Swan Lake Long-Term Management Plan
2025 Water Quality Results & Phase 2 Plan

Markham Subcommittee

Environmental Services
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April 30, 2026

Agenda

- 2025 Swan Lake annual water quality report
- Summary of consultation with Friends of Swan Lake Park and external agencies
- Phase 2 Long-Term Plan recommendations
- Proposed Council resolutions

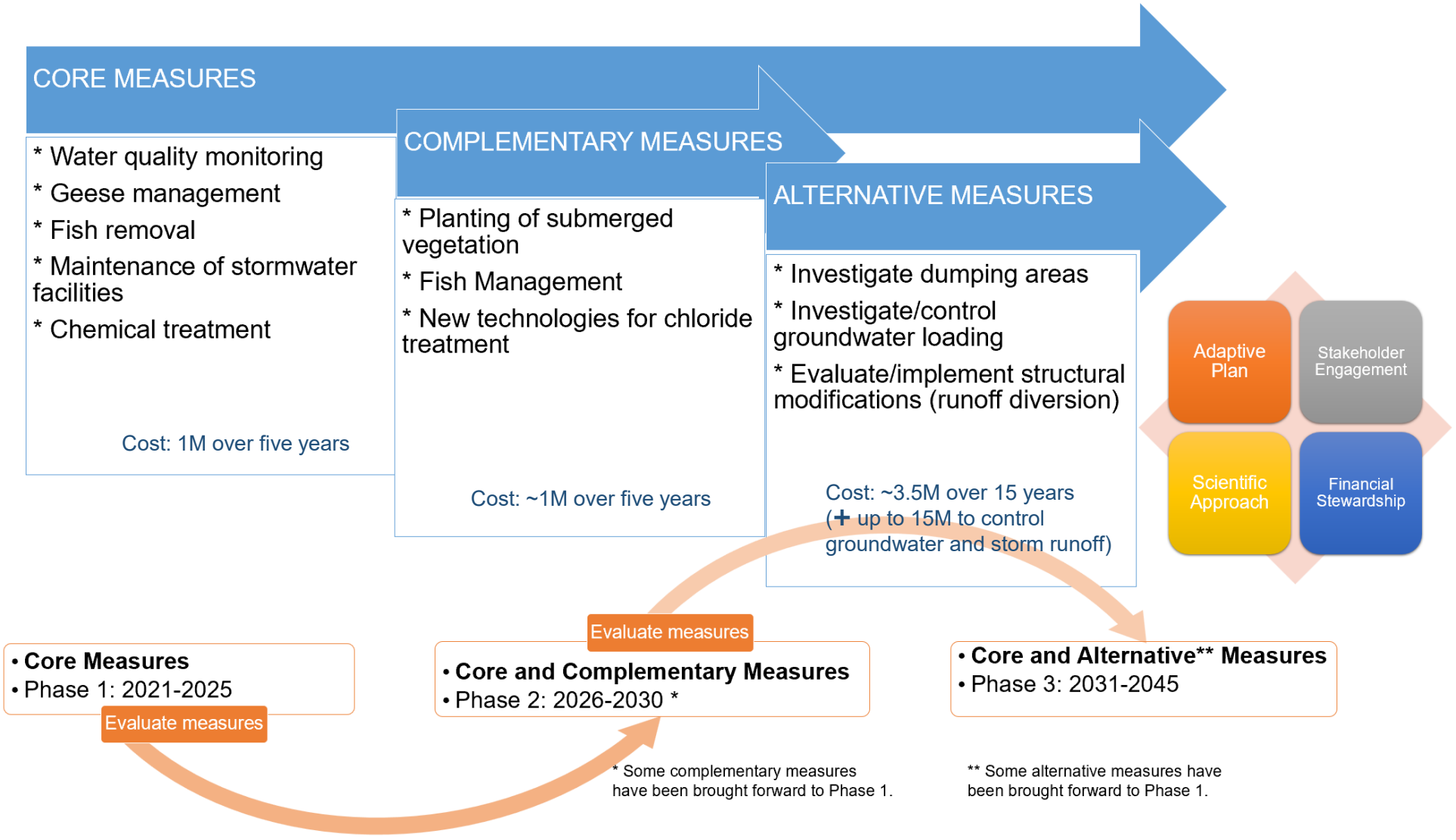
2025 Swan Lake annual water quality report

