PINAL COUNTY

COMPREHENSIVE PLAN

AREA 4-B

WATER RESOURCES

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WATER AVAILABILITY IN AREA 4-B

1. INTRODUCTION

Pinal County is in the process of developing a Comprehensive Plan that can be used to manage future growth. Although the plan incorporates several elements, a major component is water resources and, more precisely, the availability of water for future growth within the six planning areas of the Comprehensive Plan. One of these planning areas, Area 4-B is the subject of this water availability report. The objective of this report is to synthesize existing hydrogeologic information into a format that can be used to evaluate the potential impact of various developments on the water resources within Area 4-B.

In addressing water resources it is important to recognize that Arizona has legislation that governs groundwater and surface water use within the State. In both cases, the doctrine of "Prior Appropriation" applies. No individual "owns" water in Arizona. Rather, the use of that water is apportioned through a demonstration of having placed (or intending to place) a unit amount of water to a "beneficial use." The individual is then granted a "Right" to the beneficial use of that water. Inherent in this doctrine is the understanding that exercising these rights depletes the resource, either groundwater or surface water, to some extent; but, that the depletion is outweighed by the benefits derived from the use. In 1980 the state legislature codified access to the state's groundwater resources in the Groundwater Management Act. This legislation created four groundwater Active Management Areas (AMAs) within which the use of this valuable resource would be strictly regulated. In addition, it established reporting requirements for groundwater use outside of the AMAs.

Surface waters in Arizona have historically been allocated through a series of rights to divert water from streams. These rights are currently being adjudicated by the state Superior Court.

2. PHYSICAL SETTING

Geographically, Area 4-B is in the southeast corner of the county and incorporates all or portions of the communities of Saddlebrook, Oracle, San Manuel and Mammoth (Figure 1). It is a complex planning area in part because it transcends the border of the Tucson Active Management Area (TAMA) resulting in different sets of regulations governing water use inside versus outside the AMA.

Physiographically, Area 4-B is part of the Basin and Range Lowlands province of Southern Arizona. The western half of Area 4-B covers portions of two groundwater basins, the Avra Valley and Upper Santa Cruz Subbasins that are part of the Tucson AMA. The eastern portion of Area 4-B includes part of the San Pedro River basin, which is not included in an AMA.

A surface water divide at the headwaters of Big Wash defines the Avra Valley subbasin portion of Area 4-B. Similarly, a topographic divide that separates Camp Grant Wash from the Canada del Oro marks the eastern boundary of the AMA. Until new data are forthcoming, it has been assumed that these divides exists and that groundwater in the Avra Valley subbasin portion of Area 4-B flows to the northwest while groundwater in Camp Grant Wash flows to the northeast

Hydrologically, the western portion of the Area overlies aquifers within the Upper Santa Cruz and Avra Valley Sub-basins of the Tucson Basin. For the purposes of this report, the area of the Upper Santa Cruz subbasin will be referred to as the Canada del Oro area (CDO). These sub-basins are drained by the CDO and Santa Cruz respectively (Figure 1). The Santa Cruz flows to the northwest, while Cañada del Oro Wash and its tributary Big Wash, drain to the southwest.

The eastern portion of Area 4-B lies outside the AMA in the San Pedro River basin. The San Pedro River and its tributaries Camp Grant Wash on the west and Aravaipa Canyon to the east drain this watershed. Groundwater within this portion of Area 4-B flows toward the northwest except in the area of Mammoth and San Manuel where pumping from the mines has resulted in a decline in water levels.

2.1 Climate

Area 4-B exhibits characteristics of both the Lower and Upper Sonoran Desert Zones. Past weather records show that this location receives approximately eleven inches of precipitation per year. Most of this is experienced during the summer months from late afternoon or early evening thunderstorms that originate from northerly flows of warm tropical air. Summer storms are usually intense over the mountain regions producing turbulent wind and localized heavy showers. Conversely, winter precipitation is less severe but longer lasting, originating from mid-latitude storms in the North Pacific that move eastward across the United States. Winter storms resulting from frontal events produce lower intensity and longer duration flow events in local washes than summer monsoon thunderstorms.

Summer temperatures peak over 100 degrees with low relative humidity, while winter months are mild with only a few days experiencing freezing temperatures.

2.2 Vegetation

The dominant vegetation within the study area includes mixtures of mesquite, palo verde, creosote bush, ocotillo and assorted desert cacti. The overall vegetative cover is sparse, except for reaches along the San Pedro River, Big Wash, Cañada del Oro Wash and associated ephemeral tributary washes which contain dense stands of salt cedar and other phreatophytes.

