

Response to the USACOE Memorandum for Record on the subject of the Savannah River hydrodynamic model and application to the Savannah Harbor Expansion Project

A Memorandum For Record (MFR) was issued from the COE offices on May 23, 2001 concerning the Savannah River hydrodynamic model and its application, by Douglas H. Plachy, Senior project Manager, Navigation & Coastal Projects Team, Civil Works Branch, PPMD. The memorandum was issued as the result of a meeting held with representatives of various Federal Agencies involved in the Savannah River Harbor Project. A number of topics were apparently discussed at the meeting and issues were raised that the issuer of the memo may have taken out of context.

In general, all of the substantive issues raised in the MFR have been or are being addressed in the public forum of the Savannah River hydrodynamic model calibration Modeling Technical Review Group (MTRG), which meets on an approximately bi-monthly basis. It is difficult to appreciate the value of holding a 'closed door' meeting to attempt to try to resolve technical issues that are already in the public forum and are being coordinated in a very open manner.

The issues raised in the MFR are numbered or lettered and comments on the specifics of the issues will refer the original enumeration.

1. *At the request of the EPA, a multi-agency meeting of the Federal Agencies associated with the SHE project was held on Tuesday, 22 May 2000 at the Offices of the U.S. Fish & Wildlife Service to discuss concerns that have surfaced in regard to the subject model. In attendance were...*

Comment: As stated in the introductory paragraph above.

2. *It was understood that the initial goal of the subject model was to provide a method for predicting numerical values for physical parameters that may change as a result of alterations to the Savannah River. However, there is now great concern regarding the technical adequacy of the model and whether it will have the ability to accurately predict changes in the ecosystem, i.e., water levels, dissolved oxygen (DO), salinity, etc. Several examples were given, such as:*

Comment: Before we address the specific examples, a general statement regarding the adequacy of the model for predictive purposes must be made. The WQMAP model system as developed and as it stands at this point, is based on fundamental conservation equations of physics. When driven by realistic boundary conditions the model produces realistic predictions of the flow and salinity in the estuary based on the physical features of the estuary.

The model is not an empirical model dependent on a fit to data, it relies on fundamental physical relationships to make predictions and therefore is a real, predictive tool. If changes are made to the physical features of the system (e.g. a harbor deepening) the model will predict realistic changes in the hydrodynamic response.

Each of the specific examples (a-f) discussed in the MFR will be addressed below:

a. *The water levels have been off (and still are) by as much as 1 meter. It was stated that the tolerance should be no greater than +/- 3 inches. This is in light of the fact that changes of water level of only ½ inch can cause major impacts to the species of vegetation growing in the marsh.*

Comment: At no place or time is the water level off by anywhere near 1 meter. Referring to Table 7.2 in the Draft Hydrodynamic Model Calibration Report, it can be seen that the maximum difference in the mean is 0.61m at GPA-17 station, well upstream, outside of the study domain. Inside the study domain the maximum discrepancy is 0.19m, at Lucknow Canal but is well outside the norm of a 0.04m (< +/- 3in) discrepancy. For the 3m tides in the area the discrepancies mentioned amount to a 6.5% and 1.5% of the signal, respectively.

It should be noted that the differences are calculated between the model and observations at every data time step and that differences in timing will generate discrepancies. At the time of the Draft Report there was a phase shift in the model predicted water surface elevations (WSE) that is the genesis of the majority of the differences, not the difference in actual elevation.

Finally, the issue of the WSE predictions was discussed at the April 2001 MTRG meeting and was placed on the model improvement priorities list at that meeting, which is reflected in the MTRG Status Report, sent to all MTRG participants. The ATM modeling team has since addressed this issue and improvements have been made both in phase and amplitude in the study area and in the upstream areas.

b. *The model does fine at and/or near the boundary condition, but gets worse the farther you go upriver away from the boundary. A potential problem may be that the model is build upon an estuary model rather than a riverine model.*

Comment: This issue is related to the previous statement and has been addressed as stated in the comment for 2a above.

c. *A sensitivity analysis has not been done. This is a key aspect to model development.*

Comment: While a description of the sensitivity study was not contained in the Draft Final Report, the modeling team has performed a great number of sensitivity analyses during the calibration process. A description of several of the key sensitivity studies and results will be included in the Final Report.

d. *The convergence test specifically requested by the Corps has not been done to validate the grid resolution. It was noted that ATM had in the past discussed reducing the grid resolution without knowing the convergence.*

Comment: The above statement appears to be in error. The convergence test requested by the Corps, as described in the SEGDO2 Task statement, was included in the Draft Final Report. The MTRG discussion of reducing the grid resolution was prompted by a recommendation from Jim Greenfield in an attempt to reduce the final run time of the ultimate water quality model. After some

testing of various grids by the ATM modeling team, the attempt to coarsen the grid was dropped and reported to the SEG.

e. *The model has been inconsistent, i.e., sometimes it under predicts and sometimes it over predicts. Therefore, as it currently exists, it is unreliable as a tool to assess impacts of "what if" conditions.*

