APPENDIX H

BAY of QUINTE HAZARD INFORMATION

February 10, 2022

Ministry of Natural Resources / Ministère des Richesses naturelles

Ontario

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please return to Ernie

21 February 1991

MEMORANDUM TO: Larry Drennan - Eastern Region
Lower Trent Region Conservation Authority
Moira River Conservation Authority
Prince Edward Region Conservation Authority
Cataraqui Region Conservation Authority

SUBJECT: **1:100 Year Water Levels in the Bay of Quinte**

The above referenced study has been finalized and is being circulated to all Conservation Authorities involved with FDRP digital shoreline mapping projects.

Briefly, it is recommended that a 1:100 year flood level of 75.9 metres GSC be applied to the shoreline from the boundary of the Lower Trent and Moira River Conservation Authorities, westward through to Youngs Point at the western end of the Adolphus Reach, and a level of 75.8 metres be applied to the remainder of the Bay of Quinte shoreline (see attached map).

eastward

For additional information regarding the 1:100 year water levels in the Bay of Quinte, please contact Ralph Moulton of Environment Canada at (416) 336-4580.

The 1:100 year water levels in the St. Lawrence River are currently being reviewed and should be ready for circulation shortly.

M.G. Lewis
Director
Conservation Authorities and
Water Management Branch
Room 5620, Whitney Block
Toronto, Ontario M7A 1W3

our maps must be changed to reflect the new elevation of 75.9m

Attachment

AB:ec

cc: Ralph Moulton, Environment Canada

1:100 YEAR WATER LEVELS IN THE BAY OF QUINTE

Background

Calculations of 1:100 year water levels for the FDR program were undertaken for the Great Lakes, including the open shoreline of Lake Ontario. The results of this analysis are contained in the report "Great Lakes System Flood Levels and Water Related Hazards" of February 1989. This analysis utilized data from water level gauge stations, and in areas with no gauges the computer program SURGE was used. The SURGE program makes use of mathematical techniques for calculating surge and contains a database of physiographic and hydrographic information for the Great Lakes. This analysis did not include the Bay of Quinte.

Complexities of the Bay of Quinte

There are no water level gauges within the Bay of Quinte that could be utilized for this analysis. In addition, the SURGE program did not include a database for it. Each point in the SURGE database for Lake Ontario represents an area of ten kilometres by ten kilometres, whereas much of the bay is only about one kilometre wide. In order to represent the bay within the program it would have been necessary to change the scale such that several points across the width of the bay would be included. Hence the scale would need to have been changed by about two orders of magnitude.

Aside from the scale problems, the appropriateness of the SURGE program for the bay was uncertain for two reasons. The first concern relates to the impact of the Murray Canal on the bay. This canal probably constrains the flow of water between the lake and bay, which would influence the magnitude of the surge. The SURGE program is not equipped to handle this type of constraint.

The second concern relates to the convoluted nature of the bay. The SURGE program was designed for use on the Great Lakes which are large, open bodies of water. By contrast, the Bay of Quinte is narrow and twisting in shape. It was uncertain whether SURGE would be appropriate for this type of application.

Other Related Studies

Two previous FDR-funded studies analyzed localized surges within portions of the Bay of Quinte. These studies were for Ameliasburgh and Sophiasburgh Townships and were undertaken by MacLaren Plansearch and Dillon, respectively. Both studies utilized the standard equation for surge and determined that localized surges were less than 10 centimetres at the locations analyzed.

Surge Analysis for the Bay of Quinte

A calculation of localized surge values was made using the standard surge equation of:

$$S = 2.022 * 10^{-7} * U^2 * F/d$$

where
- S - surge in metres
- U - wind velocity in metres per second
- F - fetch in metres

d - depth in metres

These calculations were made for three locations in the Belleville area (north shore) and for Nut Island in Hay Bay. For these analyses, an onshore wind speed of 80 kph was used, as was used in the two studies mentioned in the previous section. For the shore west of the bay bridge at Belleville, a fetch length of 2400 m. and a depth of 6.4 m. was used, resulting in a surge of 4 cm. Between the bridge and Ox Point a fetch of 3200 m. was used along with a depth of 5.5 m., and a surge of 6 cm. was calculated. At Big Bay a fetch of 4800 m. and a depth of 5.8 m. combined to give a surge of 8 cm. The maximum fetch within Hay Bay was 3070 m. at Nut Island and an average depth of 4 m. exists over that fetch. A surge of 8 cm. was determined for Hay Bay.

For the above surge calculations the average depths were determined at a lake level of 75.8 metres, that is, the 1:100 year level. A larger surge could occur for the same wind conditions at a lower lake level since "depth" would be smaller in the above equation, but it is the combination of local surge with lake level that is of importance, and this is maximized when the lake is at the 1:100 year level.

