Swan Lake

Long Term Management Plan

Markham Sub-Committee - November 16, 2021

Environmental Services
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Agenda

- Background and Purpose
- Overview of Swan Lake
- Swan Lake Conditions
- Lake Management History and Recent Projects
- Goal Statement and Level of Service
- Analysis of Optional Measures
- Strategy Options and Recommendations

Background and Purpose

Background- Lake Formation

- Swan Lake was formed through gravel quarrying beginning in the 1850's
- Once the operation stopped dewatering, groundwater filled the hole and created the Lake
- In the late 1970's the Lake was identified as part of an overall stormwater management plan to manage flooding, erosion and water quality
- In the early 1980s, the Lake was partially filled with construction materials, some of which was contaminated

Background- Issues and Responses

- Several issues were discovered in 2010, including high phosphorus levels and significant algal blooms, low oxygen levels and degraded fish habitats.
- A Phoslock treatment was administered in 2013 to reduce the phosphorus levels and algal blooms.
- Lake monitoring and geese management undertaken since treatment.
- Further studies and initiatives ongoing since 2019.

Photo of fish kill courtesy of Jon Van Loon

Purpose

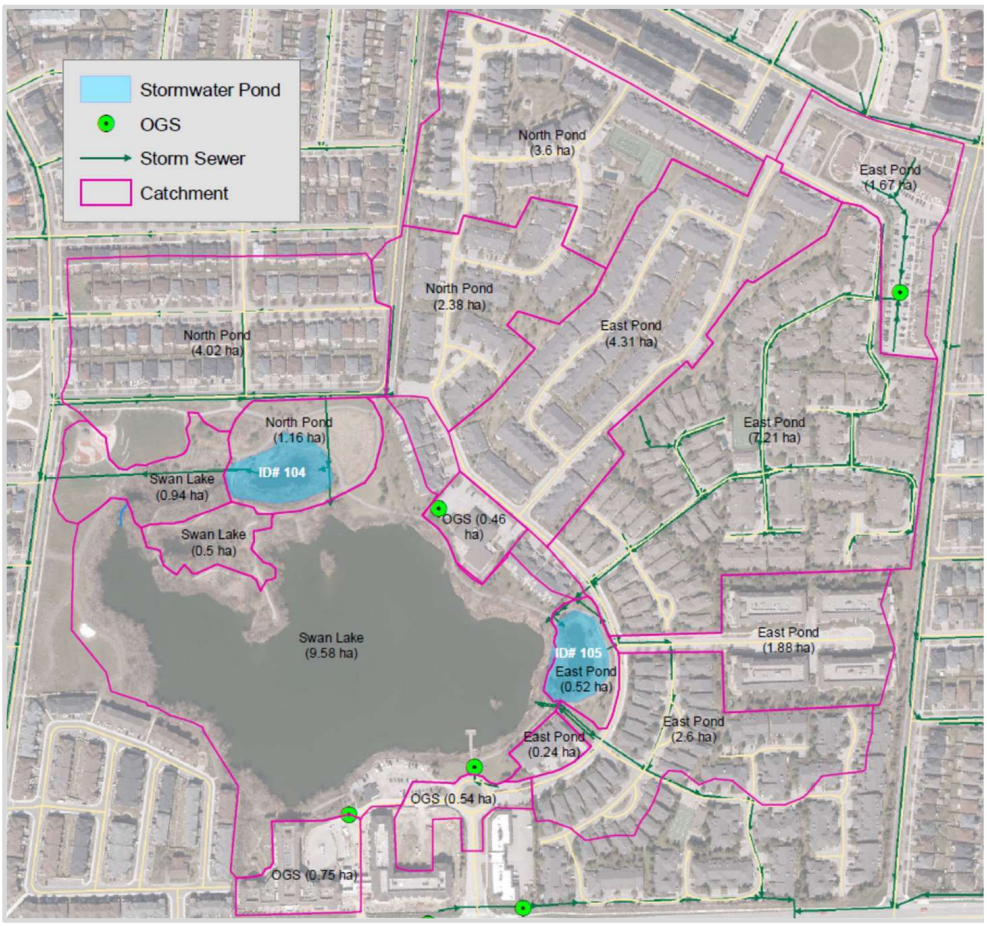
To provide a long-term strategy for water quality improvement in Swan Lake

- Important step in ensuring the long-term sustainability of Swan Lake as a valued recreational and ecological asset for the community.
- Based on the evaluation of opportunities and constraints.
- Recommendations for water quality management in the next five-year period (2021-2025) and beyond.

Overview of Swan Lake

Catchment

- Started as farmlands
- Changed to residential community, including a gated community and senior housing development
- About 45 ha:
  - Community & infrastructure (75 %)
  - Open water including Lake (15%)
  - Tree canopy or parks (10 %)



