Friends of Swan Lake Park

PATHWAY TO SUSTANABLE WATER QUALITY: Ending Swan Lake's Stormwater Management Role

June 4, 2021

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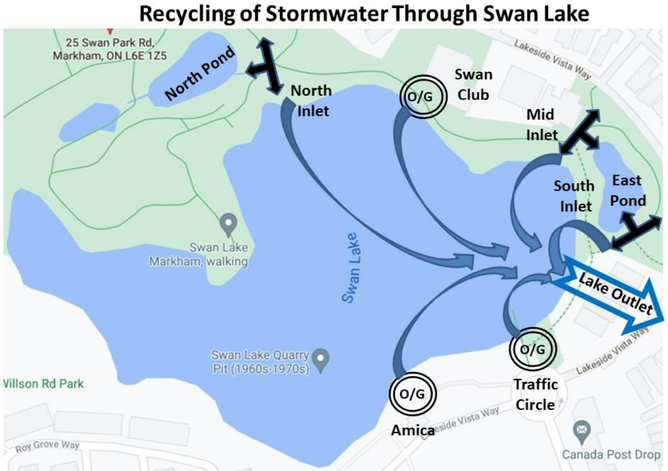
EXECUTIVE SUMMARY

Swan Lake Park's role as a "Natural Spaces/Wildlife Places" community park is undermined by a number of early design decisions that established Swan Lake as an active element in the local stormwater management regime. In essence, Swan Lake is the "third" stormwater pond in Swan Lake Park and we believe this role is not necessary and should be minimized.

Water quality in Swan Lake is deteriorating each year. Initiatives are underway to review approaches to minimize and manage phosphorus and nitrogen levels and to improve oxygen levels. Information on these issues is available in our report "A Pathway to Sustainable Water Quality for Swan Lake" at https://friendsofswanlakepark.ca/a-pathway-to-sustainable-water-quality-for-swan-lake/

Recycling of Stormwater Through Swan Lake



Currently, annual stormwater flows and road salt are unnecessarily being recycled through Swan Lake from five of six areas.

Enhanced salt management practices must be encouraged but the challenge of addressing excessive chloride levels in Swan Lake lies primarily in minimizing Swan Lake's role in the local stormwater management regime and establishing a rigorous maintenance regime.

Given that chloride use can only be minimized, not discontinued, we conclude there are four actions that can and should be taken to reduce the continuing inflow of road salt into Swan Lake:

i) Reroute two of the three oil/grit separator flows into the main stormwater sewer system;
ii) Minimize the stormwater flows bypassing the ponds and entering Swan Lake;
iii) Restore the lake level to its natural depth;
iv) Implement an effective pond monitoring and maintenance program to ensure future stormwater flows are not unnecessarily contaminating Swan Lake.

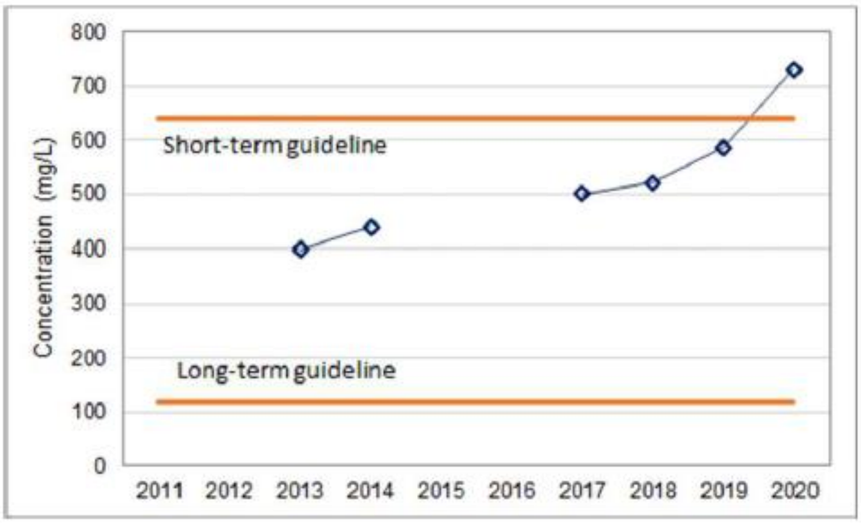
Our analysis identifies three core benefits arising from these proposed changes:

1) Swan Lake would become a self-contained entity retaining more of the clean local runoff and precipitation. Contaminated stormwater from the local communities would substantially remain in the stormwater system. Simply increasing the blend of fresh water within the lake should help enhance water quality and the aquatic environment.
2) Annual chloride contributions would be reduced by 82%. Minimizing the increase in chloride levels will provide an improved aquatic environment for zooplankton and small fish that are a natural means of controlling algae growth, reduce the risk of chloride contamination of the downstream aquifer and reduce future costs of expensive chemical treatments.
3) The amount of water directed downstream would be reduced, not increased.

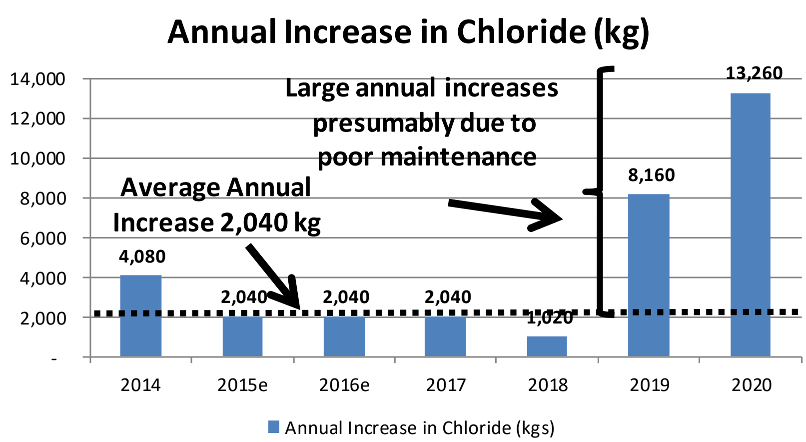
1) Impact of Chloride

Swan Lake contains an excessive amount of chloride that Freshwater Research[6] attributes to winter de-icing operations. In Appendix A we provide estimates of the sources for the chloride that have built up in Swan Lake.

Chloride does not break down and will accumulate within the lake over time, impairing the health of aquatic plants and many forms of aquatic species.



Chloride levels in Swan Lake are 6 times higher than the long term Federal standards. The excessive chloride (from road salt) is sufficient to kill small fish and eliminate zooplankton in the water, natural elements that consume algae. A healthy zooplankton colony is a building block for a naturally sustainable aquatic environment.



The adjacent chart illustrates the rapid increase in chloride levels in Swan Lake over the past few years. The annual increase prior to 2018 is estimated at 2,040 kilograms per year. In 2020 it increased to 13,260 kg.

We conclude that this rapid rise is not attributable to changes in normal winter salt management practices in the area but rather is due to the poor maintenance of the inlets. The excess attributable to poor maintenance is estimated at 24% of the current chloride content in Swan Lake.

Reduction in chloride levels, restoration of a healthy zooplankton community and a robust stock of small algae eating fish could provide a meaningful natural contribution to the control of algal growth and cyanobacteria in Swan Lake. Perhaps overstocking with algae eating fish may compensate for the loss of zooplankton.

Research studies suggest high chloride levels can lead to lower oxygen levels by diminishing aquatic plant life. Controlling oxygen levels and chloride levels opens up more natural biomanipulation options for the management of water quality in Swan Lake.

A small amount of chloride may enter Swan Lake via the aquifer but that is not likely a major concern. The greater concern should be that Swan Lake, with its very high concentrations is likely a source adding chloride to the downstream aquifer. Stormwater ponds are designed to minimize leakage into the aquifer. Swan Lake has no similar leakage prevention capabilities so a continued buildup of chloride is endangering water quality in the downstream aquifer.

Improvements in Salt Management Practices

The annual winter use of road salt in the adjacent areas is the primary source of chloride that has accumulated in the lake. A fundamental objective should be to encourage minimal use of road salt in the area. Prudent management of road salt in the local communities must be encouraged however it remains a fact that road salt is the primary tool for winter safety management and its use will continue.

Improvement in management practices needs to be encouraged. Two initiatives should be considered:

a) Review of Salt Management Protocols

Markham is responsible for the management of about 15% of the areas draining into the Swan Lake stormwater systems. The remainder is under the control of private owners.

- We believe Markham manages its salt applications under a 2005 policy guideline[8]. If so then this should be reviewed to see if there have been material advancements that could be adopted.
- Private owners should be encouraged to adopt environmentally safe protocols.
- Markham and private owners should be encouraged to hire only contractors that have completed the training program and are certified under the "Smart About Salt" program. Information on the program is available at http://smartaboutsalt.com/.

b) Consider Use of Brine

Brine introduces the concept of "anti-icing" by placing a layer of brine on the surface area before the storm to prevent freezing. Traditional road salt practices involve "de-icing" – using salt to remove ice after it has formed.

The benefit of adopting brine as part of the salt management regime was illustrated by a recent pilot project at Ryerson University that resulted in a 25% reduction in the use of salt.

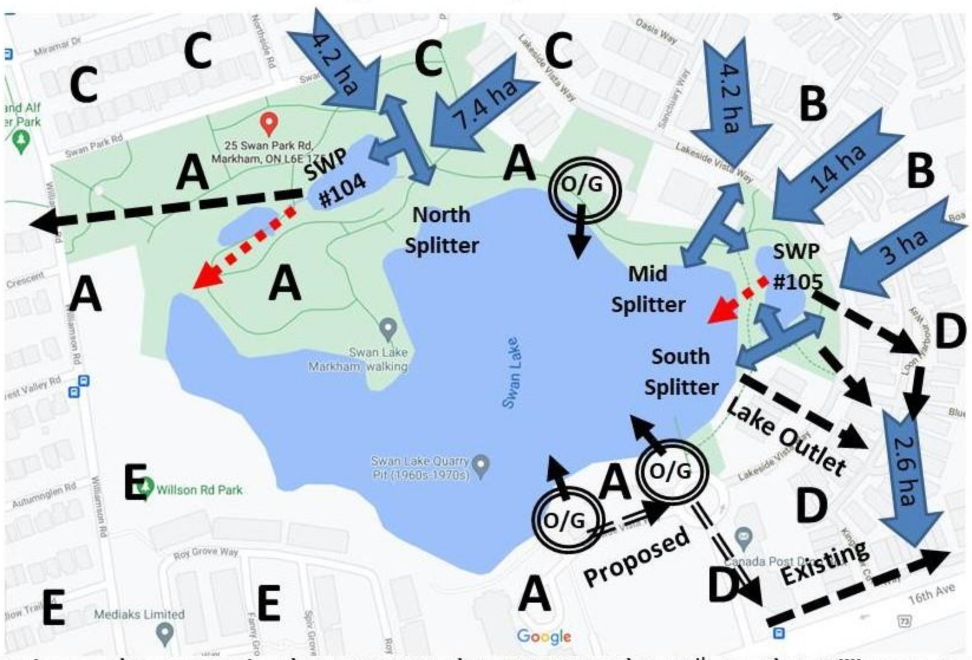
2) The Case for Minimizing Swan Lake's Role in Stormwater Management

In the fall of 2020, Friends of Swan Lake Park approached the Ontario Aggregate Trust Corporation (TOARC) for funding of the study they commissioned by Fleming College on options for addressing the issues in Swan Lake. TOARC was created to fund restoration of former quarries like Swan Lake but declined the request for funding stating:

> While the Board viewed the project as interesting, the water quality issues surrounding the man-made lake in Markham Ontario are not the result of below water extraction, but a result of the original municipal design of the site and land use planning that has since occurred surrounding it. Developing long term outcomes of this site will be dependent upon a set of negotiations to be conducted by the various stakeholders such as your municipality, the property owners and other approval authorities regarding changes to stormwater inflows, existing geese management and reduction of de-icing operations.

When it comes to the use of Swan Lake as an active element in local stormwater management it is obvious that some of the current water quality issues arise from key original design decisions and that these decisions need to be revisited. Certain original constraints are no longer relevant plus recent analysis by Markham[6] confirms that the design has resulted in unnecessarily recycling stormwater through the lake without any material stormwater management benefit. The unintended consequence of unnecessarily recycling stormwater through the lake is the buildup of road salt in the lake which has significantly undermined the aquatic environment (see Appendix A) and reduced the natural aquatic life that would normally be available to help fight the buildup of algae.

Stormwater Management System – Swan Lake Park

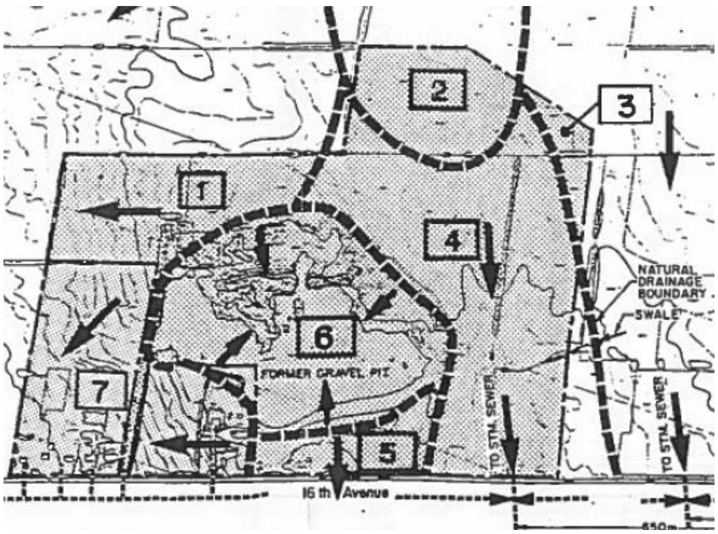


Drainage: A) To Swan Lake B) To SWP #105 C) To SWP #104 D) To 16th Ave E) To Williamson Road
Outflows to Stormwater System ▬ ▬ ▬ ▶ **Emergency Overflow** ▪▪▪▪▪▶

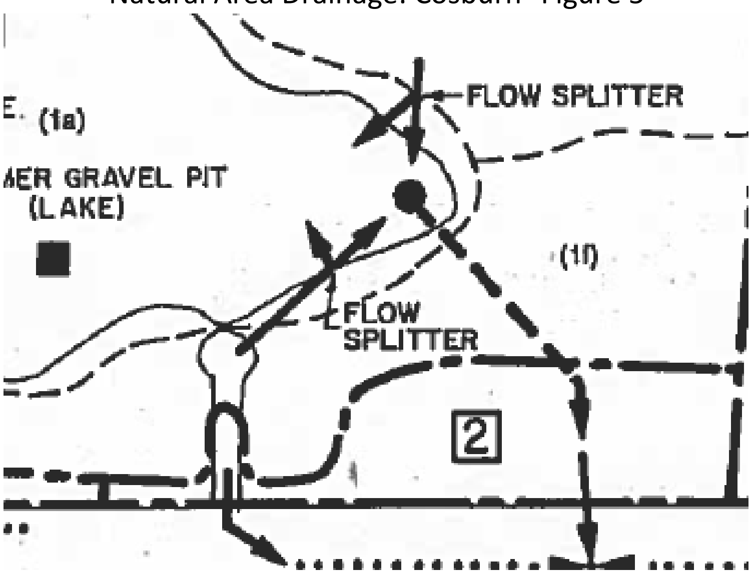
Three aspects of the original design can and should be reversed to minimize the future environmental impact:

1) Rerouting two of the three oil/grit separator volumes to 16th Avenue;
2) Reducing the amount of water bypassing the ponds;
3) Increasing the lake level back to its original depth.

