

Great Lakes-St. Lawrence River
Adaptive Management Committee

GLAM

Annual
Work
Plan

Fiscal Year

2016

First Annual Work Plan towards building a long-term vision and adaptive management strategy for the on-going review and evaluation of the regulation plans.

Covering
October 1, 2015 to
September 30, 2016

October 22nd, 2015

WORK PLAN

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Overview

Purpose The work plan provides a statement of how and when objectives of the GLAM Committee are to be achieved, by showing the major products, activities and resources required for the scope of the plan. This first work plan includes the priority activities to be carried out by the GLAM Committee in the first year covering Oct 1/15 through Sept 30/16 toward building their long-term vision and work plan for the on-going review and evaluation of the regulation plans.

Contents *The Work Plan covers the following topics.*

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The following quality criteria have been observed in developing this work plan:

- The work plan is achievable
- Estimates are based on consultation with the resources who will undertake the work, and/or historical data
- Team leads agree that their part of the plan is achievable
- It is planned to an appropriate level of detail (not too much, not too little)
- The work plan incorporates lessons from previous IJC studies
- The plan covers management and control activities (such as quality and communication) as well as the activities to create the products necessary to meet the IJC Directive
- The plan supports the GLAM Committee project management strategies including the Communication, Outreach and Engagement Strategy

Introduction

On January 16, 2015 the International Joint Commission issued a Directive establishing the Great Lakes-St. Lawrence River Adaptive Management (GLAM) Committee to report to the three Great Lakes-St. Lawrence River boards of control (Superior, Niagara and St. Lawrence (Boards)). The GLAM Committee is to undertake the required monitoring, modelling and assessment related to the on-going evaluation of the regulation plans and address other questions that may arise due to changing conditions in consultation with the Boards.

Purpose and Objectives

The general purpose behind adaptive management (AM) is to establish a structured, iterative process of robust evaluation in the face of uncertainty, with an aim to reducing uncertainty over time via system monitoring and feedback to the decision framework based on knowledge gained. In this context the overall objective of the GLAM Committee is to provide information to the Boards and advise them and the IJC regarding the effects that the control structures approved in the Commission's Orders of Approval and Directives have on levels and flows in boundary waters and the impacts the regulation plans have on the affected interests. This includes the on-going review and evaluation of regulation plans related to:

- a) the effectiveness of the existing regulation plans in managing water levels and flows in the Lake Ontario-St. Lawrence River system and the outflows of Lake Superior in the past and into the future;
- b) examining how the system may be changing over time and whether any modifications to the regulation plan(s) may be warranted to address what is learned over time including emerging issues and/or to address changing conditions; and
- c) any other questions requested by the Boards and/or IJC that may affect the Boards' water management decisions over the long-term.

The Directive to the GLAM Committee is to design a work plan that assists the Boards by addressing these questions:

1. How well are the impacts of levels and flows represented by current data and models used in the evaluation of the management of levels and flows?
2. Will future water supplies be different from those used to test the current management of levels and flows; and
3. How are other physical, chemical, biological, and/or socio-economic conditions of the system changing over time?
4. How can the management of levels and flows benefit other physical, chemical, biological and/or socio-economic conditions?

The focus of this work plan will be to provide a framework that guides all GLAM Committee regulation plan evaluations, clarifies products and annual priorities; identifies roles and responsibilities and annual resource requirements.

Scope and Timeline

The GLAM Committee's work covers the entire Great Lakes-St. Lawrence River system from Lake Superior through to Trois Rivières on the St. Lawrence River. The Work Plan covers the products necessary to meet the IJC Directive as well as management and administrative activities (such as project management, quality control and communication) to ensure an effective adaptive management process. While the work of the GLAM Committee is an on-going, long-term effort, there are timelines that must be adhered to as follows:

- Annually, the GLAM Committee will produce an updated work plan for approval by the Boards and IJC.
- Semi-annually the GLAM Committee will report on progress in fulfilling the work plan to the Boards and IJC.
- Once every three years, the GLAM Committee in consultation with the Boards will prepare a comprehensive progress report to the IJC timed to inform the Commissions' Triennial Assessment of Progress (First one in January 2017).
- As directed by the Commission, and not more than 15 years after the establishment of the GLAM Committee, the Committee will facilitate comprehensive reviews and evaluation of the regulation plans by the Boards based on the available data and information garnered over the review period.

This work plan coincides with the U.S. fiscal year and covers October 1, 2015 through September 30, 2016. It outlines activities to be carried out within that timeline by the GLAM Committee recognizing the short-term requirements of the Committee, but also supporting efforts towards the long-term commitments. This first fiscal year focusses on some immediate priority tasks that will help to address some outstanding questions and lessons learned from the most recent IJC studies (Lake Ontario-St. Lawrence River Study (LOSLR) and the International Upper Great Lakes Study (IUGLS)) as well as priorities for establishing the longer-term evaluation process.

Year 1 Work Plan - Product Descriptions, Timelines and Resources

The adaptive management process is an on-going effort that recognizes the dynamics of the system and while this work plan is based in the context of a long-term initiative and the 15 year reporting period, it represents a summary of priority adaptive management products and tasks to be initiated within the first year of the GLAM Committee reporting to the Boards of Control and covering October 1, 2015 through September 30, 2016. The Work Plan is divided into three sections. **Section A** identifies work

projects organized around the four questions in the GLAM Directive from the IJC. **Section B** includes administrative work needed to manage the GLAM Committee and support all work projects. **Section C** is empty for now, but will be used retrospectively and in future years' work plans for any special projects the Boards may ask the GLAM Committee to pursue.

The items chosen represent activities the GLAM Committee has identified as priorities and which the GLAM Committee believe can be resourced with available staff and funds and completed within the fiscal year. A few additional items are included that the GLAM Committee hopes to accomplish if it can secure some additional funding, maybe through fall submissions to the International Watershed Initiative (IWI) or through additional agency support. There are also a number of additional items included in Appendix 1 that the GLAM Committee considered for this work plan, but these activities go beyond the resources currently available to the Committee and are not expected to be accomplished this fiscal year. In addition to this 2016 Work Plan, a mid-term strategic plan covering the next three to five years will be produced to provide a broader perspective on the work to be completed, and the development of that will be a task within this annual work plan. Items identified that cannot be completed this fiscal year will be added to the mid-term strategic plan. Resources available this fiscal year are identified in the Table below.

Available Resources for FY 2016

The following resources have been identified as available to the GLAM Committee in FY 2016. In addition, agencies are providing in-kind staff contributions. These in-kind staff contributions have been divided amongst all of the identified tasks.

| Agency | Funding U.S. (\$K U.S.) | Funding Canada (\$K Cdn) |
|-----------------|--------------------------------|---------------------------------|
| IJC IWI Funding | \$45K | \$80K |
| IJC | \$5K | \$90K |
| Total: | \$50 | \$170 |

Section A - On-going Evaluation of Regulation Plans

The GLAM Committee uses the word “evaluation” in three distinct contexts. The first is consistent with the way it is used in water resources planning and was used during LOSLR and IUGLS, to mean the evaluation of alternative lake level regulation plans using a wide array of performance indicators. The GLAM Committee expects to eventually evaluate alternatives to the current regulation plans and will include this type of evaluation in the 15 year review using water levels simulated according to each plan ruleset and approximately century long historic and stochastic net basin supply datasets as well as various extreme wet and dry net basin supply sequences.

The GLAM must also consider whether the methods and models used to evaluate regulation plans are an adequate representation of reality. So, the second use of “evaluation” is the evaluation of the models used in the plan evaluations; i.e. model validation. For example, this year, GLAM will try to validate the wetland and shore protection damage models used to evaluate LOSLR regulation plans. GLAM will use actual water levels and flows for these evaluations with data series length tailored to the particular performance indicator and monitored data. These model validations are important for reducing uncertainty in model assumptions and verifying plan evaluation results.

Finally, the word “evaluation” is used in answering the question, is the regulation plan in use working out as expected? The operation of Lake Superior Plan 2012 has shown, for example, that it can be better to make the plan release through multiple partially open gates rather than through a fully opened single gate. At the same time, the actual flow through the side channel for hydropower is not always the flow assumed during the evaluation of Plan 2012 in IUGLS. Given those operational changes, GLAM has designed tasks to evaluate whether Plan 2012 releases are providing the benefits expected. Both operational simulations and actual water levels and flows will be used in these evaluations, with record length suitable to the particular issue.

These three definitions of evaluation are all important in addressing the four questions from the IJC Directive and the priority year 1 tasks identified by the GLAM Committee. Year 1 projects that are receiving funding from the IJC IWI program are identified as such.

