Grand River Conservation Authority
Reservoir Operations Policy

Approval Date: September 27, 2024

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1.0 INTRODUCTION

Under Ontario's Conservation Authorities Act and Regulation 686/21, the Grand River Conservation Authority (GRCA) is mandated to update its Reservoir Operation Policy, approved on February 2004 by GRCA board of directors (Report No. P-02-04-13, resolution No. 19-04). The GRCA manages seven medium to large multipurpose reservoirs (Figure 1), balancing flood management and attenuation throughout the year while also augmenting downstream watercourses during low-flow periods. In addition to flood management, pollution abatement and water supply, these reservoirs serve additional roles including hydroelectric power generation and recreational opportunities for the public. These seven large dams are listed below:

1. Shand Dam on the Grand River
2. Conestogo Dam on Conestogo River
3. Guelph Dam on Speed River
4. Luther Dam on Luther Marsh
5. Woolwich Dam on Canagagigue Creek
6. Laurel Dam on Laurel Creek
7. Shade’s Mills Dam on Mill Creek

Beyond the seven reservoirs listed in the above, GRCA operates an additional 21 small dams. These small dams are not part of this operating policy. The other 20 dams are generally run-of-the river dams or earthen embankment dams with small head ponds. Although the smaller dams do not serve a water management function, they are important community features. One exception regarding the 21 smaller dams is Damascus dam, although not included in the list of seven large dams, Damascus dam does provide low flow augmentation to Conestogo Dam over the summer portion of the year. The rule curve for Damascus dam is included in this report given it has a low flow augmentation objective.

Runoff generated from late winter and early spring rainfall, along with snowmelt during the spring freshet, is crucial for filling the large reservoirs each spring. These reservoirs store water that is essential throughout the year, particularly in summer and fall, Supplementing the drinking water supplies for The Region of Waterloo and Six Nations of the Grand River and all of the drinking water supply for, the City of Brantford. Flow augmentation to the river water is necessary to dilute effluents from sewage treatment plant discharges into the river, especially during summer to maintain the river's ecological functions.

Insufficient spring filling of reservoirs could lead to water shortages for communities relying on the Grand River for municipal water supply and the risk of the river drying up in summer, compromising sewage dilution in reaches downstream of these reservoirs. On the other hand, early spring reservoir filling reduces their flood management capacity, raising the risk of severe flooding during heavy rains or rapid snowmelt.

Given these conflicting objectives of flood management, pollution abatement and water supply, the Grand River Conservation Authority has established reservoir operating policies using specific rule curves for its seven multi-purpose reservoirs. These rule curves aim to balance the dual needs and conflicting objectives of flood management and maintaining adequate minimum river flows downstream of these reservoirs.

2.0 HISTORY OF EXISTING RESERVOIR RULE CURVES AND OPERATING POLICY

The Grand River Watershed has been subject to many studies over the past decades which all have played a role in shaping the current operational policies. These studies date back to 1930s and started with the 1932 Finlayson Report commissioned by the Minister of Lands and Forests of Ontario followed by the 1939 H.G. Acres report to the Grand River Conservation Commission. These reports were then followed by 11 other studies from 1939 until 1971, as presented in Appendix A-Table A1. Reports listed in Table A1 cover a period of time in the evolution of the reservoir system in the Grand River which cover the reservoir planning and construction. This concluded with recommendations to build the Woolwich and Guelph Dams in the 1972 treasury board report and the construction of Guelph and Woolwich Dams. Guelph was the final large reservoir built in the watershed; it began operation in 1976. Woolwich Dam went into operation in 1974.

Subsequent to the severe flooding of May 1974 in the Grand River Watershed and the Royal Commission Inquiry into this event, a committee of representatives from the Ontario Ministry of Natural Resources, the Ontario Ministry of the Environment and the Grand River Conservation Authority followed the recommendations for the Royal Commission inquiry and developed the first set of rules and policies for reservoir operations which were adopted and implemented by GRCA in 1978. The initial 1978 rules and policies were further refined by the Grand River Basin Management Study.

Recommendations from the Provincial Inquiry into the 1974 flood trigger a shift from reservoir planning to reviewing the need and justification for any additional reservoirs and the optimization and clarification of objectives for existing reservoirs. The Provincial Inquiry into the 1974 flood made 21 recommendations. The first five recommendations resulted in the review of existing and proposed GRCA reservoirs, the reservoir operating policy and a comprehensive review of water management in the Grand River watershed. These recommendations resulted in an Environmental Assessment of Water Control Structures in the Grand River watershed (1976-1979) and a Basin Management Study by the Ontario Ministry of the Environment (MOE) (1978-1981). Technical work completed as part of the MOE basin management study firmed up operating objectives for the existing reservoirs and resulted in an updated operating policy and rule curves for the large dams.

The operational rules and policies have been subject to several reviews and updates, as outlined in Appendix A-Table A2. A brief overview of the updates to the operational policies are provided below.

The Grand River Basin Management Study, led by Ontario Ministry of Environment and published in 1982 provided the first major revisions to the reservoir operating policy through completion of reservoir yield modeling with the objective of refining low flow operating targets for major reservoirs. These targets have been designed to be met with a 95% reliability and remain in use today. The updated operating policy and rule curves were implemented in 1984.

Over the years, several updates and revisions were made for individual reservoirs. In 1986, operational changes were implemented for Shand Dam to address ice jams at West Montrose.

In 1988, the reservoir operating policy for Guelph Dam was revised by raising the upper rule curve for the period from May 1 to August 1, which increased the reservoir's operating level to provide additional water for flow augmentation along the Speed River.

In 1988 and 1989 operating policies and rule curves were updated for Luther Dam following an internal water management study of Luther Dam and the completion of the Luther Marsh Management Plan. A reservoir yield model was created for Luther Dam and used to establish rule curves and operating procedures for Luther dam and low flow operating targets in the Grand River through the Town of Grand Valley. Low flow targets for the summer flow period were designed to have 95% reliability the same as the low flow targets downstream of the three large reservoirs analyzed in the 1982 Basin management plan. A valve was implemented at Luther Dam in 1989 to allow more precise efficient management of water from that dam. Reservoir rule curves at Luther Dam also reflect environmental considerations related to the management of Luther Marsh.

In the late 1990’s, 1997 through1999, severe drought conditions were observed across the Grand River watershed. Based on experience from these low water years, reservoir operations were adapted in the late fall and winter operating periods of the year to allow for some additional water in storage to improve reliability of reservoir filling and to provide additional water for winter flow augmentation.

Figure 1: Multi-Purpose Reservoirs in Grand River Watershed

It is important to note that earlier in the 1990's due to the aging of the dam infrastructure, dam safety become a primary focus of reservoir asset management. Dam safety reviews were completed for Shand Dam in 1993 and Conestogo Dam in 1997. Dam safety reviews or partial reviews have been completed for all the large dams except Shades Mills reservoir. A review has been initiated and is currently underway for that reservoir. While the dam safety review did not alter reservoir operating procedures or rule curves, it is important to recognize the importance of dam safety and asset management associated with the large dam infrastructure in the Grand River watershed. Dam safety and excellence in reservoir asset management and reservoir operations continue to be a main focus of the GRCA. The reservoir operating policy and rule curves are an important component of dam safety and corporate risk management.

In February 2004, a major update to reservoir operating policies and procedures was completed and approved by the GRCA Board of Directors. The 2004 update has been the basis for the current operating policy in use to this date. As part of this update and in response to the observed drought and challenges for reservoir filling during the period of 1997 to 1999, reservoir rule curves at major dams were modified and refined. This update was to allow for runoff storage in the early days of each year, specifically during the months of January and February, as well as later in the year from mid-October to end of December. The changes to the operating rule curves and policies in the early months of the year, January and February also reflected physical operating constraints or challenges at the two large dams, Shand and Conestogo. At Shand Dams the revised operating policy allow for maintenance of reservoir levels above the 48-inch valve to avoid freezing of the valve and ice accumulation in the pipe leading to the valve. In the case of Conestogo Dam the revised policy allowed for maintaining reservoir levels above the gates to avoid icing of the gate and gate gains.

The existing operating procedures, as outlined in the latest update in 2004, follow specific guidelines including:

- Target reservoir levels for major reservoirs for March 1st, April 1st, May 1st, June 1st and October 15th to balance flood management and low flow augmentation requirements. These targets have been presented in Table 1. Upper rule curve reservoir levels for April 1st, May 1st and June 1st are based on recommendations following the Provincial Inquiry into the 1974 flood.
- Minimum low flow targets on the Speed River at Guelph (Edinburgh Road), the Grand River in Kitchener (Doon) and the Grand River in Brantford, for water quality and water supply. These targets have been presented in Table 2. These low flow operating targets are based on recommendations from the 1982 basin management study. The ability to meet these operating targets with 95% reliability was confirmed in the Region of Waterloo Region of Waterloo Long Term Water Supply Strategy – Grand River Option (1994) and by the GRCA 2016 study Low Flow Reliabilities in Regulated River Reaches in the Grand River Watershed.

The operational rules and policies have been subject to several reviews and updates, as outlined in Appendix A-Table A2. A brief overview of the updates to the operational policies are provided below.

3.0 RESERVOIR RULE CURVES

In February 2004 an updated reservoir operating policy was presented to and approved by the GRCA board. The 2004 operating policy was based on a comprehensive review of reservoir operating practices, previous operating policies, technical studies and assumptions.