Comment: This statement is difficult to interpret. It is unclear to what the author is referring. It should be noted here, as stated above, that the model is a predictive tool, not a curve fit. No model predictions can match the observations of this intricacy perfectly. Therefore, the nature of modeling suggests that if the model predictions match the observations well, particularly the mean conditions, there will be certain areas of over and under prediction. An understanding of the relationship between the predictions and the observations (e.g. from a statistical analysis such as that performed for this project) allows assessment of the model predictions of present conditions as well as for "what if" scenarios.

f. *To be an adequate tool for assessing impacts, the peaks and ravines are just as important as the mean. Currently, the model has only marginally met the mean and has substantially missed the peaks and ravines. Are the problems due to limitations of the model itself (i.e., WQMAP), application of the model set up and calibration, or skill of the modelers?*

Comment: The issue of what constitutes an acceptable level of predictive capability of the model has been the focus of discussions a number of times in the MTRG. The predictive nature of the model and its capabilities as a tool for the assessment of impacts has been discussed above. The model predictions for the Savannah River application should be assessed in a qualitative and a quantitative manner, both of which reveal certain aspects of the model predictions.

It becomes clear from a qualitative review of the model to observation, salinity comparison plots, (time series, concentration contours and salinity gradient contours) that the model is capable of predicting all of the substantive trends and magnitudes exhibited by the observations. The large variation in salinity along the river, from 35ppt at the open boundary to 0ppt at I-95, is clearly represented, as is the large vertical variation, at times upwards of 10ppt. In addition, the model is capable of predicting not only the unusual occurrence of an extreme neap tide salinity intrusion event, but the large range of variation in the salinity seen over the summer period.

Finally, the observation that the model statistics for the 90th percentile salinity were not good has been discussed at the MTRG. It has been recognized that this is a concern for certain members of the MTRG and was stated as an issue to be addressed, by the ATM modeling team, at the April, 2001 MTRG meeting and noted in the Status Report. It should be noted, however, that until recently, the 50th percentile has been understood to be the intended goal of model predictive performance. To date, no clear, technical argument or precedent has been presented to indicate that the 90th percentile is preferable over the 50th percentile for determination of salinity impacts.

3. *There was extensive discussion in regard to GPA's unwillingness to provide the Federal Agencies direct access to the model. Although there had been a meeting in Atlanta prior to the last MTRG meeting to discuss the access issue, it is clear that the parties left that meeting with different understandings of the decisions and commitments made. The agencies need access to the model ASAP in order to assess & determine what may be causing the model not to perform as expected. The undersigned relayed the conversations he had with GPA shortly after the last MTRG meeting wherein it was stated by ATM that the model would be provided to EPA, etc., post calibration, i.e., not anytime soon. GPA's understanding is that EPA wants access to the model for DO and TMDL work unrelated to the SHE project. It was not understood that it was not possible for the agencies to accept the model (as it currently exists).*

Comment: As far as ATM and ASA are concerned, there has not ever been a task statement or any written agreement that requires the delivery of the model system to the EPA, or any other agency for any purpose. The request by the EPA, for the model system was first made during the planning for the Savannah Harbor Ecosystem Restoration Project (D.O. Study). It was agreed that the water quality model would be made accessible to the EPA at the completion of the calibration process (hydrodynamics and water quality) for evaluation for its potential use in a Lower Savannah River TMDL at some point in the future. This coordination was to take place under the Ecosystem Restoration Project.

Recently, the EPA request for the model system changed to a suggested delivery of the model system for review after the hydrodynamic calibration. In the spirit of cooperation, ATM and ASA agreed (at the April 24, 2001 meeting with the COE and EPA prior to the last MTRG meeting) to coordinate with GPA and the COE to deliver a working version of the model system and application to the Savannah River, to the EPA for review and assessment, after completing the MTRG recommended improvements to the calibration presented in the Draft Model Calibration Report.

In the MFR, however, the EPA has stated that the hydrodynamic model calibration cannot be accepted without the prior delivery of the system to the EPA for hands on review. The current MTRG review process does not include EPA's hands-on review of the model. Delivery of a model system to a reviewing organization for assessment of a calibration, while not unprecedented, is still rare. Delivery of a model system under development is less common still and presents a number of difficulties and potential pitfalls.

It is not the intention of the GPA, COE or SEG to require that the EPA sign off on the model calibration before they have had a chance to review the model system and application, in house, on a full working copy. It has been explained to all MTRG members that their participation will not bind their Agencies to any model approval. It is suggested however, that the ATM modeling team be allowed to continue to address the issues mentioned in the MFR, which had already been discussed in the April MTRG meeting, as stated in the Status Report.