Location and History

- Operated in the 1960s and 1970s as a gravel pit
- Construction waste dump in early 1980s
- Lake created when gravel pit operations stopped
- Drainage area is fully developed with stormwater ponds and oil/grit separators
- Closed system and prone to nutrient build-up and algae growth.
- Winter maintenance introduces chloride to the lake
- Water quality issues noticed since 2010 or earlier
- Active management since 2013, including monitoring, chemical treatment, and geese/fish/vegetation management

Swan Lake Location Map

Long Term Management Plan (2021)



2025 Subcommittee Agenda Resolutions

That the following motion passed at the Sept. 16, 2025, Development Services Committee meeting number 13:

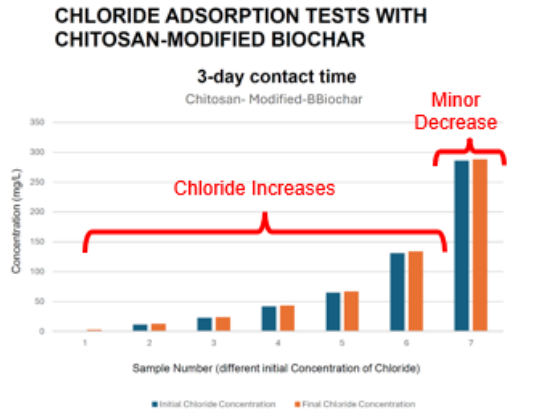
1. That the report entitled "Swan Lake - 2024 Water Quality Status and Updates" be received; and,
2. That the consolidated report entitled "Swan Lake Flow Diversion Assessment" be received; and,
3. That the presentation titled "Swan Lake - Annual Meeting with Markham Subcommittee" be received; and,
4. That Staff continue to implement the Long-term Management Plan for Swan Lake approved by Council in December 2021, including advancements previously made from Phases 2 and 3 of the Plan; and,
5. That Staff report back annually on water quality results and evaluation of adapted Core and Complementary measures for consideration in Phase 2 of the Plan through the Markham Sub-Committee with the participation of the Friends of Swan Lake Park; and,
6. That Staff consider findings and evaluations of chloride diversion options in Phase 3 of the Plan if required given future chloride levels in the Lake; and,
7. That the deputation from Kathleen Noel be received; and
8. That the Plan review be initiated in 2025 with consideration for a workshop to review external feedback; and further,
9. That Staff be authorized and directed to do all things necessary to give effect to this resolution.

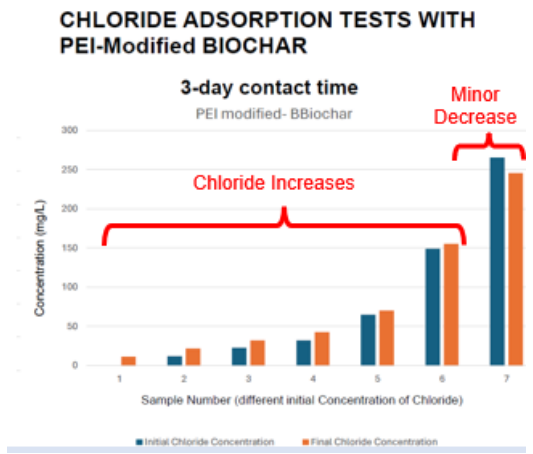
List of 2025 Activities

Activity	Phase 1 Core Measures (Years 1-5)	Phases 2/3 and Additional Measures
Water Quality Monitoring (and annual reporting to Subcommittee)	☑	
Geese Management	☑	
Maintenance of stormwater management facilities	☑	
Community Engagement	☑	
Fish Management (removal of benthic fish and fish stocking*)	☑	☑ (*P2)
Phase 1 Review, including Consultation with Experts and Agencies	☑	
Survey of Submerged Plants		☑ (P2)
New Technologies for Chloride Treatment (York U)		☑ (P2)
Flow Diversion Feasibility Study		☑ (P3)
Ultrasound pilot project for algae treatment		☑ (new)