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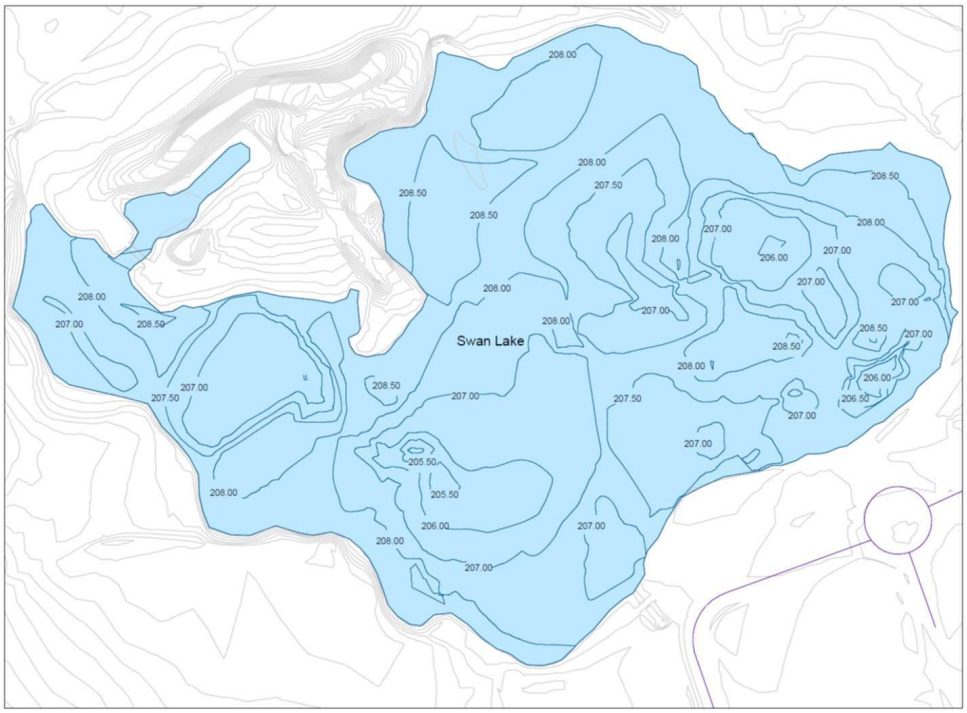
Morphometry

- Maximum depth: 4.5 m (from the deepest point at 204.5 m to the Lake edges at 209 m)
- Area at max level: 5.4 ha
- Volume at max level: 112,000 m^3
- Average depth: 2 m



Inflows and Outflows

Inflows

- Direct precipitation
- Controlled runoff:
  - Two stormwater ponds (31 ha)
  - Three oil and grit separators (2 ha)
- Uncontrolled runoff:
  - Shoreline area (5 ha)
  - Flow bypassing ponds
- Groundwater

Outflows

- Evaporation
- Flow through Lake outlet (to 16th Ave. sewer)
- Groundwater

Natural Features

- Diverse community of terrestrial species
- Resident and migratory Geese
- Mute and trumpeter swans
- Small mammals and several bird species
- Limited fish community (three species identified in 2021)
- Snapping turtles
- Invasive species (e.g., common reed)

Photo of birds and turtles courtesy of Donald and Cindy Fowler (through FOSLP)

Swan Lake Significance

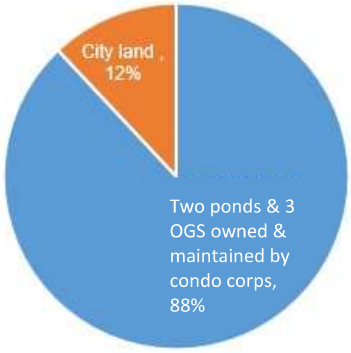
- Original objective set out by the developers in 1993:
  to transform the inactive gravel pit into a 'diverse natural habitat for aquatic and terrestrial wildlife… that incorporates passive use opportunities surrounding the Lake".
- Several studies completed over the years by the developers and the City.
- A community feature within the Swan Lake Park. The Park is widely used by residents and visitors.
- Many avid bird-watchers and photographers.

Survey conducted by the Friends of Swan Lake in 2020: residents "*support a long-term plan that involves investment in sustainable solutions and restoration of the aquatic and land-based habitat*".

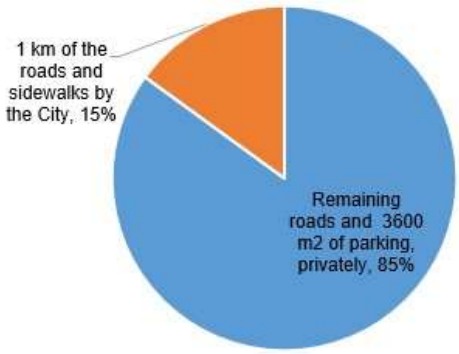
Ownership and Servicing

- In 2001, the City took ownership of most of the Lake, except for small portions on the south.
- Storm sewer lines within the catchment are owned by the City and private owners; the Region of York owns the 16th Ave. sewer.

Runoff Control



Winter Maintenance



- Intake maintenance has been identified for east pond.
- Sediment surveys by private owners identify cleaning needs.

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Swan Lake Conditions

Water Quality- Monitoring

- Water quality measured since 2014 by staff and external consultants (for specific purposes).
- Results are used to:
  - Identify trends and determine impacts of management activities.
  - Compare to Federal and Provincial guidelines for the protection of aquatic life.
  - Compare to lake classification criteria to determine eutrophic state.
- Parameters include:
  - Dissolved oxygen (DO), temperature and clarity
  - Nutrient concentrations (phosphorus and nitrogen)
  - Phytoplankton and algae blooms
  - Chloride

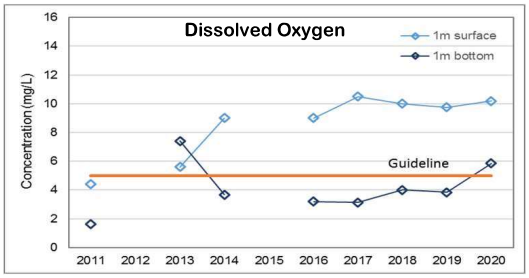
Water Quality- Guidelines

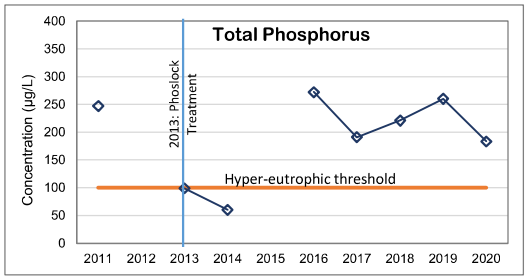
- Guidelines (used for perspective):
  - DO: low concentrations affect fish; 4-5 mg/L is required for warm water fish; some fish can acclimate to 1-3 mg/L.
  - Phosphorus and nitrogen: high concentration promotes algae growth and oxygen depletion; eutrophic lake 30-100 µg/L
  - Chloride: high concentrations impact aquatic biota; thresholds for chronic and acute exposure are 120 and 640 mg/L.

