Illinois American Water®

Dr. Derek Winstanley

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Champaign County District

Your ref	Response to ISWS'S Review of WHPA
Our ref	Report for American Water
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April 20, 2007

Re: Response to the ISWS's *Review of WHPA report, Modeling a New Wellfield for Champaign-Urbana*

Dear Dr. Winstanley,

We appreciate your review of the report, "*Modeling a New Wellfield for Champaign-Urbana,*" dated November 27, 2006, as prepared by Wittman Hydro Planning Associates, Inc. (WHPA) for Illinois American Water. This letter comprises our response and clarifications to the Illinois State Water Survey's (ISWS) review of the report dated April 3, 2007.

The report, contracted by Illinois American Water, examines the impacts on the Mahomet Aquifer of a new Illinois American Water wellfield near Champaign-Urbana, IL. The main emphasis for the report was to provide assurance to Illinois American Water that the investment in the new wellfield was viable and located for the responsible utilization of the resources based on the most current understanding of the aquifer system that we have today.

The groundwater study provides a first step to responsible growth in the region and recognizes the need for further review of the resources and pressures that future demands may cause. We appreciate the ISWS's comments and suggestions throughout this wellfield planning process and look forward to continued collaboration.

After reading the ISWS's comments on the final report, it is clear that some aspects of the work will continue to be open to interpretation. The methods used by WHPA in the groundwater modeling effort are well established and provide a conservative estimate of the impacts to the aquifer. The uncertainties within the model have been bounded such that any error in the predictive analysis will result in less impact, not more. Because of this, we feel confident in the results of the analysis.

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We believe that WHPA's report provides the first available groundwater analysis of the Mahomet Aquifer with a working model outside of the developing ISWS groundwater model. The work by WHPA provides the starting point for better understanding of the complexity of the Mahomet Aquifer. Illinois American Water feels that as ISWS continues to collect data and study the aquifer in the near and long range future that a more complete understanding of the Mahomet Aquifer will allow for us to further understand the developing pressures on the aquifer.

Task 1 – Regional Groundwater Demand Analysis

1. The regional groundwater demand analysis estimated future water use out to the year 2025. Illinois American Water provided WHPA with demand projections for the Champaign Operation that were originally projected to the year 2016 through Illinois American Water's internal planning development. The Illinois American Water demands were extrapolated out to the year 2025 and then incorporated into the regional demand to ensure that the planning timelines were consistent.

   The new wellfield was evaluated to show the impact of an additional 16 MGD, this is the *capacity* increase necessary for meet future peak demands beyond 2025 at current rates of growth.

2. The purpose of the regional groundwater demand analysis was to estimate the total withdrawals from the Mahomet Aquifer. The results provided context for the withdrawals by the Illinois American Water Champaign Operation and provided some level of understanding on the potential impact that the regional demands may have on the proposed wellfield. The projections of future groundwater demand reflect the best estimate of growth at a regional scale. When the analysis was performed the proposed ethanol plants in the region had not been announced. These additional withdrawals will be considered in future planning scenarios.

3. The focus of the study was on the impacts to the Mahomet Aquifer, therefore estimating withdrawals from the Glasford Aquifer was out of the scope of this work. The correction factors used to separate out the Mahomet water use from the Glasford Aquifer water use were based upon the data available to WHPA. The ISWS provided additional information about irrigation to WHPA after the study was complete. This information results in an increase in the current and projected irrigation withdrawals throughout the aquifer, particularly in the western counties. Future work will reflect this knowledge.

Task 2 – Aquifer Characterization and Available Data

1. The ISWS expresses concern that the Sangamon River is not included in the model. This is not true. To the extent that the topographic information used to assign head values represents the location of the Sangamon and Vermilion Rivers, these features are explicitly modeled. As stated on page 53 of the report: *In the first model, all of the rivers shown in Figure 24 were explicitly modeled. These are the rivers that are known or inferred to discharge to or receive discharge from the Mahomet Aquifer. In the second model, each cell in Layer 1 has a river boundary condition that is intended to capture the effects of both areal recharge to the aquifer and discharge to and from rivers. Consequently, the Sangamon River and the Vermilion River were explicitly modeled as the lowest reaches in the water table aquifer. The effect of this approach to modeling recharge is that the upper aquifer will be a sink at the streams and rivers (where heads were lowest) and it will allow more water into the Glasford as heads in the Glasford decline.*

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2. WHPA reviewed all the available data and literature regarding the Mahomet Aquifer in order to estimate aquifer parameters. The calculated recharge rates to the Mahomet Aquifer are reasonable and within the expected range of values.