4. *It was clear from the discussions that the Federal Agencies are not attempting to impede the development of the model, but wish to help to ensure that the model is as*

accurate and complete as possible. It was understood that without a good model, it would be very hard to grasp the potential impacts of any changes to the navigation channel. In this regard there was frustration on the part of the Federal Agencies over the following issues:

a. Requests for the 1999 data set, i.e., the electronic version of the processed data have gone unanswered. It was noted at the meeting by the undersigned that GPA might not have been aware that the agencies have requested the data set.

Comment: It is very common for consultants and researchers to keep electronic data files until a project has been completed or a technical paper has been published. ATM had already agreed to provide the electronic data files in a public database in the future after completing critical portions of the GPA project. ATM had reported to the GPA team previously that the Agencies, especially EPA, had requested the data files. ATM has recently agreed to provide EPA and the COE with access to the data files along with the model.

b. ATM has been selective in regard to what they choose to show the Federal Agencies at the MTRG meetings.

Comment: It is the opinion of the ATM modeling team that just the opposite is true. The ATM modeling team has gone out of their way to answer requests by the MTRG for data presentation and analyses and new representation forms, some of which entailed many weeks worth of additional effort. By way of example, the following is a brief list of additional analyses and plots requested by the MTRG that the ATM modeling team provided:

- Concentration contour plots
- Gradient analyses and contour plots
- Percentile analysis
- Salt dose analysis
- Statistics for various flow regimes (spring/neap cycles)

c. Dialogue and Feedback to the MTRG has changed (in a negative way) since the departure of the original ATM modelers.

Comment: Informal discussion with MTRG members other than with those present at the Agency meeting described in the MFR suggests that this is not by any means a consensus opinion. It should also be understood that even though some of the original ATM modeling team have left, the principal modelers, Dan Mendelsohn and Eduardo Yassuda, have continued to coordinate directly with the MTRG. If anything, the presentations have become more technically oriented and focused to address MTRG-specific concerns and requests.

d. There is the perception of "obstructionist behavior" on the part of GPA's contractors.

Comment: ATM and ASA have worked very hard to be responsive to any request made in the MTRG by any representative. We have communicated very openly and attempted to explain the project framework and coordination processes being followed. There has been a concerted effort by ATM to avoid any perception of control or bias in the coordination with the MTRG and in reporting

to the SEG. This effort must appear to be obstructing some other objective. What is it?

5. *Several courses of action were discussed ranging from starting all over with the development of a new model to completely giving up on attempting to model the Savannah River. However, it was eventually decided that the Federal Agencies would put together some very precise and explicit criteria a.k.a. goalposts, which clearly defines what specifically the model must provide in order to be used to assess potential impacts. (It was noted that this information should have been provided/requested very early on in the development process.) This set of requirements would be staffed by the Federal Agencies and then provided to the MTRG for discussion at the next scheduled meeting.*

Comment: The criteria cited in the paragraph above have been a topic of many MTRG meetings and have been documented as part of the discussions as of the October, 2000 Status Report. It has been the practice and has always been the intent of the modeling team to involve the MTRG in the definition and development of specific criteria for acceptance of the model as calibrated. To date, the ATM modeling team has been using the criteria, first presented to the Technical Advisory Group (as the Agency modeling review group was called at that point) in Jan. 1998, as described in the EPA document, 'Technical Guidance Manual for Performing Waste Load Allocations. Book III: Estuaries. Part 2: Application of Estuarine Waste Load Allocation Models', Project Officer, H. Biswas, Eds. J.L. Martin, R.B. Ambrose and S.C. McCutcheon. USEPA, Washington, DC.

It should be noted that very little in the way of a consensus exists in the literature regarding what constitutes a calibrated model. During consideration in the MTRG, several points were noted:

- No clear and universal rules exist for model performance acceptability
- Performance acceptability is different for different situations
- Performance evaluation should take application objective into account
- Model performance should be evaluated along two lines; qualitative (trends, processes) and quantitative (direct model-data comparison, statistics).

A number of specific steps were taken as a result of the criteria discussions. For example, it was suggested that a review of the literature for criteria used by other investigators be performed and a comparison of the Savannah River application to other similar model applications be made. This comparison showed that the Savannah River hydrodynamic model application was as good or better than comparable applications. It was also suggested that the ATM modeling team focus on 3 specific locations selected by the MTRG and to focus on specific time periods when there is a good consistent data set, (forcing data as well as in-situ observations).

6. *In addition to the above, it was also agreed that the Federal Agencies would renew their requests to obtain from GPA:*

a. *An electronic data set of the processed 1999 data collection. Since State funds were used to obtain this data set, it is felt that there should not be a problem with it being placed in the public domain.*

b. *Direct access to the model in order to attempt to determine why the model has not performed as expected. This will be necessary before any of the agencies would consider signing off on the calibration. It was stated by the undersigned at the meeting that GPA requested in April that ATM determine how to go about providing direct access of the model to the Federal Agencies.*

Comment: These statements have been addressed above. What does this mean to the MTRG review process?

7. *The information stated above is that of the undersigned's comprehension, and may not be the consensus of all of the Federal Agencies*