DRAFT

Estimates of Region-Wide and Deming Area Water Supplies

Prepared for **Interstate Stream Commission**
Santa Fe, New Mexico

June 30, 2009

Daniel B. Stephens & Associates, Inc.

6020 Academy NE, Suite 100 • Albuquerque, New Mexico 87109

Table of Contents

List of Figures

List of Figures (Continued)

Figure **Page**

List of Tables

Table **Page**

Estimates of Region-Wide and Deming Area Water Supplies

1. Introduction

This report provides a summary of the Phase 1a work completed by Daniel B. Stephens & Associates, Inc. (DBS&A) for the Arizona Water Settlement Act (AWSA) supply and demand study that is being overseen by the New Mexico Interstate Stream Commission (ISC) and the Technical and Implementation Committees of the Southwest New Mexico Stakeholders Group. The DBS&A portion of Phase 1a work is a survey of significant changes that have occurred since completion of the Southwest New Mexico Regional Water Plan, with a focus on Deming and the surrounding area as one of the presumed locations of higher demand and stress on the aquifer. Phase 1a results of the supply and demand study were presented on June 17, 2009 in Silver City. The purpose of the presentation was to provide suggestions for technical direction of the larger Phase 1 and Phase 2 supply and demand study and modeling efforts to be conducted in the 2010 fiscal year. This report documents work completed by DBS&A that was presented at the June 17 meeting. DBS&A Phase 1a activities included the following tasks:

1. Review regional water plan supply estimates (Section 2)
2. Evaluate current and historical depletion rates in the Deming area, including changes in irrigated agriculture (Section 3)
3. Estimate current water supplies in the Deming area (Section 3)
4. Identify data gaps and provide recommendations for continuing work (Section 4)

Due to the short time frame of Phase 1a, review of the supply estimates was narrowed to those that have new data available or where it would add value to revise the estimates. The bulk of DBS&A Phase 1a activities were focused on the Deming area.

2. Region-Wide Water Supplies

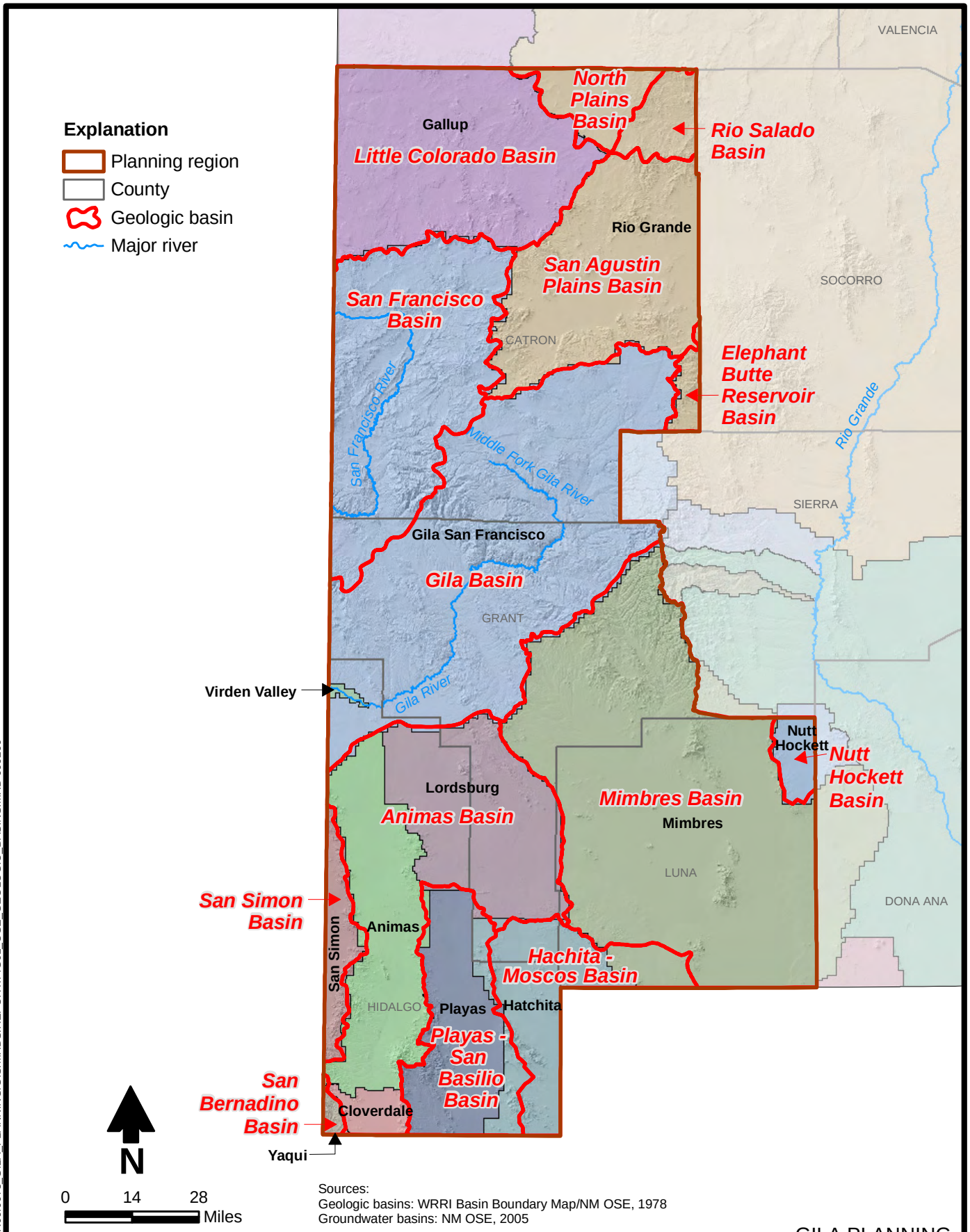
The purpose of this task was to complete a quick review of water supply information for the region to determine if new information or changed conditions create the need for revising previous water supply estimates. The four-county region contains 13 separate groundwater basins (Figure 1), all of which have been declared by the New Mexico Office of the State Engineer (OSE) for purposes of water rights administration. Groundwater supply and availability are controlled to a large extent by the nature of the geology present, the depth of groundwater, and the quality of the groundwater. The Southwest New Mexico Regional Water Plan (DBS&A, 2005) presented a general overview of supply for the hydrogeologic basins. As shown in Figure 1, the hydrogeologic basins do not always correspond to the same area as the OSE-declared basins.

DBS&A developed rough estimates of the groundwater in storage in the hydrogeologic basins by county, based on the areal extent of the geologic formations and information on aquifer thickness and specific yields (Table 1). The approximations of groundwater in storage were determined for each aquifer by multiplying the area or extent of occurrence (not the entire basin area) by the average thickness and specific yield for the aquifer. In practical terms, specific yield is a measure of the water available to wells.

As stated in the regional water plan, the amount of subsurface characterization (i.e., well logs) within the region is not adequate to allow a highly accurate determination of groundwater in storage. In addition, the quality of water varies throughout the region; although some locations may contain brackish or slightly saline waters that could be treated for use in the future, such treatment may not be practical for current and near-term demands and uses.

The values provided in Table 1 should be used only as a general guide in the water planning process, as they are approximations. The DBS&A regional water plan estimates include all water in storage, and not necessarily the water that is practically or economically developable. The available data were insufficient to evaluate water quality limitations in all areas and the estimates do not consider legal (water right) constraints or the economics of development in

DRAFT



Sources:
Geologic basins: WRRI Basin Boundary Map/NM OSE, 1978
Groundwater basins: NM OSE, 2005

GILA PLANNING

Geologic Basins and Declared Groundwater Basins

S:/PROJECTS/WR09.0073_GILA_PLANNING/GIS/MXDS/REPORT/FIG01_OSE_GEOLOGIC_BASINS.MXD 909260

Daniel B. Stephens & Associates, Inc.

06/29/2009

JN WR09.0073

Figure 1

remote areas. Consequently, these estimates cannot be considered as estimates of water that is readily available for use in the planning region.

Table 1. Approximate Amount of Groundwater in Storage by Basin and County

County	Hydrogeologic Basin	Groundwater in Storage (acre-feet)
Catron	Gila	27,485,000
	San Francisco	40,864,000
	Elephant Butte Reservoir	2,215,000
	Little Colorado	19,956,000
	North Plains	573,000
	Rio Salado	9,792,000
	San Agustin	49,908,000
Grant	Gila	26,200,000
	San Francisco	4,578,000
	Animas	7,200,000
	Hachita-Moscos	2,962,000
	Mimbres	13,060,000
	Playas-San Basilio	548,000
Luna	Animas	714,000
	Hachita-Moscos	3,315,000
	Mimbres	32,383,000
	Nutt-Hockett	2,665,000
Hidalgo	Gila	5,580,000
	Animas	38,943,000
	Hachita-Moscos	9,001,000
	Playas-San Basilio	5,990,000
	San Bernadino	400,000
	San Simon	860,000

Source: DBS&A, 2005

In particular, considerations of the amount of groundwater in storage have little practical value in areas where the use of the stream-connected groundwater is limited by legal decrees. In the Gila-San Francisco Basin, where there is a hydrologic connection with the San Francisco and Gila Rivers, use is limited regardless of the amount of water in storage. For example, the Gila River Apportionment limited the total consumptive use of such water (exclusive of uses in

Virden Valley) for any purposes to 136,620 acre-feet during any period of 10 consecutive years and to 15,895 acre-feet during any 1 year (Arizona v. California, 376 U.S. 340 (1963), at 348).

