



August 4, 2008

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SUBJECT: Response to April 4th, 2008 IDWR memo from John Lindgren to Aaron Marshal *Injury Assessment of Groundwater Impacts for Proposed Water Rights Transfer Comore Loma Subdivision*

Dear Mr. Harris:

We would like to take this opportunity to respond to a number of statements made in the IDWR memo "Per your request regarding the report Injury Assessment of Groundwater Impacts for Proposed Water Rights Transfer Comore Loma Subdivision" dated April 4th, 2008, written by John Lindgren. Mr. Lindgren made a number of statements challenging our injury assessment and concluded, "It is not appropriate to use an uncalibrated model to evaluate the water rights transfer for the Comore Loma Property." We found it interesting that in his memo Mr. Lindgren did not acknowledge the extensive data that supported the analysis, and so we feel it is appropriate at this time to respond to his statements and cite field data that supports our analysis. Hard data, such as measured water levels that differ radically from the model's predicted water levels, cannot be brushed aside with the "calibrated" IDWR model because at best, models are imperfect representations of reality. The data are indisputable and show the IDWR's model calibration in this area of the aquifer is very poor. Application of the model, without the modifications we have made, would be invalid for the Comore Loma Transfer. Without the State's imperfect model and the blind reliance upon its validity in all circumstances, we clearly show that this transfer has no adverse impacts on other users. If the modifications to the ESPAM we have made to improve aquifer representation in the subject area are accepted, then again no injury is caused by this transfer. We consider the State's position in defending the use of the model for this small transfer over a few tens of miles near the model boundary scientifically untenable. And furthermore, it is unfortunate that these comments focus only on the modeling aspects of our report. We did a significant amount of work collecting and analyzing real geology, water temperature, water chemistry, and water level data in our injury analysis that should really be the focus of our argument with the State. In our report we discuss how insignificant the injury predicted by the ESPAM is in terms of actual impacts that might possibly be caused, even if we assume the model is correct. The impacts could not be measured with any means currently available at the river reaches under consideration. Furthermore, the predicted impacts are at the limits of numerical accuracy in the model itself.



Issue 1. Mr. Lindgren's statement "The area involved and the contributing source of groundwater from outside the modeled area are assumed to be tributary to the Eastern Snake Plain Aquifer. No information is supplied in the report that would require us to conclude that waters being diverted are not tributary to the Eastern Snake Plain Aquifer." [emphasis added]

Mr. Lindgren's asserts that the waters outside the model boundary, to the east of Comore Loma are **ASSUMED** to be tributary to the Eastern Snake Plain Aquifer (ESPA), however, this is contrary to the design and summary documents of the model published by the IDWR and its contractors. Numerous IDWR and IWRI reports state that in this area, recharge to the aquifer is trivial. Specifically, the location of the model boundary was selected to minimize inflow to the model domain. Mr. Lindgren is mistaken in his assumption that the model represents water to the east as being tributary to the ESPA because there is no mechanism for the Eastern Snake Plain Aquifer Model (ESPAM) to deliver water from outside the model east of Comore Loma. We show conclusively in our report that the groundwater flow direction in the vicinity of Comore Loma is perpendicular to the model boundary, yet the model, has this edge represented as a no-flow boundary, with the flow direction parallel to the boundary. Figure 1 below is reprinted from our original analysis and has been modified to more clearly demonstrate this fact. The black line on the figure represents the model boundary, which, as we discussed above, is considered a no-flow boundary, yet the groundwater flow direction (shown with the blue arrows) points directly across the boundary. Groundwater flows in the direction of the hydraulic gradient (the direction of the blue arrows on Figure 1), and so if the water to the east of the model domain is in fact tributary to the ESPA, why does the model boundary treat it as a no flow boundary? The water simply cannot get into the model domain. The Department's own model does not support Mr. Lindgren's Issue 1 and, therefore, this comment is not valid. Our report shows how the Department's model can be modified and improved to better represent reality and when this is done, the transfer causes no injury.

Issue 2. Mr. Lindgren's statement "The report also contends that the ESPAM does not account for subterranean contributions of groundwater from outside the model. ESPAM does include the estimates of tributary underflow at specified flux model boundary cells. The location and magnitude of this tributary underflow was determined by the Eastern Snake Hydrologic Modeling Committee to be the best estimate of the total unmeasured underflow to the aquifer."

