Nottawasaga Valley Conservation Authority

Ministry of Natural Resources / Ministère des Richesses naturelles — Ontario

Environment Canada / Environnement Canada

Report

Watershed Hydrology Study for Nottawasaga, Pretty and Batteaux Rivers Black Ash, Silver and Sturgeon Creeks

Volume I — Technical Report

Canada/Ontario Flood Damage Reduction Program

May 1988
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May 3, 1988

Nottawasaga Valley Conservation Authority
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Attention: D. N. White
General Manager

Re: Watershed Hydrology Study for Nottawasaga, Pretty and Batteaux Rivers, Black Ash, Silver and Sturgeon Creeks

Dear Mr. White:

We are pleased to submit herewith our final report concerning the above-noted study.

The methodology and findings of our investigations are presented in the enclosed report (Volume I). Additional supporting documentation is presented separately in Volume II entitled "Technical Appendices".

We would like to express our sincere appreciation to all the members of the Project Committee for their co-operation and advice throughout the course of this study. All of which is respectfully submitted.

Yours very truly,
MacLAREN PLANSEARCH INC.

R. B. Wigle, P. Eng.
Project Manger

RBW:hc
Encl.

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ACKNOWLEDGEMENTS

This project was undertaken under the supervision of R.B. Wigle, P. Eng. who acted as Project Manager. The QUALHYMO modelling was conducted by M.D. Conetta, P. Eng. and assisted by P. Donahue. The DWOPER modelling was carried out by L.J.D. Alexander, P. Eng. Computer enhancements and meteorological data preparation were undertaken by G. Kearns, P. Eng. Dr. A.C. Rowney, Queen's University, served as technical advisor in as required basis.

The information presented in this report was derived with the kind cooperation and assistance of several individuals. Invaluable comments and direction were provided by the following members of the Canada-Ontario Flood Damage Reduction Program Project Committee:

- D.H. White, B.Sc., General Manager, Nottawasaga Valley Conservation Authority
- S. Moin, P. Eng., Environment Canada
- H. Sayeed, P. Eng., Ministry of Natural Resources, Central Region

The background data presented in this report was obtained from several sources including the Inland Water Directorate and the Atmospheric Environment Service of Environment Canada and the Ontario Ministry of the Environment.

We would like to express our gratitude to the Water Survey of Canada, Guelph for carrying out some of the streamflow measurements and training our staff. Finally, we would like to express our appreciation for the time and effort of all those who contributed to this project by way of information, discussions and otherwise.

1.0 INTRODUCTION

1.1 Objectives

In February 1986, the Nottawasaga Valley Conservation Authority initiated a comprehensive hydrologic study of the basins within the Authority's jurisdiction for the purpose of providing the flood magnitude on all watercourses for the 5, 10, 20, 50 and 100 year return periods and for the Regional Storm (Timmins Storm). Discharges were to be estimated on the Nottawasaga, Pretty and Batteaux Rivers and the Black Ash, Silver and Sturgeon Creeks and their tributaries under current and future urban land use conditions. Due to the large water storage capacity in the Minesing Swamp and the mild gradient of the Nottawasaga River between the Swamp and Georgian Bay, dynamic hydraulic routing procedures were to be employed to account for the attenuation effect on flood discharges.

Agricultural drainage within the Innnisfil Creek drainage catchment has reportedly contributed in recent years to the increase in the magnitude of flood peaks during the summer growing season. Hydrologic investigations were therefore, to address this concern and evaluate the hydraulic routing effect of municipal drains on larger storm flows that are experienced in Beeton Flats. Both existing and proposed drains were to be considered.

1.2 Description of the Drainage System (Ref. 4)

The Nottawasaga Basin is characterized by an extensive network of rivers and streams which collect surface run off and discharge into Georgian Bay (Figure 1.1).

The largest drainage system is the Nottawasaga River and its tributaries. It has a total length along its main channel of approximately 121 km. In the first 42 km, it flows north easterly, then swings north to follow a course near the eastern edge of the former Lake Algonquin. South of the

Minesing Swamp, the river enters the Simcoe Lowlands and meanders through the swamp northward to Jack's Lake. From there, the flow is towards the west for about 6 km following which a series of meanders lead in a straight course to the north-east through the sand dunes of Wasaga Beach to the river's outlet into Georgian Bay.