Summary of 2025 Management Activities

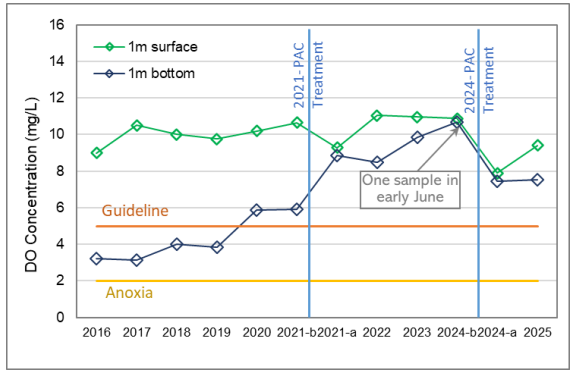
Geese Management	• Nest depredation, laser light, avian distress call and limited strategic zinc crackler pyro
Fish Management	• Removing bottom-dwelling fish to prevent sediment disturbance. • Fish in the Lake included Common Carp, Brown Bullhead, and Fathead Minnow. • 500 juvenile largemouth bass added in May 2025.
Vegetation Monitoring	• 3000 stems of wild celery planted in fenced locations on the north site in 2023 and 2024 • Naturally growing aquatic plants were also abundant in 2024 and 2025
Ultrasound Treatment	• Based on promising results from pilot project at a stormwater pond, a device installed in May 2025, removed over winter and reinstalled in 2026
Chloride Research	• Various types of biochar tested, and all increases chloride concentrations in low concentration samples. Limited reduction in higher concentration samples

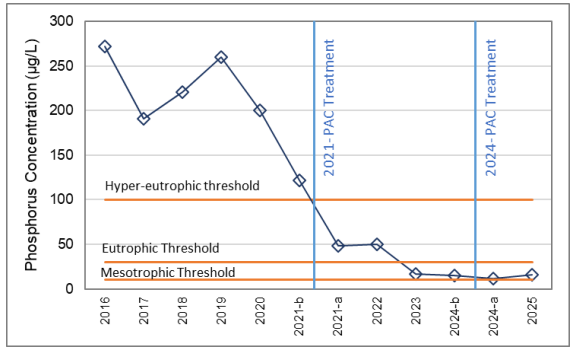


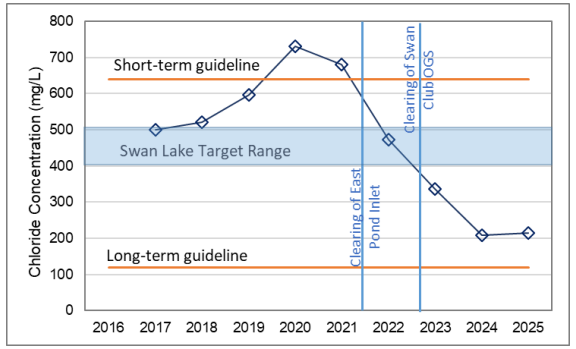


Summary of 2025 Water Quality Conditions

Dissolved Oxygen	• Surface DO met warm-water fish requirement (≥5 mg/L) • Anoxic conditions occurred at depths >2–2.5 m in limited locations during hot, dry summer periods
Transparency	• Growing-season average 0.6 m, within interim target (0.6–0.8 m)
Total Phosphorus	• Average 16 µg/L (mesotrophic) • Below interim PWQO (20 µg/L)
Total Nitrogen	• Average 0.62 mg/L (mesotrophic)
Chloride	• Lake concentrations below interim target • Consistent with GTA background levels
Algae & Cyanobacteria	• Limited surface scum observed • Chlorophyll-a below hyper-eutrophic levels







Summary of consultation with Friends of Swan Lake Park and external agencies

Plan Review Process

Expert Consultation and Engagement

- Engage with deputants and technical stakeholders involved in the Markham Subcommittee process
- Participate in a workshop or other interactive consultation with external experts and agencies (e.g., TRCA, MNRF)
- Review of stakeholders' input

Study

- Update existing condition
- Review of management outcome
- Evaluate additional management measures
- Review and update goals, objectives and targets
- Update strategy and implementation plan

