Forestar's Proposal to Pump Groundwater from the Simsboro Aquifer

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December 12, 2013

1.0 Introduction

Forestar (USA) Real Estate Group, Inc. (Forestar) is asking the Board of the Lost Pines Groundwater Conservation District (LPGCD) for permission to pump groundwater from the Simsboro Aquifer in Lee County, Texas[1]. In May 2013 the LPGCD Board granted Forestar permission to pump 12,000 acre-feet per year[2]. Forestar is now asking the Board for permission to pump 45,000 acre-feet per year[3]. The pumping rate would be phased-in over time, ultimately reaching 45,000 acre-feet/year[4].

Forestar's proposed pumping would affect groundwater levels and the discharge of groundwater to the Colorado River.

The effects of Forestar's proposed pumping were estimated using LPGCD's version of the *Central Queen City and Sparta Groundwater Availability Model* (GAM)[5]. The input files used to generate the results presented in this report were provided by the LPGCD[6]. Figure 1 shown the geologic units represented in the GAM.

2.0 Effects on groundwater

Forestar's proposed pumping would affect the Hooper, Simsboro, Calvert Bluff, and Carrizo aquifers.

Forestar's proposed pumping would create a cone on depression (region of reduced hydraulic heads) that extends to the contact of the Hooper Aquifer and the underlying Midway Group[7]. Thus, it would affect both confined[8] and unconfined[9] portions of the aquifers.

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[1] Forestar 2013.
[2] Forestar 2013, page 1.
[3] Forestar 2013, page 14.
[4] Forestar 2013, page 12.
[5] TWDB 2004; and LPGCD 2013. The GAM is based on the MODFLOW computer code developed by the U.S. Geological Survey (TWDB 2004, page 6-1).
[6] LPGCD 2013.
[7] Figure 2 shows that the cone of depression extends to the model boundary. This boundary represents the contact of the Hooper Aquifer and the Midway Group (TWDB 2004, page 6-3). The extent of the cone of depression can also be seen by comparing LPGCD's GAM output files for runs 50 (baseline) and 54 (Forestar phased-in pumping).
[8] A confined aquifer is buried below geologic units that have a relatively low hydraulic conductivity. When a well taps a confined aquifer, the water level in the well will rise above the top of the aquifer.
[9] Unconfined aquifers are usually exposed at land surface. The water level in a well tapping an unconfined aquifer represents the position of the water table in the aquifer.