With the tight schedule and limited funding for Phase 1a, the regional water plan supply estimates were reviewed only to identify and address gross inaccuracies, incorrect assumptions, or other deficiencies in previous estimates. In addition DBS&A identified five applicable reports as a part of the Southwest New Mexico document cataloging project and reviewed them for any new or previously unidentified information that would improve characterization of hydrologic and water quality conditions that control groundwater supply. The reports reviewed included:

- *Estimation of Alluvial-Fill Thickness in the Mimbres Groundwater Basin, New Mexico, from Interpretation of Isostatic Residual Gravity Anomalies* (Heywood, 2002)
- *Mimbres Basin Ground-Water-Flow Model in Support of Chino Mines Company Supplemental Discharge Permit for Closure, DP-1340, Condition 86* (McCoy and Finch, 2006)
- *Draft Town of Silver City Water Plan, Supplement on Water Use and Wellfield Service* (Balleau, 2006)
- Geologic Controls on Ground-Water Flow in the Mimbres Basin, Southwestern New Mexico (Finch et al., 2008)
- Water-Bearing Properties of Selected Geologic Materials in Mining Areas of Grant County, New Mexico (Kilmer, 2008)

The reports were reviewed to identify information that could be used to revise the existing estimates. No new hydrogeologic information was identified that would require revising the existing estimates.

Refined groundwater characterization may be most important in areas with increasing demand or locations where large-scale development is planned; therefore, DBS&A conducted

preliminary research to determine where demand might be increasing. This was accomplished by reviewing well installation trends in the region based on OSE well records (NM OSE, 2009). Figure 2 illustrates non-domestic well installation trends in the region by color coding each well based on its date of installation. Recent clusters of well installations have occurred along the San Francisco and Gila Rivers, in the Silver City, Lordsburg, and Deming areas, and in the Animas, Nutt-Hockett, and San Simon Declared Basins. Figure 3 presents these same wells with symbols identifying the well use category. Comparing Figures 2 and 3 shows that a significant number of the wells with unknown installation dates are for livestock, agricultural, or irrigation type purposes or are pre-basin or declared domestic wells not permitted by the OSE under the New Mexico Statute 72-12-1.

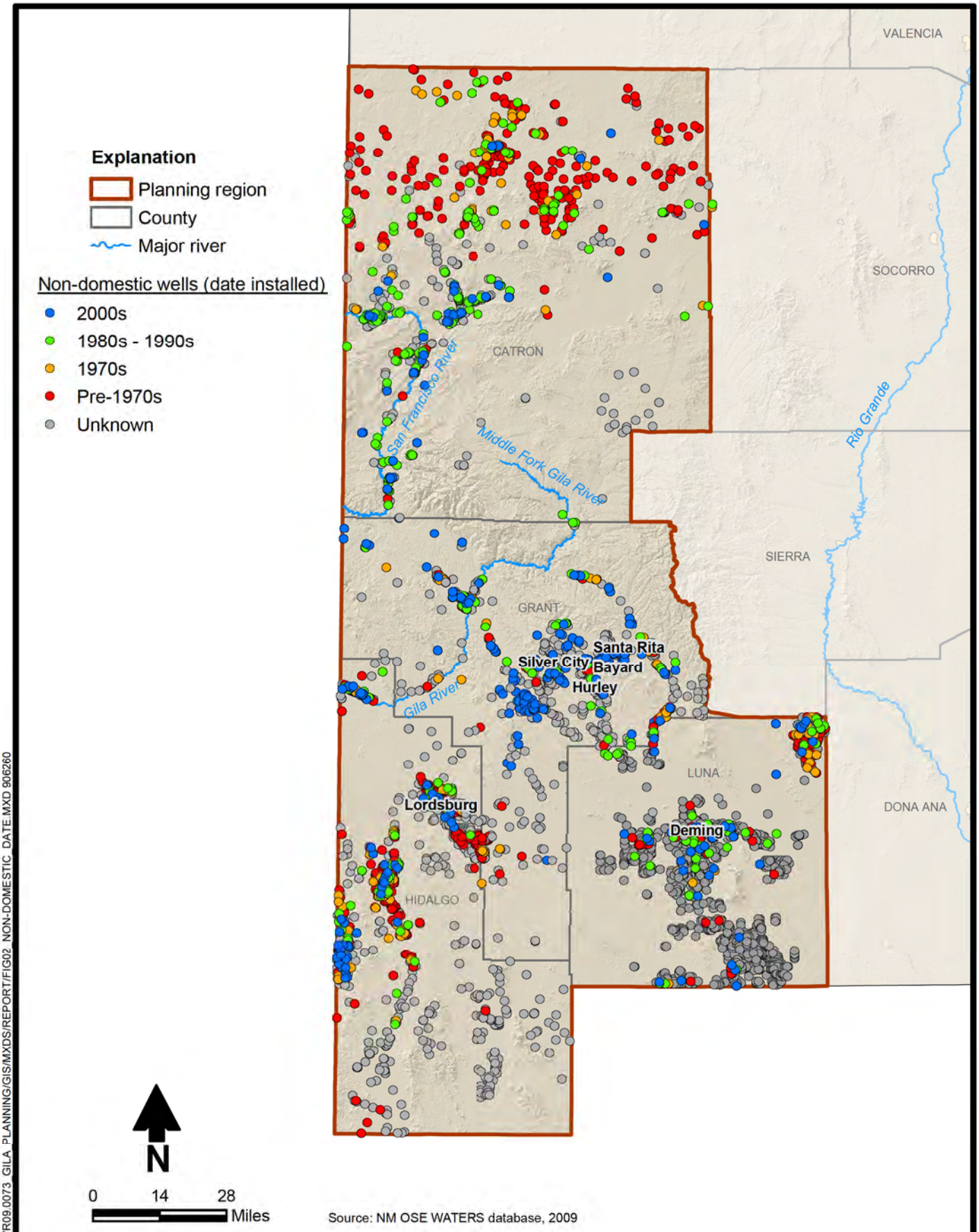
Figure 4 presents domestic well installation trends in the region by color coding by the installation date, and shows similar trends as Figure 2. Figures 2 though 4 illustrate the areas where the greatest groundwater development is occurring and where there may be the most interest in further refining the understanding of storage and other sustainability issues. Existing groundwater models may be used in these areas, possibly after modification for increased resolution, to refine the storage estimates. Figure 5 shows the locations of existing OSE administrative groundwater models in addition to the well locations shown in Figures 2 and 4. The current Mimbres Basin model (based on Hansen et al., 1994) is currently being revised by OSE and may be replaced with the model prepared by John Shomaker & Associates (McCoy and Finch, 2006).

Based on the brief overview of this topic as completed in Phase 1a, DBS&A concludes that:

- Only minimal new published data is available and it is not likely to significantly change storage estimates

- New well installations along the San Francisco and Gila Rivers in the Silver City and Deming areas illustrate locations where there is the greatest need for better understanding of aquifer conditions. Refinement of existing or development of new models is a better tool for addressing supply questions in these areas and would add information to the estimates of overall amounts of aquifer storage.

DRAFT



Source: NM OSE WATERS database, 2009

S:/PROJECTS/WR09.0073_GILA_PLANNING/GIS/MXDS/REPORT/FIG02_NON-DOMESTIC_DATE.MXD 906260

GILA PLANNING

Non-Domestic Well Installation

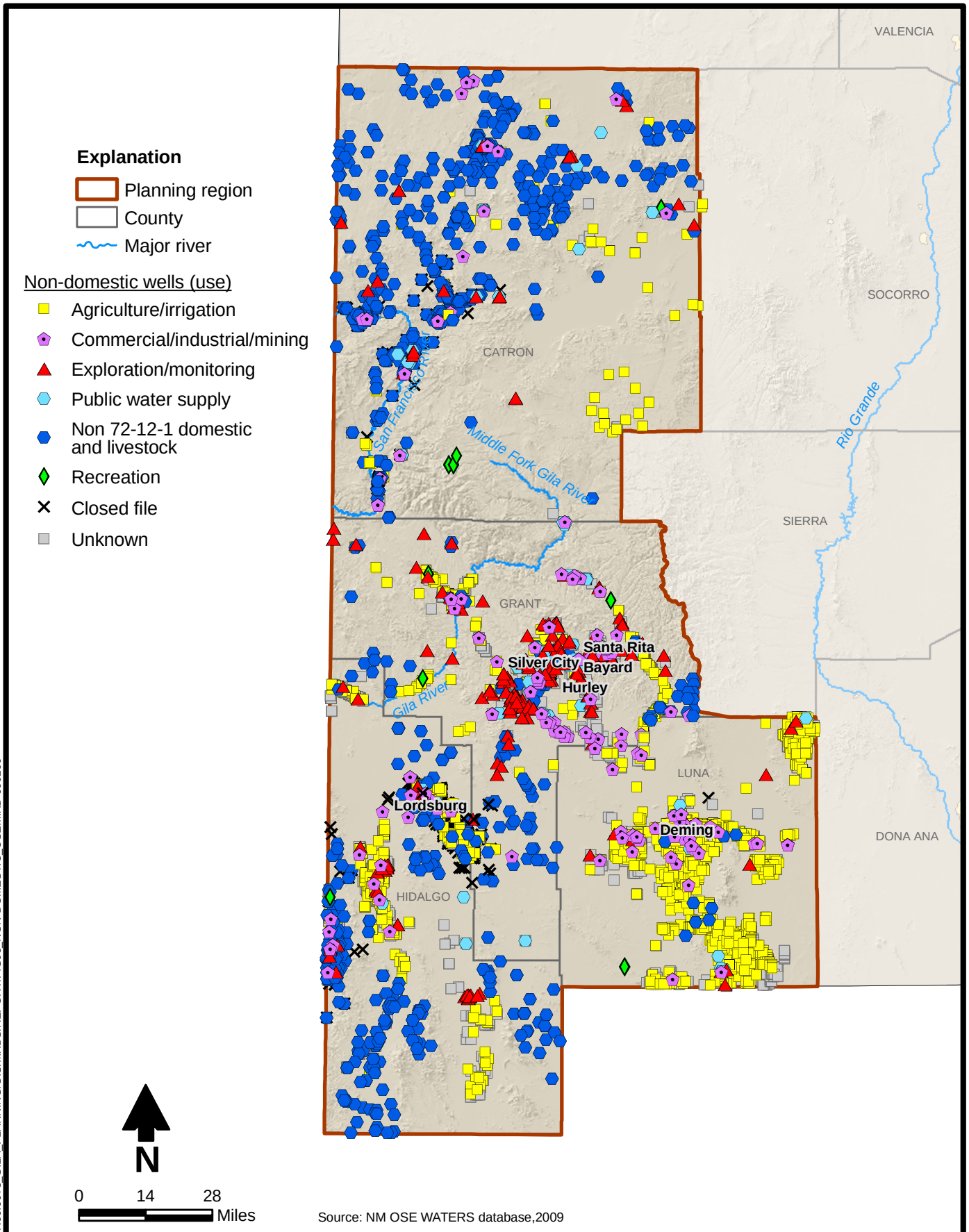
Daniel B. Stephens & Associates, Inc.