Question 1 – Are models verified by real data?

1.1 Monitoring of Lake Ontario coastal wetland habitat (IWI)

Coastal wetlands provide an ecologically important and biologically diverse transitional zone between open water and land. As water levels rise and fall, vegetation communities move along an elevation gradient, encroaching on exposed soils and receding during flooding. Along this gradient, wetland vegetation transitions among distinct zones from shrubs to meadow marsh to emergent stands and submerged aquatic vegetation beds. It has been shown that wetlands are sensitive to water level changes and require variation in water levels to maintain ecosystem functions as well as diversity. This

information is important to evaluating the impact of water-level regulation changes in Lake Ontario and to provide a standardized approach for monitoring wetland ecosystem indicators basin-wide.

Environment Canada has monitored wetland plant diversity since the end of the Lake Ontario- St. Lawrence River Study. The Lake Ontario Wetlands Monitoring project will continue detailed vegetation community surveys for eight Lake Ontario coastal wetlands along the Canadian shoreline. This work will provide a means to track and understand vegetation zonation in Lake Ontario wetlands including the meadow marsh indicator which was a primary indicator used in the evaluation of alternative regulation plans for Lake Ontario. The monitoring will provide much needed information to validate the Integrated Ecological Response Model (IERM) model outputs with empirical data. Technological advances since the completion of the LOSLR study have greatly increased the scope and accuracy of data to be collected to support wetland ecosystem monitoring with respect to water levels. This project will enhance our current understanding of wetlands and increase the confidence in model outputs. The field surveys will be undertaken in fall 2015 with the data delivered by March 31st, 2016. The IJC has approved \$30K Cdn to this project as part of their IWI program.

Products:

- Complete field surveys for 8 Lake Ontario wetlands sites on the Canadian shoreline.
- Field data input to existing databases, post-processed, reviewed and summary results provided to the IJC's GLAM Committee.
- Executive Summary and Final Summary Report describing key aspects of the field approach and general findings.

1.2 Evaluate meadow marsh algorithm (IWI)

The wetlands meadow marsh performance indicator has been a critical component of the evaluation of water level regulation plan options for the Lake Ontario-St. Lawrence River system and it is important to validate and improve the modelling approach.

This task is to compare the types of plants growing in Lake Ontario wetlands to the types predicted by the IERM used in the LOSLR study and determine whether the IERM predictions are validated by the data. The validation will have three parts:

1. Using the algorithm embedded in the IERM and actual 1945-2014 Lake Ontario levels, calculate a time series of annual elevations labeled A, B, C, D, E, F and G. These lettered elevations are defined by previous Lake Ontario levels. For example, in any year, "B" is the elevation that has not been flooded in the last ten years, "flooded" meaning under still water for 2-3 quarter-months. The letter elevations in turn can be used with area-elevation curves to predict the areas covered with upland, meadow marsh, emergent and submerged vegetation each year. For example, the bottom of the predominantly meadow marsh area is elevation "C".
2. Use the monitored plant data to determine the "actual" areas of upland, meadow marsh, emergent and submerged vegetation each year, and then

3. Compare the two and judge whether the algorithm should be corrected based on the evidence provided by the new plant data.

The IJC has offered \$40K in IWI funding to support this project. That money will be used to cover the costs of involving Doug Wilcox from SUNY Buffalo and Todd Redder from LimnoTech who were the primary researcher and modeller for this performance indicator (PI). Some preliminary work has been completed with the algorithm and the monitored data at one site for one year to help clarify what needs to be done. Short scopes of work will be drafted and contracting and funding details will be considered once tightly drafted scopes have been developed. EC and USACE staff will be engaged in working to integrate the data into the IERM and in updating the model as required. There will be two experts workshops held as part of this project. The first will be to agree on a process for characterizing the extent of upland, meadow marsh, emergent and submerged vegetation based on the monitored data and to draft a protocol for validating whether the evidence shows the algorithm is sound for its intended purpose, which is to evaluate regulation plan rules. After the monitoring data is processed, a second experts workshop will be held to present the initial findings and allow them to be challenged. This project is expected to be completed by Aug 2016.

Products:

- An excel based modelling tool that incorporates recent observed wetland monitoring data and allows for an assessment under actual water level conditions compared to expected performance indicator results from existing planning models used in LOSLR.
- Transfer of expertise on the evaluation tools from contractors to government agencies.

1.3 FEPS model - update based on shore protection information (PI verification)

Shoreline protection maintenance on Lake Ontario is the coastal performance indicator that was found to be most sensitive to the differences among candidate regulation plans during the LOSLR Study. Elevations of existing shore protection structures are estimated within the Flood and Erosion Prediction System (FEPS) database, as are the design characteristics of replacement structures when existing shore protection fails within the model. Sensitivity analysis of the shore protection results suggests that shore protection failure is sensitive to the design water level elevation used within the model and that verification of design water levels for existing and replacement shore protection would provide additional confidence of assumptions used within the model. Following the LOSLR Study work was undertaken through the USACE to conduct on-the-ground surveys of a number of locations along the south shore of Lake Ontario to gather shore protection types, quality and height of structures to compare to key assumptions in the FEPS database. The data is to be delivered to the USACE by the end of October, 2015. The data will then need to be quality checked and formatted correctly to be included into the FEPS database and a number of sensitivity tests conducted to verify model assumptions based on actual measured data. USACE is providing the staff support to integrate the new data into the FEPS database. USACE staff will also be supporting the comparison of FEPS model results using the assumed and field survey data along with staff from EC. The intent is to have the work completed by March 2016.

Products:

- Updated FEPS database of shore protection types, quality and height for locations where field surveys were undertaken on behalf of USACE.
- Initial comparison of FEPS model results using the baseline model assumption and the site specific structure information (field surveys).

Question 2 – Have Water Supplies changed? – Tracking Hydrologic and Hydraulic Factors

2.1 Track advancement towards improving quality of NBS information

In order to understand how the Great Lakes system is changing over time it is important to understand how all of the components that drive the Net Basin Supply (NBS) are changing over time. Unfortunately there is currently a large amount of uncertainty in these components, especially over-lake precipitation, runoff, and evaporation from the lake surface.

The U.S. Army Corps of Engineers (USACE) currently creates an annual report that summarizes the advancements and continued uncertainty in each of the components of the water budget. NOAA GLERL and EC continue to contribute significant research activities towards reducing the uncertainties as well. This is an ongoing process but contributions will be included in the initial GLAM surveillance summary (see sections 3.1 and 3.2) to be completed by end of March 2016.

Products:

- Integration of USACE annual report on advancements and continued uncertainty into GLAM Committee surveillance summary

2.2 Extended CaPA and GEM hindcasts of water supply components in the Great Lakes basin (IWI)

This work may provide insights that allow rectification of differences in net basin supplies determined by the component and residual methods. That in turn would improve our ability to notice changes in connecting channel conveyance and the onset of climate change and to produce more useful hydrologic data and models for the evaluation of regulation plans.

The Canadian Precipitation Analysis (CaPA) is an operational near real-time gridded precipitation product from Environment Canada available since April 2011 for North America. CaPA has generated a lot of enthusiasm in the Great Lakes-St. Lawrence River area, due to its unique capability of capturing some of the precipitation features that are specific to the Great Lakes-St. Lawrence River, in particular organized shallow convection events which are responsible for lake-effect snowfall. Indeed, because it uses a background field from the Global Environmental Multiscale Model (GEM) atmospheric model, it can represent the effects that the lakes have on the precipitation patterns, something that is very difficult to catch with the existing precipitation gauging network, as it is entirely over-land.

The objective of this project is to provide the foundation for extending CaPA and GEM hindcasts back to 1983. Samples of daily analyses will be provided (one per week from 1995 until 2012). Furthermore, the computing cost of extending the hindcast back to either 1983 or 1995 at either 50-km or 15-km resolution will be assessed, and the added value of a 15-km analysis will be assessed over the Great Lakes watershed and basins along the entire boundary. Dr. Vincent Fortin from Environment Canada is the lead researcher on this project which has been awarded with \$50K Cdn in IJC IWI funding. The initial project is to be completed by March 2016.

Products:

- CaPA and GEM hindcasts extended to 1995 at a 50-km resolution and an assessment of extending back to 1983 and the added value of a 15-km analysis over the Great Lakes watershed.