These assumptions are primarily based on studies conducted after the significant flooding in 1974, subsequent floodplain mapping studies, downstream constraints, and water supply requirements for communities situated downstream of the reservoirs. The key assumptions are outlined below:

a) Royal Commission Inquiry into Grand River Flood of 1974

Following the May 1974 flooding in the Grand River watershed, the Royal Commission Inquiry into the flood conducted a thorough investigation of the flooding, the role of GRCA reservoirs and the procedures and operational policies employed by GRCA. The inquiry identified the competing objectives of the reservoirs in the Grand River watershed for flood management and downstream water supply. Through a separate sub-committee, minimum storage requirements for the large reservoirs for April 1st, May 1st and June 1st were established. Adhering to these storage targets will enable the GRCA to maintain adequate water levels to meet downstream water supply needs with 95% confidence each year while also providing sufficient flood management capacity during the spring. These targets have been included into the upper rule curve for the three large dams: Shand, Conestogo, and Guelph.

b) Downstream Flow Augmentation Assumptions

Following the recommendations of the Royal Commission Inquiry into the Grand River Flood of 1974 and as part of the 1982 Grand River Basin Management Study conducted by the Ontario Ministry of Environment, flow augmentation targets were established. As part of the 1982 Basin Study, low flow targets were established for the Grand River downstream of the GRCA reservoirs, through Kitchener (Doon) and Brantford, and also at the Hanlon Expressway on the Speed River downstream of the City of Guelph. These targets were established such that they can be met with a 95% reliability each year and provide a balance between competing objectives of the large reservoirs for flood management and downstream water supply.

In order to meet the downstream low flow targets, flow augmentation assumptions have been developed based on a straight-line drawdown of the reservoir storage from the May 1st and June 1st storage targets to the October 15th reservoir storage target. These assumptions form the upper and lower rule curves from May 1st and June 1st through October 15th. Water in storage after October 15th is drawn down to meet downstream fall flow targets and to reduce levels to the winter holding levels at the major dams. Note the May 1st lower rule curve storage target assumes the April 1st upper rule curve storage target, it reflects the potential situation of an abnormally dry spring runoff where only April 1st storage targets are achieved. The lower rule curve is intended to help guide reservoir management and flow augmentation during dry years, defining when a consideration may be given to reducing downstream low flow operation targets due to drought conditions.

c) Regulatory Floodplain Mapping Assumptions

Regulatory flood plain mapping for the portion of the Grand River located downstream of the Shand Dam and the portion of the Conestogo River located downstream of the Conestogo Dam have been conducted by taking into account some storage available upstream of these reservoirs for the purpose of flood management. The storge requirements identified for October 15th at Shand and Conestogo Dams reflects the storage assumed available to regulate downstream regulatory storm flows used to define the floodplain associated with the Regulatory storm Hurricane Hazel.

d) Flood Management Infrastructure Design Assumptions

Following the major flooding in 1974 and the subsequent recommendations of the royal commission inquiry, flood management dikes were designed and constructed along the Grand River channel works in the Cambridge (Galt) and Brantford areas. The dikes through Brantford were designed to handle unregulated flows, assuming no flood management storage is available in upstream reservoirs. In contrast, the dikes in Cambridge (Galt) and through Kitchener (Bridgeport) were designed with the expectation that flood management storage above the upper rule curve storage target for October 15th in the Shand, Conestogo, and Guelph Dams would be available to manage (route) the Regulatory flood... To achieve the design objectives of the dikes in Cambridge (Galt) and Kitchner (Bridgeport), upstream reservoir levels are managed to meet these October 15th storage targets.

e) Physical Operational Constraints at Shand Dam

Historically, major reservoirs like the Shand Dam and Conestogo Dam were drained to very low levels during the winter months. However, due to operational challenges related to freezing of dam components, the winter operational policy for Shand Dam was updated in 2004 to reflect the operating practice of higher operating levels during winter months. Reservoir levels are now maintained above an elevation of 410.71 meters to prevent the freezing and icing of the 48-inch diameter valve. Additionally, the 66-inch diameter valve at Shand Dam is not operated when the reservoir elevation exceeds 417.75 meters and is tested each fall when levels fall below this threshold. In the case of Conestogo Dam, reservoir elevations are maintained above 380.48 meters, one meter above the top of the gates to avoid icing of the gates and gate gains.

4.0 CLIMATE CHANGE AND POTENTIAL IMPACTS ON RESERVOIR OPERATIONS

The reservoir operational rule curves which are currently in use, are based on the latest revision and updates in 2004. As part of the current review of the operational policies and procedures, and in order to account for potential impacts of climate change, the total precipitation recorded at climate stations at major dams as well as total inflow to major reservoirs have been analyzed.

Review of the recent climate and stream flow data is indicative of a shift in climate patterns in the Grand River Watershed. In general, the observations are pointing to warmer winters with more frequent melt events through the winter months, specifically in the months of January and February and smaller spring freshets as a result of losing the snow pack in the watershed earlier through several melt events. These observations are in-line with climate change studies1 conducted as a collaboration between Environment and Climate Change Canada (ECCC), the Computer Research Institute of Montreal (CRIM), the Pacific Climate Impacts Consortium (PCIC), the Prairie Climate Centre (PCC), CLIMAtlantic, Ouranos and HabitatSeven. In summary, by 2050, it is anticipated that there will be an increase in the number of days with temperatures greater than 30 °C, a decrease in the number of days with daily maximum temperature less than 0 °C, an increase in annual precipitation and an increase in heavy precipitation days (days with more than 20 mm of precipitation).

In order to evaluate the impacts of climate change on total precipitation in the watershed, specifically upstream of the large reservoirs, the total daily precipitation data measured at climate stations located at Shand, Conestogo and Guelph Dams have been reviewed for the first quarter of each year, between 1984 and 2024. The first quarter of each year has been the focus of this assessment since precipitation during the first three months of each year, specifically snow, is very critical for the purpose of filling the

[1] https://climatedata.ca/explore/variable/

reservoirs and achieving the spring targets by April 1st. The results of this assessment have been presented in Figures 2 to 4 for the Shand, Conestogo and Guelph Dams respectively. Precipitation for each year has been presented using a single bar which illustrates the total precipitation for the first quarter of the year, as well as the depth of total rainfall and total snowfall individually using different colors. A 5-year and 7-year moving average of the total precipitation have also been provided.

