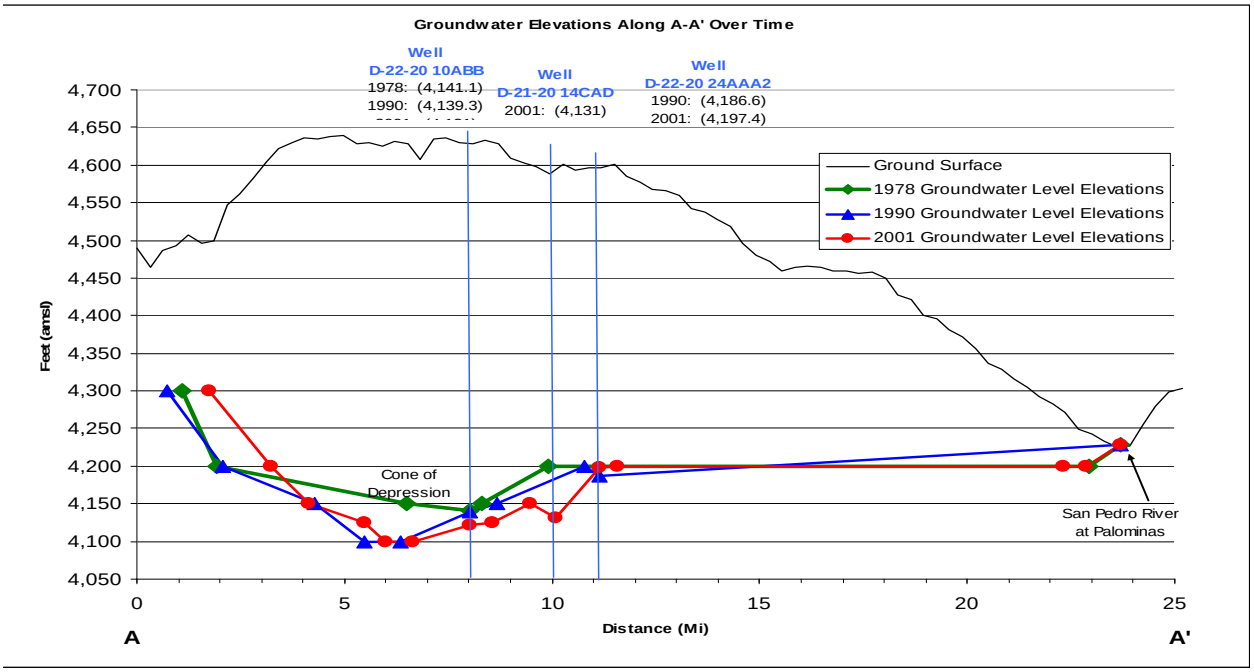


Figure 13 - Groundwater Elevation Changes 1978 – 2001: Transect A-A' on Figure 12 (ADWR)

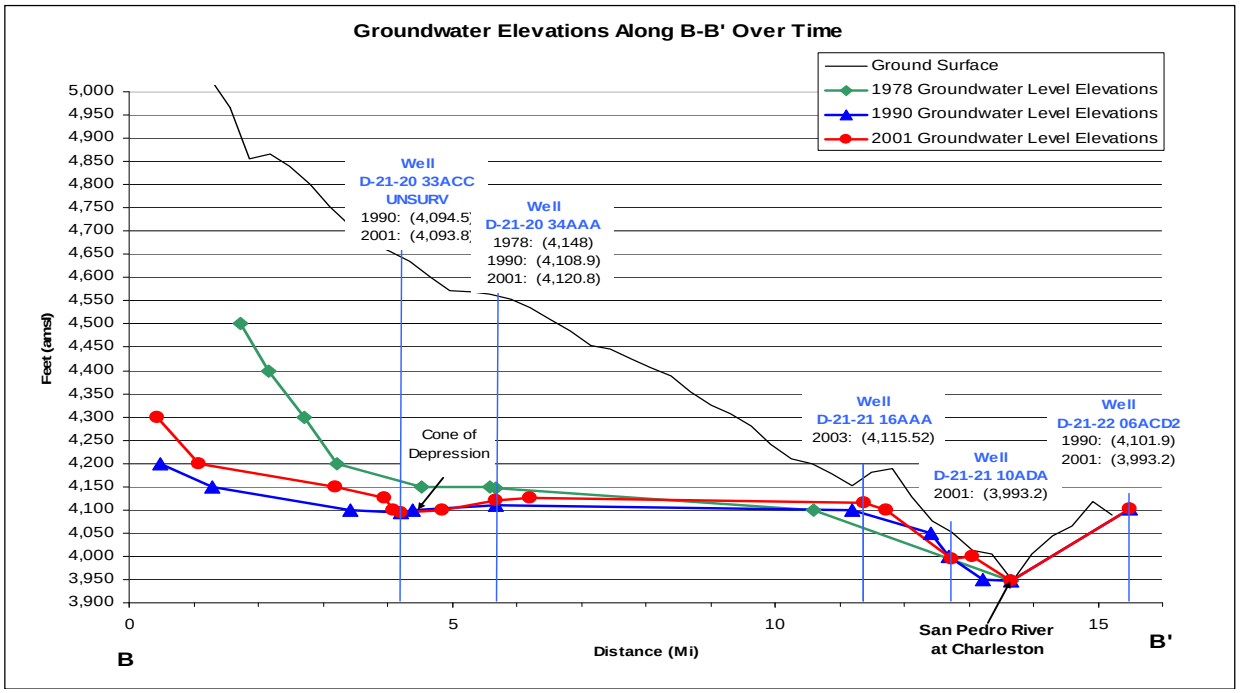


Figure 14 - Groundwater Elevation Changes 1978 – 2001: Transect B-B' on Figure 12 (ADWR)

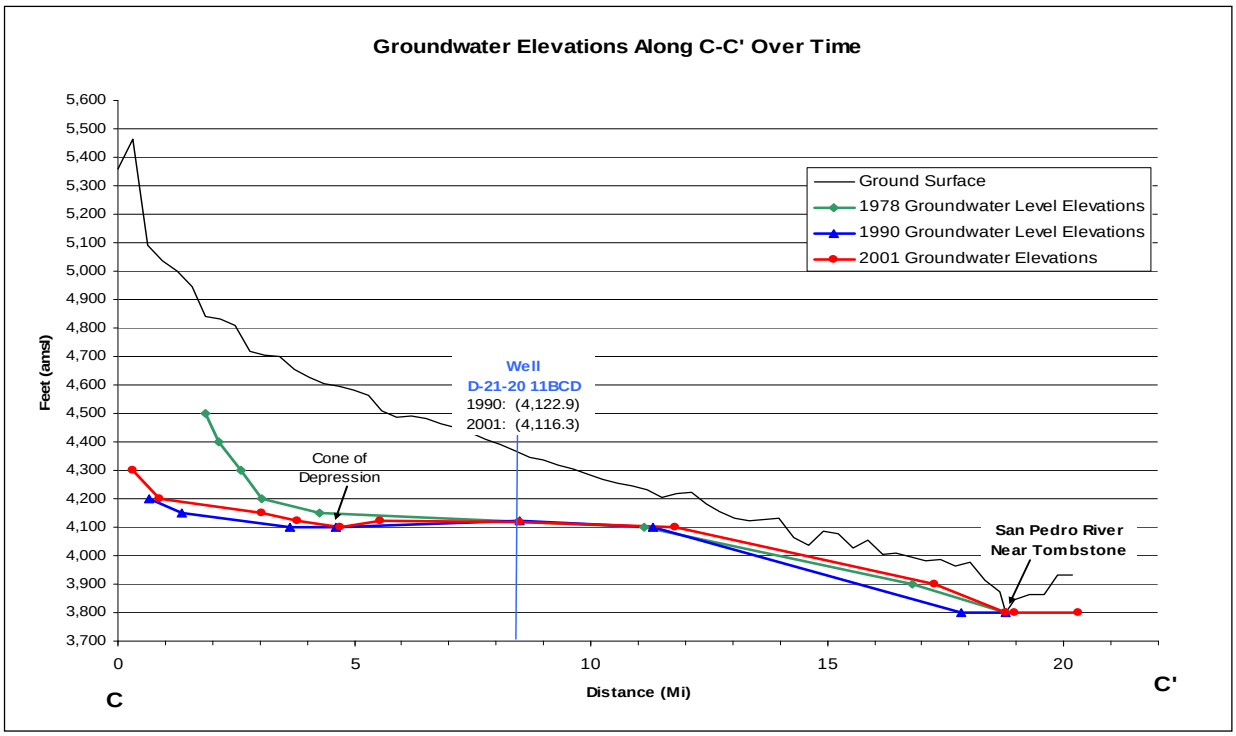


Figure 15 – Groundwater Elevation Change 1978 – 2001: Transect C-C' on Figure 12 (ADWR)

In general, water levels near the SPRNCA Boundary have risen or been relatively stable over the last several years. Large new withdrawals near the River or the SPRNCA Boundary, however, could change this condition rapidly. The threat from the long-term regional overdraft and spreading of the cone of depression south of Sierra Vista is not anticipated to have a significant impact on the base flow of the River within the next ten years. Continued and increased pumping in those areas over the next several decades, however, will have a significant and potentially irreversible impact on the base flow in the River. This observation is supported by analysis utilizing the USGS Groundwater flow model for the Sierra Vista Subwatershed. Figure 16a and 16b shows the projected percentage of effect on the availability of water to the River and the riparian system after 10 and 50 years respectively from continuous pumping at a fixed rate from different locations throughout the Proposed District. Pumping from areas designated in red will have the quickest and greatest impact on the River while areas designated in blue will take much longer and will have less of an effect on the River. The hydrologic modeling indicates that new wells located several miles from the River and even in the current cone of depression will not cause significant impacts on the River within the first ten year planning horizon of the proposed District (See Figure 16a). Of course, actions would be necessary in later years to avoid the increased effects of the new withdrawals. The significance of the projected time delay of the potential impacts on the River is that a phased approach to protect the River can be employed, wherein the most quickly implemented projects such as enhanced stormwater and effluent recharge could be

more immediately implemented, while the planning and design necessary for the implementation of larger scale augmentation and replenishment projects are simultaneously underway. Figures 17a and 17b show the location of the wells that pump less than and greater than 35 gallons per minute (exempt and non-exempt) in relationship to the zone of impacts depicted in Figure 16b. Figures 17a and 17b also identify which wells were constructed before and after December 31, 1988.

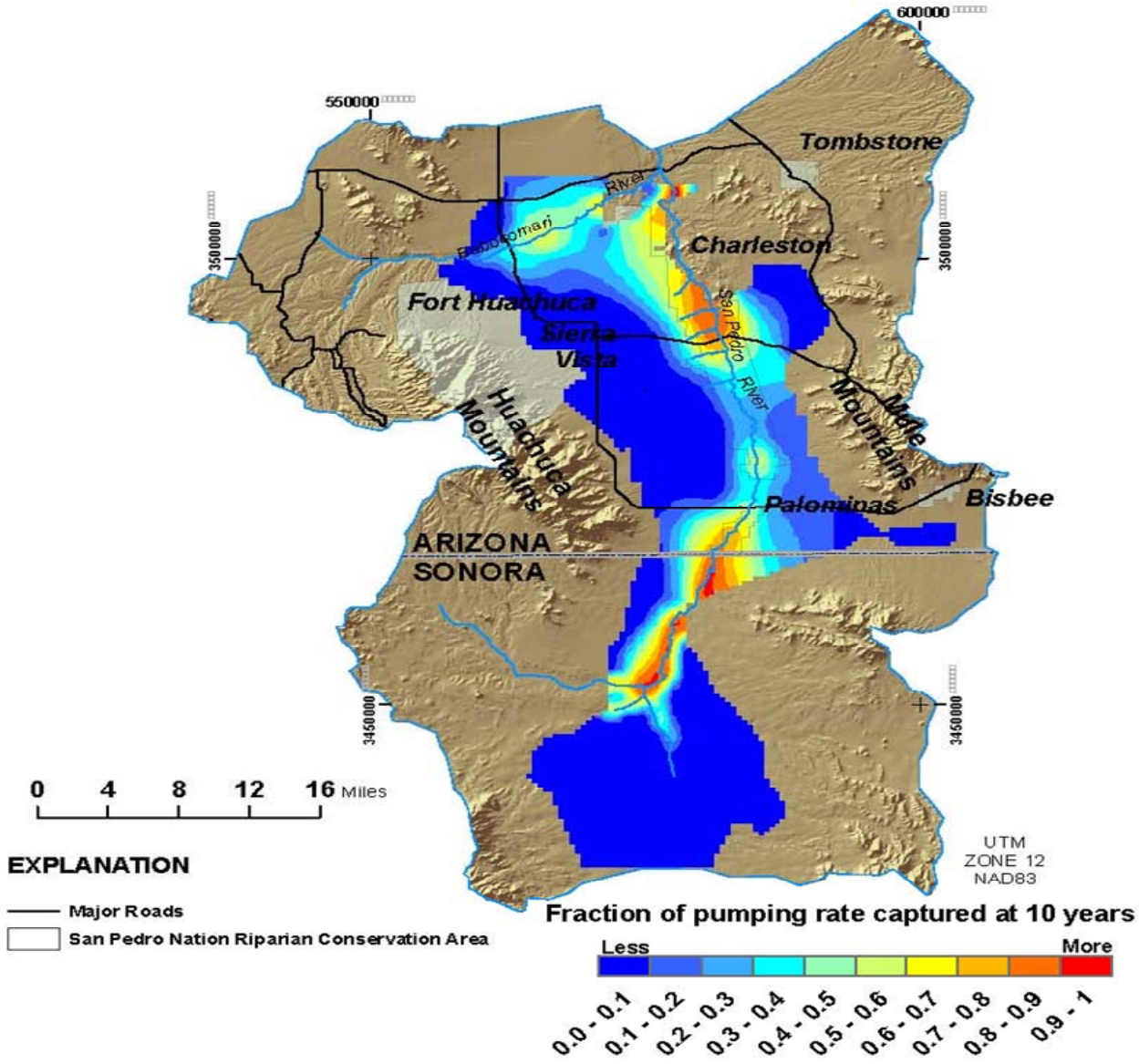


Figure 16a - Projected Percentage of Affect on the Availability of Water to River after 10 Years of Continuous Pumping at a Fixed Rate throughout Proposed District

