RECLAMATION
Managing Water in the West

Supply and Demand Correlation

New Mexico – Gila Basin – Arizona Water Settlement Act

U.S. Department of the Interior
Bureau of Reclamation
Phoenix Area Office

December 2010

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The mission of the Department of the Interior is to protect and provide access to our Nation's natural and cultural heritage and honor our trust responsibilities to Indian Tribes and our commitments to island communities.

The mission of the Bureau of Reclamation is to manage, develop, and protect water and related resources in an environmentally and economically sound manner in the interest of the American public.

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1. Task 1 – Executive Summary of Water Supply

This section summarizes the water supply studies, as Task 1, from the Phase 1a work technical memorandums and reports by the following consultants: Daniel B. Stephens & Associates, Inc.[1]; Intera Incorporated[2]; Water Resources Research Institute[3]; S.S. Papadopulos & Associates, Inc.[4]; and Balleau Groundwater, Inc.[5].

The intent is to summarize briefly, some background of the work performed to investigate the geohydrologic conditions and groundwater supply trends and issues for select areas within the four-county area, which comprises the planning area of study for this AWSA work task.

1.1. Background

The consultants focused on particular portions of the 13 groundwater basins (Fig. 1, DBSA) and four counties (Luna, Hidalgo, Grant, and Catron) within the study area. Comprehensive coverage of the entire planning study area is not available using these reports. The following summarizes each consultant's Phase 1a work submittals:

- **S.S. Papadopulos & Associates, Inc. (SSPA)** SSPA performed modeling and wrote a report entitled "Analysis of Surface Water – Groundwater Interactions along the Gila River, Gila-Cliff Basin, June 2010", in the Upper Gila and Cliff sub-basins (Gila-Cliff Basin) along the Gila River in northern Grant County (Fig. 1.1). This report discusses two riparian groundwater models, and a regional, more generalized, two-layer steady-state groundwater flow model that is not formally calibrated.

- The riparian models occur along two overlapping reaches of the Gila River and its floodplain and lower terraces, the reaches separated (model domains hinged) about 0.5 miles below Bear and Duck Creeks (Fig. 1.1). These two models cover about 18 miles of the Gila River between Mogollon Creek on the north and three miles south of Mangas Creek. The regional model is referred to as a "framework" model. It includes within its domain, the riparian corridor models but the domain extends 18 miles by 30 miles to include the major tributary alluvial deposits of eastern tributaries Mangas and Bear Creeks and Greenwood Canyon, and western tributaries Sycamore, Duck, and Mogollon Creeks (Fig. G-1). Besides the alluvium, most of the active domain of the model represents the Upper Gila Formation.

- **Daniel B. Stephens & Associates, Inc. (DBSA)** DBSA first reviewed the current state of the entire planning area (with respect to any new information that might be available) regarding water supplies and demand areas by estimating water in aquifer storage among the 13 basins, and characterizing the domestic and non-domestic distribution of wells by completion date and by type. This was primarily to highlight the demand center locations of Deming, Silver City, and Lordsburg, and the Chino and Tyrone Mines. Then they focused their Phase 1a water supply review on the Mimbres Basin in Luna County, where Deming is, since it is rapidly developing and is the largest groundwater user in the four-county area.

- **Intera Incorporated (Intera)** Intera looked at groundwater supplies in the Mimbres basin, but unlike DBSA, focused their evaluation on groundwater conditions in and around Silver City. They also presented a conceptual hydrologic water budget for the basin, and presented several demand scenarios (out to 2050 and 2120, respectively) using historical information on the number of new customer meter connections, and another methodology using per capita useage and assumed low and high estimates of annual population increases.

- The conceptual water budget by Hanson, DBSA, and Shomaker, show Mimbres Basin inflows to range between 90,691 AFY and 108,572 AFY. The outflows exceeded inflows by as much as 33,756 AFY according to DBSA, primarily because of mining of the aquifer by pumping. Shomaker and Hanson outflow estimates are only 12 and 51 AFY greater than their inflow estimates implying a much more balanced hydrologic budget, consistent with aquifer conditions prior to widespread pumping. These figures are shown in Intera's Technical Memorandum, Figure 11.

- **Balleau Groundwater, Inc.** Balleau looked at the feasibility of Silver City recharging one cfs of Gila River water (via a new 8-mile pipeline using leased mine water) using two recharge options, either using two injection wells, or managed infiltration recharge in several arroyos, to an area hydrologically upgradient of but near Frank's Wellfield. Frank's Wellfield and the proposed recharge facilities are located about four miles west of the town. Frank's Wellfield is one of several wellfields supplying municipal water. The other wellfield is the Woodward Wellfield. The Gabby Hayes and Anderson wells are other ground water supplies.

- Balleau used a calibrated numerical groundwater flow model to simulate the effects to the aquifer and well capture from pre-development and development period pumping from 1946-2008 as Scenario1, and then a projection period from 1946-2048 as Scenario 2 – the 40-year Baseline model. Balleau then developed two additional 40- year models, one scenario superimposing the one cfs recharge in an injection well onto the Baseline 2 scenario as Scenario 3, and Scenario 4 having the one cfs recharge above baseline as arroyo infiltration.

Well capture zones (extent of groundwater aquifer area diverted by pumping) for the wellfields/wells was implemented and visualized three dimensionally using a particle tracking code over the 102-year period in the Baseline and projection models from the additional one cfs recharge. In their report, Balleau provided descriptions of their proposed shallow and deep injection well and observation well designs, infrastructure, monitoring instrumentation well arrays (depth specific temperature and moisture sensor intervals), and provided cost estimates for the two recharge alternatives including design assumptions and factors. A number of water level contour maps and simulated well hydrographs round out the discussion.

1.2. Hydrogeologic Setting, Aquifer Characteristics, and Water Level Trends

The planning study area includes 13 recognized groundwater basins situated among the four-county area (Fig. 1, DBSA). The continental divide, a surface watershed divide, separates the two most prominent basins – the Mimbres on the east, and the Gila-San Francisco basin on the west side (Intera, Fig. 6) within the study area. The Mimbres and Gila groundwater basins are hydraulically connected via northwestwards groundwater flow through Upper Gila Group basin-fill sediments which fill the Mangas Valley (Trench).

The geology is varied as the planning study area spans three geologic provinces: the Colorado Plateau, the Basin and Range, and the Rio Grande Rift province (Intera). Structurally, these provinces and the planning study area are characterized by horsts (uplifts) and grabens (trenches) which form the block-faulted mountain ranges/ridges and valley basins. The basins in turn are filled with sediments forming the regional basin-fill/valley-fill and alluvial aquifer systems.

Surficial Geology and Aquifer Units:

According to the 1:500,000 New Mexico state geologic map, 2003, most surficial units deposited in the groundwater basins (valley/basin fill) in Luna and Hidalgo Counties are mapped as Quaternary piedmont alluvial deposits (Qp), which include alluvial fan deposits/piedmont slope sediments, and alluvial deposits within principal tributaries. Younger alluvium (Qa) overlies the Qp, and is especially widely distributed in Luna County below Interstate I-10. Exposed along mountain fronts and underlying the Qp are lower Quaternary to upper Tertiary-aged older basin-fill sediments and conglomerates of the Gila Group (QTg). This unit is generally not exposed in Hidalgo and Luna Counties below I-10 but is the predominant sedimentary unit filling valleys north of I-10 in Grant and Catron Counties. It also includes the Mimbres Formation in places. Faulted Tertiary volcanic and pyroclastic rocks comprise the majority of the mountains in these four counties.

These alluvial units (Qa,Qp,QTg) collectively comprise the Rio Grande basin-fill aquifers which are of interest in this study as they form the primary groundwater supplies in the four-county region. In Grant County, SSPA mention that wells withdrawing from the shallow alluvium Qa, have high yields while the yield from the QTg is highly variable, and depends greatly on its degree of consolidation, which is largely a function of depth and age, and also its degree of fracturing. SSPA also mentions that along the Gila River within Reaches 1 and 2 of their Riparian groundwater model domain, recent monitoring of alluvial observation wells installed along four transects across the river indicate shallow groundwater levels respond rapidly to changes in river stage, which indicates the stream-aquifer system is hydraulically well connected. These four observation well transects are located in Gila-Cliff Valley between Mogollon Creek to the north, and below Mangas Creek where it joins the Gila River.

1.3. Aquifer Characteristics:

Intera includes several isopach maps, Figures 3 and 4, showing thickness of the basin-fill in the northern and southern portions of the Mimbres Basin. Figure 3 shows the thickness to be as much as 2,500 feet southeast of Tyrone and Silver City along the San Vicente Arroyo valley axis. DBSA states that the average basin-fill aquifer thickness in the Deming area is about 500 feet, and the range in thickness of the Mimbres basin-fill around Deming is from 500 to over 4,000 feet thick (Fig. 4). DBSA also states that the average estimated saturated thickness was 2,000 feet. Thicker alluvial deposits have more potential aquifer storage capacity within the interstices of the sediments, and thus the chance that saturated aquifer thicknesses can be greater. Larger saturated thicknesses provide more water to wells for longer periods.

DBSA estimated the groundwater in storage by basin and county (DBSA, Table 2.1) from the areal extent and average saturated thicknesses, and published specific yields. Although these storage numbers are rough approximations and the actual recoverable volumes in aquifer storage from wells are always less than the total volume of groundwater in aquifer storage, the magnitudes of water storage between the four counties and thirteen basins is interesting. The Gila, San Francisco and Mimbres basins are by far the largest, storage wise, in Catron, Grant, and Luna Counties while Hidalgo County's Animas basin holds the most groundwater in that county. For each county the total storage in all groundwater basins within that county, in acre-feet is: Catron 150,793,00 AF; Grant 54,548,000 AF; Luna 39,077,000 AF, and Hidalgo 60,774,000 AF. The hydrologic water budget for the Mimbres basin is not well defined based on the data and discussion in the reports/technical memorandums reviewed. The difference between inflows and outflows to the Mimbres Basin is uncertain and is a data gap requiring further investigation.

