



REPLY TO
ATTENTION OF

DEPARTMENT OF THE ARMY
SAVANNAH DISTRICT CORPS OF ENGINEERS
P.O. BOX 889
SAVANNAH, GEORGIA 31402-0889

September 5, 2003

Navigation & Coastal Projects

Subject: Calibration of a Water Quality Model for the Savannah Harbor, Dissolved Oxygen Water Quality Model, Savannah Harbor Expansion Project, Georgia and South Carolina

L.T. Keegan
Project Manager
Lockwood Greene Engineers
400 Mall Boulevard
Savannah, Georgia 31406

Dear Mr. Keegan:

I am transmitting via this letter remarks received from the Savannah Multi-Agency Review Team (SMART) on the listing of actions that were gleaned from discussions at the Water Quality Joint Agency Meeting held on August 20, 2003 (Enclosure A). We appreciate the prompt receipt of this listing as it was provided on Tuesday, August 26, 2003, from Mr. Jack "Bo" Ellis, Environmental Manager, Applied Technology and Management (ATM). (Enclosure C).

I appreciate the clarifications for the record that you made via e-mail, on August 27, 2003, in regard to the listing of actions (Enclosure B). As you clearly state in your message that "...there was nothing discussed at the meeting [on August 20, 2003] that constituted a change in scope or should be considered as additional information. The feedback at the meeting was offered as indicative of the things that are expected to be part of a water quality model calibration and should be in the documentation." It is in that light we provide these comments to the listing for your use in completing the hydrodynamic, salinity transport, and dissolved oxygen model(s), i.e., they are offered as indicative of typical things that are expected and are not and should not be taken to be all-encompassing.

I have also enclosed a copy of the minutes of the Dissolved Oxygen Joint Agency Meeting to this letter, as there may be some items mentioned that may not have been covered by either the listing in Enclosure C or our remarks in Enclosure A (Enclosure D). I must note that these are comments to illustrate the technical deficiencies and should not be taken as a list of items that if corrected would make the reports and models technically acceptable; that is the professional responsibility of the authors and developers of the report and model.

My assessment of the modeling status is that there is still a significant amount of work yet to be done to calibrate the model(s) and then provide the technical information to document the results of the calibration process and the utility of the models. I must emphasize that Federal

Agencies are looking for calibration reports that presents the defensibility of the model in all aspects (application, calibration, and prediction) for evaluation of the deepening impacts. The defensibility of the model should not be left to the reader's interpretation but is the professional responsibility of the authors to demonstrate why the models are technically valid, sufficiently accurate, and usable for its intended application. Dr. Sung-Chan Kim sums this up best in his comments that "[t]he scientific merit has to be shown" and that "...[technical problems have] to be fixed instead of being explained." I therefore remain concerned about whether or not the WQMAP models will sufficiently assist the Corps of Engineers and our partners at the agencies in assessing potential project impacts.

A date of Monday, October 20, 2003, has been committed to by your contractor for sending the final calibration reports for the hydrodynamic, salinity transport, and dissolved oxygen models. I cannot emphasize enough that the Federal Agencies do not want unfinished or incomplete deliverables. If a schedule cannot be met, then it is the responsibility of members of the Project Delivery Team (PDT) to tell you and I, so that we can effectively manage the project as well as the expectations of those agencies which we need to work with throughout the project.

Your attention to this matter is greatly appreciated, as it is key to the overall completion of the Tier II Environmental Impact Statement and General Reevaluation Report.

A copy of this correspondence will be provided to the other members of the SMART for their information as well as the agencies involved with the Joint Agency Water Quality Coordination.

If there are any questions or concerns regarding this correspondence, please feel free to contact me at (912) 652-6119 or via e-mail at douglas.h.plachy@sas02.usace.army.mil.

Sincerely,

Douglas H. Plachy
Senior Project Manager
Navigation & Coastal Projects

Plachy, Douglas H SAS

From: Kim, Sung-Chan ERDC-EL-MS
Sent: Thursday, August 28, 2003 2:28 PM
To: Plachy, Douglas H SAS; 'Paul Conrads (E-mail)'; 'Jim Greenfield (E-mail)'
Subject: RE: Info Requests for Model Calibration Report

If ATM can provide all the information listed, that will be great. But, I have to emphasize a few things:

(1) Bottom line is that the hydrodynamic and water quality models should agree in transport. I don't think it is acceptable to have discussion on differences (shown in list 20 of additional write ups and analyses).