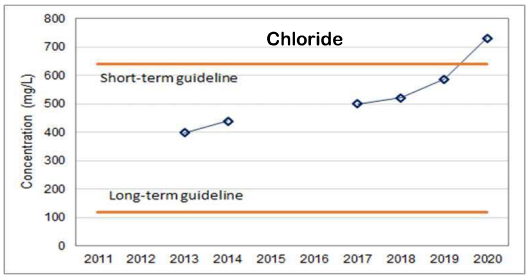
- Eutrophic Classifications (based on DO, phosphorus, clarity):
  - Oligotrophic: pristine
  - Mesotrophic: clear with some submerged plants
  - Eutrophic: somewhat unclear, lots of planktonic plant growth
  - Hypereutrophic: unclear, with frequent algal blooms

Water Quality- Measured Concentrations

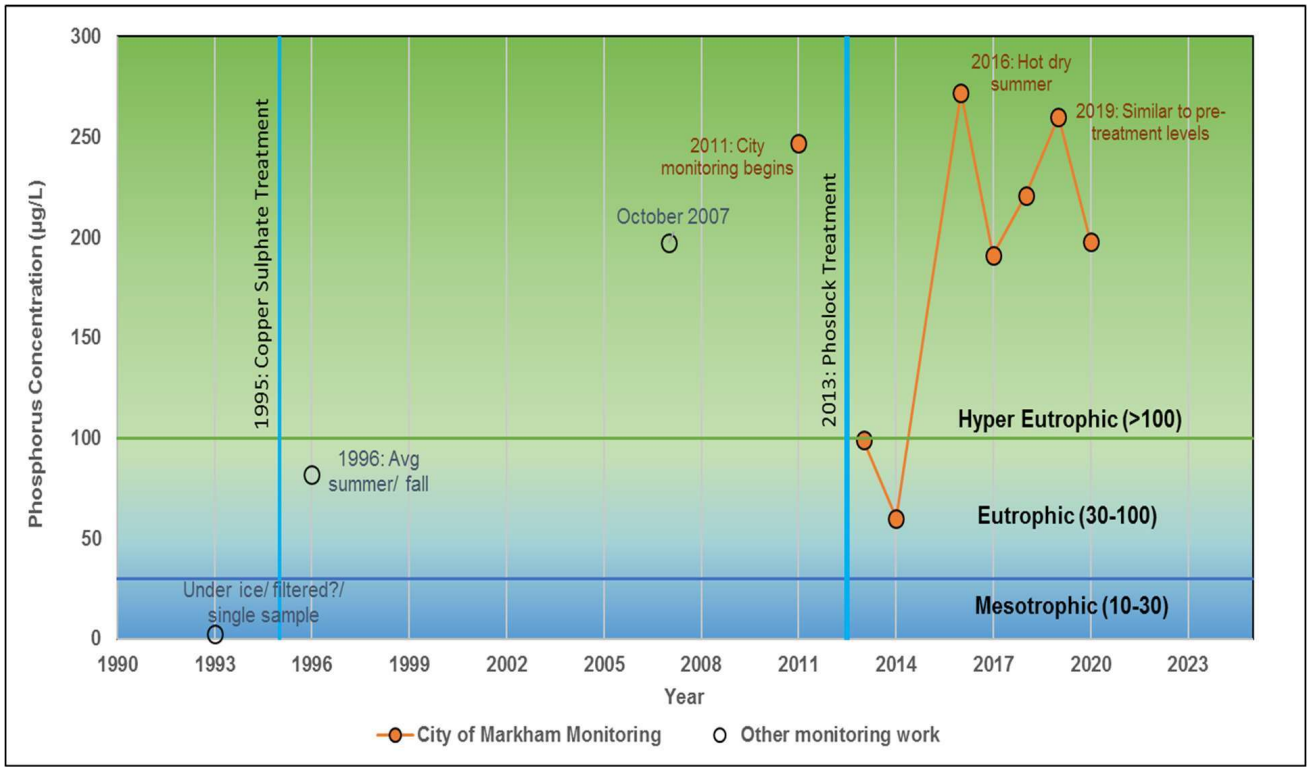
- Dissolved Oxygen:
  - Surface concentrations >5mg/L
  - Usually <2 mg/L below 2 m depth
- Total Phosphorus:
  - Growing season average > 150 µg/L (except after treatment)
  - Causing algae growth and low oxygen
  - Hyper-eutrophic conditions
- Chloride:
  - Increasing to above acute (short-term) guidelines