Different investigators have derived several widely varying conceptual estimates of the difference in inflows and outflows for the Mimbres Basin. For example, the Intera report (citing DBSA (2005) shows the estimated water budget having outflows exceeding inflows by 33,755 acre-feet annually (Figure 11). In contrast, Hansen et. al., 1994 and Shomaker, 2006, show on Figure 11 the mass balance groundwater flow budget from their groundwater modeling to be nearly balanced with outflows exceeding inflows by only 51 acre-feet and 12 acre-feet, respectively. The modeling output results of Hansen et. al., 1994 and Shomaker, 2006 were not reviewed as part of this effort, and the model water budget inflow/outflow terms were not evaluated. It may not be appropriate to compare the DBSA outflow budget against those of Hansen and Shomaker.

A true balanced hydrologic budget (inflows equaling outflows) would be expected in pre-development periods when the aquifer is at steady-state or equilibrium. There would be little change in aquifer water levels in this condition. The Hanson and Shomaker models may represent the pre-development basin water budget. The literature review based study by DBSA may have considered more recent conditions since pumping to the current time has resulted in declines in water levels, implying groundwater mining in the Mimbres basin. Pre-development periods in the southwest alluvial basins are typically considered to precede about the 1940's when population rates began to rise rapidly, irrigated agricultural demand increased, and more efficient pump technologies led to installing many more wells of greater productivity.

The apparent discrepency in the hydrologic budget between these reports is a data gap that needs more study.

Additionally, DBSA used year 2000 mining demands in Grant County (20,000 acre-feet per year), but in 2009 mining diversions were about 9,000 acre-feet per year. Estimates of evapo-transpiration and recharge in Grant County may require further study to better quantify.

DBSA estimated the groundwater in storage (potential water supply available to wells) in a 100,000-acre area around Deming using the Deming city limits and including the wellfields and some neighboring irrigated lands. They used the 500-foot aquifer thickness and the Mimbres groundwater model specific yield of 0.1 to derive 5,000,000 acre-feet in storage. Their Figure 12 shows that between

1975 and 2008, Deming pumped between 3000 and 4,500 acre-feet annually from the Mimbres Basin. The projected high demand by year 2050 is 9,000 acre-feet. This 5,000,000 acre-feet estimate is strictly a physical quantity, without considering legal, economic, water quality implications, or current or projected climatic effects such as an extended drought period.

Most of the permitted annual volume of 4,566 acre-feet groundwater supplies for Silver City also come from the Mimbres basin aquifer, specifically from the Woodward Wellfield, and Anderson and Gabby Hayes wells. These combine for a total permitted annual amount of 3,445 acre-feet (Silver City demand has averaged about 2,800 acre-feet annually between years 2001 – 2006; their wells have a total capacity of 6,318 AFY). The other wellfield, Frank's Wellfield supplying Silver City municipal demands, pump up to 1,120 acre-feet annually from the Gila Basin across the continental divide.

Balleau's Technical Memorandum states the Woodward Wellfield pumps from the Upper Gila Group aquifer while the Frank's Wellfield pumps from the Middle Gila Group. Balleau reports well yields range from 230 to 950 gpm, while Intera reports the well yields vary from 200 to 1100 gpm with typical pump rates of 300 to 500 gpm.

Well depths range from 550 to greater than 1000-foot depth with 200 to 600 feet of the Gila aquifer penetrated in the wells. The transmissivity and storativity values among the Gila Group aquifer subunits is not available from the reports reviewed, but the upper portions of the Gila Group conglomerate/sediments are often unsaturated.

Balleau discusses the Gabby Hayes well being completed and drawing from not only the Gila Group aquifer, but also a deeper water-bearing volcanic unit. This volcanic unit may be productive, based on an order of magnitude increase in the well's specific capacity (well yield per foot of pumping water level decline) compared to the other Silver City area wells which pump from only the Gila Group. Intera mentions that Hanson (1994) is quoted as saying significant quantities of groundwater flow through fractured sedimentary rocks (limestone), likely Paleozoic rocks which underlie the Mimbres Basin Gila Group conglomerates and volcanic sequences.

Intera (Fig. 9) shows municipal well production in 2002 for eight public water systems (Bayard, Casas Adobes, Hurley (Phelps Dodge), North Hurley (MDWCA), Santa Clara, Silver City, Deming, and Columbus to be about 7,900 acre-feet, with Silver City (2,820 AFY) and Deming (4,075 AFY) accounting for nearly 90 percent of the pumping.

Principal surface water courses draining the Gila and Mimbres Basins are the Mangas Creek, an intermittent stream which becomes perennial and gaining below Mangas Spring, as well as the Gila River (see Map Figure 3.1). The San

Vicente Arroyo, also intermittent, and Mimbres River, both drain the Mimbres Basin. The Mimbres River flows southwards towards Deming. Mangas Spring occurs where groundwater, flowing northwest within the Mangas Trench, daylights and discharges about 1,300 AFY (Intera T.M.) west of the continental watershed divide.

Mangas Valley (Intera, Fig. 4) is the geomorphic expression of the Mangas Trench, a structural feature which is roughly delineated by the Burro Mountains Uplift/Continental Divide to the west, and the Little Burro mountains and Silver City Range, and the faults shown on Figure 2, (Balleau) to the east. Several thousands of feet of alluvial materials constitute the basin-fill aquifer systems along the Mangas Valley and San Vicente Arroyo valley. Intera (Fig. 3 and 4) show thickness maps of the Gila basin-fill sediments, which fill the broad valley of San Vicente Arroyo.

1.4. Water level Trends:

Groundwater flows from the mountain fronts bordering Mangas Valley towards Mangas Creek and then northwestwards towards Mangas Spring and the adjoining Gila Basin dropping from about 5500 feet elevation near Tyrone Mine to about 4750 feet elevation at Mangas Springs. Groundwater flow gradients are shallower and the regional flow direction is southeastwards from Tyrone/ Silver City towards Deming along the San Vicente Arroyo axis, from about elevation 5600 (at Tyrone), to about elevation 4800 approaching Luna County.

Balleau shows pre-development and year 2008 water level contours on Figures 5 and 6. The water table geometry is similar between the maps with most water level changes occurring in well fields near Tyrone and the Silver City pumping centers. Water level changes from 1946 to 2008 vary between about 10 feet decline, to 100-foot decline around the Woodward Wellfield (Fig. 7). Five to 30 feet of groundwater mounding has developed from the Silver City WWTP.

DBSA shows the distribution of non-domestic and domestic wells installed prior to the 1970’s and through the 2000’s, within the four-county area (Figs. 2-4). Inspection shows that many private domestic and public supply wells were completed in more recent time (2000’s), particularly within the population centers, along the Gila and San Francisco Rivers, of Deming, Silver City, Lordsburg, and throughout Catron County. This has led to local water level declines, particularly in the Mimbres Basin/Deming area.

DBSA’s Figure 6 shows the average yearly water level decline rate in area wells since the 1950’s to range between 0.1 to 1.75 feet per year, with most wells dropping about one-half foot to three-quarters of a foot per year. This rate is due to historical pumpage trends, and future projected pumping increases will certainly lead to greater annual decline rates. DBSA mentions the Deming

Well #14 currently has a 250-foot (static condition) water column, and using the average 0.6-foot annual decline rate, would still have a 200-foot water column by year 2100, or only 50-feet less water to pump from in the next 90 years.

2. Task 2 – Executive Summary of Water Demands

This summary of water demand is based on the report titled "Regional Water Demand Study for Southwest New Mexico Catron, Grant, Hidalgo and Luna Counties", by AMEC Earth & Environmental, Inc., June 30, 2010[6]. The AMEC report was prepared for the New Mexico Interstate Stream Commission to assist New Mexico with decisions associated with the Arizona Water Settlement Act (AWSA).

The four counties of Catron, Grant, Hidalgo, and Luna make up the Southwest New Mexico Water Planning Region. The AWSA States "…. $66-$128 to be used to enhance water …" this planning process is "…to determine how to utilize the benefits received in the 2004 AWSA in a cost effective manner to balance historical and future demands against uncertain supply while protecting the environment."

This summary is intended to provide a quick compilation of the findings in the AMEC report. For more detailed analyses, references, and thorough breakdown of water demands within the Southwest New Mexico Planning Region, AMEC report should be consulted.

Definition of terms:

Diversion or Withdrawal – Removal of water from a stream or groundwater aquifer by human actions.

Depletion or Consumptive Use – The portion of the withdrawal that is permanently removed from the surface water or groundwater cycle. Evaporation and transpiration are the primary mechanisms for this use.

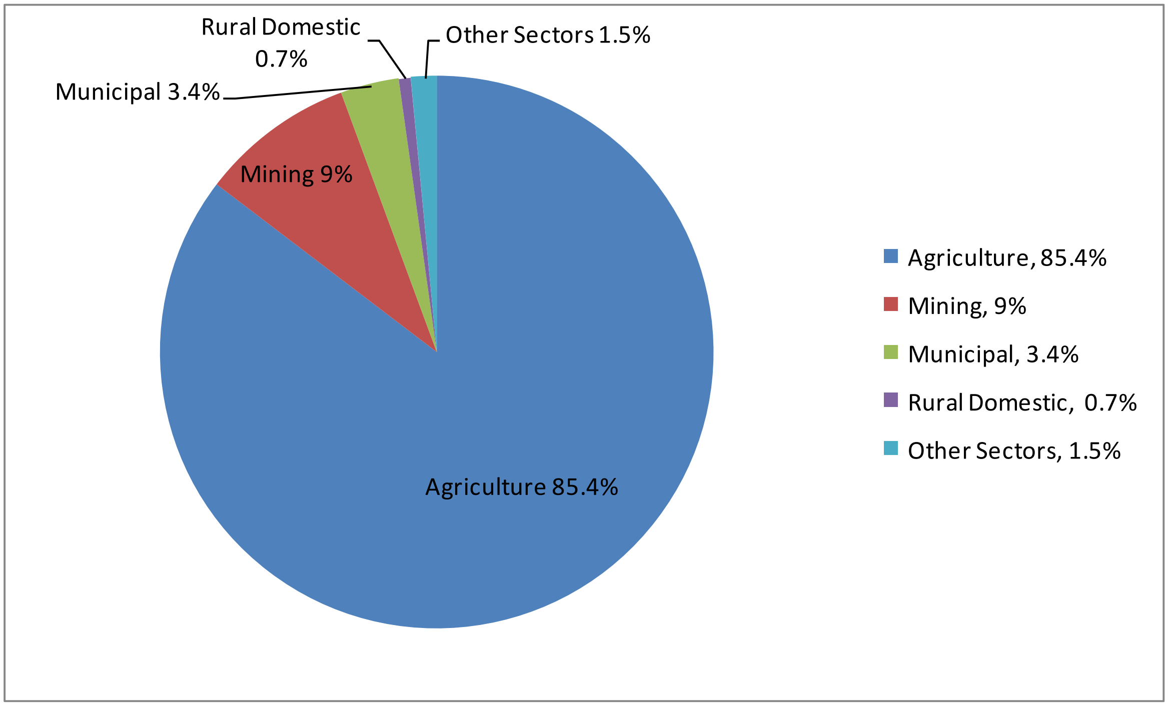
Return Flow – The portion of the withdrawal that is not consumed or depleted, and which is returned to the same water source the diversion was originally drawn.