(2) There is no need to compare QUICKEST with Upwind schemes for the advection. If the model is dispersive because of the Upwind scheme, it has to be fixed instead of being explained (item 13).

(3) Again, the vertical mixing scheme has to be justified (item 9). As pointed out before, it may not be sufficient just stating the empirical formula "works". The scientific merit has to be shown.

Plachy, Douglas H SAS

From: Paul A Conrads [pconrads@usgs.gov]
Sent: Tuesday, September 02, 2003 10:02 AM
To: Plachy, Douglas H SAS
Cc: 'Jim Greenfield (E-mail)'; Kim, Sung-Chan ERDC-EL-MS; Bailey, William G SAS
Subject: RE: Info Requests for Model Calibration Report

Doug,

I agree with Sung-Chan's points in his email last week. The only slight difference I have is that there may not be enough time or manpower to solve aspects of the model that "must be fixed", ie. the transport predictions between the models. In that case, the report will have to explain, defend and justify the utility of the model beyond "the error is acceptable."

It probably needs to be emphasized that Federal Agencies are looking for a report that presents the defensibility of the model in all aspects (application, calibration, and prediction) for evaluation of the deepening impacts. The defensibility of the model should not be left to the readers interpretation but is the responsibility of the authors to clearly and honestly present.

Their list of items to be included appears to be fairly comprehensive if the items in our written comments are also included. Just a few comments:

Model Comparison Methods:

- Item 1. Make sure time-series is shown along with comparison with percentiles.
- Item 3. Include DO saturation
- Item 7. Make sure comparison is for various stations under various conditions.
- Item 10. Re-iterate statistics should be performed for 1997 and 1999 for the identified 14-day tidal periods.

Sensitivity Tests:

- Include sensitivity to the empirical vertical mixing routine.

Model Tests:

- Demonstrate the two-rate BOD decay routines are functioning properly in the model.

Addition Report Write Ups and Analyses:

- Item 2: Re-iterate that 1997 conditions also need to be included.
- Item 12: Include longitudinal plots showing DO deficit budget.
- Item 13. Agree with Sung-Chan. If 1st Order Upwind works, use it and report it. Include change in advection

scheme in discussion of changes to the model (Items 3 and 4).

Item 20. If the transport is not resolved, thorough analysis of the error introduced into the DO model needs to be presented.

Give me a call/email if you have any questions or comments.

Take care,

Paul
Paul Conrads
USGS
Stephenson Center Suite 129
720 Gracern Road
Columbia, SC 29210-7651

email: pconrads@usgs.gov
phone: (803) 750-6140
fax: (803) 750-6181

"Kim, Sung-Chan ERDC-EL-MS" <Sung-Chan.Kim@erdc.usace.army.mil>

08/28/2003 02:27 PM

To: "Plachy, Douglas H SAS" <Douglas.H.Plachy@sas02.usace.army.mil>, "Paul Conrads (E-mail)" <pconrads@usgs.gov>, "Jim Greenfield (E-mail)" <Greenfield.Jim@epamail.epa.gov>
cc:
Subject: RE: Info Requests for Model Calibration Report

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(3) Again, the vertical mixing scheme has to be justified (item 9). As pointed out before, it may not be sufficient just stating the empirical formula "works". The scientific merit has to be shown.

Plachy, Douglas H SAS

From: Jim Greenfield [jjimgepa@mindspring.com]
Sent: Wednesday, September 03, 2003 7:23 AM
To: Douglas.H.Plachy@sas02.usace.army.mil; pconrads@usgs.gov; Kim, Sung-Chan; William.G.Bailey@sas02.usace.army.mil
Cc: Greenfield.Jim@epamail.epa.gov
Subject: Sav Harbor Calibration Report Update

No other specific comments than those that Paul and Dr. Kim have made. Except the issue if nutrients and Algea are important – I thought they were going to run the model with and with out algal components turned on.

From a practical side, the Hydro and WQ report must verbally document and discuss the results of the comparison and sensitivity runs -and interprate what they mean, what is and is not important and why. If the model is not matching the data within the acceptable range, then why not. Are the selected kinetics appropriate and how sensitive to the model results are the selected rates.