Vegetation in this region is well adapted to the desert environment. Most plants have shallow complex root systems to absorb water from localized storm runoff, storing it in the fleshy plant tissue for times of low precipitation.

3. NORTHEAST AVRA VALLEY SUB-BASIN

The portion of Avra Valley within Area 4-B is located at the extreme northeast edge of the subbasin and might best be considered a microbasin associated with the larger aquifer system. This micro basin is roughly 14 miles long and four miles wide.

3.1 Geology

The alluvial basin underlying the portion of the Avra Valley Subbasin in Area 4-B generally trends to the northwest and is a microbasin between the Suizo Mountains, Durham Hills and Black Mountain. Bedrock drops off sharply from surface outcrops to an estimated depth of 800 feet below land surface at the base of the mountains. This configuration is shown on Figure 2, as determined by Oppenheimer and Sumner (1980) from gravity surveys. It should be noted that Oppenheimer had no gravity transects in this area and, therefore, these depths were simply extrapolated from the main basin. An examination of drillers' logs of wells within the study area, indicated that none has, as yet, penetrated bedrock in this area and appear to verify at least a portion of Oppenheimer's findings.

3.1.1 Tucson Basin Stratigraphy

In order to gain a perspective for the relationship between the aquifers present in the western portion of Area 4-B and the larger system that comprises the AMA, it is important to understand the basic hydrogeology of the Tucson Basin. In this area, the main Avra Valley aquifer is bounded on the east by the Tortolita Mountains and on the west by the Picacho and Silverbell Mountains. The Santa Cruz River and its tributaries drain the watershed and provide extensive recharge to the alluvial aquifer. Since 1940 the volume of water pumped from the aquifer has exceeded natural recharge as evidenced by declining water levels throughout the system.

In Avra Valley sedimentary rocks of three major units form a single aquifer. These include the Pantano Formation, which is overlain in some areas by Tinaja beds (both of Tertiary Age), and the Fort Lowell Formation comprised of surficial deposits of Quaternary Age. Collectively these three units reach thicknesses of more than 2000 feet in places and are mainly composed of loosely consolidated to moderately cemented silty sand to silty gravel. Studies performed by both USGS and the ADWR indicate that the Fort Lowell Formation provides most of the groundwater withdrawn locally though, in some areas, very recent deposits of channel alluvium also yield substantial quantities of water. Although the entire sequence is not present in the Avra Valley portion of Area 4-B, the following descriptions are provided for reference.

> *Pantano Formation*: The Pantano Formation generally is a reddish-brown silty sandstone to gravel that is weakly to strongly cemented by calcium carbonate (Davidson, 1973). It crops out in the foothills of the Santa Catalina Mountains where it overlies bedrock. Though the Pantano has not been penetrated locally, this formation and correlative sequences of sedimentary rocks yield significant quantities of water at depth in other areas of the Tucson Basin (Davidson, 1973).

Tinaja Beds: The Tinaja beds consist of an upper member, comprised of gray to grayish-brown sandy gravel, and a lower member, which changes from a gray to grayish-brown to a reddish-to-medium-brown gypsiferous clayey silt and mudstone from west to east across the Tucson basin. In Area 4-B, the Tinaja is mainly comprised of sands and gravels which appear to be locally derived from the bordering granitic and metamorphic rocks and radiate toward the center of the basin in a large fan (Davidson, 1973).

Fort Lowell Formation: The Fort Lowell Formation consists of unconsolidated to moderately-consolidated sediments that range in color from dark- to light-reddish brown.

3.2 Hydrogeology of Area 4-B in Avra Valley

Area 4-B is located along the eastern perimeter of this system and little information is available which might be used to define the micro-basin's hydrogeology. Based upon data available for the main aquifer system; however, some characteristics can be extrapolated. Based upon Oppenheimer's maps, the maximum thickness of alluvial valley fill can be expected to be on the order of 800 feet. Data from Cuff and Anderson (1987) indicate that most of these sediments are Fort Lowell Formation possibly grading into an upper sand of the Tinaja beds. Groundwater flow in Area 4-B would be toward the northwest to join the main portion of the aquifer then generally paralleling the Santa Cruz River.

3.2.1 Avra Valley Area 4-B Aquifer Characteristics

Because of the lack of well data in the area no attempt has been made by past researchers to define the characteristics of the micro-basin aquifer. Based upon water levels collected by ADWR in the area, and Cuff and Anderson's 1987 maps, it can be inferred that the average depth to water in the area is 400 feet, with 800 feet of available alluvium. The saturated aquifer should be approximately 400 feet thick. Considering Oppenheimer's map, using the 800-foot contour to define the lateral limit of the aquifer, the microbasin aquifer would be approximately four miles wide and fourteen miles long in area 4-B. This converts to a saturated aquifer volume of roughly 120 million cubic feet of material. Data from the CDO basin, discussed later in this report, indicate that this aquifer has a specific yield on the order of 15 percent. Based upon these figures, the extractable water in storage may be approximately 400 acre-feet, depending upon the actual depth of pumping and other variables.