A) The Case for Rerouting Direct Drainage Areas Into the Stormwater System



Natural Area Drainage: Cosburn[1] Figure 5



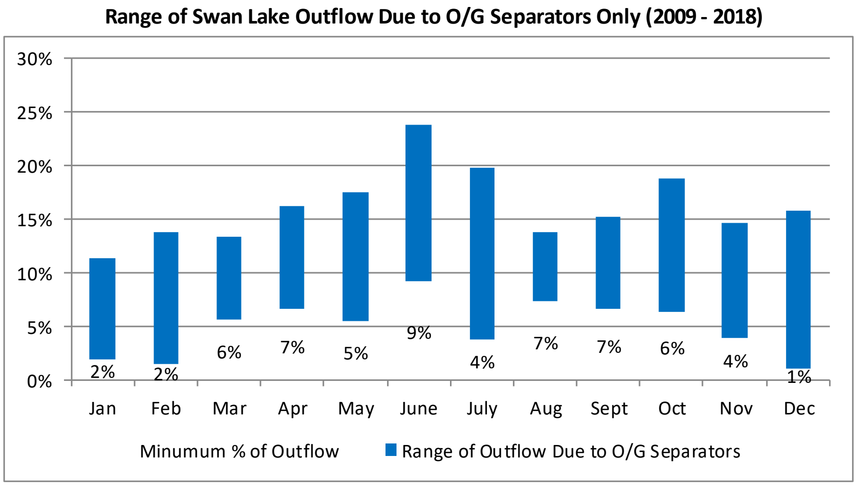
Original Drainage Plan for Traffic Circle
Cosburn[1] Figure 6

The original master drainage design for the area noted that the land immediately north of 16th Avenue (area #5) naturally drained towards either 16th Avenue or downhill to the west towards Mount Joy Creek (Exhibition Creek as it was then known as). Consequently stormwater from the southern end of Swan Lake Village and the new townhomes east of Williamson Road at 16th Avenue (area #7) were directed to stormwater systems along 16th Avenue.

However, contrary to the original recommendations, the Amica properties and the traffic circle area on Swan Lake Boulevard were permitted to drain directly into Swan Lake via oil/grit separators.

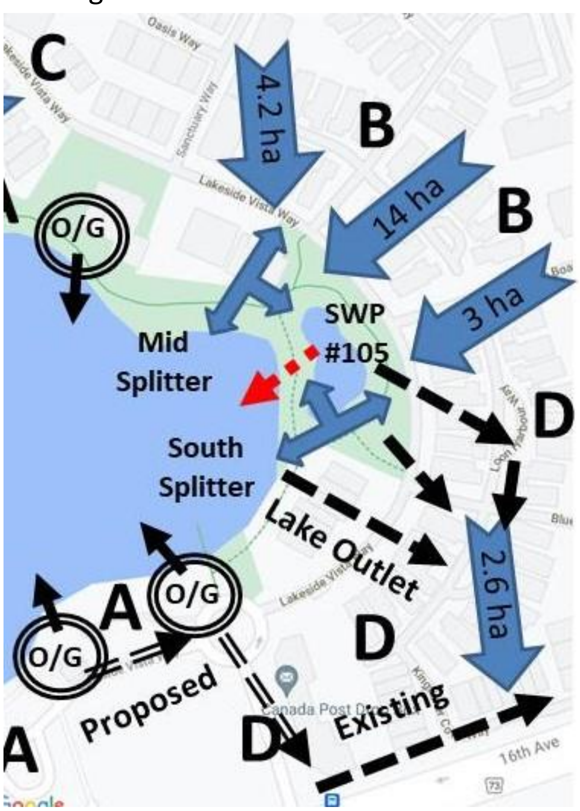
It is not clear why these areas were not routed to the East Stormwater pond as originally proposed. The adjacent diagram (Figure 6) shows the recommended flows from the traffic circle into the East Pond. The pond appears to have the capacity to handle these additional volumes.

Another option would have been to direct these flows south along Swan Lake Boulevard to the 16th Avenue system – our current recommendation.



Data from the Markham analysis[6], as illustrated in the adjacent chart, indicates that over the ten-year period 2009 – 2018, 2% - 23% of all monthly outflows from Swan Lake to the 16th Avenue system are attributable to the three oil/grit separators on the Amica property, at the traffic circle and at the Swan Club.

These water flows are believed to have the highest concentration in road salt. The flows from the separators at Amica and the traffic circle represent an estimated 76% of the normal annual chloride volumes entering the lake. Therefore a rerouting of these flows will have a significant impact on reducing the inflow of future chloride into Swan Lake.



The oil/grit separator installed in the parking lot of the Swan Club in Swan Lake Village, which may account for about 11% of the chloride, is in a low lying area (part of area #6). This area naturally drains into the lake and is below the level of the adjacent stormwater system so rerouting of the flows is not an option.

The two oil/grit separators at Amica and at the traffic circle can be rerouted to connect with the main stormwater system at 16th Ave. and Swan Lake Boulevard - the system where these flows ultimately end up through the outflow from Swan Lake.

The routing is illustrated on the adjacent chart. It will involve installing approximately 200 metres of pipe. The manhole structures are substantially in place and presumably useable.

A proper technical analysis is required of the concepts proposed to confirm their feasibility and projected benefits.

This is the most expensive of the proposed alterations. The costs of these changes will enable maintenance of a healthy aquatic community that will consume algae. The reduced need for future expensive chemical treatments should help offset some of the initial investment in these alterations.

B) The Case for Reducing Stormwater Flows Bypassing the Ponds

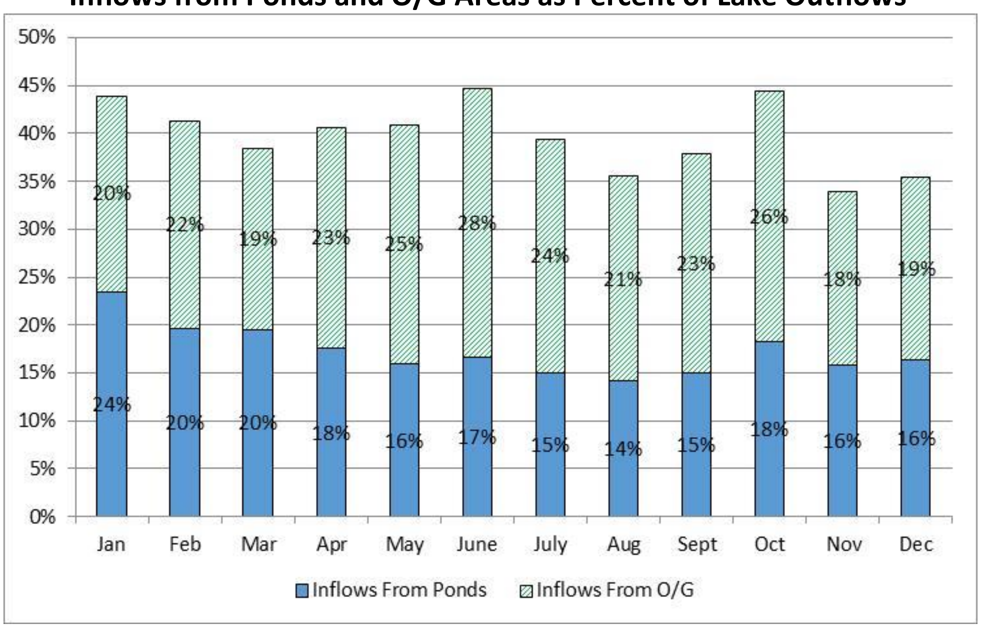
To leverage access to Swan Lake as a repository during high volume rain events, the water flowing from the main stormwater lines passes through "splitters" that help regulate the flow entering each stormwater pond. During high volume rain events, cited as being over 25 mm of rain, when the inflow into the splitter exceeds the pond's inlet capacity, the excess will go directly to Swan Lake. Recent tests have confirmed that in the spring these inflows through the splitters include significant volumes of chloride (See Appendix A).

The splitters serve an important secondary role in helping to manage flows during severe flooding. Should the ponds be nearing their design capacity, water can flow backwards from the pond and into the lake via these splitters.

One rationale during the initial design phase was that redirecting inflowing water through the splitters into Swan Lake would help reduce demand on downstream pond assets by keeping the water locally.

However an analysis of the 10-year data provided in Markham staff report[6] illustrates that there is seldom any material value since Swan Lake routinely overflows to the same 16th Avenue system. Water directed from the ponds and the oil/grit separators into Swan Lake immediately pushes other lake water into the downstream system.

Inflows from Ponds and O/G Areas as Percent of Lake Outflows



Pond inflows account for 15-20% of the lake outflows, representing an unnecessary recycling of these pond volumes.

Similarly, the oil/grit separators account for another 20-28%. On average, almost 40% of all lake outflows are attributable to these two sources of stormwater.

One unique aspect of the North Pond design is that normally stormwater flows from the pond into a different stormwater system on Williamson Road. However, volumes that bypass the North Pond and go into Swan Lake ultimately add to the flow going into 16th Avenue. Increasing the splitter at the North Pond will reduce the volumes being redirected to the 16th Avenue system.

Passing these volumes through Swan Lake is serving little purpose during normal usage since comparable volumes are immediately pushed downstream from the lake. This is a particular problem in March and April when the lake is naturally at peak levels and water entering the lake during the spring runoff is contaminated with road salt which is unnecessarily flushed into the lake.

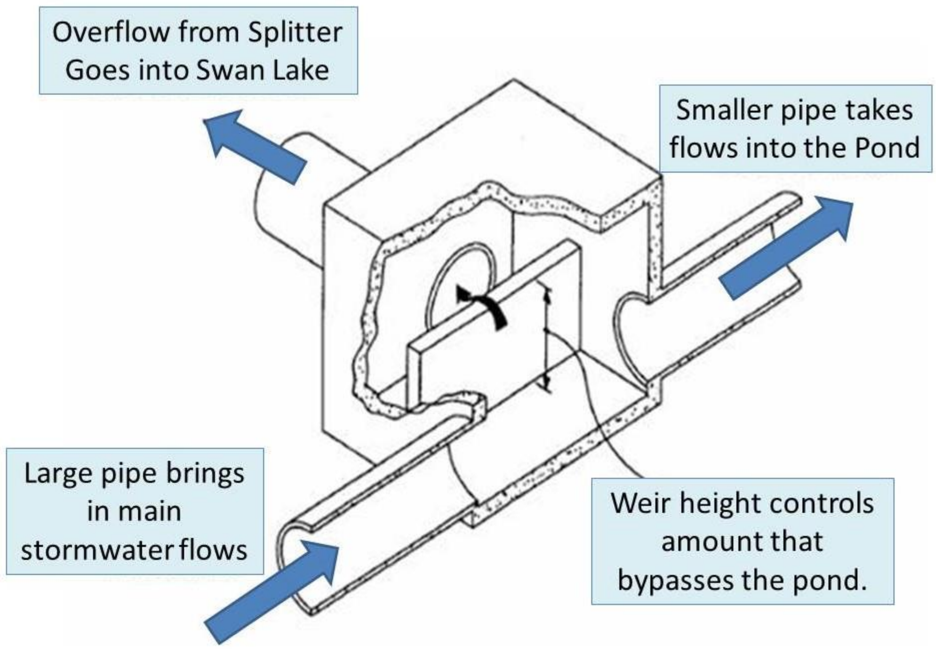


Illustration of a typical Splitter Design

The effects can be minimized by a low cost solution – raising the levels of the walls within the splitters. The impact would be to keep more of the routine rainfall events within the stormwater pond system, therefore minimizing chloride contaminated spring runoff volumes flowing into the lake.

We believe the weir within each of the two splitters serving the East Pond could be raised by 0.2 m while the weir within the one splitter at the North Pond could be raised by 0.1 metres. These changes should still remain within the design criteria for each pond but have a meaningful impact on rerouting stormwater away from Swan Lake. (More detailed information is provided in Appendices B and C related to the impact on each pond).

These are very low cost adjustments that we estimate have the potential of reducing stormwater inflows into Swan Lake by at least 50% and the annual chloride contributions by 6%.

