Exhibit A
International Upper Great Lakes Study – Sub-Product Reviews, Synthesis Product Reviews, and Draft Final Study Report Reviews Template

Peer Review of Manuscripts

This manuscript has been submitted for independent peer review to the Co-Chairs of the Independent Peer Review Group (IRG) as identified in the Independent Review Plan (IRP) of the International Upper Great Lakes Study (IUGLS).

The evaluation and acceptance of the technical report (documentation) will include, as part of the review criteria, how effectively the goals of the work have been accomplished within the limits as described in the "background and context statement in Article 9.3.1.2.

Manuscripts shall be evaluated on the extent to which the authors' efforts have been covered/documented and the extent to which the reviewers can answer the review questions:

- Are the methods employed by the authors sufficient to answer the questions;
- are they being used correctly;
- are the analyses and tests appropriate for the problem at hand; and
- are the derived conclusions supportable by the model and analyses?
- Are there any other comparable methods or approaches that may/ought to be considered, which would provide more insight for the specific task under review?

Checklist for the Reviewer

Your review is:

- To provide the authors with directions as to how they could improve their analysis and technical report. Please provide clear instructions and comment objectively, remembering the efforts that they have made to prepare the manuscripts. On a separate sheet, you may provide comments for the editor that you feel are necessary. These separate comments will not be provided to the authors.

Some additional points are:

- Please document statements adequately so that authors may fully understand your concerns. You may do this using additional sheets cross-referencing your additional comments to the specific questions below.
- Some of the questions follow a scale of 1 through 5, with 1 be the highest rank (yes -- always or excellent) and 5 being the lowest (no -- never or very poor). Please encircle your responses.

Manuscript: "St. Clair River Hydrodynamic Modelling Using RMA2: Phase I, Phase II, and Addendum to Phases I and II", Environment Canada.

Author(s): Bruxer and Thompson

Name of Reviewer: Colin Rennie

1. Are the objectives of the work clearly stated? 1 2 3 **4** 5

The three reports should be consolidated.

2. Are the methods employed valid, appropriate and sufficient to address the questions, hypotheses or the problem? 1 2 3 **4** 5

The model mesh was generated by linear interpolation of sparse data, which led to errors in channel bathymetry. This may have influenced model results.

3. Are the observations, conclusions and recommendations supported by the material presented in the manuscript (e.g., data, model and analyses)? 1 2 3 4 **5**

4. Are the assumptions used valid and are the mathematics presented correct? 1 2 3 4 **5**

5. Is the manuscript well organized, material precise and to the point, and clearly written using correct grammar and syntax? 1 2 **3** 4 5

The three reports should be consolidated.

6. Are all of the figures and tables useful, clear, and necessary? 1 2 3 **4** 5

Addendum Figure 5-1 is not clear.

7. What is the quality of the overall work? 1 2 3 **4** 5

Recommendation (please circle your response)

A - acceptable
B - acceptable with suggestions for revision
C - acceptable if adequately revised
D - unacceptable

If you have selected **C**, do you wish to receive the revised manuscript for further review? yes no

Rating (Circle the rating you would like to give this manuscript. Unacceptable work should be given a score of 40 or less.)

100 90 80 70 60 50 40 30 20 10 0

Comments (limit responses to one paragraph for each question; reference pages, charts, and data. Please distinguish if responses are of major or minor concerns.)

Please see detailed review below, which addresses these questions..

A. What is the best/most unique part of the analysis?

While the 2D modelling was useful, I was most convinced by Addendum Figure 6-5, which showed based on actual observed data the change in required head to achieve a comparable flow in the St Clair River.

B. What is the most critical aspect of the study/analysis? Why?

Obtaining a good mesh that represents the river bathymetry is the most critical component of 2D modelling. This is because 2D models directly estimate losses due to acceleration and deceleration of the flow..

C. Which aspect of the analysis/modeling is weakest? Why? How can it be improved?

The mesh was generated by linear interpolation, which did not yield a good model of channel bathymetry.

D. Are there any other suggestions that are related to how this analysis may be used more effectively or the results explicated in a more understandable manner?

Please indicate any confidential comments to the Co-Chair(s) of the Independent Peer Review Group in the space below. Comments for transmission to the author(s) should be on a separate sheet attached.