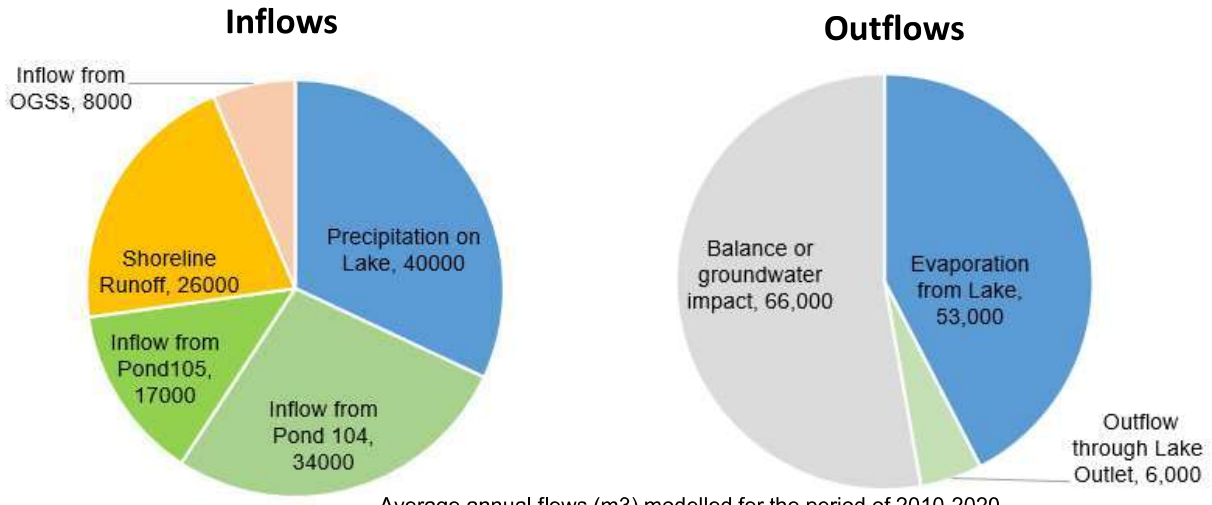


Lake Classification



Water Balance

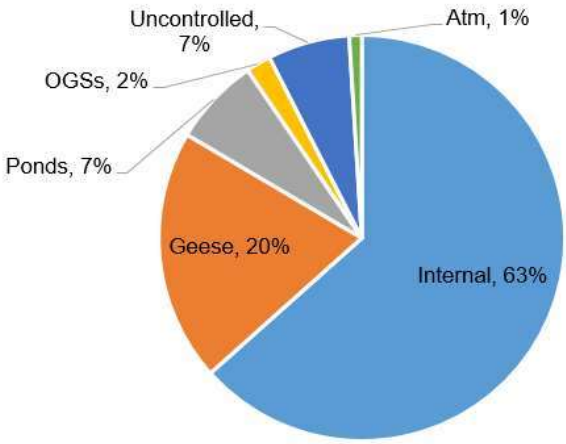
- A high-level estimate of the various catchment contributions to the total runoff into Swan Lake.
- Major contributors to nutrient loading were sufficiently quantified.
- The balance of known components was attributed to groundwater.
- Outflow through the outlet estimated using water level data.



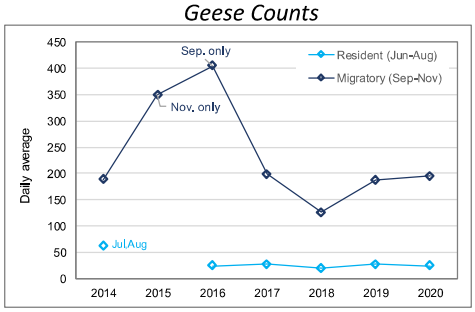
Average annual flows (m3) modelled for the period of 2010-2020

Phosphorus Budget

- Internal source (sediment):
  - Highly biologically-available,
  - Release elevated at summer water temperature
- External sources:
  - Geese dropping is the main source
  - Stormwater management facilities
  - Uncontrolled shoreline runoff
  - Possibly historic dumping area



Geese Counts



Dumping Areas

Chloride Budget

- Sources:
  - De-icing materials used for winter maintenance of roads, parking lots and walkways
  - Dust suppressants and water treatment salt
- Contributions:
  - 1 km (15%) of roads and sidewalks by the City
  - 5 km of roads, and 3600 m^2 of parking areas privately
- Salt application rates depend on weather conditions
- Chloride accumulates in the Lake and chloride input has increased over the years

Lake Management History and Recent Projects

Lake Management History

1993-2010
Several studies were completed in support of the development of Swan Lake Village and other areas.

In 2010, a resident of the Swan Lake community raised concerns about the water quality.

In 2011, the City initiated studies which resulted in the **2013** Phoslock treatment and an annual geese management program.

In 2016, the Lake had returned to pre-treatment conditions Annual monitoring and geese management.

In 2019, the City initiated a study to define a water quality management strategy for Swan Lake.

Recommendations from 2019 Study

Recommended Activities:

- Continued water quality monitoring
- Continued waterfowl management
- A treatment to address internal loading (including sediment analysis)
- Determination and potential management of bottom-dwelling fish
- Application of best management practices to decrease the nutrient contribution from the shoreline
- Investigation of phosphorus load from historic dumping areas

2019 Proposed Targets to Trigger Actions

- Surface bloom of a potential or proven toxic strain of cyanobacteria
- The occurrence of 2 blooms within 4 years covering > 25% of the lake area
- Interim goal of growing period average 150 µg/L total phosphorus
- Interim goal of growing period average 0.45 m Secchi disk transparency

2020 Council Resolutions

MARKHAM

RESOLUTION OF COUNCIL MEETING NO.10 DATED JUNE 23, 2020

4. That Council approve the following Swan Lake Water Quality Program:

a. Continue annual water quality monitoring; and,

b. Continue with the annual geese control and review additional options relating to vegetation, tree planting and strobe lights with regard to geese control and report back in the fall 2020 with recommendations; and,

c. Undertake the sediment analysis in fall 2020 which will provide data related to the frequency and dosage of the chemical treatment and will provide direction on the service level and timing of future treatments; and,

d. Undertake a chemical treatment commencing in 2021 based on the results of the sediment analysis; and further,

e. Introduce a new fish management program in 2021.