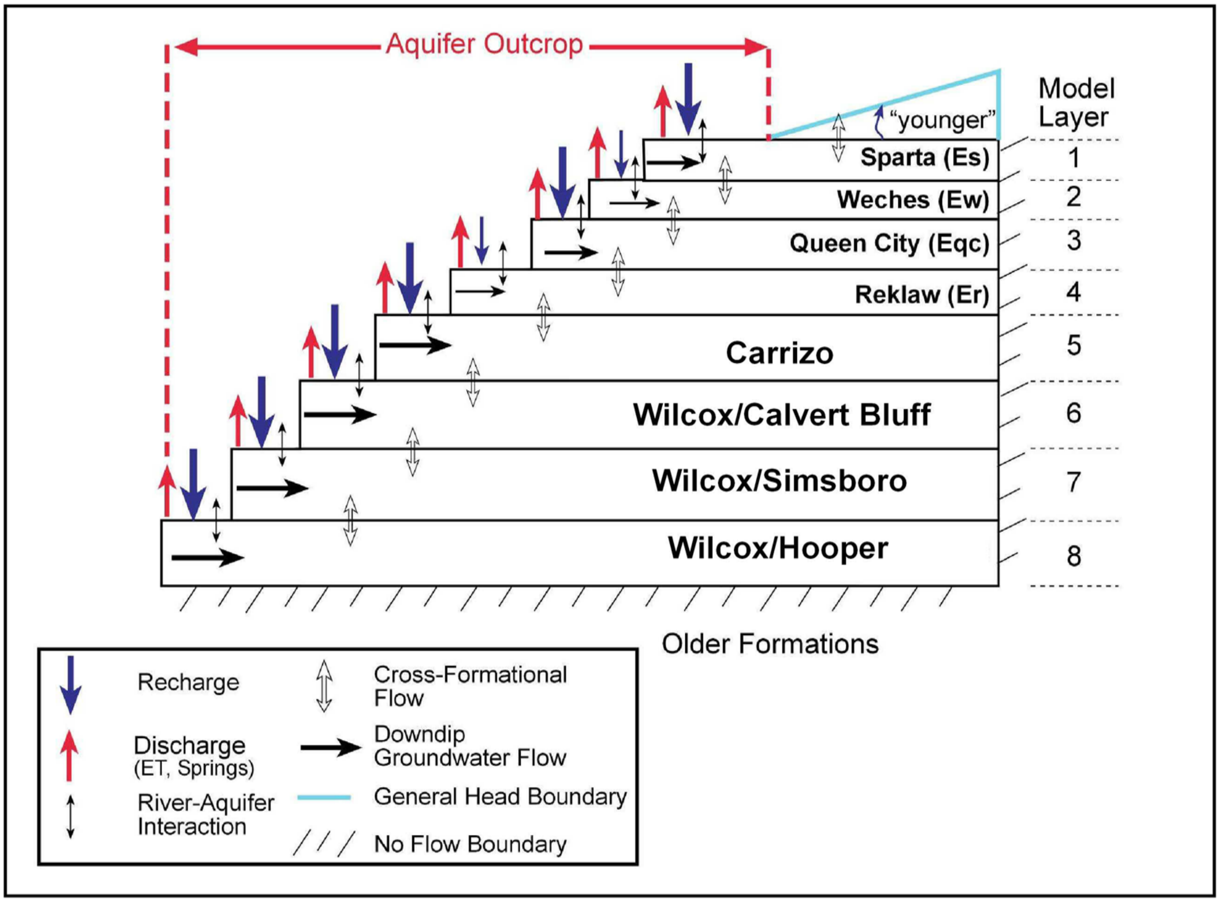

Figure 1
Geologic Units Represented in the GAM
(adapted from TWDB, 2004, figure 5.1)

Where the aquifers are confined, the reduced heads would cause water levels in wells to decline. Where the aquifers are unconfined, the reduced heads would cause dewatering of the affected portions of the aquifers. These effects are discussed below.

2.1 Simsboro Aquifer

Forestar's proposed pumping would reduce hydraulic heads in the Simsboro Aquifer. Figure 2 shows LPGCD's estimate of the effects of Forestar's pumping on the Simsboro Aquifer.

The effects extend to both the confined and unconfined portions of the Simsboro Aquifer. Where the aquifer is confined, the reduction in heads will reduce water levels in wells that draw water from the aquifer. Where the aquifer is unconfined, the reduction in heads will dewater portions of the aquifer.