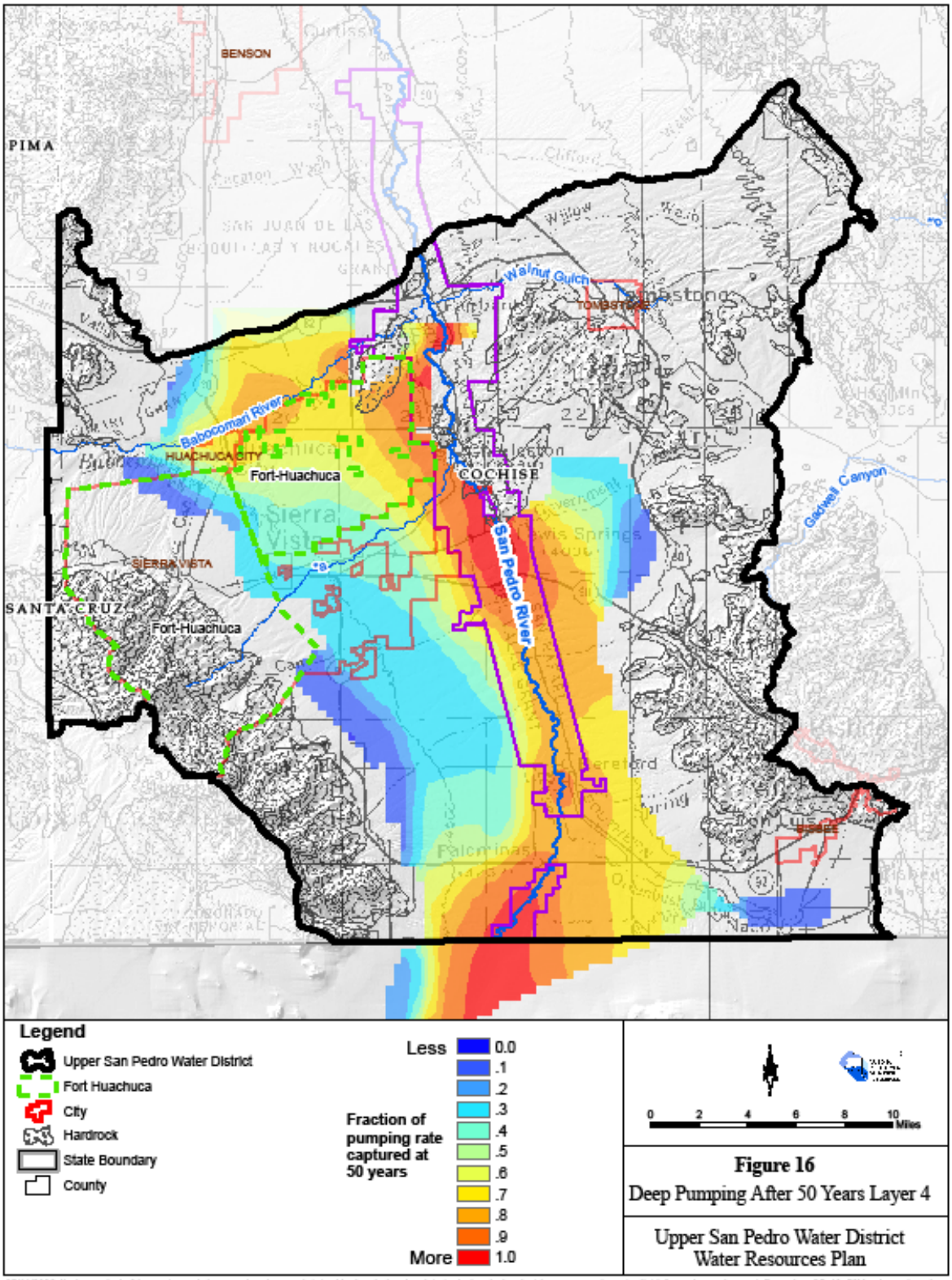


Figure 16 b – Projected Percentage of Affect on the Availability of Water to River after 50 Years of Continuous Pumping at a Fixed Rate throughout Proposed District

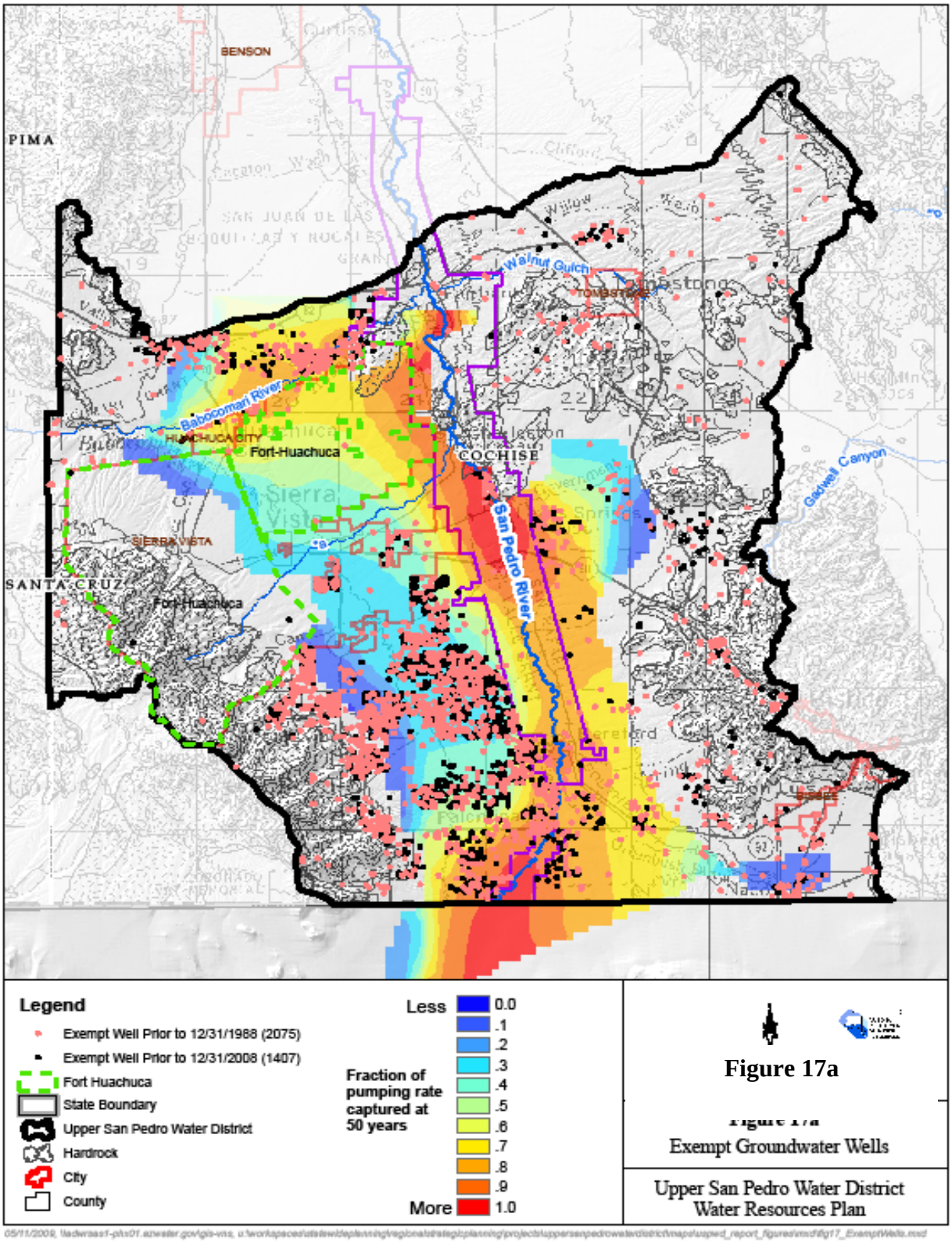


Figure 17a – Location of exempt wells (<35gpm) constructed before and after 12/31/1988 in relation to the Projected Zones of Impact after 50 Years

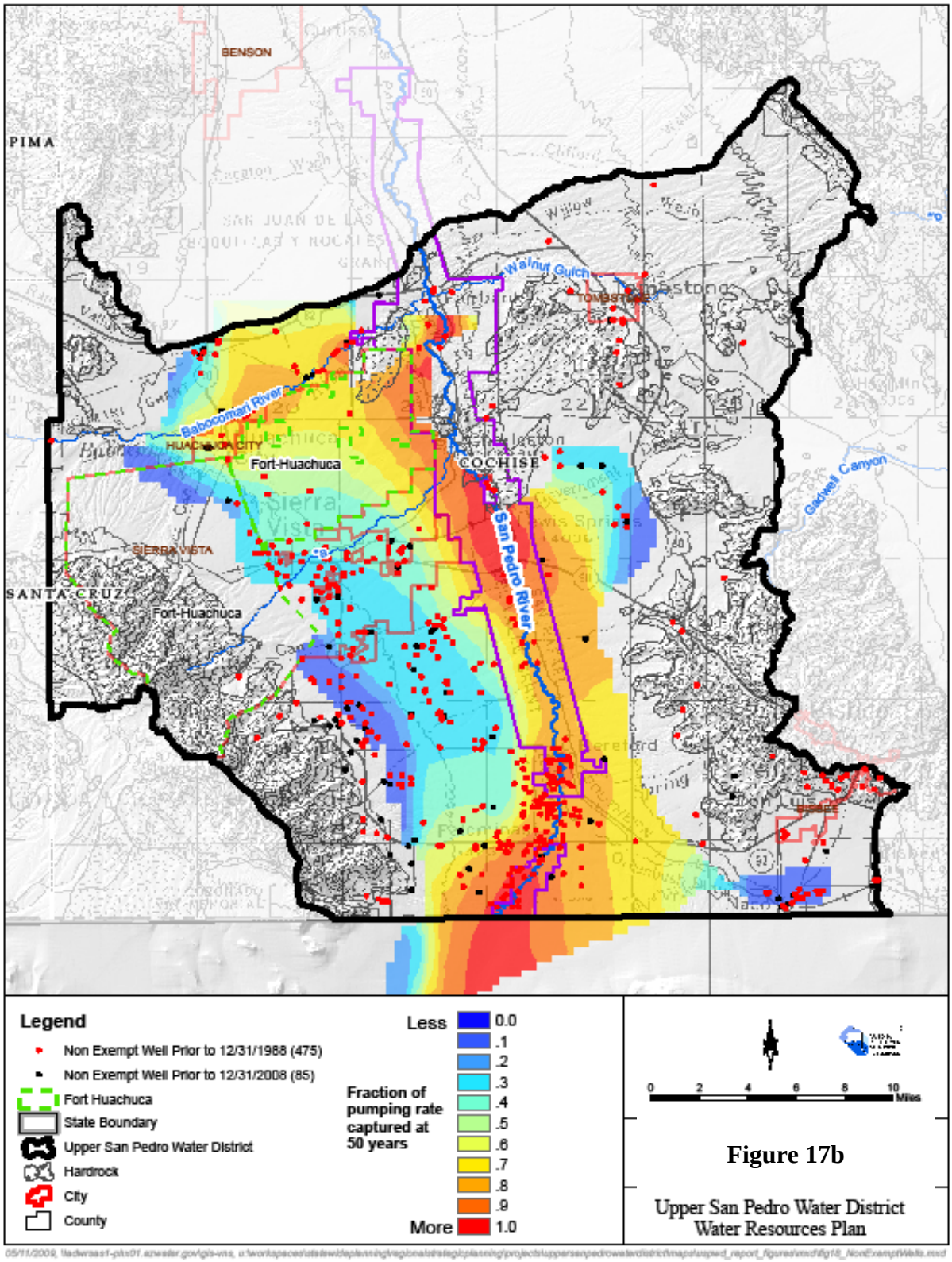


Figure 17a – Location of non-exempt wells (>35gpm) constructed before and after 12/31/1988 in relation to the Projected Zones of Impact after 50 Years

A3. Legal Framework for Dealing with Water Rights and Water Uses

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 Water from all sources flowing in natural channels does not include water flowing down paved roads, roof tops, or other sheet flow that is not in defined natural channels.