2.3 Inventory of available net basin supply (NBS) components for the Great Lakes

As an initial step to improve the quality of NBS information, the current state of the various sources of the NBS components will be inventoried. This will allow the committee to evaluate the current state of NBS information and decide whether any of the current sources need to be examined for possible improvement. It may also identify gaps in the current state of NBS information that need to be filled. The work complements the CaPA hindcast project as well as work undertaken by the USACE and NOAA. The work will primarily be carried out by EC staff through their contributions to the Coordinating Committee on Great Lakes Basic Hydraulic and Hydrologic Data (Coordinating Committee) and is anticipated to be completed by September 2016.

Products:

- Inventory of current state of NBS component information.

2.4 Review and update of historical hydrologic and hydraulic datasets for the Lake Ontario – St. Lawrence River system through Montreal and St. Lawrence River

In order to effectively assess the current regulation plan relative to others it is necessary to review the hydrologic and hydraulic datasets from the currently coordinated historical period of record, and produce updated or extended historical datasets that include more recent data. For Lake Ontario and the St. Lawrence River, the current historical period of record for data required to evaluate regulation plan performance covers the period from 1900-2000. This data includes Lake Ontario and St. Lawrence River water levels; Lake Erie and Lake Ontario outflows; Lake Ontario residual net basin supplies; Lake St. Louis outflows and lower St. Lawrence tributary flows; St. Lawrence River rating equations and ice and weed retardation factors, some of which are estimates or proxies prior to 1960. This project will be undertaken jointly by EC and USACE staff, and will involve the development of metadata and a documented process for ongoing updates to Lake Ontario-St. Lawrence River hydrologic and hydraulic

data on an annual basis going forward, and a review and update of the required datasets through 2014. This can be completed with internal resources and completed by August 2016.

Products:

- Metadata for all hydrologic and hydraulic datasets required for LOSLR plan formulation and evaluation
- Documented process for annual updates
- Review and update to historical datasets for the 1900-2014 period-of-record

Question 3 – Has the system changed, and what is impacted by changes (physical, environmental, socio-economics)?

3.1 Design a surveillance plan

This task is to design a process that would allow the GLAM Committee to more effectively capture and apply information that is not being monitored in specific GLAM Committee projects, but which could be useful to improved lake level regulation. The GLAM Committee uses the term “monitoring” to refer to a very focused act of making observations linked explicitly to performance indicators through the performance indicator algorithm, and “surveillance” to refer to the act of identifying and synthesizing information that could help improve regulation outcomes. The objective of surveillance is to find useful information we are not currently aware of. The focal length of surveillance begins where monitoring leaves off; for example, tracking scientific papers to see if there is information available through outside sources that could help update existing performance indicators or that could have an influence on existing or new performance indicators. The actual height of shore protection structures and the variety of plant species growing at different elevations along the coast are two examples of monitoring. Other surveillance efforts could cast an even wider net, looking for climate research that might improve forecasting if applied to the Great Lakes net basin supplies, discovering a new category of water level related impacts or even tracking an economic trend that could have a bearing on how levels should be regulated.

This task is to find a way to move from the accidental, anecdotal surveillance system we have now *towards* a system that catches more useful knowledge and little else in a way that is not difficult, time consuming, or expensive. The primary objective is to create a framework for design by describing the components and functions of the system. As a start, there will be **scanning** element that finds potential sources of information, a **screening** element that systematically evaluates information in terms of whether it is likely to be useful (and documents the exclusions for later use if necessary), rates the useful information in terms of priority and eliminates information that will likely not be useful, an **interpretation** part that connects the knowledge found to a possible improved outcome from lake level management and a **librarian** function – a service that brings relevant surveyed knowledge to lake level management actions as necessary. Some areas for surveillance may include a review of the scientific literature and agency grey literature to determine if there is any recent research linking water levels

and socio-economic and/or environmental impacts and water levels. It could include information that could help to update the contextual understanding of the various interest groups and what may be changing that could influence impacts. While components of the surveillance plan may require additional funding (see 3.2.1-3.2.3), the development of the initial surveillance framework will be completed by GLAM Committee members and agency support staff by June 2016. The initial framework will be utilized in the assessment of next steps in FY 2017.

Products:

- An initial framework for developing an on-going surveillance plan (including scope, timing, costs etc.)
- A initial summary report on what is learned through the surveillance efforts listed below for use in the annual priority setting exercise

3.2 Initial surveillance to determine what has changed and whether there are new data and models available to support AM effort

The IJC has some funds available for the GLAM Committee to spend this Canadian fiscal year (Apr/15-Mar/16). Since it has been a number of years since the LOSLR study was completed and 3 years since IUGLS was completed, an important first step is to determine what has changed since the studies were completed and what data and information might be available to assist the GLAM Committee. The following will be developed to be complementary with the scope of the surveillance plan initiated in 3.1 as follows:

3.2.1 Ecosystem surveillance:

Identify any new scientific literature on impacts of water levels to the ecosystem and identify any performance indicators that might be important moving forward that were not addressed by the LOSLR or IUGLS studies; identify any changes to the system or emerging environmental issues that could impact existing and/or new performance indicators (e.g. Phragmites). Approximately \$20K Cdn in IJC funding will be used to carry out the work with a planned completion date of March 2016. EC and other GLAM Committee support staff will be providing in-kind support for establishing the contract and providing oversight.

Product: Updated ecosystem contextual narratives. Database of important and related scientific research; Assessment report on available ecosystem related data sources and models/tools that could support AM effort; and a brief “lesson’s learned” summary document outlining the key successes and issues identified with the surveillance approach undertaken.

3.2.2 Socio-economic surveillance:

Identify any new scientific literature on socio-economic impacts of water levels to sectors including shoreline property, commercial navigation, hydropower, recreational boating and tourism,

municipal and industrial water uses and identify any performance indicators that might be important moving forward that were not addressed by the LOSLR or IUGLS studies; Identify any changes to the system or emerging issues that could impact existing economic performance indicators (e.g. more houses built in flood plain or the implications of a new Maritime strategy for the St. Lawrence River). Approximately \$25K Cdn in IJC funding will be used to carry out the work with a planned completion date of March 2016. EC and other GLAM Committee support staff will be providing in-kind support for establishing the contract and providing oversight.

Product: Updated socio-economic contextual narratives. Database of important and related scientific research; assessment report on available socio-economic data sources and models/tools that could support AM effort; and a brief “lesson’s learned” summary document outlining the key successes and issues identified with the surveillance approach undertaken.

3.2.3 Surveillance of physical changes and modelling tools

Review of scientific literature and GLAM NBS project mentioned above to identify any possible changes to the physical system that could influence the regulation of water levels and flows (e.g. climate change; changes to flood zones etc.) as well as assessments of the current state of the data, models and tools for assessing the physical changes to the system. Approximately \$20K Cdn in IJC funding will be used to carry out the work with a planned completion date of March 2016. EC and other GLAM Committee support staff will be providing in-kind support for establishing the contract and providing oversight.

Product:

- Contextual narrative on how the Great Lakes system may be changing based on existing literature and a written assessment of the current state of data, models and tools available for assessment of changes to the physical system including the climate of the system.
- A initial summary report on what is learned through the surveillance efforts for use in the annual priority setting exercise and integrated into the plan evaluation process itself
- A brief “lesson’s learned” summary document outlining the key successes and issues identified with the surveillance approach undertaken.

Question 4 – Can the regulation plan be improved?

4.1 Review operational issues related to implementation of Plan 2012 and conditions in the St. Marys Rapids

Recent high outflows prescribed by Plan 2012 due to higher water levels on Lake Superior combined with hydropower outages has led to concerns being raised regarding the impacts of both higher and fluctuating flows and levels on the St. Marys Rapids, specifically the impact on the rapid’s fishery and recreational anglers, and the potential for flooding of Whitefish Island. There has also been concern

regarding the risk of ice damage to the Compensating Works and structures in the lower St. Marys River when the gates are first opened following winter, the impacts of “unnecessarily spilled” water on hydropower production, and impacts to commercial navigation due to reduced levels in the lower St. Marys River if gate settings were reduced. Three tasks have been identified as a priority to initiate during this first year work plan to begin an assessment of actual Plan 2012 outcomes versus what was expected based on modelled results.

4.1.1 Review the impacts of reductions in maximum side-channel capacity due to hydropower outages and other limitations and develop optimal operational guidelines for addressing them

Plan 2012 was developed and tested during the IUGLS assuming a maximum side channel capacity of 2320 m³/s, and this assumption has carried through to the operational implementation of Plan 2012 as well. However, this constant value is based on a number of assumptions that are essentially representative of a specific set of near “ideal” conditions, and often these conditions do not exist. In particular, these assumptions do not reflect actual operational conditions in two important ways:

i. Hydropower outages

The maximum side-channel capacity of 2320 m³/s is based on the assumption that all three of the hydropower plants are running all generating units at full capacity, but the reality is that most years there are a number of scheduled and unscheduled outages at the hydropower plants that result in unit outages and a reduction in the maximum capacity of the plants.

ii. Variations in hydrologic conditions

Even when all hydropower generating units are available and running, the flow capacity of these units varies as a result of variations in hydrologic conditions, most notably changes in water levels and ice conditions. There is also a specific concern that because side-channel capacity is often limited in winter that the maximum winter flow of 2410 m³/s prescribed by Plan 2012 is unattainable (under the normal one-half gate equivalent winter setting), and this may have consequences in terms of high water levels during the following spring and summer.