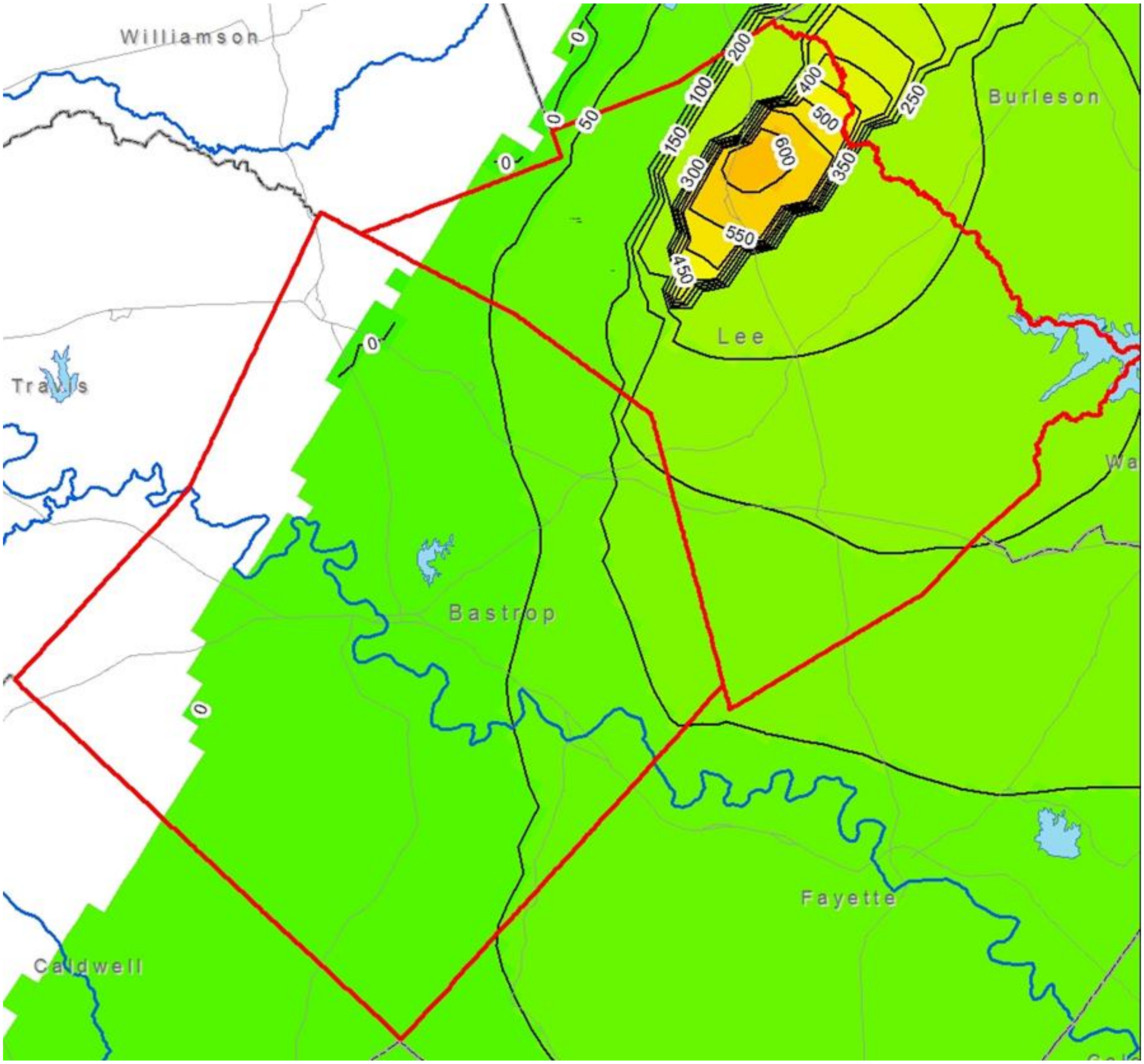

Figure 2
Effect of Forestar's Proposed Phased-in Pumping
(from files provided by LPGCD, contours indicate drawdown (ft))

2.2 Leakage from other aquifers

The effects of Forestar's pumping would not be limited to the Simsboro Aquifer. The pumping would induce leakage from the Hooper, Calvert Bluff, and Carrizo aquifers. The position of these aquifers relative to the Simsboro is shown in figure 1.

Leakage is a common and well-known phenomenon. Leakage is discussed in standard hydrology texts[10]. In figure 1, leakage (cross-formational flow) between geologic units is indicated by double-headed arrows. In a pump test conducted for End Op in 2009, End Op's hydrologist estimated that 22% of the water it pumped from the Simsboro was derived from leakage from adjacent aquifers[11].

Table 1 shows the effects of Forestar's pumping on the Carrizo, Calvert Bluff, Simsboro, and Hooper aquifers.

Table 1

GAM Predicted Drawdowns in Year 2060 for Phased-in Forestar Pumping[12]

Aquifer (model Layer)	GAM pumping scenario	Drawdown (ft)	Maximum drawdown (phased-in – baseline) (ft)	Average drawdown throughout LPGCD (ft)
Carrizo (5)	Phased-in	65	9	6
	Baseline	56		
Calvert Bluff (6)	Phased-in	205	73	34
	Baseline	132		
Simsboro (7)	Phased-in	991	624	114[13]
	Baseline	367		
Hooper (8)	Phased-in	324	108	48
	Baseline	216		

It should be noted that the phasing in of pumping makes little difference in the final amount of drawdown in the Simsboro Aquifer. Predicted drawdowns for the phased-in pumping and the constant pumping of 45,000 acre-feet/year are shown in table 2.

[10] See, for example, Davis and DeWiest 1966, pages 224 – 229; and Freeze and Cherry, 1979, pages 320 – 324.
[11] Thornhill 2009, page 8 of 19.
[12] Drawdowns calculated by comparing GAM runs using well files run50.wel (baseline) and run54.wel (phased-in pumping). Final phase-in pumping rate = 45,000 ac-ft/yr. In the Simsboro Aquifer, maximum drawdown occurs in the cell at row 36, column 119. Drawdowns in all aquifers are for model cell (X, 36, 119), where X represents the model layer.
[13] LPGCD reported an average drawdown of 113 feet (LPGCD 2103).