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 priority to the use of water before 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 (ADWR). Surface water can only be appropriated for beneficial use and beneficial use is 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 legally 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 the process to sever and transfer the right.

All streams within Arizona are over appropriated making it very difficult to obtain a new right to the use of surface water. Objections are often filed against new applications to appropriate surface water. Some of the larger objectors to applications filed in the Proposed District to appropriate surface water include the Gila Indian Tribe, San Carlos Indian Tribe, Salt River Project, and Freeport-McMoRan Copper and Gold Mining Company.

The ability of the Proposed District to obtain a right to the use of local surface water is highly unlikely because of the limited availability and the regulatory restrictions imposed upon its use. Enhanced stormwater recharge, however, can be accomplished through the use of detention structures, which do not require a permit to appropriate surface water. A detention structure is designed to temporarily detain water while allowing the detained runoff to be completely released at a controlled discharge rate. High flood

flows that are released in a controlled manner allow better percolation into the ground as the water continues its course downstream.

2. General Stream Adjudication

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 proposed 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. The Salt River Valley Water Users (SRP) filed the first petitions on the Salt and Verde Rivers. Large mining companies filed on the Gila System and Source, including the San Pedro River. The 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 (Gila Adjudication).

Any person or entity who uses water or who has made a claim to use water from the Gila River System and Source may be subject to the jurisdiction of the Superior Court. The legislature has charged the Arizona Superior Court with quantifying and prioritizing existing water rights claimed in the 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 Claimants filed by more than 28,000 parties are currently joined in these proceedings. Parties to this proceeding include irrigators, cities, business and numerous Indian Tribes. The largest of these claims was from Gila River Indian Community (about 1.5 million acre-feet). The Gila River Indian Community, Tohono O'odam Nation, several cities, irrigation districts and mining companies have agreed to a partial settlement pursuant to the federal Arizona Water rights Settlement Act. The Superior Court endorsed the settlement and intends to issue a comprehensive final decree of water rights at some future date.

The Proposed District does not currently own any wells or have rights to surface water. If the proposed District obtains water rights in the future, the adjudication court may have an effect on the use of wells by a permanently established District. See the explanation of subflow in the following Appendix A3, section 4.

3. Groundwater Regulation

Groundwater is Arizona's most abundant water resource and Arizona has some of the largest and most productive aquifers in the Southwestern United States. The regulation

of groundwater in Arizona is different for areas inside and 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 proposed District is not located within an AMA.

Inside AMAs groundwater may only be withdrawan and used if a person has a groundwater right or permit. The use and management of groundwater in AMAs are strictly regulated. For example, wells permits may not be issued if existing wells are unreasonably impacted by the proposed new withdrawals. Outside of AMAs wells may be drilled and groundwater used for any reasonable and beneficial use. All wells in the state must be drilled by a licensed well driller. But outside of AMAs there are no well spacing criteria and few other restrictions, except that the counties have restrictions regarding the proper distance from a septic system 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 proposed 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, or expand that transfer to meet the demands of its 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.

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

As a part of the adjudication effort, the Gila Adjudication Court has recognized the interconnectivity between surface water and groundwater and directed ADWR to develop a methodology for determining which wells may be potentially pumping appropriable sub-flow of the river system rather than groundwater. The Report submitted to the Gila Adjudication Court by ADWR in 2002 recommended that all wells located within the geologic zone known as the Holocene Alluvium be considered as potentially pumping appropriable sub-flow if water was historically in the river. The Holocene Alluvium is generally the sands, gravels and silts near the river channel.

ADWR is currently directed to provide a technical report to the Gila Adjudication Court in June 2009 that includes a map developed by ADWR, which delineates the Holocene Alluvium and the sub-flow zone. The Arizona Geologic Survey, under contract to ADWR has established where the Holocene Alluvium is located along the San Pedro River. ADWR is now using this information to develop a final map showing the river reaches with alluvium that historically contained water. The report will incorporate 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 include the de-minimus standard and the cone of depression tests for well pumping. The cone of depression test is quite important because wells that are located just outside of the Holocene Alluvium may also have an affect on the water supply within the Holocene Alluvium. If so, the well might be subject to the court's jurisdiction

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 will be the potential limitation on the development of new wells within the Holocene Alluvium and wells that draw water away from the Alluvium. A final Decision and Order will also lay the ground work for moving the Gila Adjudication forward to establish the relative priority and extent of surface water rights. Wells deemed to be pumping appropriable sub-flow will have a priority date established that most likely will be the date the well was drilled and put into service. This could potentially mean that all wells identified to be pumping appropriable sub-flow, that were drilled after the creation of the SPRNCA (1988) would have a junior right to the SPRNCA claims currently being considered before the Court.

The sub-flow decision by the Court will play a definite role in the operation of the proposed District regarding the placement and use of new wells by the District. In addition to restricting the placement of new wells by the District and others, it may also have the effect of reducing the current volume of water being pumped by existing wells. The limitation on the use and placement of new and existing wells will place greater emphasis on the District to identify and develop alternative supplies of water to meet the anticipated increasing demands.

5. Arizona Water Settlements Act

In 2004, Congress passed the Arizona Water Settlements 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 proposed District are exempt from any of the restrictions required by the Act. For the lands within the proposed District, the Settlement Act explicitly prohibits the construction of any new dams and requires ADWR to notify the Gila Tribe of any new non-exempt wells that pump more than 500 gallons per minute that are located within the Gila Maintenance Area.

The effects of the Settlement Act should have relatively little or no impact on the operation of a permanently established District.

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 of a proposed subdivision 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 the projected pumping of water for the proposed subdivision will not cause the depth-to-groundwater to exceed 1,200 feet below the surface of the land within 100 years (See Figure 18) at the location of the well.

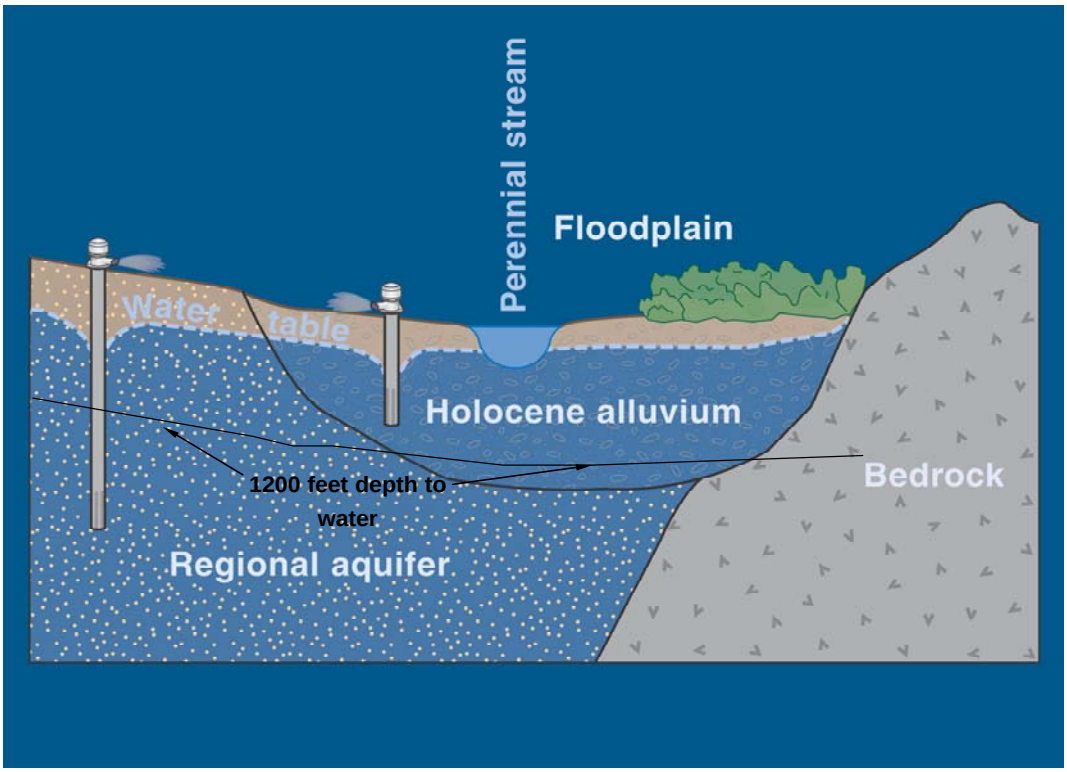


Figure 18 Depth to Groundwater Criteria for 100 Year Adequate Water Supply

Because the Adequate Water Supply Program was intended as a consumer advisory program no provisions were made to require a subdivision meet all five criteria in order for a 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 ADWR, and the disclosure of the inadequacy was only required to the first buyer of the property and not to subsequent buyers.

In 2007 the legislature passed SB 1575 that authorizes cities and towns or counties to adopt an ordinance requiring new subdivisions to demonstrate to ADWR that an adequate water supply for 100-years is available before a final plat may be approved by the local platting authority. If adopted, the Department of Real Estate also may not approve a public report without an adequate water supply determination.

In March of 2008, Cochise County was the first county to adopt the authority granted in SB 1575, making it mandatory for a proposed subdivision within Cochise County, whether in a city or town or in the unincorporated area of the County to demonstrate an adequate 100-years water supply to ADWR before a subdivision can be started. A proposed subdivision that demonstrates the groundwater will not decline below 1,200 feet from the surface of the land where the well is located in 100 years is currently deemed to have a 100-year adequate water supply. If the District is permanently formed the proposed subdivision must not only demonstrate that the groundwater will not decline below 1,200 feet from the land surface over 100 years, but must also demonstrate that the proposed pumping will be consistent with the goals of the proposed District.

7. 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.

Federal law required Fort Huachuca to take all reasonable and prudent actions to protect endangered species. 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 because such actions would jeopardize the species being protected (Section 7(a) (2)).

There are 16 at-risk species 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 Proposed District 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, a stream channel that has refuge sites safe from catastrophic flooding, and a soil that is permanently wet or nearly so, for growth and reproduction.

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.

A primary component of the goal of the District as established by the authorizing legislation is *"… to maintain the aquifer and base flow conditions needed to sustain the Upper San Pedro River….."* One of the drivers behind this component of the goal is the ESA and its potential impact on the future of Fort Huachuca for non-compliance. Maintaining the aquifer and base flow conditions of the Upper San Pedro River ensures and potentially enhances the required ecology for the sustainability of the Huachuca Water Umbel.

8. Federal Law PL 100-696 – SPRNCA Enabling Act

The SPRNCA's enabling act defines the need to conserve, protect, and enhance the resources within the SPRNCA. A Federal Reserve Water Right was created as part of the legislation establishing the SPRNCA. The Special Master in the Gila Adjudication issued a preliminary order in March 2009 regarding SPRNCA legal issues. The Special Master held that the purposes of SPRNCA are "the protection of the riparian area and the aquatic, wildlife, archeological, paleontological, scientific, cultural, education, and recreations resources of the conservation area." The Special Master also found that "Congress expressly intended to reserve water to accomplish the purposes of the conservation area."

On January 31, 2006, BLM amended its statement of claimant (SOC) in the Gila River adjudication. The amendment and accompanying attachments, quantify the federal reserved water right held by the BLM for the SPRNCA. The attachments describe stream flow claims for the San Pedro River and the Babocomari River (base flow –

median of daily means + “un-impounded storm runoff”); groundwater claims; and “point” sources, including “springs and seeps, ponds and small lakes, small capacity wells, large production wells formerly used for irrigation and industrial uses, and other naturally occurring waters (e.g., seasonal cienegas, undiscovered seeps, ponds, etc.) within SPRNCA.”