Figure 2 - Total Precipitation for Q1 at Shand Dam Between 1984 - 2024

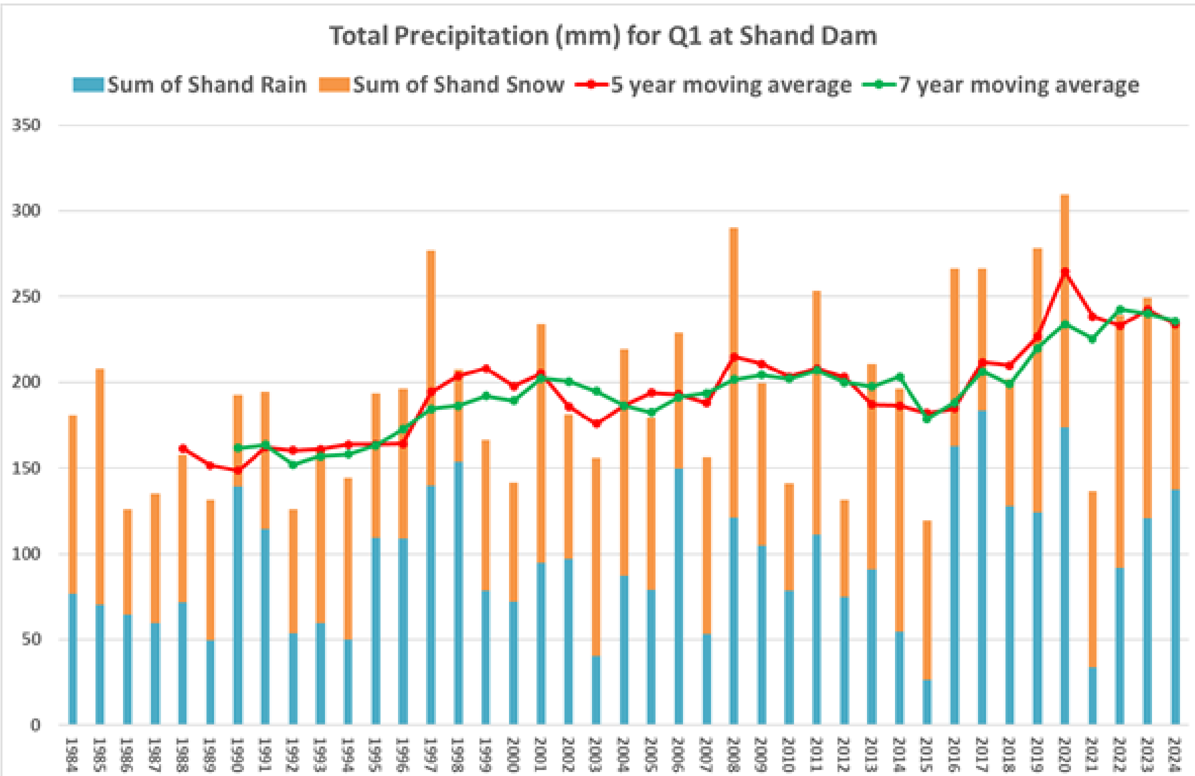


Figure 3 - Total Precipitation for Q1 at Conestogo Dam Between 1984 - 2024

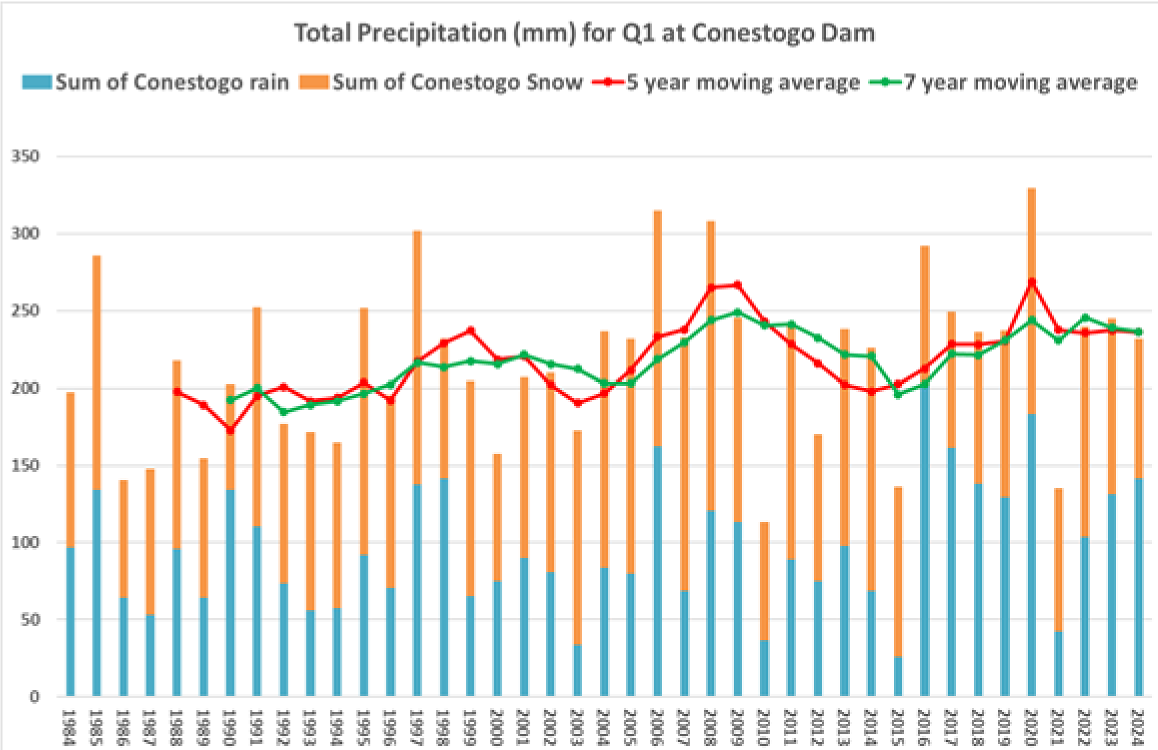
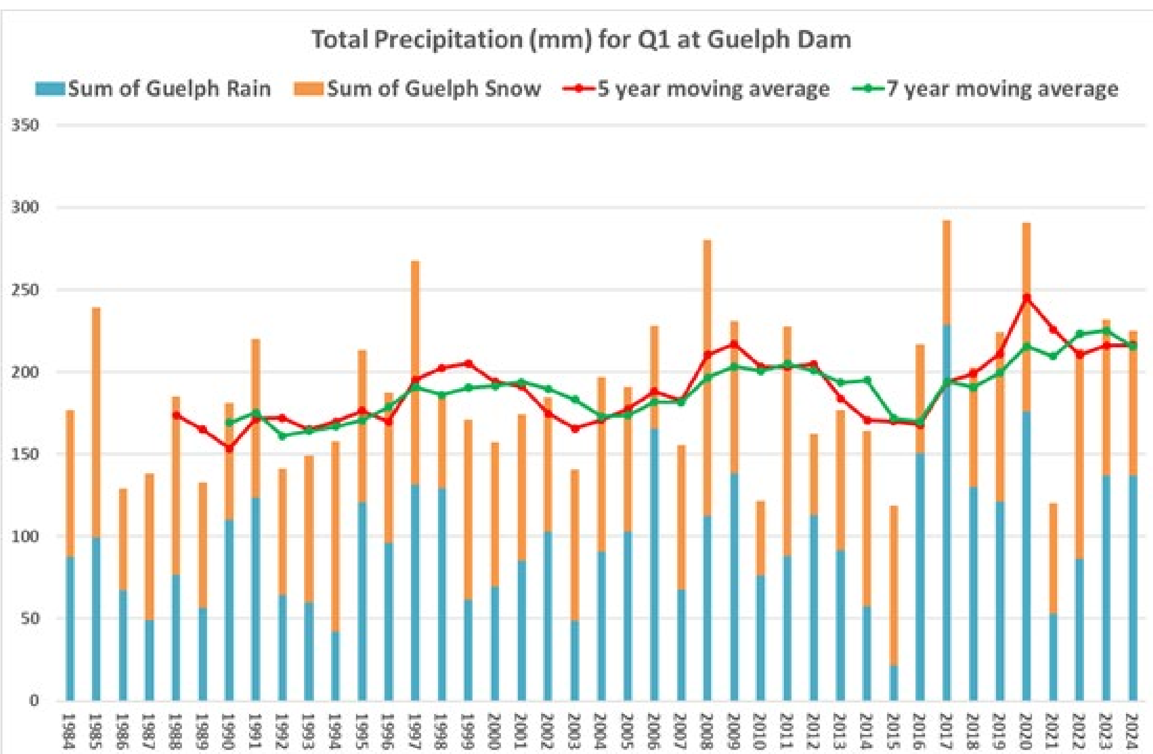


Figure 4 - Total Precipitation for Q1 at Guelph Dam Between 1984 - 2024



Results presented in Figures 2 to 4 indicate that over the past 40 years, the trend of the total precipitation for the first quarter at each dam shows a slight increase, based on both the 5-year and 7-year moving averages. This upward trend of the total precipitation aligns with climate change projections as described previously. Furthermore, it appears that the portion of the total precipitation presented in blue, which illustrates total rainfall, has increased slightly over the past few years, compared to earlier years.

During the past few years, warmer winters combined with early loss of snowpack during the winter time have raised concerns about whether the current reservoir targets for the beginning of March, April. May and June can be met. In order to evaluate the adequacy of the current operational policies and rule curves, an assessment has been conducted on the total inflow for Shand, Conestogo and Guelph reservoirs based on daily calculated reservoir inflows. The total inflows for the first quarter of each year at Shand, Conestogo and Guelph Dams for the period of 1984 to 2024 have been presented in Figures 5, 7 and 9 respectively. The total volume required to fill the reservoirs from their winter target level to April 1st target has also been presented on these figures. Additionally, the total inflows for the second quarter of each year at Shand, Conestogo and Guelph Dams for the period of 1984 to 2024 have been presented in Figures 6, 8 and 10 respectively. The total volume required to fill the reservoirs from their winter target level to June 1st target has also been presented on these figures.