3.2.2 Avra Valley Area 4-B Recharge

Recharge to this aquifer system is predominantly from streambed infiltration and mountain front recharge. Anderson (1972) estimated that the average recharge for similar mountain front areas was 100 ac-ft/mile/yr. Assuming that this estimate can be applied equally to the Suizo Mountains and Black Mountain, with seven miles of mountain front, annual recharge to the system could be estimated to be nearly 700 acre-feet.

3.2.3 Avra Valley Area 4-B Water Quality

No data are currently available regarding the quality of the water pumped from this microbasin.

3.3 Avra Valley Area 4-B Surface Water

Surface flow in local washes is ephemeral in response to storm events and no data exist for this portion of Area 4-B.

3.4 Avra Valley Water Use

In this portion of Area 4-B, water use is minimal consisting of a few small domestic and stockwater wells.

4. CAÑADA DEL ORO SUB-BASIN

Much of the western portion of Area 4-B lies between the Santa Catalina and Tortolita Mountains within the Cañada del Oro drainage basin. This area is approximately 256 square miles and, prior to development, land was used for ranching or remained as undisturbed desert. Groundwater use prior to development was from residential domestic wells scattered throughout the area and from wells owned by the Lago del Oro Water Company to serve the town of Catalina and Arizona Water Company wells serving the town of Oracle. Several communities have been master planned over the last two decades and are under development within the CDO area. During this period of growth, withdrawals from local aquifers were replenished by natural recharge, and minimal water table declines occurred. As development continues, however, increased demands on the system may change this situation.

4.1 CDO Geology

Both the Santa Catalina and Tortolita Mountains are composed primarily of metamorphic and intrusive igneous rocks. Alluvial debris eroded from these mountains was deposited over geologic time in the intermountain basin and comprises the local aquifer system. Faulting, associated with major mountain building episodes, produced a series of down dropped blocks that progressed from the mountains toward the axis of the valley.

The alluvial basin underlying the CDO portion of Area 4-B generally parallels the north-south trend of the Santa Catalina and Tortolita mountains. Bedrock drops off sharply in a westerly direction from surface outcrops to over 3200 feet below land surface within about 2 miles of the base of the mountains, shallowing to the northwest. This configuration is shown on Figure 2, as determined by Oppenheimer and Sumner (1980) from gravity surveys, and has a general accuracy of $\pm$ 30 percent. An examination of drillers' logs of wells within the study area indicated that none has, as yet, penetrated bedrock. These logs, which are on file with the ADWR, showed well depths that ranged from 465 to 1200 feet deep, listing sequences of clay, sand, gravel and conglomerate, and appear to verify at least a portion of Oppenheimer's findings.

4.2 CDO Hydrology

Water in the CDO portion of Area 4-B is supplied predominantly from wells tapping sedimentary deposits of both the Fort Lowell Formation and the underlying Tinaja sands. Both units are described in Section 3.1.1 and attain a combined thickness of over 1,200 feet in most of Area 4-B, thinning out towards the mountains and headwaters of the Cañada Del Oro Wash and Big Wash (Davidson, 1973). Groundwater in this aquifer generally occurs under unconfined conditions and is recharged by subflow from the north, mountain front recharge and infiltration along the Cañada del Oro and Big Washes.

4.2.1 CDO Surface Water

The Cañada del Oro is perennial throughout its upper reaches in the Catalina Mountains. As the stream reaches the alluvial basin and traverses the valley floor, infiltration claims most of the surface flow except during high precipitation or snowmelt events (Johnson, 1989). The average inflow from the Cañada del Oro Wash and its tributaries was calculated by Burkham (1970) to be 9,940 ac-ft/yr with an average outflow of 4,000 ac-ft/yr leaving 5,940 ac-ft/yr as recharge to the groundwater system. The U.S. Geological Survey maintained a gaging station on the Cañada del Oro (#4863) for the period 1966-1978. Their measurements indicated an average flow of roughly 1,200 ac-ft annually. (Johnson, 1989)

4.2.2 CDO Groundwater

Groundwater reserves in the CDO basin provide most of the water consumed locally. In addition to domestic and stock wells, several water companies rely upon this resource. Although pumping is increasing locally, several researchers have determined that the aquifer system is still in safe yield, and pumpage has not exceeded natural recharge.