06/26/2009

JN WR09.0073

Figure 2

DRAFT



Source: NM OSE WATERS database,2009

S:/PROJECTS/WR09.0073_GILA_PLANNING/GIS/MXDS/REPORT/FIG03_NON-DOMESTIC_USE.MXD 906260

GILA PLANNING

Non-Domestic Use Category

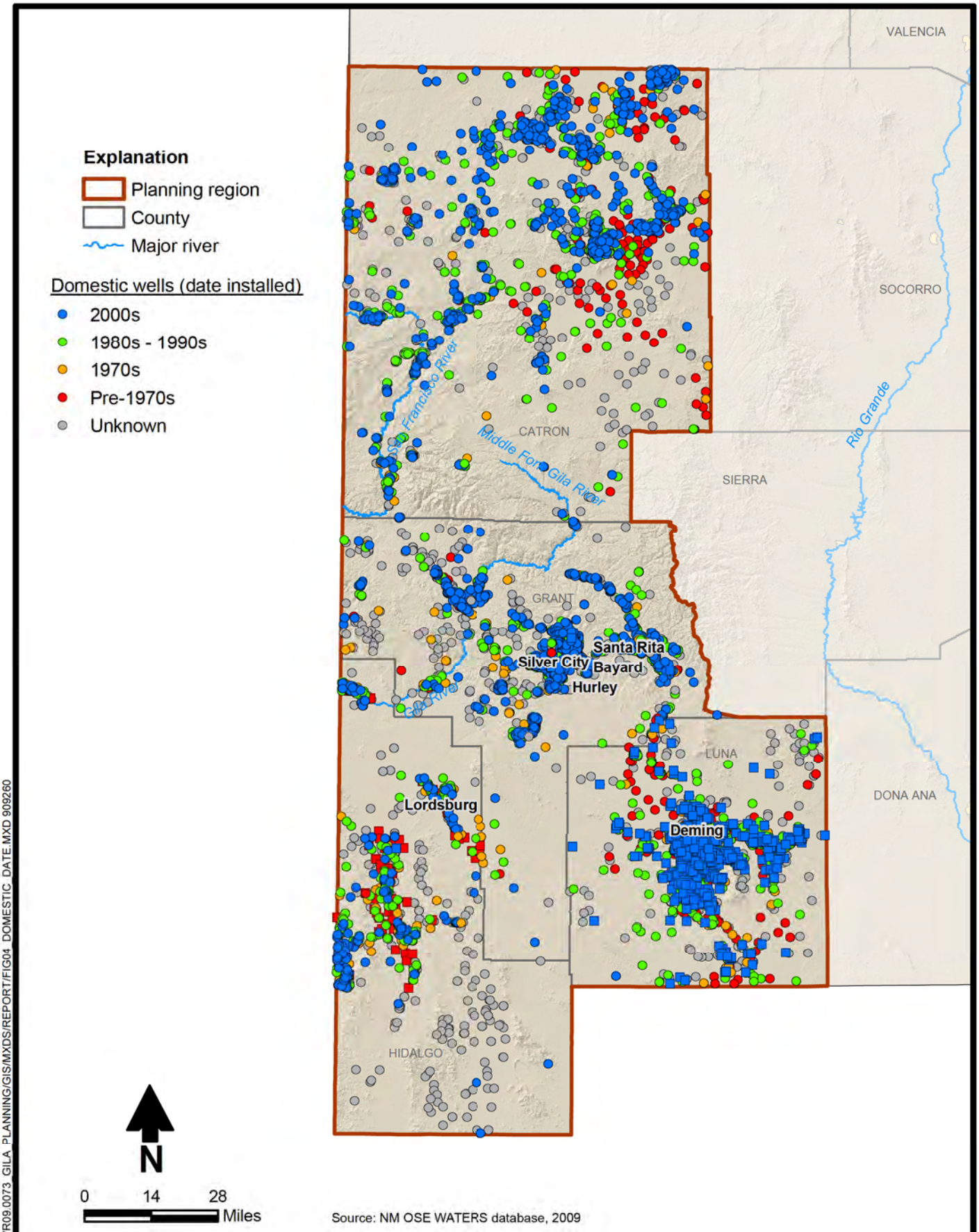
Daniel B. Stephens & Associates, Inc.

06/26/2009

JN WR09.0073

Figure 3

DRAFT



Source: NM OSE WATERS database, 2009

S:/PROJECTS/WR09.0073_GILA_PLANNING/GIS/MXDS/REPORT/FIG04_DOMESTIC_DATE.MXD 909260

GILA PLANNING

Domestic Well Installation

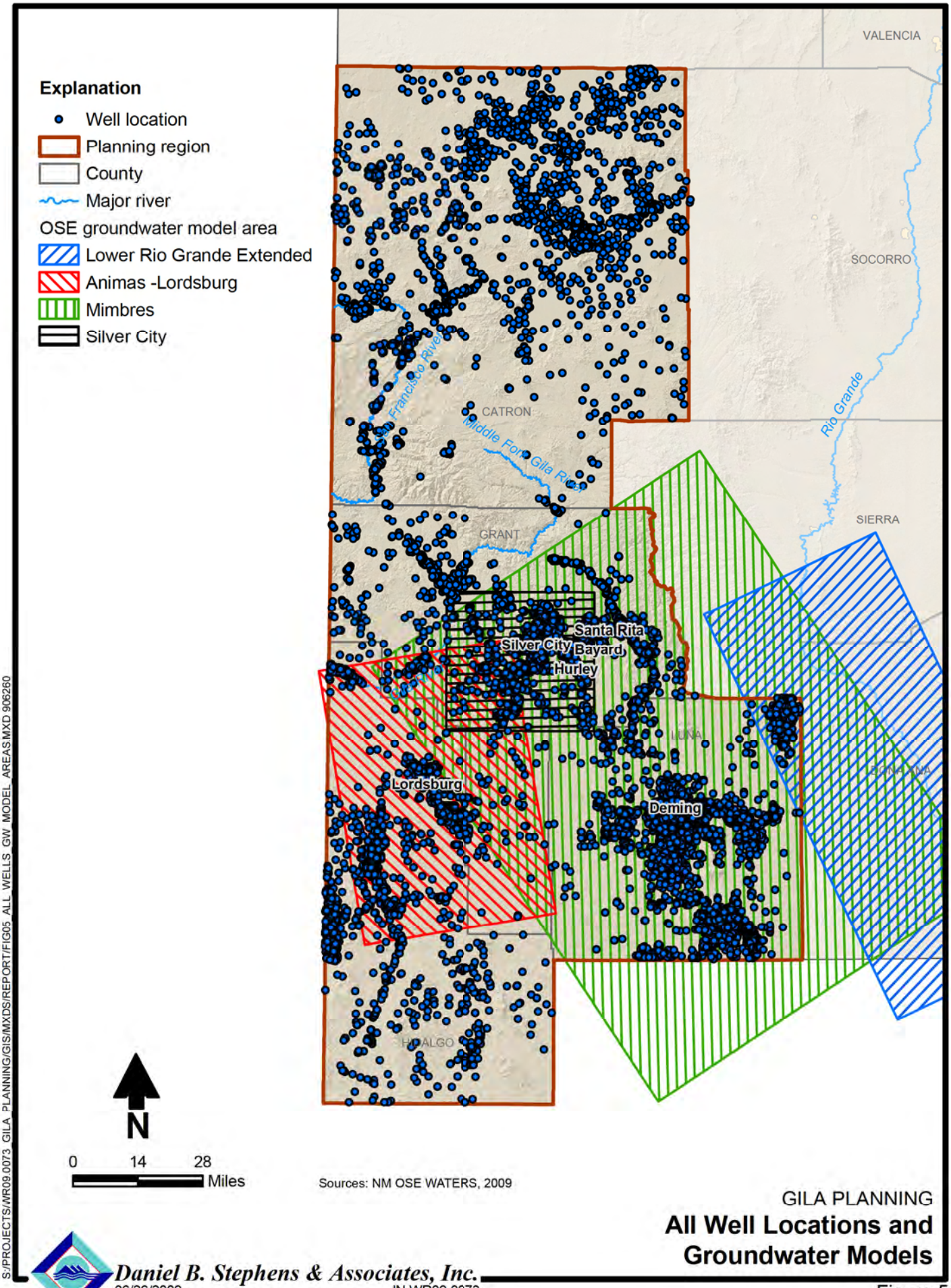
Daniel B. Stephens & Associates, Inc.

06/29/2009

JN WR09.0073

Figure 4

DRAFT



S:/PROJECTS/WR09.0073 GILA PLANNING/GIS/MXDS/REPORT/FIG05 ALL WELLS GW MODEL AREAS.MXD 906260

GILA PLANNING

All Well Locations and Groundwater Models

Daniel B. Stephens & Associates, Inc.

06/26/2009

JN WR09.0073

Figure 5

- There is a need to consider interstate compacts, water rights administration, and other legal constraints, along with economic feasibility issues, to refine estimates of practically available groundwater within the total storage estimates. Until these other issues are integrated into the analysis, it may not be efficient to spend more resources on further refinement of storage estimates.