The Nottawasaga River has a total fall of 311 m from its source in the till moraines of Amaranth Township about 5 km south of the Town of Shelburne (elevation of 488 m) to the outlet into Georgian Bay (177 m). Its average gradient is 2.5 meters per km, varying considerably from a flat gradient of 0.11 meters per km near its mouth to a steep 19 meters per km in the upper reaches near Glen Cross.

The Nottawasaga River has five major tributaries; the Boyne River (243 square kilometers), the Mad River (466 square kilometers), the Pine River (347 square kilometers), all on the west side, and Innisfil Creek (464 square kilometers) and Willow Creek (308 square kilometers) on the east side. In addition, there are a number of streams that flow directly into Georgian Bay, the more prominent being Silver Creek (28.2 square kilometers), Black Ash Creek (40.5 square kilometers), the Pretty River (72.5 square kilometers), and the Batteaux River (66.5 square kilometers), in the northwest corner of the Authority's jurisdiction near Collingwood. These streams rise on the Niagara Escarpment and are characterized by extremely steep gradients in the upper reaches and mild slopes as they approach Georgian Bay.

One of the peculiarities of the area is the almost complete lack of natural lakes. There are only three of any consequences, Edward Lake, Little Lake and Marl Lake. Jack's Lake is known locally as a lake but is simply a swelling in the Nottawasaga River. The three lakes have surface areas of 28 ha, 253 ha, and 77 ha respectively.

There are a number of wetlands and marsh areas including Minesing Swamp in Vespra and Sunnidale Townships, Bear Creek source area in Barrie and the Townships of Essa and Vespra, Osprey Wetlands in Osprey Township, the Beeton Flats in Tecumseth Township and the Bailey Bog in Adjala and Tecumseth Townships. In total, all the wetlands cover some 6,475 ha in the Nottawasaga watershed.

1.3 Background Information

1.3.1 History of Flooding

High flows within watercourses draining the Nottawasaga River Basin are most commonly experienced during the spring months when the snowpack is dissipated by solar radiation and rainfall events. Long-term hydrometric records on the Nottawasaga River at Baxter indicate that in excess of forty-three percent of the annual runoff is gauged during the months of March and April while sixty percent is produced in the four month period between February and May. Climatological stations indicate a fairly uniform occurrence of precipitation across the watershed; however, during the winter season, the combined water equivalent of snowfall and rain within the lower portion of the basin near Georgian Bay exceeds the amounts in the central and upper zones by in excess of 100 mm (Ref. 4). Similar larger depths of precipitation occur on the Escarpment in the headwaters of the Pine, Mad and Boyne Rivers (Table 1.1) and persist as snowpack later into the spring due to the cooler temperatures.

Annual flow peaks are also observed most frequently in the spring months of March and April during the height of the freshet (Table 1.2). Nevertheless, flood discharges have occurred in all months except August and September. The second largest daily flow recorded on the Nottawasaga River at Baxter over the thirty-six year record period was caused by Hurricane Hazel (254 m^3/s; October 16, 1954).

NOTTAWASAGA RIVER BASIN: CLIMATOLOGY (Ref. 1, 6)

TABLE 1.1

LOCATION	WINTER DURATION			WINTER PRECIPITATION			SNOWPACK (Median Depth)		TEMPERATURE Mean Daily Maximum			TEMPERATURE Degree - Days		
	Mean First Date of	Mean Last Date of	Mean Length of Winter (days)	Rainfall (mm)	Snowfall (cm)	Total Water Equivalent (mm)	End of February (cm)	End of March (cm)	February °C-Days	March °C-Days	April °C-Days	February °C-Days	March °C-Days	April °C-Days
Barrie	Nov. 16	Apr. 05	141	159	275	408	30-40	<5	-3.1	2.0	10.3	5.3	29.4	153.7
Collingwood	Nov. 16	Apr. 05	141	133	254	348	30-40	<5	-2.5	2.3	10.3	8.3	38.2	175.5
Angus	Nov. 16	Apr. 05	141	103	280	311	30-40	<5	-2.3	2.7	11.5	5.2	35.3	171.9
Redickville	Nov. 10	Apr. 08	151	136	291	429	>40	>5	-4.4	0.1	8.8	2.5	20.9	139.8
Alliston	Nov. 18	Apr. 04	138	137	175	309	30	2	-2.7	2.1	11.6	-	-	-
Beeton	Nov. 18	Apr. 04	138	125	209	288	30	0	-2.3	2.8	11.4	5.1	38.0	183.2
Orangeville (MOE)	Nov. 17	Apr. 04	137	164	157	323	30	0	-3.3	1.6	10.0	5.3	33	159.2
Mount Forest	Nov. 09	Apr. 08	152	185	256	407	40	>5	-3.6	1.0	9.6	3.4	31.7	150.5