The BLM also received in 1992 a certificated instream flow water right with a priority date of 1985 from the State of Arizona for the San Pedro River. The BLM currently has six pending applications for additional instream flow water rights; four on the San Pedro River and two on the Babocomari River.

9. Federal law PL 108-136 Section 321

The Defense Authorization Act of 2004, Public Law 108-136, Section 321 stipulates the way in which Section 7 of the Endangered Species Act applies to Fort Huachuca by stating that the Fort could not be held directly responsible for actions that are taken by State, local or private entities off of the installation. However, due to the interconnections between the Fort, as the region’s largest employer, and the off-installation residents and water users, a collaborative approach was suggested to avoid future endangered species issues.

The Act recognizes the Upper San Pedro Partnership (a group of 21 Federal, State, local and nongovernmental entities) that has been established to achieve sustainable yield of the regional aquifer, so as to protect the Upper San Pedro River. Section 321 of the Act directs the Secretary of the Interior to prepare reports to Congress on the steps to be taken to reduce the overdraft and restore the sustainable yield of groundwater in the sub-watershed. It also sets forth an objective of achieving and maintaining the sustainable yield of the regional aquifer by and after September 30, 2011. The Department of the Interior, in consultation with the Departments of Agriculture and Defense and in cooperation with the Upper San Pedro Partnership, has produced the required reports for the years 2005, 2006, and 2007. Each report has provided an increased level of detail and understanding of the quantification of the components of sustainable yield, the measures which are being implemented to help achieve the objective, and the progress being made to reduce groundwater overdraft.

If the Partnership is unable to achieve its annual goals of groundwater overdraft reduction it is possible that future federal appropriations to the Partnership might be discontinued. However, many community and State leaders have stated that in their opinions, such a failure will be taken into account in any future military base closure decisions and could therefore threaten the continued operation of the Fort.

The proposed District has the ability to implement large scale water development, reuse, recharge and augmentation projects across multiple jurisdictions, which the Partnership lacks the authority to do. A permanently established District could play a vital role in assisting the Partnership with meeting its goal of sustainability.

A4. Institution Framework

1. Federal Agencies

a. The United States Department of the Army

The Department of the Army controls the land within the Fort Huachuca military installation and is directly responsible for all activities occurring within the installation. The Army operates the Fort to meet the military missions of the United States. The Army is able to place more control over the management of water resources on the Fort than other off-installation agencies. For example, the Army owns and operates all water supply facilities and all wastewater treatment facilities. It also owns and operates a recharge facility located within the property. They own and operate all buildings and residences on the property and are therefore in a position to require water conservation practices that would usually be voluntary in an off-installation environment. Furthermore, the Army is in control of the land use on the Fort and can directly make decisions related to how land uses and water requirements for those uses will interrelate.

b. The Bureau of Land Management

The Bureau of Land Management (BLM) is an agency of the Untied States Department of the Interior. The agency is responsible for a variety of programs for the management and conservation of resources of 258 million surface acres as well as 700 million acres of subsurface mineral estate. Most of these lands are located within the western states. The BLM plays a major role within the boundaries of the District because it is responsible for the management and protection of the San Pedro Riparian National Conservation Area, which covers about 57,000 acres of public land. The Act which designated the SPRNCA granted the preserve a federal reserved water right and required the Secretary of the Interior to file a claim for the quantification of that right in the Gila River General Stream Adjudication.

c. The United States Geological Survey

The United States Geological Survey (USGS) is also an agency of the United States Department of the Interior. The USGS is the earth science arm of the Department of the Interior. The USGS's main role in the District is as a provider of regional surface water and groundwater data and analysis. The agency operates stream flow gaging stations on the San Pedro River which provide the basic data for the surface water supplies. They have also actively participated in investigations of the groundwater resources of the Upper San Pedro Groundwater basin including the development of a comprehensive groundwater model of the Sierra Vista Proposed District. The USGS acts as the DOI's lead agency in the preparation of the annual reports to Congress required by Section 321 of P.L. 108-136.

d. The United States Bureau of Reclamation

The United States Bureau of Reclamation (BOR) is yet another agency of the United States Department of the Interior. The BOR is best known for the planning, design and construction of numerous water resource development projects throughout the western United States. In recent years the agency has focused its attention on programs to enhance the efficiency and management of existing water projects and to provide technical assistance and expertise in planning activities. The BOR is an active member of the Upper San Pedro Partnership and has taken the lead in investigating opportunities to augment the current water supplies within the District.

2. State of Arizona

a. The Arizona Department of Water Resources

The Arizona Department of Water Resources (ADWR) is the state agency responsible for issues related to water quantity within Arizona. ADWR plays both a planning and regulatory role within the District. The legislation that established the proposed District requires the District's Board to coordinate with ADWR. The initial funding for the District was also made available through an appropriation to ADWR. In addition to its planning role, ADWR collects and analyzes basic data concerning groundwater resources, serves as the technical advisor to the Gila River General Stream Adjudication Court, regulates well drilling and enforces surface water law. It also has responsibility for determining the adequacy of water resources available for new subdivisions. In the determination of the water adequacy for new subdivisions within the proposed District's boundaries, ADWR must determine that the proposed water use is consistent with the goal of the District.

b. The Arizona Department of Environmental Quality

The Arizona Department of Environmental Quality (ADEQ) is the state agency responsible for issues related to water quality within Arizona. It administers programs related to ensuring that standards are met for both drinking water quality and for treatment and discharge of sewage effluent. ADEQ directly regulates non-federal municipal water providers within the District's boundaries, but do not directly regulate small private domestic wells used for fewer than four service connections. As the regulator of sewage treatment quality, ADEQ establishes standard for the quality of effluent water that may be discharged, recharged or reused within the District.

c. The Arizona Corporation Commission

The Arizona Corporation Commission (ACC) is the state agency responsible for the regulation of privately owned water utilities within Arizona. Within the District, it is estimated that about 90% of the area's population is served water from utilities regulated by the ACC. The ACC establishes all rates that these utilities are allowed to charge customers and regulates the conditions for providing service to new customers.

Proposals for rates based on the encouragement of water conservation are subject to ACC review and approval.

3. Cochise County

The proposed District would be located entirely within Cochise County which encompasses 6200 square miles of the southeastern corner of the State of Arizona. Cochise County has jurisdiction over tax assessments, health and social services, solid waste, elections and floodplain issues. It also has responsibility for planning and zoning in the unincorporated areas of the District. All new subdivision plats within the unincorporated portions of the District must be approved by the County. The owner of the land must demonstrate an adequate water supply for 100-years to ADWR before a final plat can be recorded. The Cochise County Board of Supervisors has adopted, as a goal, that the County will "sustain an adequate, safe water supply through water conservation measures; incentive programs; education; conservation and enhancement of natural recharge areas; and cooperative, multi-jurisdictional planning." Its efforts in the Upper San Pedro Basin to attain this goal have included funding the Water Wise program, developing water-conserving site development standards for new commercial development, inventorying water resources, funding groundwater studies, and initiating joint planning with cities in the Proposed District. The authorizing legislation provides that the Cochise County Attorney may provide legal advice and represent the District. The County is also responsible for holding the election regarding the formation of the proposed District and its Board of Directors.

4. The Cities and Towns of Sierra Vista, Huachuca City, Tombstone, and Bisbee

The Cities and Towns of Sierra Vista, Huachuca City, Tombstone and a portion of Bisbee are the incorporated communities within the District's boundaries. All of the communities are members of the Upper San Pedro Partnership. Residents within Bisbee and Sierra Vista are served water from several private water companies while Huachuca City and Tombstone operate their own municipal water utilities. All of the communities within the proposed District own and operate sewage collection and treatment facilities as well. All of the communities are actively involved in encouraging water conservation within their jurisdictions.

As an example, Sierra Vista has formed a Water Management Team even though it does not directly provide potable water delivery. The Water Management Team is tasked with developing water conservation programs, implementing municipal water mitigation actions, and involving the community in water management issues. The Water Management Team has sponsored public focus groups; surveyed residents to establish priorities; developed a toilet rebate program; facilitated free in-home retrofits of high-use water fixtures; launched a leak detection program; established an internal "Water Watch" program to monitor municipal water use; developed a partnership with the local Chamber of Commerce to fully engage the business community; and implemented an extensive marketing and public relations campaign, including video and printed materials, to educate and inform area citizens.

All new subdivision plats within the incorporated cities and town of the District must be approved by their respective Councils. Those plats will be subject to a favorable water supply adequacy determination by ADWR before a final plat can be recorded.

5. The Upper San Pedro Partnership

As described above the Upper San Pedro Partnership is a unique organization that has a significantly defined role in meeting the water resources objectives of Section 321 of P.L. 108-136. The Upper San Pedro Partnership was formed in 1998 as a voluntary consortium of federal, state and local agencies and organizations that were to assist in meeting the long term water needs of the San Pedro Riparian National Conservation Area and of the area residents. The member agencies and organizations either 1) own land within the Sierra Vista subwatershed of the Upper San Pedro Groundwater Basin; 2) control land or water within the subwatershed; 3) make policy regarding land or water in the subwatershed or 4) will provide significant technical or financial resources to assist the Partnership in accomplishing its purpose. The Partnership's web site lists twenty one member agencies that indicate a wide range of interests. The purpose of the Partnership is to coordinate and collaborate in the identification, prioritization and implementation of comprehensive policies and projects that assist in meeting the water needs of the subwatershed.

6. Other Non-governmental Organizations

The issues related to protection of the San Pedro River are a matter of concern to numerous non-governmental organizations. The Nature Conservancy, and Arizona Audubon Society are directly involved as participating members of the Upper San Pedro Partnership. Other conservation groups including the Center for Biological Diversity and the Sierra Club have shown a high degree of interest in the San Pedro River as well. Representatives of the University of Arizona, Arizona State University, and Northern Arizona University have been actively engaged in research and investigations over the years. It is probable that organizations such as these will become involved in any programs adopted under the authority of the District.

APPENDIX B

Future Risks and Uncertainties

B1. Water Budgets
1. Budget Components
    a. Inflows
    b. Outflows
2. Recent Water Budgets
3. Budget Deficits

B2. Projected Impacts of Increased Municipal, Industrial or Agricultural Groundwater Withdrawals
1. Projected Growth Rates
2. Estimates of Water Demands and Supplies
    a. Municipal water provider demands and withdrawals
    b. Exempt (domestic) well demands and withdrawals
    c. Projected Industrial Demand
    d. Projected Agricultural Demand
    e. Evapotranspiration Demands
3. Uncertainty of Estimates

B3. Land Use and Zoning Impacts

B4. Impacts of Adjudication on Groundwater Withdrawals

B5. Impacts of Reduced Underflow from Mexico

B6. Conclusions Regarding Risks and Uncertainties

B1. Water Budgets

A water budget is an accounting of the water inputs to, and the water outputs from, a hydrologic system. A current water budget for the regional aquifer of the Sierra Vista Proposed District 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 (USGS, 2007). Although the boundaries of the subwatershed and proposed District do not exactly match, they are similar enough to allow the water budgets completed for the subwatershed to be used as an approximation of the District.

1. Budget Components

a. Inflows

Natural inflows to the regional aquifer include natural recharge, primarily mountain front recharge supplemented by recharge of runoff in ephemeral channels, and underflow from Mexico (ADWR, 2005 – Table 5). Inflows to the aquifer also come from water management measures including recharge of effluent and stormwater, and a reduction in riparian evapotranspiration from mesquite removal (USGS, 2007). Other aquifer inflows from human activities are incidental and include irrigation returns, percolation from septic tanks, golf courses and park irrigation, and urban-enhanced recharge. Urban-enhanced recharge represents the recharge to ephemeral channels that results from increased surface runoff generated in urban areas from impervious surfaces.

b. Outflows

Natural outflows from the regional aquifer include groundwater discharge to the river that flows out of the Proposed District (base flow), groundwater discharge via riparian evapotranspiration, and underflow to the Benson subwatershed of the Upper San Pedro Groundwater Basin (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 (USGS 2007). With a couple of minor exceptions, in the 1960s and a significant exception in the late 1980s and early 1990s, well pumpage in the area has increased steadily throughout the 20th century (Thomas and Pool, 2006). 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 demand in the region.

2. Recent Water Budgets

Estimated total inflows and outflows from the regional aquifer of the Proposed District for years 2002, 2004, 2005, and 2006 are presented in Table 3 The estimated outflow attributed to well pumping for each of the four years is also presented. For each of the four years the estimated outflows from the regional aquifer exceeded the estimated total inflows. Whenever the annual outflows exceed the annual inflows the difference

between the two values is the volume of water the regional aquifer is estimated to have lost for the given calendar year. This is known as the annual storage deficit or overdraft.

