

-- *Final Peer Review* --

**Minimum Levels Evaluation: Johns Lake,  
Lake and Orange Counties, Florida**

By

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***Overall Impressions***

This August 2, 2010, document by Dr. Clifford Neubauer is a revision of a report that has been previously submitted for peer review. Earlier reviews concluded that the report was well written and understandable, although there were deficiencies. For the record, this revised report is much clearer and easier to read and understand. Dr. Neubauer is to be complimented for the improvements he has made in the report. It is easy to read and understand.

***General Issues***

One of my concerns has been that documents such as MFL reports should be understandable by lay persons, including District Board members, and that they should stand alone in terms of understanding the purpose and conclusions of the report. To this end, I have been critical of the fact that little had been done to provide context for the reader in terms of describing the lake and behavior of water in the lake. Previously, there was little included in the report to explain what a sandhill lake is and how it functions. To a large extent, this concern has been eliminated in the current draft of the document.

The current report continues to improve on addressing some of these issues and is much better in terms of explaining the physical setting of the lake. There is now an appendix (Appendix D) that discusses the lake water budget as it has been conceptualized by the District. It does not discuss in lay terms how groundwater and the lake interact, which I consider important if one wants to understand the rationale for why only Infrequent High (IH) and Infrequent Low (IL) levels are proposed for adoption as MFLs.

I agree that use of frequent high and frequent low MFLs is not necessary to protect the lake and that use of the infrequent high and low regimes will suffice to establish a stage regime. This is simply because the lake levels undergo wide fluctuations in lake levels, so determining if stage conforms to frequent high and low regimes will be problematic to verify. IH and IL regimes will suffice.

I had previously suggested that a water budget for Johns Lake be included in the next draft as a means for understanding why the lake levels fluctuate so much. This inclusion

was also suggested because there are some apparent inconsistencies in the text. For example, there is discussion of connection with the Floridan aquifer, and a recharge map is included in the report. There is no discussion in the main text or Appendix D about flow-through of water from the surficial and, possibly, the intermediate aquifers. This flow-through has been found to be a significant source of groundwater in sand-hill lakes (a.k.a. seepage lakes) the District.<sup>1</sup> Significant amounts of water appear to be stored in the surficial aquifer, and seepage into and out of the lake certainly affects lake levels, at least to the extent that the timing of lake-level changes induced by rainfall patterns and pumpage will be affected. Astatic lake levels are largely a result of the high level of influence of surfacewater inflows, not dominant interactions with the aquifers. By the same reasoning, the surficial and Floridan aquifers are only able to sustain certain minimum levels. By understanding the water budget, one can understand why the IL was set based on the Floridan and why it is difficult to model high lake stands. To me, including a minimal discussion of the water budget and aquifer interactions, especially why interactions of the lake and the surficial aquifer were not discussed, should result in a better understanding of the MFLs by the public and persons who are not familiar with sandhill lakes and potentially reduce criticism of the MFLs.

The current water budget appendix presents the data, but the discussion of what it means is still lacking. Based on the presentation in the appendix, the water budget includes the following components:

<b>Water Sources</b>	<b>Water Sinks</b>
<ul style="list-style-type: none"> <li>• Runoff from “impermeable” land surfaces</li> <li>• Runoff from “permeable” surfaces</li> <li>• Inflow from Black Lake</li> <li>• Direct rainfall on lake surface</li> </ul>	<ul style="list-style-type: none"> <li>• Direct evaporation from lake surface</li> <li>• Seepage into Floridan aquifer from sinkhole A and B</li> <li>• Outflow to Lake Apopka</li> </ul>

Clearly, surfacewater interactions are the driving mechanism for the rapid changes in lake levels. However, other potential sources and sinks are important to managing the lake and determining if consumptive uses can cause harm. To that end, there are other potential sources and sinks that have not been discussed. These are interactions with the surficial aquifer and intermediate aquifer and confining unit. The USGS<sup>1</sup> has shown that sandhill lakes (i.e., Lake Barco) in the northern part of the District are, at least in part, flow-through lakes with significant contributions and outflows of water from the surficial aquifer. Certainly some of the water that infiltrates in the permeable portions of the Johns Lake drainage basin makes its way to the lake as interflow. The intermediate aquifer and confining system is poorly known and may or may not be significant. It is present at Johns Lake and, like the surficial aquifer, should be discussed. Also, the sources and sinks probably vary in importance with lake stage. There is no discussion of water fluxes related to lake stage or climatic variations.

