Manuscript: __ Restoration Analysis: Lake Michigan-Huron Water Levels

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Name of Reviewer: _R. A. Halliday, P. Eng.

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

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

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

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

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.)

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

The report represents a clear exposition of the problem and some potential solutions. Supporting material is clearly presented.

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

As an exploratory report, the authors have achieved a nice balance between the use of existing studies and the conduct of new work. The key environmental considerations that would affect any commitment to a project are clearly presented.

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

The discussion in Chapter 3 of restoration modelling would be difficult to follow for the average reader. It could be clarified/simplified.

The authors tried to ensure that all limitations and assumptions of this analysis were captured in Chapter 3. Minor modifications have been made to try to simplify the text.

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?

Although the report does not include recommendations, it could include a number of conclusions that may help the reader. For example, that achieving a 50 cm restoration requires multiple projects at considerable cost, that isostatic rebound will play a role in the long-term effectiveness of any measure, and that impacts of works on endangered species are significant.

These and other key findings are summarized in chapter 8, "Restoration Analysis Summary"

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: ___2011 05 04_____

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.

General

This report meets the intent of the IJC direction to the International Great Lakes Study Team aimed at providing an exploratory level of detail on options for restoring Lake Michigan-Huron water levels. As such, it does not provide recommendations. The report flows logically through restoration scenarios, effects on various interests, specific structural measures, environmental effects, and institutional matters. The following detailed comments should be taken in that context.

The report contains numerous acronyms and, although the authors are reasonably careful to define them as they occur, it would be useful to list them in the report. Some of the figures are excellent while others are marginally legible. They should be improved in the final reports. To the extent possible, the format of figures and tables should be consistent. Although the report uses SI metric units for the most part, there are occasional lapses into English only units, especially in Chapter 5.

Detailed Comments

Executive Summary – The summary seems very terse. Inclusion of a more detail. A summary table along the lines of 8.1 would be useful.

1 – Introduction. Although the introduction provides background and quotes the direction received from the IJC, it would benefit from an explicit statement of purpose for the report.

Additional text has been added to the introduction to clarify the purpose of the report.

2.2.3 – Second bullet. This sweeping statement should be qualified in some way. Would all of the other methods implied count on adjusting either the depth or width of the channel? As such, they would be simply variations on a theme that is well-documented in the report. What other possibilities, if any, exist?

The statement has been qualified as follows: "Additional and possibly preferable methods of raising the level of Lake Michigan-Huron may be available today, but these were not investigated in this exploratory-level analysis; instead (with the exception of inflatable rubber weirs and in-stream turbines), only those options proposed in past St. Clair River restoration studies have been reviewed, as these were presumably the most likely and preferable options at the time they were first proposed."

2.2.3 – Fifth bullet. Just to add clarity, it could be noted that the costs are overnight costs; then add the caveats.

The following (sixth) bullet provides some clarity to the fifth, so the two have been combined and rewritten to fully describe what costs were and were not included in the updated costs estimates for the structures reviewed.

2.2.6 – The introductory paragraph to 2.2 mentions "broader factors", identifying two for discussion. Is 2.2.6 considered a third broader factor? Are there others that the authors could identify?

Section 2.2.6 is not considered a third broader factor, but rather this paragraph outlines additional assumptions and limitations of the analysis. The introductory paragraph 2.2 has been rewritten to provide more clarity in this regard.

Chapter 3. The restoration modelling approach used is reasonable given the exploratory nature of this report. The authors could consider emphasizing, perhaps in 3.5, that results should not be taken to imply that any single structures may be constructed that would provide water level restoration as high as 50 cm.

It is not accurate to say that no single structure could be constructed to provide restoration as high as 50 cm; certainly a dam stretching across the entire St. Clair River could be used to achieve this level of restoration, though the impacts would be undesirable for a number of reasons, as described in this report. It is also true that a combination of structures could provide greater levels of restoration, possibly approaching the upper limit of 50 cm considered in this report. However, past studies have not considered this level of restoration, so no single structures to date have been designed to achieve it. This has been documented in the report in sections 2.2.6 and 5.10.

3.4 – First paragraph. The references to sections 3.6.1, 3.6.2 and 3.6.3 are incorrect. Should be 3.4 etc.