These three components can be shown as follows:

- Depletion = Diversion - Return Flow

2.1. Current Water Demands

A breakdown of typical water withdrawals over the four-county study area is shown in Figure 2.1.



Based on AMEC report.
Other Sectors include livestock, commercial, industrial, and power.

Figure 2.1. – 2005 Water Withdrawals Throughout Study Area

2.1.1. Current Agricultural Demand

a. Irrigated agriculture accounts for the majority of water demands in the four-county area, using 87% of total withdrawals and 76% of total depletions. In 2005, agriculture made up the following withdrawal percentages:

- Catron – 96%
- Grant – 52%
- Hidalgo – 93%
- Luna – 95%

The New Mexico Office of the State Engineer (NMOSE) estimates the total irrigated acreage for the region in 2005 was 62,934 acres. From 1990 to 2005, irrigated acreage throughout the four-county area has remained fairly constant, with a slight increase from 58,374 acres to 62,934 acres. Irrigated acreage in Hidalgo County has more than doubled during that period, from 9,090 acres to 24,762 acres, while Luna County fell from 44,250 acres to 33,162 acres.

Water withdrawals for agriculture in the region total 241,788 acre-ft, of which 34% is surface water diversions and 66% is groundwater. The counties' agriculture withdrawals are split as follows:

Table 2.1. – Water Withdrawals by County 2005, % Surface Water vs. % Groundwater

County	Surface Water %	Groundwater %	County Total (acre-feet)
Catron	92	8	3,742
Grant	66	34	11,375
Hidalgo	6	94	93,225
Luna	5*	95*	133,446
Total	82,868 ac-ft	158,920 ac-ft	241,788

Based on Table 1.4, AMEC report.
* These figures were revised following discussions with ISC and NMOSE.

b. Drip Irrigation - Over the last 20 years, irrigation methods have been transitioning from flood irrigation to drip, particularly in Luna County. Federal and State incentives have been encouraging farmers to change from flood irrigation to drip and sprinkler systems. In Luna County from 1990 to 2005, flood irrigation using groundwater dropped 80% while drip increased from about 2,400 acres to 29,000 acres. During the same period, sprinkler use increased from about 2,600 acres to 11,000 acres.

Surface water is not generally used in drip irrigation systems because of the high costs associated with treatment, which is necessary to prevent clogging the lines. Groundwater requires filtering before entering the irrigation tubes, which adds to the cost of drip irrigation. Drip and sprinkler systems have expensive initial capital costs, but reduce pumping costs as less water is required per acre.

Drip irrigation withdrawals are approximately 55% of withdrawals required for flood irrigation for most crops. Exceptions include onions which require closer to 70% of withdrawals that would be required with flood irrigations. Studies show drip irrigation can irrigate between 1.3 and 1.9 times as much land, depending on the crop, as a flood irrigation using the same water. Water withdrawals with drip are lower since deep percolation and return flows are nearly zero with drip irrigation.

Because nearly all water used in drip irrigation systems is consumed by plant transpiration and evaporation, the depletion rate is nearly 100% of withdrawals. Flood irrigation typically has a depletion rate of approximately 45%; the remaining 55% percolates in the ground and, depending on geology, largely returns to the aquifer.

Plant transpiration rates increase with drip because the crops do not go into water deficit condition. Drip irrigation results in higher crop yields for a unit of land. These factors have the potential to lead to an increase in aquifer depletions, particularly if additional acreage is brought under cultivation using “saved water”.

The NMOSE does not allow the transfer of “saved water” resulting from drip irrigation to be used on additional new acreage for land previously without a water right, without first obtaining a permit to do so. The potential for additional income motivates some farmers to bring new lands under cultivation, potentially negating some water savings.

c. Conveyance losses – Water losses associated with conveyance infrastructure includes on- and off-farm water conveyance systems and evaporation. Conveyance losses as a percentage of surface water withdrawals in the study region have shrunk from 64% in 1990 to 32% in 2005.

2.1.2. Current Municipal Demand

a. Public water supply systems accounted for approximately 3% of total water withdrawals in 2005. The average gallons used per capita per day (GPCD) for municipal systems throughout the four-county area is 198 gallons, which includes industry and commercial operations. Rural areas served by public water suppliers average 131 GPCD.

Public water supply withdrawals by County from 1990 to 2005 are shown in Table 2.2. Municipal demands have been fairly stable the past 20 years.

Table 2.2. – Public Water Supply Withdrawals by County (acre-feet)

County	1990	1995	2000	2005	Population Served (2000)
Catron	125	144	170	201	1,190
Grant	3,417	4,057	4,260	4,068	22,651
Hidalgo	1,334	1,468	907	1,067	3,973
Luna	3,510	4,210	4,387	4,369	18,644

b. Losses in Public Water Supply Systems – Losses are usually due to leaking pipelines, aging infrastructure, and missing or ineffective metering. The AMEC report states, “In the Southwest Regional Water Plan, 4.8 percent of all water withdrawals for the City of Deming were unaccounted for in 1997; unaccounted uses were reduced to 4 percent in 2008. Silver City's unaccounted use was 16.6 percent in 2000. In 2000, 22 percent of Lordsburg's withdrawals were lost to unaccounted uses."

2.1.3. Current Rural Domestic

Self-supplied domestic rural users account for less than 1% of total groundwater withdrawals in the region. In 2000 they made up 41% of the population and were responsible for 15% of the total water withdrawals for municipal and self-supplied water users. Regionwide, withdrawals for self-supplied residences showed small increase from 1,965 acre-feet to 2,064 acre-feet from 1995 to 2005. During that period, the domestic self-supplied population increased from 20,364 to 21,400.

2.1.4. Current Mining Demands

Mining withdrawals make up about 9% of the region's water use, based on historical averages.

Only Grant County has significant water use associated with mining. The Tyrone mines west of Silver City and the Chino mines to the east have seen reduced production since 2008. However, the Chino mines announced in October 2010 their intent to ramp up production and hire approximately 600 people.

The Tyrone facilities obtain water from Gila River diversions and from wells in both the Gila-San Francisco and Mimbres Basins. The total permitted annual diversion for the Tyrone mines is 9,425 acre-feet form the Gila River and 1,309 acre-feet from wells. Water use in 2009 was 3,639 acre-feet, nearly the same as in 2005.

The Chino mines have rights to 29,603 acre-feet of groundwater in the Mimbres Valley, and 11,868 acre-feet of surface water. Chino facilities used 9,831 acre-feet in 2005, and 5,274 acre-feet in 2009. Water withdrawals will expected to increase in the near future based on the October 2010 announcement to hire more people.

2.1.5. Current Demands Other Sectors

Water demands for agriculture, mining, and public water supply make up 90 to 95 percent of the region's water use. The remaining 5 to 10 percent consists of rural domestic water supply, commercial, industrial, power, and livestock demands. Over the last 20 years, these demands have exhibited slow growth in total withdrawals. Domestic water has been discussed above. The other categories break down as follows:

Commercial includes self supplied businesses (e.g., motels, restaurants, recreational resorts, campgrounds) and institutions (e.g. public and private schools and hospitals), self-supplied golf courses, greenhouses and nurseries, and fish hatcheries. Region wide, commercial demand has seen a 65% increase from 1990 to 2005, and represents about 0.4% of withdrawals.

Industrial demand includes water use for factories and construction, and accounts for less than 0.1% of total withdrawals.

Powerplants required 0.33% of total withdrawals in 2005, with consistent water use.

Livestock demands were less than 0.6% in 2005 and are typically fairly steady.

2.2. Population Projections

AMEC evaluated previous population projections for the region (Daniel B. Stevens & Assoc., 2005; McDonald, 2007; Alcantara, 2008) and developed their own projections. The AMEC figures have the advantage of incorporating the impacts of the economic downturn since 2008. The results of the 2010 census will be available in December 2010. The 2010 census figures will provide critical data for the future projections and should be incorporated into the AMEC report when available.

From 2000 to 2010, the population for the study region as a whole is expected to remain about the same. Only Luna County population is expected to increase during this period. Municipalities are expected to lose population from 2000 to 2010, with the exceptions of Deming and Columbus in Luna County.

Table 2.3 shows population projections by county from 2000 to 2050. The population in all four counties is expected to increase by 2050. Table 2.4 shows projected population for the major municipalities throughout the region. All municipal population projections show an increase by 2050.