Table 3 Summary of Groundwater Inflow and Outflows

	Calendar Year			
	2002	**2004**	**2005**	**2006**
Total Inflows (acre-feet)	23,510	25,815	26,025	26,585
Total Outflows (acre-feet)	30,990	33,180	32,350	31,410
Aquifer Annual Water Budget Deficit or Overdraft (acre-feet)	**-7,480**	**-7,365**	**-6,325**	**-4,825**
Outflow From Pumping (acre-feet)	16,500	18,690	17,860	16,920

It is important to understand that water budgets will change with time and that several water budget components are estimated and contain uncertainties. These estimates may change in the future as more and better hydrologic data become available.

3. Budget Deficits

The water budget quantifies the annual storage deficits or overdraft of the regional aquifer. Annual storage deficits decrease the amount of groundwater in storage over time and create cumulative overdraft. As a result of water conservation, recharge, and other measures the annual storage deficit has decreased in recent years and is expected to be approximately 6,000 acre-feet by 2011. Had recent conservation and recharge measures not been employed, the annual storage deficit is estimated to have been more than 15,000 acre-feet by 2011. The result of the reduced annual storage deficit is to slow the cumulative overdraft. Evidence of the cumulative overdraft is shown by increasing depths to groundwater within a groundwater basin. When the water budget for the groundwater basin is in a deficit situation, especially near large wells, large cones of depression appear in the water table elevations. The increasing depths to groundwater are shown in Figure 12 and the Hydrographs in Figures 13 through 15.

B2. Projected Impacts of Increased Municipal, Industrial and Agricultural Groundwater Withdrawals

1. Projected Growth Rates

The 2000 Census population of the Proposed District 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 4 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 4 - Proposed District 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

2. Estimates of Water Demands and Supplies

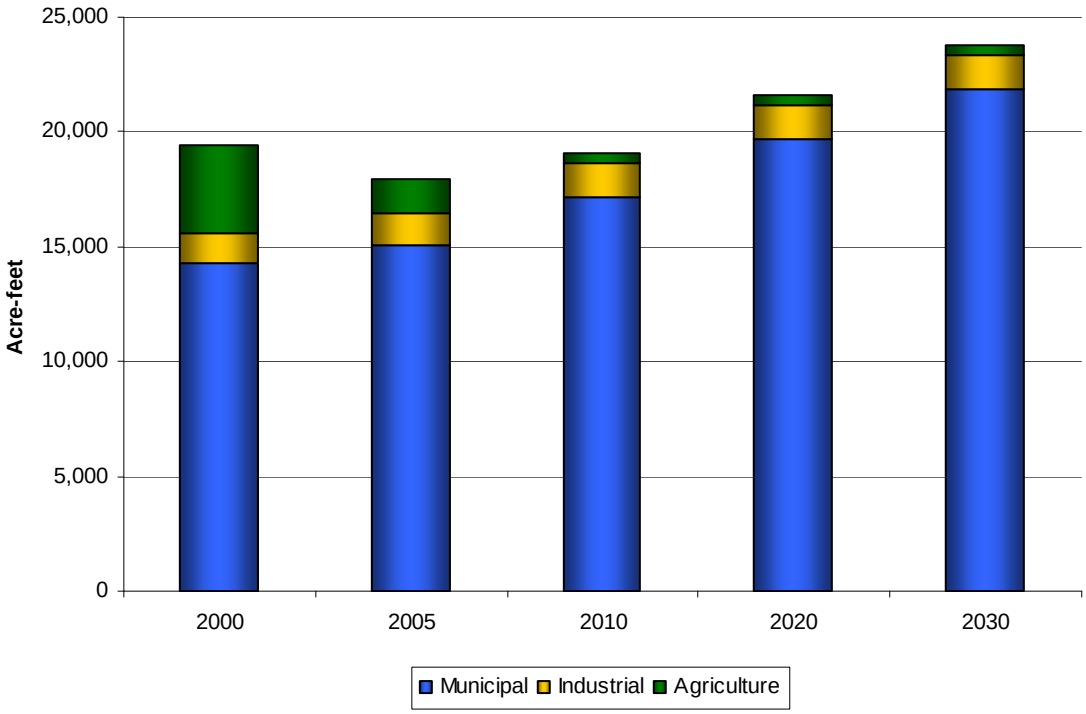
Shown in Table 5 is the estimated volume of water withdrawn or diverted to meet current and projected demand, and the amount of water that returns to the aquifer. Figure 19 shows water use by sector from 2000 to 2030. The estimated water demand by municipal, industrial and agricultural users was approximately 18,000 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 the population continues to increase, municipal and industrial demand will also increase. Total water demand is expected to increase to approximately 24,000 acre-feet in 2030 assuming that current per capita rates remain unchanged in the future, industrial sector demand increases slightly and agricultural irrigation remains at 2005 levels. The result is an increased annual overdraft from 6,325 to 9,365 acre-feet per year.

TABLE 5 – Water Budget						
INFLOWS	**Calendar Year**					
Natural Inflows	**2000**	**2005**	**2006**	**2010**	**2020**	**2030**
	ACTUAL			**PROJECTED**		
Natural Recharge – (*inflow largely from percolating rain and snow on and around mountains and ephemeral channels)*	15,000	15,000	15,000	15,000	15,000	15,000
Groundwater Inflow – (*Subsurface inflow from Mexico)*	3,000	3,000	3,000	3,000	3,000	3,000
Subtotal	**18,000**	**18,000**	**18,000**	**18,000**	**18,000**	**18,000**
Inflows From Water Management Activities						
Reduction of riparian evapotranspiration – (*management of invasive mesquite)*	0	475	475	475	475	475
Municipal Effluent Recharge		2,380	3,030	3,610	4,110	4,570
Detention Basin Recharge		130	310	310	310	310
Subtotal	**0**	**2,985**	**3,815**	**4,395**	**4,895**	**5,355**
Inflows From Incidental Recharge From Human Activities						
Incidental Recharge	3,170	2,740	2,470	2,620	2,980	3,260
Urban Enhanced Recharge		2,300	2,300	2,300	2,300	2,300
Subtotal	**3,170**	**5,040**	**4,770**	**4,920**	**5,280**	**5,560**
Total Inflows	**21,170**	**26,025**	**26,585**	**27,315**	**28,175**	**28,915**
OUTFLOWS						
Natural Outflows						
Groundwater Outflow – (*Subsurface outflow at USGS streamflow gage near Tombstone)*	-440	-440	-440	-440	-440	-440
Stream Baseflow – (*Groundwater that discharges to the river and flows out of the Proposed District)*	-3,250	-3,250	-3,250	-3,250	-3,250	-3,250
Evaporation and Plant Transpiration – (*Groundwater discharged to the River that evaporates or is consumed by riparian vegetation and transpired)*	-10,800	-10,800	-10,800	-10,800	-10,800	-10,800
Subtotal	**-14,490**	**-14,490**	**-14,490**	**-14,490**	**-14,490**	**-14,490**
Outflows From Pumping						
Municipal and Private Water Companies	-10,600	-10,830	-10,610	-12,044	-14,160	-15,770
Private Domestic Wells	-3,700	-4,200	-4,390	-4,700	-5,500	-6,100
Industrial (turf, sand and gravel, golf course, etc)	-1,300	-1,430	-1,490	-1,490	-1,490	-1,490
Agriculture	-3,800	-1,400	-430	-430	-430	-430
Subtotal	**-19,400**	**-17,860**	**-16,920**	**-18,664**	**-21,580**	**-23,790**
Total Outflows	**-33,890**	**-32,350**	**-31,410**	**-33,154**	**-36,070**	**-38,280**
Change in Volume of Water Stored in the Aquifer (inflows – outflows)	**-12,720**	**-6,325**	**-4,825**	**-5,839**	**-7,895**	**-9,365**

Note: Demand estimates based on ADES population projections and assumptions in ADWR, 2005 with 147 GPCD used for municipal demands and 312 GPCD for people served by private domestic wells. Incidental recharge is an estimate of water returned to the aquifer from septic tanks and turf watering. Urbanization causes enhanced recharge by concentrating storm runoff in ephemeral stream channels. New data from on-going studies and monitoring, and the result of management activities such as vegetation removal will cause many of these numbers to change.

Figure 19 Proposed District 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 specially constructed recharge basins. 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 5.

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 per year by 2030. Effluent is recharged to the aquifer at two facilities in the Proposed District. 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 facility. The proportion of water returned to the aquifer as either incidental recharge or artificial recharge increases through 2010, so that **annual overdraft of groundwater in 2010 is projected to be no more than the amount in 2005 even though total demand increases.** Also where pumping and recharge occurs will affect stream flows.

a. Municipal water provider demands and withdrawals

Municipal demand served by a water provider accounted for approximately 72% 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 Proposed District, but only eight serve over 250 acre-feet of water per year and only two, Huachuca City and Tombstone, are public systems. Water providers are required to report annual water use information to ADWR. 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 area served by water providers in the incorporated areas are also served by a centralized sewer system. In unincorporated areas, septic tanks are the norm and contribute to incidental recharge.

b. Exempt (domestic) well demands and withdrawals

Exempt (domestic) wells typically serve one or several large residential lots and account for approximately 26% of the municipal water demand in the Proposed District. 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 for wells that pump less than 35 gallons per minute.

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 0.35 acre-feet/person per year for the Proposed District. 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.

c. 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 Proposed District. With the exception of the Fort's use of effluent on Mountain View golf course, the industrial sector has historically relied on groundwater exclusively. In 2009, the Turquoise Valley Golf Course is projected to 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, which was not assumed in the demand projections. While copper prices have since dropped significantly, a turnaround could again revive the possibility of an increase in water demands from metal mining.

d. Projected Agricultural Demands

By 2008, much of the irrigated lands in the Proposed District had been retired, leaving about 300 actively irrigated acres mostly in areas to the west of Sierra Vista. 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 Proposed District, 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.

e. Evapotranspiration Demands

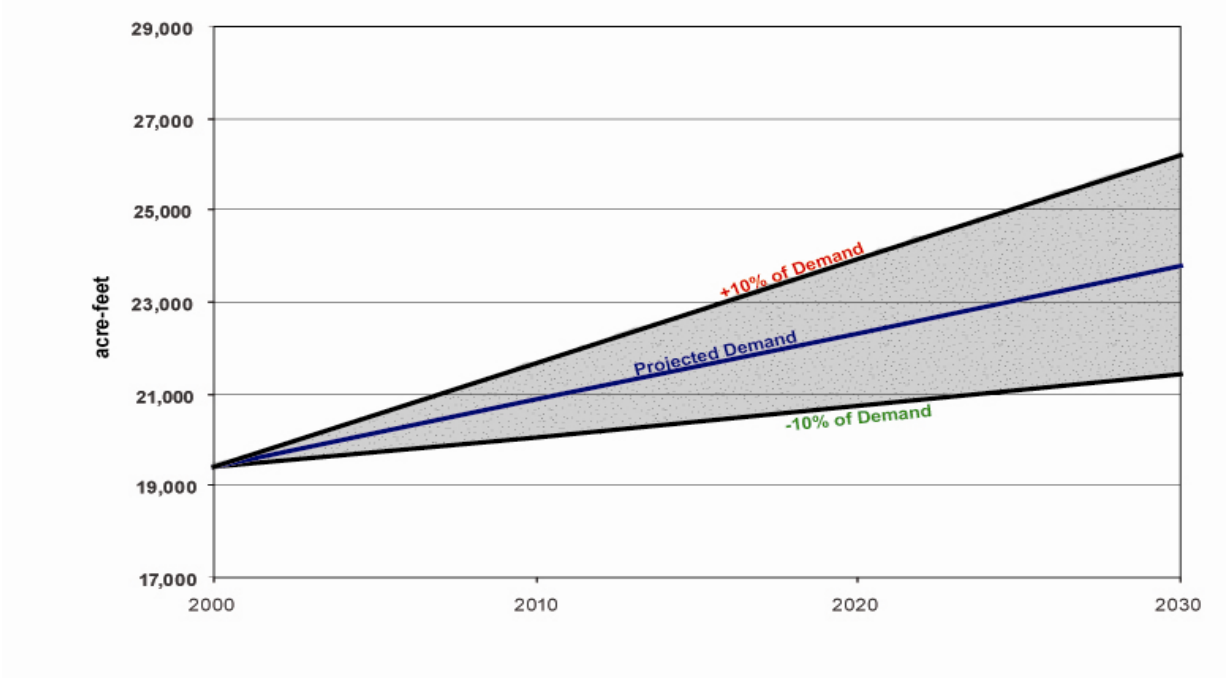
The single largest users of groundwater within the Proposed District are the riparian areas along the San Pedro and Babocomari Rivers. The riparian corridor in the SPRNCA encompasses the stream channels, streambanks, flood plains, and terraces along the streams. The corridor is vegetated, in part, by plants such as cottonwoods, willows and mesquite, which withdraw groundwater from the stream alluvium and discharge it to the atmosphere through a process known as "transpiration". Water also directly evaporates from the stream surface. Previous estimates of evapotranspiration by the streams and riparian vegetation were around 7,700 acre-feet annually. In 2005 the USGS completed Scientific Investigations Report 2005-5163 entitled "Hydrologic Requirements of and Consumptive Ground-Water Use by Riparian Vegetation Along the San Pedro River, Arizona". In Chapter D of this study, the evapotranspiration demand of the riparian system was estimated to be around 10,800 acre-feet annually. While this

number represents the best science currently available it is important to understand that it could be further refined and/or updated in the future given further monitoring and study. It is also important to understand that the water demand from evapotranspiration is subject to significant fluctuations annually based upon climatic conditions and the extent of the riparian canopy.