Figure 5 Total Inflow for Q1 at Shand Dam from 1984 - 2024

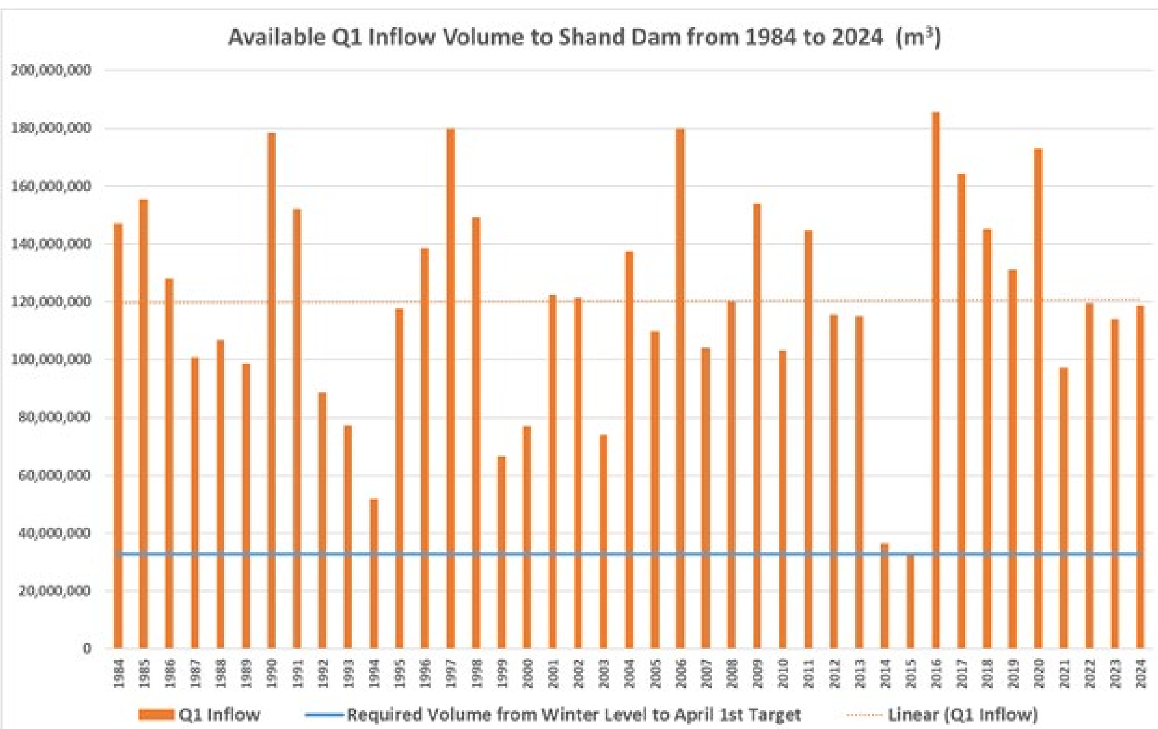


Figure 6 - Total inflow for Q2 at Shand Dam Between 1984 - 2024

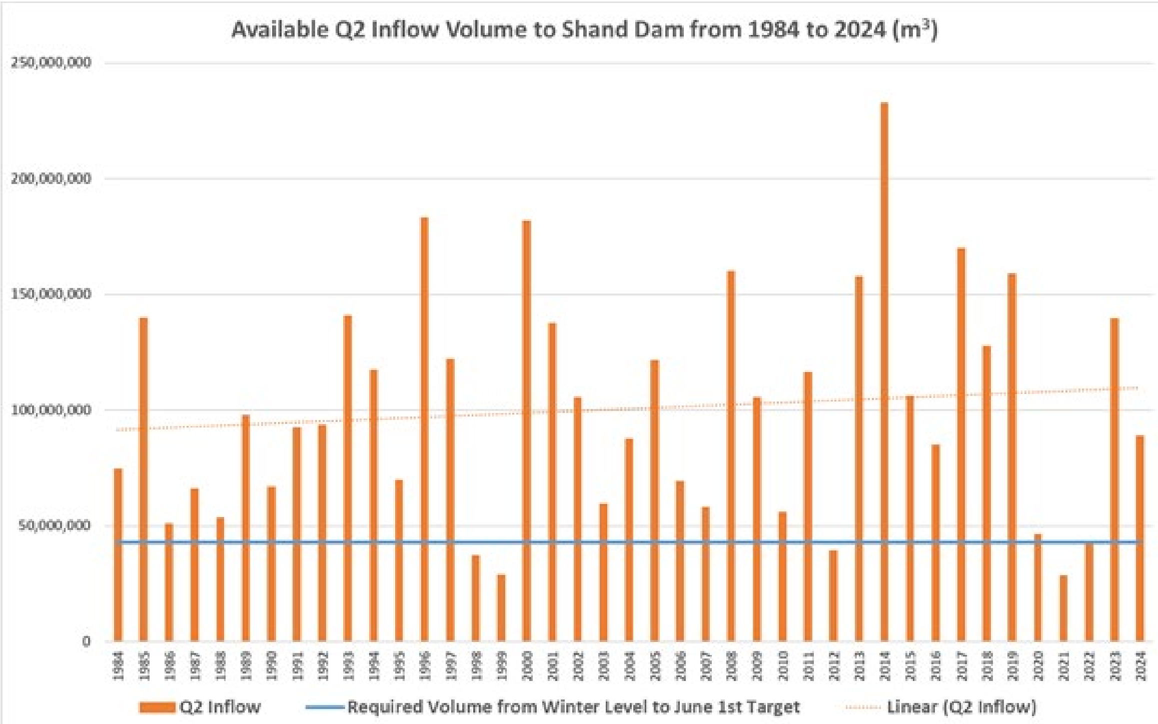


Figure 7 Total Inflow for Q1 at Conestogo Dam Between 1984 - 2024

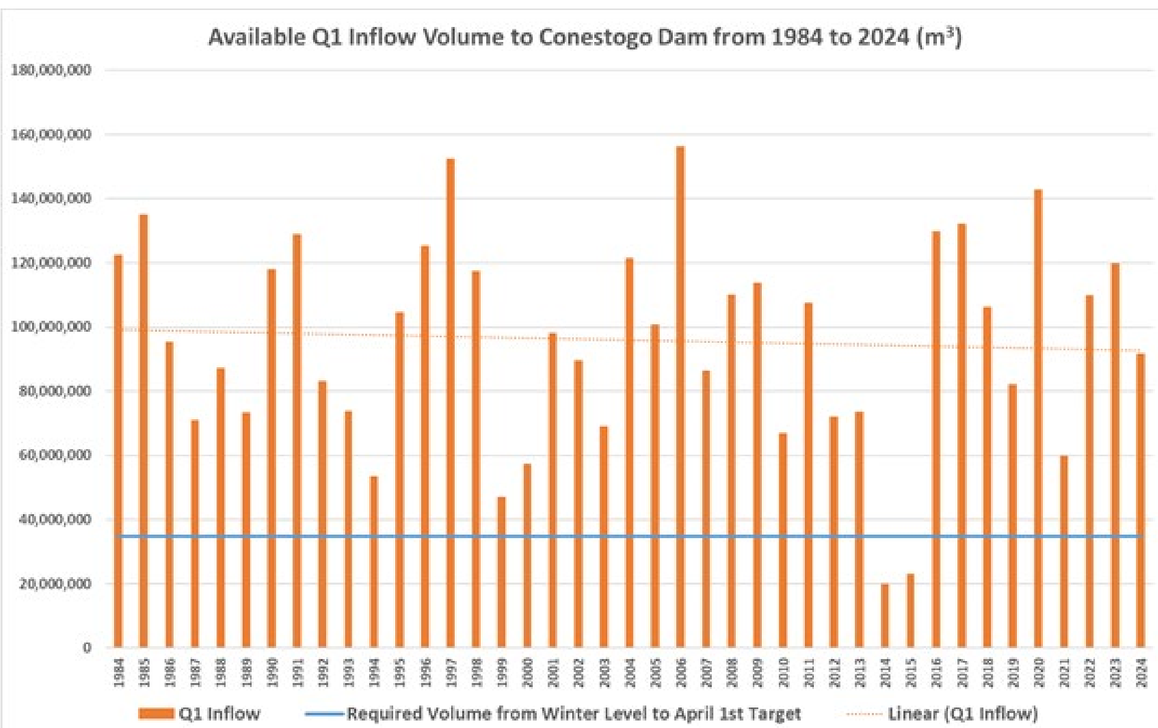


Figure 8 Total Inflow for Q2 at Conestogo Dam Between 1984 - 2024

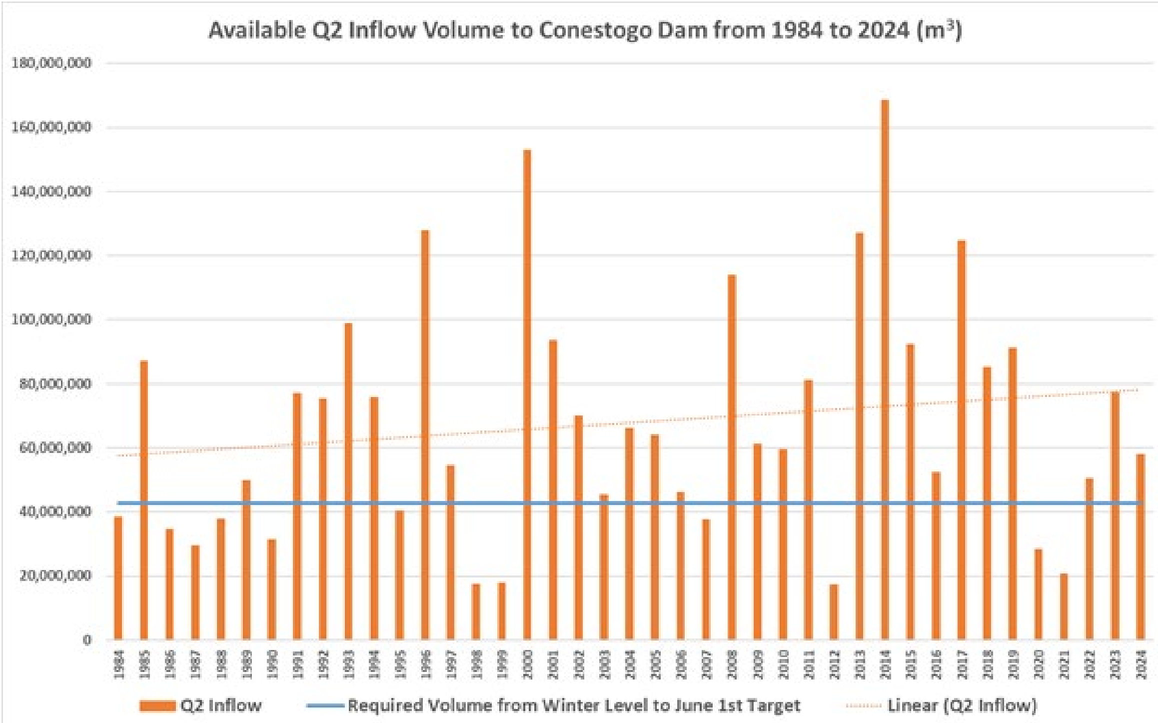


Figure 9 - Total Inflow for Q1 at Guelph Dam Between 1984 - 2024

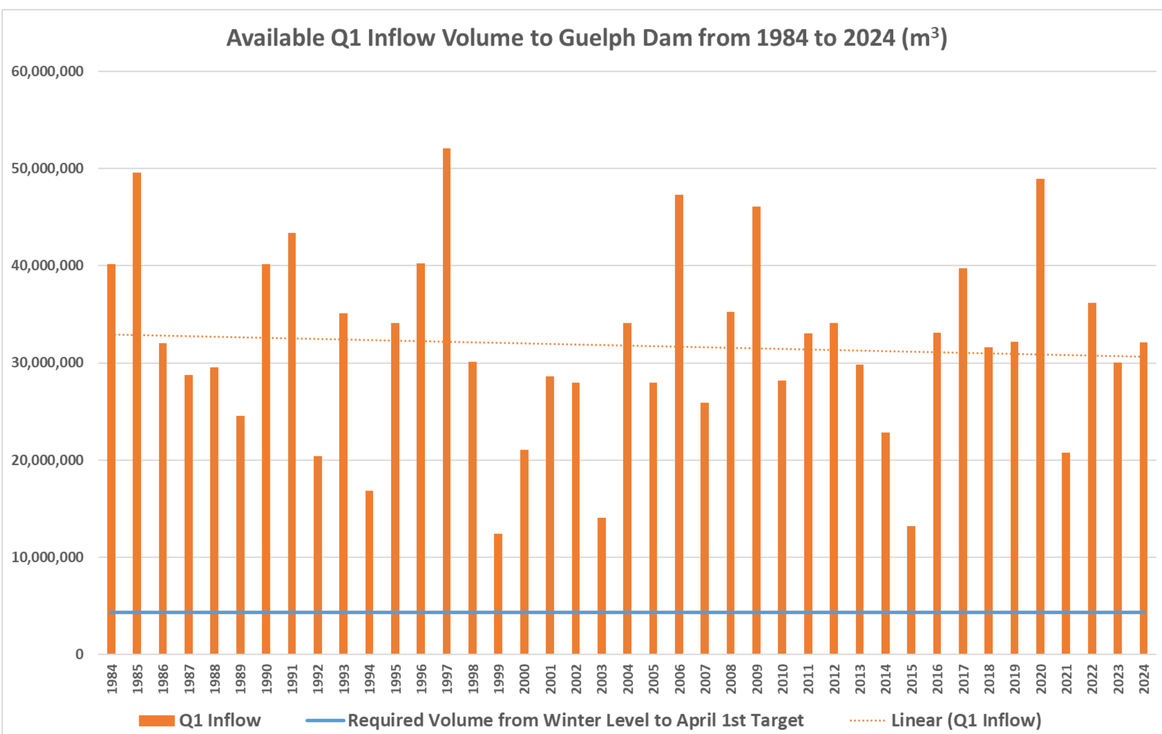
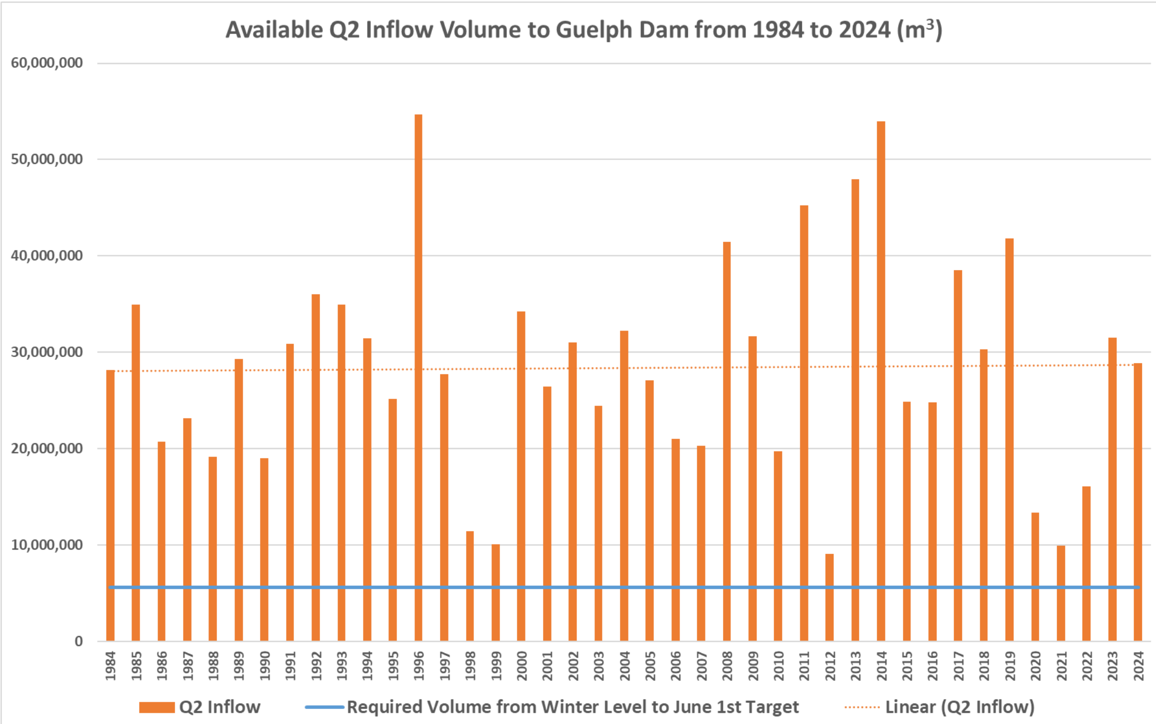