It is important to note that these surge calculations are for surge generated within the Bay of Quinte only. Surge that is generated on Lake Ontario and enters the Bay of Quinte is included in the 1:100 year level of 75.8 metres.

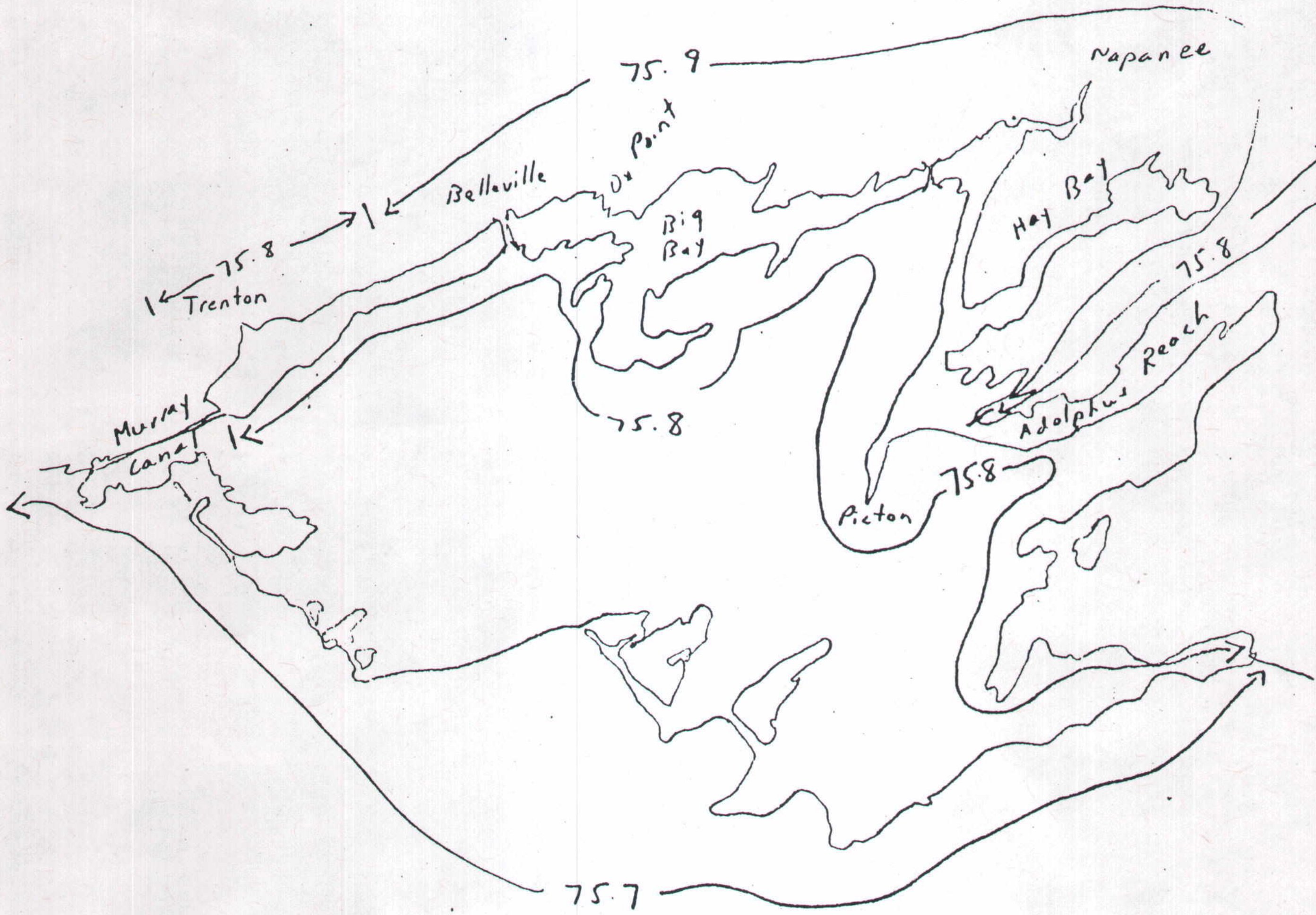
Recommendations

A rigorous determination of flood levels within the Bay of Quinte would require a major study of surge conditions within the bay. However, based on the above discussion and calculations, it would appear that little improvement in accuracy would be gained by such an analysis. Localized surge has not exceeded 10 centimetres during an onshore wind of 80 kph at any of the locations analyzed. It is recommended that 10 centimetres be the upper limit of additional surge added to the appropriate Lake Ontario flood levels for the Bay of Quinte.