Table 2

Comparison of GAM Predicted Drawdowns for Simsboro Aquifer in 2060
Phased-in Pumping VS Constant Pumping

Drawdown	Phased-in pumping (max = 45,000 ac-ft/yr)	Constant pumping rate (45,000 ac-ft/yr)
Maximum (ft)	624	629[14]
Average throughout LPGCD (ft)	114	116[15]

3.0 Effects on groundwater discharges to Colorado River

The GAM simulates the effects of groundwater pumping on groundwater discharges to the Colorado River. There are two questions regarding the simulations. First, can the GAM accurately predict the amount of discharge that will occur? Second, can the GAM reliably predict trends in the discharge?

3.1 GAM predictions of amount of discharge

The answer to the first question appears to be no. Groundwater discharges to the Colorado River have been measured for the Carrizo-Wilcox Aquifer[16] in Bastrop County[17]. The measurements ranged from about 22,000 to 36,000 acre-feet per year (table 3).

Table 3

Measured Groundwater Discharge to the Colorado River
From the Carrizo-Wilcox Aquifer in Bastrop County[18]

Year	Discharge (cfs)	Discharge (ac-ft/yr)	Remarks
1918	36	26,060	USGS
2005	50	36,200	LCRA
2008	30	21,720	Saunders

However, between the years 2000 to 2010, the GAM predicts groundwater discharges between 8,000 and 12,000 acre-feet per year (figure 3). Clearly, these predictions are inaccurate.

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[14] From comparison of drawdowns in GAM runs for baseline (well file = run50.wel) and constant pumping of 45,000 ac-ft/yr (well file = run51.wel).
[15] LPGCD 2103 (Model Results.xlsx).
[16] The Wilcox Aquifer consist of three parts: the Calvert Bluff, Simsboro, and Hooper aquifers.
[17] Saunders 2009.
[18] Saunders 2009, page 3.