5. That Staff report back in 2021 with an overall water quality (with service levels) and park improvement program that will be sustainable into the future; and,

6. That Staff report back on this matter to General Committee through the Markham Sub-Committee with the participation of the Friends of Swan Lake; and,

7. That Council direct staff to contact the private property owners who own a portion of Swan Lake to obtain financial contribution to the Swan Lake Water Quality Improvement Program; and further,

8. That Staff be authorized and directed to do all things necessary to give effect to this resolution.

Recent Projects – Fish Management

- The TRCA was hired to complete a fish inventory and removal/relocation
- Fish were captured using an electrofishing boat and nets in April/May 2021.
- Only three fish species tolerant of poor habitat were captured in Swan Lake:
  - 7 Common Carp (non-native): euthanized
  - 209 Brown Bullhead (native, bottom-dwelling): relocated to Milne Pond
  - >10,000 Fathead Minnow (native minnow): returned to Lake
- TRCA recommended to complete a Fish Management Plan after water quality is improved.

Recent Projects – Geese Management

- Geese management options were reviewed.
- Regular geese hazing was enhanced by more frequent visits during migratory seasons. Hazing is done using trained border collies, drone and laser.
- Nine strobe lights purchased and installed on the Lake and the two ponds. The lights are meant to flash light and disrupt geese' sleep pattern (not effective).
- Hired the TRCA to remove existing nests and eggs (13 nests and 52 eggs) and to relocate resident geese (40 adults).
- Reviewed additional options, e.g., night-time hazing.

Photo courtesy of Fred Peters through the TRCA

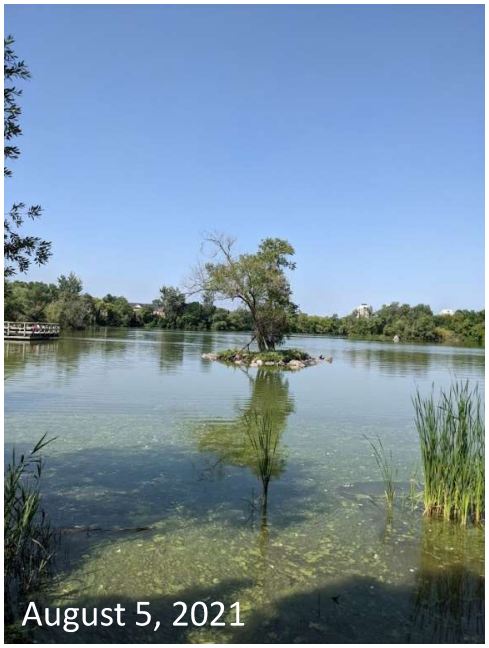
Recent Projects – Chemical Treatment

- Two chemical materials were found limnologically-feasible for Swan Lake:
  - Phoslock: currently not available for application in Canada
  - Poly Aluminum Chloride (PAC): applied in August 2021
- PAC optimum dosage was determined using jar tests.
- Application was spread over several days to avoid impact on water chemistry.

Chemical Treatment - Initial Results

- Phosphorus concentration after treatment and up to end of Sep 2021 has remained below and around 50 µg/L.
- Secchi transparency increased to above 1 m immediately after treatment and has been above 0.6 m since treatment.
- Although the water quality has deteriorated slightly since September, we expect it to recover in the spring, when this year's algae has died off.

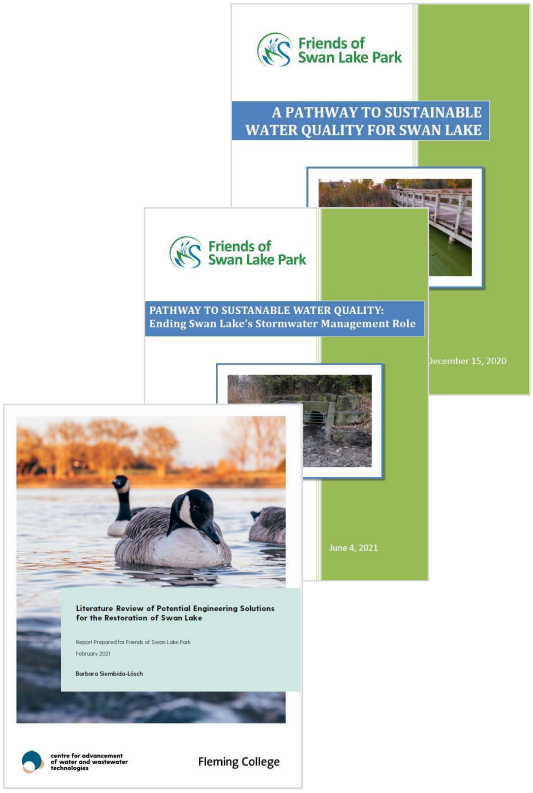
Before and After Photos



Before and After Photos

Stakeholder Engagement

- Residents of Greensborough Community have been very involved.
- Friends of Swan Lake Park (FOSLP) pursued initiatives and provided several reports and survey results.
- Site walk with staff and local Councilor.
- Residents have assisted with geese count and reporting other observations about the Lake.
- Staff in contact with developers (through Development Services) for pond maintenance.
- Operations/Parks Department is working on a Parks Refresh Plan.



Public Education

- Algae sign was developed to warn against contact with water.
- Geese signs were upgraded to provide information on geese impact and City geese count survey.
- An online application was developed for public input into geese count.
- Swan Lake page on website updated.

Goal Statement and Level of Service

Goal Statement

To improve the overall health of Swan Lake, which will provide opportunities for no-contact activities for the enjoyment of the community

Interim Targets (5-year)

Parameter	Current Values	Interim Target	Objective and Rationale
Total phosphorus (µg/L)	>200	50-100	Current value: the avg. of growing season TP values in the period since 2016 has been 200 (pre summer 2021 treatment). Interim target: will provide a low eutrophic condition in the first year after treatment increasing to eutrophic in year three
Secchi Depth (m)	<0.5 m	0.6-0.8 m	Correlates with the phosphorus target. Secchi is also a substitute for Chlorophyll a.
Chloride (mg/L)	700	400-500	Chronic guideline for the protection of aquatic life (120 mg/L) is not achievable at this time. To remain below acute guideline (640 mg/L) and close to 2013-2014 values
Frequency of algae blooms	Annual	Every three years	Trigger for treatment every three years
Internal phosphorus load (kg/yr)	53	0 - 25	Both internal and external loads should be controlled to achieve the lake concentration target (see above)
External phosphorus load (kg/yr)	30	15	

Treatment and Source Reduction

- Various scenarios were modelled to determine the optimum treatment frequency and external load reduction requirements to achieve set targets.
- Recommended improvements:
  - Chemical treatment every three years
  - 50% reduction in external nutrient sources

- Impact of climate change on future concentrations considered.