This task will be to investigate the impacts of hydrologic conditions on maximum hydropower plant capacity and develop mathematical relationships that relate the two and which can be incorporated into evaluation and operational models/tools. It will also be to review the impacts of reduced side-channel capacity in winter, notably the potential for higher Lake Superior levels in spring/summer than were estimated during IUGLS plan formulation and evaluation, and how to address this issue. Finally, this task will include a study of the impacts of large and fluctuating flows in the St. Marys River due to varying maximum side-channel capacity, and develop and evaluate methods to address these impacts. This analysis should consider the positive and negative impacts

on impacted stakeholder groups. Recommendations should include rules, limits, and/or guidelines that the Board could follow in addressing these issues, including the potential use of deviations from Plan 2012 or permanent changes to Plan 2012 itself. Staff of the Lake Superior Board at EC have begun to investigate the relationships between hydropower capacity and hydrologic conditions using limited data when the plants were running at full capacity recently; this analysis would benefit from additional data (both from the past or available in the near future) and from involvement of the hydropower operators themselves. It is expected this task can be conducted with GLAM Committee staff at EC and USACE through the Board regulation representative offices and initial products completed by August 2016. Based on these initial products an assessment will be made of what further work required in next fiscal year's work plan.

Products:

- Draft Report on varying hydropower plant capacity due to hydrologic conditions
- Evaluation and initial draft report on impacts and potential strategies to address reductions in hydropower capacity

4.1.2 Review the use of multiple partially open gate settings at the Compensating Works and impacts on St. Marys River stakeholders

As a result of the recent rise in upper Great Lakes water levels, regulated outflows from Lake Superior through the St. Marys River have also increased, and this has required the gate setting of the Compensating Works at the head of the St. Marys Rapids to be increased above the minimum one-half gate equivalent. A number of concerns have been raised in using fully open gates including the impacts of higher flows and levels on the St. Marys Rapids fishery and recreational anglers, potential flooding of Whitefish Island, the risk of ice damage to the Compensating Works and structures in the lower St. Marys River, the impacts of "spilled" water on hydropower production, and impacts to commercial navigation due to reduced levels in the lower St. Marys River if gate settings were reduced. Since May 2014 the Superior Board began employing multiple partially open gates in lieu of fully open gates in order to provide a number of potential benefits in the St. Marys Rapids. One issue with this new approach is that the existing hydraulic relationships and the flow measurements used to verify the relationships are applicable to flow through fully open gates at the Compensating Works only, and cannot be applied to partially open gate settings. Flows through the partially open gates have been calculated using standard, textbook gated flow equations. Flows through the Compensating Works constitute a significant component of the overall flow through the St. Marys River, particularly during periods of high flows when they make up a greater proportion of the total. Therefore, understanding the relationships between water levels and flows through partially open gates is critical to the operation of the Compensating Works and to the determination and regulation of the total outflow from Lake Superior.

In this task the GLAM Committee and support staff will work with stakeholders, including ecosystem/fisheries scientists, recreational anglers, First Nations/Whitefish Island and hydropower operators, to develop a better understanding of the advantages and disadvantages of partially

open gate settings. If necessary, any issues may be addressed through modifications to the Coordinated Great Lakes Regulation and Routing Model (CGLRRM), Plan 2012 and/or the operational guidelines for Lake Superior regulation. The Superior Board staff working with the GLAM Committee will use recently collected St. Marys Rapids flow measurements at partially open gate settings, to begin to develop and verify partially open gated flow equations and these equations will need to be incorporated into the CGLRRM so that it could be used operationally by the Board for Lake Superior regulation and by GLAM for the ongoing evaluation of regulation plans. It is expected this task can be conducted with GLAM Committee staff at EC and USACE through the Board regulation representative offices and initial products completed by August 2016. Based on these initial products an assessment will be made of what further work required in the next fiscal year.

Products:

- Initial report on benefits/disadvantages to stakeholders of partially open gate settings
- Initial joint report with Superior Board on partially open gate setting flow relationships for operational implementation and incorporation into CGLRRM

4.2 Develop a shared vision planning/modelling process for the on-going evaluation of regulation plans.

GLAM will periodically **review the current regulation plans** to assess how well they are fulfilling their design objectives, and will **evaluate alternative regulation plans** in a manner consistent with the reporting requirements of the directive. Detailed plan evaluation processes were established in each of the LOSLR and IUGLS studies that allowed Study Boards and the IJC to effectively rank regulation plans. As part of this process, GLAM will also **validate and update the models used to evaluate regulation plans** based on data gathered after the models were built. This task is to develop a written process for conducting these three interrelated assignments.

The first objective of this task is to provide a clear protocol that explains how the past evaluations were done and provides easy access to the models and data needed to run the evaluations. Subtasks for this work are:

- Write a short paper summarizing the available information on evaluating alternatives, including access to the necessary models and data, and determine what additional work is necessary. The paper would include a short comparison and assessment of the ranking protocols, which were different for Lake Ontario and Upper Lake studies.
- Identify important sensitivity analyses to find the most significant areas of uncertainty in the evaluation models.

The second objective is to develop processes for validating and updating the models used to evaluate plans. This could include writing a paper that describes the potential for change in each major element of the existing evaluation framework matrix from the LOSLR and IUGLS and outlining a process for making those changes. It could also include the development of GLAM procedures for ratifying changes. For example, we expect new information regarding shore protection structures in New York State that

could change the LOSLR Study estimates of damage. The GLAM procedure would include a method for determining and documenting whether the new information was different enough to warrant a change in the shore protection element of the FEPS model, a procedure for designing and approving those changes (including requirements for communication with stakeholders, the Boards, and the IJC).

The third objective is to establish a process for assessing how the plan currently in operation is doing relative to expected outcomes. This will require a modification to the approach and methods used during the past studies for comparing and ranking plans, although the approach will rely heavily on existing data, tools and models from those studies. The focus for the first year will be to generate ideas for how best to assess how the current plan is doing in meeting expected outcomes building on existing performance indicators and modelling tools. The St. Marys River projects (4.1.1 and 4.1.2) represent specific examples of assessing operational performance and will contribute to the methodology development under the current task.

It is expected that the development of the On-Going Evaluation Process that considered alternative plan rankings, model validation, and assessment of current plan will be initiated this fiscal year, but may not be fully developed until a number of initial products from this annual work plan can be assessed and utilized.

Product:

- A paper describing the evaluation and ranking processes used in the LOSLRS and IUGLS and any suggestions for the evolution of those processes.
- A generic standard operating procedure for model validation
- A proposed method for assessing how well current plans are meeting expected outcomes
- A procedure for making GLAM recommendations in these three areas
- Guidelines for developing a shared vision process for the on-going review of the regulation plans (scope, process, engagement, time horizon etc.)

4.3 Learning phase and test run of existing evaluation models using any updated information/tools and various scenarios

While a focus of the GLAM Committee in the initial years will be to establish the shared vision planning for the on-going plan evaluation process as described in task 4.2 above, the purpose of this task is to initiate a learning phase with technical staff to allow them to run the existing and/or updated evaluation models and tools so more people know how to use the SVM. Some test sensitivity analyses with updated information as examples could be used to teach GLAM Committee support staff how to run through an evaluation process so they can begin to familiarize themselves with the tools and methods. The test evaluation could use all updated models/tools including the updated wetlands model developed as part of task 1.2, the new shore protection design heights for coastal damages in the FEPS from task 1.3, and new data and information from varying hydropower plant capacity from task 4.1.1 and partially open gate setting flow relationships from Task 4.1.2 as well and any new or revised water supply sequences and performance indicators that are available to the GLAM Committee. The plan

evaluations could be re-run and tested under different scenarios and using examples of different sensitivity analyses to determine where areas of greatest uncertainty exist and where model improvements might be possible. During this phase, a help page will be developed for known issues with the evaluations, such as the difficulties in running IUGLS shore protection code. The test process will include documentation of what was done, lessons learned and recommendations for improvements in the future. The work is expected to be completed by September 2016 using staff contributions from USACE and EC along with GLAM Committee participants.

