



January 26, 2011

Compilation and Analysis of 1995 to 2008 Water-Level Data at Monitoring and Test Wells, Fort Huachuca, AZ

Purpose

We update the U.S. Army Corps of Engineers (Corps) 2005 study, *Compilation and Analysis of April 1995 to April 2005 Water-Level Data at Monitoring and Test Wells, Fort Huachuca AZ*. (Memorandum for Record, Subject: *Compilation and Analysis of April 1995 to April 2005 Water-Level Data at Monitoring and Test Wells, Fort Huachuca AZ*, CEIWR -HEC-HHT, Jon P. Fenske P.E., Hydrologic Engineer, U.S. Army Corps of Engineers, Hydrologic Engineering Center, Davis, CA, 16 May 2005.)

From 1995 to 2005, Fort Huachuca contracted with the Corps' Davis, California Hydrologic Engineering Center to compile, organize and analyze data from groundwater monitoring wells on Fort Huachuca. In 2005, the Corps' analysis of the well data concludes:

"From analysis of water-level data from 1995-2005, a clear trend has developed. The cone of depression in the Fort Huachuca area is growing, and measured water levels within 2 miles of the [San Pedro] river have been declining. If groundwater development in the Fort Huachuca/Sierra Vista continues at present rates, water levels will continue to decline in the region...it is likely this decline in water levels currently extends to the river, resulting in a reduction of groundwater discharge to the river when compared to predevelopment conditions." (Ibid.)

The Corps' 2005 conclusion contradicted Fort Huachuca's public relations campaign aimed at concealing recognition of the deleterious effects of the deficit groundwater pumping subsidized by the Base's groundwater-dependent local activities. The Fort cancelled the Corps' contract shortly after release of the Corps' 2005 study.

In this study, we update the Corps' 2005 analysis using updated monitoring well data from the same Fort Huachuca wells. The conclusion of our updated analysis is unchanged from the Corps' 2005 study. The "trend" continues.

Analysis

The San Pedro River is the Southwest's last surviving, undammed desert river. Groundwater dependent activities related to and subsidized by Fort Huachuca jeopardize the River and its dependent endangered species.

In the 2005 analysis, the Corps used Fort Huachuca monitoring wells numbers 3, 4, 5 and 1. These wells were installed in December 1994 on the eastern section of Fort Huachuca between the Fort Huachuca/Sierra Vista groundwater pumping center and the San Pedro River. The wells were installed “to better quantify the impact of Fort Huachuca/Sierra Vista groundwater pumping on baseflow discharge to the San Pedro River over time.” (Ibid.) The wells are located along a line in the approximate direction of ground water flow from the Huachuca Mountains through the underground aquifer to the River.

We add a fifth well to our updated analysis with data obtained from the Arizona Department of Water Resources (SITE_ID # 313317110165201). We add this additional fifth well because it lies along the same line of ground water flow as the Fort Huachuca wells and because it has a long history of well readings. Figure 1 shows the location of the wells included in this study.

We obtained data for the monitoring wells from the U.S. Geological Survey (USGS). We compared the new data with the data in the Corps' 2005 report to determine if they were corrected for the "stick up" height. "Stick up" height is the distance from the top of the measuring stick to the ground. The corrected well depth measurements were used along with data for the production well from the Arizona Department of Water Resources in this updated analysis.

Figure 2 shows the water level elevations for the monitoring wells in 1995 and 2008 (top and bottom numbers on the graph, respectively). Distance to the San Pedro River is on the horizontal axis. Elevation in feet is on the vertical axis. Figure 2 shows the interpolated water level elevations at the wells. It gives a visual representation of the cone of depression.

Similar to the Corps' 2005 analysis, we estimate changes in groundwater flow between neighboring wells and the River by determining the change in hydraulic gradient. This change is equal to the difference in water levels at adjacent wells divided by the distance between the wells. Volumetric flow is directly proportional to the hydraulic gradient given that hydraulic conductivity and flow remain constant (Darcy's Law).

Table 1 shows the differences in the water levels between the monitoring wells. The negative pressure head difference between wells 3 and 4 indicates that water is flowing away from the San Pedro River in that area. This difference has increased by 0.5 feet from the Corps' last comparative reading in 2004 to the last available data in 2008. The difference indicates deepening and widening of the cone of depression toward the River from the Fort Huachuca/Sierra Vista groundwater pumping center.