<sup>1</sup> Sacks, L.A., T.M. Lee, and A.B. Tihansky, 1992. Hydrogeologic Setting and Preliminary Data Analysis for the Hydrologic-Budget Assessment of Lake Barco, an Acidic Seepage Lake in Putnam County, Florida. U.S. Geological Survey, Water-Resources Investigations Report 91-4180, 33 p.

Figure 7 shows the modeled recharge to the Floridan aquifer in the vicinity of Johns Lake. The caption should indicate the source of this map, and the text should discuss the fact that this recharge is an estimate. Is it a calibration variable in the flow model? What has been done to verify the data? The extremely large recharge numbers are in the sandhill uplands. Is all recharge going to the Floridan through the intermediate aquifer and confining system, which is relatively thick under the uplands surrounding Johns Lake? Is there no shallow interflow to the lake and surficial aquifer discharge to the lake and flow out of the lake?

Modeled and measured high stages did not agree. The explanation as to why is weak. I do not see how the discrepancy would cause difficulties with the MFL process. The statement on page 44 that "... the recorded stage data are higher than they should be [emphasis added] (based on the hydrologic model), ..." is problematic. Assumption that the model is right and that the data are wrong should be based on an analysis of the data. Otherwise, the reverse should be the concern.

Evaluation of the 10 water resource criteria is excellent, and the case has, in my opinion, been made that protection of fish passage and habitat is the appropriate criterion for MFL development. I agree that this criterion is limiting for Johns Lake.

Several times in the document there is mention of the 14 foot fluctuation in lake levels between 2001 and 2004. This statement gives the impression that this fluctuation is atypical. The fluctuation is simply a result of juxtaposition of extreme drought and then high rainfall and is an excellent demonstration as to how sensitive sandhill lakes are to climatic events.

I have also reviewed the modeling report by Price Robison. It was this review that created my concern that the SSARR model did not account for all potential water sources and sinks in the water budget and that an explanation as to why these other sources/sinks were not included should be presented. This modeling document and appendices to the MFL report place considerable emphasis on the groundwater flow model (East-Central Florida or ECF model), which includes an active surficial aquifer. Is there a problem using one model that does not include the surficial aquifer and another that apparently does not?

### ***Summary***

As noted above, this edition of the Johns Lake report is generally excellent and a great improvement over the previous versions. My concerns are that the report leaves some questions about the physical limnology of the lake.

It is important to understand that I do not think my concerns about the water budget and omission of interactions with the surficial aquifer affect the MFLs for Johns Lake. It is my opinion that the methods used and values set for the MFLs are appropriate. My primary concern at this date is with implementation of the MFL during permitting.

### ***Review Questions***

The District has requested that the following items be included in the review process.

1. Assess adequacy of environmental data in terms of quality and length of record.

- a. Are there any deficiencies and/or errors regarding data availability?  
None that are evident.
- b. Were appropriate analytical methods and procedures used for data collection?  
Yes
- c. Were reasonable quality assurance assessments performed on the data?  
Yes
- d. Was relevant data available but discarded without appropriate justification?  
None that are evident
- e. Would use of discarded information significantly affect the development of the MFLs?  
I have not identified any discarded data. Discrepancy in modeled and measured high water levels is not discussed well, but has little effect on the MFLs in my opinion
- f. Was “best information available” utilized in developing the MFLs?  
Yes, with respect to water level and ecological data.

