

2015 Compensating Works Flow Measurements in Support of Improved Management of the St. Marys Rapids



*International Watersheds Initiative (IWI) Project Summary Report
from the
International Lake Superior Board of Control
to the
International Joint Commission*

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Executive Summary

A series of flow measurements were conducted at the St. Marys Rapids in 2015 under various partially open gate settings at the Compensating Works. These measurements were conducted jointly by the U.S. Army Corps of Engineers, U.S. Geological Survey, and Water Survey of Canada on behalf of the International Lake Superior Board of Control, and were partially funded by the International Joint Commission through its International Watersheds Initiative program. Starting in 2014, the Board began employing partially open gate settings at the Compensating Works in lieu of the historically more typical use of fully open gate settings. Partially open gate settings provide a number of potential benefits, including reduced risk of ice-related issues during the spring, more natural and consistent flow conditions in the St. Marys Rapids, and more precise and consistent flows overall. Flow measurements were conducted as gate settings were changed gradually throughout the summer and fall of 2015 in order to allow for a wide range of conditions to be measured, but without the need for large, abrupt fluctuations in the St. Marys Rapids and potential adverse impacts. The measurements will be used to develop and verify flow relationships for partially open gate settings and in further studies aimed at better understanding the hydrodynamics of the St. Marys Rapids and the effects on stakeholders.

Background

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 resulted in the International Lake Superior Board of Control (ILSBC) requiring that the gate setting of the Compensating Works at the head of the St. Marys Rapids be increased above the minimum one-half gate equivalent setting. Starting in August 2013, when six gates were fully opened (the highest gate setting since 1997), a number of concerns were raised related to the gate setting of the Compensating Works, and the unusually high water level and flow conditions in the St. Marys Rapids. These included: the impacts of higher flows and levels on the St. Marys Rapids fishery and recreational anglers; potential flooding of Whitefish Island, located immediately adjacent to the rapids; 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.

The Board has since worked with the International Joint Commission (IJC), the hydropower entities, and other stakeholders, to try to address these concerns, while adhering to the principles of the Boundary Waters Treaty and the Orders of Approval for Lake Superior regulation. Starting in May 2014, the 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. Severe ice conditions in May 2014 prohibited the use of fully open gates. Instead, by partially opening the gates this reduced the amount of ice that was passed through the Compensating Works structure and reduced the risk of ice-related damages and the potential for damages to structures further downstream in the St. Marys River.

Shortly thereafter, Board staff sought input from fisheries experts and recreational anglers, who provided positive feedback on the potential benefits to the St. Marys River ecosystem of having the flow more evenly distributed across the St. Marys Rapids. Partially opening gates also allows flows to be set with more precision, allowing for more consistent flows and a potentially reduced risk of flooding of Whitefish Island, located immediately adjacent to the rapids. While opening multiple gates partially is more operationally demanding than opening a lesser number of gates fully, the hydropower entities that own and operate the gates expressed that the additional effort was manageable and agreed to continue cooperating with the Board on this initiative. As a result, partial gate settings were employed for the remainder of 2014 and the Board agreed to continue this practice again in the summer of 2015, and potentially long-term.

However, one issue with this new approach is that the existing hydraulic relationships used operationally by the Board to determine flow through the Compensating Works, which were first developed in 1931, are applicable to flow through fully open gates at the Compensating Works only and cannot be applied to partially open gate settings. Furthermore, flow measurements used by the Board to verify the flow relationships have historically been collected almost exclusively at fully open gate settings. 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 is critical to the operation of the Compensating Works and to the determination and regulation of the total outflow from Lake Superior.

Starting in the summer of 2014, a series of flow measurements was collected at the Compensating Works under varying water level conditions and at various partially open gate settings. These measurements were collected on behalf of the Board by the U.S. Army Corps of Engineers (USACE), the U.S. Geological Survey (USGS) and Water Survey Canada. However, only three measurements were able to be collected during this first year that partially open gate settings were employed, and additional measurements were deemed necessary for Board staff to verify the theoretical flow relationships used to determine flow at partially open gate settings.

2015 Flow Measurement Campaign

In the spring of 2015, the Board, with support from USACE, USGS and Water Survey, planned an extensive field data collection campaign for the open-water season of 2015. This campaign would allow for additional flow measurements at partially open gate settings, and also fulfill the requirements of a previously approved International Watersheds Initiative (IWI) proposal led by the USACE aimed at investigating the rate of change of gate movements at the Compensating Works and the hydraulic effects on the St. Marys Rapids. On behalf of Water Survey of Canada, the Board also submitted an additional IWI proposal, which was approved by the IJC in June 2015, to help fund Water Survey's participation in the additional flow measurements proposed for this year.