4.2.2.1 CDO Water Levels

Water level information within the study area was available from records of the City of Tucson and the ADWR. In the western portion of Area 4-B groundwater flow is toward the southwest at an average gradient of approximately 35 feet per mile and depths to water average 400 feet across the study area.

In 1989, Johnson examined historic groundwater records to determine an annual decline rate, in feet per year, for the CDO area. From this data, it appears that the overall change in Area 4-B was an increase in water levels over the period of measurement from 1950 to 1986. Johnson noted, however, that this increase could have been due to unusually high rainfall in the late 1970s and early 1980s. More recent data from local wells, however, still indicates water level fluctuations but no continuous decline.

4.2.2.2 CDO Aquifer Characteristics

In order to evaluate the resources present within the CDO aquifer system, establish its potential, and determine its limitations, available information was used to define the principal geologic features of the regional aquifer in relation to its hydrologic characteristics. Although the characteristics of the shallow alluvial aquifer have not been determined through aquifer testing, tests of deep wells have been conducted at Rancho Vistoso, Goodman and Lago del Oro water companies and the City of Tucson. Upon analysis, these yielded an average transmissivity of roughly 50,000 gallons per day per foot and a storage coefficient of 15 percent for the aquifer.

4.2.2.3 CDO Underflow and Recharge

Johnson (1989) calculated that the groundwater recharge to the CDO aquifer north of the Pinal County line was approximately 8,900 ac-ft/yr. In addition, he estimated that 7,580 ac-ft/yr of recharge occurred in the southern portion of the CDO basin between the county line and the confluence of the Cañada del Oro and Big Wash. Using annual pumpage reports on file with ADWR, he determined that average annual withdrawals for the entire CDO totaled 2,000 acre-feet. Using these figures, the resulting underflow from the Cañada del Oro subbasin to the Upper Santa Cruz system would be approximately 14,000 acre-feet per year.

This estimate was supported by Halpenny (1991) who calculated total recharge to be 11,775 acre-feet annually (7,875 ac-ft/yr north of the county line and 3,900 ac-ft/yr in the southern basin area).

4.2.2.4 CDO Storage

Johnson calculated the storage capacity of the aquifer from the land surface to 1200 feet of depth (approximately 600 feet of saturated thickness) to be slightly more than three million acre-feet north of the Pinal County line and five million acre-feet south of the county line to the confluence of Cañada del Oro and the Santa Cruz River. The 1200-foot depth was chosen because, at the time that Johnson performed his calculations, this corresponded to the regulatory lower limit of pumping for 100-year assured water supply demonstrations. Since that time, the regulations have changed and the new lower limit of pumping is 1000 feet below the land surface. This effectively reduces the volume of available saturated aquifer by approximately one third. Assuming that the storage capacity of the aquifer decreases with depth and compaction, a conservative estimate of the volume of water available for development would still be nearly two million acre-feet.

4.2.2.5 CDO Water Quality

Water in the CDO area is generally of good quality and is currently used for urban, domestic and various industrial purposes. Johnson found it to be mostly a bicarbonate type and generally low in total dissolved solids in Pinal County.

4.2.2.6 Page-Trowbridge Landfill

The Page-Trowbridge Landfill occupies approximately three acres of the Page-Trowbridge Ranch owned by the University of Arizona (UA). The site is located in an undeveloped area north of State Highway 77 between Oracle Junction and Oracle. The landfill is capped by six to eight feet of soil and surrounded by a security fence. There are four groundwater monitoring wells at the site.

UA began using the site in 1962 for disposal of radioactive wastes. Disposal of chemical waste at the site began in the early 1970's. All disposal at the site was properly permitted and in 1986 the site was closed. The closure was closely monitored and that monitoring will continue.

In January 2000, Dames and Moore reexamined all of the issues surrounding this landfill. Their conclusion was that the landfill posed no imminent threat to the local aquifer. The landfill cap is thick enough to prevent infiltration of rainwater and the local water table is 650 feet below the land surface. At this time there is no reason to question their findings.

4.3 CDO Current and Projected Water use

Several communities have been master planned over the last two decades and are under development within the CDO area. During this period of growth, withdrawals from local aquifers were replenished by natural recharge, and minimal water table declines occurred. It is important to recognize, however, that water use was only a portion of the water requirements for these developments that had been permitted by the ADWR. This "Committed Demand" must also be accounted for when evaluating long term impacts on the groundwater system. In 1991, Halpenny examined the committed demand in Area 4-B as part of his hydrogeological analysis of the Biosphere II development's water requirements. Since that time, Units have been added to the Saddlebrook Subdivision and two new Master Planned Communities (SaddleBrooke Ranches and Willow Springs Ranch) are being considered for development in the area. If approved by the ADWR, their committed demands will have to be added to the total.