Product:

- A tutorial based on a short paper summarizing the available information on running evaluations, including access to the necessary models and data outlined in 4.2
- A paper documenting the tests run, lessons learned and recommendations for improvements in the future

Section B: Management and Administration

5. Coordination, Management, Operation and Oversight of Work of GLAM Committee

5.1 GLAM Committee Coordination, Management, and Reporting

This is a basic task that includes the on-going coordination, management operation and oversight of GLAM Committee activities and working groups. It includes primarily the work of the co-chairs, secretaries and their staff who help support the operation of the GLAM Committee. This activity is supported primarily through the USACE and EC with some operation and maintenance funds provided through the IJC-Ottawa. This is an on-going activity. There are a series of sub-tasks associated with the ongoing GLAM Committee Coordination, Management, and Reporting.

5.1.1 Prepare and submit annual work plan

Each year the GLAM Committee will prepare an annual work plan for submission to the Boards outlining the activities to be undertaken and products to be delivered in support of the adaptive management process. The work plan will identify the priority work items, the project leads, timeline, any external costs, GLAM Committee contributions and product deliverables. This will be submitted to the Boards in advance of their fall semi-annual meeting and presented to the Boards at their fall meeting. The Boards will present the work plan to the IJC at the IJC Appearances. The Boards may request the GLAM Committee co-chairs to present the work plan on their behalf to the IJC.

Product:

- Annual work plan for FY 2017 for submission to the Boards

5.1.2 Establish working groups

Each item within the annual work plan will need project managers and in many cases a team to complete. These teams need to be assembled quickly as soon as the annual work plan is approved by the Boards/IJC. The GLAM Committee members are to identify any internal resources (staff, etc.) that they can bring to the annual work plan efforts.

Product:

- A list of team leads and team members for each product.

5.1.3 Develop semi-annual reports

As per the IJC Directive, the GLAM Committee will prepare a semi-annual progress report outlining the status of the GLAM Committee in meeting the commitments of their annual work plan. This progress report will be prepared by the GLAM Committee secretaries and co-chairs and presented to the Boards at their March meetings in advance of the IJC Appearances. The Boards will report on progress to the IJC or may ask the GLAM Committee co-chairs to present on their behalf.

Product:

- A semi-annual progress report for submission to the Boards in March 2016

Strategic Planning

5.2 Develop triennial report outline

The first Triennial Report of the IJC on the progress of the Great Lakes Water Quality Agreement is due in January 2017. As per the GLAM Committee’s Directive from the IJC, the GLAM Committee shall report to the IJC on a similar schedule. Given that the first Triennial report is only a year and a half away, it is a priority of the GLAM Committee to develop a 2017 report outline that can be agreed upon by the Committee and shared with the Boards and IJC well in advance so that there is agreement on what is expected. This will be completed by the GLAM Committee by March 2016.

Product:

- An annotated outline of the January 2017 Triennial Report

5.3 Prepare a mid-term strategic plan

In addition to the annual work plan, the GLAM Committee will develop a longer time-horizon plan that supports the long-term requirement for a 15 year full evaluation of the regulation plan. The mid-term strategic plan allows the GLAM to consider what can be done within a 3-5 year time horizon and the stages required to support the 15 year plan evaluation. The 3-5 year outlook of a mid-term strategic

plan will consider important stages of the adaptive management process and provide a broader planning horizon over which to consider the arc of an adaptive management process. The first mid-term strategic plan will be completed and presented to the Boards by their Fall 2016 meeting using GLAM Committee resources.

Product:

- A mid-term strategic plan covering 2015-2017 inclusive and looking out to 2020.

Operating Procedures

5.4 Establish annual priority setting procedures

Each year the GLAM Committee will be required to establish priorities in supporting the overall adaptive management process. With limited funding and resources, the GLAM Committee in consultation with the Boards will have to choose which activities have the highest priority for that year. To undertake this prioritization, the GLAM Committee will develop a set of criteria for ranking priorities. The GLAM Committee will establish a standard procedure for ranking and prioritizing tasks by December 2015. This will be undertaken as a GLAM Committee exercise and no external funding is necessary.

Product:

- A written process for evaluating annual priorities

Quality Assurance and Quality Controls

5.5 Monitoring of the work plan delivery

The GLAM Committee secretaries in conjunction with the GLAM Co-chairs will lead the effort to develop the details of how the work plan will be monitored and controlled. This could include, for example EC Worksheets; USACE controls; contractor requirements; semi-annual reporting; project assurance by IJC advisors and Board members, etc. The strategy for monitoring work plan delivery will be developed by the GLAM Committee by the end of December 2015.

Product:

- Mechanisms will be established and in place for monitoring work plan delivery

Information Management – Data portal/Data visualization

5.6 Establish internal information management system

A key priority as the GLAM Committee initiates its work is to have a means for internal communication. This task will focus on setting-up and utilizing internal information management mechanisms such as a

share point site and ftp sites for exchanging files and sharing documents, data and models. The work will largely be conducted by the secretaries as is expected to be operational by June 2016.

Product:

- An effective framework for sharing GLAM files (includes SharePoint, website, etc.)

6. Communication, Outreach and Engagement

A Communications, Outreach and Engagement strategy has been developed and shared with the Boards of Control. This strategy outlines the basic communication principles, procedures, products and tactics for on-going communications, outreach and engagement. In the first year, the GLAM Committee will strive to undertake the following items within that strategy.

6.1 Develop story line of the evolution of the GLAM

This task will assist in communicating the history and objectives of the GLAM Committee to government agencies, organizations/interest groups, academia, and stakeholders. The success of the GLAM Committee will depend on outreach to, and the engagement of outside parties in order to take advantage of research, studies, projects, and other efforts that may coincide with GLAM objectives. Explaining the history and objectives of the Committee will be a crucial communication tool to provide a consistent and clear message when engaging parties that may be able to assist in the needs of the GLAM effort. This story line will be developed by the GLAM Committee with support from IJC Communications staff by December 2015.

Product:

- A standard presentation and fact sheet on what the GLAM Committee is and what it does for distribution and posting to GLAM Committee website.

6.2 Identify key advisory groups to the GLAM Committee

6.2.1 Engage with agency senior management to encourage collaboration, sharing, and exchanging information

The engagement of government agencies will be a key element to leverage existing or future agency efforts to support the monitoring and/or research needs required for the on-going assessment of the regulation plans. Engagement with agency senior management may be accomplished by developing a list of key agencies, establishing a point of contact for each agency, and create a consistent communication frequency and method. Members of the GLAM Committee will support this effort with the intent of a preliminary product by December 2015.

Product:

- Identify a network of key agency representatives

6.2.2 Develop stakeholder circles of influence

The engagement of stakeholders will assist in the evaluation of indicators used to measure the impact to the six areas of interest including domestic, municipal, and industrial water uses, commercial navigation, hydroelectric generation, ecosystems, coastal zone, and recreational boating and tourism. Ideally, the stakeholder circles of influence will consist of identifying individuals to represent each interest and establish a consistent communication method by which they may be engaged. The circles of influence members may be asked to provide input on current algorithms used to calculate indicators, or to provide information on changes occurring within the system. Members of the GLAM Committee will support this effort with the intent of a preliminary product by March 2016. Input from the Boards of Control will be sought.

Product:

- A completed table outlining the current state of the relationship between key stakeholders and the GLAM Committee members and Board members.
- A list of key contacts representing various circles of influence

6.2.3 Establish a research community network

The engagement of the research community (i.e. academia) will be another important element to leverage existing or future efforts to support the monitoring and/or research needs required for the on-going assessment of the regulation plans. Engagement with academia may be accomplished by developing a list of universities, professors, or others individuals to encourage new, or take advantage of existing research efforts that may aid the GLAM Committee in reducing uncertainty of certain indicators, or identify new indicators over time. This effort will be led by members of the GLAM Committee with anticipated completion by March 2016.

Product:

- Develop a list of research organizations and contact information for individuals who the GLAM Committee can reach-out to on a fairly regular basis

6.2.4 Establish appropriate connections related to the Great Lakes Water Quality Agreement

The IJC Directive to the GLAM Committee specifically highlights the importance of ensuring coordination and liaison between the Great Lakes control boards and the boards created by the Great Lakes Water Quality Agreement (GLWQA) – the Great Lakes Water Quality Board (WQB) and Science Advisory Board (SAB). To better link water levels and flows regulation with water quality considerations, the GLAM Committee is requested to engage in outreach activities with the WQB and SAB. The GLAM Committee co-chairs have committed to participating in joint meetings of the WQB and SAB. Additionally, the GLAM Committee needs to identify the most appropriate connections with the GLWQA Annex activities through the Great Lakes Executive Committee related to habitat, biodiversity,

ecosystem indicators and climate change impacts. This task will be to establish an appropriate list of GLWQA connections by December 2015.