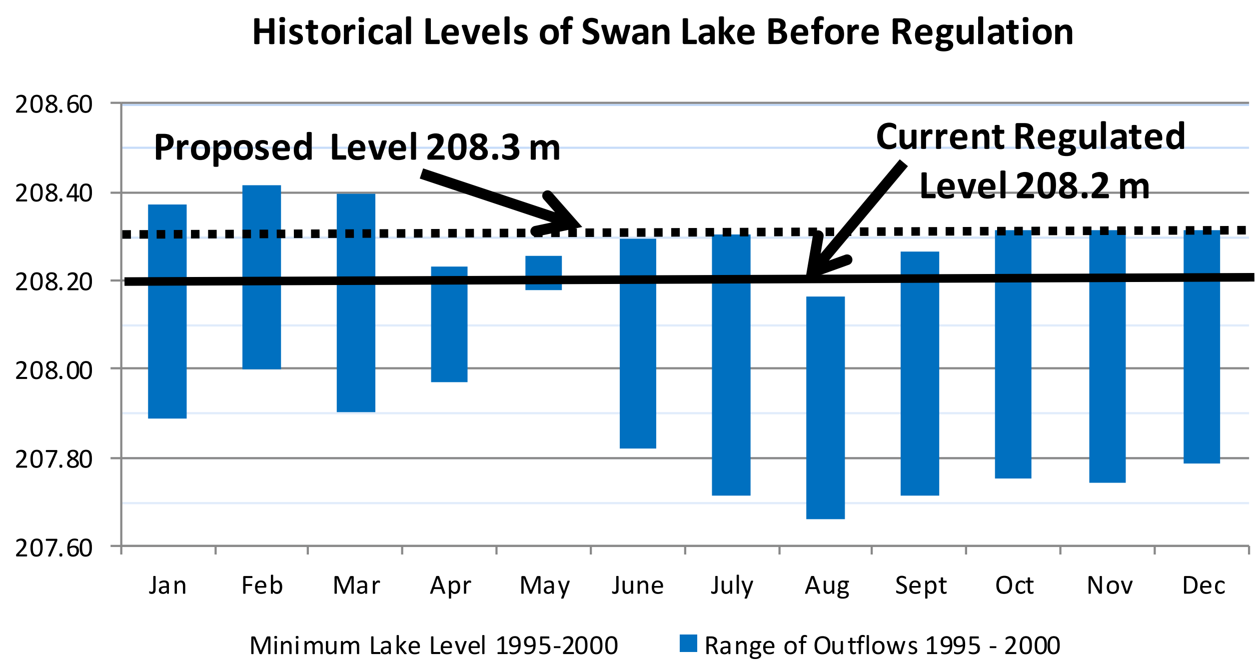
Even with these proposed adjustments, the splitters would still serve as important flood control mechanisms during an extreme rainfall event.

C) The Case for Restoring Lake Levels

Prior to construction of the surrounding residential community, Swan Lake was an abandoned gravel pit. As cited in the original Environmental Drainage Plan[1]

> "The former gravel pit has no drainage outlet and all captured water either evaporates or infiltrates. The former gravel pit has filled with ground water to an elevation of approximately 208.35 m (fluctuates between 208.5 and 208.2 m)"

One of the key original design decisions made was to regulate Swan Lake to the lower depth of 208.2 metres through the installation of an overflow drainage pipe to 16th Avenue. This lower level supports the recycling of stormwater through the lake.



One step towards restoring Swan Lake to a self-contained, stormwater free water body is to increase the lake outlet. The original natural level of the lake was at an elevation of 208.35 m. We developed an analysis to show that raising the lake level to only 208.3 m, will provide substantially most of the benefits, particularly if the flows from the oil/grit separators are rerouted. If the stormwater flows from the ponds and oil/grit separators are redirected, then restoring the lake depth to its original elevation of 208.35 would mean that the lake would only rarely contribute any volumes to the 16th Avenue stormwater system making the lake a fully self-contained entity free from external stormwater contamination other than the oil/grit separator at the Swan Club.

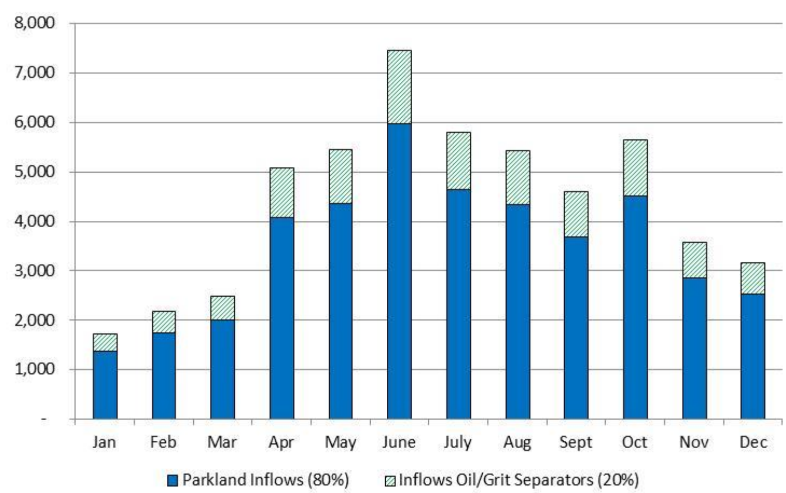
Lake depth is regulated by the location of the bottom level of the grate on the left of this photo.

There would be little cost involved in raising the bottom of the grate 0.1 or 0.15 metres.

The pipe on the right is the inflow from the southern splitter serving the East Pond. If the splitters in the East Pond are raised 0.2 m, the inflow through this pipe will occur less frequently.

This simple, low cost change of raising the lake level to 208.3 m will have two immediate impacts.

1) It will significantly reduce the downstream impact on the 16th Avenue stormwater system.
2) It will increase the lake storage capacity by approximately 5,400 m^3, or the equivalent of 2.8x the current active storage capacity of the two ponds. But the water it would retain would be from natural fresh sources – primarily precipitation, periodically from the aquifer.

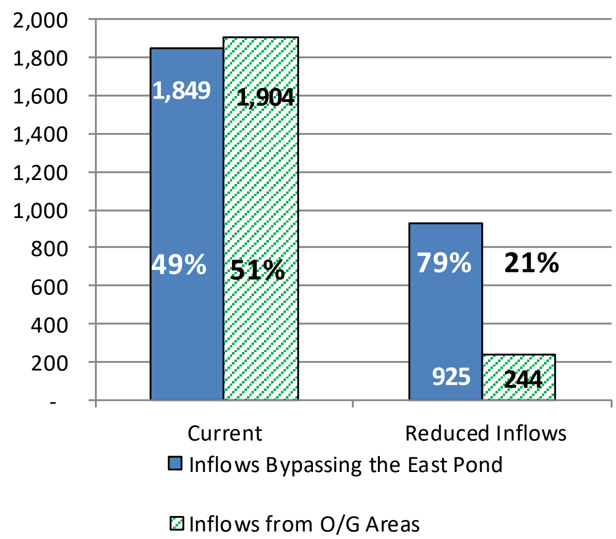


The adjacent chart shows the average monthly volumes of inflow into the lake that the staff report attributes to runoff from local areas. We estimate that 20% of these volumes arise from the two oil/grit separators which we recommended be redirected to the 16th Avenue system. The remaining 80% consists of relatively fresh runoff from the adjacent parkland that will substantially all be retained and kept from the downstream system.

Raising the lake level is only beneficial if the inflows from the stormwater ponds and the oil/grit separators are reduced. If these sources are not reduced but the lake level is increased, the effect will be to convert the lake into a permanent stormwater pond. It will no longer be recycling contaminated water, it will be storing it.

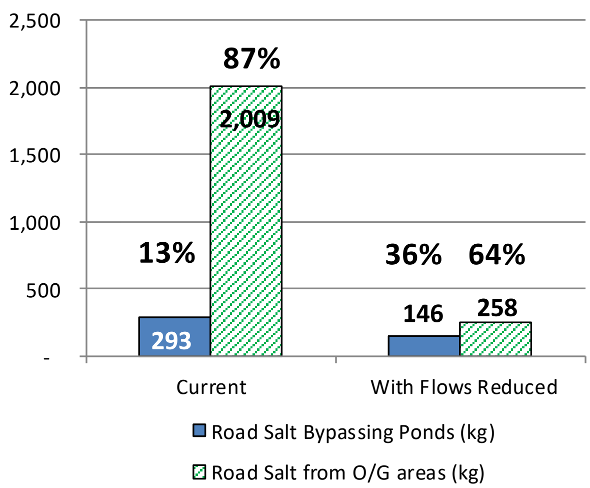
3) Benefits Arising from Reducing Swan Lake's Stormwater Role

A) Significant Reduction In Build Up of Chloride



By rerouting the inflows from the two oil/grit separators at Amica and the traffic circle, 87% of the direct stormwater flows into the lake can be eliminated. Consequently all of the road salt from this source would be eliminated. The road salt flowing from the oil/grit separator at the Swan Club, about 11% of the current amounts going into the lake, would continue.

The inflows from the oil/grit separators would drop from 1,904 m^3 to 244 m^3, from 51% of external inflows to only 21%. This will result in the reduction of road salt from 2,009 kg to 258 kg.



We have assumed raising the level of the splitters will reduce the stormwater flows bypassing the ponds by at least 50% resulting in a similar reduction in chloride entering the lake. Higher flow reductions are possible.

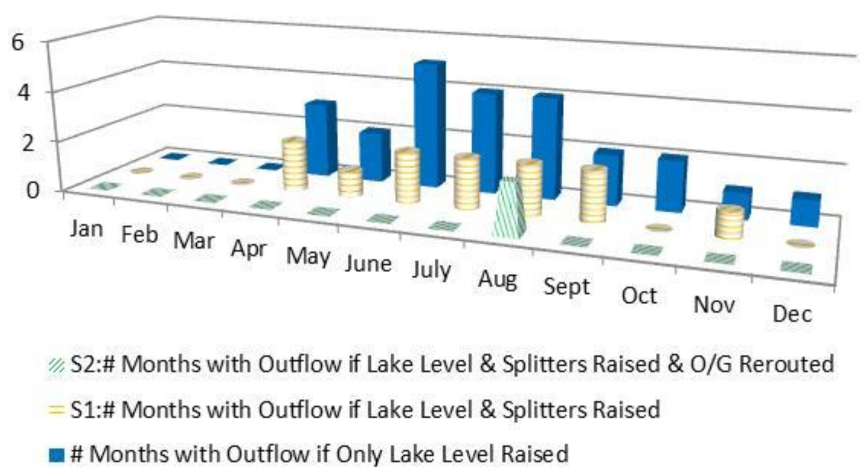
The reduction in the bypass flows triggers an estimated overall drop of 146 kg in the annual amount of road salt entering Swan Lake, a reduction of 50% from 293 kg to 146 kg per year.

Reducing the lake's annual role in stormwater management will greatly reduce the amount of road salt entering the lake without undermining Swan Lake's important backup role for area flood control.

B) Improved Water Quality in Swan Lake

Increasing the water level in the lake would make Swan Lake a more self-contained entity. Water quality would improve because Swan Lake would retain more of the clean local runoff and precipitation. Contaminated stormwater from the local communities would substantially remain in the stormwater system. Simply increasing the blend of fresh water within the lake should help enhance the aquatic environment while minimizing the ongoing buildup of chloride levels.

The chart below illustrates the change in the outflows from the lake under each scenario. The bars represented the number of times over a 10 year period (2008-2018) when there would have been lake outflows under the proposed changes. Currently there are outflows most months of the year.



Simply raising the lake would reduce outflows to primarily the summer months.

By reducing the flows bypassing the ponds there would be only periodic outflows from the lake while almost no outflows from the lake are expected if the O/G separators flows are also redirected.

C) Reduced Demands on the Downstream Stormwater System

One important consideration is whether these adjustments would add any material risk to the downstream system. Our analysis suggests that all of these changes could be implemented and the amount of water directed downstream would be reduced, not increased.

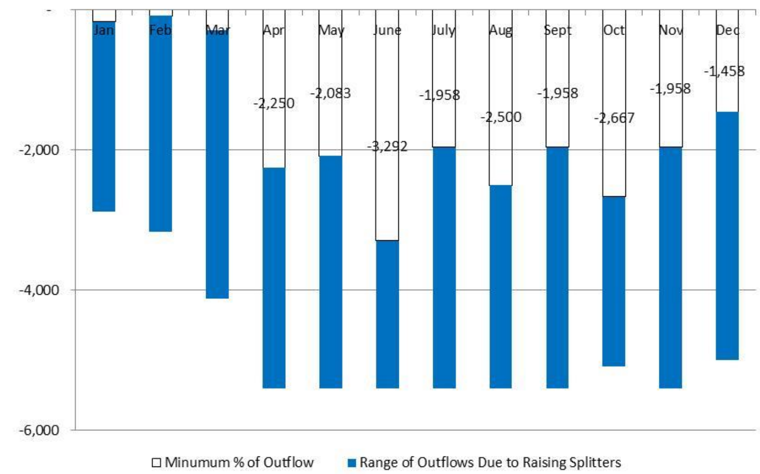
We considered two scenarios;

1) Raise the lake level by 0.1 m to 208.3 m, slightly below the historical level of 208.35 m and increase the splitters (the east Pond by 0.2 m and the North Pond by 0.1 m). This is the low cost option and is estimated to reduce the annual chloride input by only 6%, perhaps more if the flows bypassing the ponds are reduced by more than our conservative estimate of 50%.
2) Raise the lake and the splitters as above but invest in re-routing the Amica and traffic circle oil/gas separator volumes to 16th Avenue. This will cost significantly more but should result in the potential reduction of future annual chloride volumes by 82%. Under this scenario the only direct contributor of chloride to Swan Lake will be via the oil/grit separator in the Swan Club in Swan Lake Village. Additional efforts can be made to encourage improved salt management practices for this area in particular.

Scenario #1: Raise Lake and Only Increase Splitters

The following chart illustrates the reduction in volumes flowing into the 16th Avenue stormwater system resulting from raising the lake level and only raising the splitters.

During the early months of the year there may be only small reductions in volumes but there will be substantial reductions throughout the balance of the year.

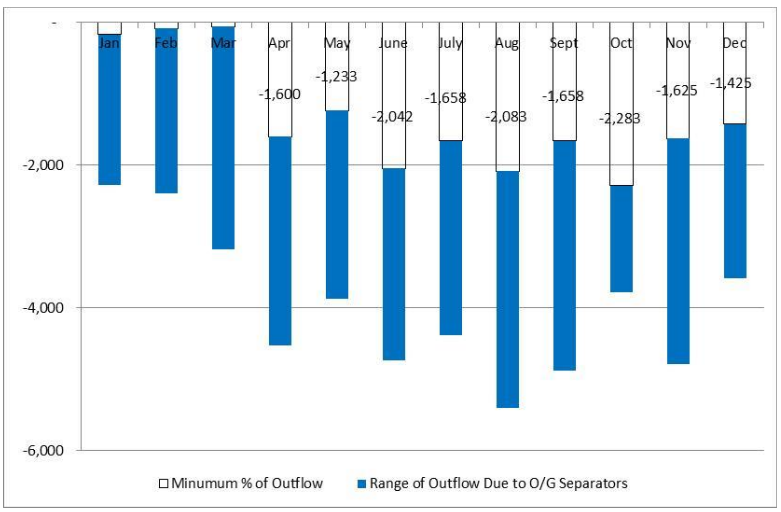


For example, over the 10 year period (2008-2018), the volume reductions were as low as 83 m^3 through January to March but in some years the reduced volumes by 5,400 m^3.