Mr. Lindgren's assertion that our report contends that the ESPAM does not include subterranean flow is true at the local scale only. We state that the ESPAM does not account for underflow from the mountain front to the east of Comore Loma, which it does not. However, we are confused as to how Mr. Lindgren construed this to mean that we said no underflow is represented anywhere in the ESPAM. It is well documented that there are specific areas at the boundaries of the model where underflow is tributary. As a matter of fact, we employed these same flux boundary conditions in our modeling runs using the ESPAM. The nearest location where underflow is specified in the ESPAM is nearly 10 miles away from Comore Loma. Figure 2 below is a reprint of Figure 22 from



IWRRI Technical Report 06-002 (Cosgrove et al., 2006), showing the locations of specified underflow. Figure 3 shows the specified flux cells near the Comore Loma property.

The ESPAM report (Cosgrove et al., 2006), when discussing underflow from tributary basins, stated (p. 35) "Because tributary underflow is subsurface flow, it is difficult to estimate." Further there is no discussion in the document of how underflow is calculated, located, or allocated to the ESPAM. We went through the effort to collect the necessary data, that being hydraulic head and aquifer test data, and then calculated very conservative and reasonable estimates for underflow. From their published reports, it is not possible to know how IDWR estimated the location and volumes for underflow. As Mr. Lindgren stated, their values were simply "determined by the Eastern Snake Hydrologic Modeling Committee", accurately represents poor documentation to the calculation of underflow.

In conclusion, we are in agreement with Mr. Lindgren's Issue 2, although we do not see it as an issue. The ESPAM has certain flux boundaries, usually coincident with rivers or streams where subterranean water can enter the model domain. We also agree that the calculation of the underflow flux is poorly documented and hard to trace other than to say it is the "best estimate of the total unmeasured underflow to the aquifer" as determined by the Eastern Snake Hydrologic Modeling Committee. No other response is necessary to this issue.

Issue 3. Mr. Lindgren's statement "The use of this boundary condition supplies a "new source" of water for the diversion.....the proposed modification to the ESPAM boundary puts no limits on the inflow ... "

Mr. Lindgren overstates the obvious. Anytime a flux boundary is put into a model, water can move into the model, that is the point of the flux boundary. He is wrong about the limitations on inflow. The inflow is limited by the aquifer transmissivity and the hydraulic gradient, just like the flux boundaries for the ESPAM. The modifications we made do not create any "new water", they simply improve the modeled representation of the aquifer and better match the available data. We improved the ESPAM so that it more accurately represents reality. Four lines of data including, the hydraulic gradient, the water chemistry, the geology and the water temperature indicate that water from the mountains to the east flow into the ESPA near Comore Loma, yet the model doesn't account for it. Mr. Lindgren's assertion that the water to the east is tributary to the ESPA supports our assertions and the data.

As to the assertion that our modification places no limits on the inflow into the ESPA, that is simply not the case. Our report clearly demonstrated (see page 28) that the potential volume of water that is likely entering the ESPA from the mountains to the east is on the order of 57,000 acre-ft/year per linear mile of the model boundary. This estimate was based on Darcy's Law and field measurements of water levels and aquifer tests. We intentionally kept the model modifications conservative, with the final result only allowing approximately 970 acre-ft/year to enter the model domain.



We are perplexed at the State's resistance to improving the model to better represent the flow of water in the aquifer. Clearly, the model was built and designed to simulate the flow of water in a 11,000 square mile aquifer. It is not reasonable to think that a water transfer of only a few tens of miles near the aquifer boundary can be represented accurately in the ESPAM without modification using local data. We wish that Mr. Lindgren would focus on the real data and the real modeling that we did, rather than making sweeping generalizations about the grand ESPAM. No model is perfect and it is healthy and prudent to continuously improve and refine a model as new information becomes available.

Issue 4. Mr. Lindgren's statement "It is not appropriate to use an uncalibrated model to evaluate the water rights transfer for the Comore Loma Property."

Again, Mr. Lindgren is overstating the merits of the ESPAM as a calibrated model, especially at the scale important for the Comore Loma Transfer. The ESPAM was calibrated at the scale of the model domain, some 11,000 sq miles, to water levels in about 1009 aquifer wells. This is very few wells at the scale of the aquifer and cannot possibly be rigorous enough for the purposes of the Comore Loma transfer, in fact, page 101 of the ESPAM report states "*the ESPAM is a regional model and is not intended for predictions of impacts to individual springs. A regional model is limited to replicating broad-scale heterogeneity in the physical system and cannot replicate localized heterogeneities.*" Figure 4 shows the locations of IDWR's calibration points for the steady-state version of the ESPAM (reprinted from Figure 55 in IWRRI Technical Report 06-002). The nearest calibration point is over 10 miles away from Comore Loma.

