April 10, 2008

RE: Peer Review of the St. Clair River Task Team's *Draft Hydraulic and Sediment Modelling Strategy* for the International Upper Great Lakes Study.

The review team convened by the Independent Review Group has assessed the Hydraulic and Sediment Modelling Strategy put forth by the St. Clair River Task Team, and has participated in a lengthy discussion with the Technical Study Directors/Managers and the International Joint Commission Engineering Advisors regarding the modelling strategy.

The Task Team was asked to address the following two primary science questions:
1) Has the conveyance of the St. Clair River changed since the 1962 dredging?
2) Has the morphology of the St. Clair River been altered after the 1962 dredging?

The 1962 dredging was the first dredging to the current 27 foot deep navigation channel.

The Task Team has identified three science questions associated with each of the primary questions:
1.1) What is causing the declining head difference between Lakes Michigan/Huron and Erie?
1.2) Has the St. Clair River flow regime (i.e. water level-discharge relationship) changed with time and if so, why?
1.3) Have the velocity patterns in the St. Clair River been modified, and if so, what are the implications?
2.1) Is the St. Clair River bed stable or eroding?
2.2) If the bed of the St. Clair River is eroding, what initiated it, and when?
2.3) Has the sediment budget for the St. Clair river changed, and if so, what are the implications?

The task team has developed a strategy, which includes 24 major tasks itemized in a project work plan, to address these questions. The strategy includes tasks related to the following four possible explanations for the observed change in lake levels:

1) changes in net basin supply
2) diversions and consumptive uses
3) glacial rebound and subsidence
4) changes in St. Clair River conveyance flow capacity

With respect to the fourth possible explanation, the strategy specifies required measurements and modelling to assess changes in St. Clair River channel morphology and conveyance capacity. The review team was requested to assess the methodology of the strategy with respect to hydraulic and morphodynamic modelling of the reach.

The review team has assessed the scientific methodology of the strategy, and has also considered needs related to public understanding of model results. It is the consensus of the review team that the proposed methodology:

- Is appropriate for the task,
- Has clearly stated objectives, and
- Uses appropriate models, measurements, and calculations.

Based largely on the technical discussions, the review team makes the following observations and recommendations:

1) **Modelling strategy**: direction, and too much or too little?

- The study team is proposing a significant amount of overlapping, redundant hydraulic and sediment transport modelling. The review team initially considered this to be excessive. However, redundancy will help quantify model uncertainty with respect to model architecture. The proposed redundant approach also allows for determination of the minimum required degree of modelling to answer the study questions and for long-term operations of the St. Clair River.
- The strategy contemplates the need for three-dimensional modelling. Three-dimensional modelling is required if there are significant vertical velocities in the reach. Three-dimensional modelling is also required to resolve local scour and/or secondary currents in bends. Three-dimensional models are not generally employed over long reaches of river due to excessive computational demands. There is not currently sufficient evidence of vertical velocity or vertical transport in the reach that would necessitate the use of a 3D numerical model. If 3D modeling is eventually considered to assess erosion/deposition at a specific location in the reach, it would be prudent to weigh the relative merits and costs of 3D numerical versus physical modelling.
- To evaluate patterns of erosion and deposition in the reach between 1971 and 2007, it will be necessary to employ a coupled flow/sediment 2D model. For example, it should be possible to employ 2D Telemac with coupled sediment transport routines.

2) **Time baseline:** The 1971 survey appears to be the *de facto* baseline, despite the fact that the high level questions relate to change since 1962 (the year of increased depth of the navigation channel). The review team strongly supports the current efforts to georeference the available 1954 cross-sections. Secondly, a validated 2D flow/sediment transport model could possibly be employed to hindcast changes between 1962 and 1971.

3) **Survey data**: The review team suggests that analysis of the available survey data for 1971 and 2007 may go a long way toward answering the question of change in channel morphology. The review team recognizes that hydraulic modelling will still be necessary to assess change in channel conveyance. The review team fully supports the effort put toward data gathering and QA/QC.

4) **Ice and weed-growth implications**: The review team suggests that ice and weed-growth regimes are important factors in the channel conveyance. The influence of ice and weed-growth should be incorporated into the modelling effort.

5) **Uncertainty**: The strategy includes statements that uncertainty of model results must be assessed. The review team strongly supports this initiative. However, methods to assess uncertainty of model results need to be specified. The key parameters for hydraulic modelling were appropriately identified in the strategy document: channel bathymetry, boundary conditions, and spatial distribution of channel roughness. Furthermore, evaluation of uncertainty related to choice of model discretization was discussed during the meeting. Uncertainty of sediment transport modeling was not discussed. For sediment transport modeling, the choice of transport model and specification of the sediment size distribution are critical. A sensitivity analysis is necessary for key parameters. However, correlation between uncertain parameters is difficult to assess with sensitivity analysis. If the uncertainty of model results is to be assessed, then more intensive procedures such as Monte Carlo analysis should be employed.

6) **Performance metrics**: The study team has proposed the use of Hydraulic Performance Curves for 1971 and for 2007 to demonstrate change in conveyance. These curves will indeed demonstrate a change in conveyance and are useful for a scientific audience. However, alternative tools should be investigated for communicating study results to the public. Possibly, a more useful visual communication tool would be a comparison of longitudinal profiles of conveyance (calculated at each cross-section) for a given flow.

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