3. Uncertainty of Estimates

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 ADWR 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 from 1997 predicted that in 2010 the population of the Sierra Vista Proposed District would be approximately 76,500 residents. As shown in Table 4, 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 20 illustrates two possible municipal, industrial and agricultural demand scenarios: one at 110% of the baseline projection by 2030 and another at 90% of the baseline projection.

Figure 20. Proposed District projected municipal, industrial, and agricultural demand and 10% variations on demand by 2030



B3. Land Use and Zoning Impacts

In the Proposed District land use regulation can be divided into three categories; unincorporated areas, incorporated areas and federal land. The local governments within the Proposed District 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 Subwatershed Water Conservation and Management Policy Plan (Plan) to guide development in the unincorporated areas of the Subwatershed. 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 Proposed District. 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 Subwatershed 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 Proposed District; it does not change the underlying zoning. (Cochise County Code § 1802.2) 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. 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 21) 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 Proposed District 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.

Principal federal land holders within the Proposed District are the United States Department of Defense (DOD) and the Bureau of Land Management (BLM). The majority of the BLM land in the Proposed District 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 Proposed District, 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)

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.

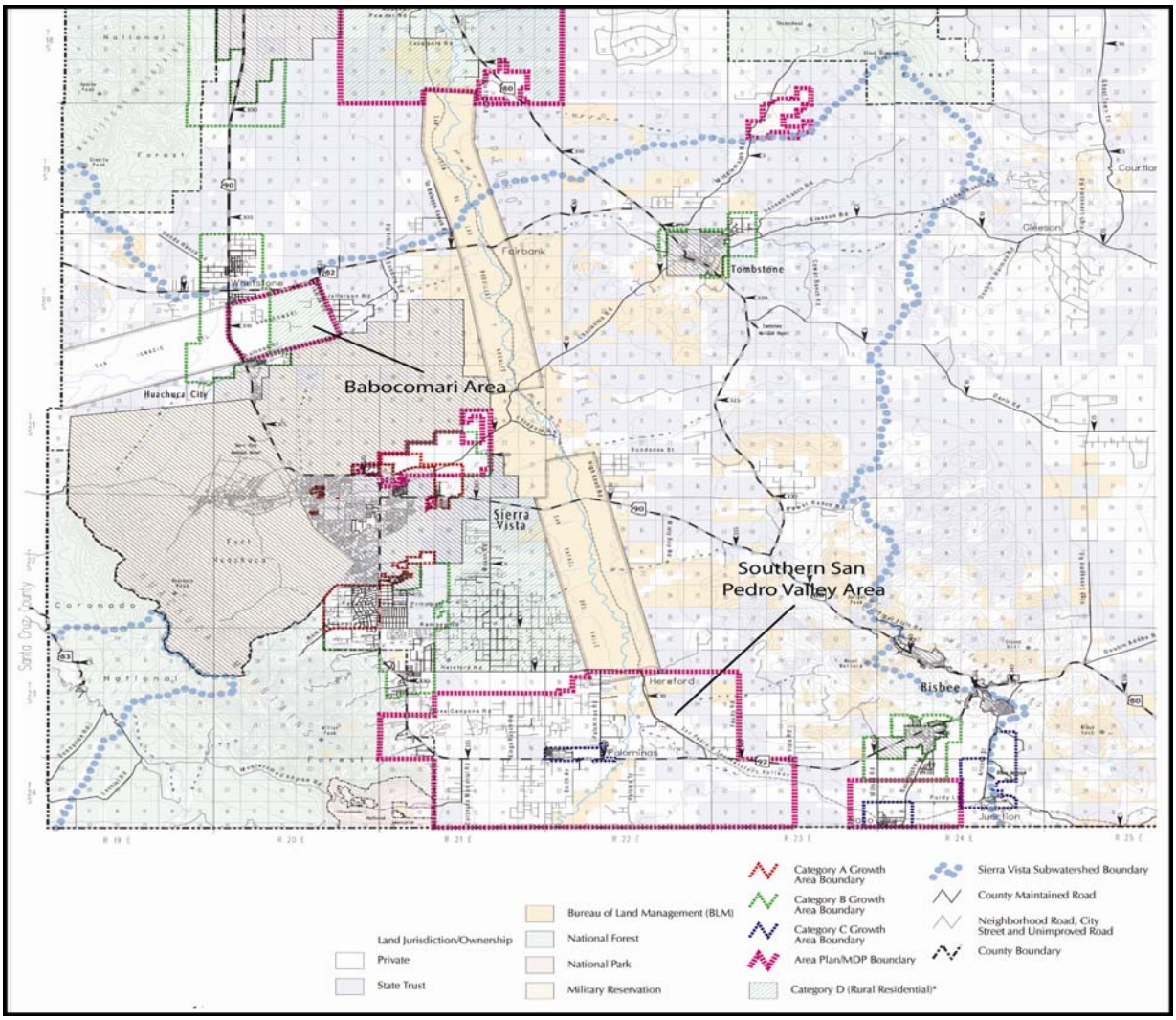


Figure 21: Excerpt from Cochise County Comprehensive Plan Map, 2006

B4. Impacts of Adjudication on Groundwater Withdrawals

As explained in Appendix A.3, Section 4, 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 sub-flow. ADWR is currently developing sub-flow zone maps for the watershed, including the area of the proposed 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 Adjudication Court may need to regulate the amount of water pumped from some wells to protect existing surface water uses.

B5. Impacts of Drought and Corresponding Natural Recharge

Natural recharge to the Proposed District 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 Proposed District. The average 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 precipitation at four stations in the Proposed District showed a general trend of increasing winter precipitation and decreasing 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.

As previously mentioned in Appendix A.2, Section 1.a,in early July of 2005, the San Pedro River stopped flowing at the Charleston gaging station for the first time on record; a condition that persisted for 10 days. The USGS has continuously collected data beginning in 1936, 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 the Charleston gaging station almost ceased again in both 2006 and 2007 prior to the onset of the monsoon.

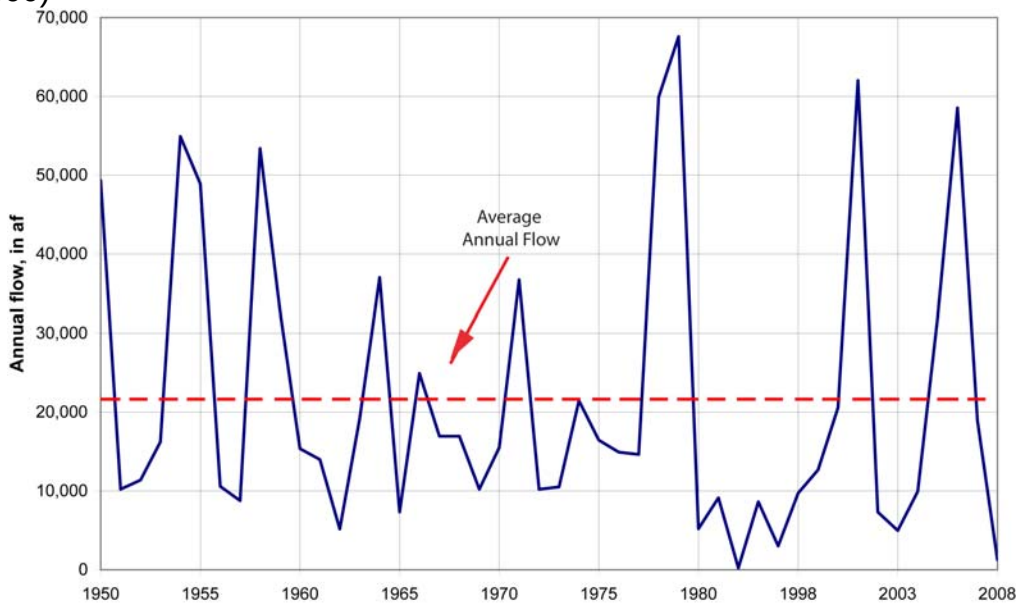
During the 2002-2005 time-period when drought conditions were extreme, there were reports of water level declines in some shallow, drought-sensitive domestic wells located along the base of the Huachuca mountains.

B6. Impacts of Reduced Underflow from Mexico

Cross border groundwater flux into the Proposed District 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 22). 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.

Figure22 - Annual Flow at the San Pedro River near Palominas USGS Streamgage (#9470500)



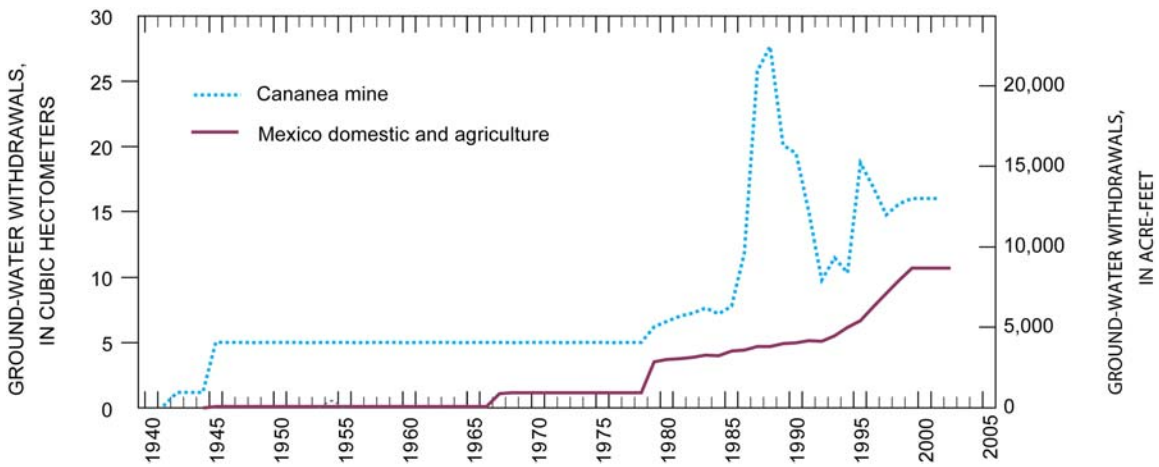
Source: USGS, 2008

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 23. 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).

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).

Figure 23 - Groundwater withdrawals in the Sonoran portion of the Upper San Pedro Basin (modified from Pool and Dickinson, 2007)



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.

B7. Conclusions Regarding Risks and Uncertainties

Population growth will likely be the primary factor affecting future demand in the Proposed District. 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 overdraft of 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, the resulting increase in effluent, rather than groundwater, could be used to irrigate parks and golf courses in the future. Even though some reductions in return flow from the septic tanks is expected, the overall overdraft may be reduced through reuse. Difficult decisions must also be made between the relative benefits of using effluent for aquifer recharge purposes near the river, as opposed to reducing pumping through reuse programs in other areas. The USGS groundwater model is the best tool to clearly define the tradeoffs of these regional water management decisions.

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 south of 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 as depicted in Figures 16, 17a and 17b. 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 Proposed District. While it is not possible to control this variable, mitigation measures may be undertaken to minimize risk.

