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July 22, 2004

Dick Ewing
Twin Lakes Aquifer Coalition
Winthrop, WA.

RE: ***Groundwater Model of the Twin Lakes Aquifer***

Dear Mr. Ewing:

As per your verbal authorization, I have completed the groundwater model of the Twin Lakes Aquifer. This model was calibrated to lake levels over time and return flows to the stream look reasonable (based on USGS literature). As a result, I believe that it has capabilities to evaluate aquifer responses from a wide variety of scenarios.

The principal scenario that I evaluated was the potential difference in the Twin Lakes lake level after the Wolf Creek Irrigation District's main canal was converted to a piped system and what it would have been if the canal had not been converted.

Figure 1 shows a plan view of the model superimposed on the USGS topo map. The model predicted aquifer levels in 2002 are shown. This is about the time when we had collected a few water levels in the aquifer. Two observation wells are shown in the model (red dots). The most westerly monitoring well is shown at Big Twin Lake in the location of the campground well. The easterly observation well is located at another well in the aquifer.

The green box plots (error bands) shown next to the well mean that the computed well elevations were within 10 feet of the measured levels. I will discuss this plot in more detail later. However, this is the model computed levels in 2002 in a simulation started in 1960.

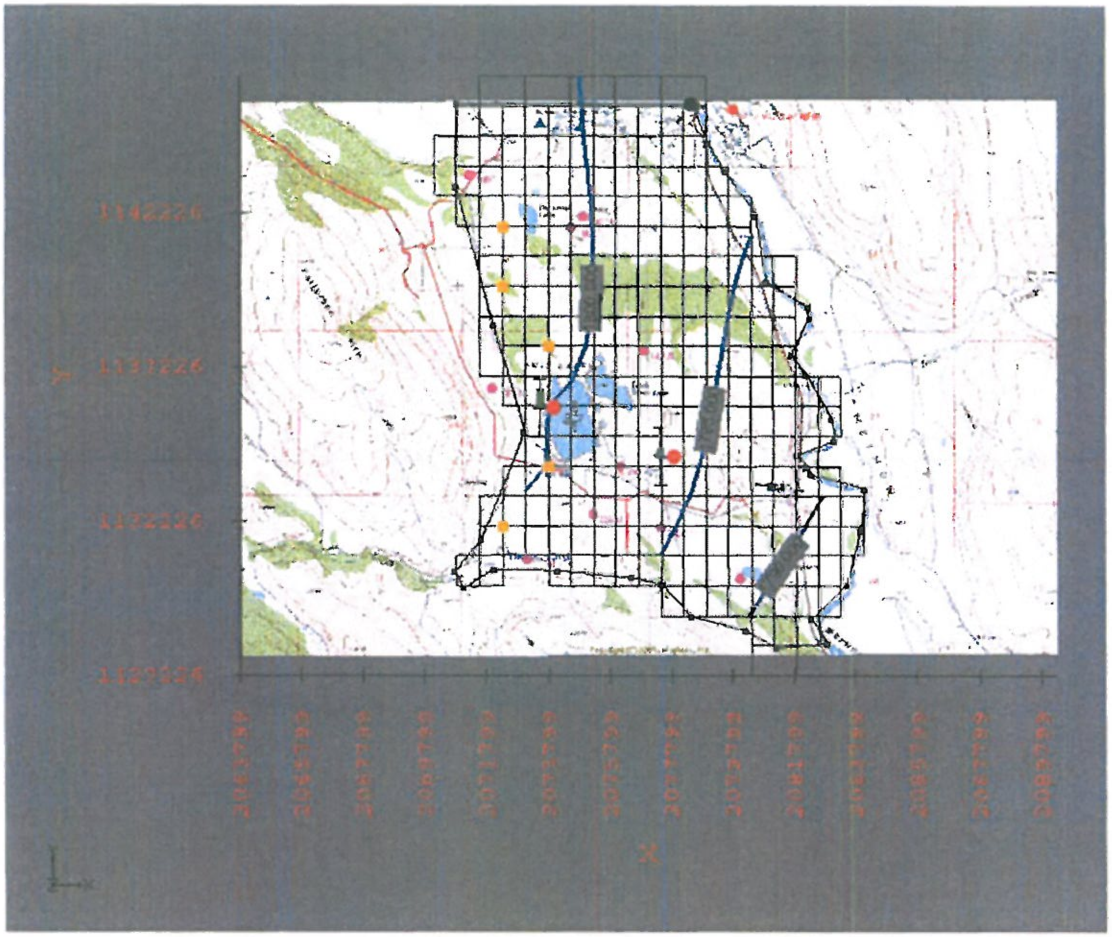

Figure 1. Groundwater model of predicted water levels in 2002.

In Figures 2 and 3 are the results of the predicted and observed water levels at the observation wells during the long term simulation.

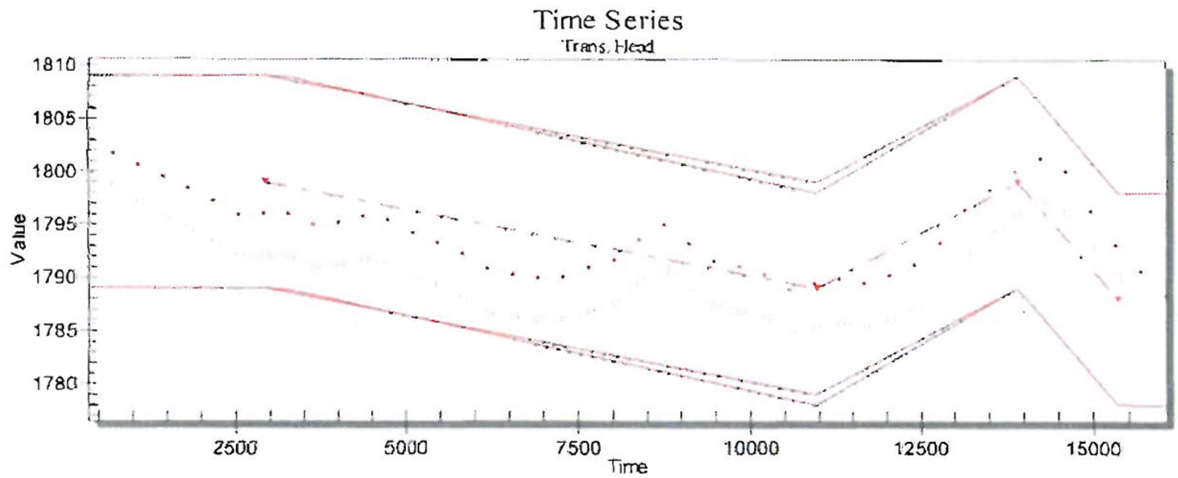

Figure 2. Water levels over time at observation wells from 1960 to 2002 with canal removed. Water levels in 2002 are 1788.2 and 1785.6 for the Campground well and the west well, respectively. Computed error (difference in observed versus computed water level for the simulation is 4.3 feet).