The paragraph has been modified to correct this error.

Figure 3.9 – caption – Welland

The caption has been corrected.

4.2 – Note typos in last sentence of first paragraph – 50 RI and 50 RS.

Corrected.

4.4.1.2 – This section attempts to combine a discussion of permanent changes in generation at St. Marys with temporary changes downstream of Lake Erie with mixed

success. Table 4.7, particularly, is problematic. One approach may be to calculate losses over a specified time period, say 30 years.

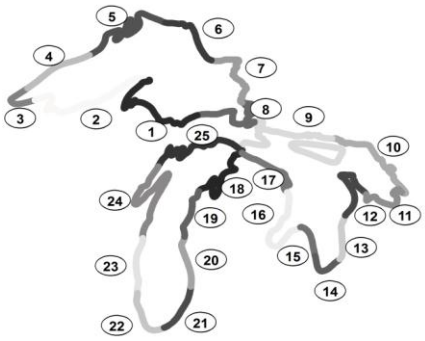
Losses were calculated over a specific time period, as suggested by the reviewer, that being the full 109 year historic period of record. All costs reported in this section (as in all subsequent sections) are the average annual costs associated with each of the various restoration plans. Table 4.7 will be re-labeled to indicate that the figures shown for both the St. Marys and the Niagara River are the average net impact per year over the entire 109 year simulation period. The negative impacts at the St. Marys result from permanently raised tailwater elevations and affect each of the 109 years. While most of the negative impacts on Niagara hydropower occur in the years immediately following the implementation of restoration structures, the costs reported are averaged over the entire 109 year period. That is, the negative impacts on the Niagara occur only at the beginning of the 109 year period, when Erie levels are reduced by the restoration. The Niagara values shown are an average of both the early years where losses occur and the remaining years where there is no net change in Erie water levels or energy value at Niagara. This was necessary for regulation and restoration plan evaluation, but has understandably led to some confusion. The text of the report has been modified to make the analysis results more clear.

Table 4-8 – In light of the previous comment this table and other similar tables should be labeled "Annual Benefits …" or "Total Benefits …", as appropriate. The units should also be indicated.

Corrected, as suggested.

4.3.3.1 – Paragraph 3, re description of SAT. Do the 25 shoreline segments encompass the entire shoreline of the two lakes, or are they simply a sample? (Figure 4-13 implies a sample.) If they are a sample, what is the sampling methodology?

The 25 shoreline segments encompass the entire shoreline of the two lakes. Figure 4-13 (reproduced below) shows that the shoreline segments cover the entire shore of each of the two lakes (Superior and Michigan-Huron). As stated in the text, however, while estimates of the number and length of existing shore protection structures were available throughout the 25 zones shown (plus wave characteristics at these sites), more detailed information on the nature and characteristics of the structures were available in only three reaches: Racine County, Wisconsin; Lake and Cook Counties, Illinois; and the Collingwood-Wasaga Beach area of Ontario. Therefore, the structural characteristics from these three reaches provided a sample for the remaining sections, and this was used to establish the model.



4.4.4 – The approach taken is reasonable and the findings are appropriate. As indicated in the peer review of the IERM report, however, the transition from 34 performance indicators to the Zone A, B, C methodology is not clear. If that report is revised based on the peer review, some of the changes should migrate to this report.

The authors will consider this after reviewing the peer reviewed documents related to the IERM.

4.4.5 – This section is presumably based on the recreational boating report, which is undergoing peer review. Since that report describes the findings related to only 17 zones around the lakes, the authors need to be careful to avoid leaving the impression that information can be provided for all facilities on the lakes. This is particularly true, as the degree to which the 17 zones represent the entire population is not known. An explanatory comment in 4.4.5.1 would be in order.

This clarification does not affect the overall finding that water level restoration is beneficial. The text related to Figures 4-18 and 4-19 and to Table 4-20 should be revised to indicate that the findings relate only to a sample, not to the entire lakes.