Analysis of Optional Measures

Issues and Opportunities

ISSUES

- Closed system resulting in contaminant build-up
- Internal source of phosphorus highly bio-available
- External source of phosphorus, mainly geese dropping, difficult to control
- Increasing chloride concentration, with no feasible way of treating existing chloride
- Most of the catchment is privately serviced (runoff and winter maintenance)

OPPORTUNITY

- Swan Lake and park are well used amenities with strong community support for sustainable solutions
- Existing stormwater management infrastructure to treat most of runoff

Measures to Control Internal Nutrient Load

Chemical Treatment for Phosphorus Control	Bottom-Dwelling Fish Management	Nitrogen Control
Most effective and immediate method of controlling internal phosphorus load	Fish removal will avoid disturbance of lake sediment, and hence lowers the nutrient release	• Phosphorus reduction will control productivity and hence reduce nitrogen • Goose control will help reduce nitrogen • Lowering nitrogen too much can promote cyanobacteria species • Existing methods are too expensive and/or not efficient, and have adverse side effect such as increasing temperature or geese habitat
$150,000 per application $50,000/ year for a 3-year cycle	$18,000 for major removal; $5,000 for maintenance removal	Not pursued

Measures to Control External Nutrient Load

Geese Management	Pond Maintenance	Shoreline Planting/ Improvements	Groundwater and Dumping Areas
• Major source of nutrient to be controlled • To improve migratory geese management (additional hazing)	• Proper functioning will reduce contaminant load to Swan Lake • Currently owned and operated privately • Discussion underway for Acceptance for Maintenance followed by Assumption	• Will help treat uncontrolled runoff • Limits geese access to the Lake	• Contribution has not been characterized • Site investigation and rehabilitation will be expensive and involves private parties • Lower priority if other measures do not achieve targets
$27,000 to continue existing programs $40,000 additional funds (annually)	$1500 annually $500,000 cleanout (33,000 annualized)	$35,000 design $125,000 implementation (Parks budget)	Significant ($2M – $10M TBD)

Measures to Improve Oxygen Level

Mechanical Aeration	Chemical Aeration
• Addition of oxygen to the Lake to reduce internal nutrient loading from bottom sediment by underwater aerators • Mixing caused by aeration may result in further resuspension of nutrients, increasing algal growth	• A chemical treatment (such as calcium peroxide) may increase oxygen concentration without the negative effects of water mixing. • At research state and could be considered as a pilot project through a research institute
Not pursued	Pilot project through research institute

Measures to Control Chloride Concentration

Winter Maintenance on Private Land	Physical or Biological Treatment	Redirecting Stormwater
• Major source of chloride is salt application on private land • Engaging developers and private owners on the rate and frequency of salt applications and chloride alternatives, as well as snow removal	• Treating existing chloride is very complex and expensive	• Proposal to redirect most of stormwater away from Lake • Complex and very expensive due to studies required, major disturbance to area, ownership, downstream impact • Not justified as fish can survive in current concentration
Privately funded	Not pursued	Significant

Measures to Improve Natural Features

Shoreline Planting/ Improvements	Planting of Submerged Plants	Fish Stocking
Natural water plants especially cattails will provide habitat and prey for fish	Native submersed plants will help solidify the sediment and provide fish habitat	• Fish Management Plan through discussions with the TRCA and MNDMNRF regarding suitable species and the potential of stocking (increase species diversity) • MNDMNRF pilot project to raise largemouth bass and bluegill sunfish for stocking in stressed urban waterbodies
$35,000 design $125,000 implementation	Estimated $20,000	MNDMNRF Fish Culture program

Community Engagement

Chloride and Nutrient Reduction	Data and Observations Sharing	Progress Reviews and Plan Updates
• Public education on salt usage and promotion of chloride alternatives • Engaging the village and other areas regarding BMPs for winter maintenance • Public education on geese feeding, fertilizer use and lot-level controls	• Continuing with the geese count to help assess the effectiveness of geese control measures • Report illegal activities to relevant agencies (e.g., turtle poaching, fishing for consumption, dumping)	• Participation in Markham Sub-Committee's review of Swan Lake Annual reports • Reviewing periodic reports and participation in the Plan updates • Participation in Shoreline Improvement Plan review

Strategy Options and Recommendations

Strategy Options

- The strategy to reach the interim water quality targets should align with City areas of strategic focus, e.g., promoting:
  - **Safe, Sustainable, & Complete Community**: support the enhancement of the natural environment and built form through sustainable integrated planning, infrastructure management and services.
  - **Stewardship of Money & Resources**: provide a reasonable cost-effective level of service.
- The strategy should follow an **adaptive management** approach where management measures are adjusted to maximize benefits / minimize impacts:
  - "**Core**" measures will be relied upon initially (cost-effective and technically effective methods to improve water quality)
  - Added "**Complementary**" measures introduced in subsequent phases
  - "**Alternative**" measures to be studied / considered in later phases if required based on observed water quality

Option 1 - Expanded Core & Complementary Measures
and Evaluate the need for Alternative Measures