APPENDIX C

Proposed Action Elements

C1. Powers and Duties of the District

C2. Spatial Water Management Emphasis of the District

1. Meeting Water Needs of the Next Decade Through Spatial Water Management

C3. Water Supply Adequacy – Consistency with the Goal of the District

C4. Water Conservation Plan

1. Past and Current Water Conservation Efforts
2. Future Water Conservation Efforts
3. The District's Role in Water Conservation
4. Conservation Easements and Other Examples of Demand Reduction

C5. Augmentation Plan

1. Engineered Augmentation
2. Redistribution
3. Spatial Water Management
4. Importation

C6. Water Reuse Plan

C7. Groundwater Recharge Plan

C8. Monitoring Plan

1. Aquifer Water Level Changes
2. Surface Water Flows
3. Climatic Changes
4. Land Use Changes

Proposed Action Elements

C1. Powers and Duties of the District

The proposed District was granted various powers and duties that will enable it to accomplish the goal. The characteristics of the powers the District may utilize are those needed for the implementation of water supply projects that will augment the existing supplies. The new supplies will be used initially to avoid any increase in the aquifer overdraft situation, and then later to reduce or eliminate the current level of overdraft. Based on the description of the powers of the District, it is apparent that the legislature envisioned the proposed District to be an action entity that will be involved in the construction and operation of these projects. A partial listing of those powers includes:

- Acquire property easements and rights of way (but without the power of eminent domain.)
- Purchase, construct, own, lease, maintain and operate all works, facilities, and other property necessary for the uses and purposes of the District
- Acquire, transport, deliver, treat or recharge water … including recharging stormwater and providing or selling water at wholesale to a person or entity that makes deliveries of water.
- Negotiate, make, execute, acknowledge and perform any contract, agreement or obligation it deems advisable for the interest of the District to carry out or accomplish the purposes of the legislation including agreements to acquire water supplies and water rights for water exchanges, recharge, underground storage, and water deliveries
- Plan, coordinate, construct, operate, maintain and dismantle water augmentation projects that are operated by the District, including treatment, recharge, underground storage and recovery and retention projects, water treatment and wastewater treatment and reuse projects.
- Acquire energy resources to operate district facilities.

The authorizing legislation does not empower the proposed District to be a retail water provider to water customers. Furthermore, it did not grant the District any regulatory authority including the authority to require measurement of pumping or mandates for water conservation. The District and its members may enter into voluntary agreements for these purposes. These limitations only seem to re-enforce the idea that the legislature intended the proposed District to address the goal through real “wet water” solutions.

C2. Spatial Water Management Emphasis of the District

1. Meeting the Water Needs of the Next Decade Through Spatial Water Management

Since the initial focus of this Comprehensive Water Management Plan is to address the District’s short-term goal (by 2020), the focus of all proposed District projects in this plan

are aimed at stabilizing current baseflow and groundwater conditions near the river by 2020, as the plan goal states. Spatial water management recognizes that where water is removed from, or recharged to, the aquifer can have just as much impact to the river as how much is removed, especially over shorter time scales; years to decades. Therefore the projects and policies pursued by the proposed District, such as water adequacy, water conservation, augmentation, redistribution, recharge, and importation, should all be strategically designed with spatial water management implications in mind. The relative impacts and/or benefits in terms of spatial water management from all of these strategies can be rigorously assessed through the use of the USGS groundwater model.

Options for spatial water management that minimize or prevent water demands near the river include the Transfer of Development Rights away from hydrologically sensitive areas, relocating existing groundwater extraction wells farther away from the river, and the establishment of conservation easements to limit future pumping near the river. Options for spatial water management that maximize the benefits of recharge projects include locating effluent and stormwater recharge facilities at key locations near the river where they can provide the most benefits within the shortest time period.

Although a spatial water management approach will not address the proposed District's longer term goals, (over decades to centuries), it will greatly assist in meeting the District's needs over the next decade, while additional strategies can be designed for the future. Eventually, any groundwater extracted from anywhere within the Proposed District will impact natural outflows (Alley and others, 1999), but employing this approach will allow the additional time needed to implement more comprehensive strategies that more completely address the sustainable yield of groundwater.

C3. Water Supply Adequacy - Consistency with the Goal of the District

Appendix A3, Section 6 above describes the Adequate Water Supply laws that are currently in place within the State of Arizona. The legislation which authorized the Upper San Pedro Water District amended the general water adequacy provisions by adding a critical additional component. This critical component, found in A.R.S. 48-108.1states:

> "For the purposes of Section 45-108, if the Upper San Pedro Water District is established … for proposed uses in the District "Adequate Water Supply" means a water supply that complies with all of the following…
>
> 2. The projected water use is consistent with the goal of the District as set forth (in the statutes) and the District's ability to meet the measurable objectives for achieving the goal as included in the District's most recent comprehensive plan as determined by the (ADWR) Director. If the District is established, the Director shall adopt rules containing criteria for making determinations under this paragraph and shall consult with the District Board in developing the rules."

The proposed District should take an active role in the rule making process with ADWR. The statutory provisions that require ADWR to consult with the District will give the District significant influence in shaping the Adequacy Rules to be consistent with its plans and measurable objectives.

Adequate Water Supply determinations apply to new growth associated with the development of subdivisions. Developments that occur through splitting of property into five or fewer parcels are not considered subdivisions and therefore are not subject to the adequate water supply laws. The determination of adequate water supply may be made either for a municipal water provider's entire service area, which is known as a designation of water adequacy, or on a subdivision by subdivision basis. Currently, there are no designated water providers within the Proposed District, so the water adequacy determination burden will fall upon each development that proposes to have a subdivision plat recorded.

Population projections shown in Table 14 anticipate growth of 12,840 people between the years 2010 to 2020 and an additional 9,766 people between the years 2020 to 2030 that will likely be associated with new subdivisions. Currently, all municipal water supplies within the Proposed District are derived from groundwater withdrawals. If groundwater continues to be the source of the new municipal water supplies needed to serve those subdivisions, the pumping of that groundwater will need to be found to be consistent with the goal of the District. Over the 100 year water supply timeframe required by the statutes, this may prove to be a daunting test since that pumping cannot cause an increased depletion of the aquifer or cause a reduction in the base flow of the San Pedro River. Without access to an alternative water supply source growth will be severely restricted.

By statute, the proposed Upper San Pedro Water District is intended to directly assist communities obtain adequate water supplies. It is anticipated that the proposed District would enter into contractual arrangements with subdivision developers or with designated municipal water providers to provide the alternative water supply assurances that will be necessary to ensure consistency with the District's goal. Based on these contractual assurances, which will be backstopped by the District's projects, ADWR may approve the adequacy of each subdivision's water supplies. These alternative supply sources may be provided in the form of direct delivery from augmentation sources or through the indirect delivery through artificial groundwater recharge projects. The groundwater recharge project approach has been in place for a number of years under a very similar framework in the Phoenix, Pinal and Tucson Active Management Areas. In those Areas, the Central Arizona Groundwater Replenishment District (CAGRD) was created by the State Legislature. A subdivider who needs to demonstrate an Assured Water Supply (a program similar to Adequate Water Supply, but applicable in Active Management Areas) can enroll the lands within the CAGRD and thereby obtain a determination of Assured Water Supply. The CAGRD is responsible to obtain alternative resources that may be recharged back into the groundwater aquifer to offset the amount of groundwater that would have otherwise

been depleted from the aquifer. It is envisioned that the proposed District will provide similar services within its boundaries.

Without new water supplies, the impact of the current water demands in combination with the projected demands from new growth will lead to an increase in the long-term overdraft of the regional aquifer. The resulting increased overdraft will eventually cause depletion of the surface water flows of the San Pedro River. Affecting the surface water flows may impact downstream water rights holders. Several down stream water right holders have a prior claim on the water supply. For example, the water right claims for the San Pedro Riparian National Conservation Area date from 1988. The St. David Irrigation District downstream of the proposed District has a priority date as early as 1881. Conflicts between water rights holders will be settled by the Superior Court. At this time the Court is considering the issue of "sub-flow" along the San Pedro River. All current and newly proposed wells that are presumed to be interfering with the flow of water in the river channel will be subject to Court regulation and possible limitations or curtailments in order to protect older, first-in-time, water rights.

The impact of the Gila River Adjudication proceedings and sub-flow determination for the Upper San Pedro River may affect the legal availability of water for new subdivisions whether the District is permanently formed or not. If increased groundwater withdrawals from existing and new wells are subject to Court jurisdiction, the formation of the District will be essential for assisting new developments with obtaining a water supply that complies with the adjudication and mitigates the potential impacts to the River.

C4. Water Conservation Plan

Water conservation plans identify projects and programs that when implemented reduce the demands for water. Typically this demand reduction is accomplished by increasing the efficiency of the water use process and by reducing and/or eliminating waste. Fort Huachuca and the cities, towns, water companies and the NRCD in the Proposed District have demonstrated that water conservation is an effective method of balancing the supply/demand equation. Therefore, conservation will continue to be an important component in accomplishing the proposed District's Measurable Objectives.

1. Past and Current Water Conservation Efforts

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

For example, several members of the Partnership, including the City of Sierra Vista, the City of Bisbee, Cochise County, and Fort Huachuca have made significant investments

in water conservation and have seen corresponding reductions in water use. ADWR monitors these conservation efforts. State law requires that each system include conservation in their water system plans and report on the updates to the plans to ADWR 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 systems are owned and operated by members of the Partnership.

Table 6 Community Water Systems Annual Water Use

Water System	2006 Water Use (acre-feet)	2007 Water Use (acre-feet)	2007 Reported Connections
Antelope Run Water Co.	63	Not Reported	161
Arizona Water Co. Bisbee	936	913	3439
Naco Water Company – Bisbee	12	12	70
Bella Vista South	176	168	644
Bella Vista – City	3212	3154	7427
Cloud Nine Water Co.	32	26	175
East Slope Water Co.	290	Not Reported	784
Holiday Water Co./ Tombstone	46	Not Reported	Not Reported
Indiada Water Co.	12	Not Reported	Not Reported
Naco Water Co. Bisbee	67	65	286
Northern Sunrise WC (Mustang/Crystal)	10	25	122
Palominas Water & Sewer Co-op	Not Reported	3	14
Pueblo Del Sol Water Co.	1426	1398	4897
Southern Sunrise WC Cochise/Horseshoe	Not Reported	129	545
Southern Sunrise WC Miracle Valley	Not Reported	31	241
Southland Utilities – Golden Acres	153	161	591
Huachuca City	245	213	761
Tombstone	145	155	802

2. Future Water Conservation Efforts

Other planned conservation measures, whose impacts are not currently quantified, include greater public education, building code changes, and water efficiency rebates.

3. The Proposed District's Role in Water Conservation

The proposed District is prohibited from directly imposing water conservation requirements. Instead, the District must rely on the conservation requirements adopted by other governmental entities as it evaluates its progress in meeting the District's goals and accomplishing its measurable objectives. Considering the active support that the other governmental entities have demonstrated toward conservation programs, it does not appear as if the District can increase the conservation activities to any significant degree. The successes of the District, however, will likely hinge on a strong and effective demand reduction program. To the extent the District will enter into contracts to provide alternative water supplies or to offset groundwater overdraft, that task is directly made more feasible when the collective water demand is reduced through water conservation efforts. Every percent that a subdivision can reduce its estimated water needs by using best management practices is a percent saved from having to be obtained from augmentation projects or recharged to accomplish aquifer replenishment. Therefore, to minimize the overall cost for future water supply augmentation, the District should consult and cooperate with the water providers and local governmental governing bodies to jointly adopt conservation goals and preferred conservation practices. By adopting conservation goals and objectives, the District can assist in conservation education programs and incentive programs to help implement the goals, whereas, the cities, towns and other governing bodies would be responsible for most conservation regulations. An active, coordinated successful conservation program will help the District to estimate the long-term water supply augmentation needs for the area. More accurate estimates allow better financial and investment planning.

If the District water conservation goals and preferred practices are consistent with the other governing bodies in the Proposed District and directly related to accomplishing the District's goal, it makes logical sense for ADWR to assume those conservation best management practices will be utilized as it reviews and evaluates new applications for Adequate Water Supply for subdivisions within the proposed District's boundaries.

4. Conservation Easements and Other Examples of Demand Reduction

Another effective form of water conservation relates to limiting water demand by placing restrictions on future land uses. Within the proposed District there have been several examples where conservation easements have been purchased. A conservation easement is a land use covenant that restricts current landowners and their successors from developing the land in a manner that uses excessive amounts of water. For example, a conservation easement could be purchased on land which would prevent that land from being developed using groundwater to support commercial irrigation or large subdivisions. This technique may be especially effective if it is targeted toward lands located near the San Pedro River where new groundwater withdrawals over time could have a negative impact on base flow conditions. Since this type of conservation program would not be considered to be an imposition of a water conservation requirement, the District would be free to participate in such programs. Similarly, developers of new subdivisions may be able to make investments in this type of off-site

conservation effort to obtain credit that would be viewed as an offset to proposed pumping that might otherwise not be consistent with accomplishment of the District's goal.