In addition to these, Pinal County has estimated that approximately twenty sections of land west of State Route 77 at Oracle Junction will eventually be developed to an average density of three residences per acre. On this size lot, in this area, the ADWR estimates that an average of 2.2 people would occupy each residence. This converts to a population of 84,480 people on 38,400 lots. In the Tucson AMA, ADWR estimates an indoor water use of 57 gallons per day per person and 118 gallons per day per lot of outdoor use. Using these estimates, the 38,400 lots would have an outdoor water use of slightly less than 5,100 acre-feet annually. Indoor water use would be approximately 5,400 acre-feet each year at full build-out. Therefore, the total yearly water demand on these 20 Sections, using ADWR's figures, would be 10,500 acre-feet if the property were developed to the densities specified.

These demands are shown in the following table.

AREA 4-B COMMITTED WATER DEMAND	
Service Provider	**ac-ft/yr**
Arizona Water Company	375
SaddleBrooke and Lago del Oro Water Company	2,577
Eagle Crest	763
Biosphere II	1,350
Total currently committed	**5065**
Proposed Developments	
SaddleBrooke Ranches	2700
Willow Springs Ranch	4000
20 Sections at 3 residences per acre	10,500
Total expected Demand	**22,265**

Although, once these committed demands are realized, CDO pumping in Area 4-B will exceed recharge by some 14,000 acre-feet annually, sufficient water will be available from storage to make up the shortfall. In addition, these estimates do not take into account the five million acre-feet of water in storage in the aquifer south of the county line.

4.4 CDO Effluent Use

Management of water resources in the Tucson AMA includes not only regulating the use of fresh water but actively seeking ways to reuse sewage effluent as well. Historically effluent from the Tucson Wastewater Treatment Plant was discharged into the bed of the Santa Cruz River and gradually infiltrated to recharge the Avra Valley aquifer. Although this produced some limited benefit, it was not the most efficient use of a limited resource since fresh water continued to be used for purposes such as irrigation that could as easily have been satisfied with effluent. The problem was that the point of potential use was far removed from the treatment plant discharge point.

More recently, however, the problem has been examined in greater depth. As an example, in October 2000 the town of Oro Valley at the southern end of the CDO completed an examination of the renewable water resources available to the community. Although no plans have as yet been implemented as a result of this investigation it represents the commitment of local residents to utilize all of the resources available to them.

Within Area 4-B, plans have been proposed for the utilization of effluent in golf course irrigation. At present, however, none of these plans have been implemented.

5. SAN PEDRO RIVER BASIN

5.1 Geology

In addition to the Upper Santa Cruz and Avra Valley subbasins, the eastern part of Area 4-B spans a portion of the San Pedro River basin. The lithology of this area is distinctly different from that encountered in the Cañada del Oro and Big Wash areas. The Galiuro and Dripping Springs Mountains border the basin on the east and the Rincon, Santa Catalina, and Black Mountains form it's western boundary.

5.2 Hydrology

The lower San Pedro basin spans an area of approximately 1,550 square miles. Runoff from this watershed feeds aquifers in the flood-plain alluvium and the valley-fill deposits. Some springs issue from the surrounding mountains; however, these are of little significance as water sources with flows ranging from 0.06 to 112 gallons per minute as reported by Jones in 1980.

5.2.1 Surface Water

The San Pedro River is ephemeral throughout most of its length with only a few exceptions where high bedrock forces flow to the surface. It enters the U.S. near Palominas, Arizona and flows northward to its confluence with the Gila River near Winkelman. Historically, numerous water rights claims have been made to the flow of this stream; and, the Court is currently evaluating these claims.

5.2.2 Groundwater

Two distinct groundwater systems are found in this area. The upper, water table system is in direct contact with the stream and is recharged from intermittent streamflow and mountainfront recharge. The lower system is confined by a gypsiferous clay layer of limited aerial extent and is recharged at the mountainfront.

5.2.2.1 Water Levels

The aquifer in this area is in direct contact with the flow of the San Pedro River. Because the San Pedro River serves as the major source of recharge to the system, water levels fluctuate seasonally in response to surface flows. In general, the direction of flow is to the northwest paralleling the axis of the river and is normally encountered at depths of 40 to 60 feet below the surface.