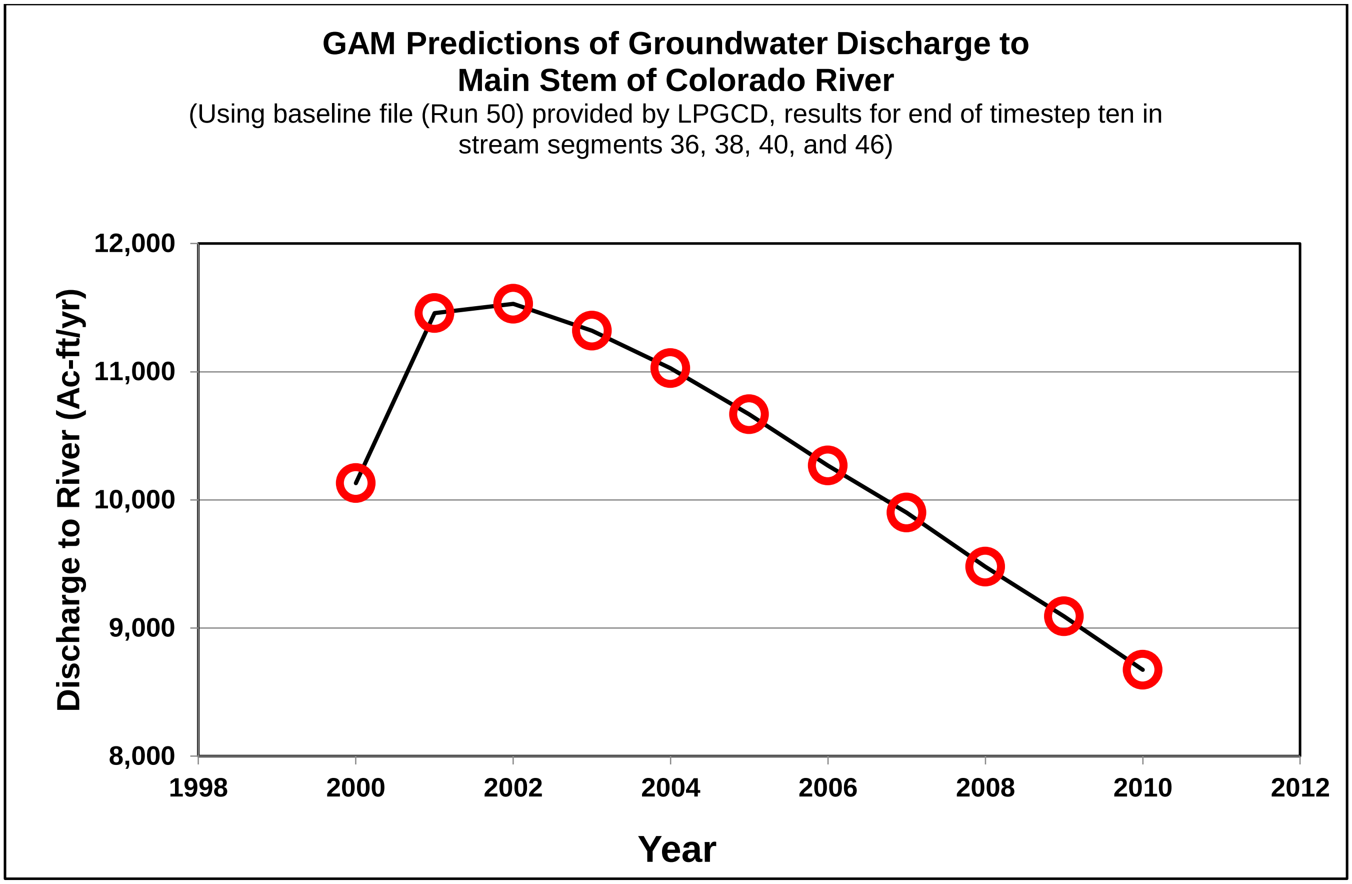

Figure 3
GAM Predicted Discharges to Colorado River

3.2 GAM predictions of discharge trends

The answer to the second questions appears to be yes. This is because GAM results are consistent with what groundwater discharges would be expected to do in response to pumping. That is, we would expect the following:

- Pumping rates: higher groundwater pumping rates should result in less discharge to the river.
- Duration of pumping: longer durations should result in less discharge to the river.
- Distance of pumping: pumping closer to the river should have a greater effect than pumping farther from the river.

3.2.1 Pumping rates

GAM predictions are consistent with expectations regarding the effect of pumping rates. Figure 4 shows that the GAM predicts less discharge to the river when pumping is increased by 56,000 acre-feet per year over baseline pumping rates, and more discharge when water is injected at a rate of 56,000 acre-feet per year over baseline rates.