We show in our report that the water table in the vicinity of the Comore Loma property, based on measured water levels in wells, flows in a northwesterly direction, which is perpendicular to the model boundary. The ESPAM predicts a southwesterly flow direction parallel to the model boundary and perpendicular to the measured groundwater flow direction. We also document how the ESPAM water table elevation is 300 feet lower than the actual water table. This miss-match between the "calibrated" ESPAM and real data indicates either a serious flaw in the model "calibration" and/or a problem with the conceptual model used to build the numerical simulation. Figure 5 shows the groundwater map of the ESPAM and the flow direction and the water table map based on well measurements.

The mismatches between flow direction and water table elevation are serious and render the ESPAM nearly useless for the Comore Loma Transfer, but the problems could be corrected by simple modifications to the ESPAM. Consider Darcy's Law:

$$Q = K A \frac{dh}{dl}$$

This is the governing equation of groundwater flow and a simple analysis shows a way to correct the head mismatch represented by the ESPAM. Keeping the hydraulic conductivity (K) and aquifer thickness (which when multiplied by the width of a model



cell gives the area (A)) constant, increasing the flux (Q) across the boundary will force the gradient (dh/dl) to increase, thereby raising the predicted water levels along the model boundary. Notice that in order to increase the elevation of the ESPAM water table more flux must come from the mountain front to the east (just as we have been arguing all along).

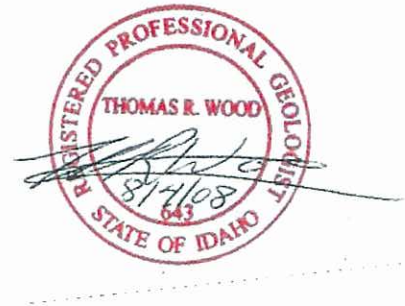
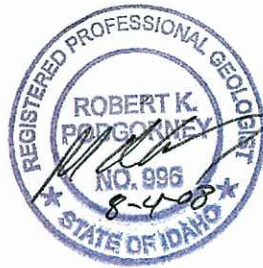
The “calibration” of the ESPAM that Mr. Lindgren refers to is only valid at the full scale of the model and when considered at the scale of the Comora Loma Transfer it lacks scientific rigor. We find that Issue 4 is without merit at the scale of a few tens of miles.

In summary, we have shown that use of the ESPAM for the Comore Loma Transfer is inappropriate. Further, we have identified at least two serious calibration issues that call into question the validity of the ESPAM in this area. For the record we state that in general the model is a fine representation of aquifer flow AT THE SCALE OF THE ENTIRE AQUIFER. However, small transfers, especially near the boundary of the model, cannot be accurately represented in its current configuration. We made improvements to the ESPAM to better represent the aquifer conditions. If the State does not like the modifications we have made to improve the ESPAM, then we suggest that the model be ignored for this case and the assessment of injury be based on field data and standard equations of groundwater flow. The real issue is not in the technical details of the model, but in doing a true and correct assessment of injury for this proposed transfer.

We hope this information is helpful; please feel free to call if you have any questions (Rob 208-520-9361 or Tom 208-589-5555).

Sincerely,

Robert K. Podgorney, Ph.D., P.G.
Thomas R. Wood, Ph.D., P.G.