Plan Update

- Share draft report with stakeholders
- Receive feedback
- Present final report to Markham Subcommittee

Consultation Process (December 2025 to March 2026)

- Reports prepared by FOSLP and their consultants reviewed by City staff and consultant
- Comments were provided to reports' authors
- City staff and consultant met with each report's authors to discuss submissions and comments
- Meeting presentations and minutes were provided to FOSLP and its consultants – updated reports received
- Staff met with FOSLP to discuss their report, which was updated based on feedback to their consultants
- Meeting presentation and minutes were provided to FOSLP

* All meeting presentations and minutes are appended to the Phase 2 Plan Review report (300 pages).

List of reports reviewed:

- Swan Lake Aquatic Conditions Review (R.J. Burnside & Associates)
- SLTMP: Water Quality Monitoring Program Preliminary Review (NSRI)
- Literature Review of Management Options and Effects of Increased Oxygenation in Swan Lake (NRSI)
- Drone-Based Monitoring Swan Lake Water Quality, Report (Swan Lake Citizen's Lab)

Summary of Phase 2 Take-aways from Consultations

- ☑ Habitat enhancement, e.g., woody debris if macrophytes are not sustained
- ☑ Monitoring of bass survival and further fish management adjustment
- ☑ Targeted or periodic monitoring of TSS, total metals and E. coli
- ☑ Documenting missing sampling events
- ☑Targeted sediment characterization to support future chemical treatment planning
- ☑ Pond sediment characterization (under Excess Soil management regulation)

FOSLP Submissions

Submission Title	Staff Feedback	Report Update
Towards Sustainable Water Quality For Swan Lake, Submission for Markham's Swan Lake Water Quality Review (Dec.3, 2026)	Memo by City Consultant (AECOM, Feb. 2, 2026), with Attachment A – Technical Review of NRSI report (see previous slides) Staff met with FOSLP and their consultants (Feb. 10 and 11, 2026).	Towards A Sustainable Naturalized Wetland For Swan Lake, Submission for Markham's Swan Lake Water Quality Review (Mar.12, 2026)
Discussion Paper, Proposal for an Environmental Health Card for Swan Lake (February 5, 2026)	Staff advised the unsolicited proposal to outsource current monitoring to universities (i.e., York and Trent) and to add additional research-focused monitoring would have to be made to the City's purchasing department.	
It's Time to End Swan Lake's Stormwater Role (Feb.7, 2026)	This is a position paper in support of some of the recommendations in the Dec/Mar report on the Flow Diversion Study, including suggestions of new routes without considering future need for access. This can be reviewed in Phase 3 if the flow diversion is reconsidered.	
Printout at the meeting entitled Discussion Notes Meeting Markham Staff and Phase 2: Three Core Objectives (March 25)	A summary of objectives and recommendation from the Dec/Mar report	

Revised FOSLP Report

Points of Overall Agreement with Staff

- ☑ Significant improvements in surface water quality attributable to the Phase 1 program
- ☑ Evidence does not support the need for oxygenation
- ☑ There is no technical rationale for sediment removal
- ☑ Drone Monitoring: Withdrawn
- ☑ Groundwater characterization using existing information, and collecting water level and chloride concentrations
- ☑ Review of information on chloride uptake from soil through planting and harvesting