The 1:100 year flood level at the Lake Ontario entrance to the Adolphus Reach is 75.8 metres. This flood level would be associated with a west or southwest wind. Winds from these directions would cause localized surge primarily on the mainland portion of the Bay of Quinte, but not on the Prince Edward County portion. Localized surge on the Prince Edward County portion would occur with winds from the northerly through easterly directions, but these winds would also cause a setdown of Lake Ontario levels at the entrances to the Bay of Quinte. This setdown would more than offset the localized setup.

It is recommended that an allowance of 10 centimetres for localized surge be added to the Lake Ontario level at the entrance to the Adolphus Reach for most of the mainland portion of the shoreline, resulting in a flood level of 75.9 metres. This addition is not considered to be necessary for the shoreline of the Adolphus Reach due to its great depth (about 25 to 50 metres), which would virtually eliminate local setup in that area. Near the Murray Canal, the flood level would be affected by the lake flood level at the outlet of the canal, which is 75.7 metres. It is recommended that the 10 centimetre allowance for localized setup be added to this elevation in this area.

In summary, it is recommended that a 1:100 year flood level of 75.9 metres be applied to the shoreline from the boundary of the Lower Trent and Moira CA's westward through to Youngs Point at the western end of the Adolphus Reach, and a level of 75.8 metres be applied to the remainder of the Bay of Quinte shoreline.



75.9
Napanee
Ox Point
Belleville
Big Bay
Hay Bay
75.8
Trenton
75.8
75.8
Adolphus Reach
Murray Canal
75.8
Picton
75.7

March, 1992

MEMO Re: Change in Floodline Elevation for the Bay of Quinte

Great Lakes System Flood Levels and Water Related Hazards Report

In February,1989, a study was completed by the Conservation Authorities and Water Management Branch of the Ministry of Natural Resources which updated flood levels for portions of the Great Lakes including Lake Ontario. The information was largely derived from the Great Lakes Hazard Technical Committee report submitted to the Ministry in November 1988. Based on the findings of this study it was determined by this Authority, as well as our neighbouring authorities, that the Bay of Quinte flood elevation is 75.9m (GSC), a significant decrease from the previous estimate of 76.7.

The flood hazard information and the erosion hazard information being compiled will form the basis for the background Technical Guidelines to accompany the Draft Shoreline Hazard Management Policy Statement. However, the Branch has circulated the updated 100 year flood information to assist authorities in the preparation of shoreline hazard mapping.

M.N.R. Correspondence:

The following points summarize a conversation with Ministry staff concerning the updating of the Authority's floodplain mapping for the Bay of Quinte and the lower portion of the Napanee River.

Larry Drennan

- updating does not have to be done immediately
- if the mapping base is decent, the line could be redrafted on
- new policies are proposed that will consider wave action
- mentioned that a 15m horizontal setback from the floodline could be implemented to account for waves

Norm Goldstein

- when a new study has been completed that proves old data to be wrong, the new data should be applied
- the Authority can guestimate where the new floodline will be, based on the present contours and spot elevations on the schedules
- the Authority should then send the revised drawings and a letter of explanation to the municipalities involved ("to make things legal and clean")
- Mark Law from the Ministry should be contacted concerning wave uprush and the possibility of applying a 15m setback
- the setback is a "take it or leave it" deal; you either apply it or you don't

Actions/Decisions by Authority Staff

It was decided by Authority staff that the present maps could be revised by delineating the new floodline based on the existing contours and spot elevations. Since the maps were revised, however, problem areas in the maps became evident, particularly in the area of Unger's Island. In the Fall of 1991 staff began surveying the area and it was confirmed that the floodline is far from accurate and further studies will be necessary. Until these problems are corrected the Authority will use the revised mapping, with site inspections where there is some question as to the exact location of the floodline, but the maps will not be sent to the affected municipalities.

It was also decided that there is no need for a 15m setback because of those areas mapped the only area that might be subject to the effects of severe wave action would be the Town of Deseronto and the Town already requires that buildings be set back 80 feet from the floodline.

Lower Trent Region
Conservation Authority

Inter-office Memorandum

Date: June 15, 1995

Memo to: Planning Staff

From: Randy

Re: Bay of Quinte Water Levels

Further to our staff meeting, I have spoken to Ralph Moulton regarding the 1:100 year Bay of Quinte Water Levels. The results of my research are as follows.

The MNR report of February 21, 1991 (attached) does not include wave uprush calculations as I indicated at the planning meeting.

The 0.2 metre uprush factor from the "Canada-Ontario Great Lakes Flood and Erosion Prone Areas" mapping legitimizes the addition of this factor to the 75.8 metre calculation from the 1991 report.