Table 2.3. – Projected County Population, Years 2000 to 2050 by 10-Year Increments (AMEC)

Year	Region	Catron	Grant	Hidalgo	Luna
2000 (Census)	65,493	3,543	31,002	5,932	25,015
2010	65,988	3,405	29,844	4,910	27,829
2020	72,493	3,673	31,772	5,538	31,510
2030	79,094	3,683	34,958	6,093	34,361
2040	85,853	3,695	38,083	6,601	37,470
2050	93,196	3,796	41,406	7,174	40,820

Table 2.4. - Projections for Southwest Water Planning Region, by County and Incorporated Community, 2010 – 2050 (AMEC)

County	2000 Census	2010 estimate	2020 projection	2030 projection	2040 projection	2050 projection
Catron County	3,543	3,405	3,673	3,683	3,695	3,796
Reserve	387	371	367	368	379	380
Balance of County	3,156	3,034	3,265	3,260	3,381	3,472
Grant County	31,002	29,844	31,772	34,958	38,083	41,406
Silver City	10,545	9,932	10,574	11,410	12,430	13,250
Mining District	5,942	5,587	6,419	6,418	6,992	7,454
Balance of County	14,596	14,325	14,779	17,130	18,661	20,702
Hidalgo County	5,932	4,910	5,538	6,093	6,605	7,174
Lordsburg	3,379	2,492	2,759	2,978	3,167	3,372
Virden	143	123	128	152	165	179
Balance of County	2,410	2,295	2,641	2,963	3,273	3,623
Luna County	25,015	27,829	31,510	34,361	37,470	40,820
Deming	14,116	15,584	17,668	19,572	21,343	23,615
Columbus	1,765	1,948	2,183	2,419	2,638	2,918
Balance of County	9,134	10,297	11,659	12,370	13,489	14,287
Southwest Water Planning Region	65,492	65,988	72,493	79,094	85,853	93,196

2.3. Future Water Demands

2.3.1. Future Agricultural Demand

Irrigated agriculture is the highest demand sector in the four-county area. Because of the large percentage of water withdrawals attributed to agriculture, changes in irrigation methods, crop types, acreage, and water rights transfers have the potential to significantly impact total water withdrawals. However, total withdrawals and depletions are not projected to change dramatically. The recent shift from flood irrigation to drip irrigation reduces water needs per acre, but also enables farmers to irrigate additional land, if permitted. A major change in crop patterns is not expected in the next 40 years. Water rights transfers to municipalities may take place, depending on demographic changes. For example, Silver City's 40-year plan indicates that demand will exceed the city's permitted water rights between 2021 and 2043.

AMEC's future projections of agriculture related withdrawals and depletions depict a range of water use to 2050. Current agriculture demands fall within this range, indicating that today's water use is a reasonable representation of future agricultural needs, and demand will remain relatively stable. However, the upper range of projections for agriculture withdrawals and depletions (Tables 3.11 and 3.12, resp. in AMEC report) show potential for increase over the next 40 years. Because agriculture accounts for about 87% of water withdrawals, fluctuations in agriculture use can impact water supplies more significantly than other sectors (with the exception of mining in Grant County).

2.3.2. Future Municipal Demand

Municipal demand supplied by public water systems is expected to rise modestly through 2050. Table 3.21 in the AMEC report contains projected withdrawals to 2050 for public water suppliers for the study area, with population centers itemized. Throughout the region withdrawals are projected to increase 47% from 2010 to 2050 assuming no conservation, and 5% with conservation. The principal towns with areas of increased municipal demand are Deming, Columbus, and Silver City. The largest percentage increase was rural domestic use fed by public water suppliers.

2.3.3. Future Rural Domestic

Over the next 40 years, regional demands associated with domestic wells are expected to increase by roughly 50%. All domestic wells that are currently permitted are regulated as non-consumptive use. Legislative changes allowing consumptive use for outdoor gardens would likely result in higher demand numbers for this particular sector. New domestic wells are expected to be added at a rate of 110 to 260 wells per year throughout the four-county area. A

50% increase in water use for self-supplied residences would result in an increase from current 2,100 acre-feet to about 3,200 acre-feet regionwide.

2.3.4. Future Mining Demands

New Mexico mining activities are expected to decline over the next 40 years. It is unlikely the mines will withdraw water to their maximum permitted levels. Regardless of the magnitude of mining operations, reclamation activities requiring water use will continue through the next 100 years.

2.3.5. Future Demands Other Sectors

Commercial, industrial, power, and livestock sectors account for less than 2% of total withdrawals. This is expected to remain steady with the possible exception of power. Development of biofuel and solar power could potentially increase water depletions ten times current levels.

3. Task 3 – Impacts of Current and Future Demands on Groundwater Levels and Surface Water Supplies

The referenced supply and demand studies and reports were utilized to develop the findings described below as part of Task 3. Surface and groundwater supplies were estimated in the referenced reports. Demands were quantified and categorized in the AMEC report. Using the data from these reports, probable impacts to groundwater levels are projected to 2050.

In general, demand is expected to continue to expand from current levels through the next 40 years. The demand category of public water suppliers, particularly in Deming and Silver City, will continue to have increasing impacts on localized groundwater levels. Agriculture demands throughout the Mimbres basin will continue to mine groundwater faster than it is naturally recharged. The rate of demand increase may be tempered, or possibly negated, by water conservation efforts, depending on the success and goals of such programs. The escalating demand witnessed from 1990 to 2005 was reversed by the recent economic downturn, except in Luna County which continued to increase in population. However, within a few years, demand rates should settle back into a more traditional slow steady rate of increase throughout the study region, particularly in the population centers.

3.1. Correlation of Supply and Demand Studies – Areas of Greatest Concern and Associated Groundwater Depletion

3.1.1. Population Centers

Silver City – Two well fields and two additional wells provide water for Silver City's public system. The Woodward wellfield, Anderson well, and Gabby Hayes wells are in the Mimbres Basin, while the Franks wellfield is located within the Gila Basin. Current withdrawals are about 2,800 acre-feet/year. Historical groundwater change since 1948 is shown in Figure 7 of the Balleau report. Groundwater levels have declined over that period about 50 feet (0.8 feet/year) for all wells except the Woodward wellfield, which has declined 100 feet (1.7 feet/year). As demand increases, groundwater will decline at a faster rate per year. AMEC projected the public water service demand by 2050 to be 26% higher than current Silver City demands. Assuming groundwater declines continue at current rates, by 2050 groundwater would be between 34 and 68 feet lower than today. These wells are from 550 feet to over 1,000 feet deep and penetrate 200 to 600 feet of the Gila Group aquifer. A simplified analysis would indicate this rate of groundwater decline could continue for over 100 years before impacting wells, other than increased energy costs associated with the higher lift.

The aquifer depth underlying Silver City's well fields is estimated at 2,500 feet thick, indicating wells/pumps could be deepened if necessary provided water quality is acceptable.

Silver City is permitted to use 4,566.64 acre-feet per year. Silver City's 40-year water plan estimates the sometime between 2021 and 2043 demand will exceed permitted water rights owned by the city. So, it appears Silver City is limited more by permitted withdrawals than by the availability of groundwater. The purchase and transfer of groundwater irrigation rights to municipal use may be reduced to as low as 20% of the original water right by the NMOSE.

Mining District (east of Silver City) – Municipal demands are projected to increase 23 % by 2050 from current withdrawals of about 800 acre-feet.

Deming – Municipal water for the City of Deming is supplied entirely by Mimbres Basin groundwater. City wells are scattered throughout the municipality. The city's current municipal withdrawal rights are 6,102.92 acre-feet. Actual withdrawals are about 4,000 acre-feet/year. Groundwater levels associated with city wells withdrawals have been declining at an average rate of 0.6 feet/year, which equates to 24 feet over the next 40 years. As demand increases, groundwater will decline at a faster rate per year. AMEC projected the public water service demand by 2050 to be 43% higher than current demands. Depending on actual well configurations, the current rate of groundwater decline could continue for over 100 years before impacting wells, other than increased energy costs associated with the higher lift. The aquifer depth underlying Deming's well fields is estimated at 2,500 feet thick, indicating wells/pumps could be deepened if necessary.

Lordsburg – Water demand is not expected to increase in Lordsburg over the next 40 years. Annual withdrawals are about 610 acre-feet. The municipal well field for the municipal system is not currently experiencing significant groundwater decline.

Columbus – Although Columbus is experiencing the fastest growth rates in the region, annual withdrawals total only about 240 acre-feet/year. Groundwater withdrawals associated with Columbus are probably relatively insignificant to the overall aquifer, although additional study is recommended.

3.1.2. Agricultural Areas

Mimbres Basin – The largest and most heavily used basin in the region, the water budget indicates the Mimbres basin is in a deficit condition, although the magnitude of the deficit is not quantified and requires further study. The main population centers in Southwest New Mexico of Silver City, Deming, and Columbus all draw from the Mimbres Basin. Agriculture and mining make up almost 80% of withdrawals from the Mimbres basin. There has been roughly a 50-foot drop in the water table over the last 50 years.

Nutt-Hockett Basin – Withdrawals in this basin are nearly all associated with irrigated agriculture. Limited recharge results in an annual water budget deficit of 10,000 acre-feet/year (total withdrawals are 16,000 acre-feet/year) and significant groundwater declines.

Animas Basin – 87% of groundwater withdrawals are for agriculture. This basin is experiencing moderate water budget deficit conditions; -3,500 acre-feet/year associated with total withdrawals of 32,000 acre-feet/year.

San Francisco River Basin – Irrigated agriculture in the vicinities of Glenwood, Luna, and Reserve rely almost entirely on surface water diversions. In a typical year, irrigators have permitted water rights that cannot usually be met by the river, resulting in reduced acreage for crops.

3.1.3. Rural Areas

Self-supplied domestic rural users account for less than 1% of total groundwater withdrawals in the region. Concentrations of self-supplied wells near population centers contribute to local groundwater declines, but more isolated wells have minimal impacts to regional groundwater basins.

1964 USSC Decree and subsequent adjudication prohibit outdoor use of withdrawals in the Gila Basin. However, outdoor use could be provided through a transfer from existing agriculture water rights to domestic wells. The transferred agriculture water would be replaced by diversion and use of AWSA water.

3.1.4. Mines

New Mexico mining activities are expected to decline over the next 40 years as water use shifts from mining to reclamation activities.