These are normal outputs for a calibration report

Jim

Plachy, Douglas H SAS

From: Bailey, William G SAS
Sent: Wednesday, September 03, 2003 12:45 PM
To: Plachy, Douglas H SAS
Subject: FW: Info Requests for Model Calibration Report

I reviewed the file Bo sent and have the comments listed below. Please add these to the ones from the other Federal agencies.

Model Comparison Methods

1. Items #3 & 6 state that statistics will be presented "at other stations where appropriate". The Expectations Document stated that "Based on the resources of concern, the model calibration should focus on the following stations:

- . Elevation and Salinity: GPA 5, 6, 7, 8, 9,10, 11R, 12R, 15, 22 and USGS Stations 02198840 (I-95), 02198920 (Houlihan Bridge), 02198979 (Limehouse), and 021989791 (USFW Dock).
- . Temperature: GPA 2, 4, 6, 8, 9,10, 11R, 14, 21, and 22.
- . Dissolved oxygen: GPA 2, 4, 6, 8, 9,10, 11R, 14, 21, and 22."

In light of this, the report should present model-to-data comparison statistics at the locations listed above or explain why such comparisons cannot be made.

2. Although Bo's document doesn't request such information, the Expectations Document says that the same statistics as listed in #3 and 6 should also be presented in the Hydro Model Calibration Report for Elevation, Salinity, Temperature, Surface Currents, and Volume Flows.
3. The Expectations Document says that the "Timing of Maxima" for (elevation, salinity, surface currents, volume flows) D.O. and D.O. Deficit should also be compared between the model and the data.

Sensitivity Tests

1. The Expectations Document says that sensitivity analyses should be conducted on the offshore salinity concentration.

BB

-----Original Message-----

From: Jack Ellis [mailto:Jellis@appliedtm.com]
Sent: Tuesday, August 26, 2003 2:58 PM
To: William.G.Bailey@sas02.usace.army.mil

Letter to L.T. Keegan - 5 Sep 03

Cc: Danny Mendelsohn; Steve Peene; lkeegan@lg.com;
Douglas.H.Plachy@sas02.usace.army.mil
Subject: Info Requests for Model Calibration Report

Bill,

As requested, ATM has provided a list of the information to be included in the Final WQ Model Calibration Report. This list includes information from the Draft Report, as well as the additional information requested at the 8-20-03 Meeting.

We understand that you will be sending this list to the rest of the Inter-Agency Working Group for their review and comments. Please let us know ASAP if there are any comments or additional needs.

Thanks!

Bo

Plachy, Douglas H SAS

From: Keegan, Larry (LGE-SV) [lkeegan@lg.com]
Sent: Wednesday, August 27, 2003 3:40 PM
To: Jack Ellis
Cc: Danny Mendelsohn; Steve Peene; Douglas.H.Plachy@sas02.usace.army.mil; William.G.Bailey@sas02.usace.army.mil
Subject: RE: Info Requests for Model Calibration Report

In the interest of correcting the record, there was nothing discussed at the meeting that constituted a change in scope or should be considered as additional information. The feedback at the meeting was offered as indicative of the things that are expected to be part of a water quality model calibration and should be in the documentation.

(Note the wording - "indicative of" - no one should construe the discussion topics as comprising a complete list of things to be fixed.)

Also, the first paragraph of the attachment refers to: "...meeting for changes to the Water Quality Model report..." The meeting was to provide feedback on the submitted calibration report, there was no change in content or scope discussed.

If you recall, at the end of the meeting, all agreed that there was nothing discussed that was a change in scope. The federal agencies are very sensitive to change to a contracted scope of work when they do not administer the contract. They work hard to avoid doing that. We should respect that and ensure our documentation is precise in its phraseology.