Figure 10 - Total Inflow for Q2 at Guelph Dam Between 1984 - 2024



Results presented in Figures 5, 7 and 9 indicate that with the exception of a few years, the total inflow during the first quarter of the year over the past 40 years has generally been sufficient to fill the reservoirs to their April 1st target. Results presented in Figures 6, 8 and 10 also indicate that the total volume of inflow to the large reservoirs during the second quarter of the year over the past 40 years has generally been sufficient to fill the reservoirs to their June 1st target from their winter level. In other words, if reservoirs fall short of their April 1st target due to early loss of snow pack or low precipitation, the reservoirs have received sufficient inflows in the second quarter of the year to achieve water supply targets and reliably maintain low flow targets for downstream communities.

Other considerations have also been taken into account when operating the reservoir with respect to climate change and recent weather patterns. To address the increasing risk of ice jams downstream of major reservoirs due to recent freeze and thaw patterns, Shand Dam's operation has been adjusted. During the freeze-up period, discharge rates are carefully managed to prevent conditions that have historically led to ice jams. Specifically, flow rates are regulated to promote the formation of a smooth and stable ice cover through the West Montrose reach downstream of the Elora Gorge, an area where ice jams have been frequently observed in recent years.

5.0 GENERAL OPERATING PROCEDURE

Operating rule curves for the seven multi-purpose reservoirs have been presented in Figures 11 through 17. Additionally, the operating rule curve for Damascus Dam has been presented in Figure 18. The upper and lower rule curves, as well as minimum flood storage requirements established based on the 1974 Royal Commission Inquiry have been presented on these figures. The established target reservoir levels and available storage volumes for flood management for March 1st, April 1st, May 1st, June 1st and October 15th for multi-purpose reservoirs have been presented in Table 1. Low flow targets for the Grand River in Kitchener and Brantford and for Speed River in Guelph which have been established as part of the 1982 Grand River Basin Management Study have been presented in Table 2.

In the operation of multi-purpose reservoirs, the allocation of storage between flood management and flow augmentation changes with the seasons. Generally, water available for flow augmentation is lowest in late winter or early spring and highest in late spring or early summer. Conversely, storage capacity for flood management is greatest in late winter or early spring and lowest in late spring or early summer. Flood management planning in the Grand River Watershed focuses primarily on spring runoff and extra-tropical storms in fall. Operational policy dictates that reservoir capacity is maximized for spring runoff, with approximately 65 percent of this capacity available by mid-October. To address the recent trend of warmer winter months and the early loss of snowpack before the spring freshet, the rule curves for Shand, Conestogo, Woolwich and Guelph Dams have been adjusted between February 22nd and April 1st. The upper rule curve has been revised to be shown as a dashed line during this period of the year. This revision allows for greater flexibility in capturing runoff from potential early snowmelt events. However, should an early snowmelt occur and lead to increased reservoir levels before April 1st, the levels at Shand, Conestogo and Guelph Dams will be managed to remain at or below the April 1st target to ensure that sufficient flood management storage remains available.

Operational details change annually based on weather conditions. Following the spring runoff from snowmelt, the Shand and Conestogo reservoirs are typically stabilized at an elevation about 1.5 meters below the normal high-water level in late March. Normal high-water level is the June 1st upper rule curve elevation. As spring advances, the reservoirs are gradually raised to approximately 0.6 meters below the normal level by early May, and ideally reach full level by the end of May. Table 3 illustrates the target reservoir levels throughout the spring period and the available storage volume in the reservoirs for flood management.

Table 1 - Target Reservoir Levels and Available Storage Volume for Flood Management

	March 1		April 1		May 1		June 1		October 15	
Dam	Target *Reservoir level** (meters))	Available Storage (x 1000m^3)	Target *Reservoir level** (meters)	Available Storage (x 1000m^3)	Target *Reservoir level** (meters)	Available Storage (x 1000m^3)	Target Reservoir level* (meters)	Available Storage (x 1000m^3)	Target Reservoir level* (meters)	Available Storage (x 1000m^3)
Shand	420.500	31,798	423.684	12,335	424.592	6,044	425.074	2,336	417.700	45,000
Conestogo	388.379	29,719	391.978	10,361	392.584	6,414	393.192	2,208	386.205	38,574
Guelph	346.000	9,533	347.472	5,292	348.000	3,586	348.000	3,586	346.000	9,533
Small Dams**	varies	3,824	varies	3,824	varies	3,824	varies	3,824	varies	3,824
Total		74,874		31,812		19,868		11,954		97,111

*All elevations are based on CGVD28 datum.

**Small Dams include: Laurel Creek, Woolwich, Shade's Mills

Table 2 - Minimum Low Flow Targets Downstream of Large Reservoirs

River	Location	Timing	Minimum target (m^3/s)
Grand	Grand Valley	Annual	0.42 at Leggatt gauge
	Shand Dam	Annual	Lesser of 2.8 or inflow
	Doon	May 1 – Sept 30	9.9 before Mannheim water-taking of 0.9
		Sept 30 – Dec 31	7.1 before Mannheim water-taking
		Dec 31 – Feb 29	2. 8 before Mannheim water-taking
	Brantford	May 1 – Oct 31	17.0
Conestogo	Conestogo Dam	Annual	Lesser of 2.1 or inflow
Speed	Guelph Dam	Annual	0.57
	Edinburgh Rd	June - Sept	1.7
		Oct - May	1.1
Canagagigue	Woolwich Dam	Annual	0.3

Table 3 - Water in Storage When Reservoirs are Full

	Normal High-Water Level (June 1st Upper Rule Curve Level)			Maximum High-Water Level (Full Reservoir Level)		
Dam	Water Level* (meters)	Water in Storage (x 1000m³)	Available Storage (x 1000m³)	Water Level* (meters)	**Water in** Storage (x 1000m³)	Available Storage **(x 1000m³)**
Shand	425.074	61,410	2,336	425.379	63,746	-
Conestogo	393.192	57,214	2,208	393.497	59,422	-
Guelph	348.0	16,944	3,586	348.996	**20,530	-

*All elevations are based on CGVD28 datum.

**Storage in Main Reservoir exclusive of storage above Hwy 24 Dam

Note Above an elevation of 348.086 m water from the main Guelph Dam Reservoir backs up into the reservoir above Hwy 24 Dam, between an elevation of 348.086 m and 3489.996 m there is an addition storage of 566 1000’s of m3 of storage upstream of Hwy 24 Dam.