3.2. Conclusions

3.2.1 Data Gaps and Recommended Actions

- Resolve the discrepancy between the previous Mimbres Basin studies. This could require conducting additional comprehensive Mimbres basin modeling to quantify the system imbalance and water budget. At the very least, data gathering and analysis of groundwater levels and groundwater trends for the entire basin is needed.

- Model Lordsburg basin and evaluate groundwater trends.
- Evaluate water quality at different locations and depths throughout the region.
- Quantify effects of Mexican groundwater pumping on Mimbres and other border basins, and conversely, effects of US pumping on Mexican aquifers through modeling.
- Update AMEC report with 2010 census figures and revisit mining withdrawals every few years.

3.2.2 Future Unknowns

Any projected use of water involves assumptions of future conditions. While many variables directly affect water withdrawals (population, economic conditions, climate, e.g.) there are a few that warrant special emphasis. These items have the potential to make a noticeable difference in the water budget but are difficult or impossible to predict with any certainty.

- Mining – Dependant on economy and prices.
- Renewable power – The magnitude and timing of renewable power sources and associated water needs remain uncertain.
- Agriculture – Historical yearly fluctuations associated with water withdrawals for agriculture have often exceeded all other sector fluctuations combined. While long-term average withdrawals related to agriculture are expected to remain fairly steady, actual yearly withdrawals are shaped by weather, acreage, and crop types.

3.2.3 General

- As previous studies have concluded, there are specific areas within the Southwest New Mexico Region that are experiencing groundwater declines of more than 2 feet/year. Wells in the Deming area show a decrease in water levels of about 0.6 feet/year since the 1950’s. Water levels in Silver City’s municipal wells have dropped as much as 150 feet since the 1950’s. Groundwater pumping for the Tyrone Mine has resulted in 200-foot water level declines in wells. These localized declines have little impact on regional basin aquifers which appear to contain an ample supply of water for the next 100 years, provided water quality is acceptable. Groundwater withdrawals can be expected to increase with demand through the next 40 years. The upward trend in demand is driven primarily by projected population increases. Agriculture demands are expected to remain stable with modest gains, along with other sectors. Water demands will likely result in lower water tables and impacts to specific wells (depending on locations and well/pump configurations), and may require mitigations such as deepening wells, conservation, and repair and development of new infrastructure. Continued reliance on current infrastructure and aquifers will eventually create more required mitigation actions and at greater frequencies. Continued declining groundwater could begin to negatively impact municipal wells and individual self-supplied domestic wells, potentially creating financial hardship for residents in affected areas.

- Groundwater cones of depression related to pumping drawdowns near population centers are localized and typically tie back into regional groundwater levels within a few miles. Regional aquifers are relatively unaffected by localized drawdowns at population centers. Large scale regional declines in groundwater levels, particularly in the Mimbres Basin, need to be monitored and modeled to fully understand and manage underground aquifers.

- In light of declining groundwater levels in high demand areas and deficits in the Mimbres Basin water budget, long term solutions should be developed, of which AWSA water supplies could play a part.

- The AMEC report describes losses in agricultural irrigation and municipal systems. AWSA mitigations of these losses need to balance the impacts of withdrawals versus depletions when considering management strategies.

The reports conducted to date and summarized here suggest that groundwater will continue to decline at some locations in the region. Demands are expected to increase throughout the study period. These conclusions emphasize that care should be given to incorporating water management strategies in the four-county area, targeting both supply and demand management actions for the long-term benefit of area residents.

References

[1] Daniel B. Stevens & Associates, Inc. (DBS&A). *Estimates of Region-Wide and Deming Area Water Supplies*. June 30, 2009.

[2] INTERA Incorporated. (INTERA). *Technical Memorandum, Gila Planning project, Work order GR-09-1*. June 30, 2009.

[3] Water Resources Research Institute. (WRRI). *Trans-International Boundary Aquifers in Southwestern New Mexico*. March 2000

[4] S.S. Papadopulos & Associates, Inc. (SSPA). *Analysis of Surface Water – Groundwater Interactions along the Gila River, Gila-Cliff Basin*. June 2010.

[5] Balleau Groundwater, Inc. *Groundwater recharge Analysis and Estimate of Recharge Option Costs*. Julu 16, 2010.

[6] AMEC Earth & Environmental, Inc. (AMEC). *Regional Water Demand Study for Southwest New Mexico - Catron, Grand, Hidalgo and Luna Counties*. June 30, 2010.

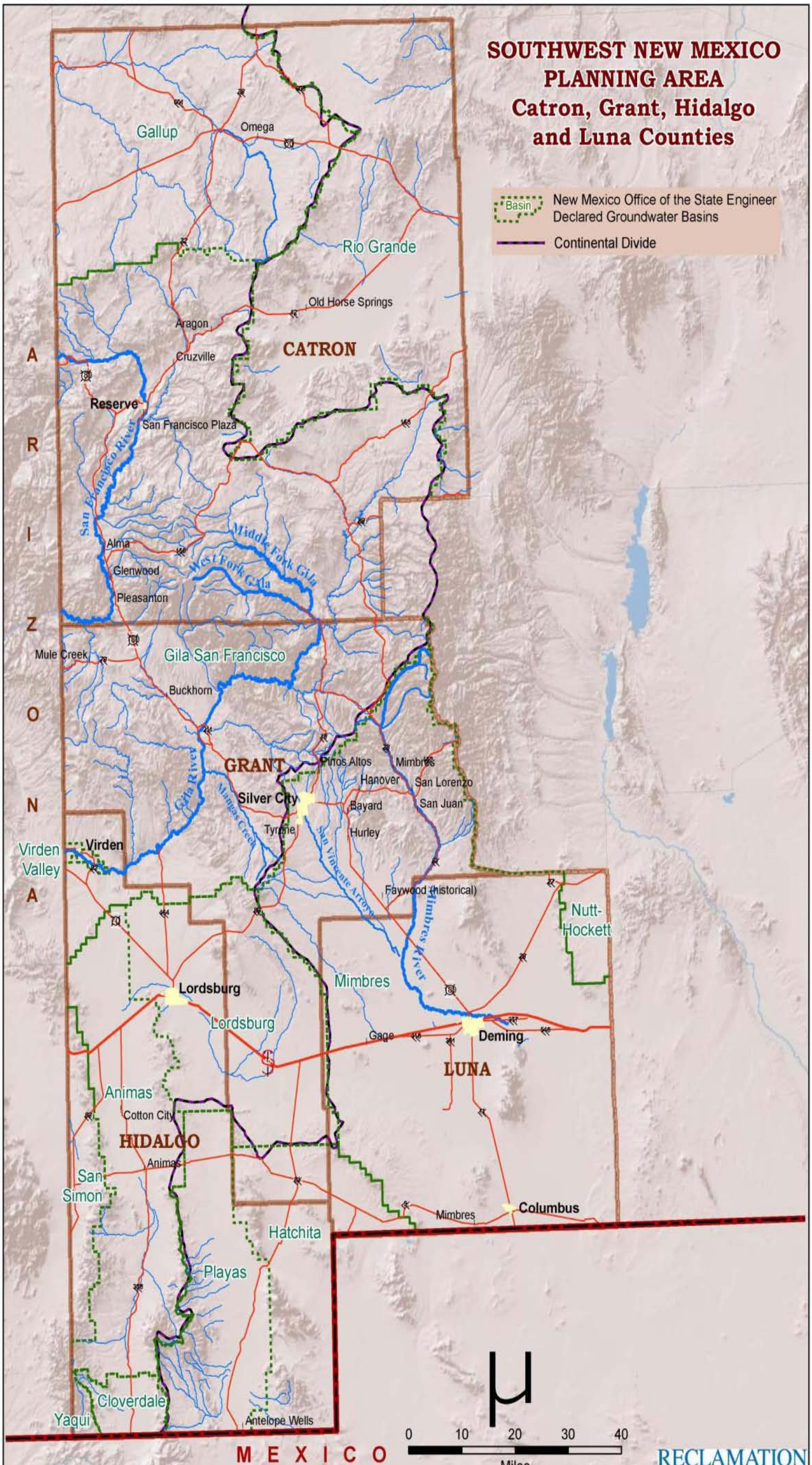


Figure 1

Figure 3.1. – Map of Southwest New Mexico Planning Area

Attachment A – Comments/Responses

Supply and Demand Correlation

New Mexico – Gila Basin – Arizona Water Settlement Act

U.S. Department of the Interior
Bureau of Reclamation
Phoenix Area Office

December 2010

Attachment A – Comments/Responses

Supply and Demand Correlation

New Mexico – Gila Basin – Arizona Water Settlement Act

This attachment contains comments submitted by the following individuals:

Craig Roepke, Office of State Engineering, New Mexico
Gerald Schultz, Member IMP/TEC Combined Committees
Peter Russell, Town of Silver City, New Mexico
Allyson Siwik, Gila Conservation Coalition
MH Dutch Salmon, Town of Silver City, New Mexico
John Ward RG., Groundwater Consultant, Tucson, Arizona

Responses are provided by:

Jeffrey P. Riley, P.E., Chief Design and Construction Branch,
Bureau of Reclamation, Phoenix Area Office
Bradley D. Prudohm, Registered Geologist, Design and Construction Branch,
Bureau of Reclamation, Phoenix Area Office

Attachment A – Comments/Responses

Comments Submitted By Craig Roepke, Office of State Engineering, New Mexico. Received 10/22/10.

1. **P7, section 2, last par:** ***Comment:*** Change to Depletion = Diversion – Return.

   Response*:* Paragraph revised.

2. **P8, section 2.1.1, table 2.1:** ***Comment*****:** I'm trying to think of surface water sources in Luna County. I can't remember any of significance. The Mimbres is essentially dry, except for flood flows, by the time it gets to Luna County. I re-visited Fig. 1.11 in the AMEC report. Looks like a bust for the 2005 projections?

   Response: This information was taken from Table 1.4 and Figure 4.10 in the AMEC report. Subsequent conversations with ISC and NMOSE indicate that Luna County does not withdraw 50% of irrigation water from surface water sources. The actual figure is estimated to be closer to 5% surface water sources. AMEC's figure might be linked to water rights volumes rather than actual withdrawals, or the Mimbres "wild flooding" listed in Table 3.13. In light of feedback from the State of New Mexico, Table 2.1 in the Reclamation report has been modified to reflect this comment.