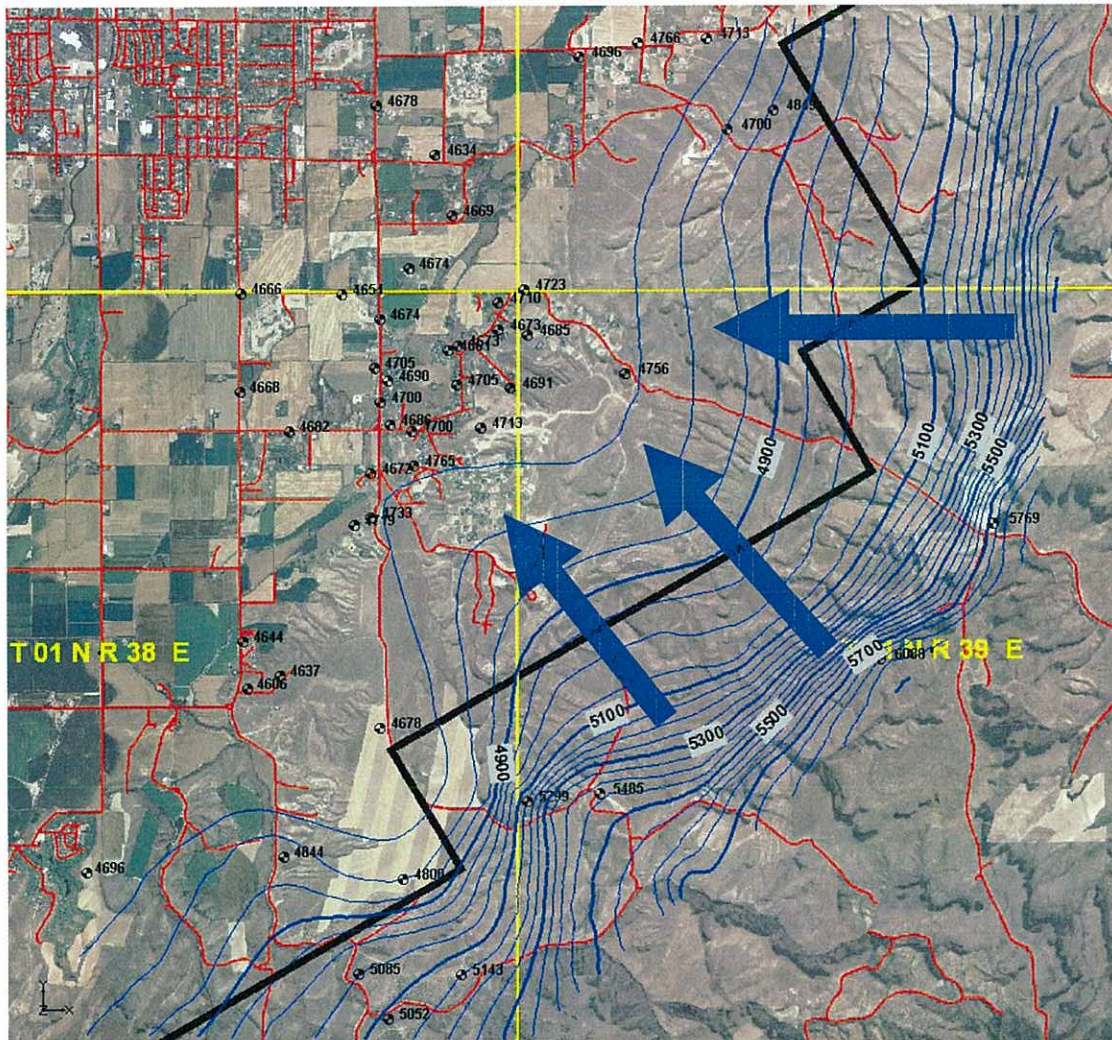


Figure 1. Groundwater elevation contours (blue lines) and inferred flow directions (blue arrows) based on actual field measurements. The heavy black line represents the model boundary, which is setup as a no-flow condition.