In a report entitled "Great Lakes System- Flood Levels and Water Related Hazards, February, 1989, MNR" (attached), it is recommended that the 15 metre setback for wave uprush is satisfactory for the open lake. The Bay was not calculated. However, a 3 metre setback for wave uprush for the connecting channels was recommended.

Therefore, from a technical perspective, the following values may be used:

75.8 + 0.2 (1:100 yr flood elevation + wind setup + wave uprush)

or

75.8 + 3.0 metres setback (1:100 yr flood elevation + wind setup + connecting channel setback)

or

75.8 + 15.0 metres setback (1:100 yr flood elevation + wind setup + open coast setback)

Randy

SJL Engineering Inc.
Office | Ottawa, ON
Phone | +1 613 898 1729
Email | slogan@sjleng.ca

Lower Trent Region Conservation Authority
714 Murray Street
Trenton, ON
K8V 5P4

Status: Final
February 29, 2020

Reference # 1052.01
RE: BAY OF QUINTE 100-YEAR COMBINED FLOOD LEVEL

The 100-year combined flood level is defined as the maximum instantaneous water level resulting from a combination of static lake level and storm surge with a probability of occurrence of 1% in any given year. The 100-year combined flood level is a critical component in the determination of regulated shoreline hazards on the Great Lakes. Shoreline hazards within the jurisdiction of the Lower Trent Region Conservation Authority (LTRCA) are defined in Ontario Regulation 163/06 (Lower Trent Region Conservation Authority: *Regulation of Development, Interference with Wetlands and Alterations to Shorelines and Watercourses*).

100-year combined flood levels for the north shore of Lake Ontario including the LTRCA shoreline have recently been reassessed as a component of the Lake Ontario Shoreline Management Plan, a project led by Zuzek Inc. and supported by SJL Engineering Inc. (2020). Prior to the adoption of these new levels, regulatory flood levels for the region were based on work completed by the Ministry of Natural Resources and Forestry and documented in a 1989 report titled *Great Lakes System Flood Levels and Water Related Hazards* (MNRF, 1989). Updated levels presented in Zuzek Inc. (2020) were determined based on an improved joint probability analysis of historical static water levels with adjustments to account for current water level regulation on Lake Ontario (Plan2014) and measured storm surge data at multiple water level gauge locations. These datasets feature an additional 30 years of data over those used in the 1989 study and include the 2017 and 2019 high water seasons during which water levels on Lake Ontario surpassed previous historical records.

Based on the results of the updated joint probability analysis, the recommended 100-year combined flood level for the LTRCA portion of Lake Ontario shoreline is +76.03 m IGLD85'. This represents an increase of 0.23 m over the previously published value of +75.80 IGLD85'. The Bay of Quinte was, however, not included in this updated water level analysis. The LTRCA has jurisdiction over approximately 20 km of shoreline at the west end of the Bay of Quinte. As such, SJL Engineering Inc. was retained by the LTRCA to provide this letter of opinion concerning the application of 100-year regulatory flood levels for the Bay of Quinte.

Review of Past Studies

Great Lakes System Flood Levels and Water Related Hazards (MNRF, 1989):

In 1989 the MNRF undertook an ambitious study to defined 100-year combined flood levels for the Canadian side of the entire Great Lakes basin. Static lake levels associated with various average recurrence intervals were assessed by performing statistical extreme value analyses (EVA) of historical monthly mean lake levels determined from a coordinated network of water level gauges around each of the Great Lakes. Local storm surge events were quantified by performing extreme value analyses of recorded storm surge elevations at several established water level gauge locations around each of the Great Lakes. A joint probability analysis of static lake level and storm surge was subsequently performed at each gauging station to determine the 100-year combined flood level at that location.

Between gauging stations, Environment Canada's SURGE model was used to model storm surge magnitudes associated with various recurrence intervals. The model featured grid cells with a spatial resolution of 10 km by 10 km. Each cell was attributed an average cell depth based on bathymetric charts. Average water level surface elevations in each grid cell were calculated using simplified basic hydrodynamic equations (Welander, 1961) on an hourly basis. The model was driven by wind speed data courtesy of Atmospheric Environmental Service (ECCC) and was calibrated to measured storm surge data at each of the established gauging locations around the lake. The accuracy of the model was reported to be within 0.1 m for all validated surge events.