On average the reduced flow volumes for the first three months of the year are in the order of 1,890 m^3. This is equivalent to 1.7x the active storage volumes in the East Pond.

Scenario #2: Raise Lake Level, Raise Splitters and Reroute 2 O/G Separators

This scenario illustrates a similar pattern but the overall the volume reductions going into the 16th Avenue system remain lower throughout the year.



Over the 10 year 2008-2018, the volume reductions were as low as 58 m^3 through January to March but in some years the reduced volumes exceeded 4,525 m^3.

On average the monthly volume reduction from January to March is in the area of 1,496 m^3 – this is equivalent to 1.4x the current active storage volumes in the East Pond.

More thorough technical analysis is required to ensure that there are no complications arising in the ability of the upstream and downstream facilities to handle peak flows.

If the lake levels were raised to make Swan Lake a self-sustaining entity, the end result will be a significant reduction of average volumes entering the 16th Avenue system. It will lighten the load of the downstream system, not add to its demand.

This can be only accomplished if the stormwater from the ponds currently entering the lake from the ponds and the oil/grit separators are redirected away from Swan Lake. The potential initial volumes from the ponds and oil/grit separators are offset by virtually eliminating inflows from the lake. The redirected flows are substantially the same as the volumes that have traditionally been recycled through the lake. The 16th Avenue system is already handling these volumes. The primary reduction arises because the natural precipitation and park runoff remain within the lake.

4) The Need for More Rigorous Maintenance

Typically ponds such as these are cleaned for the first time immediately before being turned over to the municipality. Usually this is often 10 years after being built.

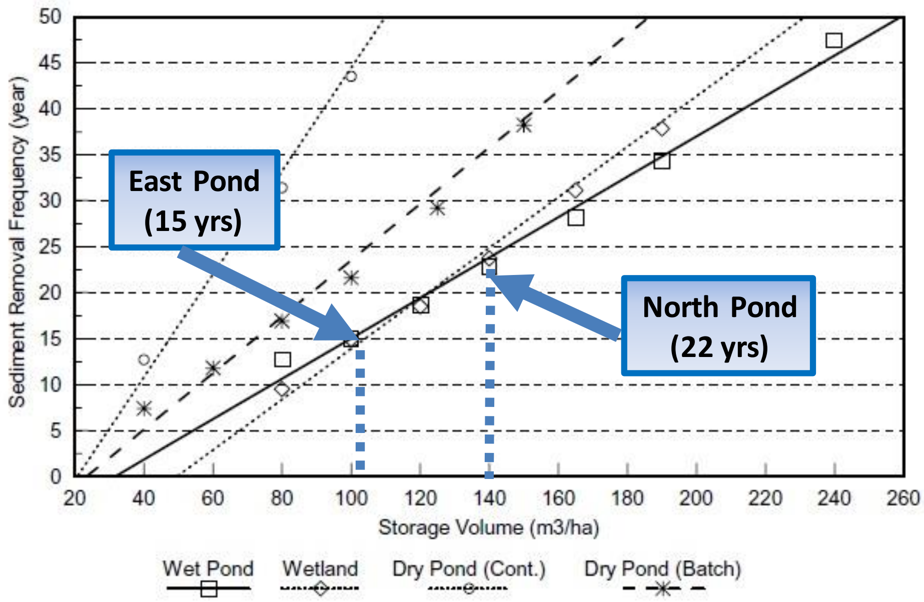
However, these ponds are more than 20 years old and remain under the control of the developer. Ontario's guidelines[9] call for regular monitoring and maintenance of all the elements of a stormwater pond system.

The ponds require cleaning periodically based on the relationship between the size of the area served and the pond design capacity, the oil/grit separators are recommended to be cleaned every year and the design assumes that all outlets and inlets remain clear and fully functional.

There is little evidence of active monitoring and maintenance of the Swan Lake system.

Permanent Storage vs Removal Frequency

Ontario SWP Manual 2019 (55% Impervious Catchments)



The guidelines suggest that the East Pond should be cleaned approximately every 15 years and the North Pond every 22 years. There may have been some cleaning activity performed at the East Pond around 2010 when the last phase of construction was completed in Swan Lake.

The Ministry of the Environment typically imposes requirements to monitor the ponds to ensure they are performing as designed when they issue their Certificate of Approval. In the case of these ponds we have been unable to determine if any monitoring program for the ponds was required by the MOE or if any has been done.

Five Examples of Poor Maintenance of Inlets and Outlets

The pipes feeding into the pond and those removing water also must be monitored on a regular basis and be kept clear of debris. Five examples of poor maintenance were recently documented.

i) Main Lake Outlet and South Inlet

Until the fall of 2020, the primary outlet from Swan Lake was overgrown, effectively impacting the maintenance of planned water levels in the lake.

Lake Outlet June 25, 2020 (Before clearing)[5]

Lake Outlet December 2020 (After clearing)

ii) Oil/Grit Separator at the Traffic Circle

Oil/Grit Separator Uncovered December 2020

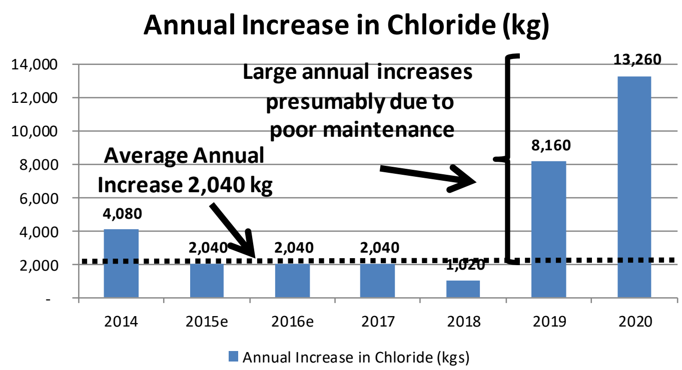
The oil/grit separator at the traffic circle was hidden by small bushes and it took several attempts by Markham staff to locate the oil/grit separator in December 2020.

It clearly had not been cleaned every year. The maintenance record for the oil/grit separator on the Amica property is not known. We were able to confirm that the oil/grit separator located at the Swan Club was cleaned in 2020.

iii) East Pond Splitter (the Mid Splitter)

In spring of 2021, it was noted that the feed from the splitter at the north end of the East Pond was partially blocked by soil and weeds meaning that in all likelihood a large portion of the water volumes entering this splitter were proceeding directly into Swan Lake. This splitter supports about 65% of the drainage volumes from Swan Lake Village. It is expected that this blockage explains the abnormally large spike in chloride levels added to the lake over the past 2-3 years as illustrated in the chart below.

Blocked Splitter Channel – East Pond
April 2021



Estimated Annual Chloride Volumes
Entering Swan Lake Due To Blockage of Inlet Pipes

iv) Oil/Grit Separator at the Swan Club

As the following photos indicate the outlet from the oil/grit separator from the Swan Club parking lot into the lake is fully clogged. Only the top of the grating is identifiable. Due to the low elevation of this oil/grit separator there appear to be no alternatives available to reroute the flows from the lake.

Swan Club Parking Lot Location (May 14, 2021)

Clogged Inlet to Swan Lake (May 14, 2021

v) North Pond Splitter

The inlet into the north Pond from the splitter is partially blocked by debris and a dead animal which is impairing its operation.

These photos (May 2021) show the build up of reeds near the inlet from the splitter into the North Pond and the partially clogged inlet into the pond from the splitter.

The lakeside portion of the outlet (The North Inlet) is relatively clear.

This photo shows the flow from the outlet through the small valley and into the Swan Lake after a 29 mm rainfall event on March 26, 2021.

It is not known how much of this flow into Swan Lake can be attributed to the partially blocked pond inlet.

Immediate Monitoring and Cleaning Required

These ponds have been in service over 20 years so an assessment of their capacity is warranted. We strongly believe that a monitoring program for the ponds should be established immediately, the inlets cleared and the ponds cleaned as soon as possible.

5) Recommendations

The core goal of these proposed adjustments is to minimize future chloride contributions to the lake by minimizing Swan Lake's role as an active component of the stormwater management system.

We recommend that a proper technical analysis be undertaken of the concepts proposed to confirm their feasibility and projected benefits.

If technically feasible, we would recommend four immediate actions be implemented to minimize the impact of chloride entering Swan Lake:

1) That the level of Swan Lake be increased to at least 208.3 m, only if, one or both of the following actions are implemented;
2) Rerouting the stormwater flows from Amica and the traffic circle to 16th Avenue system (or the East Pond if possible);
3) Increasing the walls within each of the two splitters serving the East Pond by 0.2 metres and the one at the North Pond by 0.1 m to minimize the amount of routine rainfall going into the lake, particularly during the spring runoff period;
4) That a monitoring program for the ponds be established immediately and that the inlets and ponds be cleaned as soon as possible.

Our analysis identifies three core benefits arising from these proposed changes:

i) Swan Lake would become a self-contained entity retaining more of the clean local runoff and precipitation. Contaminated stormwater from the local communities would substantially remain in the stormwater system. Simply increasing the blend of fresh water within the lake should help enhance the water quality and the aquatic environment.
ii) Annual chloride contributions will be reduced by 82%. Minimizing the increase in chloride levels will contribute to an improved aquatic environment. A healthy aquatic environment for zooplankton and small fish will provide natural resources that can aid in controlling algae growth and reduce the risk of chloride contamination of the downstream aquifer.
iii) The amount of water directed into the 16th Avenue stormwater system would be reduced, not increased.

References:

1) Environmental Master Drainage Plan, Cosburn Patterson Wardman Limited, Revised September 1995

2) Swan Lake Water Budget and Levels, Letter to Town of Markham from Barenco, September 19, 2000

3) Swan Lake – North Pond, Stormwater Management Brief, Earth Tech Canada Inc., Revised July 31, 2000

4) Swan Lake Village Townhouses, Stormwater Management Brief, Earth Tech Canada, Revised September 2005

5) Swan Lake Monitoring Program 2020 Annual Report, Markham Environmental Services, March 2021

6) Hydrological Modeling (City of Markham), Appendix C, Swan Lake Water Quality Management, Freshwater Research July 17, 2020

7) Markham Stormwater Management Guidelines, City of Markham, October 2016

8) Salt Management Plan, City of Markham, March 16, 2005

9) Stormwater Management Planning and Design Manual, Ministry of Environment, Ontario, March 2003

10) Storm Water Management Facility Sediment Maintenance Guide, Greenland International Consulting Inc. August 1999

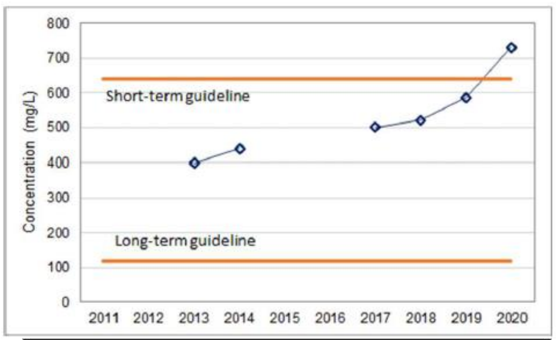
11) Various technical drawings made available by City of Markham

Appendix A: Chloride Issues in Swan Lake

Swan Lake contains an excessive amount of chloride that Freshwater Research[6] attributes to winter de-icing operations. Chloride does not break down and will accumulate within the lake over time, impairing the health of aquatic plants and many forms of aquatic species.

Swan Lake has average chloride readings exceeding 700 micrograms per liter of water with peak readings of almost 800 mg/l recorded in 2020. The water, appropriately classified as "brackish" water, can no longer be referred to as "fresh" water. Swan Lake is categorized as a sub-saline lake.

Environmental Importance of Reducing Chloride Impact



Chloride levels in Swan Lake are 6 times higher[5] than the long term standards for protecting aquatic life.

Levels of chloride in Swan Lake in 2020 are well in excess of a safe environment for 50% of the species on which the federal guidelines were based, including zooplankton and small fish such as the Fathead Minnow, which was identified as an original species in Swan Lake.

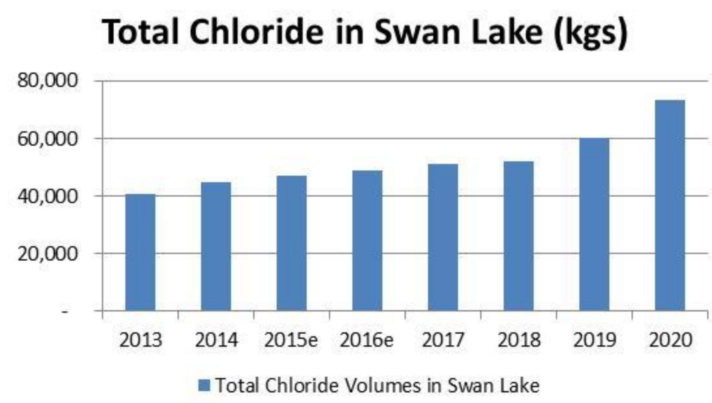
Zooplankton is a beneficial element in freshwater because it consumes phytoplankton (microscopic algae and microbes) but the high levels of chloride is undermining the existence of zooplankton in Swan Lake.

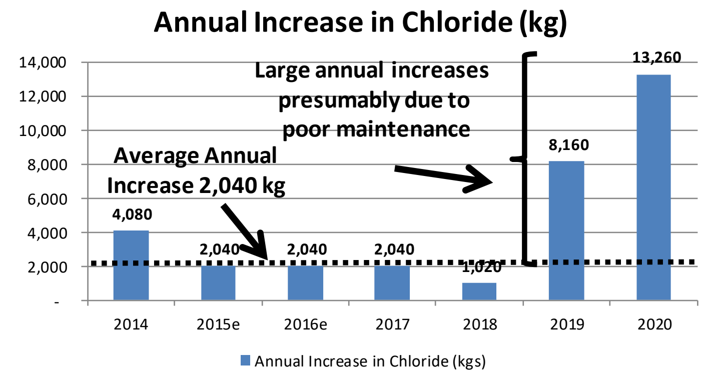
Reduction in chloride levels, restoration of a healthy zooplankton community and a robust stock of small algae eating fish could provide a meaningful natural means of reducing algal growth and cyanobacteria in Swan Lake.