2. Assess methods and procedures for data analysis, including, where appropriate, performing appropriate statistical analyses of data to ensure that each is statistically valid and is used appropriately.

- a. Are there any deficiencies and/or errors in analytical methods and procedures?  
Failure to evaluate the roles of the surficial aquifer and intermediate aquifer and confining unit systems in the water budget is problematic. This does not appear to affect the MFLs, only how one implements them.
- b. Were appropriate analytical methods and procedures used for data analysis?  
See above. As for statistical analysis and stage-duration curve analyses, yes.
- c. Were the analytical methods and procedures appropriate given the “best information available”?  
See above. I do have concerns about the way the SSARR model deals with the hydrogeology of the lake. With respect to ecological and hydrological data, yes.
- d. Do the analyses include all necessary factors?  
See above.
- e. Were the analyses correctly applied?  
See above.
- f. Were any limitations and imprecisions in the information handled appropriately?  
See above.
- g. Are the analyses repeatable?  
Yes.

3. Evaluate the validity and appropriateness of all assumptions used in the development of the MFLs analysis and water resource assessments.

a. Are the assumptions reasonable and consistent given the “best information available”?

I have concerns that the groundwater/surfacewater interactions have not been completely dealt with. The bases for the assumptions that the SSARR model, as constructed, adequately addresses these interactions are not presented or discussed. Important literature, specifically the work by the USGS on Lake Barco<sup>1</sup>, should be evaluated in the context of this lake.

b. Is there information available that could have been used to eliminate any of the assumptions? Would the use of this additional information substantially change the development of the MFLs?

See above.

c. Are the assumptions stated clearly?

No. With respect to groundwater/surfacewater interactions, they are not stated.

d. What, if any, assumptions are implied or inherent in the methodologies?

With respect to groundwater/surfacewater interactions, (1) there is no flow-through or interflow to the lake from within the surficial aquifer, (2) the intermediate aquifer and confining unit is either not present or simply a leaky membrane (there is no flow to or from the lake in this system), (3) the interactions of the lake and Floridan aquifer are the sole groundwater/surfacewater interaction.

e. Are other analytical methods or procedures available that would require fewer assumptions but could provide comparable or better results? Are adequate data available to support using these alternative methods or procedures?

There are other models available to evaluate the groundwater/surfacewater interactions.

f. Are there deficiencies and/or errors in the MFLs or water resource assessments or application of findings?

See above.

- If so, describe each deficiency and/or error.

See above.

- If the identified deficiencies can be remedied, then enumerate and describe each necessary remedy, including the precision, accuracy, and an estimate of time and effort required to develop and implement each remedy.

I would hope that these deficiencies can be dealt with through a good discussion of the hydrogeology of the lake and reasons that the assumptions were made. If this cannot be done, there will be a need to remodel the hydrology of the lake.

- If the identified deficiencies cannot be remedied, then identify one or more alternative methodologies that are scientifically defensible given the available data. If the reviewer identifies an alternative methodology, the reviewer shall also describe the precision, accuracy, and estimate the time

and effort required to develop and implement that methodology. If the identified deficiencies cannot be remedied without additional data, then identify what additional data is needed and provide recommendations for capturing such data.

Integrated groundwater/surfacewater models are available. I would, however, investigate using the ECF model for boundary condition estimation, creating a sub-regional model for the lake with the intermediate aquifer/confining unit as an active layer, and evaluating the surficial and intermediate groundwater fluxes. These results can then be blended with the SSARR model data.

- g. Identify all sources of uncertainty and assess their impact on developing MFLs that will prevent significant harm to water resources or ecology of the area.

See above. I do not think the hydrogeologic issues affect the ecologically based MFL regime. They do create uncertainty in the evaluation of lake level responses to water use.

4. Determine if the data, analyses, and interpretation of results support the recommended MFLs.

See above. I am comfortable with the MFL lake level regime. The hydrological data analyses can be defended. As far as I am concerned, the ecological bases for the MFLs are sound.