The gradient between wells 4 and 5 has declined by over a foot since 2004. By applying Darcy's law, we determine that reduction of groundwater flow was been reduced by 11.26% in this region since the wells' installation.

The gradient between the monitoring wells closest to the river, wells 5 and 1, has also decreased by nearly a foot since 2004. On a relative basis, however, the flow gradient has not decreased as much when compared to wells 4 and 5. The reason for the relatively lessened gradient is not known with certainty, but is most likely due to the influence from the nearby City of Sierra Vista recharge facility which started recharging in 2000.

Figure 1: Location of wells



Figure 2: Water level elevations

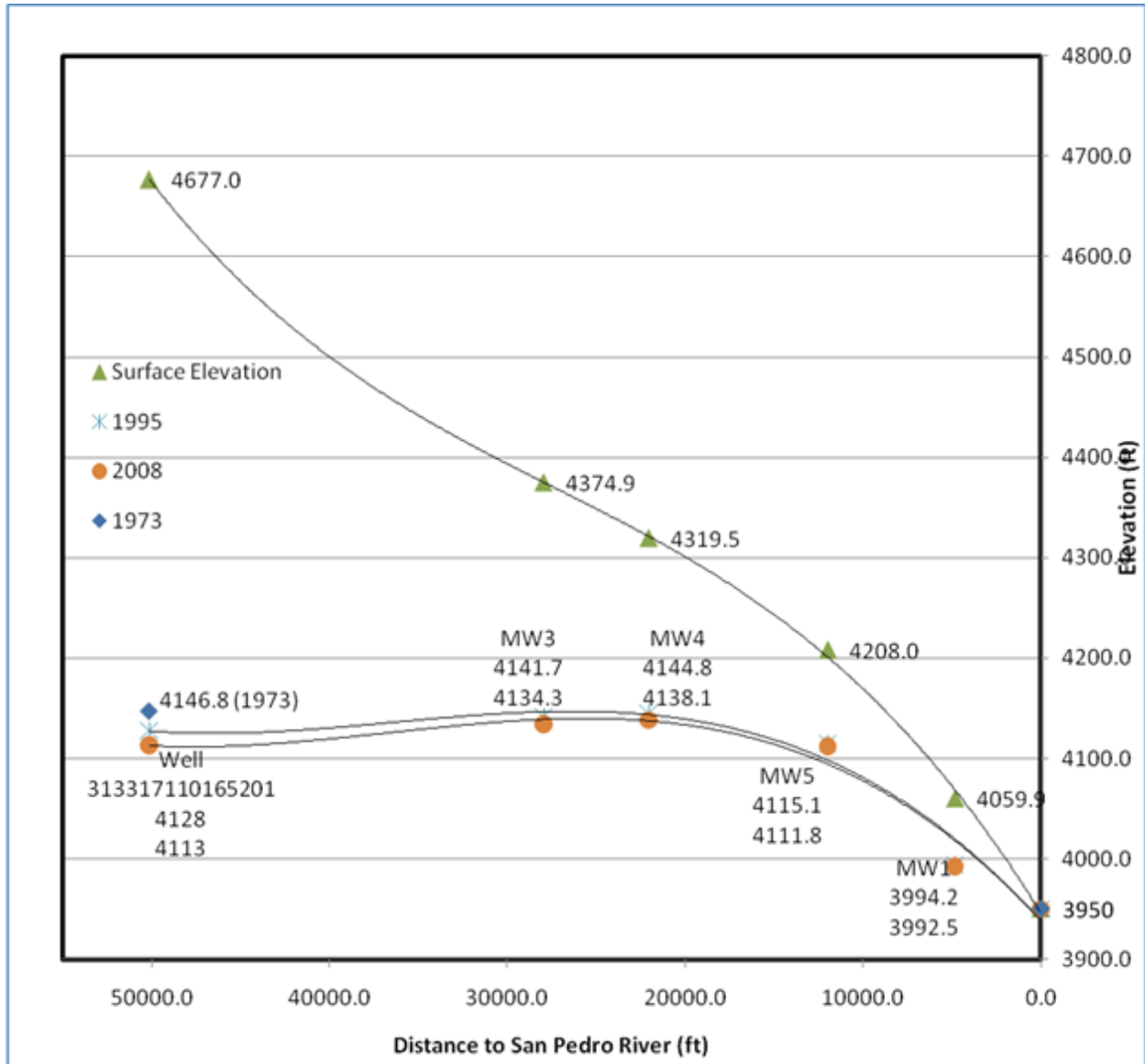


Table 1: Differences between measured water levels at monitoring wells

Date	MW3 - MW4	MW4 - MW5	MW5 - MW1
4/14/1995	-3.13	29.65	120.89
4/4/1996	-3.07	30.36	119.86
4/11/1997	-2.94	30.17	119.73
4/10/1998	-2.99	28.89	120.58
4/12/1999	-3.01	28.4	120.63
2/22/2000	-3.03	27.99	120.33
2/20/2001	-3.16	27.37	120.23
2/19/2002	-3.09	27.61	120.04
2/18/2003	-3.22	27.53	120.2
2/9/2004	-3.28	27.42	120.12
1/13/2005	-3.28	27.01	120.13
2/6/2006	-3.4	26.73	119.75
1/16/2007	-3.59	26.37	119.31
01/03/08	-3.77	26.31	119.26

Conclusion

We analyze Fort Huachuca well data from 1995 - 2008 from wells located between the Fort Huachuca/Sierra Vista groundwater pumping center and the San Pedro River. We conduct our analysis in a manner identical to the Corps' 2005 analysis of these same wells.

In 2005, the Corps' concluded that a "clear trend has developed. The cone of depression in the Fort Huachuca area is growing, and measured water levels within 2 miles of the river have been declining..."

In 2011, we conclude identically. The "trend" continues.

The data shows a growing cone of depression expanding from the Fort Huachuca/Sierra Vista groundwater pumping center towards the San Pedro River. The data shows that the effects of the groundwater pumping center are increasing.

In 2010, USGS did not find isotope evidence that the Fort Huachuca/Sierra Vista groundwater pumping center had yet affected San Pedro River surface flow. (Kennedy, J.R., and Gungle, Bruce, 2010, Quantity and Sources of Base Flow in the San Pedro River near Tombstone, Arizona: U.S. Geological Survey Scientific Investigations Report 2010-5200.) But USGS notes,