Points of Overall Disagreement

- ☒ Management objectives
- ☒ Groundwater impact
- ☒ Chloride levels/treatment

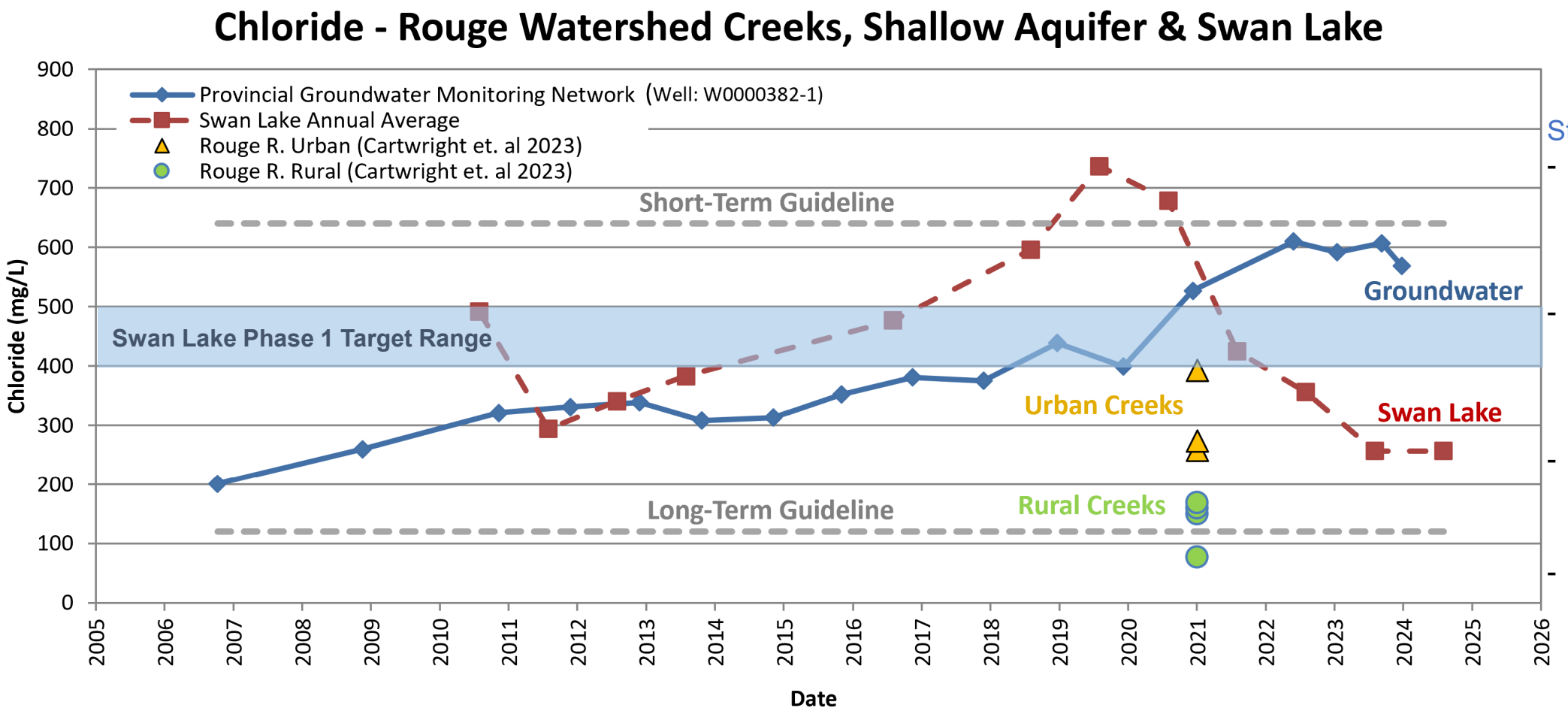
Summary of Opposing Positions on Management Objective

FOSLP Objective	Staff Position
The Definition of "Health" includes all of the aquatic elements in the lake – in particular the lower-level elements in the food chain. * Outsourcing of monitoring program	Monitoring of lower-level biota does not address any unresolved management questions. * Implemented by staff for continuity, long-term consistency, and operational decision-making
Strive for a Sustainable Solution by implementing programs to further reduce algae and to improve clarity to the mesotrophic level.	Maintaining mesotrophic clarity is not sustainable in Swan Lake given its physical setting.
Return To a Naturalized State by minimizing the impact of stormwater inflows.	Groundwater interaction is not well defined, and removal of stormwater inflows is premature.