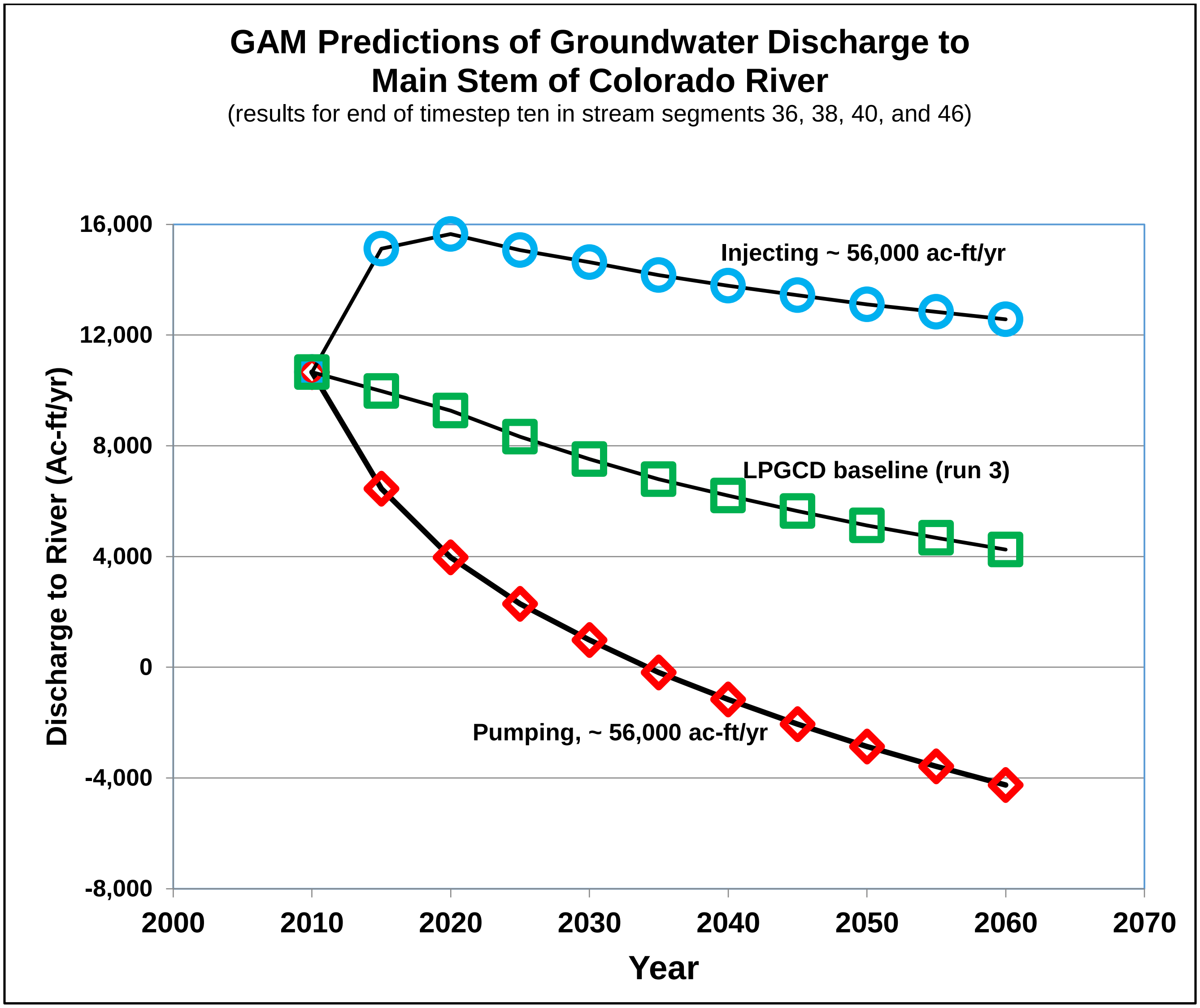

Figure 4
GAM Predicted Effects of Varying Pumping Rates and Pumping Duration

3.2.2 Pumping duration

GAM predictions are consistent with expectations regarding the effect of pumping duration. That is, longer pumping times result in less discharge to the river (figure 4).

3.2.2 Distance of Pumping

GAM predictions are consistent with expectations regarding the effect of distance. Figure 5 illustrates the effects of pumping from four wells at a rate of 3400 acre-feet per year over baseline pumping rates. The GAM predicts less discharge for pumping wells that are adjacent to the river, than for pumping wells that are approximately one mile from the river.