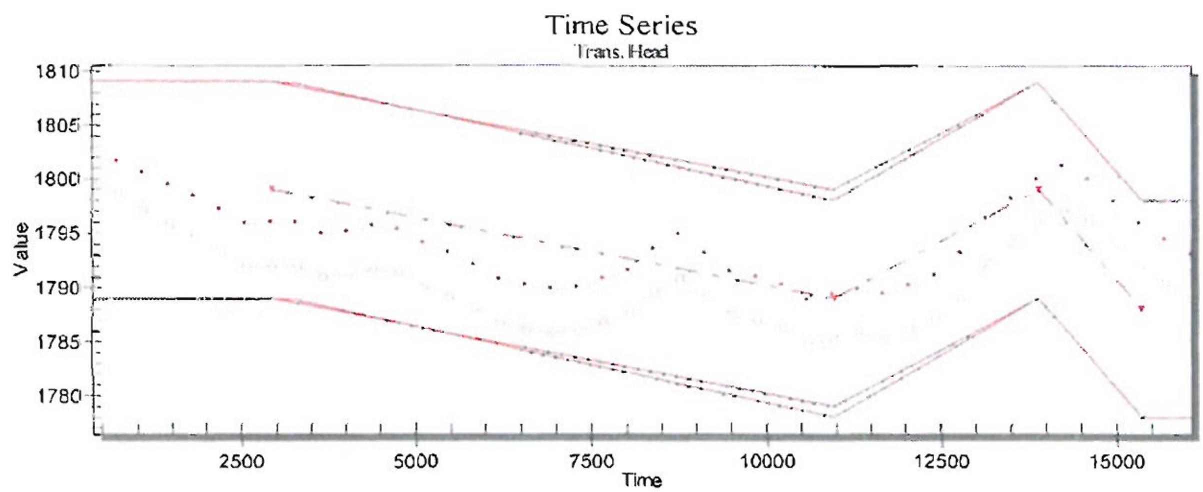

Figure 3. Water levels over time at observation wells from 1960 to 2002 with canal converted to a piped system. Water levels in 2002 are 1792.9 and 1789.0 for the Campground well and the west well, respectively. Computed error (difference in observed versus computed water level for the simulation is 9.4 feet).

As can be seen in Figures 2 and 3, the predicted lake levels follow the observed lake levels fairly well from 1960 to 2002 (Time 0 to about 15,500 days).

The differences between water levels shown in Figures 2 and 3 starts at about day 14,000, when the canal is replaced with the pressure line. The resulting difference in water levels in 2002 is about 4.5 feet with the canal removed.

The canal discharge was modeled with four injection wells along the canal line with a discharge into the aquifer of 600 acre feet per year for all wells. This volume was our best estimate of the water lost to the aquifer from the canal lining.

Not all of the elevation loss is due to the canal lining. As can be seen in comparison of Figures 2 and 3, about half of the lake level change is due to lowered recharge from precipitation during that period (as we said in our report).

In Figures 3 and 4, I have expanded the model time series to 2017 with the reduction in canal losses discussed above and low and average precipitation, respectively.

As can be seen in Figures 3 and 4, the water levels continue to decline. Water level decline is much faster with low precipitation (Figure 3). Figure 3 shows Twin Lakes essentially disappearing by 2015. The water level decline is slower with average precipitation (Figure 4). The lake will disappear, but not during the length of this simulation.

Figure 5 shows the resulting water levels in the aquifer in 2017 with average precipitation.