SEASONAL OCCURRENCE OF ANNUAL PEAK FLOWS

TABLE 1.2

GAUGE LOCATION	Drainage Area (km^2)	Record Period (Years)	MAXIMUM MEAN DAILY FLOW		INSTANTANEOUS PEAK FLOWS		FREQUENCY OF OCCURRENCE OF ANNUAL PEAK INSTANTANEOUS FLOWS BY MONTH											
			m^3/s/(Date)	$m^3/s/km^2$	m^3/s (Date)	$m^3/s/km^2$	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept	Oct.	Nov.	Dec.
Beeton Creek near Tottenham	86.0	1969-1984 (16 years)	17.0 (Mar. 5/79)	0.20	22.7 (Mar. 5/74)	0.26	1	3	7	5								
Bailey Creek near Beeton	207.0	1964-1978 (15 years)	49.8 (Mar. 5/74)	0.24	67.0(1) Mar.5/74	-	1		3	9		1				1		
Boyne River at Earl Rowe Park	211.0	1969-1984 (16 years)	85.0 (Apr. 19/75)	0.40	122.0 (Apr. 19/75)	0.58		2	5	9								
Pine River near Everett	195.0	1969-1984 (16 years)	36.2 (Mar. 5/80)	0.19	53.0(1) Mar.5/80	-		2	5	9								
Mad River near Glen Cairn	295.0	1964-1984 (21 years)	82.1 (Apr. 19/75)	0.28	129.0 (July 1/67)	0.44		1	7	10	1		1					1
Nottawasaga River near Baxter	1180.0(2)	1949-1984 (36 years)	267.0 (Apr. 13/51)	0.23	370.(1) (Apr. 13/51)	0.31	1	3	14	15						1	1	1
Willow Creek above Little Lake	94.8	1973-1984 (12 years)	30.0 (Mar. 25/76)	0.32	35.3 (Mar. 21/80)	0.37		1	5	5								1
Willow Creek at Midhurst	127.0	1973-1984 (12 years)	19.9 (Mar. 15/77)	0.16	20.2 (Mar. 15/77)	0.16		1	7	4								

(1) Instantaneous Flow Not Recorded; Estimated From Daily Record (Rep. No. 27)
(2) Source of Information; Water Survey of Canada

Flooding has been of major concern throughout the history of the Nottawasaga Area (Ref. 3). Newspaper reports from the 1800's onwards describe floods within the basin with frequent regularity. Unfortunately, early accounts do not provide sufficient information regarding monetary values of flood damages, the amount of precipitation or streamflows. A historical summary of flood reports is presented in the Authority's Conservation Report (1973). Within rural areas, most flood damages have been in the form of crop losses, field erosion, loss of livestock and fences, silty deposits on the fields, contamination of wells and ponds, and the deterioration or destruction of roads and bridges.

The greatest damage resulting from a single flood occurred as a result of Hurricane Hazel in October 1954. Six lives were lost during this storm within the Authority's area and estimated losses corrected to 1987 prices were approximately $2,850,000.

Field inspections, interviews with local residents, as well as interpretation of aerial photographs during the preparation of the Authority's 1973 watershed report disclosed seasonal flooding along Bailey Creek, Batteaux River, Beeton Creek, Black Ash Creek, Lamont Creek, Innisfil Creek, Lisle Creek, Mad River, Nottawasaga River and Penville Creek. Lands around the perimeter of the Minesing Swamp are also subject to periodic flooding especially during the spring period. The extent of inundation has been documented for a typical high flow year (Ref. 3).

More recently, an inventory of flood damage centres was assembled (Ref. 4) as part of the Authority's water management plan. These are highlighted in the following points and noted in Figure 1.1:

Collingwood - Black Ash Creek

Significant areas along Black Ash Creek ~~has~~ have suffered damage during spring flood periods due to a combination of high flows and ice jams. During the summer, severe rainfall events have produced damaging flows.

Angus - Nottawasaga River and Pine River

The Village of Angus experiences significant flood damages at regular intervals of approximately five years.

Creemore - Mad River

The Village has developed in the flood plain of the Mad River. While flooding has not occurred in recent years the river rose to flood stage on February 22, 1937 in less than two hours. During this event, both the public school and continuation school were surrounded by water.