The nearest gauging stations to the LTRCA shoreline are located at Cobourg to the west and Kingston to the east. Three shoreline reaches were established between these gauge locations using the results of the static lake level and SURGE model joint probability analysis. The established 100-year combined flood levels at each of these locations are summarized as follows (MNRF, 1989):

- Cobourg (Reach O-7) = +75.67 m IGLD55'
- Wellington (Reach O-8) = +75.58 m IGLD55'
- Point Petre (Reach O-9) = +75.54 m IGLD55'
- Prince Edward Bay (Reach O-10) = +75.62 m IGLD55'
- Kingston (Reach O-11) = +75.81 m IGLD55'

For mapping purposes, the values presented above were converted from International Great Lakes Datum (1955) to Geodetic Survey of Canada datum (GSC). The following 100-year flood levels are achieved based on datum conversions provided in the Great Lakes Technical Guide (MNRF, 2001):

- Cobourg = +75.74 m GSC
- Wellington = +75.68 m GSC
- Point Petre = +75.65 m GSC
- Prince Edward Bay = +75.75 m GSC
- Kingston = +75.95 m GSC

Since 1989 the Lake Ontario shoreline within the LTRCA boundaries has been regulated based on the values presented above for Cobourg and Wellington. The entrance to the Bay of Quinte, however, lies within the Prince Edward Bay reach. Interestingly, before being mapped, the MNRF rounded all 100-year flood levels presented above to the nearest 10 cm. This resulted in the Cobourg, Wellington and Point Petre levels being rounded to +75.7 m GSC, and the Prince Edward Bay level being rounded to +75.8 m GSC. This gives the impression that the 100-year flood level at the entrance to the Bay of Quinte is 10 cm higher than it is at Cobourg and Wellington, when in reality the difference between the two locations was determined to be only 1 cm based on the GSC vertical datum (i.e. negligible). Figure 1 presents the 100-year flood level map for this portion of Lake Ontario with 100-year flood levels rounded to the nearest 10 cm, as per MNRF (1989).

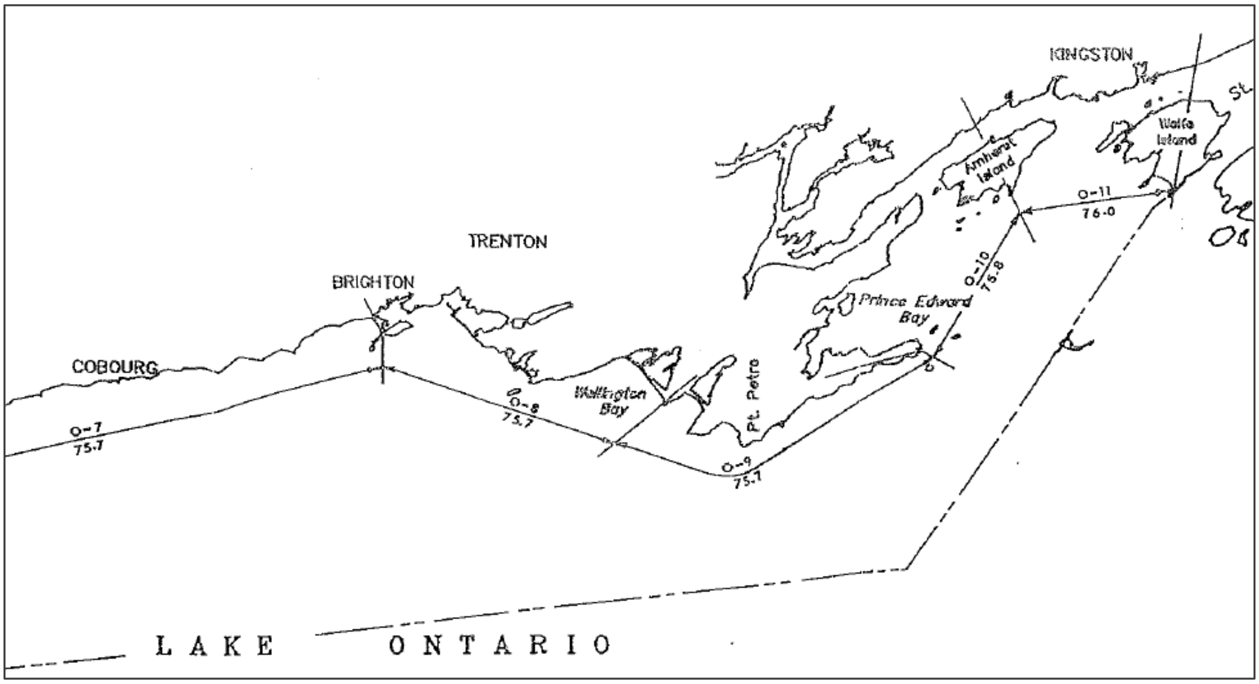


Figure 1 - 100-year flood level map from MNRF 1989 for the north shore or Lake Ontario (vertical datum = GSC)