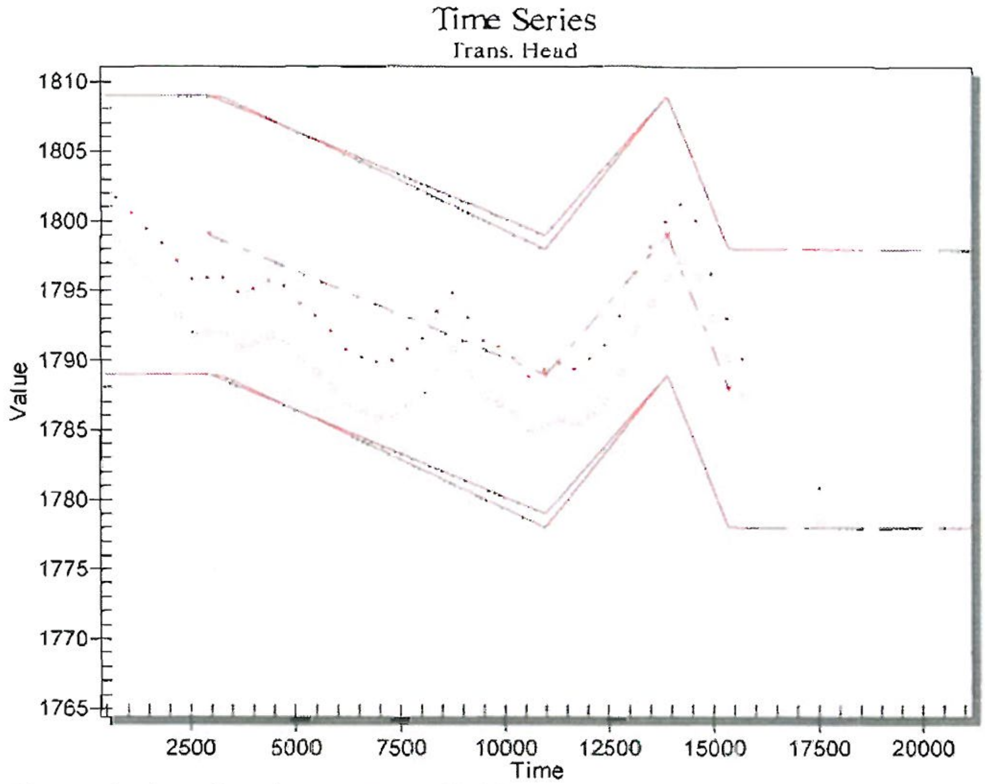

Figure 3. Low Precipitation, 2002-2017.

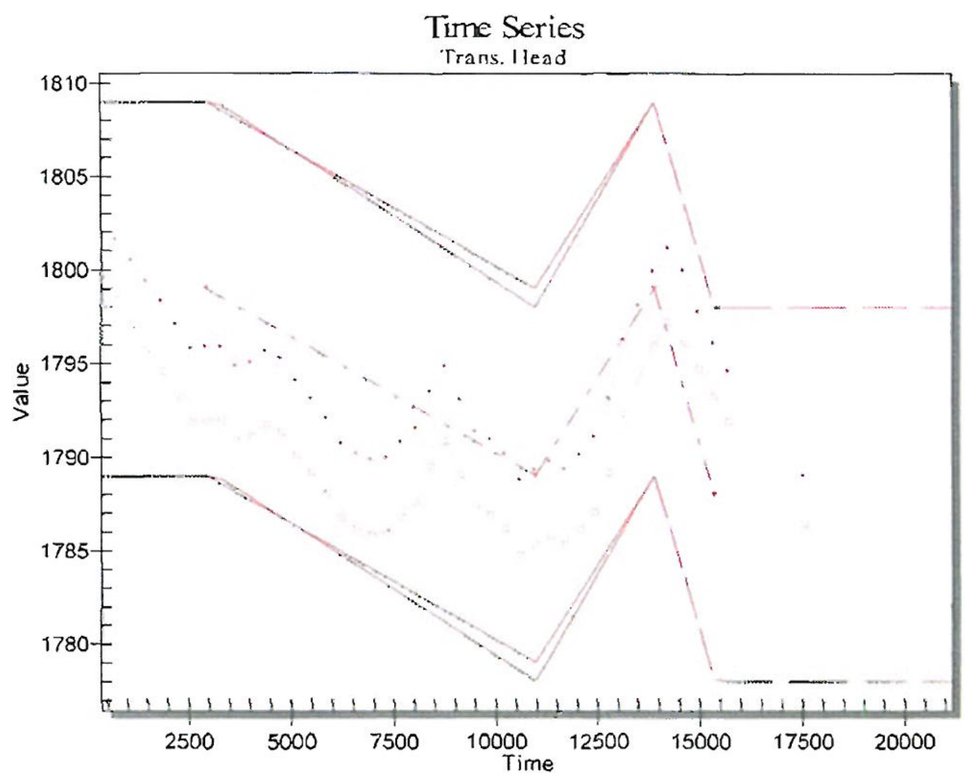

Figure 4. Average Precipitation, 2002-2017.