"Continued regional groundwater pumping will, however, eventually lead to a decline in the contribution of regional groundwater to base flow." (Ibid.)

Our updated study confirms that expansion of the Fort Huachuca/Sierra Vista groundwater pumping center's cone of depression has continued from 1995 through 2008. Evidence of the cone of depression's expansion is particularly concerning with respect to the San Pedro River as local groundwater pumping shows no sign of decreasing. (Arizona Department of Water Resources "Wells 55" CD, June 2003. Water Management of the Regional Aquifer in the Sierra Vista Subwatershed, Arizona—2007 Report to Congress, U.S. Department of the Interior Dirk Kempthorne, Secretary U.S. Geological Survey Mark Myers, Director U.S. Geological Survey, Reston, Virginia, 2008. Arizona Department of Water Resources "Wells 55" CD, January 2010.)

In 2003, the Upper San Pedro Partnership promised to "balance the area's water deficit by 2011." (USPP's resolution called a 'bold step;' Group pledges to help balance water deficit, Bill Hess, Sierra Vista Herald, September 13, 2003.) **The Partnership has not kept its promise.** (Water Management of the Regional Aquifer in the Sierra Vista Subwatershed, Arizona—2007 Report to Congress, U.S. Department of the Interior Dirk Kempthorne, Secretary U.S. Geological Survey Mark Myers, Director U.S. Geological Survey, Reston, Virginia, 2008.)

Increasing groundwater-dependent local Department of Defense Fort Huachuca activities fuel increasing deficit groundwater pumping. (Annual Economic Impact Statement, October 1, 2004 - September 30, 2005, Fort Huachuca, Arizona, Resource Management Office U.S. Army Garrison, Fort Huachuca, AZ, March 31, 2006. 2008 Fort Huachuca Economic Impact Statement Analysis, Contract Number: W9124A-08-D-0002, Vernadero Group Incorporated and Elliot D. Pollack & Company, July 2009.) **Jeopardy to the San Pedro River increases as the effects of the Fort Huachuca/Sierra Vista groundwater pumping center move ever closer to River.**