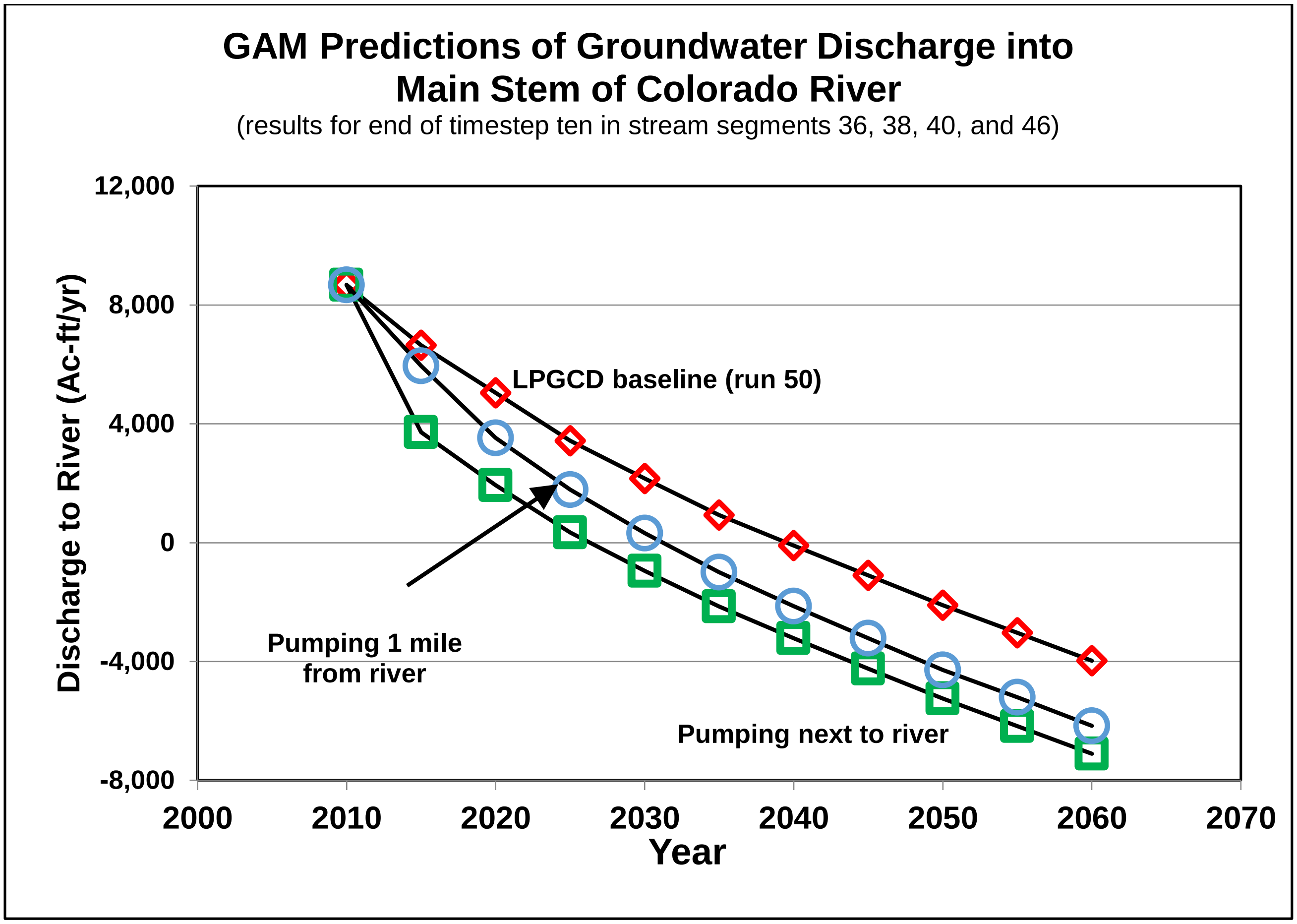

Figure 5
GAM Predicted Effects of Pumping Distance

The results presented above indicate that the GAM can reliably predict how pumping will affect trends in the discharge of groundwater to the Colorado River.

3.3 Effects of Forestar's proposed pumping on discharges to the Colorado River

As shown above, the GAM does not accurately predict the effect of pumping on the amount of groundwater discharged to the Colorado River. It does, however, reliably predict the trends in groundwater discharge resulting from pumping.

Figure 6 shows that Forestar's proposed phased-in pumping will decrease groundwater discharge to the Colorado River. After about 2040, the predicted effect of the phased-in pumping is little different from pumping at a constant rate of 45,000 acre-feet per year.