3. Deming Area Water Supplies

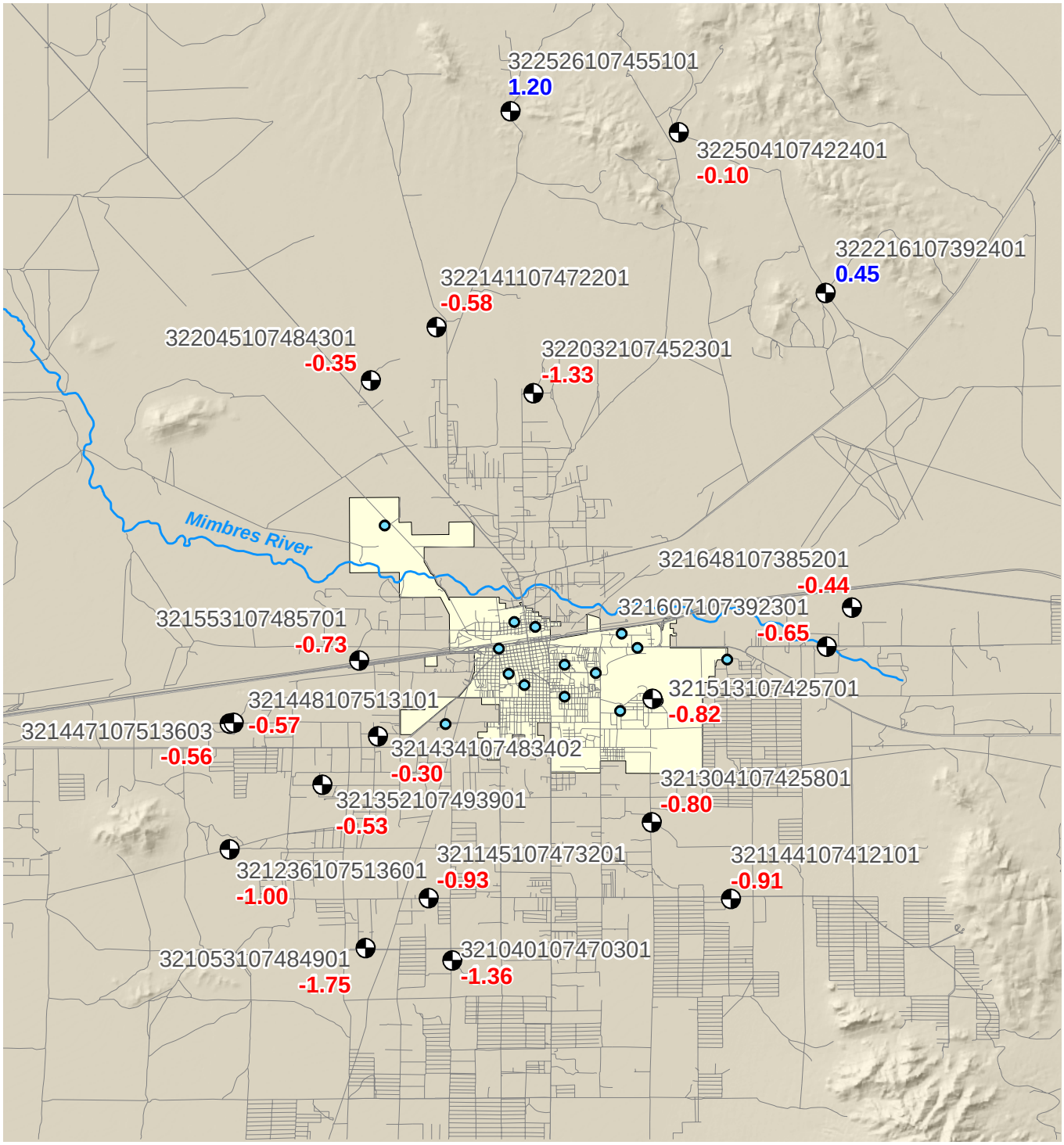
The purpose of this task was to provide an overview of groundwater supply and demand issues in the Deming area and identify areas where more data collection or analysis may be useful. As discussed above, the Deming area is experiencing relatively rapid development of new groundwater supplies, and is therefore a logical candidate for more detailed analysis.

The U.S. Geological Survey (USGS) has been recording water level measurements in the Deming area of the Mimbres Basin for over 7 decades. Figure 6 shows the locations of the wells near Deming where measurements have been taken by the USGS. Based on the period of record of water level measurements for each well, an average rate of change per year was calculated. The majority of wells show net decreases over time, with the average annual rate of change ranging from –1.75 to –0.1 feet per year (ft/yr). Collectively, the wells in the Deming area show about a 0.6 ft/yr rate of decrease in water levels since the 1950s.

Figure 7 shows the water level measurements through time for a USGS monitored well located approximately 4 miles southwest of the center of Deming. Over 800 measurements were taken at this well between 1939 and 2007. In those 68 years, the water level has dropped about 36 feet, leaving a water column of only 19 feet. The time-series plot (Figure 7) shows that significant decreases in water levels occurred in the 1950s and again in recent years.

The majority of groundwater diversions in Luna County are for irrigated agricultural purposes. Figure 8 shows the volume of water use (diversions) by category in 5-year intervals from 1975 to 2005 based on OSE Water Use and Conservation Bureau reports (Longworth et al., 2008; Sorensen, 1977 and 1981; Wilson, 1986 and 1992; Wilson et al., 2003; and Wilson and Lucero, 1997).

DRAFT



Source: USGS, 2009

N

0 1 2 3 Miles

Explanation

- Deming
- Road
- City well
- USGS monitored well

Average annual water level change (feet per year):

- 0.45 Water level increase
- -0.57 Water level decrease

GILA PLANNING

USGS Monitored Well Trends

Daniel B. Stephens & Associates, Inc.