Product:

- A list of appropriate GLWQA contacts for review by IJC and GLEC

6.3 Develop an engagement plan for advisory networks

As the GLAM Committee works to identify important representative to support agency networks, stakeholder, and academia advisory groups and GLWQA connections, the GLAM Committee will need to work to develop an engagement strategy for each network. This will build upon the Communications, Outreach and Engagement Strategy by providing details of how and when the GLAM Committee should/could engage with each network and what mechanisms they will use to reach out to the various representatives and how they will be engaged. It will also consider resources and timelines and will directly feed into next year’s annual work plan. This effort will be led by members of the GLAM Committee with support from IJC staff with anticipated completion by August 2016.

Product:

- Detailed engagement strategy of GLAM advisory networks

Section C: Other Special Projects Requested by the Board(s)

From time to time the Boards of Control may have special questions that they wish the GLAM Committee to address. These requests will be made in writing to the GLAM Committee as special reference projects and will be included in the annual work plans. No special Board projects have been included in this first year work plan.

Work Plan Table

| 1. Are Models Verified by Real Data? | | | |
|--|---|--|---------------------------|
| Task | Proposed Task | Proposed Products | Estimated Delivery |
| 1.1 | Monitoring of Lake Ontario coastal wetland habitat (IWI) | 1) Complete field surveys for 8 Lake Ontario wetlands sites on the Canadian shoreline 2) Field data input to existing databases, post-processed, reviewed and summary results provided to the IJC's GLAM Committee 3) Executive Summary and Final Summary Report describing key aspects of the field approach and general findings | Mar-16 |
| 1.2 | Evaluate meadow marsh algorithm (IWI) | 1) An excel based modelling tool that incorporates recent observed wetland monitoring data and allows for an assessment under actual water level conditions compared to expected performance indicator results from existing planning models used in LOSLR. 2) Transfer of expertise on the evaluation tools from contractors to government agencies. | Aug-16 |
| 1.3 | FEPS models - update based on Shore Protection Information (PI verification) | 1) Updated FEPS database of shore protection types, quality and height for locations where field surveys were undertaken on behalf of USACE. 2) Initial comparison of FEPS model results using the baseline model assumption and the site specific structure information (field data). | Mar-16 |
| 2. Have Water Supplies Changed? Tracking Hydrologic and Hydraulic Factors | | | |
| 2.1 | Track Advancement Towards Improving Quality of NBS Information | 1) Integration of USACE annual report on advancements and continued uncertainty into GLAM Committee surveillance summary. | Mar-16 |
| 2.2 | Extended CaPA and GEM Hindcasts of Water Supply Components in the Great Lakes Basin (IWI) | 1) CaPA and GEM hindcasts extended to 1995 at a 50-km resolution and an assessment of extending back to 1983 and the added value of a 15-km analysis over the Great Lakes watershed. | Mar-16 |

| Task | Proposed Task | Proposed Products | Estimated Delivery |
|---|--|--|--------------------|
| 2.3 | Inventory of Available NBS Components for the Great Lakes | 1) Inventory of current state of NBS component information. | Sep-16 |
| 2.4 | Review and Update of Historical Hydrologic and Hydraulic datasets for the Lake Ontario - St. Lawrence River system through Montreal and the St. Lawrence River | 1) Metadata for all hydrologic and hydraulic datasets required for LOSLR plan formulation and evaluation 2) Documented process for annual updates 3) Review and update to historical datasets for the 1900-2014 period-of-record | Aug-16 |
| 3. Has the System Changed and What is Impacted? (physical, environmental, socio-economic)? | | | |
| 3.1 | Design a Surveillance Plan | 1) An initial framework for developing an on-going surveillance plan (including scope, timing, costs etc.) 2) A initial summary report on what is learned through the surveillance efforts listed below for use in the annual priority setting exercise | Jun-16 |
| 3.2 | Initial Surveillance to determine what has changed and whether there are new data and models available to support AM effort. Includes subtasks: - 3.2.1: Ecosystem Surveillance - 3.2.2: Socio-economic Surveillance - 3.2.3: Surveillance of physical changes and modelling tools | 1) Updated ecosystem contextual narratives. Database of important and related scientific research; Assessment report on available ecosystem related data sources and models/tools that could support AM effort. 2) Updated socio-economic contextual narratives. Database of important and related scientific research; assessment report on available socio-economic data sources and models/tools that could support AM effort. 3) Contextual narrative on how the Great Lakes system may be changing based on existing literature and a written assessment of the current state of data, models and tools available for assessment of changes to the physical system including the climate of the system. 4) A initial summary report on what is learned through the surveillance efforts for use in the annual priority setting exercise and integrated into the plan evaluation process itself | Mar-16 |

| 4. Can the Regulation Plan Be Improved? | | | |
|--|--|---|---------------------------|
| Task | Proposed Task | Proposed Products | Estimated Delivery |
| 4.1.1 | Review the impacts of reductions in maximum side-channel capacity due to hydropower outages and other limitations and develop optimal operational guidelines for addressing them | 1) Draft Report on varying hydropower plant capacity due to hydrologic conditions 2) Evaluation and initial draft report on impacts and potential strategies to address reductions in hydropower capacity | Aug-16 |
| 4.1.2 | Review the use of multiple partially open gate settings at the Compensating Works and impacts on St. Marys River stakeholders | 1) Initial report on benefits/disadvantages to stakeholders of partially open gate settings 2) Initial joint report with Superior Board on partially open gate setting flow relationships for operational implementation and incorporation into CGLRRM | Aug-16 |
| 4.2 | Develop a shared vision planning/modelling process for the on-going evaluation of regulation plans | 1) A paper describing the potential for change in each major element of the existing evaluation framework matrix from the LOSLR and IUGLS and outlining a process for making those changes. 2) A generic standard operating procedure for model validation 3) A proposed method for assessing how well the plan in operation is meeting expected outcomes 4) A GLAM procedures for ratifying changes 5) Guidelines for developing a shared vision process for the on-going review of the regulation plans (scope, process, engagement, time horizon etc.) | Jun-16 |
| 4.3 | Learning Phase and test run of evaluation process using any updated information/tools of various scenarios | 1) A tutorial based on a short paper summarizing the available information on running evaluations, including access to the necessary models and data outlined in 4.2 2) A paper documenting the tests run, lessons learned and recommendations for improvements in the future | Sep-16 |

| GLAM Committee Coordination, Management, and Reporting | | | |
|---|---|--|---------------------------|
| Task | Proposed Task | Proposed Products | Estimated Delivery |
| 5.1 | GLAM Committee Coordination, Management and Reporting Includes: - 5.1.1: Prepare and submit annual work plan - 5.1.2: Establish working groups - 5.1.3: Develop semi-annual reports | 1) Annual work plan for FY 2017 for submission to the Boards 2) A list of team leads and team members for each product. 3) A semi-annual progress report for submission to the Boards in March 2016 | Sep-16 |
| Strategic Planning | | | |
| 5.2 | Develop triennial report outline | 1) An annotated outline of the January 2017 Triennial Report | Mar-16 |
| 5.3 | Prepare mid-term strategic plan | 1) A mid-term strategic plan covering 2015-2017 inclusive and looking out to 2020. | Sep-16 |
| Operating Procedures | | | |
| 5.4 | Establish annual priority setting procedures | 1) A written process for evaluating annual priorities | Dec-15 |
| Quality Assurance and Quality Controls | | | |
| 5.5 | Monitoring of the work plan delivery | 1) Mechanisms will be established and in place for monitoring work plan delivery | Dec-15 |
| Information Management | | | |
| 5.6 | Establish internal information management system | 1) An effective framework for sharing GLAM files (includes SharePoint, website, etc.) | Jun-16 |
| 6. Communication, Outreach, and Engagement | | | |
| Task | Proposed Task | Proposed Products | Estimated Delivery |
| 6.1 | Develop story line of the evolution of the GLAM | 1) A standard presentation and fact sheet on what the GLAM Committee is and what it does for distribution and posting to GLAM Committee website. | Dec-15 |
| 6.2 | Identify a number of advisory groups to the GLAM Committee Includes: | 1) Identify a network of key agency representatives 2) A completed table outlining the current state of the relationship between key stakeholders and the GLAM Committee members and Board members. 3) A list of key contacts representing various circles of influence 4) Develop a list of research organizations and contact information for individuals who | Mar-16 |

GLAM Committee Annual Work Plan for 2016

Created/updated 02/12/16

| | | | |
|-----|--|--|--------|
| | <p>6.2.1: Engage with agency senior management to encourage collaboration, sharing, and exchanging information</p> <p>6.2.2: Develop stakeholder circles of influence</p> <p>6.2.3: Establish a research community network</p> <p>6.2.4: Establish appropriate GLWQA connections</p> | <p>the GLAM Committee can reach-out to on a fairly regular basis</p> <p>5) A list of appropriate GLWQA contacts for review by IJC and GLEC</p> | |
| 6.3 | Develop an engagement plan for advisory networks | 1) Detailed engagement strategy of GLAM advisory networks | Aug-15 |

The work plan outlined above represents an ambitious yet achievable set of products for the first year. The year 1 work plan items are but a few of the key priorities chosen from an extended list by the GLAM Committee. Additional priorities considered are summarized in Appendix 1 and these will be further scoped out as part of the mid-term 3-5 year strategy. Some of these items have been discussed as possible candidates for IWI submission either in the Fall 2015 or Spring 2016 sessions to acquire additional resources and these are listed in the following table. The estimated resource requirements for these projects are currently under assessment and the decision on whether to submit will depend on the GLAM’s ability to add on these extra tasks without sacrificing other year 1 work plan commitments.