Avening - Mad River

The Hamlet of Avening immediately downstream of Creemore on the Mad River experiences flooding on a regular basis due to a combination of high flows and ice jams. About twenty-five residential dwellings are flooded to a minor degree, on a regular basis (1 in 5 years).

Wasaga Beach - Nottawasaga River

Within the Town of Wasaga Beach a considerable number of cottages and permanent residences have been established in low lying areas along the Nottawasaga River in the Oxbow area. Flooding can be caused by ice jams as well as high flows. The most recent occurrence was in the

spring of 1981 when the blasting of ice jams was required as a relief measure.

Oro Township - Willow Creek

Oro Township has one minor flood damage centre along Highway No. 11 at Willow Creek. Frequent localized flooding is common at this location near the Second Line due to ice jams during spring runoff.

Sunnidale Township - Mad River

The lower reaches of the Mad River in the Township of Sunnidale has presented increasingly serious drainage and flooding problems to agricultural lands, township roads, and six residential dwellings. Continued erosion upstream on the Mad River has reportedly contributed to significant siltation of the lower reaches of the River upsteam of its confluence with the Nottawasaga River and the attendant loss of waterway conveyance capacity. This has caused a persistent problem throughout the spring and during high flow periods throughout the rest of the year. Portions of Sideroad 21 and Concession Road 11 were under water for more than 30 days in the spring of 1982 and during a number of days throughout the balance of the year.

Innisfil Township - Innisfil Creek

Flooding along Innisfil Creek due to rainfall events during the growing season between May 1 and November 1 causes considerable damage to agricultural crops.

1.3.2 Previous Hydrologic Studies

During the initial stages of the Hydrology Study, previous water resources reports on the Nottawasaga River basin were reviewed and pertinent informa-

tion related to flood discharges and hydrologic parameters was abstracted. This data was subsequently used in establishing the basin hydrologic model and comparing the recurrence interval and Regional Storm flows with those established in earlier investigations. A synopsis of these reports together with a bibliography is presented in Appendix A of this report. The following points are considered relevant to this study.

i) watershed locations at which floodplain mapping is available from previous studies is shown in Figure 1-1

ii) hydrologic investigations have been completed for portions of the Conservation Authority's watershed noted in Table 1-3. When carried out in conjunction with floodplain mapping studies, design flows have been limited to Regional Storm discharges and with the exception of the Willow Creek and Black Ash studies, no calibration of hydrologic models has been undertaken

iii) hydrologic discretization of sub-basins during the current investigation took into account wherever possible the watershed units which have been used previously for flood plain mapping projects.

iv) earlier hydrologic investigations did not define the future land use on the basis of planning documents. It was, therefore, necessary to develop this information during the current study from Official Plans and amendments supplied by municipal offices. Existing land use inventories are not generally available from planning documents or previous hydrologic studies with sufficient definition to permit allocation to sub-basins used for hydrologic investigations. This information was assembled from aerial photography, Official Plans and Agricultural Land Use Systems maps.

TABLE 1.3

HYDROLOGICAL STUDIES WITHIN THE NOTTAWASAGA RIVER BASIN

Watercourse/Basin	Author/Title	Flows											
		5-Yr		10-Yr		25-Yr		50-Yr		100-Yr		Regional	
		E	F	E	F	E	F	E	F	E	F	E	F
Upper Nottawasaga River and Sheldon Creek	R.J. Burnside & Associates; Floodplain and Fill Line Mapping, Township of Mono, 1978	x		x		x		x		x		x	
Upper Nottawasaga River and Bailey Creek	Ainley and Associates Ltd.; Fill and Floodline Mapping of Adjala Twp., 1979												x
Beeton Creek	Triton Engineering Ltd. Beeton Floodline Mapping, 1973												x
Vespra Township-Nottawasaga River, Willow, Matheson, Marl and Bear Creeks	Ainley and Associates Ltd., Fill Line Mapping Township of Vespra, 1981												x
South Branch - Boyne River	Triton Engineering Services Ltd., Report on Hydrology for Channel Improvement Study on South Branch of the Boyne River, 1978	x		x		x		x		x			
Little Creek Town of Shelburne	Triton Engineering Associates Ltd.; Hydrological Analysis, Willow Creek, 1982	x		x		x		x		x		x	

Note: E = existing land use
F = future land use