06/30/2009

JN WR09.0073

Figure 6

S:/PROJECTS/WR09.0073_GILA_PLANNING/GIS/MXDS/REPORT/FIG06_USGS_WELL_WATER_LEVEL_TRENDS.MXD 900360

DRAFT

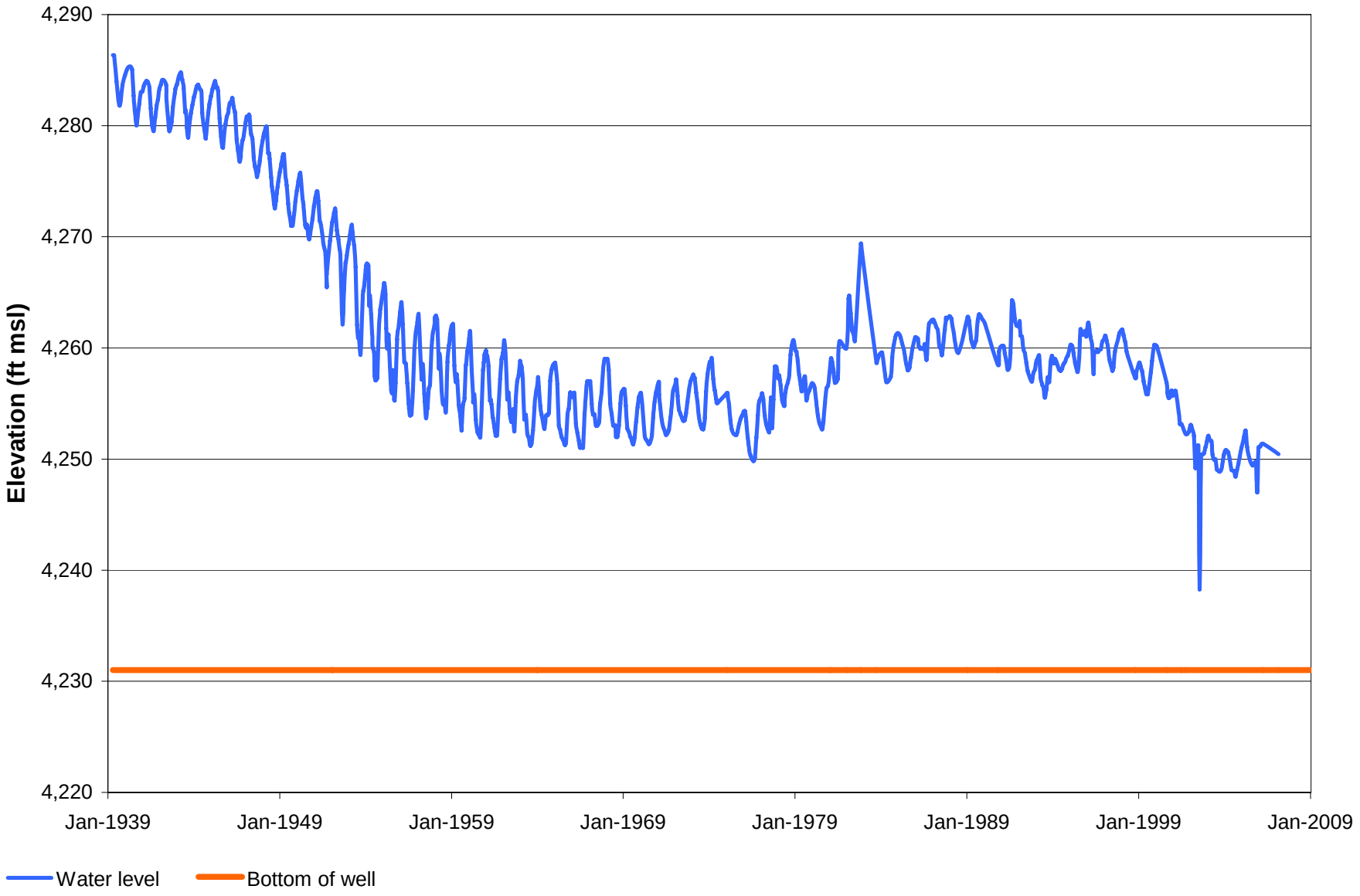


Figure 7

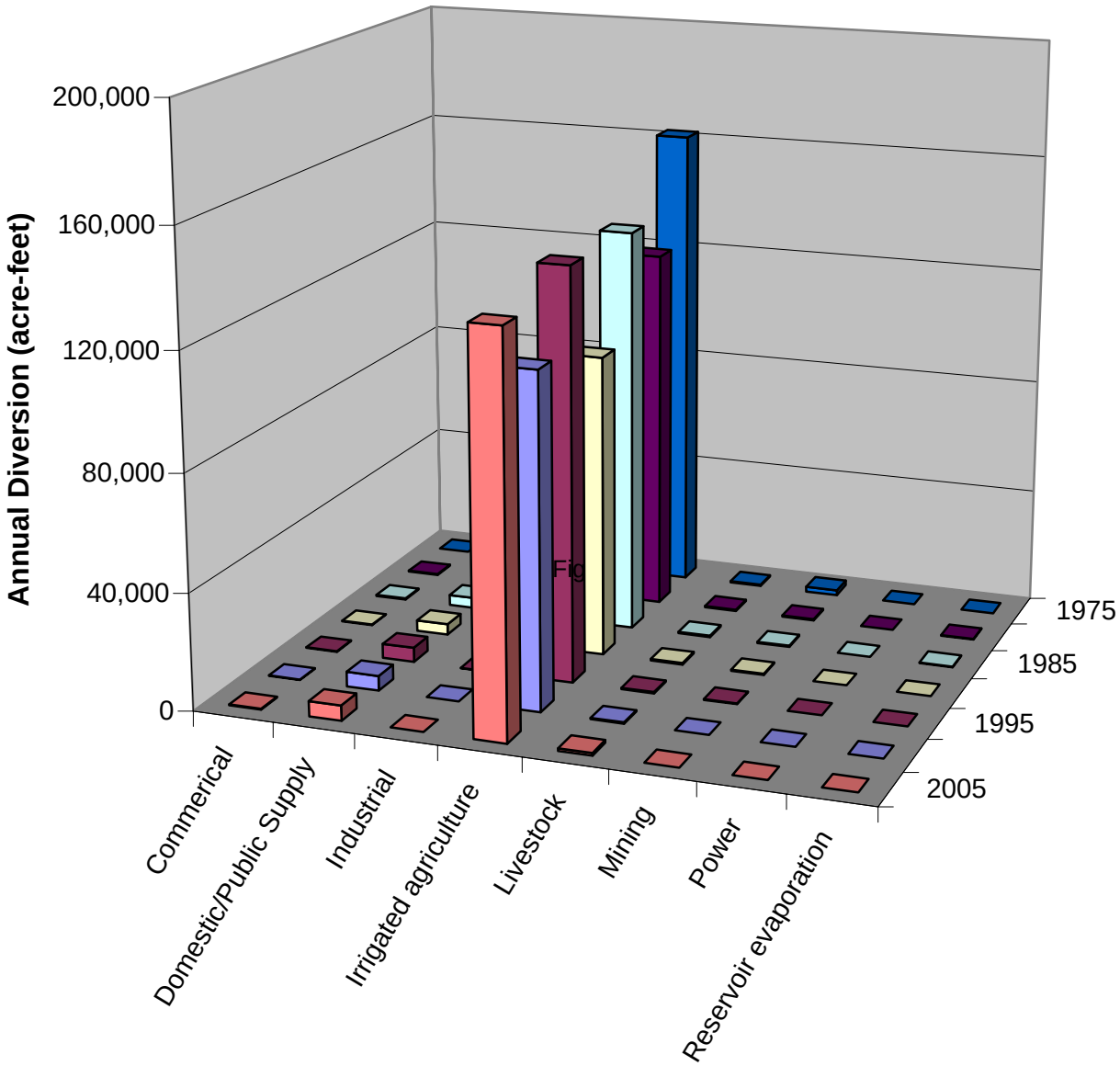
GILA PLANNING

USGS Monitored Well Time-Series

Daniel B. Stephens & Associates, Inc.

6/30/09

DRAFT



GILA PLANNING

Annual Water Diversions by Category for Luna County

Daniel B. Stephens & Associates, Inc.

6/30/09

Figure 8

Table 2 provides the amounts of total irrigated agricultural land in Luna County, which includes crops irrigated and idle and fallow lands in crop rotation; not all of this land is irrigated in any given year. Estimated amounts of this acreage that were irrigated from 1980 through 2005 are shown in Figure 9, which also shows the proportion of land irrigated by groundwater, surface water, or both. The majority of crops are irrigated using groundwater, and the portion irrigated using surface water is most likely located near the Upper Mimbres River closer to Grant County, and not in the Deming area.

Table 2. Total Irrigated Agricultural Acreage in Luna County

Year	1940	1945	1950	1955	1960	1965	1970	1975	1980	1990–1995
Total Acres	11,700	16,000	25,800	33,500	37,000	40,600	68,660	69,440	73,940	73,950

Note: Includes crops irrigated and idle and fallow lands in crop rotation
Sources: Sorensen, 1977 and 1981; Wilson, 1992; Wilson and Lucero, 1997

Estimated volumes of water diverted to irrigate crop land in Luna County are shown in Figure 10. These amounts were calculated by OSE and are not based on actual measurements. The OSE also provides the type of irrigation methods used to apply water to crop land within the Mimbres Basin (Figure 11). Flood irrigation is the most used method, but an increase within the past decade in the application of groundwater with sprinkler and drip irrigation methods is noticeable.

As shown in Figure 8, demand from domestic and public water supply categories has also been increasing. Figure 12 shows the volume of groundwater the City of Deming has pumped out of the Mimbres Basin annually between 1975 and 2008. Decreases in the volume of water pumped since 2005 are likely due to conservation efforts by the City, as population has continued to increase. Also provided in Figure 12 are the low and high future water use projections from Deming's 40-year water plan (DBS&A, in progress). Water demand is likely to double over the next 40 years, as the population in the Deming area is also projected to steadily increase.

DRAFT

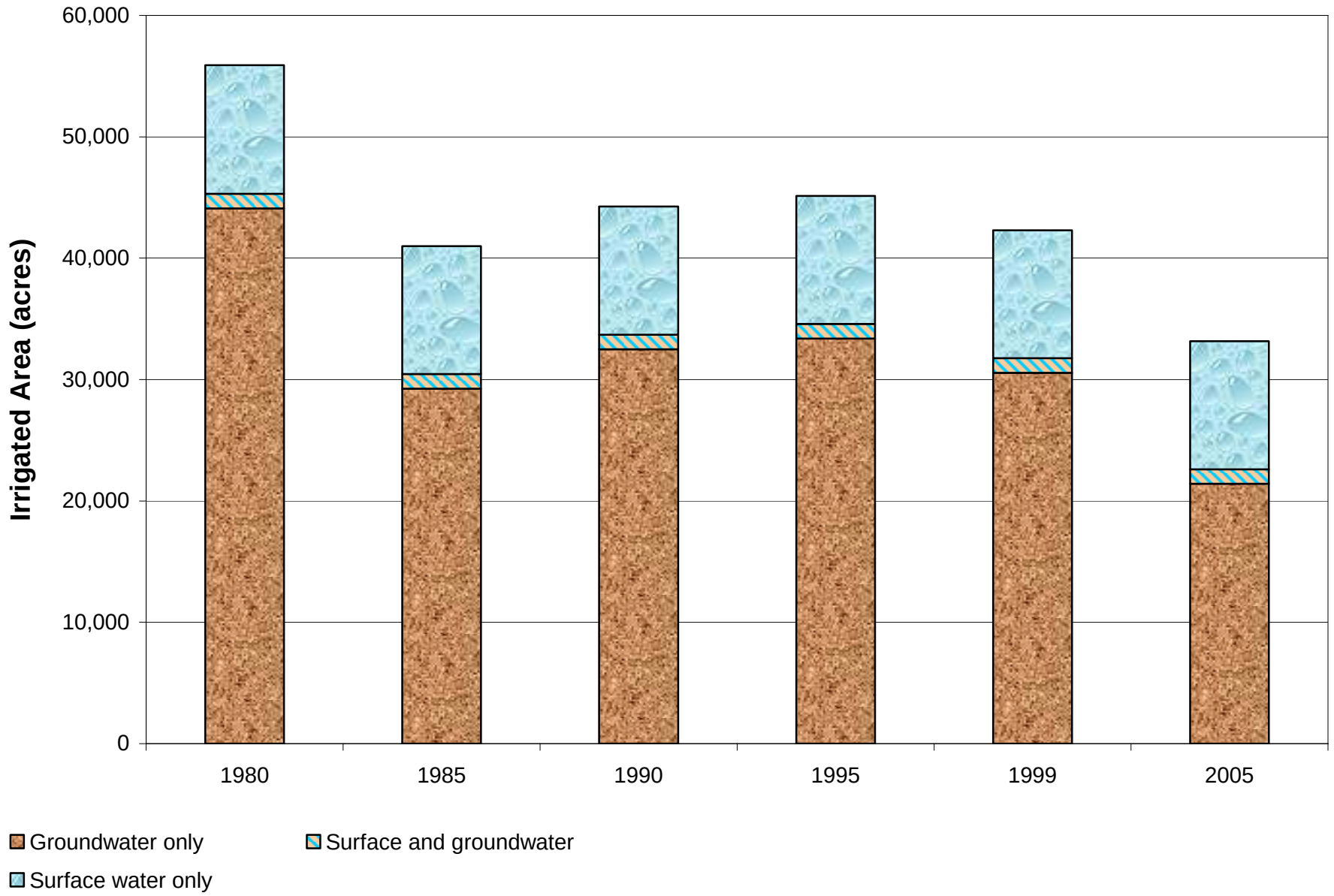


Figure 9

GILA PLANNING

Irrigated Acreage Trends in Luna County

Daniel B. Stephens & Associates, Inc.