POSSIBLE IWI SUBMISSIONS (See Appendix for Full Description)

| Task | Proposed Task | Proposed Products | Estimated Delivery |
|--|--|--|---------------------------|
| Have Water Supplies Changed? Tracking Hydrologic and Hydraulic Factors | | | |
| A1 | Redevelop Coordinated Great Lakes Regulation and Routing Model | - Updated operational Great Lakes Routing Model | TBD |
| A2 | Application of a new statistical modelling framework across all Great Lakes and over a historical time period | - Closing of the water budget on all five Great Lakes to identify key areas of uncertainty in estimates of NBS components | TBD |
| Has the System Changed and What is Impacted? (physical, environmental, socio-economic)? | | | |
| A3 | Conduct a follow-up surveillance workshop to begin developing the surveillance plan | - A workshop to glean lessons learned on surveillance outcomes and possible long-term approaches | TBD |
| A4 | Determine influence of regulation on Lake Ontario-St. Lawrence River Phragmites (develop a project strategy to undertake work) | - The design of an AIS monitoring approach for Phragmites on the Lake Ontario- St. Lawrence River system | TBD |
| A5 | Lower River Integrated Ecological Response Model – IERM2D to be converted to new code | - An updated IERM2D for lower St. Lawrence River to new modelling code to allow for the assessment of ecological outcomes for the lower river. | TBD |
| A6 | Scope out the monitoring and modelling approach for ecosystem impacts on the St. Marys River | - A monitoring and modelling approach for the assessing ecosystem impacts on the St. Marys River | TBD |
| Information Management | | | |
| A7 | Develop an Information Management Plan (includes a process for sharing interim | - Brief strategy document outlining key Information Management | TBD |

| | | | |
|--|---|-----------------------------------|--|
| | results that GLAM members are interested in (e.g. SharePoint) | guidance for use by the Committee | |
|--|---|-----------------------------------|--|

Work Plan Annex: Background/Work Plan Context:

Principles

The following are a set of principles that will guide the work of the GLAM Committee and the implementation of this Annual Work Plan by:

1. Adhering to the existing authorities of the Boards and IJC and the existing procedures for making changes to a regulation plan
2. Conforming to meet the IJC Directive to the GLAM Committee
3. Addressing the long-term (15 year) reporting horizon, the mid-term triennial reporting period and short-term annual progress reporting and not within-year decisions.
4. Being product based
5. Addressing how a plan is performing under recent shorter term conditions (past number of years based on real data) and how a plan performs under variable and extreme conditions (scenario based evaluations)

Adaptive Management Framework

This annual work plan represents an action plan of activities required to carry out effective adaptive management. It is based on a system-wide framework for decision support through state-of-the-art hydroclimate and climate change science for the Great Lakes - St. Lawrence River system; on-going understanding of risk and how the system is changing; tools for developing and evaluating regulation plans; and linking that information and knowledge with the Boards of Control and IJC who make decisions from a water levels management perspective and those most affected by those decisions. The overall AM Framework includes five interrelated and interdependent components that together provide the information, tools and process for on-going and adaptive decision making. These components include:

1. Hydroclimate Monitoring and Modeling
2. Performance Indicators and risk assessment
3. Plan Evaluation tools and process
4. Information Management and Distribution
5. Communication, Outreach and Engagement

These five components provide the basis for supporting the principles of adaptive management, to monitor, evaluate, learn and adjust and form a basis for this annual work plan.

Work Plan Prerequisites and External Dependencies

Prerequisites required to ensure the success of this work plan include the on-going annual support of the agencies represented on the GLAM Committee along with additional staff support as identified by those agencies. It also assumes that funding confirmed by the IJC in the order of \$80K Cdn and \$45K U.S. to support a number of approved IWI projects will be forthcoming and that a base level of funding promised by the IJC (\$90K Cdn and \$5K US) will also be made available and that the mechanisms for ensuring the transfer of funds to the supporting agencies are in place. The priorities set within this work plan assumed the current regulation plans including Lake Superior Plan 2012 and Plan 1958 DD regulating the outflows of Lake Ontario were in place. Should the IJC's recommended Plan 2014 be implemented within the fiscal year, this could have implications to the work priorities established. The work plan might also be affected by water level conditions should any of the lakes move into extreme conditions within the year, and this could alter the prioritization and/or addition of new tasks.

As this is an on-going effort and this represents the first annual work plan, the priorities set and commitments made are estimates based on what the Committee understand to be the resources available. The expertise available through the agencies is still being evaluated relative to the priorities identified. There may in fact be need to readjust proposed products depending on the expertise required and available to complete the task. These assessments will occur throughout the year as the work plan progresses. Should the GLAM Committee determine that they are not able to deliver on any of the products identified, they will notify the Boards through the Board secretaries.

Lessons Incorporated

While the GLAM Committee is a newly established Committee of the IJC, it is not starting from scratch. The GLAM Committee has the benefit of two major IJC studies on the regulation plans – the International Upper Great Lakes Study (IUGLS) and the Lake Ontario-St. Lawrence River (LOSLR) study – which both concluded that adaptive management is the best way to address the uncertainties associated with climate change and the potential for extreme water levels and their associated impacts. These studies provide the backbone from which the adaptive management effort can be built, including the development of multiple water supply sequences, performance indicators, evaluation tools and models, along with a process for evaluating and ranking regulation plans. In essence, the AM effort begins where the studies left off and recognizes these studies as an important contribution to the first phase of the AM effort.

Many lessons were learned from these studies and post study efforts that will help the GLAM Committee as it develops its long-term evaluation strategy and sets priorities. A few of the lessons that have most influenced the priority setting for this first annual work plan are listed below.

From LOSLR:

- The review of regulation plans for Lake Ontario and the St. Lawrence River has been controversial and difficult to resolve. Opponents to a change in regulation plans continue to focus objections on uncertainties about the science and unknowns related to future climatic and economic conditions. The LOSLR Study and subsequent Government Working Group recognized that adaptive management provides an effective way to address uncertainties through on-going strategic monitoring, analysis and review.
- There are four key environmental performance indicators that have been identified for follow-up from the LOSLR study and post LOSLR efforts and these include: wetland vegetation, bird communities, northern pike, and muskrat. These four performance indicators were identified during the LOSLR Study and subsequent follow-up as being highly significant in terms of representing broad ecosystem response, being sensitive to water level changes, and representing a relatively high degree of scientific certainty.
- There are a number of socio-economic performance indicators that have been identified for follow-up to verify simulated model results, particularly from the Flood and Erosion Prediction System (FEPS) developed and used in the LOSLR Study. Shore protection maintenance was determined to be the performance indicator most sensitive to changes to a regulation plan. The shore protection design height assigned to various geographical locations around the lake were found to be quite sensitive to small changes in the regulation plans. Follow-up monitoring of actual design-height has been identified as a priority for on-going plan evaluation.
- Some follow-up to recreational boating, commercial navigation, municipal infrastructure and hydropower has also been identified from the LOSLR study and post LOSLR efforts for the Lake and River.

IUGLS

- Based on regulation plan formulation and evaluation efforts undertaken in IUGLS, there were only a few performance indicators identified that would be greatly improved or degraded by the Lake Superior regulation plan. Therefore, minimal follow-up of performance indicators is required in the near term, though ongoing assessment of emerging issues may identify additional performance indicators over the longer term. Follow-up analysis is needed to assess the implications on a few performance indicators specific to the St. Marys River area.