Policy Document for Ontario Regulation 163/06 – Appendix I – Bay of Quinte Elevation (2016):

Appendix I of the LTRCA Policy Document for Ontario Regulation 163/06 includes a number of correspondences concerning the 100-year combined flood level within the Bay of Quinte. Of particular interest is a letter from the MNRF to the LTRCA dated February 21, 1991, documenting an assessment of storm surge implications within the Bay of Quinte, and recommended adjustments to the 100-year combined flood level at Prince Edward Bay. Key excerpts from this letter are summarized as follows:

- Two prior technical studies assessed surge within the Bay of Quinte for Ameliasburgh and Sophiasburgh Townships. These studies were undertaken by MacLaren Plansearch and Dillon, respectively. Both studies determined that localized surges were less than 10 cm at all analyzed locations.
- The MNRF extended the previous studies to include sites west of Bay Bridge, between Bay Bridge and Ox Point, at Big Bay and at Hay Bay. They found the potential for local surge to be less than 10 cm at all locations, with the site west of Bay Bridge (LTRCA shoreline) being particularly small at only 4 cm.
- The letter suggests that a significant storm surge on Lake Ontario effecting the north shore and entrance to the Bay of Quinte would have to be produced by winds from the southwest quadrant. As such, only the north shore of the Bay of Quinte could experience simultaneous localized surges during the 100-year event.

- The impact of the Murray Canal to the west and the highly variable alignment of channels within the Bay of Quinte to the east, likely constrains flow through the Bay of Quinte sufficiently to reduce the magnitude of surge propagating from the lake.
- Based on the above, it was recommended that the mainland portions of the Bay of Quinte be subjected to an additional 10 cm of storm surge potential in addition to the 100-year flood level at the entrance to the Bay of Quinte. The remainder of the Bay of Quinte shoreline, including the entire portion within the LTRCA jurisdiction, should have a 100-year flood level equal to the level at Prince Edward Bay of +75.8 m GSC.

Figure 2 shows a sketch that accompanied the February 21, 1991 letter from the MNRF discussing recommended 100-year flood levels for the Bay of Quinte.