Research studies suggest high chloride levels can lead to lower oxygen levels by diminishing aquatic plant life. Controlling oxygen levels and chloride levels opens up more natural biomanipulation options for the management of water quality in Swan Lake and will help reduce the reliance on future expensive treatments such as Phoslock.

A small amount of chloride may enter Swan Lake via the aquifer but that is not likely a major concern. The greater concern should be that Swan Lake, with its very high concentrations is likely a source adding chloride to the downstream aquifer. Stormwater ponds are designed to minimize leakage into the aquifer. Swan Lake has no similar leakage prevention capabilities so a continued buildup of chloride is endangering water quality in the downstream aquifer.

Managing Sources of Chloride





The adjacent chart illustrates the rapid increase in chloride levels in Swan Lake over the past few years.

The annual increase prior to 2018 is estimated at 2,000 kg per year. In 2020, it increased by over 13,000 kg.

We conclude that the rapid rise since 2018 is not attributable to changes in local winter salt management practices in the area but rather is due to the poor maintenance of the inlets, in particular the blockage at the mid inlet at the East Pond.

The excess attributable to poor maintenance is estimated to account for 24% of the current chloride content in Swan Lake.

Reducing Road Salt Use

Chloride entering Swan Lake is attributed to the use of road salt in the adjacent communities.

Product	Cost Relative to Road Salt	Freezing Point Depression (degrees C per unit weight)	Effective Lower Limit (degrees F)	Corrosive?	Aquatic Toxicity	Other Environmental Impacts
Road Salt or Rock Salt ($NaCl$)	$1.00	1	20	Yes	Moderate	Roadside tree damage
Potassium Chloride (KCl)	$1.60	0.78	12	Yes	Very	K fertilization
Magnesium Chloride ($MgCl_2$)	$2.40	0.29	5	Yes	Very	Mg addition to soil
Calcium Chloride ($CaCl_2$)	$5.70	0.53	-25	Very	Moderate	Ca addition to soil
CMA- Calcium Magnesium Acetate ($C_8H_{12}CaMgO_8$)	$19.30	0.30	0	No	Indirect	Decreased aquatic oxygen
Potassium Acetate (CH_3CO_2K)	$26.30	0.60	-15	No	Indirect	Decreased aquatic oxygen
Urea (CH_4N_2O)	$1.80	0.97	15	No	Indirect	N fertilization
Sand	$0.60	0	-	No	indirect	Sedimentation

Use of road salt is essential for winter safety but is detrimental to all environmental areas.

Road salt, or rock salt, is halite, the mineral form of sodium chloride ($NaCl$) as it is naturally mined. Table salt is just a purified version of the same mineral.

Though dated, the adjacent table developed by Carey Institute illustrates the popularity of rock salt since it is the lowest cost option available.

Improvement in Management Practices Needed

Improvement in management practices needs to be encouraged. Two initiatives should be considered:

a) Review of Salt Management Protocols

Markham is responsible for the management of about 15% of the areas draining into the Swan Lake stormwater systems. The remainder is under the control of private owners.

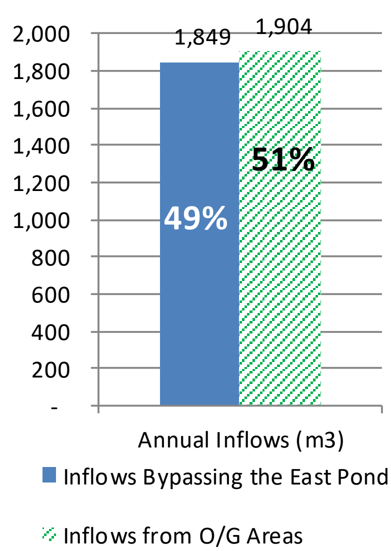
- We believe Markham manages its salt applications under a 2005 policy guideline[8]. If so then this should be reviewed to see if there have been material advancements that could be adopted.
- Private owners should be encouraged to adopt environmentally safe protocols.
- Markham and private owners should be encouraged to hire only contractors that that have completed the training program and are certified under the "Smart About Salt" program. Information on the program is available at http://smartaboutsalt.com/.

b) Consider Use of Brine

Brine introduces the concept of "anti-icing" by placing a layer of brine on the surface area before the storm to prevent freezing. Traditional road salt practices involve "de-icing – using salt to remove ice after it has formed.

A recent pilot project by Ryerson University illustrated the benefit of adopting brine as part of the salt management regime. The Ryerson project achieved a 25% reduction in the use of salt. https://www.ryerson.ca/water/research/salt_project/

Sources of Chloride



The stormwater from the major drainage area of 32.8 ha goes directly into one of the two stormwater ponds. Based on the data provided in the Markham analysis we estimate that 15% of these flows bypass the ponds. This represents about 1,849 m^3 or 49% of the annual salt bearing volumes.

Though the three oil/grit separators serve only 3.9 ha, they contribute comparable volumes of water into Swan Lake. Annual estimates are 1,904 m^3, or 51% of the annual flows that bring road salt into the lake.

The critical difference is that the flows from the oil/grit separators contain a much greater density of chloride than do the flows bypassing the ponds.

An Ohio based website for snow plow industry professionals suggests operators plan on an average seasonal usage of 2,000 lbs of road salt per acre (or 2,242 kg per ha) but advises that typical usage may be closer to 1,500 lbs (1,681 kg).

The average precipitation for Markham from December to March is 101 mm. Using the lower estimate of 1,681 kg/ha, we estimate that stormwater during normal salt operations will, on average over the season, have a density of 1,055 mg/L of salt. This provides an indication of the amount of direct contribution coming from the three oil/grit areas (about 3.9 ha) directly connected to the lake.

The chloride inflows from the pond area are considered to be much lower density. Conceptually, during a rain storm or spring melt, the initial stormwater flows, referred to as the "first flush", will carry the bulk of the road salt into the ponds. The amount bypassing the ponds arises from later flows and is assumed to contain lower concentrations of salt.

Following recent heavy rainfalls on March 26 and April 11, 2021, water samples were taken from the flows bypassing the ponds. Testing of the samples by Markham confirmed that these flows still contained significant amounts of chloride. Unfortunately the flows from the oil/grit separator sites were not accessible so no samples were taken.

In two of the three inlets, the samples showed chloride levels in the order of 80 – 130 mg/L. For the south inlet, the readings were much higher - 673 and 957 mg/L. These high readings may reflect a mixing with the higher levels in the lake water. The samples are illustrative but they confirm that the amounts bypassing the ponds and entering the lake carry some level of chloride.

For our analysis we have assumed that on average the density of chlorides in the flows bypassing the ponds are approximately 15% of the average levels directly entering from the oil/grit separators. The following table summarizes the estimates of the range of salt volumes possibly in use. For our calculation, we assumed the lower volumes representative of a typical winter.

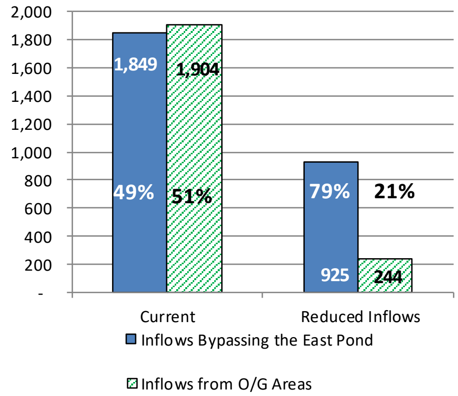
Estimated Use of Road Salt	**Typical Winter**	**Recommended Budget**
Amount Per Hectare	1,681 kg	2,242 kg
Content in Flows from oil/grit separators	1,055 mg/L	1,407 mg/L
Content in Flows Bypassing the Ponds (15%)	155 mg/L	211 mg/L

This leads to our conclusion that, though both sources contribute comparable volumes of stormwater to Swan Lake, the oil/grit separators account for 87% of the regular sources for chloride while the flow bypassing the ponds accounts for only 13%.

This underscores the importance of rerouting the flows from the oil/grit separators into the stormwater sewer system.

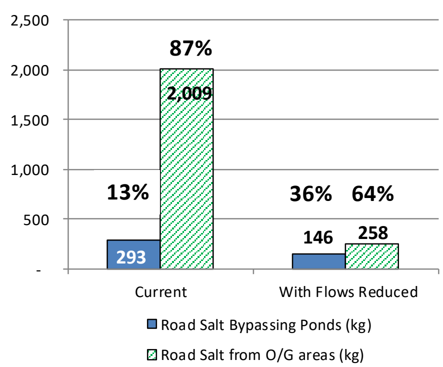
Impact of Recommended Changes

The reduction of road salt entering Swan Lake is directly tied to the ability to reduce the inflows from the oil/grit separators and the amounts bypassing the ponds.



By rerouting the inflows from the two oil/grit separators at Amica and the traffic circle, it is estimated that 76% of the road salt inflows into the lake can be eliminated. The road salt flowing from the oil/grit separator at the Swan Club, about 11% of the current amounts going into the lake, would continue.

The inflows from the oil/grit separators would drop from 1,904 m^3 to 244 m^3, from 51% of external inflows to only 21%. This will reduce road salt attributed to oil/grit separators from 2,009 kg to 258 kg.



We have assumed raising the level of the splitters will reduce the stormwater flows bypassing the ponds by at least 50% resulting in a similar reduction in chloride entering the lake. Higher reductions are possible.

The reduction in the bypass flows triggers an estimated overall drop of 146 kg in the annual amount of road salt entering Swan Lake, a reduction of 50%, from 293 kg to 146 kg per year.

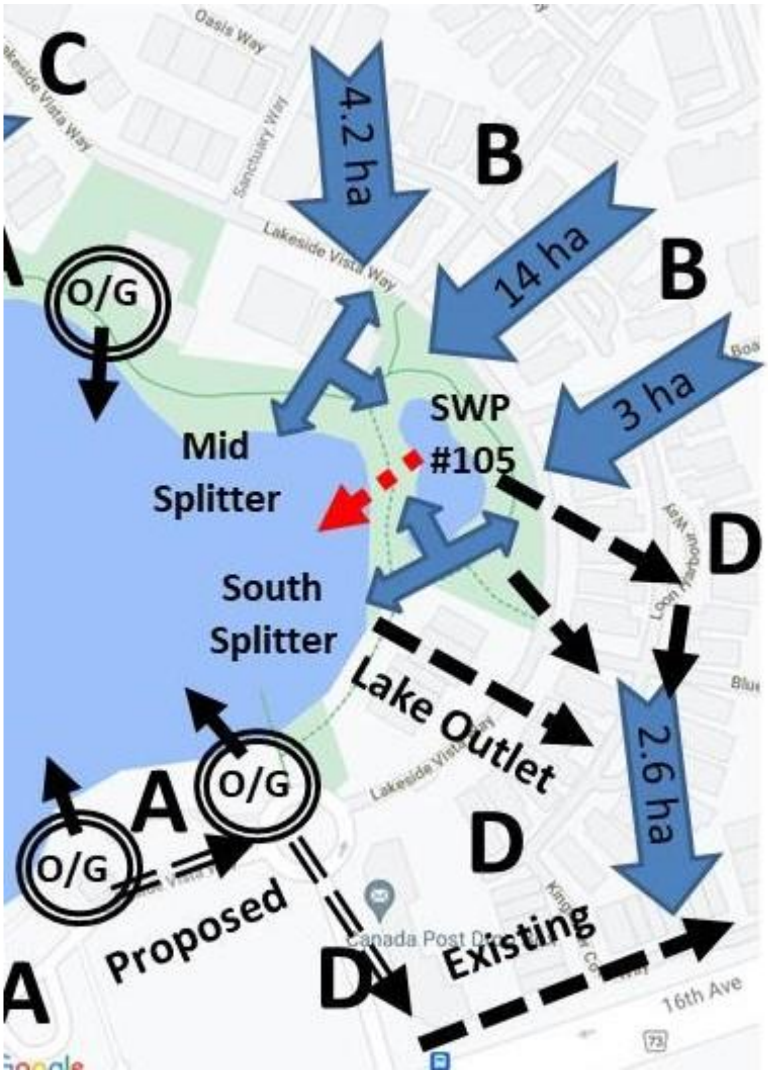
The following table summarizes the overall drop in road salt entering the lake through rerouting the flows and raising the splitters. Estimated annual increases of 2,302 kg would be reduced to 404 kg or by 82%. Perhaps more, if raising the splitters reduces inflows bypassing the lake by more than 50%.

	Estimated Currently		After Proposed Changes		
Sources of Road Salt	**Annual Salt Levels (kg)**	**Percent**	**Salt Reductions**	**Projected Salt Levels**	**Percent Reduction**
From Amica and Traffic Circle	1,751	76%	1,751	-	100%
From Swan Club	258	11%	-	258	0%
Due to Pond Overflow	293	13%	146	146	50%
Estimated Annual Impact	2,302	100%	1,897	404	82%
Attributed to Poor Maintenance	10,958		10,958	-	100%

The additional road salt, estimated at 10,958 kg, which is flowing into the lake bypassing the ponds due to blockage at the inlets, will presumably, be totally eliminated once the pipes are cleared and the system functions as designed.

Appendix B: East Stormwater Pond (#105)

Pond Outflows



The East Stormwater Pond serves 21.2 hectares (ha) in the central area of Swan Lake Village.

There are two outlets in the East Pond that join up with the system that drain the 2.6 ha south end of Swan Lake Village before connecting to the stormwater sewer system on 16th Avenue.

The lower outlet in the middle of the pond controls the normal water level at an elevation of 208.3 metres (m) and regulates the permanent storage volumes in the pond. This lower outlet removes any build up to 208.45 m at which point the second outlet (grates on the east shoreline) direct additional volumes to 16th Avenue through a 66 mm outlet.

Under normal rainfall circumstances the two splitters route water into the ponds but they have another role. The splitters also serve as the third tier of outlets when the pond level exceeds 208.7 m, the top of the dividing barrier in the splitters (the "weir"). Under these conditions water can leave the pond and flow into Swan Lake via the splitters.

Under extreme conditions, if the pond were to rise an additional 0.55 metres to 209.25 m, there is an emergency overflow area that will take pond water to the lake over the pathway adjacent to the lake.