	Activity	Phase 1 Core Measures (Years 1-5)	Phase 2 Core+ Complementary Measures (Years 6-10)	Phase 3 Core+ Alternative Measures (Years 11-25)
Core	Water quality monitoring and annual reporting to Subcommittee	☑	☑	☑
Core	Geese management and explore enhanced methods	☑	☑	☑
Core	Remove benthic-dwelling fish	☑	☑	☑
Core	Maintenance of stormwater management facilities (by developers then City)	☑	☑	☑
Core	Community Engagement	☑	☑	☑
Core	Chemical treatment (adjusted frequency at the end of each Phase)	☑	☑	☑
Core	Shoreline planting / Improvements	☑		
Complementary	Chemical oxygenation pilot project (by research institute)	☑		
Complementary	Fish management plan and fish stocking (by MNDMNRF)		☑	
Complementary	Planting of submerged plants		☑	
Complementary	New technologies for chloride treatment		☑	
Alternative	Investigate contribution from groundwater and dumping areas if required			☑
Alternative	Evaluate/design structural modifications such as lake water recirculation and stormwater redirection, if required			☑
Alternative	**Evaluate implemented measures and report back**	☑	☑	☑

Need TBD (Cost Excluded)

Option 2 - Expanded Core, Accelerated Complementary and Alternative Measures

	Activity	Phase 1 Core+ Complementary Measures (Years 1-5)	Phase 2 Core+ Alternative Measures (Years 6-10)	Phase 3 Core+ Alternative Measures (Years 11-25)
Core	Water quality monitoring and annual reporting to Subcommittee	☑	☑	☑
Core	Geese management and explore enhanced methods	☑	☑	☑
Core	Remove benthic-dwelling fish	☑	☑	☑
Core	Maintenance of stormwater management facilities (by developers then City)	☑	☑	☑
Core	Community Engagement	☑	☑	☑
Core	Chemical treatment (adjusted frequency at the end of each Phase)	☑	☑	☑
Complementary	Shoreline planting / Improvements	☑		
Complementary	Chemical oxygenation pilot project (by research institute)	☑		
Complementary	Fish management plan and fish stocking (by MNDMNRF)	☑		
Complementary	Planting of submerged plants	☑		
Complementary	New technologies for chloride treatment	☑		
Alternative	Investigate contribution from groundwater and dumping areas if required		☑	
Alternative	Evaluate/design structural modifications such as lake water recirculation and stormwater redirection, if required		☑	
Core	**Evaluate implemented measures and report back**	☑	☑	☑

Cost Included

Costs (25-yr, Inflated)

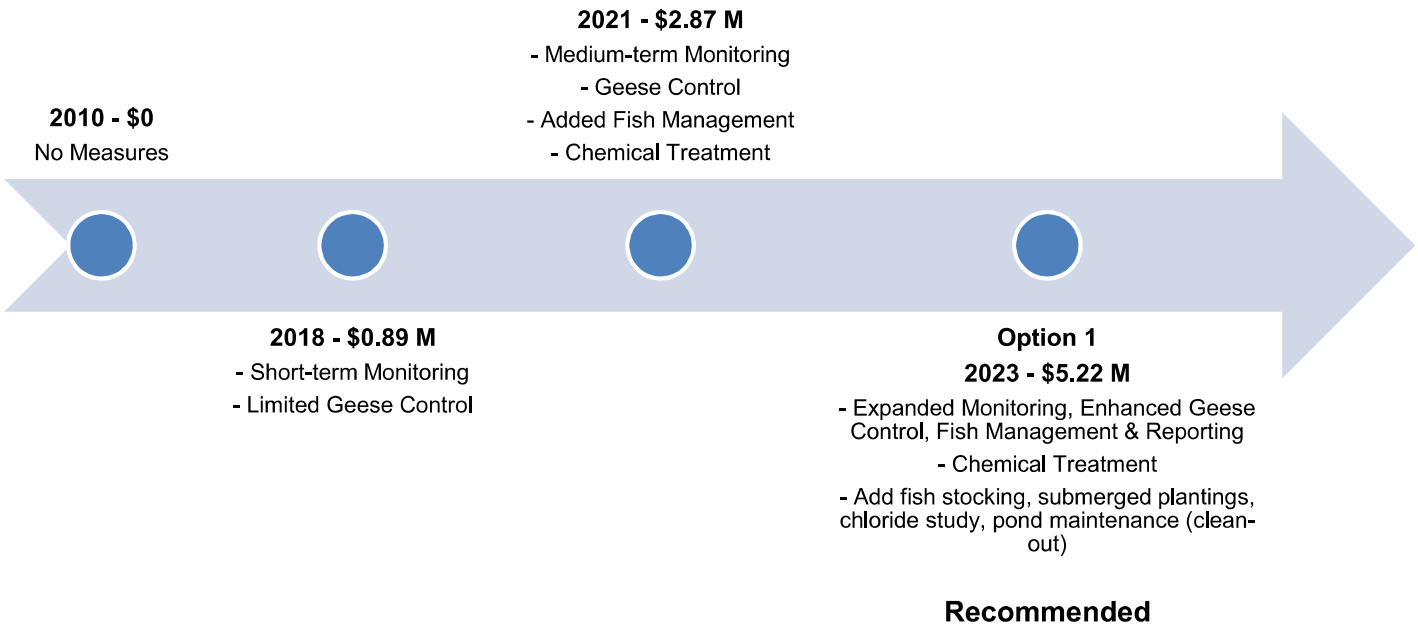
Alternative		Measure	Phase 1	Phase 2	Phase 3	Total
	Core	Continue water quality monitoring	$149,356	$ 164,901	$ 605,013	$ 919,270
	Core	Continue geese management and enhanced methods (including	$275,037	$ 383,582	$ 1,407,339	$ 2,065,958
	Core	Remove benthic-dwelling fish	$ 38,608	$ 28,165	$ 103,336	$ 170,109
	Core	Maintenance of stormwater management facilities	$ 4,591	$ 8,284	$ 528,374	$ 541,249
	Core	Chemical treatment with adjusted frequency and dosage *	$309,181	$ 261,141	$ 806,227	$ 1,376,549
	Complementary	Fish management plan and fish stocking **	$ -	$ 20,000	$ -	$ 20,000
	Complementary	Planting of submerged plants **	$ -	$ 20,000	$ -	$ 20,000
	Complementary	New technologies for chloride treatment **	$ -	$ 50,000	$ -	$ 50,000
		Investigate dumping areas	$ -	$ -	$ 20,000	$ 20,000
		Investigate groundwater **	$ -	$ -	$ 200,000	$ 200,000
		Control groundwater loading**	$ -	$ -	$ 2,000,000 to $10,000,000	$ 2,000,000 to $10,000,000
		Evaluate structural modifications **	$ -	$ -	$ 200,000	$ 200,000
		Implement structural modifications **	$ -	$ -	$ 5,000,000	$ 5,000,000
		Evaluate measures	$ 25,000	$ 27,602	$ 33,647	$ 86,249
		Option 2 - 25-year cost with Alternative Measures	$801,772	$ 963,675	$10,903,936 to $18,903,936	$12,669,383 to $20,669,383
		Recommended Option 1 - 25-year cost without Alternative			$ 3,450,289	**$ 5,215,736**