Data available from the Arizona Department of Water Resources (1993) indicates that groundwater in the basin-fill can be found in both confined and unconfined conditions. Water levels are generally stable in the basinfill. In the lower confined aquifer, however, pumping by the mines has resulted in an annual decline of approximately one foot per year for at least the last thirty years. Because these is no connection between the two systems, the water table contour map currently being developed for the area by ADWR using 1995 data shows no significant change in water levels since Jones mapped water levels in the area in 1979.

5.2.2.2 Aquifer Characteristics

Two major water-bearing units have been identified in the San Pedro system. The uppermost of these, the streambed sediments, are generally referred to as the Holocene alluvium and form the channel and floodplain of the river. Beneath the streambed sediments is the alluvial basin-fill that comprises the principal aquifer in the valley. This basin-fill has been further subdivided into the upper basin-fill, the lower basin-fill and a basal conglomerate. (ADWR 1993)

The hydrologic characteristics of the regional aquifer vary depending upon the amount of compaction and the presence or absence of fine-grained clay layers. Groundwater in the alluvium is unconfined and water levels are usually less than 60 feet below the surface (Jones, 1980). Where saturated, this unit yields large quantities of water to wells and is recharged directly from stream flow. In the Mammoth area, deep wells access artesian sand and gravel aquifers at depths between 600 to 800 feet and 1,200 to 1,300 feet. (Page 1963)

5.2.2.3 Underflow and Recharge

In 1993, the ADWR calculated the water budget for the Lower San Pedro River, which includes Area 4-B. No attempt was made to differentiate the portion of the lower watershed lying within Pinal County; however, because most of the groundwater development in this reach occurs within Pinal County, and a large portion of the recharge also occurs here, these numbers should still provide a reasonable estimate of water availability. At that time, ADWR calculated a basin-wide recharge of 24,000 acre-feet per year coupled with an underflow from the Upper San Pedro basin of 120 acre-feet per year and underflow from Aravaipa Canyon of 800 ac-ft/yr based on data from a 1990 report. This was compared to a water use of 35,750 ac-ft/yr resulting from a mining and industrial use of 21,220 ac-ft/yr, an agricultural irrigation use of 13,250 ac-ft/yr and a public supply/domestic use of 1,280 ac-ft/yr. The resulting deficit of nearly 11,000 ac-ft/yr was coming from aquifer storage.

5.2.2.4 Storage

Although no attempt has been made to isolate the volume of water stored in the Area 4-B section of the San Pedro River aquifer system, in 1952 Halpenny calculated the volume of water in storage for the entire Lower San Pedro River basin from The Narrows on the south to Winkleman on the north. At that time, he calculated that the older alluvial fill occupied an area of 640,000 acres with a saturated thickness averaging 300 feet. With an estimated specific yield of two to six percent Halpenny estimated that the volume of water in storage in the older alluvium to range from four to twelve million acre-feet. In a similar fashion, Halpenny went on to measure the aerial extent of the recent alluvial fill to be 23,000 acres with an average thickness of 60 feet and a specific yield of 15 percent. This resulted in an additional volume of water in storage in the recent alluvium of 200,000 acre-feet.

Given that Area 4-B covers more than half the watershed of the Lower San Pedro River, a conservative estimate of the volume of water in storage in Area 4-B would be half of the volumes calculated by Halpenny or 2,100,000 acre-feet using the lower of his estimates for the older alluvial fill.

5.3 Current and Future Water Use

Although detailed annual water consumption data is not available for the Lower San Pedro Basin on a continuous basis, in 1990 the ADWR tabulated water use for the 1988-1989 water year. Their findings were as follows: mining and industrial uses accounted for 21,220 acre-feet of pumping, agricultural irrigation required 13,250 acre-feet of water and public supply and domestic uses totaled 1,280 acre-feet for a grand total of 35,750 acre-feet. It is interesting to note that ten years earlier Jones (1980) had estimated the water use for the 1978 water year to be 55,000 acre-feet with 30,000 ac-ft used for irrigation.

Although this reduction in pumping may not be a trend, it can be hypothesized that the total volume of water pumped in the Lower San Pedro basin in 1988-89 will probably not change. Because of the ongoing adjudication of the waters of the San Pedro River it is anticipated that no new water uses will be developed prior to the year 2025.

6. REGULATIONS GOVERNING WATER USE

Sections 4 through 5 of this report described the water resources available, or potentially available, for development within Area 4-B. Not all of the water in the three subbasins may be available for use, however, because of regulations controlling water use within Arizona.