6/30/09

DRAFT

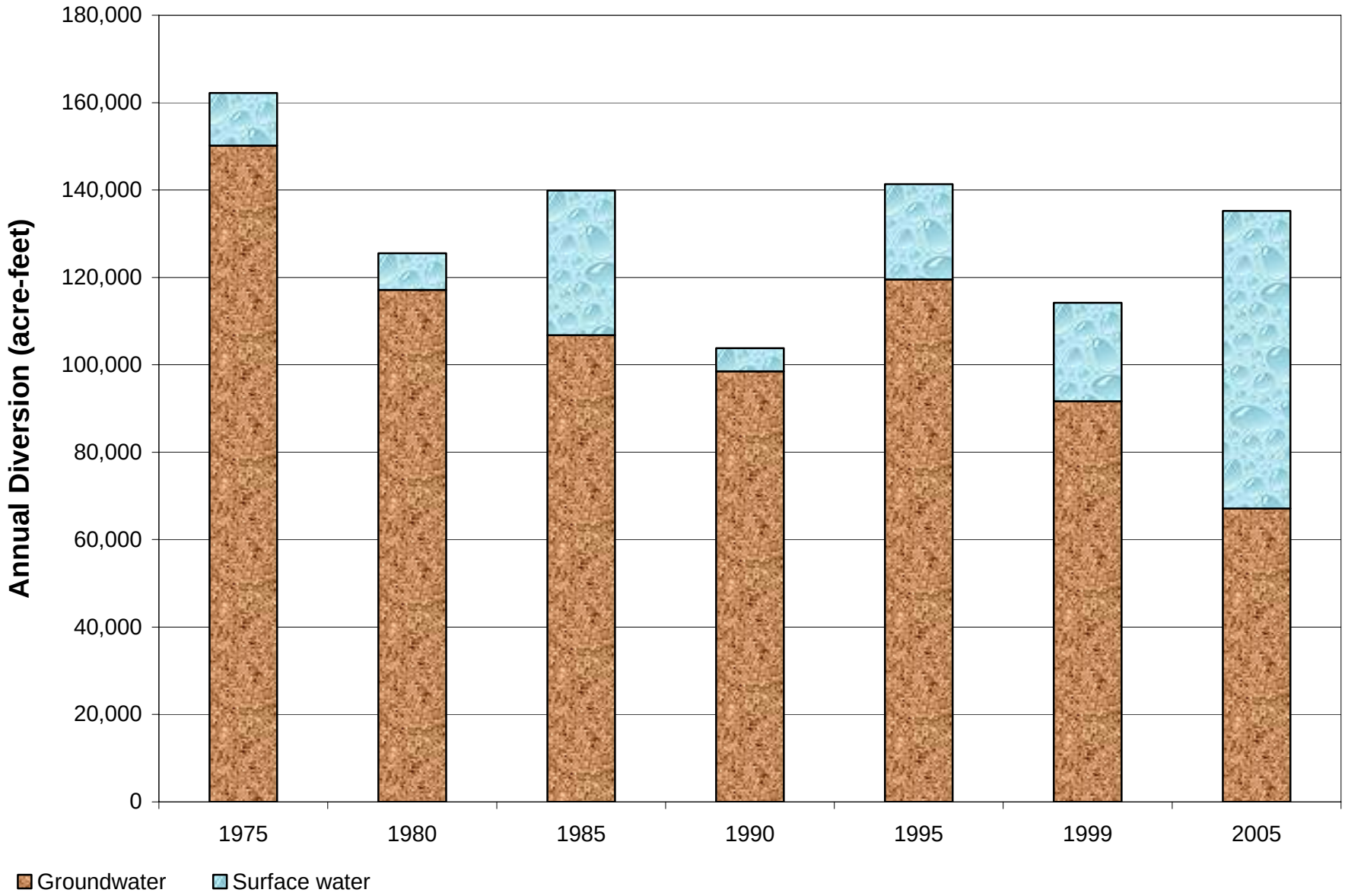


Figure 10

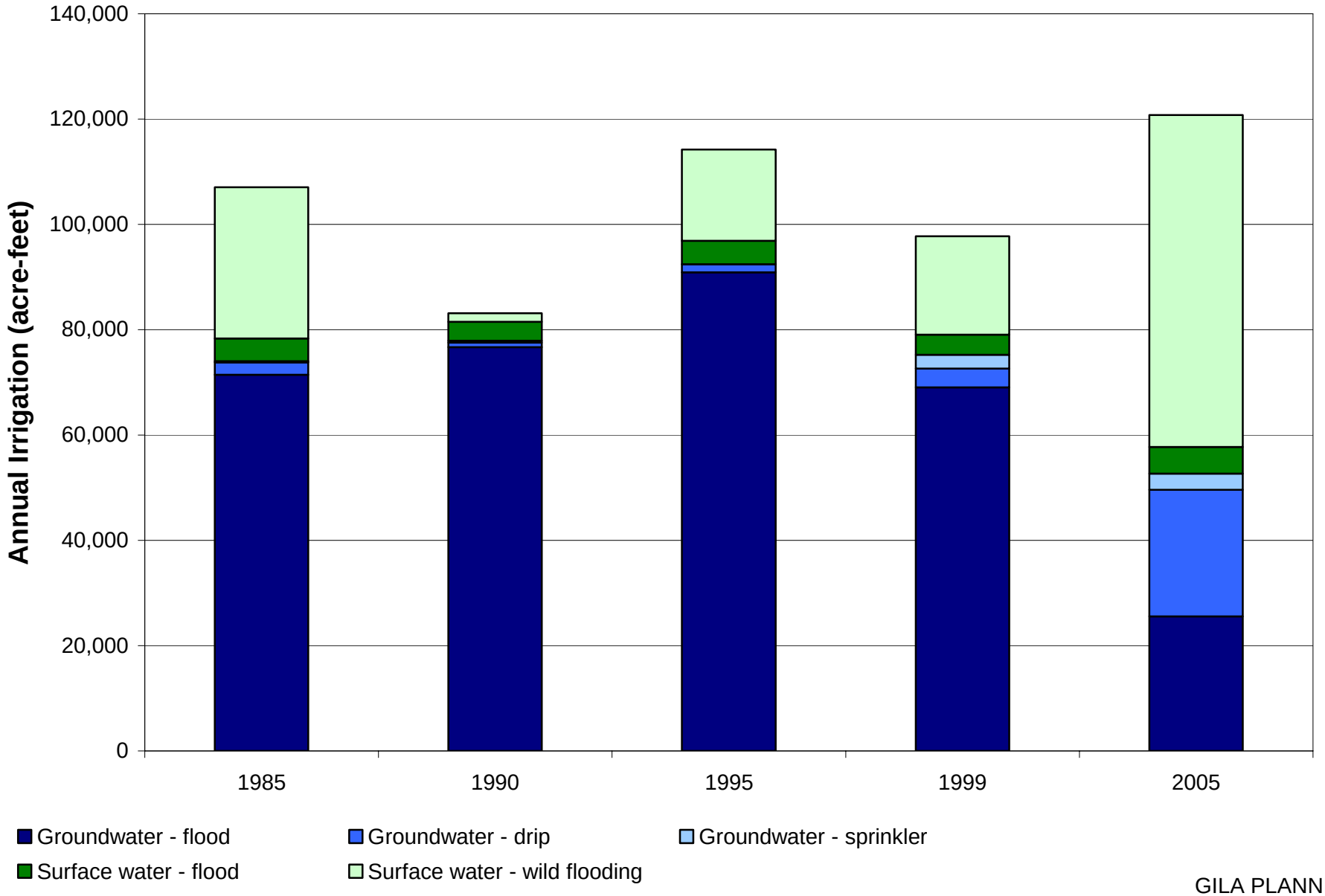
GILA PLANNING

Luna County Irrigated Agriculture Diversions

Daniel B. Stephens & Associates, Inc.

6/30/09

DRAFT



GILA PLANNING

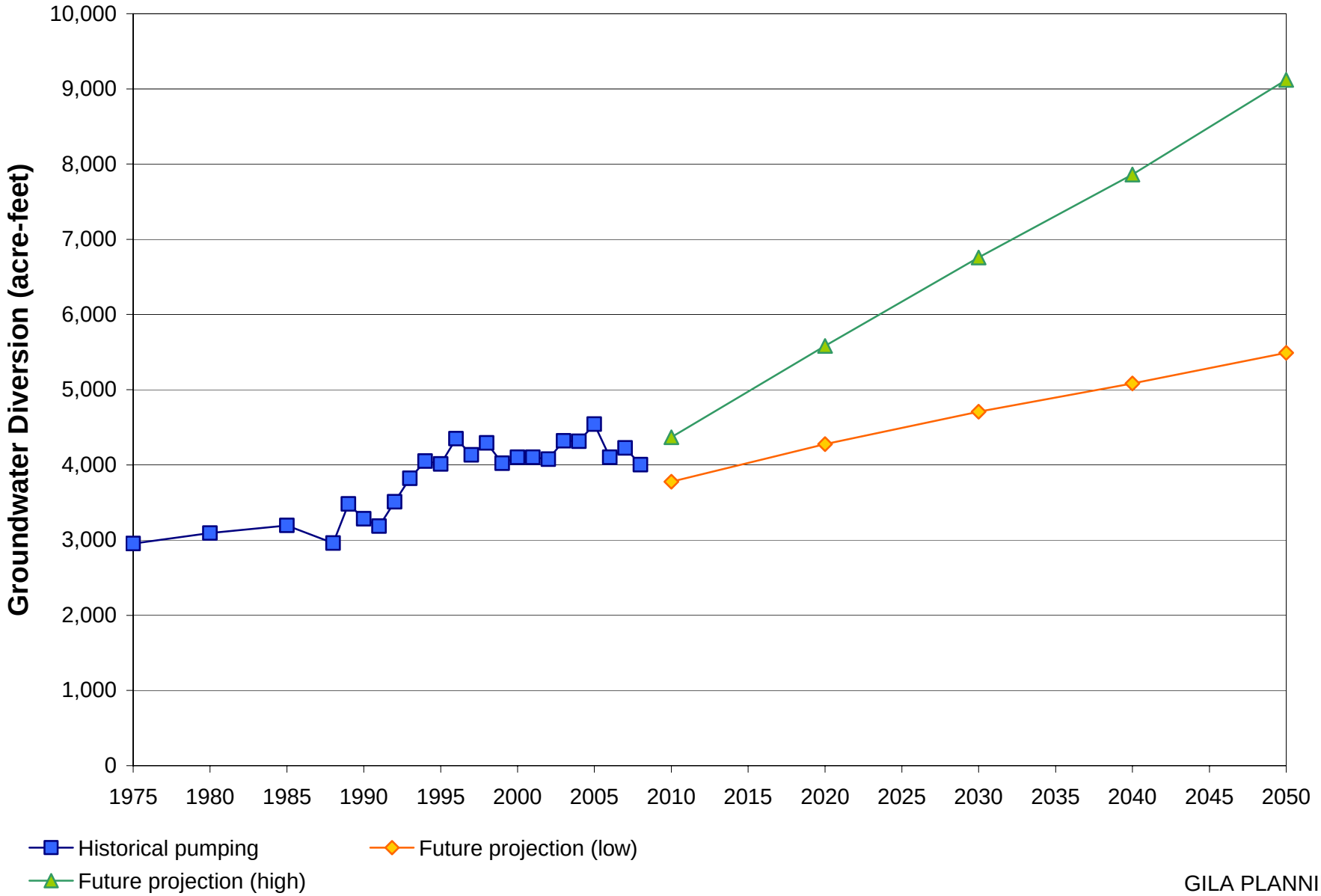
Luna County Irrigation Method Trends in Mimbres Basin