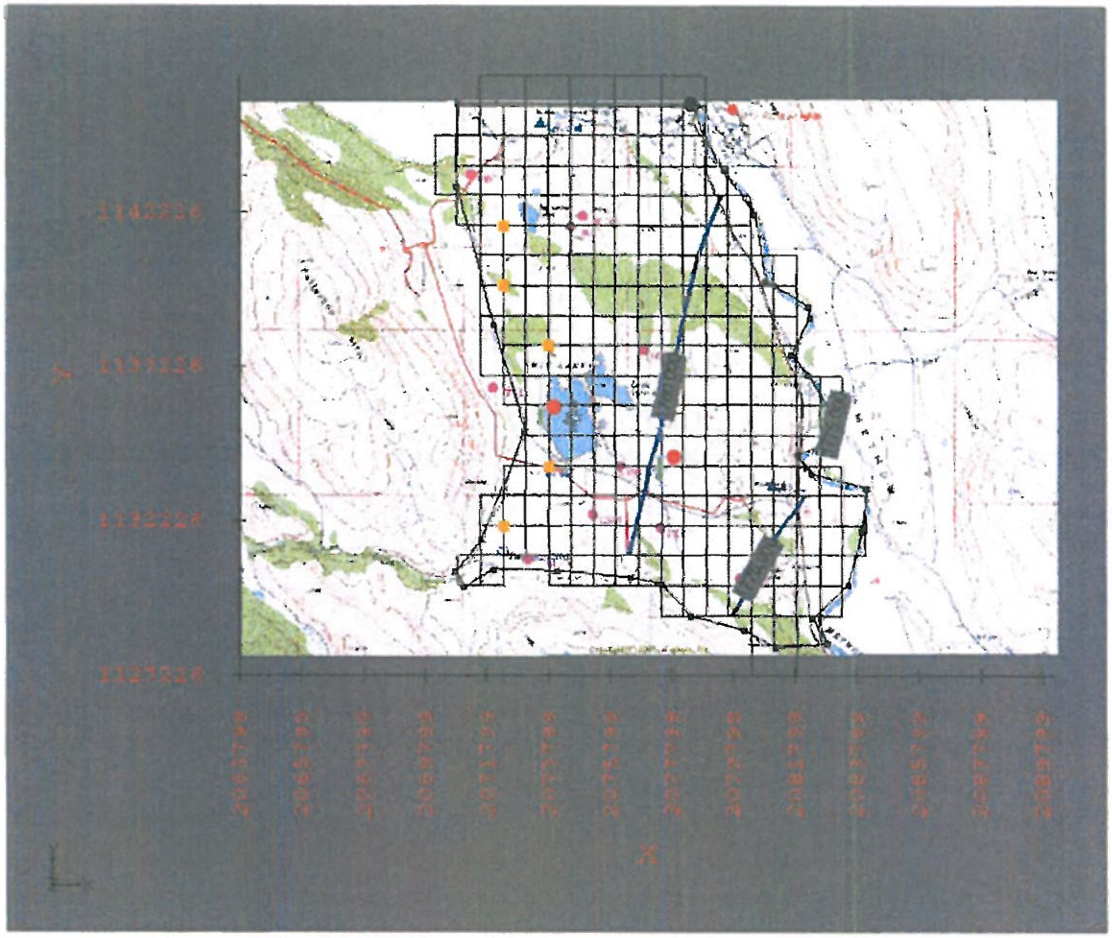

Figure 5. Water levels in 2017 with average precipitation. Compare to Figure 1.

Finally in Figure 6, I have tried to show the impact of adding water to Barnsley Lake thereby keeping groundwater levels high in this location.