L.T. Keegan
Lockwood Greene Engineers, Inc.
400 Mall Blvd, Suite E
PO Box 13983
Savannah, GA 31406
(T)912/352-3000

-----Original Message-----

From: Jack Ellis [mailto:Jellis@appliedtm.com]
Sent: Tuesday, August 26, 2003 2:58 PM
To: William.G.Bailey@sas02.usace.army.mil
Cc: Danny Mendelsohn; Steve Peene; Keegan, Larry (LGE-SV); Douglas.H.Plachy@sas02.usace.army.mil
Subject: Info Requests for Model Calibration Report

Bill,
As requested, ATM has provided a list of the information to be included in the Final WQ Model Calibration Report. This list includes information from the

Letter to L.T. Keegan - 5 Sep 03

Draft Report, as well as the additional information requested at the 8-20-03 Meeting.

We understand that you will be sending this list to the rest of the Inter-Agency Working Group for their review and comments. Please let us know ASAP if there are any comments or additional needs.

Thanks!

Bo

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Savannah Harbor Expansion Project **Information Requested for the** **Water Quality Model Calibration Report**

The following outlines the requests made at the August 20, 2003 meeting for changes to the Water Quality Model report. This report will be Volume 2 with the hydrodynamic model calibration report to be Volume 1. Appendices for both reports will be included as a separate set of volumes. Items in italics below are items that were included in the report submitted on August 1, 2003. They are listed here to provide a complete list of what will be included in the final report. Where comments related to missing or mis-numbered figures, these will be fixed.

Model Comparison Methods:

The following lists the types of model to data comparison methods to be utilized in the final report.

- 1) *Comparison of simulated 10th, 50th, 90th percentiles for CBOD_u, Ammonia, Nitrate/Nitrite, Organic Nitrogen, against actual measured data longitudinally for surface and bottom in the Front River, and Middle River and Little Back River at mid-depth.*
- 2) *Comparison of simulated and measured 10th, 50th and 90th percentiles for surface and bottom DO along the Front River channel and bottom or surface data at other stations outside of the channel. Presented both graphically and in tabular form.*
- 3) *Mean Error, Absolute Mean Error, Root Mean Square Error, and Relative Mean Error for dissolved oxygen at surface and bottom along the Front River Channel and at the surface or bottom at other stations where appropriate. Presented both graphically and in tabular form.*
- 4) *Time series comparisons of the measured versus simulated dissolved oxygen, CBOD_u, Organic Nitrogen, Ammonia, and Nitrate/Nitrite at all stations and all levels where measured data were available.*
- 5) Comparison of simulated and measured 10th, 50th and 90th percentiles for surface and bottom DO deficit along the Front River channel and bottom or surface data at other stations outside of the channel. Presented both graphically and in tabular form.
- 6) Mean Error, Absolute Mean Error, Root Mean Square Error, and Relative Mean Error for DO deficit at surface and bottom along the Front River Channel and at the surface or bottom at other stations where appropriate. Presented both graphically and in tabular form.
- 7) Develop a vertical profile DO comparison to observations from intensive surveys
- 8) Include saturation analysis and plots in the DO model calibration report
- 9) Show the 5-day CBOD data on all of the CBOD comparison plots
- 10) Generate comparison statistics for the various tidal regimes compared in the hydro and salinity model analysis

- 11) Show comparisons with snapshots of GAEPD stations collected in 1999 or other snapshots from vertical profiling.

Sensitivity Tests:

The following is a list of the sensitivity tests to be performed and reported in the model report.

- 1) *SOD*
- 2) *BOD Decay*
- 3) *Marsh Loadings*
- 4) Point Sources
- 5) Nitrification Rate
- 6) Vertical Mixing
- 7) Reaeration
- 8) Upstream flow boundary (i.e. distribution of 10% of flow below Clyo)
- 9) Sensitivity to upstream loadings and downstream loadings
- 10) Perform an f-ratio sensitivity test run
- 11) Sensitivity of 2-decay rate simulation
- 12) Compare hydrodynamics and salinity model predictions with and without the momentum advection terms active

Model Tests:

The following lists the model tests to be performed and reported in the final report.

- 1) *WASP versus BFHYDRO transport comparison test.*
- 2) Mass balance test

Additional Report Write Ups and Analyses:

The following lists additional details or additional write ups to be included in the final report. These reflect items that were not included in the August 1, 2003 report or, based upon comments at the August 20, 2003 meeting were not described in sufficient detail:

- 1) Add a comparison section to the WQ modeling in the Tier I EIS, in the Final Report.
- 2) Add more detail to the environmental input data description.
- 3) Document any changes from the original Muin and Spaulding hydro model to the model being utilized for this application.
- 4) Document any changes from the original WASP 5 model.
- 5) Better documentation of the decision making in the MTRG for pertinent aspects of the Savannah application.
- 6) Description of modeling and calibration philosophy.
- 7) Better description of approach and goals.