While it is unknown how well the marina slips surveyed represent the entire population, a efforts were made to survey a large number of slips, and the reviewer is correct in stating that clarification does not affect the overall finding that water level restoration is beneficial. Of note is that in excess of 17000 marina slips were physically surveyed in 17 zones around the Great Lakes. Zones were 80 kilometres in diameter and were selected to give representation of topography, forest type and geological formation types as well as areas that had higher concentrations of marinas. A total of one hundred and twenty five marinas were selected within the zones. Once a marina was identified the owner was approached to obtain permission to undertake depth sounding and a personal interview was competed. Each slip was depth sounded to determine its depth and compared to chart datum. Information gathered from the personal interviews was used to provide data and opinions on how changing water-levels had affected their business. Additional text has been added to the report for clarity.

5.3 – Page 79, first paragraph, last sentence. Based on the authors' judgment, can they indicate a possible upper limit of restoration? That is, is a 50 cm restoration using a combination of structures a reasonable scenario?

The authors are unable to comment on the upper limit of restoration, as this was beyond the scope of this work and would require additional study, including detailed hydraulic modeling analysis of various options and different combinations. The authors do wish to reiterate that while a 50 cm restoration scenario has not be studied in the past, it would almost certainly be possible to achieve with some sort of structure (for example, a dam stretching across the entire width of the St. Clair River); however, the costs of such a structure would be extremely high (well beyond the costs associated with the structures described in the report), and within the report the benefits and disbenefits of providing this level of restoration have been well documented.

5.4.1 – Last paragraph. Syntax problem in third sentence.

Corrected.

5.4.3 – First two sentences. Just to be clear, the sills were tested in the physical model, I assume.

That is correct, Franco and Glover (1972) tested the sills and various combinations using a physical model. This has been clarified in the text.

5.8 – In view of the discussion earlier in the report of instantaneous and staged restoration, it might be useful for the reader if a nominal duration of construction for each of the four options were provided. It would be understood that staging the construction would extend this time.

As stated in the report, "instantaneous" construction is impossible, and construction of any of the structures would take some amount of time. The reviewer notes that staging construction would extend this time. The cost estimators provided time estimates for construction of each of the three options they reviewed, including submerged sills, the parallel dikes extending into Lake Huron, and the fixed Stag Island obstruction. It was noted that the time for construction does not take into account solicitation, contracting, mobilization, demobilization or survey. The cost estimator also assumed that one marine crew using a crane barge, tugs, barges, and land equipment would work 24 hours per day, 7 days per week as this is normal for marine work since construction will usually take place only 8 months of the year due to ice and winter weather. For the submerged sills, the time of construction would depend on the number and type of sills constructed. For the Type 4 sills, structures 1 thru 8 will take approximately ten months to construct, and structures 1a to 5a will take approximately four months to construct, so a total of 14 months for all sills of this type. Note that this estimate does not include any down time for winter conditions, so the total time to complete construction might be greater than this, depending on the number of construction seasons required. Of course if less than

this amount of sills were to be constructed, the time required would be reduced. For the Type 11 sills, structures 1 thru 8 will take approximately 17 months to construct, and structures 1a to 5a will take approximately six months to construct, so a total of 23 months for all sills of this type. Again, this does not include any down time for winter conditions, but the time may also be reduced if less than all sills evaluated were constructed. The construction of the parallel dikes into Lake Huron will take approximately 30 months or four construction seasons, while the weirs connecting the dikes to the mainland will take additional time, which the cost estimators noted would be dependent on wave action (high waves would result in some days where construction may not occur). The Stag Island obstruction and extension will take approximately 34 months or 4 construction seasons to construct, while a similar Fawn Island obstruction and extension will take approximately 23 months or 3 construction seasons to construct; the addition of submerged rock sills used for mitigation of increased velocities at either location (150 total) will take approximately 16 months or two construction seasons to construct. As described in the text, cost and schedule estimates were not provided for the inflatable flap gate option at Stag Island, but it can likely safely be assumed that this option would take a similar number of months to construct. Text has been added to the main report describing these schedules.

5.10 – It would be useful to include a table indicating the approximate cost and the range of restoration/regulation provided by each of the four alternatives.

A table has been added, as suggested.

6 – There is a passing reference to effects of one project on the ice regime in section 5 of this report. Although it could be considered beyond the scope of an exploratory report, it would be useful to flag that further more detailed studies should investigate the effects of any proposed structures on the ice regime of the system. This could include changes in frazil ice generation in the St Clair River, ice jam frequency, and ice effects on structures.