Revision History

Date of next revision:

| Revision Date | Previous Revision Date | Summary of Changes | Changes Marked |
|---------------|------------------------|--|----------------|
| Sep 10 | Aug 10 | Reorganized certain tasks, filled-in sections still needing to be completed, deleted tasks that could not be completed this fiscal year, updated table, added a table of available resources | Yes |
| Sep 16 | Sep 10 | Addressed input and comments received from GLAM Committee | No |
| Oct 22 | Sep 16 | Addressed comments provided at GLAM Committee Meeting and from presentational to the Boards of Control | No |

Endorsement

This document has been endorsed by the three Great Lakes Boards of Control.

APPENDIX – Additional Work Items Considered

The following tasks have been identified as priorities, but are beyond the resources currently available. These items are currently viewed as possible candidates for IWI funding. These are presented by category and not in order of priority.

Have Water Supplies Changed? Tracking Hydrologic and Hydraulic Factors

A1. Redevelop the Coordinated Great Lakes Regulation and Routing Model

The current Coordinated Great Lakes Regulation and Routing Model (CGLRRM) has been employed since the 1990s. It is used to simulate water levels and connecting channel flows in the Great Lakes – St. Lawrence River system under different water supply scenarios and regulation scenarios. The model was employed during the IUGLS for plan formulation and evaluation purposes, and has been used by various agencies for operational regulation, forecasting and research purposes, including the U.S. Army Corps of Engineers (USACE), Environment Canada (EC) and by the National Oceanic and Atmospheric Administration's (NOAA) Great Lakes Environmental Research Laboratory (NOAA-GLERL). The Routing Model provides a critical step in the on-going review and assessment of the regulation plans by translating net basin supplies (overlake precipitation+runoff-overlake evaporation) into water levels and flows. This model requires updating to ensure an authoritative, coordinated numerical model that efficiently and accurately simulates water levels and connecting channel flows in the Great Lakes – St. Lawrence River system through Montreal, given various possible net basin supply scenarios and under alternative regulation approaches. The model must be flexible, easy to learn, modify and employ, and must be well-documented.

Products:

- An updated operational Coordinated Great Lakes Regulation and Routing Model

A2. Application of a new statistical modelling framework across all Great Lakes and over a historical time period

In order to understand and differentiate hydrological drivers behind water level fluctuations on the upper Great Lakes, new historical estimates of the major components of each lake's water budget were developed by NOAA and EC within a Bayesian Markov chain Monte Carlo (MCMC) framework. Unlike conventional water budget estimation methods used in previous studies (including, for example, deterministic physically-based model simulations), this approach leverages information from multiple models and datasets while explicitly acknowledging and resolving the bias and uncertainty of each source. This approach can help in resolving the regional water budget across monthly and inter-annual time scales and represents an important stepping stone towards addressing a long-standing need in the Great Lakes for clear and defensible differentiation between hydrological, climatological, geological, and anthropogenic drivers behind seasonal and long-term changes in Great Lakes water. This framework has been applied to Lake Superior and Michigan-Huron to explain the recent surge in water

levels since January 2013 and this proposal would be to extend this work across all of the Great Lakes and over a historical time period.

Products:

- The closing of the water budget on all Great Lakes to identify key areas of uncertainty in estimates of NBS components

Has the System Changed and What is Impacted? (physical, environmental, socio-economic)?

A3. Conduct a follow-up surveillance workshop to begin developing the surveillance plan

Task 3.1 of the year 1 work plan is to develop a long-term surveillance plan. Work will be initiated on three initial surveillance efforts under task 3.2. The purpose of this IWI proposal would be to host a follow-up workshop to the three surveillance projects to bring in experts to discuss the outcomes from these surveillance projects covering ecosystems, socio-economic implications, and physical changes and modelling tools to glean lessons learned from these projects and work with experts to begin the design of a long-term surveillance plan to more effectively capture and apply information that is not being monitored in specific GLAM Committee projects, but which could be useful to improved lake level regulation.

Products:

- A workshop to glean lessons learned on surveillance outcomes and possible long-term approaches

A4. Determine influence of regulation on Lake Ontario-St. Lawrence River Phragmites

There is some concern that any establishment and expansion of Aquatic Invasive Species (AIS) within Lake Ontario and the St. Lawrence River could have some relationship to the management of water levels and flows. An AIS monitoring program is proposed to monitor the effect of a regulation plan on AIS establishment versus dyked wetlands that are hydrologically separated from the lake or river and not influenced by regulation of water levels and flow. Of particular interest is expansion of Phragmites, a common reed (*Phragmites australis*) throughout the Lake Ontario – St. Lawrence River Basin. The task would be to develop an AIS monitoring program that would draw on existing programs and expertise in the lower Great Lakes-St. Lawrence River basin and incorporate a suite of control ‘coastal’ wetlands with managed or lost hydrologic connectivity to Lake Ontario and the St. Lawrence River (e.g., dyked wetlands or wetlands with permanent barriers). Project elements include: alignment with existing AIS and common reed monitoring programs, accumulation of expertise, study design and field/Geographic Information System (GIS) methodology, and costing.

Products:

- The design of an AIS monitoring approach for Phragmites on the Lake Ontario-St. Lawrence River system

A5. Lower River Integrated Ecological Response Model – IERM2D to be converted to new code

The Integrated Ecological Response Model for the lower river, otherwise known as the IERM2D is an ecohydraulic modelling tool used to estimate environmental impacts on the lower river under varying water levels and flows. It is an integral part of the Shared Vision Model (SVM) utilized during the LOSLR. To run the model for future applications will require that the code be updated from .Net format to python code. This IWI proposal will be to conduct that update of the code so the IERM2D can be utilized for GLAM purposes.

Products:

- An updated and functioning IERM2D for the lower St. Lawrence River using new modelling code to allow for the assessment of ecological outcomes for the lower river.

A6. Scope out the monitoring and modelling approach for ecosystem impacts on the St. Marys River

Task 4.1.1 and 4.1.2 of this GLAM Committee year 1 work plan examine how operational components of Plan 2012 such as assumptions of a maximum side channel capacity and the relationship between partially open gate settings in the Compensating Works can impact on various stakeholders including environmental interests in the St. Marys River. One of the intended goals of the new regulation plan was to have smoother, more natural flows in the St. Marys River to improve environmental outcomes on the River. To fully understand the potential environmental implications of any changes there needs to be a proper monitoring and modelling approach established on the St. Marys River. The purpose of this IWI proposal would be to design such a monitoring and modelling approach to better understand the ecological implications of the regulation plan over time on the St. Marys River (including the rapids) to better assess whether the regulation plan is meeting expected outcomes.

Products:

- An ecological monitoring and modelling approach for the St. Marys River

A7. Develop an Information Management plan

The Information Management Strategy is a framework for successfully managing incoming and outgoing information created, received, or maintained by the GLAM Committee as part of ongoing activities. The Strategy will provide guidance on what might need to be managed and how that management could occur. As part of the initial task, the Strategy will primarily focus on internal information management issues identified by the Committee. A short strategy document will be prepared for review and approval by the Committee. Going forward, the Information Management Strategy will need to align closely with the Communications Strategy to ensure materials prepared by or on behalf of the Committee are made available to the right audiences. As well, there are overlaps with model management efforts. By March

2016, further scoping will be undertaken regarding Information Management requirements as they relate to external communications and the management of large datasets and models used by the Committee.

Products:

- Brief strategy document outlining key Information Management guidance for use by the Committee
- Initial scoping document for broader Information Management requirements of the Committee including linking with Communications Strategy and the management of models and datasets

List of items considered, but moved to the mid-term strategic plan

- A8. Analyzing Uncertainty in NBS Components
- A9. Improved NBS and Water Level Forecasting
- A10. Conveyance Change Monitoring in the Connecting Channels
- A11. Develop broader understanding of St. Marys hydrodynamics and impacts on stakeholders (IWI)
- A12. Work on navigation PI for Lake Ontario/St. Lawrence/IUGLS
- A13. Develop a PI that tracks recreational boating impacts on MH
- A14. Develop a PI that tracks shoreline damages on Lake MH
- A15. White paper discussing stability of dam (St. Marys River)
- A16. Review Whitefish Island flooding in the context of Lake Superior regulation plan formulation and evaluation
- A17. White paper (or discussion paper) about what can be done during high Superior levels (what would you do to reduce damages under extreme high NBS to Lake Superior?)
- A18. Establish Full list of Lesson Learned
- A19. Initial plan for version control of existing tools and models - Assign responsibility for model management
- A20. Develop Peer review process