C5. Augmentation Plan

The introduction of new sources of water that will augment the supply in a manner that is consistent with the Goals and Measureable Objectives is the District's most difficult challenge and also it's most important function. Augmentation is essential to demonstrate an adequate water supply to ADWR. The discussion of available sources and estimated supplies and demands in Appendix B2, Section 2 indicates that local groundwater will remain the dominant water resource available to meet municipal, industrial, and irrigation needs. While the volume of groundwater withdrawals does not directly equate to groundwater overdraft, at the currently projected growth rates even with conservation efforts for existing and new uses, the projected aquifer overdraft is estimated to increase by 3,100 acre-feet by 2020 and 4,500 acre-feet by 2030. To offset the projected overdraft, one or more sources of supplemental water supplies will be needed in the future.

Before augmentation projects can be built, the District will have to commission appraisal studies, engineering and economic feasibility studies, and design studies leading to construction contracts. Studies related to augmentation projects that have already been completed through the efforts of the Upper San Pedro Partnership should be evaluated by the District prior to commissioning additional studies to eliminate the possibility of duplicating the same study. The process will take years to complete and financing mechanisms will have to be put in place as soon as possible.

Augmentation opportunities can be categorized as Engineered Augmentation, Redistribution, and Importation. For example, the most recent Draft Report to Congress prepared by the USGS in collaboration with the U.S. Department of Agriculture and the Upper San Pedro Partnership pursuant to the requirements of PL 108-136 Section 321 uses these categories.

Two additional water management concepts, redistribution and spatial water management are effective tools in aiding the District in meeting its goals and measurable objectives, but do not augment the overall water budget.

1. Engineered Augmentation

Engineered Augmentation refers to projects which could result in additions to the inflow components of the water budget within the proposed District by capturing water that, in the absence of the project, would not have been available for use. Examples of such projects are enhanced recharge of storm water through detention or salvage water that may otherwise be lost to plant transpiration or evaporation.

The Bureau of Reclamation, at the request of the Upper San Pedro Partnership, investigated options to capture urban runoff through construction of new collection systems that will utilize this water for subsequent recharge or direct uses. These opportunities appear to have the potential to yield positive results and result in as much as 1,800 acre-feet per year of additional recharge. Expansion of the opportunities evaluated by the Bureau of Reclamation could potentially increase this projected yield.

Considering the scope and the more local nature of these types of engineered augmentation projects, the Proposed District should emphasize this approach during the short-term period (prior to 2020.)

2. Redistribution

An example of augmentation by redistribution of water supplies has been described by the Bureau of Reclamation in an appraisal-level study to explore the option of removing water from the underground works of the Copper Queen mine near Bisbee, treating it, and transporting it to an upstream reach of the SPRNCA for recharge. The withdrawal of water from the underground works is not new. From 1906 to 1987 groundwater was withdrawn from the mine to facilitate mining operations. Since the cessation of mining operations, groundwater levels within the underground works have been rising and may eventually ‘daylight’ at the bottom of the Lavender open pit.

Transporting water from the Copper Queen mine for recharge near the SPRNCA is considered to be beneficial due to the relatively lengthy distance between the mine and the river, and evidence that the geology of the area will minimize any negative effects to streamflow in the future (Southwest Groundwater Consultants, 2004). The withdrawal of water from the mine also has the potential to minimize environmental issues for the mining company if the groundwater daylights in Lavender Pit. The Copper Queen mine redistribution appraisal report was recommended by the Partnership for continuation to feasibility analysis, although recent correspondence from the owner of the mine indicates that this specific proposal has been removed from further consideration at this time.

3. Importation

Importation refers to obtaining rights to water resources located outside of the Proposed District and then transporting those water resources into the Proposed District for beneficial use. Imported water could be used to replace existing uses of groundwater, or the District could use imported water sources to meet the Adequate Water Supply requirements for future subdivisions. One example cited as an importation project is the delivery of Central Arizona Project (CAP) water. CAP water would only be available from a turnout on the CAP aqueduct system and the nearest point of delivery would be in Pima County near Tucson. Any project proposed to pipe the water from that location to be delivered within the District is obviously very complicated and potentially very expensive. Within the first ten years (through the year 2020) the District should investigate the feasibility, including financial feasibility, of various importation

alternatives including the importation of CAP water. Large scale projects such as CAP will take decades to investigate, plan, finance and construct. Long-term studies are helpful even if large scale projects are not feasible in the short-term. Smaller scale projects are most likely to be feasible in the first ten to twenty years.

C6. Water Reuse Plan

Reuse projects will create the opportunity to collect water that has been utilized in some manner so that it can be put to a secondary beneficial use. Reuse projects typically involve the collection and transportation of treated municipal effluent. The effluent, once treated to appropriate standards would be available for a secondary use, such as irrigation of commercial crops, athletic fields, parks, or golf courses.

Reuse of wastewater may be a practical and efficient method to reduce the demand for groundwater. For example, if a subdivision plat included an open space area that requires water for the irrigation of landscaping, the overall water demand for groundwater within the subdivision will be reduced by substituting effluent for groundwater to meet that need. In a larger sense, the overall demand for groundwater within the District's boundaries can be reduced if current groundwater uses can be replaced with effluent provided by a reuse project.

The mechanism for developing an effective reuse project by the proposed District will first require a contract to purchase effluent from an entity that owns and operates a municipal wastewater treatment facility. At the present time this could be the City of Sierra Vista, Fort Huachuca, the City of Bisbee, or the City of Tombstone. Of course, new opportunities for additional local wastewater treatment plants may arise from developments located in the unincorporated portions of the County. Once the effluent supply has been obtained, a pipeline or open canal system could be constructed to transport the effluent to the various proposed places of use. An example of a large-scale effluent reuse distribution system is the current system operated by the City of Tucson to provide effluent to numerous golf courses within its water service area. Within the Proposed District, Fort Huachuca provides effluent to the Mountain View Golf Course and in the near future effluent from the City of Bisbee's wastewater treatment plant will be used for irrigation of the Turquoise Valley Golf Course in Naco, Arizona.

In giving consideration to making investments in a reuse system the proposed District needs to give consideration to the point raised by the USGS in its discussion of reuse in the 2007 Report to Congress which correctly states that "Reuse only reduces groundwater demand, however, if existing uses of groundwater are retired. If reused water is viewed as a source of water to initiate a new use, say a turf facility that would not otherwise exist, then the result is still a net increase in water use and not a mitigation of existing groundwater use."

Another equally important consideration in planning a reuse project is to consider what would have been the disposition of the effluent supply if it were not collected and transported for reuse. Currently, most of the municipal effluent is being effectively

utilized through groundwater recharge facilities which have an equally beneficial affect on reducing the aquifer overdraft condition and are very cost effective. Due to the fact that effluent is currently being recharged effectively, it would not appear that the development of a large scale reuse project by the proposed District would be sought before the year 2020. However, within an individual subdivision or within the service area of a designated municipal water provider who needs to obtain approval for a water adequacy application, reuse may be an effective component in demonstrating supplies that are consistent with the District's goal.

C7. Groundwater Recharge Plan

Artificial groundwater recharge projects refer to constructed shallow ponds that are used to rapidly infiltrate water back into the ground. Across Arizona, artificial recharge is one preferred method to store water for later use. Within the Proposed District, such projects have been extremely successful in reducing the annual overdraft. As shown in the Water Budget (Appendix B2, Section 2, Table 5) in the year 2005 approximately 15% of the groundwater withdrawn for municipal uses was offset by recharging effluent back into the aquifer. By the year 2030 this percentage is expected to grow to about 21% as a higher percentage of the population will be severed by to sewage treatment facilities rather than septic tank systems.

There are currently two active recharge projects within the Proposed District. One is owned and operated by the City of Sierra Vista and the other is owned and operated by Fort Huachuca. Both systems recharge treated municipal effluent. Fort Huachuca recently reached an agreement with the Huachuca City to transfer up to 400 acre feet per year of that community's sewage effluent to the treatment plant located on the Fort. The treated effluent will then be recharged at the Fort's recharge project. This project will replace Huachuca City's current disposal technique of discharging the water to lined lagoons for disposal though evaporation.

Artificial recharge projects are assisting in meeting the District's goals and measurable objectives. The goal of maintaining the aquifer is assisted by offsetting the groundwater withdrawals by putting a portion of the water back into the aquifer. They can also assist in preserving the baseflow conditions of the Upper San Pedro River by strategically locating the recharge projects in locations where the recharged water will either flow toward the River or create a mound of water to slow the expansion of any cones of depression caused by up-gradient wells. For these reasons, recharge will be necessary to implement many of the action plan activities.

As the District moves forward with contracts to provide replenishment service for new subdivisions, it will need a comprehensive recharge project plan to maximize the return of municipal effluent and to recharge new water supplies in areas that will maximize the protection of the groundwater levels and baseflow of the San Pedro River and its tributaries. During the first ten year period, it is most likely that the District will not construct and operate an independent recharge facility, but would either pay to expand existing facilities or lease unused capacity (if available) in the two existing facilities. The

District will need to create long-term agreements with Sierra Vista and Fort Huachuca for use of existing facilities. In the future, partnerships to build and operate facilities may be advisable to manage costs and increase efficiencies. In the following decade, as opportunities to obtain additional augmentation water supplies are identified and developed, the District may find that it will need to develop new facilities that can be used to meet replenishment obligations and ultimately to reduce current levels of overdraft as outlined in mid-term and long-term measurable objectives goals.

C8. Monitoring Plan

Adopting the proposed Measurable Objectives and Planning Goals establishes a quantitative baseline for the District to determine the potential and actual success of any adopted Water Management Plan as well as provides a means to evaluate the effectiveness of each proposed project. The regional groundwater model developed by the U.S. Geological Survey is the best tool for predicting whether or not the proposed District planning strategies are adequate to meet these goals.

The groundwater model uses actual, measured groundwater levels. The model accurately portrays the historical groundwater level changes of the previous decades. Its reliability and accuracy is considered very high. The model is a very useful tool to predict the results of various groundwater recharge, conservation and reuse actions that the District might contemplate.

Even though the model is a useful predictive tool, monitoring of actual conditions in the field should be used to assess the actual performance of management measures over time. Monitoring will involve a systematic approach to data collection so that it may be input in a timely manner into the analytical models that will be used by the District. There are a number of data aspects that will be actively monitored.

1. Aquifer Water Level Changes

An active program of water level measurements will be continued and potentially enhanced. Key wells will be identified that will be used as indicator or index wells. ADWR already has an established monitoring program that includes 36 index wells that are measured annually. However, some of these index wells are pumping wells which can be influenced by the effects of localized pumping, depending upon the timing of measurements. In addition, ADWR periodically (at least once every five years) will perform a sweep of all known wells to develop a broader based data set. The information from the groundwater level sweep is analyzed by ADWR. Based on the analysis, water elevation maps and water elevation change maps are published for public information. These data will be enhanced by water level data from the USGS and Fort Huachuca. Water levels are typically obtained quarterly by those two entities at approximately 23 additional wells. A number of those wells are monitored continually using pressure transducers. The District will evaluate the current ADWR, USGS, BLM, and Fort Huachuca water level monitoring programs to determine if further

enhancements are needed. If so, the District will request that these entities make adjustments to their water level monitoring programs to meet the District's needs.

2. Surface water flows

There are currently nine USGS streamflow gages located within the District's boundaries. San Pedro River discharge is measured by gages near Palominas, near Charleston and near Tombstone. The Babocomari River is measured by two gages, one above Arizona Route 90 and one below, the Babocomari's confluence with the San Pedro River. There are also USGS streamflow gages located in Ramsey Canyon, Huachuca Canyon, Garden Canyon, and on Banning Creek. The Agricultural Research Service (ARS) also operates a number of gages in Walnut Gulch. Considering the number and strategic location of active gages, it is probable that no additional stream gages will be needed to monitor surface water flows, aside from one at or very near the international border.

3. Climatic changes

In order to provide the level of sensitivity needed to evaluate groundwater model results weather and climate change information will be useful. In general, consumptive use by plants is related to temperature, precipitation and solar radiation. The District will collect this information from existing weather station sources, and then analyze the data to determine when above normal or below normal weather conditions may be significantly affecting water use patterns or riparian plant evapotranspiration. Resources from the University of Arizona CLIMAS center, USDA Agricultural Research Service, and the ADWR Drought Monitoring Technical Committee may be available to support the District efforts.

4. Land use changes

Land use changes, especially those related to agriculture and construction can have an effect on water use or groundwater recharge. The proposed District will work collaboratively with Cochise County to monitor land use changes. Satellite photos or other available aerial photos will be used to obtain this information.