Figure 11 Shand Dam Rule Curve (August 2024)

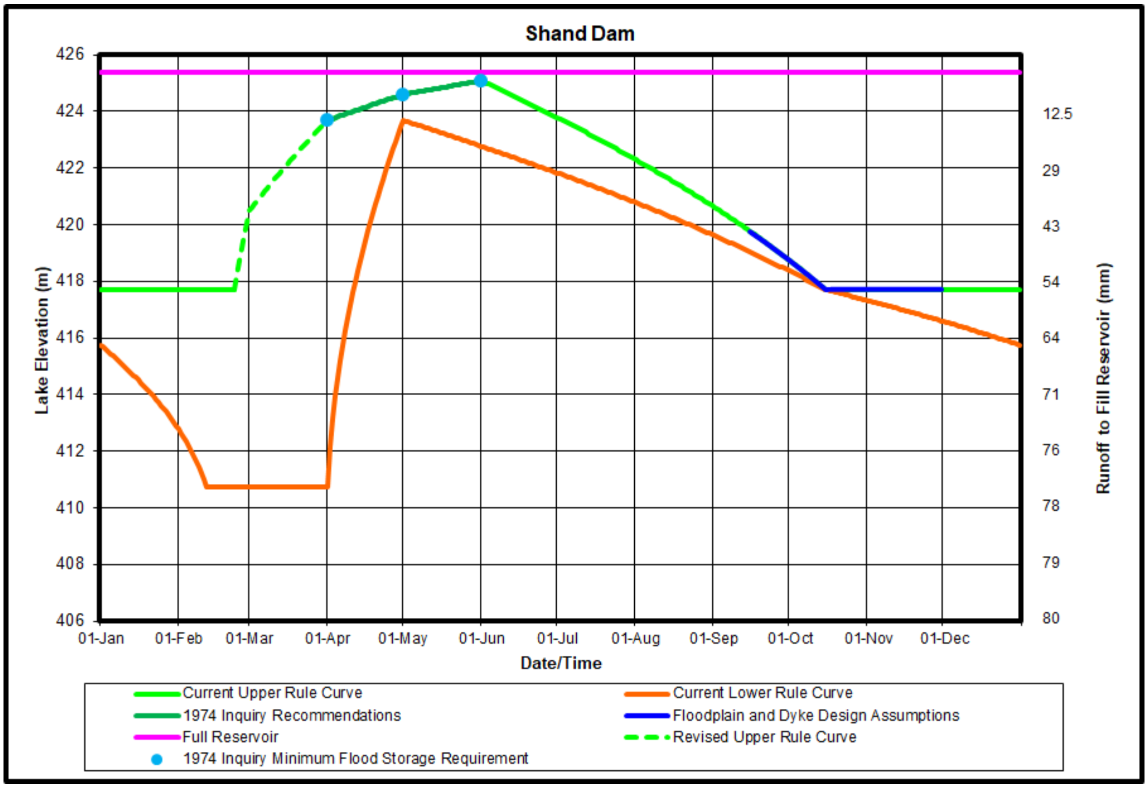


Figure 12 Conestogo Dam Rule Curve (August 2024)

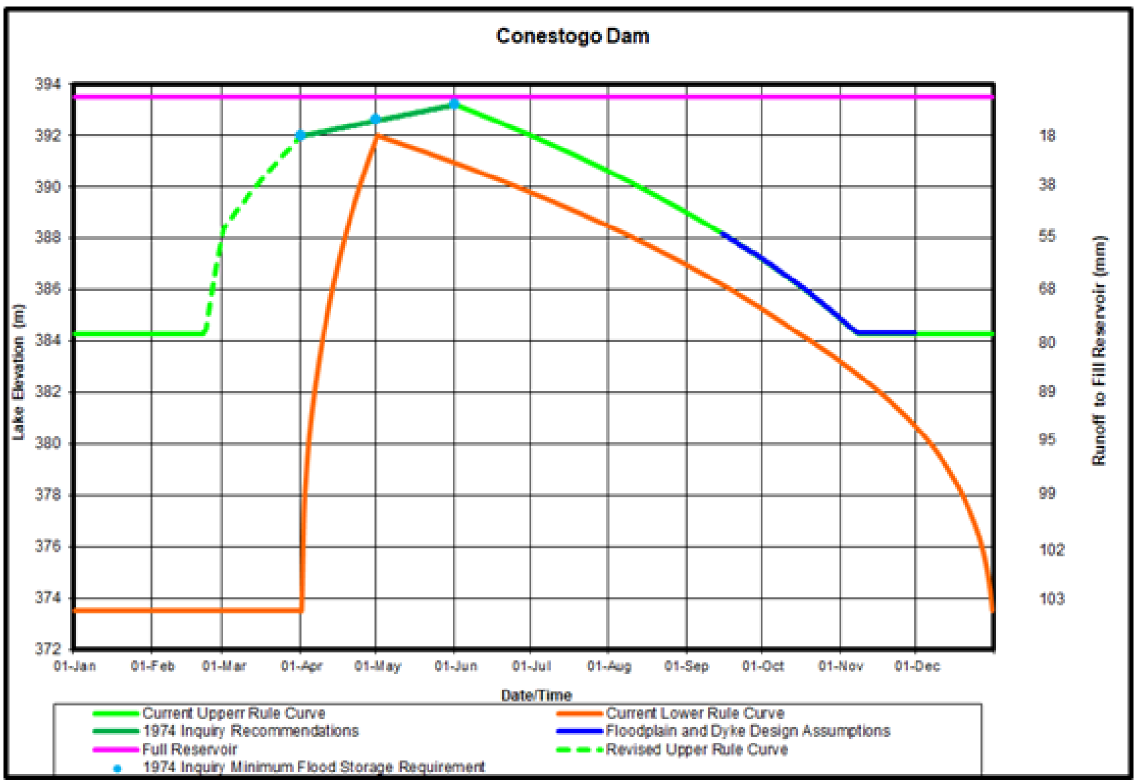


Figure 13 Guelph Dam Rule Curve (August 2024)

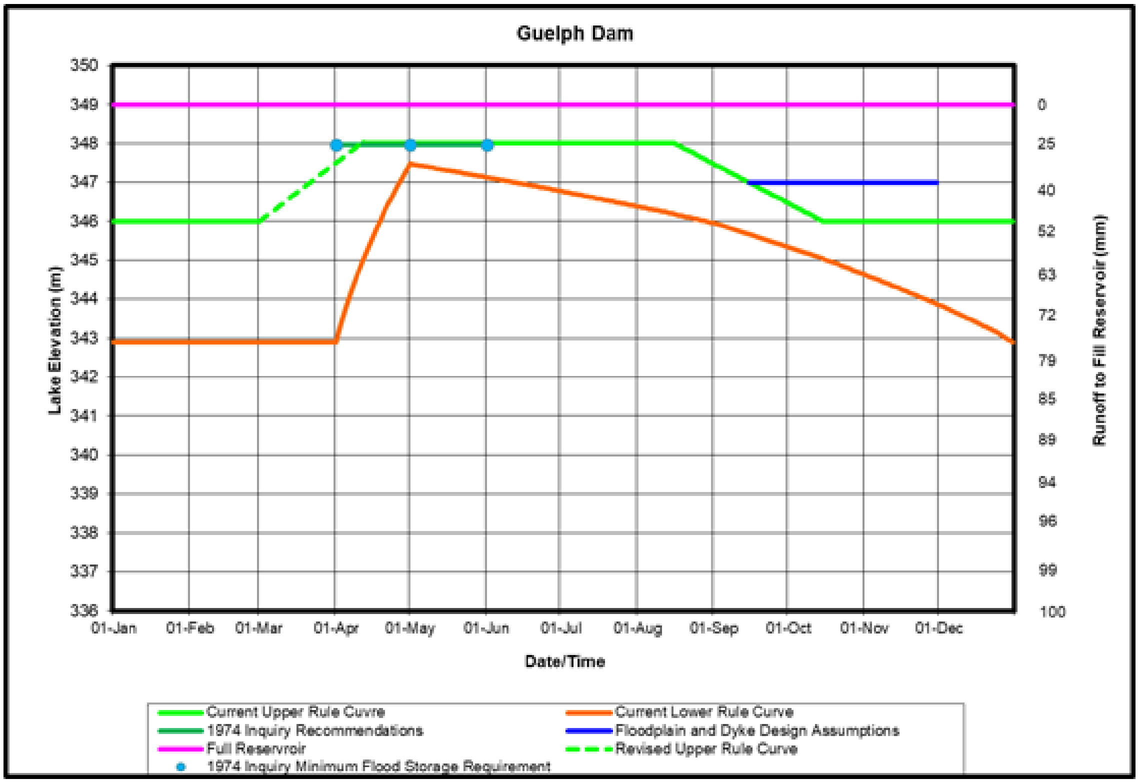


Figure 14 - Luther Dam Rule Curve (August 2024)

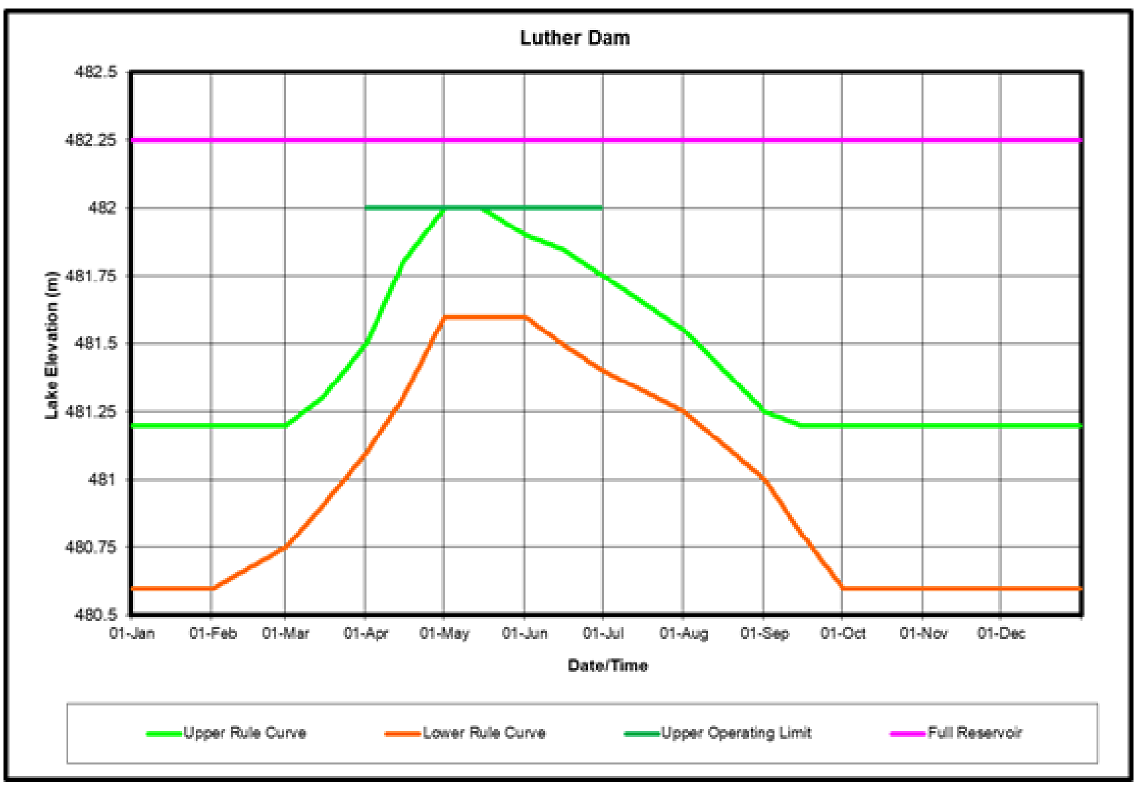


Figure 15 - Woolwich Dam Rule Curve (August 2024)