Figure 11

Daniel B. Stephens & Associates, Inc.

6/30/09

DRAFT



GILA PLANNING

Groundwater Diversions for the City of Deming

Figure 12

Daniel B. Stephens & Associates, Inc.

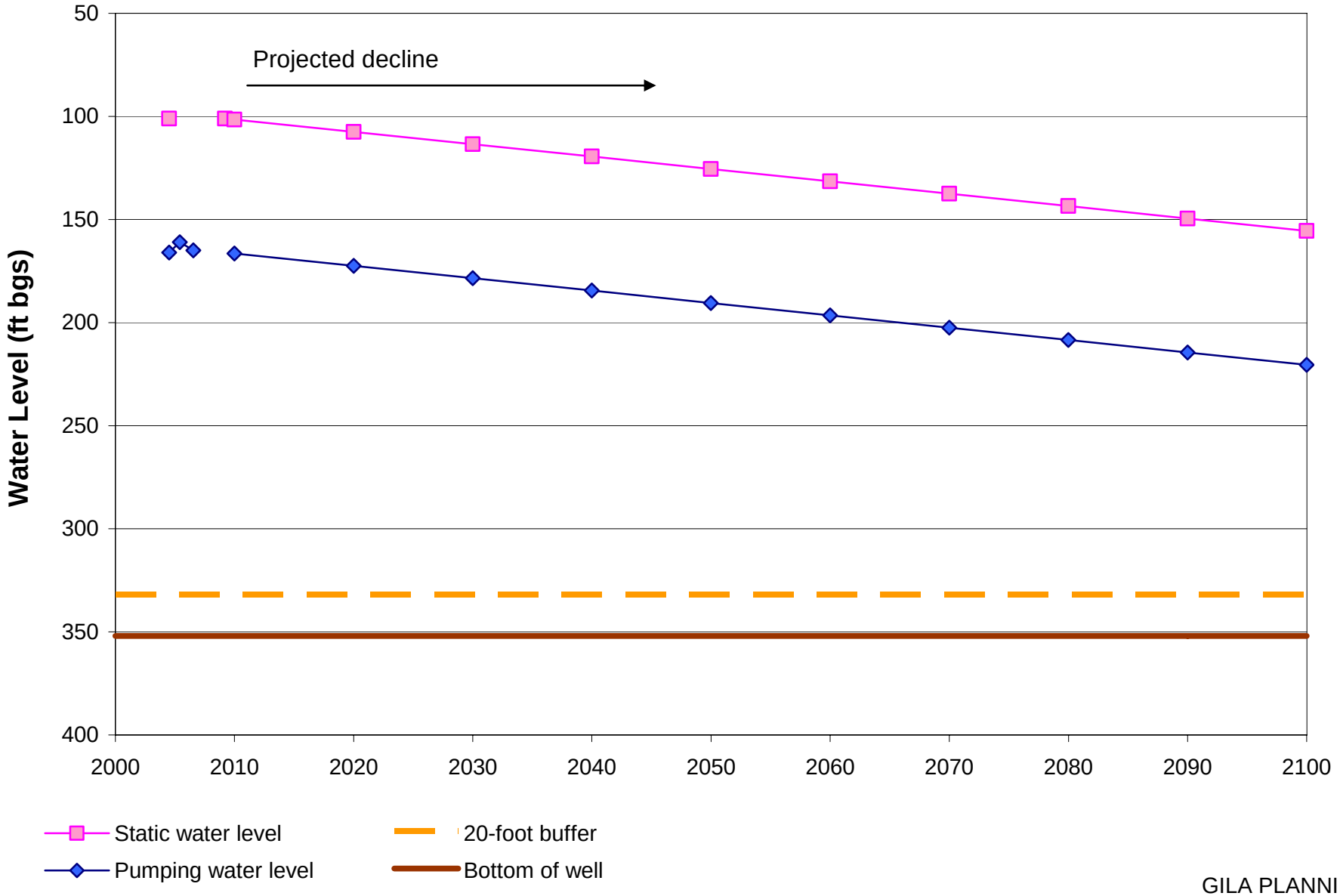
6/30/09

Based on historical water demand in the Deming area (Figures 6 and 7), DBS&A assessed the impact of decreasing water levels on the City's existing wells. Figure 13 shows the static and pumping water level data for Deming Well #14. This well currently has an approximately 250-foot water column and experiences about 65 feet of drawdown when the pump is running. Based on an average annual rate of decline of 0.6 ft/yr (the average rate of decline for the surrounding USGS monitored wells), Well #14 will have an estimated 200-foot water column remaining in the year 2100, which equates to a loss of 50 feet over the next 90 years. Similar analysis was completed for each of the City of Deming supply wells. The projected decline rate is based on historical volumes of diversions in the Deming area. If demand continues to increase, the projected rate decline will also increase, leading to further decreases in the water column in Well #14 as well as other wells in the area.

To estimate the approximate groundwater in storage in the vicinity of Deming, an area was defined surrounding the city limits and including the City's existing municipal wells (Figure 14). The delineated Deming area encompasses approximately 100,000 acres and includes some but not all of the neighboring irrigated agricultural land. This area can be redefined as necessary to include more or less of the nearby irrigated agricultural land. The estimated groundwater in storage in the Deming area is summarized in Table 3.

The average aquifer thickness of 500 feet was estimated based on existing well depths (NM OSE, 2009) and the Deming cross section from Hawley et al. (2000). While the thickness of basin fill sediments in the Deming area ranges from 500 feet to over 4,000 feet (McCoy and Finch, 2006) with an average estimated saturated thickness of 2,000 feet, it is expected that the aquifer productivity would be considerably lower than 500 feet in saturated thickness (Hawley, 2009). The specific yield value for basin fill from the Mimbres Basin groundwater model was used for the groundwater estimate (McCoy and Finch, 2006). The Deming area groundwater estimate does not consider legal or economic limitations or an analysis of potential public welfare impairment should additional supplies be developed.

DRAFT



GILA PLANNING

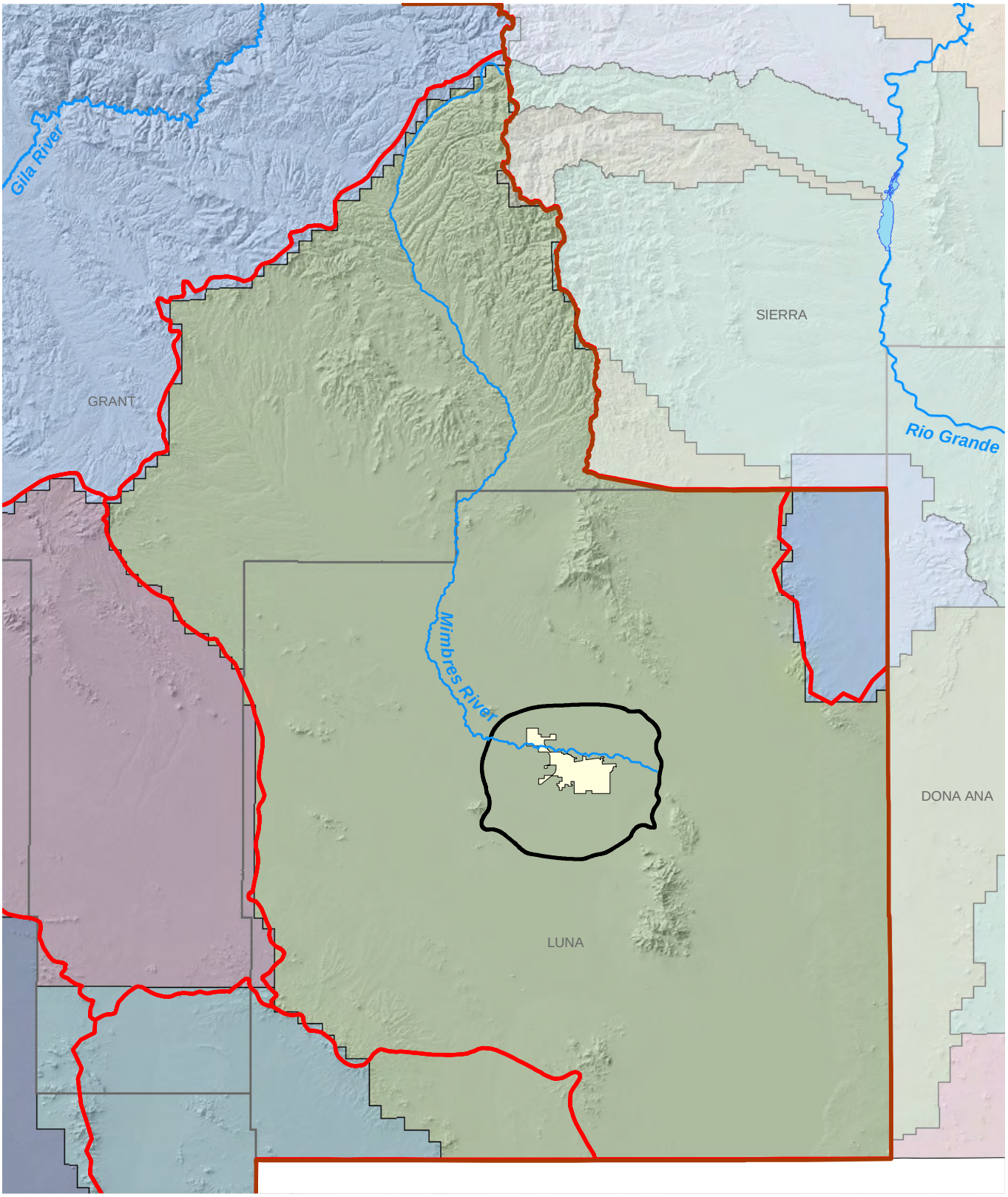
Projected Water Levels for Deming Well 14