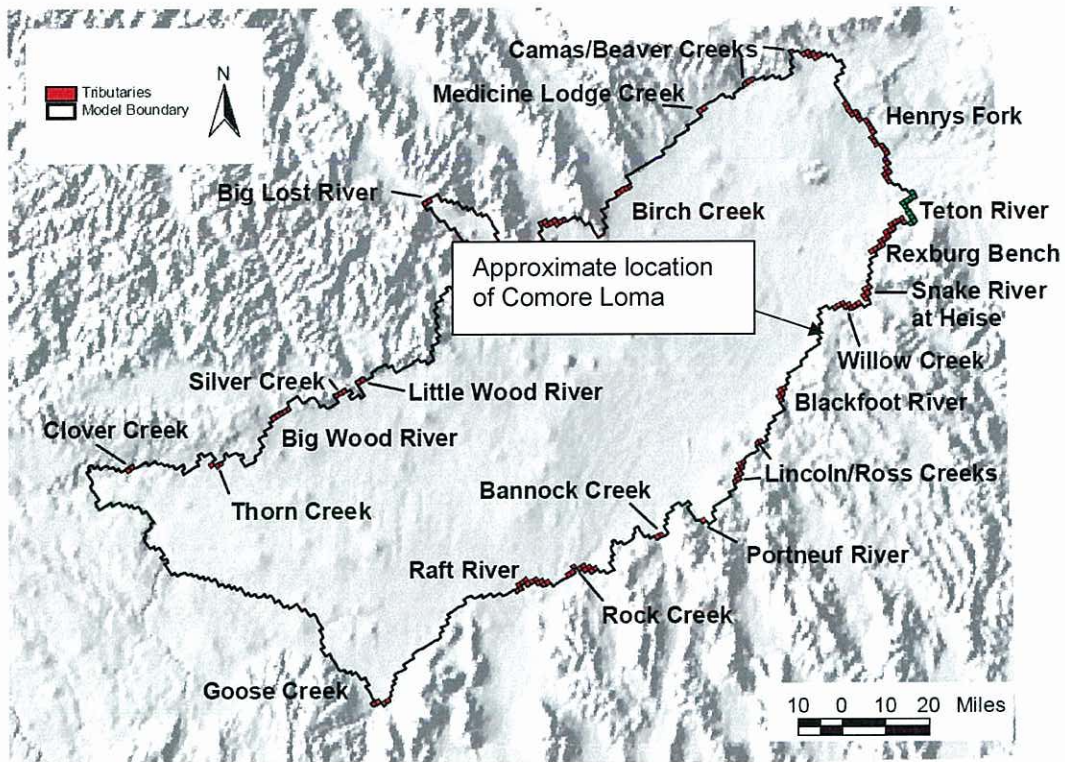


Figure 22. Specified flux tributary underflow locations.

Figure 2. Location of model cells representing specified flux into the ESPAM. Approximate location of Comore Loma shown for reference. Reprinted from IWRRRI Technical Report 06-002 (Cosgrove et al., 2006).