It is proposed to use some of this underutilized capacity to increase pond retention volumes by increasing the height of the barriers in the splitters.

Storm Management Role of the Splitters

Under normal rainfall conditions, the splitters are designed to direct stormwater runoff directly to the pond. But during large rain events some of the runoff is directed into Swan Lake. The main sewers bringing stormwater into the East Pond are 675 mm in diameter while the pipes that direct flows from the splitter into the lake are only 450 mm in diameter and therefore can handle only 34% of the peak inflow. Once the pond inlet pipe is at capacity, the excess storm water will go over the weir and flow directly into Swan Lake, bypassing the pond.

Recent tests have confirmed that these flows that bypass the splitters contribute chloride to Swan Lake. The main contributors are the three oil/grit separators that direct all of their flows directly into the lake (see Appendix D for information on the impact of the oil/grit separators).

Reducing Flows into Swan Lake

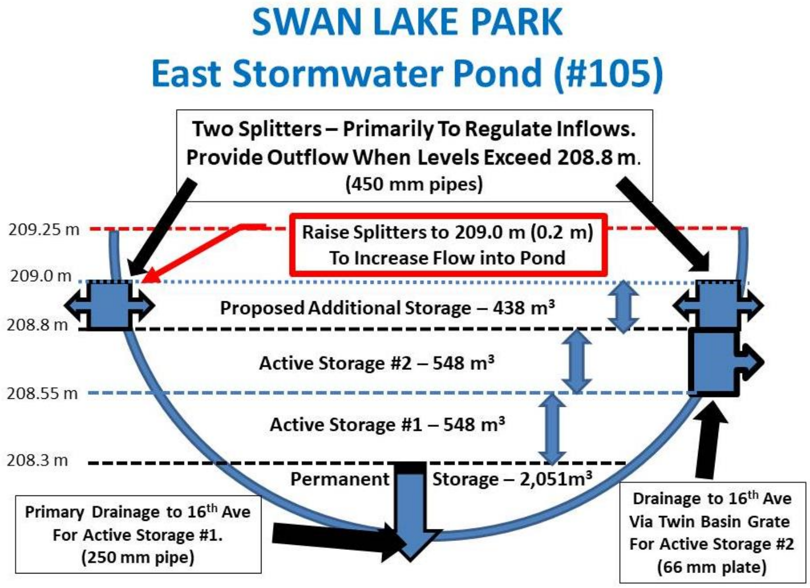
The amount of water bypassing the splitters can be reduced by increasing the height of the weir within each splitter. There is a difference of 0.45 metres between the current height of the weir and the maximum level that the East Pond can support. Increasing the weir height by 0.2 metres (7.87 inches) will add 40% to the pond's active storage capability and more of the spring runoff will be directed into the pond resulting in less road salt going into Swan Lake. The amount redirected into the pond depends upon the severity of the storm event. Once the chamber in the splitter is filled, water will overflow and go directly into the lake. We estimate raising the splitter will reduce the flows bypassing the pond by at least 50%.

Two Issues need to be considered: a) The ability of the pond to support these additional volumes; and, b) the impact, if any, on the capacities of the downstream and upstream systems.

a) Pond Capacity

The pond was built with an active storage capacity of 1,096 m^3 that is 129% of the required capacity[4]. Increasing the splitter level increases the active capacity by 438 m^3 to 1,534 m^3 or 181% of the required capacity.

	Required	As Built	% of Requirement	Proposed Increase	% of Requirement
Active Storage	848 m^3	1,096 m^3	129%	1,534 m^3	181%



The adjacent chart illustrates the active storage elements and the proposed extension of the storage realized by raising the level of the splitters by 0.2 metres.

Calculations for determining the capacity of stormwater ponds are complex. We provide some preliminary estimates that suggest that if the weirs were raised by 0.2 metres, the East Pond would support and clear the additional volumes.

Basic Design requirement

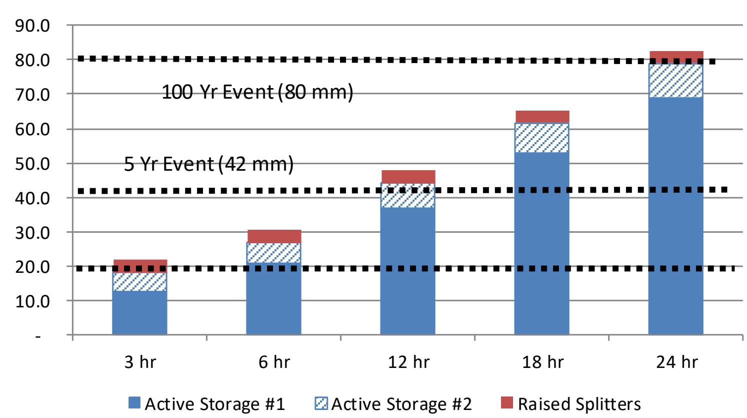
24 hr	20 mm

3-hour Design Storm Measures

5 Year	42 mm
100 Year	80 mm

The criteria set out in the design of the pond include that it must be able to clear a 20 mm rain event in 24 hrs and that it can handle extreme weather events. Markham[7] sets out two measures for extreme weather events: i) the ability to handle a 5 year rain event of 42 mm over 3 hours and ii) the ability to handle a 100 year rain event defined as 80 mm over 3 hours.

Raising the weirs 0.2 m means that the pond capacity will increase by 438 m^3 which translates into the ability to hold the flow from an additional 3.8 mm of rainfall. Flows in excess of these amounts will, as they do now, bypass the pond and flow through the splitters directly into Swan Lake.



The chart illustrates the ability of the current pond design to handle the different design criteria through the outlets to 16th Avenue before any overflow into the lake via the splitters. For example, currently the pond can support a 18.1 mm rain event over 3 hours before the overflow to the splitters occurs. Raising the splitters 0.2 metres increases this by 3.8 mm to 21.9 mm over 3 hours.

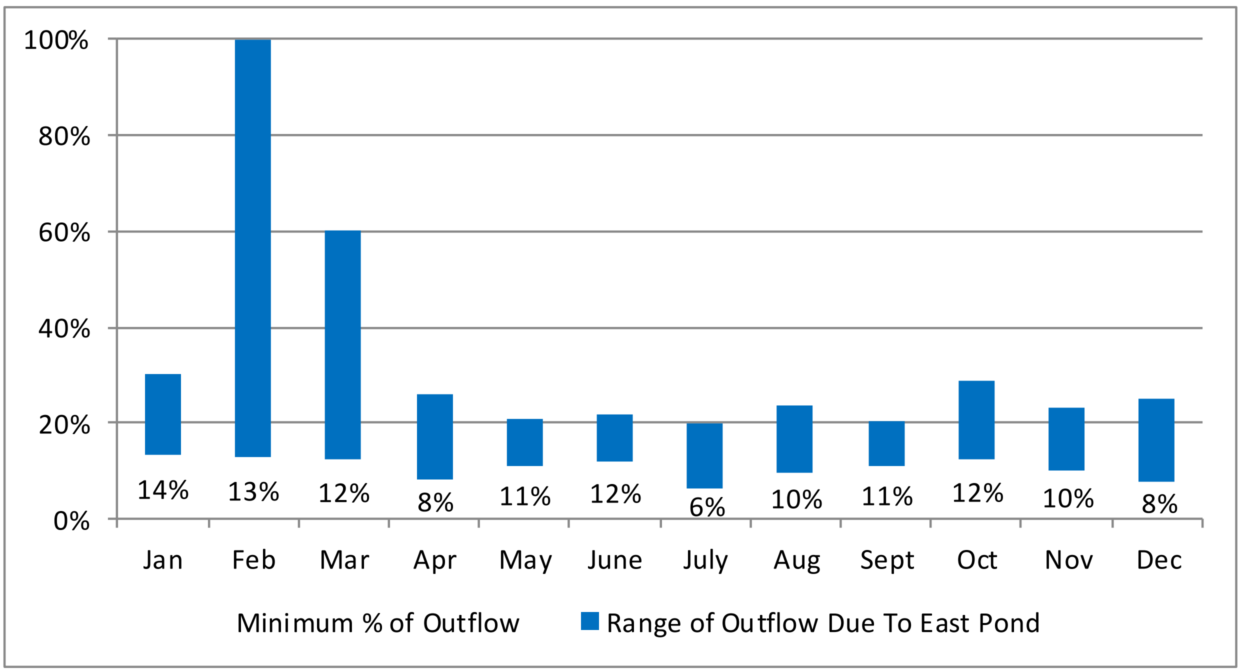
Similarly the pond can currently handle a 26.8 mm rain event over 6 hours before water is diverted to the lake. This increases to a 30.6 mm rain event if the weirs are raised. The performance of the pond should not be materially impacted by raising the splitters but less rainfall will bypass the ponds during major rain events and therefore less road salt will be redirected to the lake.

b) Downstream Impact

One rationale for redirecting inflowing water through the splitters to the lake is that by directing water into Swan Lake it helps reduce demand on downstream stormwater system assets by keeping the water locally. However an analysis of the data from the 10-year simulation provided in the Markham staff report[6] illustrates that there is seldom any material benefit since Swan Lake routinely overflows to the 16th Avenue system, particularly in the spring period when the lake is typically already at its peak capacity. Water directed from the ponds to Swan Lake immediately pushes other lake water into the same downstream system.

As the following chart illustrates, over the 10-year period 2009 – 2018, from 6% - 100% of all monthly outflows from Swan Lake to the 16th Avenue system are attributable to inflows from the East Pond.

Range of Swan Lake Outflow Due to East Stormwater Pond (2009 - 2018)



Therefore the downstream 16th Avenue system is already handling these volumes that are bypassing the pond. Volumes are unnecessarily being rerouted through the lake particularly during the spring period when the lake is typically at its peak level and at a time when the inflows contain road salt.

As noted earlier, the downstream and upstream systems would need to be reviewed to ensure the system doesn't surcharge due to raised pond volumes but it would appear they are currently handling these volumes.

Pond Cleaning

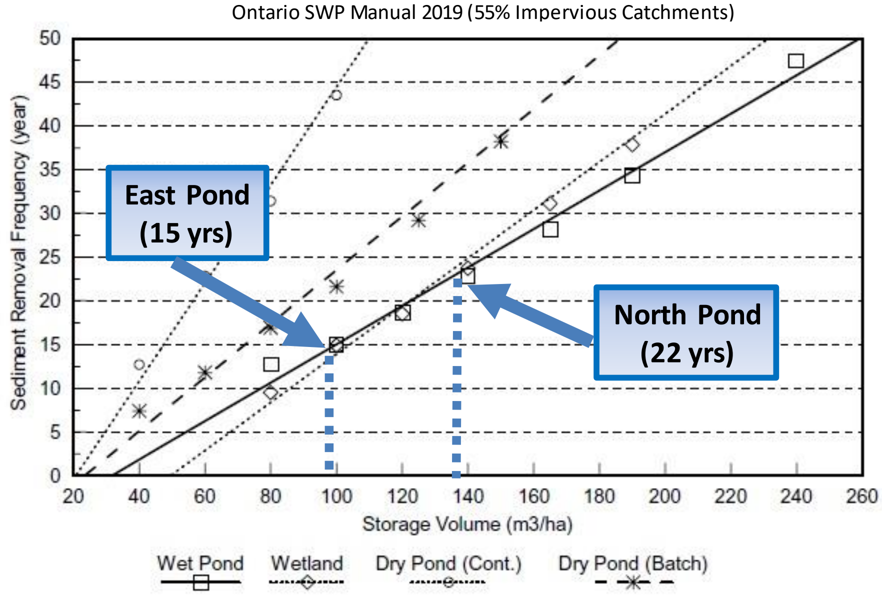
Ontario guidelines[9] call for regular monitoring of the elements of a stormwater pond system. The ponds require cleaning periodically based on the relationship between the size of area served and the pond design capacity.

	North Pond	East Pond
Area Served (ha)	11.6	21.2
Permanent	1,558	2,051
Permanent/Ha	134	97

Ontario guidelines suggest that the East Pond should be cleaned approximately every 15 years and the North Pond every 22 years. There may have been some cleaning activity performed at the East Pond around 2010 when the last phase of construction was completed in Swan Lake.

Permanent Storage vs Removal Frequency

Ontario SWP Manual 2019 (55% Impervious Catchments)



The Ministry of the Environment typically imposes requirements to monitor the ponds to ensure they are performing as designed when they issue their Certificate of Approval. In the case of these ponds we have been unable to determine if any monitoring program for the ponds was required by the MOE or if any has been done. These ponds have been in service over 20 years so an assessment of their capacity is warranted. We strongly believe that a monitoring program for the ponds should be established immediately and the ponds cleaned out as soon as possible.

Maintenance of Inlets and Outlets

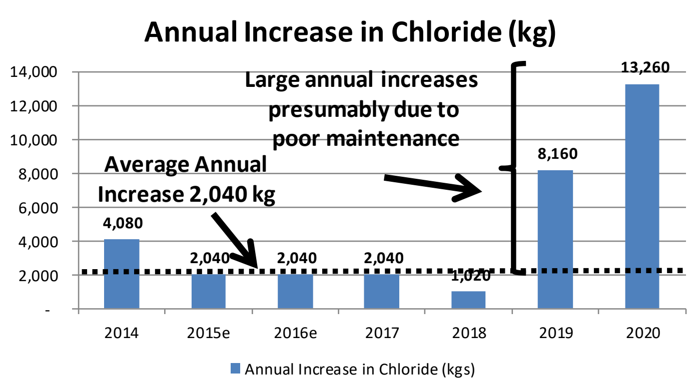
The pipes feeding into the pond and those removing water also must be monitored on a regular basis and be kept clear of debris. As the following photos taken April 26, 2021 illustrate, the areas adjacent to the splitters are overgrown and in one case clearly clogged. It is not possible to assess whether the underwater outlet in the middle of the pond requires clearing but it appears to be functioning properly.

A) Clogged East Pond Splitter (north end)

A visual assessment of the splitter at the north end (the Mid Splitter into the lake) shows the pond input pipe to be clogged by mud and plant growth. In the above photo only the top of the protective grate is viable. It is apparent that this inlet has been clogged for several years.

The photo to the right shows the inlet pipes from the south splitter pipes where they enter the East Pond. This illustrates the amount of pipe below the top of the grate that is buried in the north splitter inlet.