Daniel B. Stephens & Associates, Inc.

6/30/09

Figure 13

DRAFT



N

0 6 12 Miles

Explanation

- Planning region
- County
- Deming city limits
- Deming area
- Geologic basin
- Major river

GILA PLANNING

Deming Area

Daniel B. Stephens & Associates, Inc.

06/30/2009

JN WR09.0073

Figure 14

S:/PROJECTS/WR09.0073_GILA_PLANNING/GIS/MXDS/REPORT/FIG14_BASINS_DEMING.MXD 900360

Table 3. Deming Area Estimated Groundwater in Storage

Location	Delineated Area (acres)	Average Aquifer Thickness (feet)	Typical Specific Yield	Groundwater in Storage (acre-feet)
Deming area	100,000	500	0.10	5,000,000

4. Summary and Recommendations

Previous region-wide groundwater estimates were confirmed based on a review that focused on identifying and addressing only gross inaccuracies, assumptions, or deficiencies. No new information was identified that would require revising the existing estimates, although refined groundwater characterization may be needed in areas with increasing demand or locations where large-scale development is planned. Recent well installations have occurred along the San Francisco and Gila Rivers, in the Silver City, Lordsburg, and Deming areas, and in the Animas, Nutt-Hockett, and San Simon Declared Basins.

The Deming area groundwater supply was estimated at approximately 5,000,000 acre-feet. This estimate does not consider legal or economic limitations or an analysis of impairment should additional supplies be developed. Groundwater levels in the area are gradually declining at an average rate of 0.6 ft/yr, while demand is projected to be steady to increasing. The City of Deming's supply wells are predicted to lose 50 feet of their water columns over the next 90 years.

The data gaps identified in Phase 1a are provided in Section 4.1; recommendations for additional study are outlined in Section 4.2.

4.1 Data Gaps

Areas identified during Phase 1a where additional data and/or analysis are needed in order to make better estimates of groundwater in storage include:

- Uncertainty in groundwater estimates with depth due to changes in water quality or aquifer properties

- Integration of legal and economic limitations into the supply analysis

- Integration into the analysis of new administrative criteria based on an updated groundwater model for the Mimbres Basin that are under consideration by OSE

- Review of new OSE and exploration well logs and geophysical information for areas of interest

4.2 Recommendations

Recommendations for future work that can help fill these data gaps include:

- Incorporate results from the May 2009 Economic Forum and additional studies on future demand and projections to modify and extend existing demand projections and estimate long-term future demand for the region. Make use of "desired future conditions" and other possible demand scenarios generated by local representatives.

- Revise supply estimates for the San Francisco Basin based on the results of the concurrent Phase 1a investigation of geologic structure and resulting aquifer locations conducted by the Water Resource Research Institute and John Hawley.

- Review OSE well records and oil/gas exploration logs and any other relevant available geophysical information in areas of interest, such as locations where demand is increasing (along the San Francisco and Gila Rivers, in the Silver City, Lordsburg, and Deming areas, and in the Animas, Nutt-Hockett, and San Simon Declared Basins).

- Develop a local groundwater model of the Deming area, incorporating OSE administrative criteria to provide a quantitative evaluation of the longevity of groundwater supplies in the Deming area and determine where and when shortages are likely to occur and where development of new supply infrastructure (wells, pipelines) might be

feasible. Review whether new administrative criteria under consideration promote practical development of local groundwater and transfer of water rights between administrative blocks without impairing overall Mimbres Basin aquifer management. Propose modifications, if necessary, to facilitate water rights and well field management under the new administrative criteria. Water quality, transmissivity and depth-to-water constraints will be considered.

- Perform an aquifer test on the City of Deming's deep Well #17 (1,500 feet total depth) to determine aquifer properties and water quality changes with depth.

- Locate additional wells for potential aquifer tests and/or water quality sampling.

- Develop model scenarios for the local Deming area based on various future projections.

References

Balleau Groundwater, Inc. (Balleau). 2006. *Draft Town of Silver City water plan, supplement on water use and wellfield service.* Prepared for the Town of Silver City. February 2006.

Daniel B. Stephens & Associates, Inc. (DBS&A). 2005. *Southwest New Mexico regional water plan.* Prepared for Southwest New Mexico Regional Water Plan Steering Committee, City of Deming, New Mexico, Fiscal Agent. May 2005.

DBS&A. In progress. *City of Deming 40-year water plan.* Prepared for the City of Deming, New Mexico.

Finch, S.T. Jr., A. McCoy, and E. Melis. 2008. Geologic controls on ground-water flow in the Mimbres Basin, southwestern New Mexico. pp. 189-196 in *New Mexico Geological Society Fall Field Conference Guidebook - 59, Geology of the Gila Wilderness-Silver City area*.

Hanson, R.T., J.S. McLean, and R.S. Miller. 1994. *Hydrogeologic framework and preliminary simulation of ground-water flow in the Mimbres Basin, Southwestern New Mexico*. U.S. Geological Survey Water-Resources Investigations Report 94-4011. Prepared in cooperation with the New Mexico State Engineer Office.

Hawley, J.W., B.J. Hibbs, J.F. Kennedy, B.J. Creel, M.D. Remmenga, M. Johnson, M.M. Lee, and P. Dinterman. 2000. *Trans-international boundary aquifers in southwestern New Mexico.* New Mexico Water Resources Research Institute Technical Completion Report, Interagency contract no. X-996350-01-3. Prepared for U.S. Environmental Protection Agency, Region 6, and International Boundary and Water Commission, U.S. Section. March 2000.

Hawley, J. 2009. Personal communication with John Hawley at June 17, 2009 meeting in Silver City, New Mexico.

Heywood, Charles E. 2002. *Estimation of alluvial-fill thickness in the Mimbres Ground-water Basin, New Mexico, from interpretation of isostatic residual gravity anomalies.* U.S. Geological Survey Water-Resources Investigations Report 02-4007. Prepared in cooperation with the New Mexico Office of the State Engineer.

Kilmer, C.L. 2008. Water-bearing properties of selected geologic materials in mining areas of Grant County, New Mexico. pp. 199-203 in *New Mexico Geological Society Fall Field Conference Guidebook - 59, Geology of the Gila Wilderness-Silver City area*.

Longworth, J.W., J.M. Valdez, M.M. Magnuson, E.S. Albury, and J. Keller. 2008. *New Mexico water use by categories 2005.* New Mexico State Engineer Office Technical Report 52. June 2008.

McCoy and Finch, 2006. *Mimbres Basin ground-water-flow model in support of Chino Mines Company supplemental discharge permit for closure, DP-1340, Condition 86.* John Shomaker & Associates, Inc. Prepared for Chino Mines Company. February 2006.

New Mexico Office of the State Engineer (NM OSE). 2009. Water Administration Technical Engineering Resource System (W.A.T.E.R.S.) database. Available at <http://www.ose.state.nm.us/waters_db_index.html>. Accessed June 2009.

Sorensen, E.F. 1977. *Water use by categories in New Mexico counties and river basins, and irrigated and dry cropland acreage in 1975*. New Mexico State Engineer Office Technical Report 41.

Sorensen, E.F. 1981. *Water use by categories in New Mexico counties and river basins, and irrigated acreage in 1980*. New Mexico State Engineer Office Technical Report 44.

United States Geological Survey (USGS). 2009. *Groundwater levels for New Mexico.* <http://nwis.waterdata.usgs.gov/nm/nwis/gwlevels>. Accessed June 2009.

Water Resources Research Institute (WRRI). 1999. *Basin boundaries map*. New Mexico State University, Las Cruces, New Mexico. Scale 1:1,250,000. March 1999.

Wilson, B.C. 1986. *Water use by categories in New Mexico counties and river basins, and irrigated acreage in 1985*. Technical Report 46, New Mexico State Engineer Office.

Wilson, B.C. 1992. *Water use by categories in New Mexico counties and river basins, and irrigated acreage in 1990*. Technical Report 47, New Mexico State Engineer Office. July 1992.

Wilson, B.C., A.A. Lucero, J.T. Romero, and P.J. Romero. 2003. *Water use by categories in New Mexico counties and river basins, and irrigated acreage in 2000.* Technical Report 51, New Mexico State Engineer Office. February 2003.

Wilson, B.C., and A.A. Lucero. 1997. *Water use by categories in New Mexico counties and river basins, and irrigated acreage in 1995*. Technical Report 49, New Mexico State Engineer Office. September 1997.