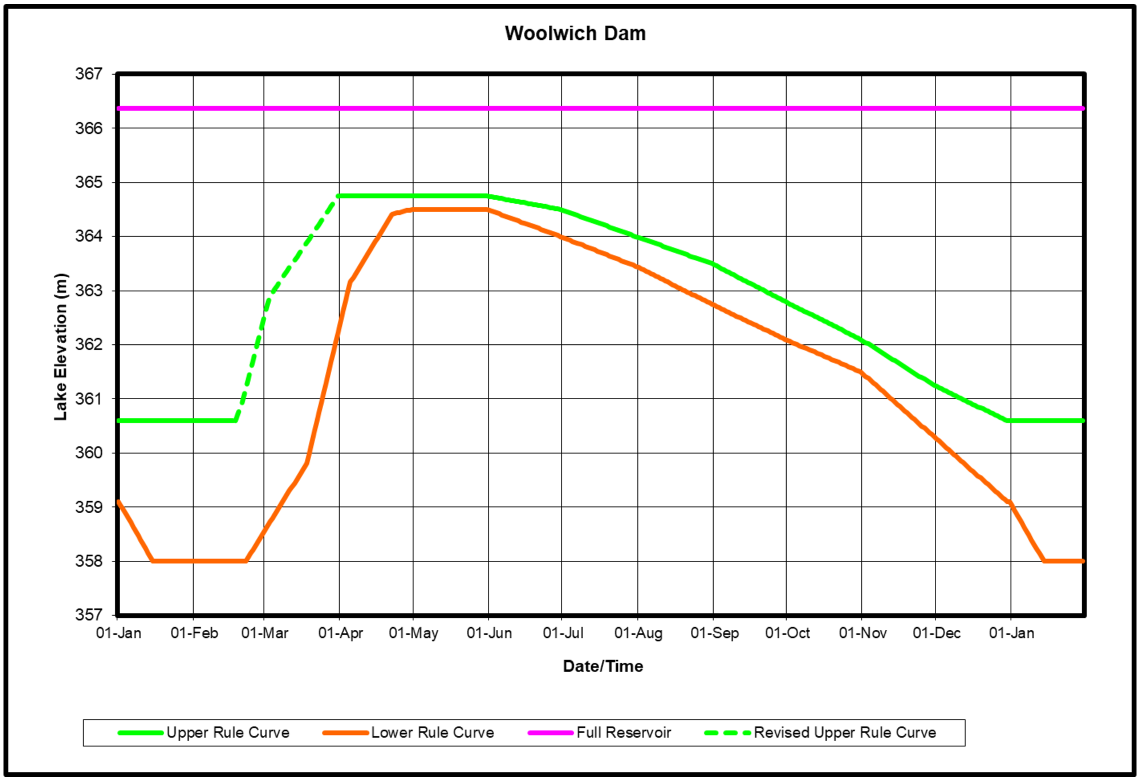


Figure 16 - Laurel Creek Dam Rule Curve (August 2024)

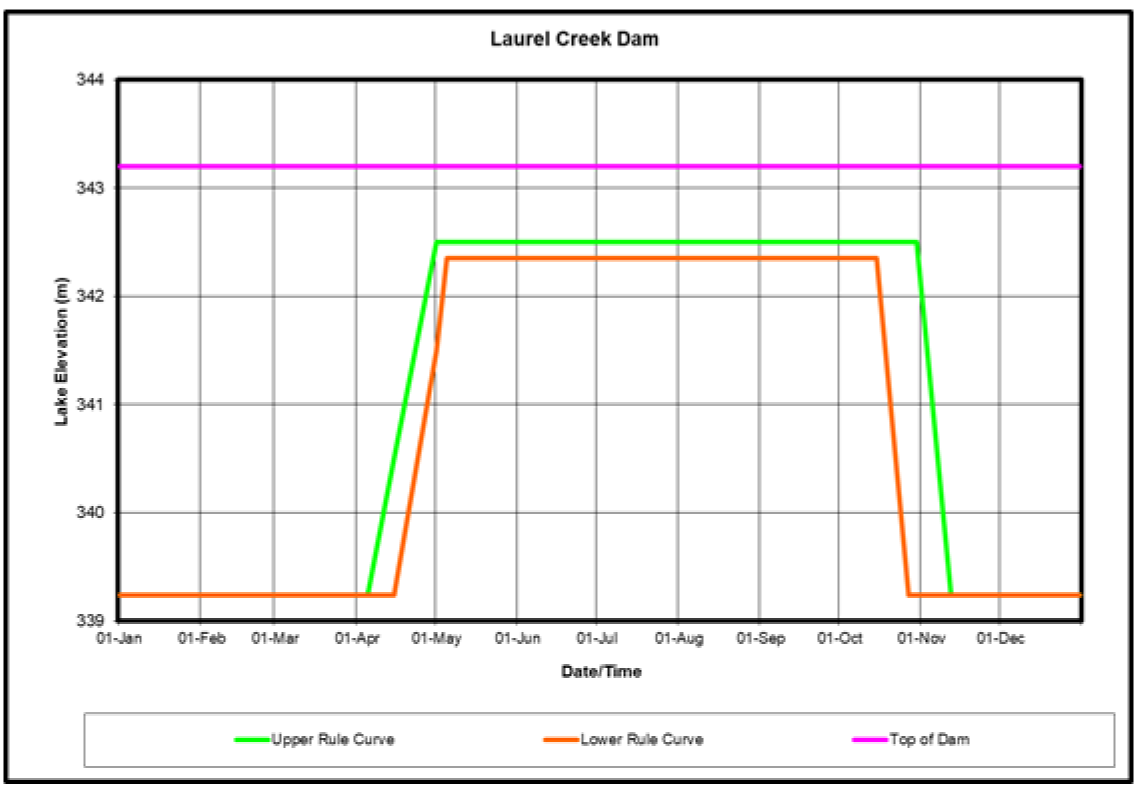


Figure 17 - Shade's Mills Dam Rule Curve (August 2024)

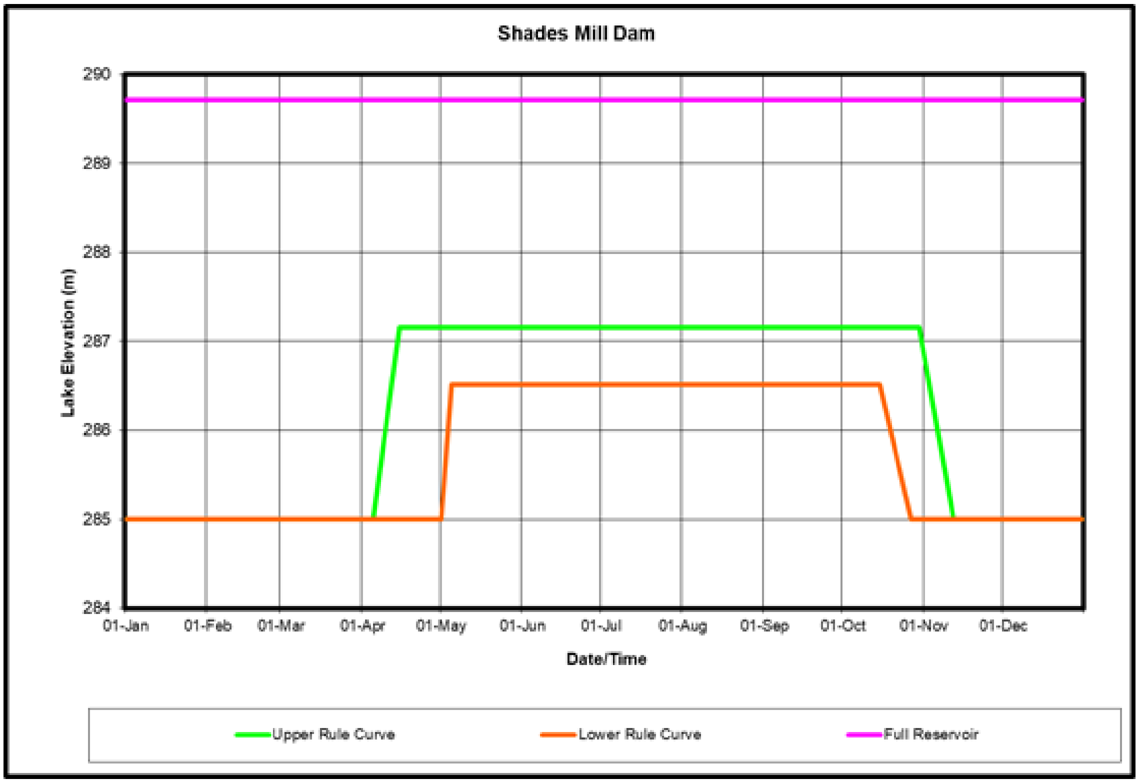
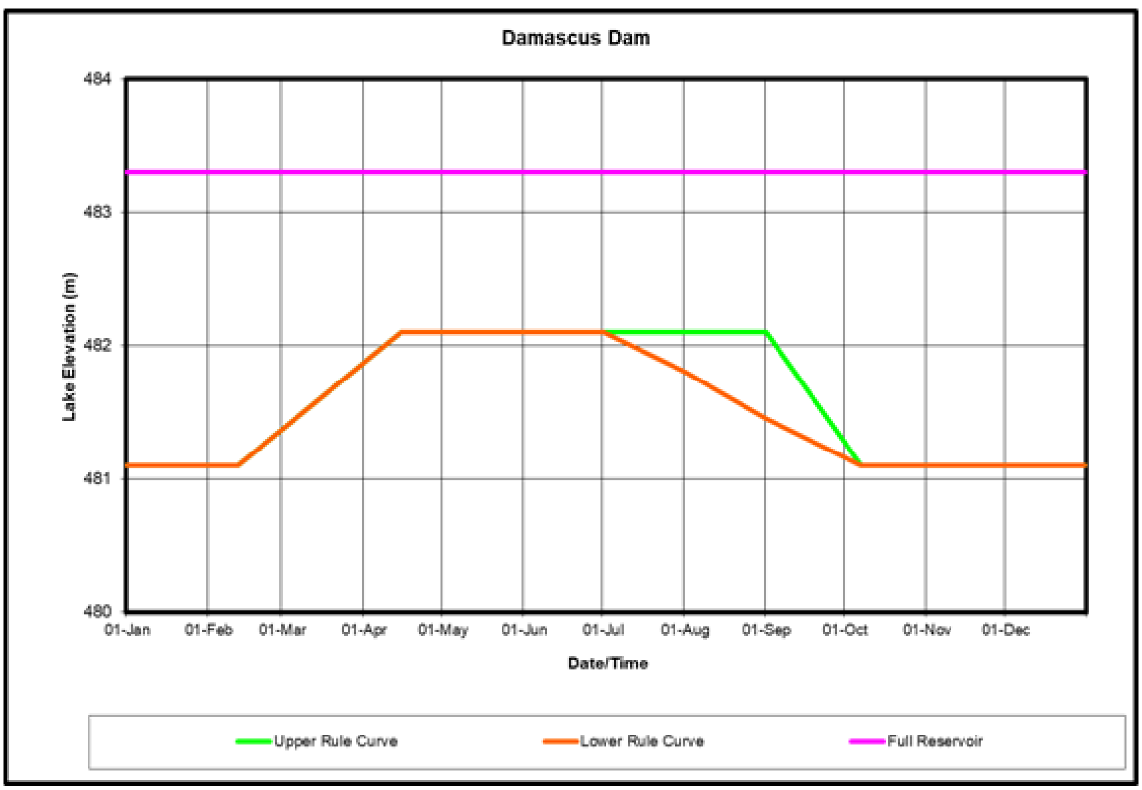