3. **P9, section 2.1.1, par 7:** ***Comment:*** Unfortunately the water rights are couched in diversion amounts and place and purpose of use only, not depletions. A farmer can't expand irrigated acreage, but when they put in a drip system, they can grow more crop on the same acreage. Table 1.7 does a good job of illustrating crop yield (i.e., depletion) increases due to drip. I don't think the increases in yield consider multiple plantings; e.g., two crops/year for onions, etc.

   Response: Paragraph was clarified.

4. **P10, section 2.1.4, par 1**: ***Comment*****:** But hasn't water use remained pretty steady or even increased?

   Response: According to AMEC's Figure 4.17 and Sections 1.3.6 and 1.3.8, there was a reduction of about 5,800 acre-feet from 2008 to 2009 in mining water use at Tyrone and Chino mines.

5. **P13, section 2.3.4, par 1:** ***Comment*****:** Have they ever? BTW, the Chino mine is supposed to re-open today. The AMEC people, after a number of

interviews with the mines, concluded that, "No long term predictions on the future of mining in the region can be made because of the current economic conditions and environmental regulations.

Response: Noted.

6. **P15, section 3, par 2:** ***Comment:*** "? The AMEC report concluded, based on the latest studies, that agricultural conservation efforts; e.g., drip and sprinkler irrigation, usually resulted in increased depletions.: "…it was found that while required diversions are significantly less for drip systems, actual crop water depletions may increase when converting from flood to drip."

   Response: Noted. A more in-depth discussion is provided in paragraph 2.1.1.b.

7. **P16, section 3.1.1, par 1:** ***Comment:*** "Given the lack of WQ information at depth, is this a robust conclusion?"

   Response: A reference to water quality was added to this and other appropriate paragraphs.

8. **P16, section 3.1.1**, **par 3, last sentence:** ***Comment:*** "When I gave a talk to the Deming Rotary Club, a woman approached me afterward and told me that she had grown up on a nearby ranch. When they stayed in town, the water was so soft that it was hard to get the soap suds off. She said that was no longer the case. She asked if the GW got harder with depth?"

   Response: A reference to water quality was added to this and other appropriate paragraphs.

9. **P 17, section 3.1.3, par 2:** ***Comment*:** "1964 USSC Decree and subsequent adjudication proscribe outdoor uses in the Gila Basin. There is no legislative fix. However, outdoor use could be provided through a transfer from existing ag WR's to domestic wells. The transferred ag water would be replaced by diversion and use of AWSA water. I think I've heard some interest in direct allocation of AWSA water to domestic wells. Because you can't turn off the well effects, that won't fit into the diversion constraints. It might be helpful to make that clear here?"

   Response: The paragraph has been revised.

10 **P17, section 3.1.4, par 1:** ***Comment:*** "Chino mine was re-opened today. FMI stated that copper prices have risen enough to make it profitable. Although copper prices will be cyclical, I doubt the long-term trend will be downward. There is a large, untapped body of oxide ore that can be profitably mined with today's technology. The statement in the AMEC report, "the expected permanent downturn in copper mining means that less water will be needed for active mining, although a large fraction of past use will continue to be needed for long-term closure reclamation activities for as much as 100 years" is probably too pessimistic – or too optimistic, depending on your viewpoint.. .. Demand for remediation activities could utilize all existing

WR's, even those not currently or perhaps ever previously exercised. The idea that mining demand will decline may be contrary to future reality."

Response: Reclamation acknowledges your assessment and revised the paragraph to reflect the latest mining activity.

11. **P17, section 3.3, bullet 1:** ***Comment:*** "Assuming WQ is there."

    Response: Agreed. Paragraph revised.

12. **P17, section 3.3, bullet 1:** ***Comment:*** "Doesn't the AMEC study find a potential for a projected increase of 17% in ag, especially if newer, more efficient irrigation technologies are employed? You said the population sector was projected to increase: "AMEC projected the public water service demand by 2050 to be 26% higher than current Silver City demands.?" If ag demand remains stable along with other sectors, where comes the "upward trend in demand" in the previous sentence?"

    Response: Population projections would result in increased demand in the municipalities. An important unknown is agriculture demand, which could influence withdrawals because of the magnitude of agriculture water use. Agricultural demand projections are subject to interpretation as AMEC's demand projections show by 2050 withdrawals could increase or decrease from current levels. The median value projected for 2050 appears to reflect a gain in total withdrawals from historical levels.

13. **P18, section 3.3. bullet 4:** ***Comment:*** "Conservation" is an often misused term. The only true water conservation equates to reductions in net depletions. The AMEC report notes that "Although the effect on total depletions is minimal, there are several conservation measures that can reduce total withdrawals for residential users." Withdrawals do not equate to depletions. Does repairing leaking infrastructure really conserve water or just pumping costs?"

    Response: Paragraph clarified.

14. **P18, section 3.3, bullet 5:** ***Comment:*** "The dilemma is many-fold: First, if you install more efficient irrigation technology, someone has to pay for it. If it's the farmer, he needs to grow more crop to cover his investment for all or part of the "improvement." This increases depletions. If you pay with AWSA $, you still have to at least maintain net depletion amounts, so you have to maintain crop volume. If you only maintain, not decrease, net depletions you haven't conserved water at all, you haven't produced more crop, so why bother anyway? You get cost savings in energy and labor, but water depletions are almost primarily a function of crop, not irrigation application

technology. The latest studies also indicate that drip or sprinklers may well result in more ET even at the same crop volume due to increased E from an upper soil layer constantly kept wet. The AMEC report wasn't clearly written on this, "Recent observed trends in irrigated agriculture in the Study Area suggest that irrigated agricultural demands will remain stable, and have the potential to increase given water availability. In agricultural areas where irrigation water is supplied by groundwater, the increases [in] farm profitability associated with conversion from flood to drip and sprinkler irrigation can be expected to lead to increases in water demand." The laws of physics and the functions of ecology have remained stubbornly independent of statute, consensus, or regulation. I don't see any legislative or administrative fixes that can really address those issues."

Response: This bullet has been deleted.

Comments Submitted By Gerald Schultz, Member IMP/TEC Combined Committees. Received 10/24/10.

1. **P3, section 1.2, lst par:** ***Comment:*** An earlier Balleau report speaks of the Mangus Trench subsurface connection between the Gila and Mimbres Basins. Did any of the reports speak about this?

   Response: The earlier Balleau report (2006?) was not available but several of the summarized reports did discuss groundwater flow from the Mimbres to the Gila basin. A "subsurface connection" was not explicitly cited but Balleau (2009) mentions Trauger, 1972, p. 22 describing the Mangas Trench. Their 2009 report, page 4, talks of groundwater flow through the basin-fill of the Mangas Trench and their Figure 2 shows the Upper Gila Group – piedmont basin-fill unit to extend across the divide. And, the Balleau 2009 T.M. show the water level contours depicting a gradient between basins. Intera pages 4 and page 15 also discuss underflows between the basins.

   Some additional text was added to clarify that there is a hydraulic connection between the Mimbres and Gila groundwater basins.

2. **P3, section 1.2, par 3:** ***Comment****:* I am basically aware of this Hwy as being between Silver City and the Gila Cliff Dwellings (North).

   Response: Highway 15 was misread on a plotted copy of the downloaded New Mexico State Geologic map. It should have said I-10. All instances of Highway 15 were replaced.

3. **P4, section 1.2, par 4*:* *Comment*:** Does SSPA specify where or in different locations?

Response: SSPA did mention recent monitoring of alluvial observation wells installed along four transects across the Gila River (Figure 3.1) in the Gila-Cliff Valley. It is interpreted the statement refers to the four transects (FM-1, FM-2, Bird, and TNC transects; see Fig. 3.1) and intervening seepage investigation measurement areas (see Fig. 3.8) along the Gila River in their two Riparian models, in Reaches 1 and Reach 2. These two model areas occur between Mogollon Creek at Gila River to the north, and below Mangas Creek where it joins the Gila. They were able to characterize gains and losses in reaches between the USGS gage Gila River near Gila (09430500) and the Bird Area, which is located upstream of the Middle Box area.

The text was rewritten to better clarify the location.

4. **P4, section 1.3, par 3, last sentence:** ***Comment:*** Did DBSA say anything about climate change while they did not consider legal, economic, or water quality implications?

   Response: DBSA did not explicitly mention the estimate being under any particular (e.g., drought) climatic conditions or projected climate changes. The estimate seems to have been made under recent time or current conditions.

   The sentence was rewritten to clarify that the estimate apparently did not include effects from climate changes, as DBSA did not mention that.

5. **P10, section 2.1.4**: ***Comment:*** The Mining Company announced during the week of Oct 17 that they will be hiring around 570 workers starting in Nov. I assume that water use will increase to pre-2009 levels.

   Response: The paragraph was revised to reflect the latest mining activity.

6. **P16, section 3.1.1:** ***Comment:*** Did any report discuss the effect that Mexico's irrigation pumping is having on the USA part of aquifer shared by both countries?

   Response: Reclamation is not aware of such a discussion. This may warrant modeling to evaluate.

7. **P16, section 3.1.2:** ***Comment:*** Many reports fail to mention the effect that Mexico's pumping has on the Mimbres Aquifer in the border region. I just wish to note it here.

   Response: Noted.

8. **P17, section 3.2, bullet 1:** **C*omment:*** "Need data to reflect declines/trends of USA side of border due to pumping in Mexico."

   Response: Reclamation concurs and added this to data gaps.

9. **P17, section 3.3, bullet 2 last sentence:** ***Comment:*** This monitoring and modeling needs to be done in the Mimbres border aquifer (along with Mexican coordination). This should also be checked out regarding other border aquifers.

   Response: Reclamation concurs and added this to data gaps.