Flow measurements were conducted at the Compensating Works over the course of a week during each of the months of June, July, August, October and November (generally near the start of each month to coincide with normal regulatory operations), and during each of these five weeks the gate settings were changed gradually in between measurements in order to allow for a variety of gate settings to be measured, but without the need for large, abrupt fluctuations in the St. Marys Rapids and potential adverse impacts on stakeholders. Field crews also scheduled the St. Marys Rapids measurements in coordination with additional measurements that were conducted in support of the Board, including hydropower canal flows and total river flows at the International Gauging Station in the lower St. Marys River.

The measured flow data for both 2014 and 2015, along with the corresponding gate settings and observed water levels at South West Pier, are provided in Table 1. A total of 11 measurements were collected during 2015 (2 or 3 per week, with the exception of August when only one measurement was conducted due to technical issues with equipment). Note that the agencies involved are currently conducting a detailed review of the dataset, and all flow measurement data reported here should be considered as preliminary. Once the review is complete and the data is finalized, it will be used by the Board to establish and verify flow relationships at partially open gate settings, and these will be used operationally to determine St. Marys Rapids flow. The measured flows will also be used in further studies aimed at better understanding the hydrodynamics of the St. Marys Rapids and the effects on stakeholders.

Preliminary Flow Measurement Results (data subject to review)

Date	Start Time	End Time	Flow (m ³ /s)	SW Pier Level (m)	US Slip Level (m)	Gate Settings (cm)																
						1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	
2014																						
03-Jun	10:30	11:30	754	183.38	176.85	20.0	68.6	68.6	68.6	68.6	68.6	68.6	68.6	68.6	68.6	68.6	68.6	68.6	68.6	68.6	--	
15-Jul	09:30	10:30	918	183.58	176.96	20.0	94.0	94.0	94.0	94.0	94.0	94.0	94.0	94.0	94.0	94.0	94.0	94.0	94.0	94.0	94.0	5.0
07-Oct	10:00	11:00	836	183.62	177.12	20.0	--	80.0	80.0	80.0	80.0	80.0	80.0	80.0	78.7	78.7	78.7	78.7	78.7	78.7	78.7	--
2015																						
09-Jun	12:50	13:30	611	183.54	176.90	20.0	--	62.0	62.0	62.0	62.0	62.0	62.0	71.0	71.0	71.0	71.0	71.0	71.0	--	71.0	5.0
10-Jun	12:50	13:30	640	183.48	176.98	20.0	--	71.0	71.0	71.0	71.0	71.0	71.0	71.0	71.0	71.0	71.0	71.0	71.0	--	71.0	5.0
13-Jul	16:40	17:40	725	183.46	177.10	20.0	71.0	71.0	71.0	71.0	71.0	71.0	71.0	71.0	71.0	71.0	71.0	71.0	71.0	--	71.0	5.0
14-Jul	15:30	16:20	818	183.55	177.02	20.0	89.0	89.0	89.0	89.0	89.0	89.0	89.0	89.0	89.0	89.0	89.0	89.0	89.0	--	89.0	5.0
04-Aug	15:20	16:20	840	183.53	177.14	20.0	89.0	89.0	89.0	89.0	89.0	89.0	89.0	89.0	89.0	89.0	89.0	89.0	89.0	--	89.0	5.0
06-Oct	9:10	10:20	744	183.47	176.93	20.0	76.0	76.0	76.0	76.0	76.0	76.0	76.0	76.0	76.0	76.0	76.0	76.0	76.0	--	76.0	5.0
07-Oct	8:05	9:25	679	183.51	176.93	20.0	63.5	63.5	63.5	63.5	63.5	63.5	63.5	63.5	76.0	76.0	76.0	76.0	76.0	--	76.0	5.0
07-Oct	14:00	15:00	619	183.49	176.84	20.0	63.5	63.5	63.5	63.5	63.5	63.5	63.5	63.5	63.5	63.5	63.5	63.5	63.5	--	63.5	--
02-Nov	15:45	16:00	519	183.42	176.93	20.0	51.0	51.0	51.0	51.0	51.0	51.0	51.0	51.0	51.0	51.0	51.0	51.0	51.0	--	51.0	--
03-Nov	17:20	17:35	343	183.25	176.80	20.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0	--	33.0	--
04-Nov	10:20	11:00	239	183.38	176.80	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	--	20.0	--

Table 1: Measured flows under partially open gate settings during 2014 and 2015