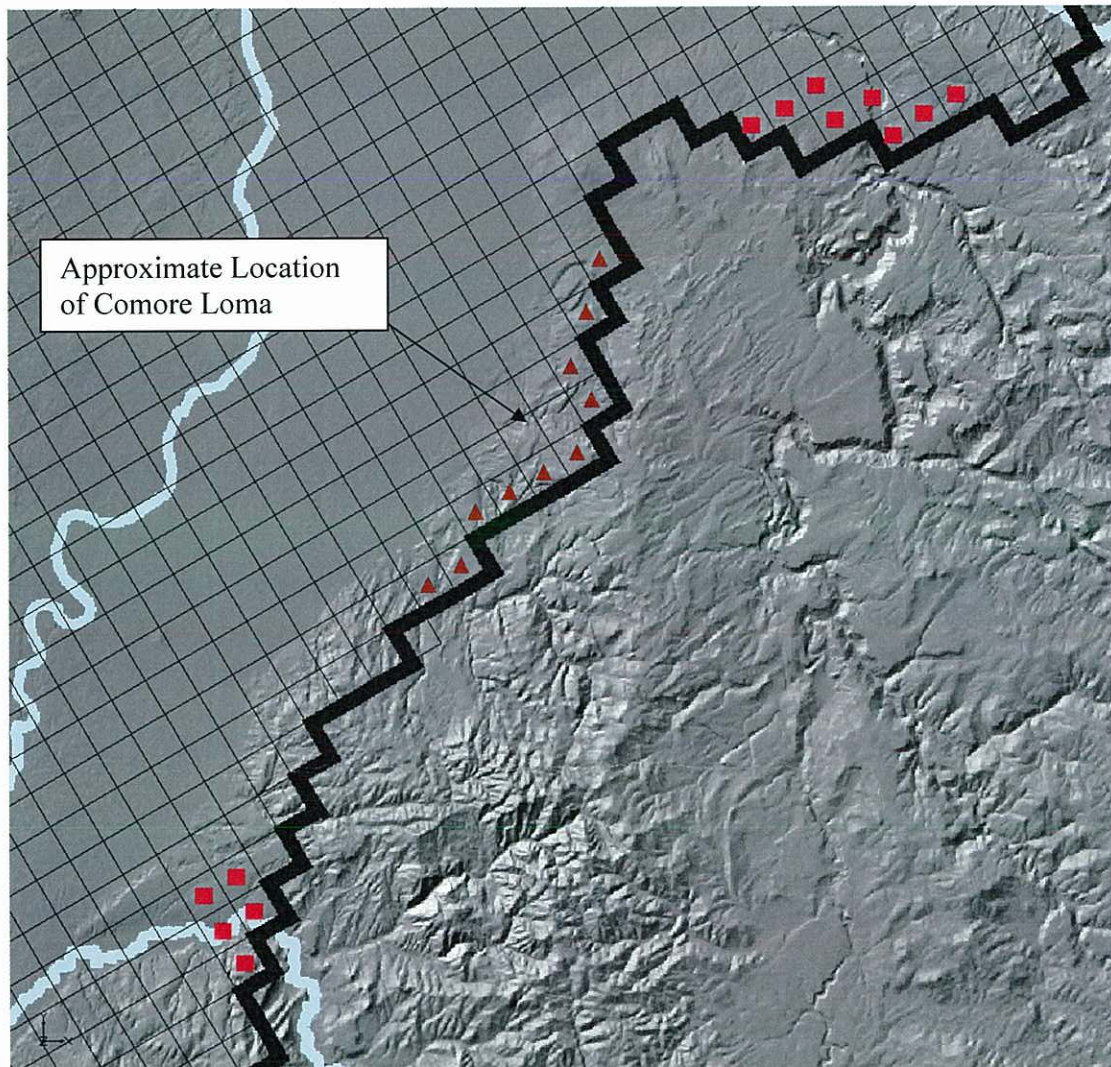


Figure 3. Detail location map showing the locations of specified flux cells (squares) and the location of the model cells converted to general head boundaries (triangles).

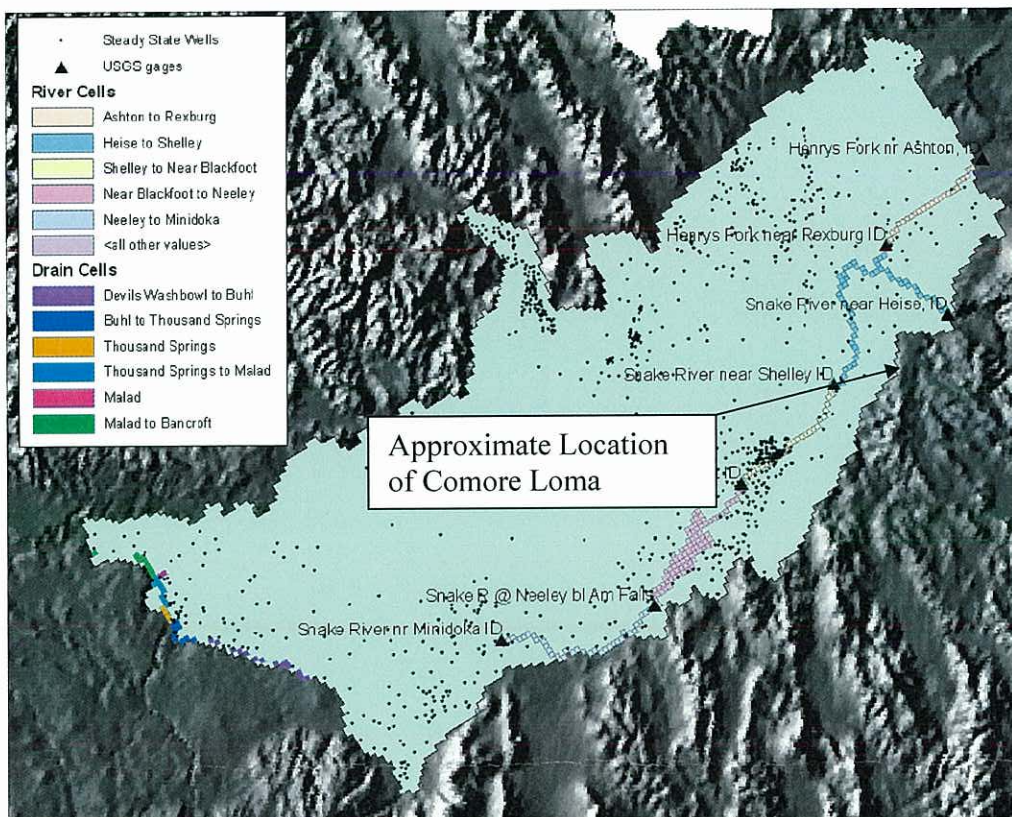


Figure 55. Location of steady state calibration water level targets.