- 8) Better description of how EPD-RIV 1 output was used for the upstream boundary conditions.
- 9) Provide a more detailed justification for the vertical mixing scheme used (this will also be explained in detail within the Hydrodynamic Model Report).
- 10) Check salinity at GPA-08 and GPA-09 for consistency with observations – it may have affected the saturation calculations
- 11) Evaluate the dynamic DO boundary condition upon receipt, and incorporate into the DO calibration if adequate and there is sufficient time
- 12) Run a component analysis on the various input loads to the DO model isolate the following impacts, i.e. develop unit response for each.
 - a. Marshes
 - b. Point Source Loads
 - c. Upstream Boundary
 - d. SOD
- 13) Test the QUICKEST advection scheme versus the First-Order Upwind Scheme
- 14) Incorporate Primary Productivity into the simulations to show that it is not a significant issue in the system.
- 15) Include the 1997 verification run comparison
- 16) Include all referenced materials in appendices to completed report volumes. Make this a stand alone document.
- 17) Look at salinities for the downstream CBOD measurements to see if they reflect true offshore conditions.
- 18) Make sure all references listed are either included in the appendix or available through standard literature search.
- 19) Present a detailed discussion of the hydrology and meteorology under which the calibration and verification are being done and how this relates to the full range of conditions that occur within the river.
- 20) Discussion of how the differences in the WQ transport versus the Hydro transport (if significant) will affect the overall calibration.

CESAS-PD-E

3 September 2003

MEMORANDUM FOR RECORD

SUBJECT: Savannah Harbor Expansion Project;
Summary of 20 August Joint Meeting on Review of Draft D.O. Model
Calibration Report

1. Attendees:
ATM: Daniel Mendelsohn, Steve Peene & Bo Ellis
Hydroqual: Tom Gallagher
LGE: Larry Keegan
GPA: Hope Moorer
City of Sav'h: Bob Scanlon & Larry Neal
GA DNR-EPD: Roy Burke & Paul Lamarre
SC DHEC: Wade Cantrell & Larry Turner
EPA: Jim Greenfield
USGS: Paul Conrads
CE-ERDC: Sung-Chan Kim
CESAS: Doug Plachy & Bill Bailey
2. The Agenda is attached.
3. The following is a summary of the discussion and does not include all the information that was presented or all comments made during the discussion.
4. The City provided its comments first. Larry Neal spoke for the City. He led off by stating that the City's main goal is for the model to be an accurate and defensible representation of the point source dischargers' effects on the D.O. Deficit in the harbor. He then provided the following specific comments:
 - Model appears to be sensitive to CBOD decay rates.
 - Would like to see sensitivity of CBOD loading at Clyo and the ocean boundary.
 - ATM should look at the salinity levels in the samples collected at Fort Pulaski.
 - It appears that the model has too much BOD at the upper end (boundary) and too little at the lower end (boundary).
 - GADNR-EPD stated that there are possible additional sources of BOD loads from the saltmarshes in the lower portion of the estuary. In SC, from marshes around Wright River and New River. In GA, from marshes around Wilmington River and South Channel. This is possible justification for adding more BOD in the lower end of the model.

- Concerned about ATM using a single CBOD decay rate for each point source discharge, marshes, etc.
 - GADNR-EPD stated that the following actions could be pursued to obtain an acceptable calibration: (1) adjust the long term decay rates from the few values that were measured, and (2) use spatially variable rates.
- Would like to see a test of the sensitivity of the f-ratio of point sources and marshes.
 - Hydroqual suggested using a unit-response approach to identify the effect of changes in f-ratios.

5. GADNR-EPD provided its comments next. Roy started by questioning the purpose of this review. I stated that this review of the Draft Report was an opportunity to suggest revisions, while the review of the Final Report will be for determining whether the model is Acceptable or Not Acceptable for its proposed use. We would have a Comment/Response round on the Final Report before seeking the agency's position on the model.