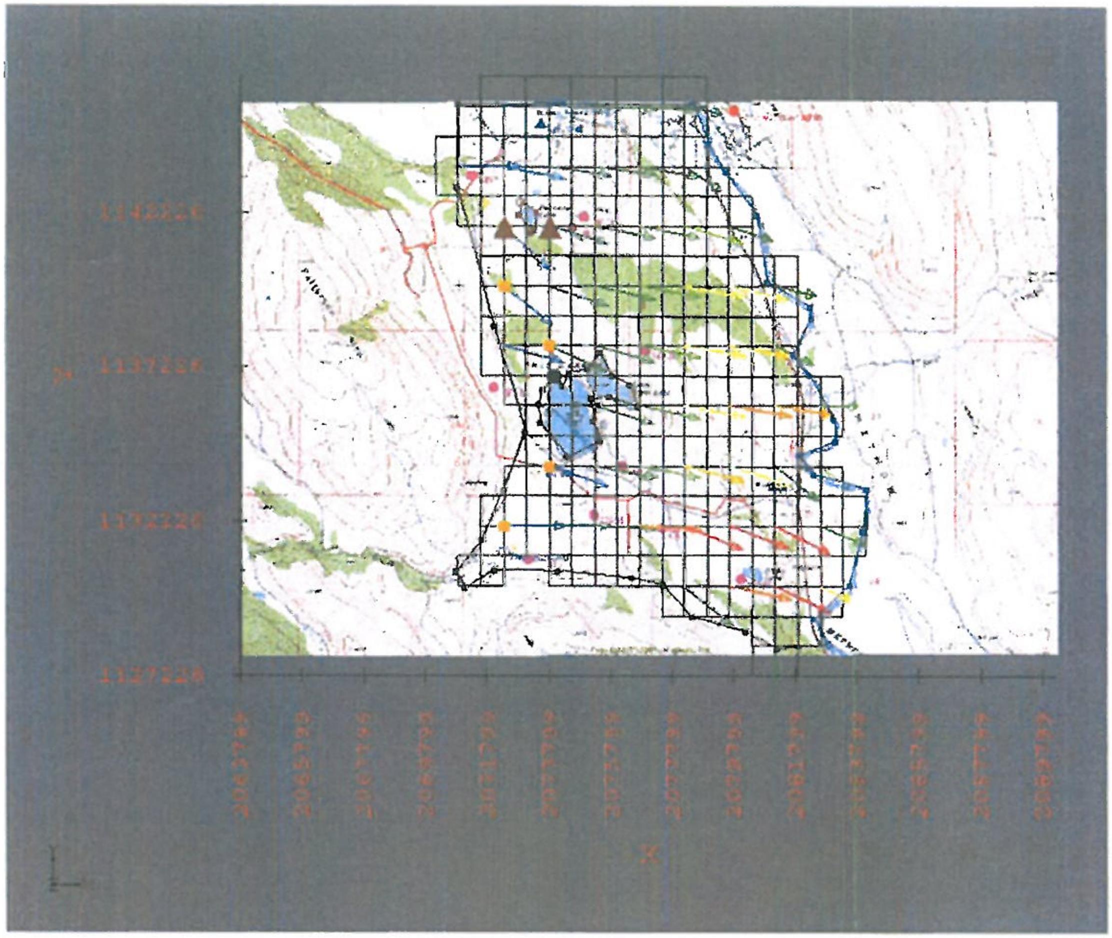

Figure 6. Vector plot of groundwater flow directions.

As can be seen in Figure 6, water level directions are generally southeast and east in the aquifer. Water added to Barnsely Lake does not appear to discharge to Twin Lakes. However, this is probably due to high water levels to the west of Twin Lakes in the model. When those water levels decline (they are probably relics from canal leakage), then water from Barnsley Lake will discharge to Twin Lakes. These are the quick but useful results. The model shows the impact of the canal lining and the resulting water levels into the future without the project. Twin Lakes will disappear without action. It is only a question of how fast.

Sincerely,

James D. Graham

James D. Graham, LG
Expires 7/18/05