Signature:  Date: June 24, 2009

Comments for Transmission to Authors

It would be useful to have both general comments and specific comments for major and minor revision. Please use additional sheets should they be required.

Bruxer and Thompson, 2008-2009, "St. Clair River Hydrodynamic Modelling Using RMA2: Phase I, Phase II, and Addendum to Phases I and II", Environment Canada.

Summary

The Bruxer and Thompson (2008-2009) report utilized a 2D hydraulic model to assess change in conveyance since 1971. In general, the study was performed well. However, there was a key weakness in the studies, which was that the SMS routine of the RMA2 model utilized linear interpolation when generating the model mesh. This resulted in substantial errors in modelled bathymetry for survey years with sparse data, and the authors should have considered other means for generating the model mesh.

Review

The authors have presented a detailed account of their hydraulic modelling exercise. The report was written well, although consolidation of the three reports would have been useful, and the reviewer prefers use of "data" as plural. In general, the modelling was performed well. However, this reviewer offers a few suggestions, as outlined below.

Calibration Data

Phase I p.5. It appears that only monthly flows and water levels were considered in this analysis. Are water levels in Lakes Huron and St.Clair and the associated flow in the St.Clair River sufficiently steady that monthly values capture the full range of observed conditions? Similarly, did the calibration values (Table 3-1, p.7) cover the full range of conditions? Presumably this is the case, but it was not stated in the report. The issue of calibration for roughness across years is discussed in the Addendum report.

Furthermore, the authors have chosen to calibrate their 2D model only with water elevations, as opposed to velocity distributions. The original RMA2 model by Holtschlag and Koschik (2002) utilized velocity distributions for calibration, but the authors re-calibrated after remeshing. Accordingly, modeled velocity distributions are somewhat suspect in their model. This may not be important, as the authors have not utilized the modeled velocity distributions in their analysis.

Error Analysis

Phase 1 p.12, Table 3-2 (also Phase II Table 3-1, and other tables in the document). It would be useful to include a Mean Absolute Difference statistic, which is less subject to outliers than the Root Mean Square Error (RMSE). Note also that the label "Sum Sq Error" does not reflect the square root operation. Is this an RMSE?

Phase I p.12. It would be very useful to include longitudinal plots of observed and simulated water levels, and associated longitudinal plots of errors, which would give an indication of any longitudinal trend in errors.

Bathymetry and Interpolation Procedure

First of all, the reviewer would have appreciated plots of the interpolated bathymetry for each year. The bathymetry is the single most important driver for a 2D hydraulic model, and it is difficult to interpret model results without plots of the model bathymetry. One similar suggestion is to colour code the 1971 survey dots in Phase I Figure 4-1 (p.14), so that change in surveyed elevation between 1971 and 2007 could be visually identified.

Phase 1 p.13 Linear interpolation was utilized, because this is the interpolation procedure available within SMS of the RMA2 package. However, linear interpolation is inappropriate for sparse irregular data. This is most clearly evident in Addendum Figure 5.5 (p.21), where high bathymetric elevations extend from the shore out into the channel wherever cross-section data are unavailable. This is a classic problem, but can be overcome using kriging interpolation with breaklines and an anisotropic variogram. The authors should have considered interpolating the bathymetric survey data using kriging, possibly employing techniques to preserve all measured elevations, and then inputting the interpolated data to SMS for grid generation. The reviewer notes that Bennion (2009) utilized kriging to interpolate the river bathymetry and assess errors in the interpolation. It would have been useful if the hydraulic model had used optimum bathymetric interpolation for the process of model mesh development.

The second advantage of kriging is that kriging standard deviations may be calculated (again, see Bennion 2009), which can be used as indications of local interpolation error. As acknowledged by the authors, the interpolation errors are not uniform throughout the model domain. The SSB technique utilized by the authors to determine interpolation error was useful (Phase II, Chapter 3). It would have been helpful if the authors had presented spatial plots of interpolation error (similar to Addendum Figure 5.5, possibly with the survey points also colour coded by surveyed elevation), which would have demonstrated spatial trends in interpolation error.