6.1 Inside AMAs

Within AMAs any well owner with a well pumping more than 35 gallons per minute must have a legal authority to withdraw water from the aquifer, whether it be for agricultural, municipal or industrial use. This use is regulated using a series of Grandfathered Water Rights, Certificates, Permits and Designations. Each requires a different level of hydrologic demonstration. Three levels of Grandfathered Water Rights were established by the Groundwater Management Act to protect those groundwater withdrawals that had been in place prior to the advent of active groundwater management. These included:

- ?? Irrigation Rights pertaining to lands that had a history of irrigation and upon which that irrigation will continue.
- ?? Type I Non-Irrigation Rights pertaining to lands that had a history of irrigation (within the five years from 1975 to 1980) but upon which that irrigation had ceased.
- ?? Type II Non-Irrigation Rights pertaining to water uses other than irrigation. This included industrial, mining and recreational uses.

Obtaining a Grandfathered Right required a simple filing detailing the historic water use and the amounts of water used over a period spanning the period from 1975 to 1980. These filings were reviewed by the Arizona Department of Water Resources (ADWR); and, Certificates were granted to eligible water users.

6.1.1 <u>Assured Water Supplies</u>

Within AMAs the use of water is strictly regulated. New developments cannot be approved for the sale of subdivided lots without a Certificate of Assured Water Supply. This Certificate can only be granted pursuant to a demonstration that the proposed subdivision has access to sufficient water to meet the needs of its residents for a period of 100 years. There are five criteria that are used to evaluate these demonstrations:

1. The water must be physically available within the aquifer to a depth of a thousand feet and the demonstration must account for current and committed water demands on the aquifer system as well.
2. The water must meet the Arizona Department of Water Quality's requirements for human consumption.
3. The developer must have the financial capability to construct the necessary infrastructure to serve the subdivision.
4. The development must be consistent with the AMA's management plan.
5. The development must be consistent with the AMA's management goal. In the Tucson AMA this goal is safe yield, i.e. groundwater use does not exceed recharge (natural plus artificial). Although artificial recharge and participation by

the developer in the Central Arizona Groundwater Replenishment District meets this goal, on a site specific basis groundwater depletion may still occur. The reason for this is that existing regulations do not require that the recharge take place in the same portion of the aquifer system as the withdrawal.

Once a demonstration is deemed complete, the ADWR publishes a notice of their intent to grant a Certificate in a newspaper of general circulation in the affected AMA. This publication is followed by a fifteen-day public comment period. If objections are forthcoming, a hearing must be held to evaluate the evidence presented by the responding party.

Subdivided lots in an AMA may not be sold without this Certificate.

6.1.2 General Industrial Use Permits

In many cases a need for water may not be associated with subdivision development, but rather, with an industrial use such as golf course development or gravel mining. In these cases, the developer of the intended use must first seek service from an existing water company. If no water company is available, or if service is denied, the developer can lease and transfer Type II rights or purchase/lease Type I Non-Irrigation rights adjacent to the site. If no existing rights are available for use, the developer can apply for a General Industrial Use Permit.

Permits are normally granted for twenty years, but can be reviewed at any time by ADWR in the event that alternative sources of water become available. The permit application requires a hydrogeologic demonstration of the impact of pumping by the industry on the local aquifer. If the industry's pumping will adversely impact local wells, the well owners must agree to allow the additional pumping, or the industrial pumping must be moved. An adverse impact is defined as causing five feet or more of additional drawdown at the neighboring well after ten years of pumping or twenty-five feet of drawdown over the life of the project.

6.1.3 Well Impact Studies

New wells can be constructed inside AMAs; however, if the well is designed to pump in excess of 500 gallons per minute, the application for a permit to drill the well must be accompanied by a hydrologic impact study. This study sets forth the available data related to hydrogeologic conditions in the area of the well. It also provides an estimate of the impact of the well on the aquifer and on neighboring wells. This impact study is the same as that required for General Industrial Use Permits.

6.2 Outside AMAs

Although groundwater use is rigorously controlled within AMAs, outside AMAs the regulations are less restrictive and the demonstration of a 100-year water supply is voluntary.

6.2.1 Water Adequacy

Outside AMAs new subdivisions need only demonstrate an "Adequate" water supply. Although this demonstration is normally for a 100-year period, the proof is less rigorous and can usually be satisfied with a hydrologic demonstration. These demonstrations are voluntary. In the event that the developer elects to not provide a demonstration, or the demonstration proves to be inadequate, subdivided lots can still be sold; however, all sales documents must carry the notice that the water supply may be "Inadequate". No well impact studies or other demonstrations are required.