Figure 18 Damascus Dam Rule Curve (August 2024)



Appendix A

Table A1 - Studies Conducted on the Grand River Watershed Shaping Operational Policies of Dams

#	Year of Study	Name of Study
1	1932	Finlayson Report by the Minister of Lands and Forests of Ontario https://www.grandriver.ca/en/our-watershed/resources/Documents/Water_History_1932Finlayson.pdf
2	1939	H. G. Acres, Improvement of the Grand River, report to the Grand River Conservation Commission (Library Ref. W.08.3102.000.03)
3	1939	Cost Apportionment Report
4	1954	Conservation Report (Sec. Ed. 1962) 1954 Hydraulic Report (Library Ref. W.02.1005.101.004)
5	1961	Flood Control and Water Conservation Brief (Library Ref. W.01.1206.101.018)
6	1964	R J.M. Tomlinson and Associates. Report to the Grand River Commission, General Report on West Montrose and Ayr Reservoirs (Library Ref. W.02.1005.101.004)
7	1965	Speed River Report (Library Ref. W.02.1005.106.01)
8	1966	Grand River Conservation Authority Report, Brief on Flood Control and Water Conservation for the Grand River Watershed, (Library Ref. W.02.1005.101.02)
9	1967	Cost Allocation Report (Library Ref. W.01.1203.101.003)
10	1967	Montrose Functional Report (Library Ref. W.08.3101.000.012)
11	1971	Treasury Board Report (Library Ref. W.01.1208.101.001)

Table A2 - History of Reservoir Operation Policy Development and Update Studies

Name of Study	Description
Royal Commission Inquiry into the Grand River Flood. 1974 (W.01.1209.101.005)	Investigation into the 1974 Flood Recommendations for Flood Forecasting System and Reservoir System and Operations Minimum flood management storage April 1^{st}, May 1^{st} and June 1^{st} for major dams.
Hydrology Report for Cambridge Galt and Brantford. (W.01.1206.403.01)	Establish Regulatory Flood Flows for Galt and Brantford with Reservoir Regulation Assumptions, Design Flows For Major Dykes. Major initiative to map floodplains
Environmental Assessment of Water Management Structures. 1975-79 (W.04.2302.101.020)	Study to address Judge Leaches Recommendation to build the Montrose Reservoir. Assessed several reservoirs previously proposed. Assessed and pared down reservoir options.
Reservoir Operating Policy. February 1978	Updated operating policy and procedures for major dams. Beginning to incorporate recommendations from the 1974 flood inquiry.
Basin Study 1978 to 1981 lead by Ontario Ministry of Environment. (W.02.1302.101.008)	Published in 1982 recommended existing reservoirs and proposed dyking of specific communities to reduce flood damages. Montrose reservoir was proposed to remain on the books as a potential future project primarily for water supply and water quality purposes. Reservoir Yield modeling was completed to refine low flow operating objectives for major reservoirs. Low flow targets designed to have a 95% reliability. Reservoir rule curves used to guide reservoir operations.

Name of Study	Description
Revision to Reservoir Procedures for Shand Dam. January 19, 1981	Memo issued regarding revised winter holding level for Shand Dam recommending holding levels above the obvert of the 48” valve
Update Reservoir Operating Policy and Procedures. October 27 1982	Updated operating policy and procedures incorporating updated reservoir low flow operating targets and recommendations form the 1982 basin study.
Update Reservoir Operating Policy and Procedures. July 4 1984	Refined low flow operating targets for summer and winter low flows.
Operating Considerations for Shand Dam to mitigate freeze in ice jams at West Montrose. February 1 1986 (W.02.1008.304.001)	Internal analysis of ice jams at West Montrose and flows from Shand Dam during the freeze in period with recommended flow ranges for ice sheet formation through the West Montrose Reach
Updated Reservoir Operating Policy for Guelph Dam. November 2, 1988	Formerly implemented operating procedure for slot gates and modified upper rule curve for the May 1st to August 1st period of the year. Recommended non regulation of Regulatory Flood flows by Guelph Dam for the Speed River Floodplain Mapping.
Luther Marsh Reservoir Operating Curve and Procedure Modification. 1988-1989	As part of the Luther Marsh Management Plan update, a reservoir yield analysis was completed to determine reliable flow augmentation targets for the Leggatt Gauge station. Analysis recommends an operating curve which also incorporated environmental considerations for Luther Marsh. A valve was recommended to better manage flows and was implemented in 1989.
Region of Waterloo Long Term Water Supply Strategy – Grand River Option (1994 Paragon Engineering) W.01.1208.411.013	Review of flow reliability provided by large dams in the Grand River Watershed. Report included an updated Reservoir Yield Analysis to confirm reliability of meeting low flow operating targets through Kitchener and Brantford in the Grand River.
Updated Reservoir Operating Policy and Procedures. February 17, 2004	Update Reservoir Operating Policy approved by the GRCA board. Currently operating policy in use. Modified and refined reservoir rule curves at major dams to allow for holding water early in the year January to March 1st and late in the year October

Name of Study	Description
	15th to December 31st. This change was in response to droughts during the 1997-1999 period and recognized the practice of holding water in Conestogo Dam over the early winter months that evolved over the 1990's.
Updated Reservoir Yield Analysis flow augmentation targets for Grand Valley Sewage Treatment Plant. October 19, 2004	As part of the assimilative capacity assessment for the Grand Valley STP the reservoir analysis was updated include the late 1990's droughts and confirm low flow targets for the Leggatt gauge station.
Presentation of Reservoir Operating Policy to MOE Technical Staff. November 23, 2004	MOE technical staff questioned the reliability of low flows from GRCA reservoirs. Low flow augmentation from GRCA reservoirs strongly influence assimilative capacity requirements for sewage treatment plants in regulated reaches of the river. The purpose of the meeting was to provide information to MOE technical staff so they had a better comfort level with low flow reliability downstream of GRCA dams.
Guelph Dam Reservoir Yield modeling for Guelph Master Water Supply Plan. October 31, 2005	Updated reservoir yield analysis for Guelph dam considering additional municipal water taking from the Eramosa River and potential municipal surface water taking from Guelph Dam.
Climate Change Note/Memo. March 3, 2009	Brief technical note regarding key adaptions to respond to climate change related to GRCA reservoirs and dykes.
Update Reservoir Yield Analysis and Low Flow Reliability Tech Report. May 16, 2016	Updated reservoir yield analysis for the 1950 to 2010 period of record at major dams. Confirmed reliability of low flow operating targets for major GRCA dam using updated 2004 reservoir operating policy. Calculated low flow 7Q20's for regulated and unregulated reaches of river. Applied MNRF's climate data sets to test Reservoir Reliability under changed climate conditions.

Name of Study	Description
Board Report Montrose Reservoir Project Update. December 15, 2017	Board report responding to question from board member whether the Montrose reservoir project should remain as a GRCA project.
Board Report Assessment of GRCA Reservoirs to Reduce Floods. November 20, 2020	Board Report responding to a board members question whether additional upstream reservoirs are needed to regulate flood flows in the southern GRCA River. Board report summarizes the flood mitigation strategy and plan from the 1982 basin study.
Guelph Dam Reservoir Yield modeling for Guelph Master Water Supply Plan Update. February 2, 2021.	Updated reservoir yield analysis for Guelph dam considering additional municipal water taking from the Eramosa River and potential municipal surface water taking from Guelph Dam. Extended previous analysis period of record to 1950 to 2020.
Response to Cottage Lot Association Questions Regarding Reservoir Operations. April 14, 2021	Response to cottage lot owners questions regarding reservoir operating policy at Shand and Conestogo Dams.
Response to Cottage Lot Association Questions Regarding Dredging of Shand Dam. November 4, 2021	Response to cottage lot owners questions regarding need to dredge Shand Dam