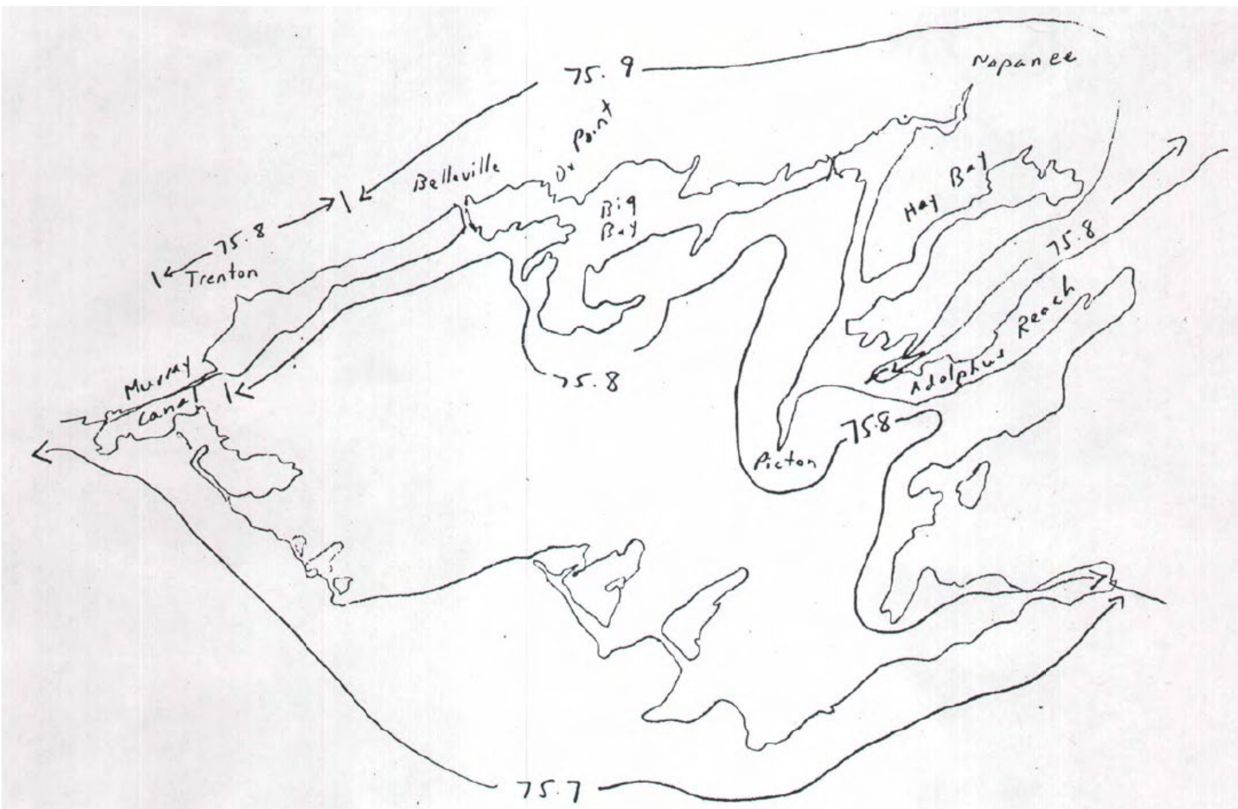


Figure 2 - Sketch from 1991 MNRF letter illustrating recommended 100-year combined flood levels for the Prince Edward County and the Bay of Quinte (vertical datum = GSC)

Updated Assessment of 100-year Flood Levels for the Bay of Quinte

100-year Flood Levels at Prince Edward Bay (Entrance to the Bay of Quinte):

The first step in determining appropriate regulatory flood levels for the LTRCA Bay of Quinte shoreline is to determine the appropriate 100-year flood level at the entrance to the Bay of Quinte. This area was denoted "Prince Edward Bay" in the 1989 MNRF study.

Converting the 1989 MNRF 100-year flood levels from GSC to the 1985 International Great Lakes Datum (current vertical datum for the Great Lakes) and accounting for the 1 cm level of accuracy originally reported in MNRF (1989) results in the following values:

- Cobourg = +75.80 m IGLD85'
- Wellington = +75.73 m IGLD85'
- Point Petre = +75.70 m IGLD85'
- Prince Edward = +75.79 m IGLD85'
- Kingston = +75.99 m IGLD85'

As such, according to the MNRF (1989) study, the 100-year flood level at Prince Edward Bay is approximately equal to the 100-year flood level at Cobourg based on the IGLD85' datum (as was the case for the GSC datum). The 100-year flood level at Cobourg has been updated to +76.01 m IGLD85' as a component of the Lake Ontario Shoreline Management Plan (Zuzek Inc., 2020). Therefore, it is reasonable to assume based on the SURGE modelling completed by the MNRF (1989) and the updated joint probability analyses completed by Zuzek Inc. and SJL Engineering Inc. (2020), that the 100-year combined flood level at the entrance to the Bay of Quinte (Prince Edward Bay) should be equal to +76.01 m IGLD85'.

To the author's knowledge, the SURGE modelling completed by the MNRF (1989) still represents the most comprehensive study of storm surge gradients for this region of Lake Ontario.

Propagation of Storm Surge from Lake Ontario into the Bay of Quinte:

Whether the storm surge experienced at the entrance to the Bay of Quinte has sufficient time to propagate to the LTRCA shoreline at the western end of the bay is a complicated question that would require detailed numerical modelling to accurately assess. This is largely due to the complicated geography of the Bay of Quinte that includes very narrow channels, shallow depths and several partial barriers or constrictions to flow. However, a reasonable check can be performed by examining the timing and duration of storm surge events at the Kingston and Cobourg water level gauges.

If we assume the 100-year combined flood level is primarily influenced by static lake level, then we can assume that the combined 100-year flood level at Prince Edward (+76.01 m IGLD85') can be produced by a 100-year static lake level (+75.84 m IGLD85' as per Zuzek Inc., 2020) and a 17 cm surge event. Looking at the top 10 historical surge events at the Kingston water level gauge (1960 to 2019), the average duration in which the surge elevation remained at least 17 cm above the static lake level was over 6 hours. Furthermore, the average time required for the storm surge elevation to fully develop from static lake levels at Kingston was less than 3 hours. As such, it is reasonable to assume that if a storm surge event can be fully developed at Kingston, some 130 km from the mode (centre) of the lake and persist for upwards of 6 hours, propagation of the same event a distance of roughly 60 km to the end of the Bay of Quinte before water levels begin to fall is likely possible.

Since Lake Ontario is a closed basin, storm surge will generate a seiche within the lake. A seiche is the process by which an observed water level increase at one end of the basin (Lake Ontario) is offset by a decrease in water level at the opposite end, which subsequently oscillates back and forth. The period of oscillation depends on the effective basin length and the average basin depth. The period of oscillation for Lake Ontario was studied in detail by Rao and Schwab (1976), and later published in the Coastal Engineering Manual (USACE, 2012). The paper concludes that the primary period of oscillation for the long axis of Lake Ontario is 5.11 hours. The time required to reach maximum seiche from static lake level would therefore be half of this value, or approximately 2.5 hours. This further supports the conclusion that a major seiche event would likely have sufficient time to propagate to the western end of the Bay of Quinte before water levels began to fall.