Furthermore, in the analysis of model uncertainty introduced by interpolation error (Phase II, Chapter 3), it would have been more representative to use local kriging standard deviations to perturb the model than a completely random perturbation. The random perturbation utilized by the authors would have produced random bathymetric error, which would have produced a change in roughness but a zero average change in section area. As demonstrated in Addendum Figure 5.5, the interpolation procedure actually did result in a change in section area, and this was not captured in the uncertainty analysis.

With respect to the survey data themselves, survey data for the delta region were only available from the 2000 survey (Phase I, p.15). Thus, no change in delta bathymetry was employed for the models for 1971, 2000, and 2007. Is there any evidence for delta aggradation or degradation, and if so, what influence would this have on model results? Secondly, it is not surprising that model results only started to diverge upstream of the delta, because all the models were the same downstream of the delta (Phase I, p.21).

The authors assumed that all unsurveyed near shore water depths were 1 m, mostly to assist model convergence (Phase I, p.15). It may have been more realistic to extrapolate the surveyed bathymetry to the water surface line. This option was evaluated in the Addendum (p.12), and was found to influence significantly the model results, unless survey data of equal density were utilized when comparing models for different years. This implies that if both models use the same method, the shoreline modelling does not influence estimated change in conveyance. However, this effectively removes changes in the shoreline from the modelling effort.

Variogram Analysis

Addendum Figure 5-1 (p.17). It is unclear to the reviewer why the deterministic model produced so many variogram data points.

Actual Flow Data

The reviewer appreciated the analysis of change in actual flows over time for similar boundary conditions (Addendum Section 6.2).

It appears to the reviewer that the authors could demonstrate a significant change in conveyance if standard errors are calculated in Table 6-4 (or Table 6-3) using the number of independent pairs as the sample size.

While Figures 6-2 to 6-4 appear to demonstrate also a change in conveyance, the reviewer found these figures difficult to interpret. The must be a more straightforward means to present this information.

Figure 6-5 is the most direct evidence of the change in conveyance of the St Clair River during the study period. It appears that about 20 cm less head was required in 2001 than in 1962 to force the same discharge in the St Clair River. The boundary conditions for each data set should be stated in the figure title, to emphasize the similarity of the boundary conditions for each case. Furthermore, the difference in water elevation at Fort Gratiot should be stated in the figure title.

Roughness Calibration

This reviewer appreciated the re-calibration of the model for each year to account for possible changes in roughness (Addendum, Chapter 4). The Phase I and Phase II reports assumed that roughness remained unchanged between 1971 and 2007, despite changes in bathymetry that resulted in changes in conveyance. In fact, a river will adjust such that it can convey its flow and sediment load. This adjustment can occur via changes in channel gradient, channel section, and/or channel roughness. It is important, therefore, to consider simultaneous changes in bathymetry and roughness.

It is worth noting that a 2D model need not be freely calibrated for roughness if the grid is of sufficient resolution to capture form roughness. In such cases, the roughness coefficient represents the grain roughness only, and it can be initially estimated from the grain size distribution. However, in the present case the grid resolution is 75 m x 25 m, thus the roughness coefficient will include form roughness, and calibration is required.

Based on Addendum Table 6-10 (p.40) and Table 6-11 (p.41), in which calibrated Manning's n values for the 1971 and 2007SSB71 models were similar, the authors conclude that roughness did not change substantially between 1971 and 2007. However, Table 6-11 reveals a longitudinal trend in the change in calibrated roughness values, which does indeed suggest a small but important change in roughness. This change in roughness is the reason for the reduction in the estimated lowering of Fort Gratiot water level for the re-calibrated model (Table 6-12). Table 6-12 suggests that the reduction in water level between 1971 and 2007 at Fort Gratiot for the average boundary condition was about 7 cm, whereas the Phase I and II modelling without consideration of change in roughness suggested a water level reduction of 12 ± 3 cm.

The authors argue that each re-calibrated model is fully determined by the data used to calibrate the model. This is, of course, true. This also demonstrates the sensitivity of the model to roughness. Very similar calibrations, with Manning's n values similar to two significant digits, produced different results (Tables 6-10 and 6-12). Rather than reject model re-calibration to account for changes in roughness as proposed by the authors (see Addendum Conclusions p.48), the reviewer suggests that a more complete data set be used to calibrate the 1971 and 2007 models, rather than just a set of five observations of flow and water level used for each calibration (see Table A1 in Addendum Appendix).