Figure 4. Reprint of Figure 55 from IWRI Technical Report 06-002 (Cosgrove et al., 2006) showing the location of steady state calibration water level wells (small black dots). The approximate location of Comore Loma is shown with the arrow. As can be seen, there are no calibration wells even remotely in the vicinity of Comore Loma. This significantly reduces the chances of the model correctly representing aquifer conditions near Comore Loma.

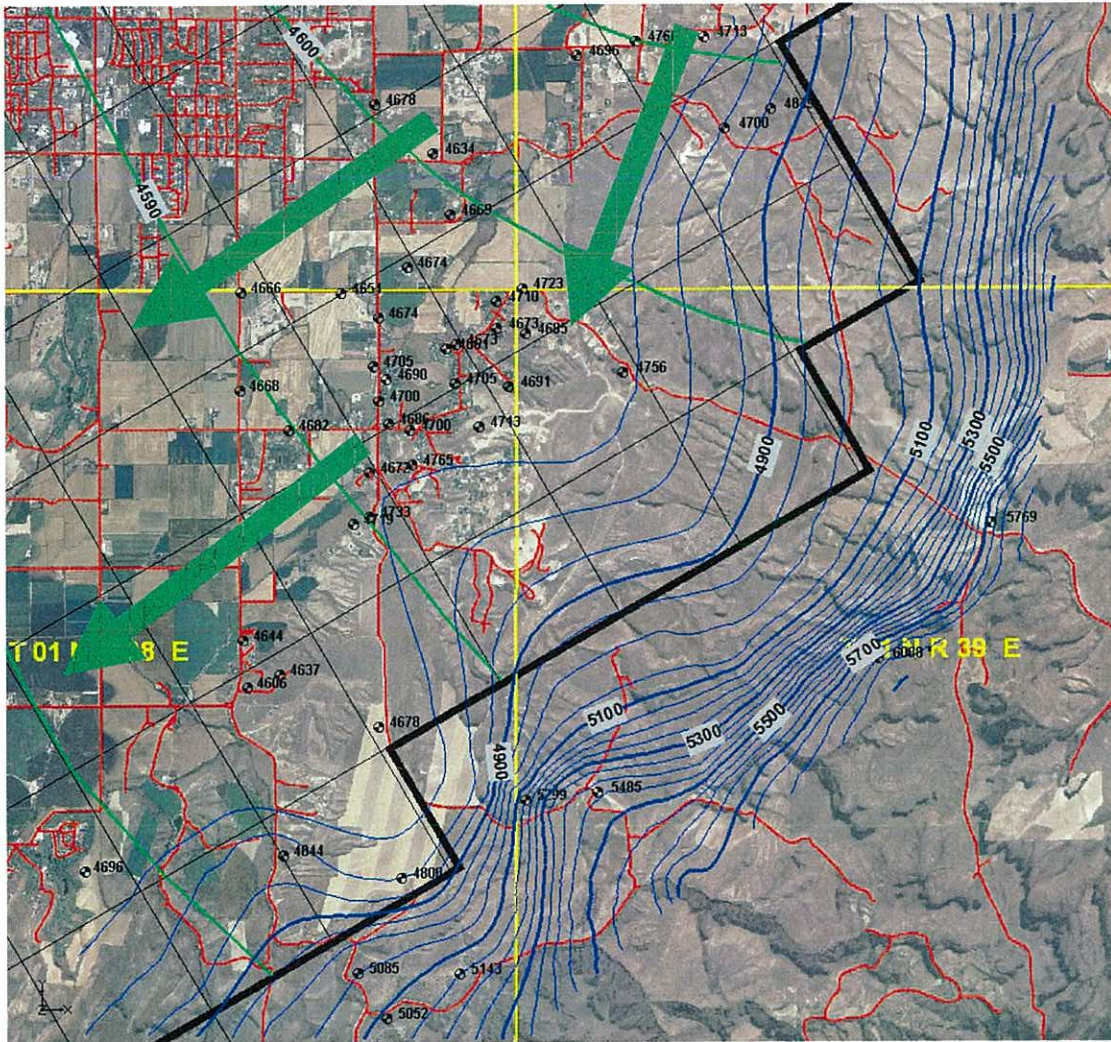


Figure 5. Comparison of actual measured water levels and those predicted by the ESPAM in the vicinity of Comore Loma. Note the extremely large discrepancy, with measured values approximately 4,900 ft AMSL along the model boundary, while the model predicts values on the order of 4,600 ft AMSL, a 300 foot discrepancy!