Based on the above discussion, the 100-year combined flood level at the west end of the Bay of Quinte should be at least equal to the 100-year combined flood level at Prince Edward Bay of +76.01 m IGLD85'.

Local Storm Surge Generated Within the Bay of Quinte

There are two scenarios in which locally generated storm surge could result in a significant water level increase at the west end of the Bay of Quinte. The first scenario was previously explored in the 1991 letter authored by the MNRF and presented in Appendix I of the LTRCA Policy Document (discussed above). In this scenario the maximum (100-year) combined flood level at the entrance to the Bay of Quinte is generated by extreme winds out of the west-southwest. These winds would subsequently blow over the Bay of Quinte, resulting in small amounts of surge on the mainland (north) shoreline.

This localized surge was assessed to be on the order of 4 cm for the LTRCA shoreline by the MNRF as documented in the 1991 letter discussed above. This scenario was reassessed by SJL Engineering Inc. to confirm the findings of the MNRF. First, the 100-year sustained wind speed from the southwest quadrant was assessed from 35 years of WIS (Wave Information Study) data offshore of Prince Edward County. The WIS dataset (USACE, 2012) is a comprehensive wind-wave hindcast dataset covering all five Great Lakes. The surge equations of Ippen (1966) and those presented in Kamphuis (2000) were subsequently used to calculate storm surge along the north shore of the Bay of Quinte near the town of Trenton. The resulting storm surge magnitude was on the order of 10 cm. Adding this value to the previously discussed 100-year combined flood level at the entrance to the Bay of Quinte results in a total 100-year flood level of +76.11 m IGLD85' for the LTRCA Bay of Quinte shoreline.

The second scenario that could result in elevated water levels at the west end of the Bay of Quinte would be an extreme wind arriving from the east north-east (ENE) direction, directly down the long access of the bay between Trenton and Belleville. This wind direction would however result in storm surge at the west end of Lake Ontario, temporarily lowering the water level at the east end. The 100-year storm surge elevation at Burlington for example (west end of Lake Ontario) is presented in MNRF (1989) as 0.94 m. As such, a 100-year wind blowing from the ENE would likely result in a temporary reduction in the water level at the entrance to the Bay of Quinte on the order of 0.8 – 0.9 m below the 100-year static lake level. The resulting water level within the Bay of Quinte would be approximately +75.0 m IGLD85'.

The equations of Ippen (1966) and those presented in Kamphuis (2000) were once again consulted to determine the magnitude of local surge generated in the western arm of the Bay of Quinte due to this 100-year ENE wind. The resulting surge magnitudes at the west end of the Bay of Quinte (LTRCA) were determined to be on the order of 0.9 m. Adding this to the drawn-down elevation of +75.0 m IGLD85' at the entrance to the Bay of Quinte results in a water level elevation west of Trenton of approximately +75.9 m IGLD85'. This scenario assumes that no water can escape the west end of the bay via the Murray Canal (conservative).

Between the two scenarios discussed above, the first scenario in which an extreme surge event originates from the west-southwest results in the higher water level at the west end of the Bay of Quinte.

Closing Remarks

Based on the review of past studies and updated, high-level, desktop analyses discussed herein, it is our opinion that a suitable 100-year combined flood level for the LTRCA portion of shoreline on the Bay of

Quinte would be +76.11 m IGLD85', or 10 cm higher than the 100-year combined flood level established at the Cobourg gauge. This value is 8 cm higher than the recommended 100-year combined flood level for the LTRCA portions of exposed Lake Ontario shoreline (+76.03 m IGLD85'), as presented in the Lake Ontario Shoreline Management Plan (Zuzek Inc., 2020).

The information presented in this document is the result of a high-level assessment of past studies and desktop analyses using available data. The conclusions presented and the opinions of the author are informed, though not the result of thorough and rigorous engineering analysis. Such an analysis would require the application of a high resolution, hydrodynamic numerical model and is outside the scope of this assignment. It is recommended that a water level gauge be established at the west end of the Bay of Quinte in the future, such that the conclusions presented in this letter and those presented in the previous studies discussed above can be validated with measured data.

If any additional documentation is requested by the LTRCA beyond that which is contained in this letter, we would be pleased to provide it. Finally, if you have any questions about the content of this letter or the views expressed within, please don't hesitate to contact me.

With thanks,

Seth Logan, M.A.Sc., P.Eng.
President | Coastal Engineer
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