6.3 Surface Water Rights

Area 4-B spans the watersheds of several streams including Cañada del Oro and the San Pedro River. Surface Water Rights in Arizona have been the subject of controversy almost since the first time that more than one person diverted water from the same stream and have historically been allocated on a "First in time – First in right" basis. The earliest rights date back to the reserved rights of the Indian Communities and Spanish Land Grants followed closely by those associated with the first agricultural and ranching operations in the state. Collectively these are referred to as pre-1919 rights, referring to those beneficial uses already in place when an initial attempt was made to quantify the diversions from Arizona's surface waters. To claim a right to surface water, the claimant must use that water beneficially. If this beneficial use ceases for a period of five years, the State may deem the right abandoned and allow the water to be claimed by others.

The Superior Court is currently overseeing the allocation of Arizona's surface waters. Termed an "Adjudication", it is anticipated that this will, for all time, establish the rights of individual claimants to divert water from the state's rivers and streams. This court proceeding is a multi-phase process. First each claimant must file a Statement regarding their water use. This constitutes a claim. In most cases, far more water has been claimed on each of Arizona's streams than actually exists in nature. To overcome this, the ADWR will compile a report on each stream system setting forth the anticipated volume of water available. The ADWR will then assist the court with prioritizing individual claims and determining the actual volume of water used. Once the claims have been prioritized and assigned a volume of available water, the court will hold hearings at which individual claimants can dispute the court's or ADWR's determinations. This process is likely to continue for decades; and most water rights probably will not be quantified for several decades.

Surface Water can include water flowing beneath the surface but in direct connection with the stream. The most recent finding by the court defined this subsurface flow as water in the Holocene alluvium, flowing in the same direction as the stream, having the same chemical character and generally not associated with tributary flow. Wells tapping this flow are considered to be pumping surface water and subject to adjudication.

When considering surface water rights it is important to recognize that these are simply rights to use the water if it is available. They do not constitute a guarantee that the water will be continuously available for any period of time. It is a common misconception that these rights relate directly to the 100-year Assured Water Supply requirements established for subdivision development within the AMAs. Under existing regulations, a water supply is "Assured" only if the source of that water is continuously available. Most surface water sources in Arizona are dry at least some portion of the year. Therefore, the use of surface water to demonstrate the existence of an Assured Water Supply requires that the developer provide adequate storage to contain the water when streams are flowing and utilize that stored water during dry periods. For this reason, few surface water rights have been used to demonstrate the existence of Assured Water Supplies for new subdivisions. In most cases, surface water rights have only been acquired by entities capable of storing, or arranging for the storage of, the surface water.

6.4 Water Right Transfers

Most water rights in Arizona are appurtenant to the land on which they are used and transfer with the land at the time of sale. Some rights, however, are appurtenant to a use and can be transferred within an AMA or a watershed, with some limitations to satisfy that use.

Over the years a "market" has developed for water rights within Arizona. Although relatively unstructured, this market has allowed for the transfer of rights from one user to another for the continued beneficial use of the water. With groundwater rights, the point of use cannot change while the well location may change with permission from the ADWR. The exception to this rule is the Type II Grandfathered Groundwater Right that is appurtenant to a use rather than a location. Alternatively, surface water rights belong to the right owner for a beneficial use and are not tied to the land. Therefore, both the point of use and the point of diversion may change as long as the rights of others are not infringed upon. Generally, surface water rights are transferred with a property to continue the beneficial use of water on that property. The exception has been when surface water rights were the subject of trades involving satisfaction of Indian water right claims, Federal swaps with municipalities and various reclamation activities.

Few surface water rights are sold in the individual land development marketplace simply because they could not be directly applied to a demonstration of assured water supply. Although the ADWR does not have a firm set of rules for incorporation of surface water rights into such a demonstration, it is generally accepted that they would first determine the annual low flow of the stream in question and require the developer to provide adequate alternative resources for the remainder. Surface water also must be treated prior to use.

7. SUMMARY AND CONCLUSIONS

Area 4-B is a complex planning area with the western half in the Tucson Active Management Area and the eastern half in the San Pedro River Basin, outside the AMA but in an area where water rights have yet to be firmly established. As a result, different challenges must be faced in either area when seeking to ensure that sufficient water is available to complete a project. The following table is based upon published reports dealing with the water resources in each part of Area 4-B and summarizes the water available in the planning area.

AREA 4-B WATER RESOURCES				
	Water Available			Demand
	Subflow In	Recharge	Storage	Pumping
Sub-Area	ac-ft/yr	ac-ft/yr	ac-ft	ac-ft/yr
Avra Valley	0	700	400	unknown
Canada del Oro	0	8,900	2,000,000	22,265
San Pedro River	800*	24,000**	2,100,000	35,750

* Underflow from the Upper to the Lower San Pedro system

** Recharge calculated by ADWR for the entire Lower San Pedro Basin

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