Task 3 – Groundwater Flow Modeling

1. The ISWS questions how error is assess in the model calibration. And although we consider the work of Anderson and Woessner a learned treatise, substantial progress in model calibration methods has occurred since the book was published in 1992. As described in Sections 4.2 and 4.3 of the report, our modeling work is based on state of-the-art methods, such as regularized inverse modeling, dual calibration, and predictive certainty analysis.
2. As described in the modeling report, a conductance term is applied along with the head. This type of boundary condition ***does not*** keep the head in aquifer within 10 ft of the land surface. Refer to the MODFLOW documentation regarding the river package [McDonald and Harbaugh, 1988, Chapter 6].
3. As described above, the boundary condition in no way forces the head to be a certain value. The variation in simulated head with respect to ground surface in response to greater withdrawal from the Mahomet Aquifer (which is simulated to be two layers below the layer to which the "river" boundary is applied) is completely rational and reinforces our position that this was a smart way to model the system.
4. The model was designed to do the following: (1) fix recharge at a maximum value in cells representing the Glasford Aquifer that have a simulated water table more than 20 feet below ground surface, (2) account for lowering of the transmissivity of layer 1 as the water level drops below the top of the layer, (3) account for horizontal flow in Glasford Aquifer beyond the lateral limit of the Mahomet Aquifer, and (4) make the vertical leakage from the water table aquifer available to the Mahomet aquifer in areas where the layer representing the Glasford Aquifer remains saturated. The simulated recharge rate appears linear in withdrawal because not enough of the river cells attached to Layer 1 have become percolating to make the non-linearity apparent. As simulated heads in layer 1 decline below the elevation specified as the elevation of the river bottom, they assume a fixed leakage rate based on the specified conductance and thickness of the boundary condition (they percolate). During automated calibration, the inverse engine was able to both increase the scale factor on pumping and decrease the conductance of the river cells simulating recharge. Through calibration, a balance was struck between these and other parameters that minimized the sum-of-squared errors between measured and observed water levels and the other information included in the model calibration. As above, this narrative sounds completely consistent with the anticipated response of the aquifer system.

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5. The reviewer's comment indicates they assume we fixed recharge and tweaked the scale factor on pumping to calibrate the model. As described in the responses to this comment, the scale factor on pumping and river cell conductance were calibrated simultaneously. Also, the comment that the recharge rate is too high has no basis. As described in the modeling report (top of p. 56), the scaling of known pumping was a nod to the fact that there is much that we do not know about pumping from the Mahomet Aquifer. WHPA agrees that this is not completely appropriate for Champaign County, in particular, because the known pumping for public water supply is such a large fraction of the total estimated withdrawal. However, since this ramification of our modeling approach is conservative, we consciously chose to work with the scale factor despite its bias toward over-estimating withdrawal in the Champaign-Urbana area.
6. This comment is not pertinent to the current study but contains useful suggestions for further investigation required to understand the aquifer system. Illinois American Water is providing substantial funding for this further investigation.
7. To the extent that the topographic information used to assign head values represents the location of the Sangamon and Vermilion Rivers, these features are explicitly modeled. As stated on page 53 of the report: *In the first model, all of the rivers shown in Figure 24 were explicitly modeled. These are the rivers that are known or inferred to discharge to or receive discharge from the Mahomet Aquifer. In the second model, each cell in Layer 1 has a river boundary condition that is intended to capture the effects of both areal recharge to the aquifer and discharge to and from rivers. Consequently, the Sangamon River and the Vermilion River were explicitly modeled as the lowest reaches in the water table aquifer. The effect of this approach to modeling recharge is that the upper aquifer will be a sink at the streams and rivers (where heads were lowest) and it will allow more water into the Glasford as heads in the Glasford decline.*

Task 4 – New Wellfield Evaluation and Estimates of Impact

1. The well interference assessment examined the logs of wells within 2-3 miles of the new wellfield because these are the wells most likely affected by drawdowns.
2. The impacts of the Decatur wellfield on the Mahomet Aquifer are not part of the scope of this study. The goal of the work was to determine impacts of an additional 16 MGD withdrawal from the aquifer near the City of Champaign using the best available understanding of the aquifer system.
3. Analysis of withdrawals from the Glasford Aquifer and the effects of additional withdrawals on the Glasford or the rivers is not part of the scope of this project.
4. The uncertainty we are most concerned about is the uncertainty in the predicted drawdown in response to development of the new wellfield. Therefore, we placed conservative constraints on our model calibration and then translated parameter uncertainty into an uncertainty as to the predicted drawdown. As we discussed in our report and in our presentation of the report to the ISWS/ISGS, the use of steady-state simulations likely ***overestimates*** drawdown.

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Thank you for your time and effort in reviewing the report, "*Modeling a New Wellfield for Champaign-Urbana*". Illinois American Water believes that through the report that WHPA provided us with an early planning tool to utilize in the development of our new wellfield. Illinois American Water recognizes that this report was the first step in ensuring that new wellfield was developed with an understanding of the potential impacts on the aquifer and an understanding of the impacts to the wellfield by regional demands. As this is the first step, Illinois American Water will be utilizing additional studies to correlate the projected impacts that this report to those found in actual measurements as the wellfield is developed. It is hoped that with this starting point and further collaboration with the ISWS that will assist in developing a better understanding of the complexity of the Mahomet Aquifer and the supporting ground water system.

Sincerely,

Illinois American Water

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