It is estimated that this splitter carries 80% of the stormwater volumes directed to the East Pond. The rapid increase in chloride levels in the lake during the past few years is likely attributed to this blocked pipe from the splitter. Water that should be going into the East Pond is bypassing the pond and going directly into Swan Lake. We estimate that the increase in chloride attributable to poor maintenance is approximately 24% of the current volumes of chloride in Swan Lake.

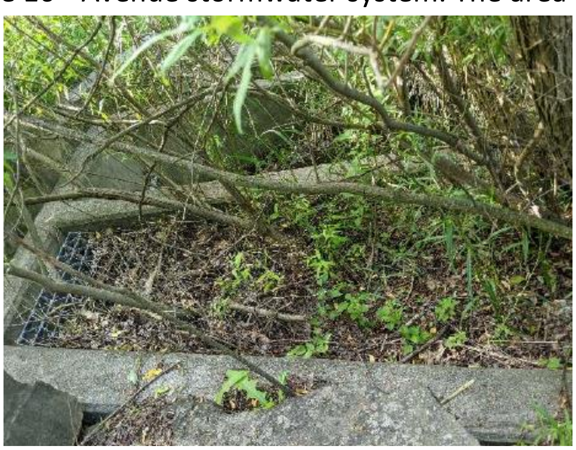


The lakeside portion of the outlet (the Mid Inlet) is relatively clear though there is a large development of reeds in the area.

B) East Pond Splitter (south end)

Inlet from the South Splitter appears clear but buildup of reeds may impact overflow role.

Lake inlet from the south splitter (the South Inlet) is to the right of the grate that drains the lake into the 16th Avenue stormwater system. The area was covered in reeds until cleared in the fall of 2020.



Lake Outlet and South Inlet Pipe
June 25, 2020 (Before clearing)[5]

Lake Outlet and South Inlet Pipe
December 2020 (After clearing)

c) Overflow Grates to 16th Avenue

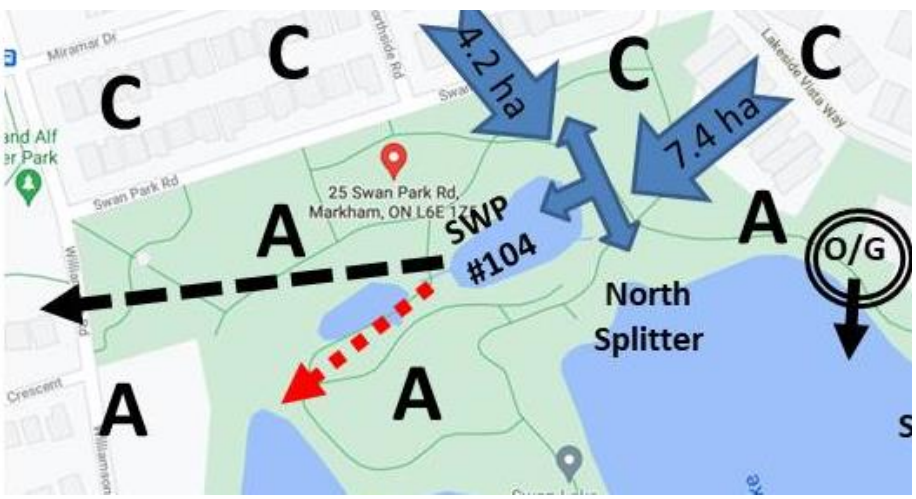
The grates that take the overflow to 16th Avenue system are partially overgrown but appear to be functional.

Appendix C: North Stormwater Pond (#104)

The North Stormwater Pond serves 11.6 hectares (ha) which includes 7.4 ha in the western portion of Swan Lake Village and 4.2 ha consisting of homes north of Swan Park Road, the northern boundary of Swan Lake Park.

Pond Outflows

Unlike the East Pond which has two outlets supporting the active storage capacity, the North Pond has only one outlet in the middle of the pond to clear the active storage volumes. This outlet is at an elevation of 208.3 metres (m) and regulates the permanent storage volumes in the pond. Any water above this level is directed to the stormwater system on Williamson Road which clears any buildup up to 208.8 m.



Under normal rainfall circumstances the splitter will route water into the pond but its second role is serve as the second tier outlet when the pond level exceeds 208.8 m, the top of the dividing barrier in the splitter (the "weir"). Under these conditions water can leave the pond and flow into Swan Lake via the splitter.

Under extreme conditions, if the pond were to rise an additional 0.2 metres to 209.0 m, there is an emergency overflow area that will take pond water to the lake through the North Channel.

It is proposed to use some of this underutilized capacity to increase pond retention volumes by increasing the height of the barrier within the splitter by 0.1 metres.

Storm Management Role of the Splitters

Under normal rainfall conditions, the splitter is designed to direct stormwater runoff directly to the pond. But during large rain events some of the runoff is directed into Swan Lake. The main sewer bringing stormwater into the North Pond is 675 mm in diameter while the pipe that direct flows from the splitter into the pond is only 450 mm in diameter and therefore can handle only 34% of the peak inflow. Once the pond inlet pipe is at capacity, the excess storm water will go over the weir and flow directly into Swan Lake, bypassing the pond.

In the springtime these runoff waters contain chloride from the road salt. Recent tests have shown that the flows that bypass the splitters contribute to the chloride entering Swan Lake. The main contributors are the three oil/grit separators that direct all of their flows directly into the lake (see Appendix D for information on the impact of the oil/grit separators).

Reducing Flows into Swan Lake

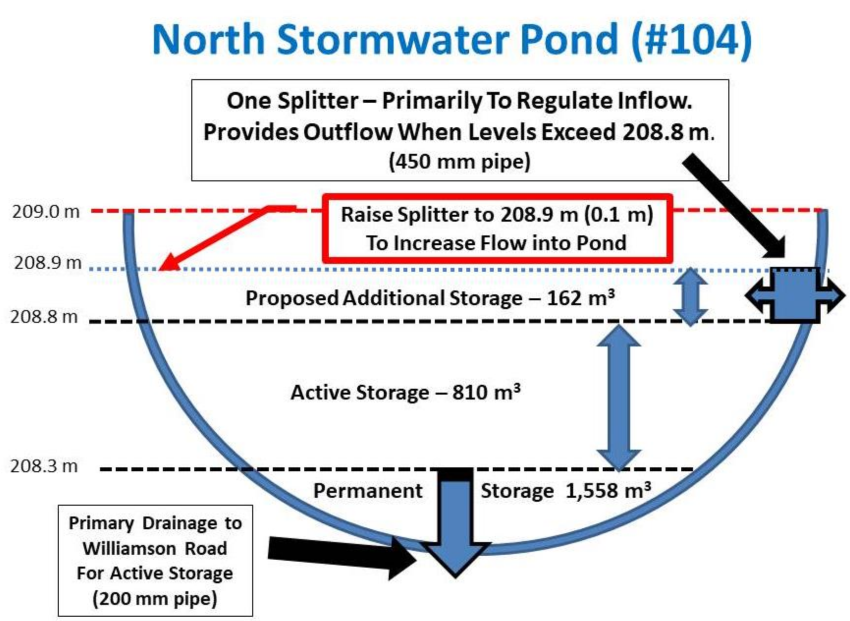
The amount of water bypassing the splitter can be reduced by increasing the height of the weir within the splitter. There is a difference of 0.2 metres between the current height of the weir and the maximum level that the North Pond can support. Increasing the weir height by 0.1 metres (3.9 inches) will add 20% to the pond's active storage capacity and more of the spring runoff will be directed into the pond resulting in less road salt going into Swan Lake. The amount redirected into the pond depends upon the severity of the storm event. Once the chamber in the splitter is filled, water will overflow and go directly into the lake. We estimate raising the splitter will reduce the flows bypassing the pond by at least 50%.

Two Issues need to be considered: a) The ability of the pond to support these additional volumes; and, b) the impact, if any, on the capacities of the downstream and upstream systems.

a) Pond Capacity

The pond has an active storage capacity of 810 m^3 that is 175% of the required capacity[3]. Increasing the splitter level 0.1 m increases the active capacity by 162 m^3 to 972 m^3 or 209% of the required capacity.

	Required	As Built	% of Requirement	Proposed Increase	% of Requirement
Active Storage	464 m^3	810 m^3	175%	972 m^3	209%



The adjacent chart illustrates the active storage elements and the proposed extension of the storage by raising the level of the splitters by 0.1 metres.

Calculations for determining the capacity of stormwater ponds are complex. We provide some preliminary estimates that suggest that if the weir were raised by 0.1 metres, the North Pond would support and clear the additional volumes.

Basic Design requirement

24 hr	20 mm

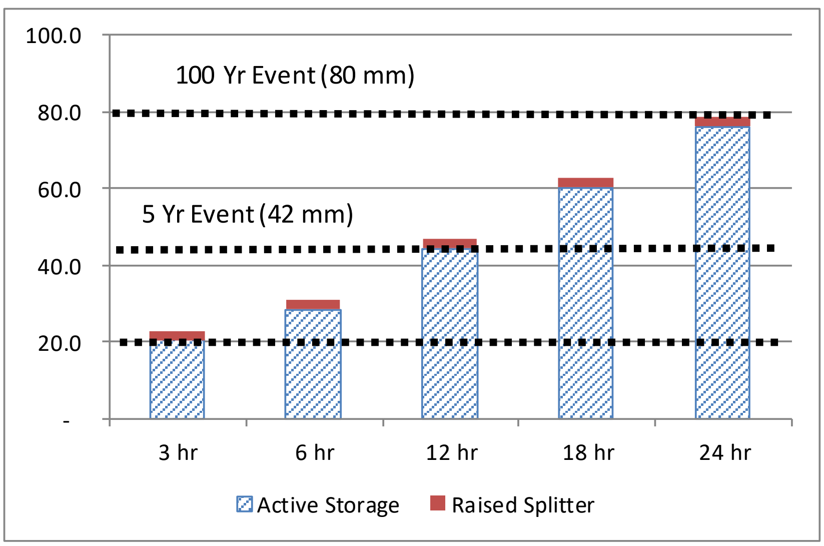
3-hour Design Storm Measures

5 Year	42 mm
100 Year	80 mm

The criteria set out in the design of the pond include that it must be able to clear a 20 mm rain event in 24 hrs and that it can handle extreme weather events. Markham[7] sets out two measures for extreme weather events: i) the ability to handle a 5 year rain event of 42 mm over 3 hours and ii) the ability to handle a 100 year rain event defined as 80 mm over 3 hours.

Raising the weir 0.1 m means that the pond capacity will increase by 162 m^3 which translates into the ability to hold the flow from an additional 2.5 mm of rainfall. Flows in excess of these amounts will, as they do now, bypass the pond and flow through the splitters directly into Swan Lake.

The chart below illustrates the ability of the current pond design to handle the different design criteria through the outlet to Williamson Road before any overflow into the lake via the splitters.



For example, currently the pond can support a 20.7 mm rain event over 3 hours before the overflow to the splitters occurs.

Raising the splitter 0.1 metres increases this by 2.5 mm to 23.2 mm over 3 hours. Similarly the pond can currently handle a 28.6 mm rain event over 6 hours before water is diverted to the lake. This increases to a 31.1 mm rain event if the weir is raised.

The performance of the pond should not be materially impacted by raising the splitter but less rainfall will bypass the ponds during major rain events and therefore less road salt will be redirected to the lake.

As noted earlier, the downstream and upstream systems would need to be reviewed to ensure the system doesn't surcharge due to raised pond volumes but it would appear they are currently handling these volumes.

b) Downstream Impact

One rationale for redirecting inflowing water through the splitters to the lake is that by directing water into Swan Lake it helps reduce demand on downstream stormwater system assets by keeping the water locally.

The analysis by Markham staff indicates that the North Pond is not a regular contributor to Swan Lake volumes however there are certainly times when it does contribute. The unique feature of the design of the North Pond system is that when volumes bypass the North Pond these volumes go first into Swan Lake and then contribute to demands on the 16th Avenue systems, diverting flows from the Williamson Road system.

Raising the splitter level would keep more water in the Williamson Road system. When the North Pond was designed, it was noted that the downstream ponds had not been built so redirecting flows to 16th Avenue seems to have been intentional. Keeping additional volumes within the Williamson Road system lessens the load on the 16th Avenue system. The amounts involved (162 m^3) would not seem to be material but the impact would need to be reviewed.

Pond Cleaning

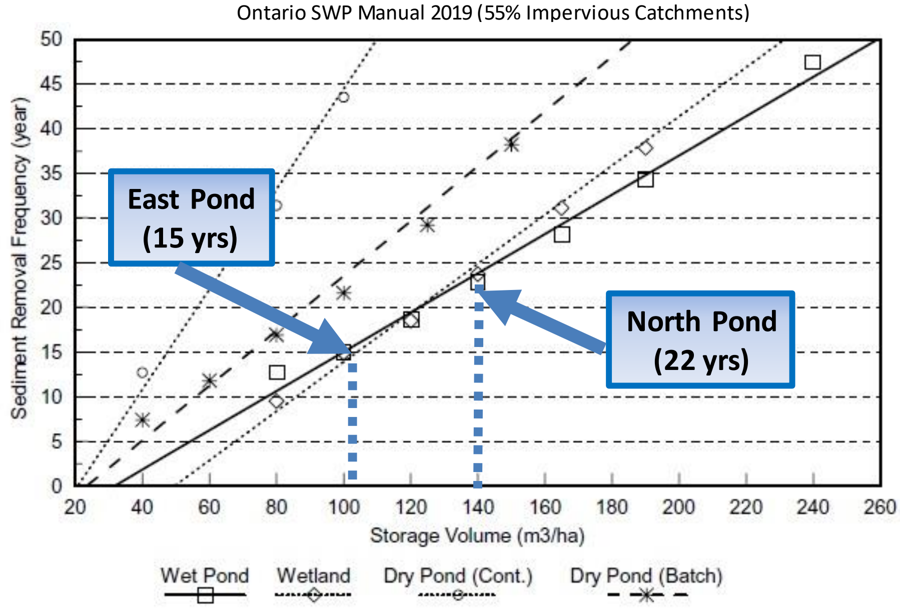
Ontario guidelines[9] call for regular monitoring of the elements of a stormwater pond system.

	North Pond	East Pond
Area Served (ha)	11.6	21.2
Permanent	1,558	2,051
Permanent/Ha	134	97

The ponds require cleaning periodically based on the relationship between the size of area served and the pond design capacity. The guidelines suggest that the East Pond should be cleaned approximately every 15 years and the North Pond every 22 years.