A note on recommendations for further study of ice impacts has been added to section 5.6.1.

6.5 – First paragraph. Several sentences are duplicated.

Corrected

6.9 – Summary. A few sentences related to Lake St. Clair should be added.

A sentence on Lake St. Clair impacts has been added to the summary for chapter 6.

7.2 – Throughout this report the term restoration has been used. This should be continued rather than using compensating. The latter term is used for the St Marys River, but so be it. There is also potential for confusion with financial compensation, *e.g.* 7.3 and 7.4.

The authors regret the confusion, but in some cases it was unavoidable, as the terms are not entirely synonymous. "Compensation" is the term often used in past studies, since the structures proposed were meant to "compensate" for the specific impacts of the dredging projects that took place. Today, because we are not necessarily compensating for any one particular past event but rather we are investigating the impacts of raising water levels to reverse the effects of any number of events and activities that have taken place (including dredging and natural changes to the river), we use the term "restoration". The executive summary gives a good example of the correct usage of both terms: "Restoration implies a permanent increase in the Lake Michigan-Huron levels, relative to what they would otherwise be, to compensate for the lowering of lake levels due to the episodic dredging and channel enlargement in the St. Clair River over the past 100 years." The text has been modified accordingly, with an explanation given in chapter 1: when in the report we refer to compensating for any specific event, we have used the term "compensation"; when the goal of the structures would be to restore water levels to some pre-defined position, and not necessarily to compensate for any specific event, we have used the term "restoration".

7.4 – Last sentence. Further elaboration is needed. Provide examples of unintended benefits?

Examples of unintended benefits (of increased St. Clair River conveyance) include lowered shore protection costs, wider beaches, reduced flooding risks (each of which may have led to construction in areas closer to the lowered water level, which poses a significant issue should water levels be restored) and increased hydropower production at Sault Ste Marie. A sentence describing these has been added to this section as requested.

7.5.1 – Is the implication that the two federal governments could authorize a structure in boundary waters is such a way that the need for an IJC Order-of-Approval would be obviated correct? Can the authors provide an example?

Yes, this statement is correct. The two federal governments are well within their right to, as a special agreement provided for under the Boundary Waters Treaty, enter into their own agreements or treaties outside of the auspices of the IJC. Furthermore, even under such circumstances, the governments can also still choose to engage the IJC if desired. The Niagara Treaty of 1950 is an example of a special agreement. In this case the two governments chose to manage the waters of the Niagara River by separate treaty that replaced certain portions of the Boundary Waters Treaty; however, the governments continue to involve the IJC in the Niagara River, as the IJC, through its International Niagara Board of Control, exercises control over the operation of the International Niagara Control Works to meet the objectives of the Niagara Treaty, oversees regulation of levels of the Chippawa-Grass Island Pool and matters which may have a trans-boundary impact on water levels . This example has been added to the final report.

7.5.2 – Page 137, last paragraph, sixth line. “likely” would be a better word than “possibly”.

The wording has been modified as suggested.

7.6 – Last bullet. Would the USACE then be the legal owner of the works? Are any particular authorizations required to allow the extra-territorial construction of works?

Legal ownership is unclear, but the USACE would be responsible for construction and ongoing maintenance. Furthermore, by agreement through exchange of notes, there would likely be stipulations imposed by the Canadian governments that Canadian labour, materials, and equipment be used during construction and maintenance activities, and also that sovereignty be obeyed, including that USACE be subject to Canadian laws and regulations when working in Canadian territory.

8.6 – Table 8.1 – It’s not clear why different thresholds were used in footnotes 3 and 4. For an exploratory report, this implies much greater accuracy of estimation than one would expect and it needlessly complicates the table.

Table 8-1 is meant to show that benefits and disbenefits of restoration are mixed, that they vary among the different interest groups, and also vary in magnitude based on the level of restoration provided. The footnotes and threshold values reflect the estimates of benefits and disbenefits determined in the study; the values are not meant to imply a high level of accuracy, only to give the reader a more specific idea of the magnitude of the numbers used to produce the summary table. More detail is provided in Chapter 4 of the report, and a note in this regard has been added to the text and footnotes.