Roy said that the time series for D.O. indicate that the model currently doesn't capture the range of highs and lows in the data. He stated that the diurnal highs and lows indicate to him that the D.O. processes are tidally-driven rather than being driven by photosynthesis. It appears that there are equal errors of D.O. on the surface and bottom, indicating to him that there is not a vertical mixing problem. The differences in D.O. between the surface and the bottom appear to be more of a longitudinal effect. He called this area of D.O. sag in the harbor another example of a "coastal big dipper", an effect that can be observed in other larger coastal rivers.

EPA requested that ATM show a comparison of model and data with the 24-hour and 36-hour synoptic sampling that was performed of both salinity and D.O..

6. SCDHEC had no comments at this time.

7. I followed with the comments from CESAS.

- Talked through the written comments that we already provided to ATM.
- Requested that the smaller data reports (such as EPA's SOD Report) referenced in the Calibration Report be included on the CD containing the Calibration Report.
- ATM will at a minimum conduct a sensitivity analysis of the effects of using a dynamic offshore boundary. They will review the results of USGS's ANN work on the offshore boundary if it becomes available in time. ATM will review the USGS ANN work and determine how it could be included in the D.O. Model calibration. They will inform the Corps of their position. The possible extent to which ATM could include that ANN information will be greatly influenced by when the USGS completes that work.

8. The USGS was next. Paul gave the following specific comments in addition to the written ones already provided to ATM:

- The report needed to better describe how and why the modelers made decisions during the model development process.
- ATM should explain their modeling philosophy (trying to match at GPA17 and Fort Pulaski; adjusted values at the boundaries to match data at those locations, etc.).
- Should show the sensitivity of reaeration rates.

9. The CE-ERDC was next. Dr. Kim gave the following specific comments in addition to the written ones already provided to ATM:

- The report should describe the range of flows covered by the calibration and verification data.
 - Hydroqual recommended that the report show the range of all important environmental conditions (tidal range, etc.)
- The vertical mixing issue is critical to resolve before ERDC could recommend use of the model for evaluation of harbor deepening scenarios.

10. EPA was last. In addition to the written comments already provided to ATM, Jim expressed a few general comments. One was that the report needed to include more to make the model defensible. Any changes to the model code should be described, explained and justified. Was the advection term turned off or not? If so, why is that not important to the model? EPA would like faster run times for these models. He questioned whether the coarser grid – with 4-8X faster run time – could be used to conduct some screening of alternatives.

11. We then discussed vertical mixing. The agencies stated that a better explanation was needed of (1) what was done, (2) why those choices were made, and (3) why the procedure is acceptable for application on a proposed harbor deepening project.

12. We discussed the upcoming schedule for production of the Final Calibration Report and agency review. We agreed that the Final Calibration Report for the Hydrodynamic & Salinity Model would be completed at the same time as the one for the D.O. Model. For a schedule, the group agreed to 30 days for the review, 30 days for the comment/response resolution, and then 15-30 days to get a written agency position. EPA indicated that if the reports become available later than scheduled, they would not be as available to review the reports, resulting in a longer review time for them. At the time, the D.O. Model was scheduled for completion on 3 October. ATM agreed to review the comments and inform GPA when they would complete the reports. Their initial reaction was that the comments did not constitute a change in scope from the work they had been contracted to perform. ATM has since notified GPA and the Corps that the reports will be sent out on 24 October. That will likely extend the review time beyond 30 days.

William Bailey
Environmental Resources Branch

**SAVANNAH HARBOR EXPANSION PROJECT
AND
SAVANNAH HARBOR
ECOSYSTEM RESTORATION PROJECT**

**JOINT REVIEW OF
DRAFT D.O. MODEL CALIBRATION REPORT**

AUGUST 20, 2003

AGENDA

OPENING & INTRODUCTIONS	CESAS
REVIEW OF PRELIMINARY COMMENTS	Reviewers
<ul style="list-style-type: none">• City of Savannah• GA DNR-EPD• SC DHEC• CESAS• USGS• CE-ERDC• EPA	
VERTICAL MIXING IN HYDRO MODEL	CESAS
REVIEW OF SCHEDULE AND REQUIREMENTS	CESAS
NEXT STEPS	
<ul style="list-style-type: none">• Incorporation of comments	LGE

NOTE: There will be no presentation by ATM on the D.O. Model