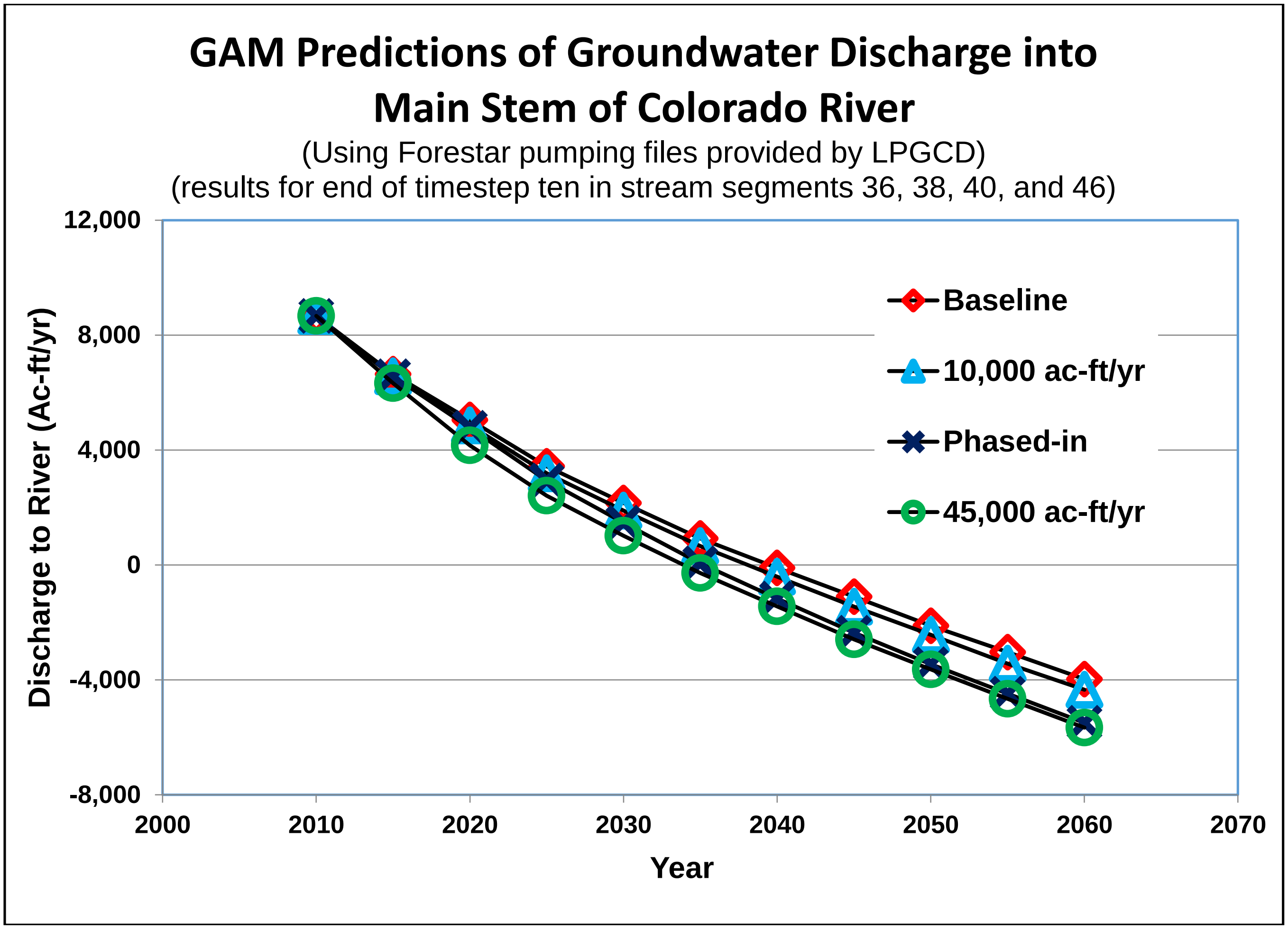

Figure 6
Effects of Forestar's Proposed Pumping on Colorado River

4.0 Conclusions

Forestar's phased-in pumping would:

- Reduce hydraulic heads in the Hooper, Simsboro, Calvert Bluff, and Carrizo aquifers.
    - Where these aquifers are confined, the reduced heads would cause water levels in wells to decline.
    - Where these aquifers are unconfined (i.e., recharge areas), the reduced heads would cause dewatering of portions of the aquifers.
- Reduce groundwater discharge to the Colorado River, thereby reducing the amount of water flowing in the river.

5.0 References

Davis, S.N., and DeWiest, R.J.M., 1966, *Hydrogeology*.

Forestar (Forestar (USA) Real Estate Group, Inc.,) 2013, *Forestar (USA) Real Estate Group, Inc.'s Motion for Rehearing to the Lost Pines Groundwater Conservation District*, August 6, 2013.

Freeze, R.A., and Cherry, J.A., 1979, *Groundwater*.

LPGCD (Lost Pines Groundwater Conservation District), 2013, input, output, and summary files related to LPGCD's GAM runs.

Saunders, G.P., 2009, *Low-Flow Gain-Loss Study of the Colorado River in Bastrop County, Texas*.

Thornhill (Thornhill Group, Inc.), 2009, *A Report of Results of Drilling and Testing Programs to Verify Ground-Water Supplies in the Simsboro Aquifer – Proposed End Op, LP Well Fields in Bastrop and Lee Counties, Texas*, April 15, 2009.

TWDB (Texas Water Development Board), 2004, *Groundwater Availability Models for the Queen City and Sparta Aquifers*, Figure 5.1, October, 2004.