Permanent Storage vs Removal Frequency

Ontario SWP Manual 2019 (55% Impervious Catchments)



The Ministry of the Environment typically imposes requirements to monitor the ponds to ensure they are performing as designed when they issue their Certificate of Approval. We have been unable to determine if any monitoring program for the ponds was required by the MOE or if any has been done.

These ponds have been in service over 20 years so an assessment of their capacity is warranted. We strongly believe that a monitoring program for the ponds should be established immediately and the inlets and ponds cleaned out as soon as possible.

Maintenance of Inlets and Outlets

The pipe feeding into the pond and those removing water must also be monitored on a regular basis and kept clear of debris. As the following photos illustrate, the areas adjacent to the splitter inlet to the North Pond are overgrown but the inlet appears to be functional. It is not possible to determine whether the underwater outlet in the middle of the pond requires cleaning.

North Pond Splitter

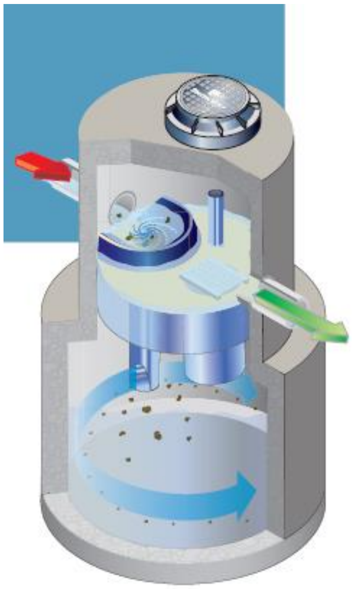
These photos (May 2021) show the build up of reeds near the inlet from the splitter into the North Pond and the partially clogged inlet into the pond from the splitter.

The lakeside portion of the outlet (the North Inlet) is relatively clear.

This photo shows the flow from the outlet through the small valley and into the Swan Lake after a 29 mm rainfall event on March 26, 2021.

It is not known how much of this flow into Swan Lake can be attributed to the partially blocked pond inlet.

Appendix D: Oil/Grit Separators at Swan Lake



Stormceptor Oil/Grit Separator by Imbrium

Oil/grit separators are designed to remove oils and heavy particles to minimize the pollutants. The polluted waters enter the container and fall to the bottom. The heavy material remains in the container and the somewhat cleaner water then rises and flows out and into Swan Lake.

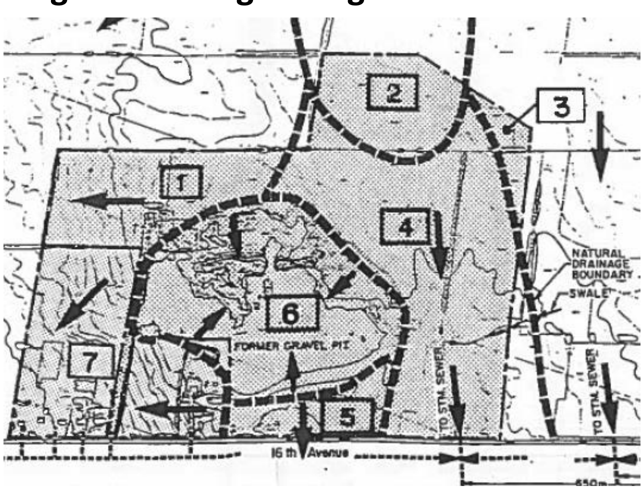
These units have no ability to remove road salt and other pollutants that are soluble and absorbed by stormwater runoff.

The units installed at Swan Lake are all manufactured by Imbrium and are units in their Stormceptor product line.

These units are not designed to retain the runoff. As noted in the table below most of the storage capacity is devoted to retaining sediment. The manufacturer notes the importance of monitoring the buildup of sediment each year and removing the sediment once it exceeds 15% of capacity.

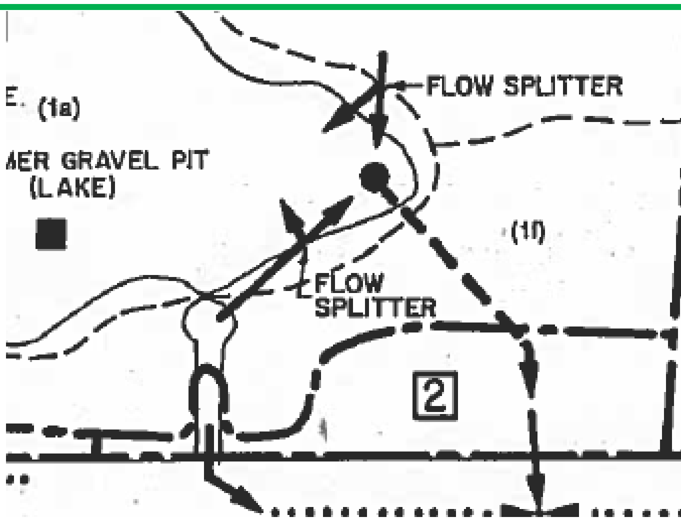
				Sediment Capacity	
Location	**Size of Area Supported**	**Product**	**Total Storage Volume (m^3)**	**Maximum (m^3)**	**% of Storage**
Traffic Circle on Swan Lake Blvd	0.8 ha	STC 2000	6.2	5.9	82%
Amica property	2.6 ha	STC 1500	7.3	6.2	85%
Parking lot at the Swan Club	0.5 ha	STC 300	1.8	1.5	95%

Original Drainage Design



Natural Area Drainage: Cosburn Figure 5

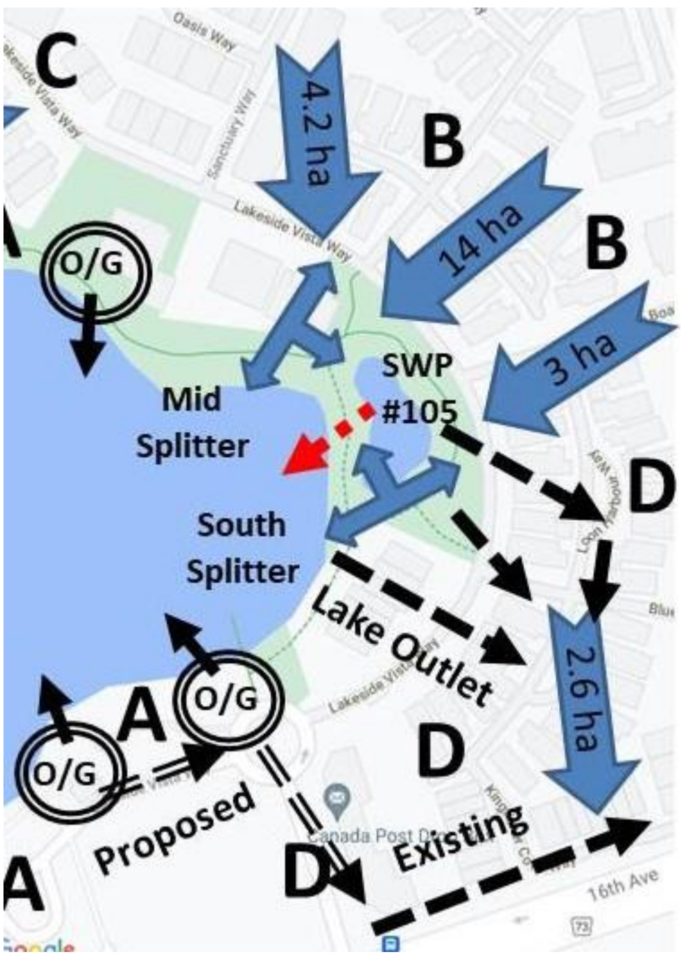
The original master drainage design[1] for the area noted that the land immediately north of 16th Avenue (area 5) all naturally drained towards either 16th Avenue or downhill to the west towards Mount Joy Creek (Exhibition Creek as it was then known as). Consequently, stormwater from the southern end of Swan Lake Village and the new townhomes east of Williamson Road at 16th Avenue were directed to stormwater systems along 16th Avenue.



Original Drainage Plan for Traffic Circle
Cosburn Figure 6

However, contrary to the original recommendations, the Amica properties and the traffic circle area on Swan Lake Boulevard were permitted to drain directly into Swan Lake via oil/grit separators. Consequently these two areas directly contribute chloride and other contaminants into the lake.

It is not clear why these areas were not routed to the East Stormwater pond. The pond has the capacity to handle these additional volumes. The adjacent diagram (Figure 6) shows the intended flows from the traffic circle into the East Pond.



The lake outlet pipe and the South Splitter block the ability to connect the two oil/grit separators to the East Pond as originally proposed. It appears technically feasible to direct the flows from these areas to 16th Avenue by connecting the Amica separator to the one in the traffic circle and then connecting this area south along Swan Lake Boulevard to the existing 16th Avenue system that flows east – the same system that handles flows from the lake outlet and the East Pond.

The one time cost of installing 200 m of new pipe would be partially recovered over time by the reduced cost of future chemical treatments due to the maintenance of healthy aquatic species that can consume and help contain algae.

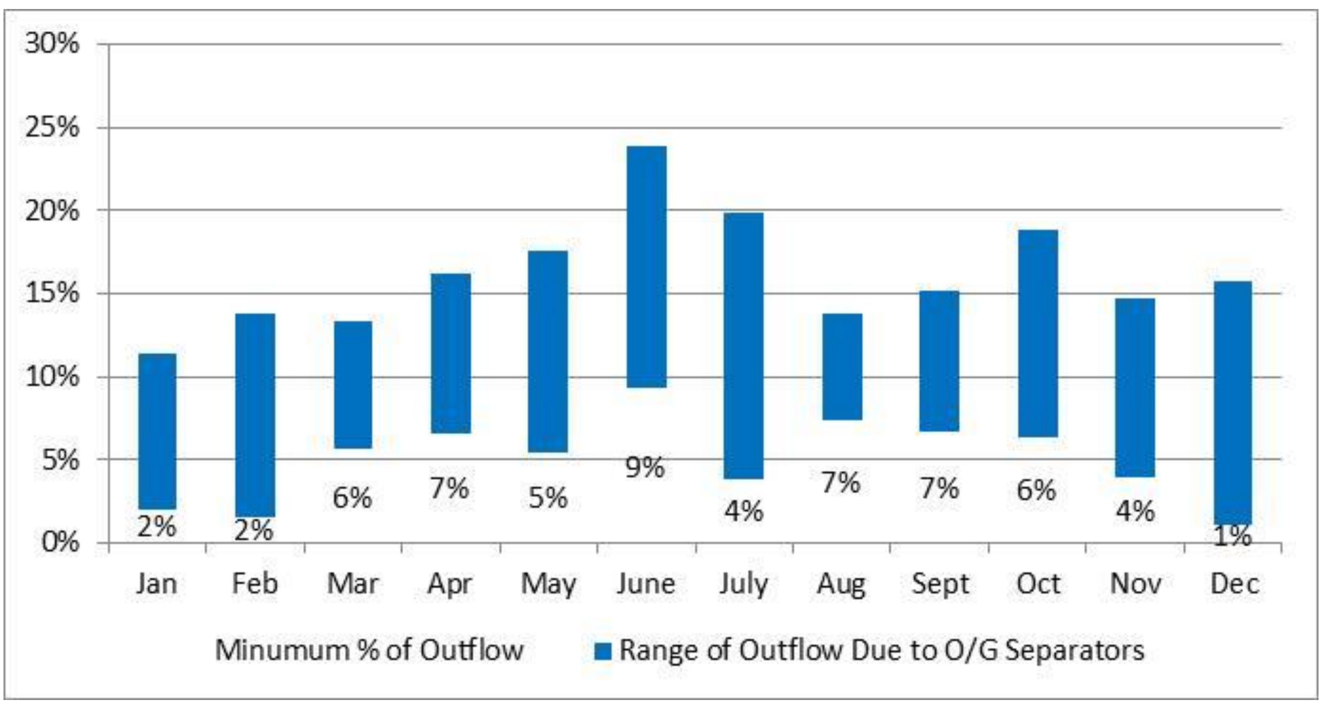
An oil/grit separator was also installed in the parking lot of the Swan Club in Swan Lake Village in a low lying area below the level of the stormwater system so rerouting of the flows from this oil/grit separator is not an option.

Downstream Impact

Currently the flows from the oil/grit separators flow into the lake but during times when the lake is at its peak levels these volumes are not retained in the lake – they displace other water in the lake into the 16th Avenue system. Therefore in effect the downstream system is already supporting these volumes during the critical spring runoff period when the flows contain road salt.

The storm sewer system on 16th Avenue would need to be analysed to ensure that during major rainfall events the rerouted drainage would not surcharge the storm sewer system from Swan Lake Boulevard to where the pond outflows connect with the 16th Avenue system, approximately 300 m east of Swan Lake Boulevard. Flows beyond this point are controlled by an orifice plate.

An analysis of the data from the 10-year simulation provided in the Markham staff report[5] illustrates that over the 10-year period 2009 – 2018, an estimated 2% - 24% of all monthly outflows from Swan Lake to the 16th Avenue system are attributable to inflows from the oil/grit separators.



The volumes from the two oil/grit separators are unnecessarily being rerouted through the lake particularly during the spring period when the lake is typically at its peak level and at a time when the inflows contain road salt.

Maintenance of Oil/Grit Separators

Both the manufacturer and the guidelines sponsored by the Toronto and Region Conservation Authority[10] underscore the importance of regular monitoring and cleaning of oil/grit separators.

There is little evidence to support that there has been regular cleaning of the separators. The one located at the traffic circle was buried under small bushes until it was located in the fall of 2020 while the pipe from the Swan Club separator to the lake is clearly blocked.

i) Swan Club Separator

Location in Swan Club Parking Lot
Cleaned in 2020

Blocked outlet from Swan Club Separator
to Swan Lake (May 2021)

ii) Traffic Circle Separator

Buried Separator found in 2020.
Possibly cleaned in fall of 2020.

Outlet from Traffic Circle Separator to Swan Lake.
Appears functional though somewhat overgrown.

iii) Amica Separator

We do not know the maintenance record of the oil/grit separator at Amica.

It is possible the oil/grit separator was upgraded and/or cleaned during the recent construction.

The outlet to the lake appears functional but somewhat overgrown.