Comments Submitted By Peter Russell, Community Development Department, Town of Silver City, New Mexico. Received 10/27/10

Thank you for the opportunity to comment on this draft. I appreciate the effort that you have put into this draft and know that you sifted through a lot of data in a very short time to help the Stakeholders group move its projects forward. I have a ***comment*** regarding recommended actions in the Conclusions (Section 3.3), which I will address first, and then some ***comment***s about some language in the body of the text that may need to be clarified.

1. **P17, section 3.3:** ***Comment*:** There are four recommended actions stated in the conclusion section and a fifth one that is implicit in the body of the draft correlation report but not expressly stated. The stated actions are:

   1. Model and monitor large-scale regional declines to fully understand and manage underground aquifers; and

2. Use AWSA water supplies to address supply issues in over-drafted basins; and

3. Use AWSA funding to improve conservation measures, including the repair of leaking infrastructure; and

4. Use or develop sound water management regulations to ensure that conservation efforts achieve the desired results.

   Unidentified but implicit in the draft correlation report is a fifth action, which needs to be added:

5. Develop local networks of new infrastructure to access new water sources, as well as new water rights, in order to augment existing systems, to improve the overall management of sustainable water yields, and to improve reliable delivery of water to users in urbanizing areas.

In the Silver City area, for example, this action is supported by the following data in the text:

- The Intera report states that most recharge to the Mimbres Basin occurs in the upper part of the basin, which lies in Grant County. Not stated in the report, but displayed on the maps that accompany the report, is the fact that this area is where the mountains meet the plain and benefits from mountain front recharge. The higher rainfall in the mountains runs down the arroyos to be stored underground in the alluvium of the plain. This area is where most of the wells of Silver City and its neighboring communities lie.
- The Intera report and the Balleau report identity a sustainable yield of 15,900 AFY of water flowing through the Mangas Trench, which is adjacent to the mountains mentioned above. This area is also where the wells of Silver City and its neighboring communities lie.
- The correlation report (p.4) states that there is 54,000,000 AF of water stored underground in Grant County.
- The Intera report concludes that "it is likely that there is adequate groundwater to supply Silver City."
- The draft correlation report notes that groundwater drawdowns caused by pumping near population centers are localized and that regional aquifers are relatively unaffected by these drawdowns (p.18).
- The draft correlation report states that the mines of Freeport McMoRan own a little over 30,000 AF of ground water rights and 15,000 AF of surface water rights (p.11), and it forecasts that demand for mining use in the future is likely to decline. The Town of Silver City is currently negotiating with the mining company for the transfer and use of water rights for municipal purposes.

In summary, the draft correlation report, and the other reports that it assessed, show there is adequate groundwater and a local source of water rights to address the long-term needs of Silver City and its neighboring communities. A local development and delivery system here is an essential component of a reasonable strategy for meeting these needs. While AWSA water may be available to supplement or replenish the local groundwater sources, and would be used if available, that water is not essential. AWSA funding is essential, however. It would provide a unique opportunity to develop an integrated system that taps into the nearby parts of the large regional aquifer that is unaffected by localized drawdowns. It would supplement existing well systems and provide a common system for sharing resources. The AWSA funds could either provide direct support or indirect support by leveraging grants and allocations from other funding programs. This scenario is supported by the Town of Silver City and by the Grant County Water Commission. It has been also presented repeatedly to the Stakeholders group and to members of the New Mexico delegation, and it would be negligent not to include it as a possible action along with the other possible actions identified in the conclusions section.

Similar local networks of water development and delivery might also benefit other dispersed communities in the very large of southwestern New Mexico, communities such as Deming and Lordsburg and Columbus and Reserve.

Response: Noted. Reclamation does not disagree with your point 5, but considers it too project specific to add to the report.

2. **P4, section 1.3, par 2, 2nd to last sentence: *Comment:*** This sentence suggests that all three reports agree on the amount of deficit, but only DBSA arrives at the 30,000 AFY figure. The other two arrive at a 51 AFY deficit and a 12 AFY deficit respectively. This information is displayed on a bar graph in Intera's report. Because the 30,000 AFY appears to be an outlier, it probably should not be used in the conclusion as the principal justification for the use of AWSA water.

   Response: Reclamation concurs that the statement should be qualified and rewritten. The text was rewritten to better reflect that this issue is a data gap which requires further reconciliation.

3. **P9, section 2.1.2 through section 2.1.5**: ***Comment:*** This section apportions water demand by sectors. It would be useful to include a pie chart that allows relative proportions of demand by sector to be easily seen.

   Response: A pie-chart has been added.

4. **P8, section 2.1.1.b. second par**: ***Comment:*** In the Mimbres Basin, the NMOSE does not allow the transfer of "saved water" resulting from drip irrigation to be used on additional new acreage. The potential for additional income motivates some farmers to bring new lands under cultivation, potentially negating some water savings.

   These two sentences appear to contradict each other.

   Response: This paragraph has been revised.

5. **P11, section 2.1.4, Second and third par**: ***Comment:*** It might be useful to also look at mining demand in 2005, when the mines were operating so that a cross comparison can be made with the other economic sectors in the same year. This information is also in the document assembled by Intera. It might also be useful to assign a percent figure to mining's water demand relative to all water demand in the four-county area.

   Response: These items have been added to the report.

6. **P11, section 2.1.5 first par,**. ***Comment:*** Information in the following paragraphs and in paragraph in Section 2.1.3 , however, only allocate a total percentage of 3.33 to those identified uses (domestic rural users 1%; commercial .4%; industrial .1%; power plants .33%, livestock .6%) While this number is close to the lower cumulative estimate of 5 percent for these demands, the remaining five or six percent is unaddressed, which could be a rounding error except that it represents an amount nearly twice as large as the estimated percentage of current municipal demand (3%). This problem may be an artifact of not having an approximate demand percentage for mining.

   Response: This discrepancy has been resolved.

7. **P13, section 2.3.1, par 1 sentence 2nd, 3rd and 4th**: ***Comment:*** This last sentence seems to be contradicted by the first sentence in the second paragraph of page 10.

   For example: *Silver City's 40-year water plan indicates that demand will exceed the city's permitted water rights between 2021 and 2043.*

   Generally Silver City has acquired new water rights from mining interests and not agriculture interests. The continued prospect of using this source seems likely given the forecast for declines in nearby mining demand for water. Deming, which has recently been purchasing agricultural water rights, is probably a better example.

And while the italicized sentence is true, the forecasts are made on 2.9% and 1.2% annual rates of growth, which are hypothetical rates that do not match the current situation. Given the growth estimate in the preceding table in the text, the likely to exceed date is more likely 2100. Exceeding water rights is a concern clearly, but there appears to still be ample time to address it, and it is a different concern than running out of water.

Response: Noted.

8. **P13, sections 2.3.2 and 2.3.3**: ***Comment:*** These sections forecast a 47% increase in municipal demand and a 50% increase in rural domestic demand, which seem to be large increases over 40 years, except that the proportions are relative to much bigger figures in other sectors. Municipal demand is currently 3% of total demand and may increase to 4.5% of total demand. Rural domestic demand is 1% of total demand and may increase to 1.5% of total demand. A bar graph here might help avoid misleading conclusions.

   Response: The pie-charts in AMEC's Figures ES-1, -2, and -3 address this comment.

9. **P14, section 2.3.5:** ***Comment:*** This section allocates only 2% to commercial, industrial, power, and livestock demands and seems to conflict with Section 2.1.5. Also see discussion above regarding Section 2.1.5.

   Response: This discrepancy has been resolved.

10. **P15, Task 3, second par, first sentence:** ***Comment:*** Since irrigated agriculture, which accounts for 87% of water demand (Section 2.1.3), is forecast to remain steady over the next 40 years (Section 2.3.1), and mining—the second highest demand (Intera)—is forecast to decline (Section 3.1.1.4.), it seems unlikely that overall demand will expand. Municipal, rural domestic, commercial, industrial, power, and livestock demand will likely increase, but combined these demands only account for 7.5% of current total demand (Sections 2.1.2, 2.1.3, and 2.1.5), and any increase will likely be more than offset by declines in mining demand.

    Response: Population projections would result in increased demand in the municipalities. An important unknown is agriculture demand, which could influence withdrawals because of the magnitude of agriculture water use. Agricultural demand projections are subject to interpretation as AMEC's demand projections show by 2050 withdrawals could increase or decrease from current levels. The median value projected for 2050 appears to reflect a gain in total withdrawals from historical levels.

11. **P15, section 3.1.1, first par*:*** ***Comment:*** The purchase of groundwater irrigation rights may be reduced to as low as 20% of the original water right.

Since Silver City has generally acquired new water rights from mining use, the diminution in the transfer of agricultural rights is unlikely to be a factor. Where did the 20% figure come from, by the way?

Response: AMEC report Section 3.1.2.

12. **P16, section 3.1.2, first par, first sentence:** ***Comment:*** Only one of three water budget analyses identifies a 30,00 acre-foot deficit. It may be misleading if the others are not also mentioned.

    Response: The report has been revised to clarify this issue.

13. **P16, section 3.1.2, first par, 2^{nd} to last sentence:.** ***Comment:*** Based on the bar graph estimates done by Intera for 2005, it appears that 90% may be a better figure. Going back earlier to 1975, the proportion is even higher.

    Response: Noted.

14. **P17, section 3.3, first par, first sentence.** ***Comment:*** The only time the phrase significant decline has been used previously in this draft correlation report is for the Nutt-Hockett Basin. That basin should probably be included in the italicized sentence for purposes of clarity. If other areas are intended for inclusion, the phrase "significant decline" probably needs some better precision.

    Response: Agreed. This paragraph has been revised.

15. **P18. section 3.3, first par, third and fourth sentences**: ***Comment:*** Previous statements in this document suggest that population increases will raise the municipal and rural domestic demand very modestly (from 4% of overall demand to 6% of overall demand). This increase is more than likely to be offset by declines in mining demand.

    Response: Noted.

Comments Submitted By Allison Siwik, Gila Conservation Coalition. Received 10/28/10

Thank you for your hard work in quickly pulling together the supply/demand correlation for the AWSA Stakeholders Group. We appreciate the opportunity to provide you with comments on the draft.