* Assumed 25% decrease in five years and 25% in 10 years (not reduced from Phase 2 due to climate change impact).
** Values are order of magnitude and are rough estimates for perspective.
Assumed pond cleanout/retrofit during the period.

Comparison of Options

Option	Pros	Cons
Option 1 Expanded Core & Complementary Measures, and Evaluate the need for Alternative Measures *(Recommended)*	• Relies on Core Measures that are cost-effective, technically effective. • Phased approach supports adaptive management.	• Alternative Measures not evaluated until later phases, after Core Measures are assessed.
Option 2 Expanded Core, Accelerated Complementary and Alternative Measures	• Pros per Option 1 above • Earlier implementation of Complementary Measures • Earlier evaluation of Alternative Measures to consider in later phases.	• Complementary measures may not be effective until water quality is achieved. • Alternative measures may not be needed to achieve quality targets. • Research/pilot-scale measures have uncertain benefits. • High/uncertain costs. • Structural modifications of private works (unassumed) impractical. • Potential flood risks (TBD) for structural measures.

25-Year Lifecycle Costs (Environmental Services)



Recommendations

1. THAT the report entitled "Swan Lake Water Quality Management Plan" be received;
2. AND THAT Staff implement the Plan presented as Option 1 including proposed Core and new Complementary measures beginning in 2023;
3. AND THAT an additional $2.35M over 25 years be reflected in the 2022 Lifecycle Reserve Update;
4. AND THAT Staff report back annually on water quality results and evaluation of adapted Core and Complementary measures for consideration in Phase 2 of the strategy through the Markham Sub-Committee with the participation of the Friends of Swan Lake Park;
5. AND THAT Staff be authorized and directed to do all things necessary to give effect to this resolution.

Costs – 2021 Lifecycle Comparison

	Measure	Phase 1	Phase 2	Phase 3	Total	Current Life-Cycle (2021)	Increase Over Current Life-Cycle
Core	Continue water quality monitoring	$149,356	$ 164,901	$ 605,013	$ 919,270	$ 87,095	$ 832,175
Core	Continue geese management and enhanced	$275,037	$ 383,582	$ 1,407,339	$ 2,065,958		
Core	Remove benthic-dwelling fish	$ 38,608	$ 28,165	$ 103,336	$ 170,109	$1,017,325	$ 1,218,742
Core	Maintenance of stormwater management	$ 4,591	$ 8,284	$ 528,374	$ 541,249	$ -	$ 541,249
Core	Chemical treatment with adjusted frequency	$309,181	$ 261,141	$ 806,227	$ 1,376,549	$ 1,763,350	$ (386,801)
Complementary	Fish management plan and fish stocking **	$ -	$ 20,000	$ -	$ 20,000	$ -	$ 20,000
Complementary	Planting of submerged plants **	$ -	$ 20,000	$ -	$ 20,000	$ -	$ 20,000
Complementary	New technologies for chloride treatment **	$ -	$ 50,000	$ -	$ 50,000	$ -	$ 50,000
Alternative	Investigate dumping areas	$ -	$ -	$ 20,000	$ 20,000	$ -	$ 20,000
Alternative	Investigate groundwater **	$ -	$ -	$ 200,000	$ 200,000	$ -	$ 200,000
Alternative	Control groundwater loading**	$ -	$ -	$ 2,000,000 to $10,000,000	$ 2,000,000 to $10,000,000	$ -	$ 2,000,000 to $10,000,000
Alternative	Evaluate structural modifications **	$ -	$ -	$ 200,000	$ 200,000	$ -	$ 200,000
Alternative	Implement structural modifications **	$ -	$ -	$ 5,000,000	$ 5,000,000	$ -	$ 5,000,000
Alternative	Evaluate measures	$ 25,000	$ 27,602	$ 33,647	$ 86,249	$ -	$ 86,249
	Option 2 - 25-year cost with Alternative Measures	$801,772	$ 963,675	$10,903,936 to $18,903,936	$12,669,383 to $20,669,383	$2,867,770	$ 9,801,613 to $17,801,613
	Recommended Option 1 - 25-year cost without Alternative Measures			$ 3,450,289	**$ 5,215,736**		**$ 2,347,967**

* Assumed 25% decrease in five years and 25% in 10 years (not reduced from Phase 2 due to climate change impact).
** Values are order of magnitude and are rough estimates for perspective.
Assumed pond cleanout/retrofit during the period.