1. **P4, section 1.3:** ***Comment:*** Water Budget for Mimbres Basin – BOR summary statement that Mimbres Basin is being mined at a rate of 30,000 acre-feet/year does not clearly communicate the fact that the INTERA report presents a wide range of findings for the Mimbres water budget. Hansen (1994) and Shomaker (2006) results are based on modeling and find that the water budget is more closely balanced (i.e., inflows=outflows) with the difference between inflows and outflows being -12 acre-feet/year to -51 acre-feet/year. DBSA results, although based on a literature review, rely on outdated information and do not properly account for the geographic component of the groundwater budget.

   Grant County – The data show the projected storage loss in the Mimbres Basin in Grant County is only about 3,000 acre-feet per year. The groundwater budget also shows that most of the basin's recharge occurs in the Grant County area of the basin: about 22,000 acre-feet/year out of a total recharge of 25,000 acre-feet/year. In addition, the Grant County portion looks even healthier when the most recent mining water use data are used. The regional water plan, from which the DBSA estimates derive, uses data from 2000 showing about 19,000 acre-feet per year for Grant County mining outflows, whereas more recent mining outflows in 2002, 2003 and 2009 have been only about 6,000 acre-feet per year. Updating the groundwater budget with this more current data shows that there is a positive net change in storage in the Grant County section of almost 6,000 acre-feet per year. It would appear that the Grant County section of the Mimbres aquifer is in relatively good shape.

   Luna County - Luna County is responsible for the loss of 31,000 of the aquifer's 34,000 acre-feet per year according to DBSA estimates in the SWNM Regional Water Plan. Most of the loss in Luna County is due to irrigation. But the Luna County portion may be better off than indicated by the groundwater budget. For example the regional water plan acknowledges that the estimates of evapotranspiration and recharge are highly uncertain, and that specifically, evapotranspiration may be overestimated by 10,000 acre-feet per year.

   Revised Mimbres Groundwater Budget – Factoring in the more recent mining water use data and the potential overestimate in evapotranspiration, basin-wide net outflows are reduced to about 15,000 acre-feet per year rather than 31,000 acre-feet per year. Moreover, the Grant County portion of the Mimbres Aquifer does not appear to be significantly under stress. The more recent Balleau groundwater modeling appears to confirm this.

Response: Reclamation concurs that the statement as the last sentence in paragraph 2 under 1.3 Aquifer Characteristics, regarding the 30,000 acre-feet per year outflow deficit, should be qualified and rewritten. The text was rewritten to better reflect that this issue is a data gap which requires further reconciliation.

2. **P10, section 2.1.4:** ***Comment:*** Given the fact that Freeport-McMoRan has historically used and is currently using only a small portion of their permitted water rights, what does this mean for water planning and management in the region?

   Response: Given the cyclical nature of mining in Grant ounty, speculation on the potential for water rights transfers from mining to other sectors is beyond the scope of this report.

3. P15, section 3.1.1: ***Comment:*** Silver City – It would be helpful to include the sustainable yield estimates for Mimbres-Mangas Trench to put into perspective this discussion of "areas of greatest concern.

   Response: The reports did not address this.

   Comment: Deming – it would be helpful to put into context the fact that Deming already has sufficient water rights to meet their needs for the 40-year planning horizon according to their most recent water plan (July 2009).

   Response: Noted. The AMEC report addresses this.

   Comment: Columbus – not sure if groundwater levels are declining. Last I heard, groundwater levels were stable.

   Response: Paragraph has been revised.

4. **P 16, section 3.1.2:** ***Comment:*** Mimbres Basin – see ***comments*** above re: 30,000 afy deficit. Also this discussion paints the basin with a broad brush, when we know that most of the net depletions are occurring at the southern end of the basin. Also re: the 50 foot drop in water table over last 50 years—is this significant vis-à-vis OSE regs?

   Response: Reclamation agrees that additional information is needed in order to draw specific conclusions regarding the Mimbres basin as a whole.

5. **P 17, section 3.3:** ***Comment**:* Significant groundwater declines – please define significant. Is BOR definition consistent with OSE definition and are groundwater declines in the region considered "significant" under state regulations?

Response: This paragraph has been revised.

Comment: Foreseeable future – What is the timeframe under which BOR conclusions are made?

Response: Paragraph revised.

Comment: Conservation measures – are you referring only to agricultural infrastructure or municipal infrastructure and conservation measures also? Please clarify**.**

Response: Both agricultural and municipal. Paragraph revised.

Comments Submitted By Dutch Salmon, Town of Silver City, New Mexico. Received 11/01/10

Jeff: Although past the stated deadline, I trust the following will get a reading/consideration........my excuse is the previous week I was taken up with setting bear and cougar regulations with the New Mexico Game Commission, a thankless task wherein a "happy" medium is not to be found (I'm sure you can relate!).

I can be brief as Allyson Siwik has already addressed well the issues in your draft supply/demand document for the Gila Conservation Coalition.
In addition however, I will comment on the following statement from your study: under:

1. **P 17, section 3.3:** ***Comment:*** in light of declining groundwater levels in high demand areas and a 30,000 af/year deficit in the Mimbres Basin water budget, a long term solution utilizing AWSA water supplies for over-drafted basins is an appropriate strategic approach."

   Even at 30,000 af/yr overdraft, "solution" is a questionable word to attach to the possible AWSA water contribution. This potential diversion totals up to 14,000 af/year but 4,000 af is dedicated to Catron County and the San Francisco drainage leaving up to 10,000 af/yr (not counting reservoir storage evaporation) possibly available for transfer from the Gila River to the Mimbres Basin. If the goal, as implied, is to eliminate groundwater mining in the basin and bring the water budget into inflow/outflow balance, this "solution" would fail as 20,000 af/yr (2/3rds of the original) would still be in the groundwater "mining" category while the outflow in expenditure to gather the 10,000 af/yr is variously estimated at $220 million (OSE) to over $300 million (extrapolation from BoR study of the 1988 "Mangas Diversion" option) in capital costs. An AWSA unit would augment Mimbres Basin supply by about 8,000 af/year but I think it an over-reach at this juncture to call it a "solution" while it's value as "an appropriate strategic approach" awaits further correlation with economics, cost/benefit analysis, and environmental review.

Response: Reclamation concurs that the statement as the last sentence in paragraph 2 under 1.3 Aquifer Characteristics, regarding the 30,000 acre-feet per year outflow deficit, should be qualified and rewritten. The text was rewritten to better reflect that this issue is a data gap which requires further reconciliation.

Comments Submitted By John Ward, RG.,Groundwater Consultant, Tucson Arizona. Received 11/03/10

The purpose of the BOR Demand-Supply Correlation Study was to determine the balance between ater supply and water demand, and to identify data gaps. On October 15, BOR provided a draft final report on the results of this study to the stakeholder committee for review. This memo provides my review of their report.

In general the report comports with what was described in the September 14 work plan. My ***comments*** are focused on **P. 15, section 3.1**: Correlation of Supply and Demand Studies.

1. **P17, section 3.2:** ***Comment:*** Identify Data Gaps Associated with Correlating Supply and Demand Studies This section only listed "overall Mimbres basin" and "overall Lordsburg basin" groundwater eclines or trends, a discussion of which needs to be included. Additionally, there are many other significant data gaps:

    1. At a minimum, data gaps or uncertainties that were identified in the various demand and supply studies should be listed and discussed. For example, AMEC concluded that the largest component of municipal demand uncertainty was due to the unavailability of 2010 census data. This uncertainty carried through to the ranges in water demands over the next 50 years.

    2. An additional significant data gap is the amount of water to be used for future mining, or in the absence of mining, the disposition of the mining

water rights, which total to greater than 52,000 acre feet annually. As the Town of Silver City has noted, transfer of some water rights to municipal use has occurred and will probably continue.

3. Irrigated agriculture, as the Town of Silver City has also pointed out, may not expand due to legal, water availability, or economic conditions, or all three. The eventual disposition of the water currently used for agriculture, should be recognized as highly uncertain, and should probably be included as a data gap.

4. Finally, on the demand side, are large uncertainties related to industrial demands, especially in power generation. As has happened in other areas in the Southwest, transfer of mining water rights to power plants has resulted in no net reduction of water demand when mining declines. Note that the AMEC report included a very large range of potential industrial demand, due primarily to the power generation uncertainty.

5. On the "supply" side, the report notes that there is (roughly) more than 200 million acre feet of water in groundwater storage (p 4). Equating this volume to current or projected demand gives a misleading impression that there will be, regionally, no supply problem. The data gaps associated with supply, as discussed (for example) in the DBSA report, should focus on the practical availability of this water supply, such as volume of recoverable water available at certain pumping depths; the uncertainty as to whether groundwater even exists at developable quantities and qualities at depth in the larger groundwater basins is a significant data gap. Finally, the legalities of out-of-basin water transfers may present a significant restriction to solving local water shortages with regional supplies.

Response: List of data gaps has been expanded in the report.

2. P 17, section 3.3: ***Comment:*** The conclusions sections may be expanded based on the identification of uncertainties and data gaps.The conclusions should be based on the correlation work in Section 2, and should primarily betechnical in nature.

Comment: This section also includes several BOR opinions, such as 1) "the situation is manageable under current supply conditions" (1st bullet); 2) "there does not appear to be an immediate need to augment water supplies" (3rd bullet); 3), "conservation measures ... is a reasonable water to utilize AWSA related funding; and 4) "these types of regulations, or legislative development ... are necessary to ensure conservation efforts achieve the desired results" (5th bullet).

These opinions should be examined carefully before finalizing this report. The first and second opinion may not be justified based on the results of the demand and supply studies. The third opinion strays into a recommendation for a particular direction of future OSE funding. The fourth opinion is a legal one, and appears to stray from the objective of this study.

Technical recommendations should be broken out. Those related to solving the data gaps should be most important. Monitoring and modeling in the regional declines in water levels, particularly in the Mimbres Basin (first bullet) is an appropriate recommendation. However, comprehensive (4 county) groundwater and surface water modeling may also be needed.

Response: This section of the report has been revised.