Summary of Opposing Positions on Groundwater and Chloride

Subject	FOSLP	Staff
Key hydrologic feature	Swan Lake also meets the technical criteria set for key hydrologic features	Identified Key Hydrologic Features are a resource for protection during the development process.
Significant recharge area	Swan Lake is a significant natural source for recharging the aquifer	Groundwater interaction with Swan Lake does not constitute a significant aquifer recharge function for study and management outside the already-completed development review process
Chloride concentrations and impacts		• Levels are consistent with urban waterbodies in the area • No evidence of ecological impairment due to chloride
Groundwater flushing	Assumes clean and chloride free	Available Provincial data indicate high shallow groundwater concentration, additional testing being planned
Chloride target	CCME for the most sensitive species	Site-specific targets defined to support lake management objectives
Chloride treatment	Relies on ongoing research on Biochar	• No evidence of ecological impairment due to chloride • Biochar does not appear viable for short-term implementation
Flow diversion	Analyze further scenarios and implement in Phase 2	• No evidence of ecological impairment due to chloride • Deferred to consider in Phase 3, if required

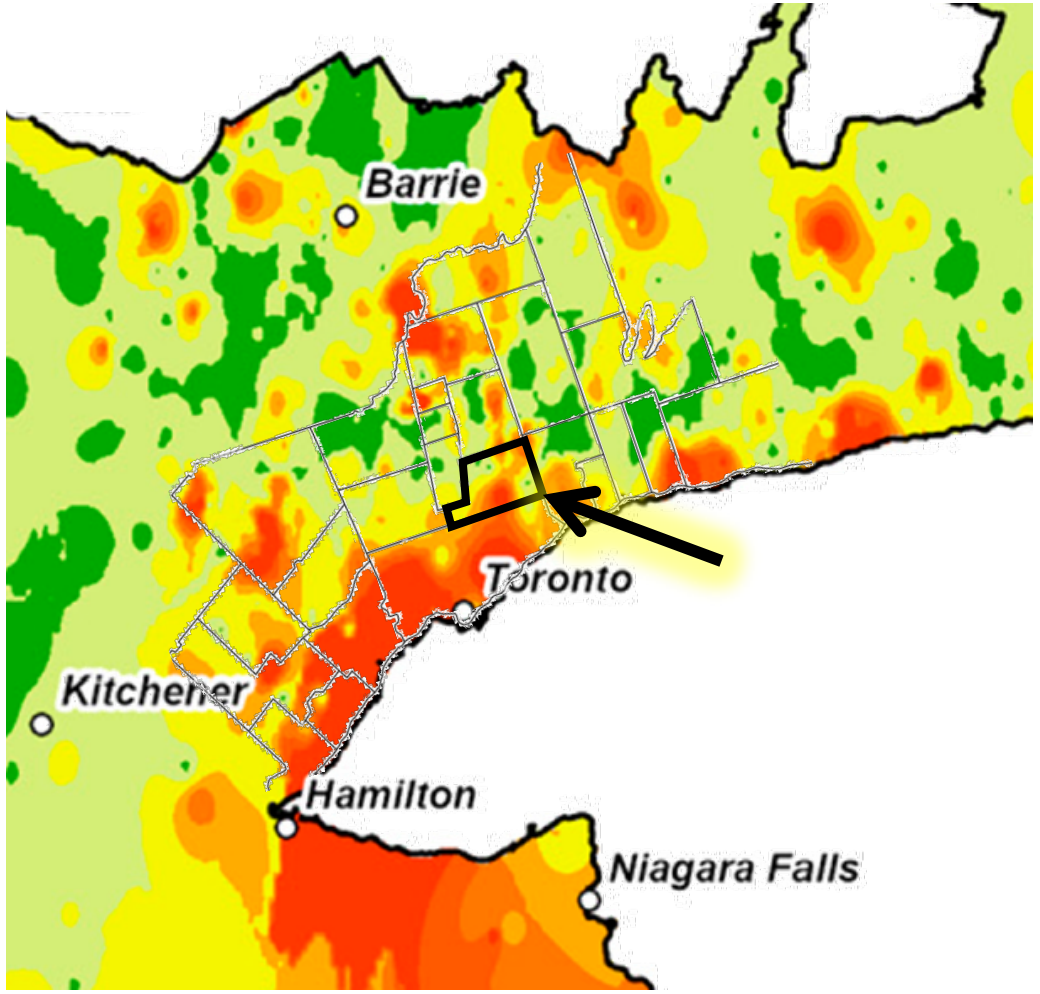
Chloride Target and Background Concentrations



Staff Position:

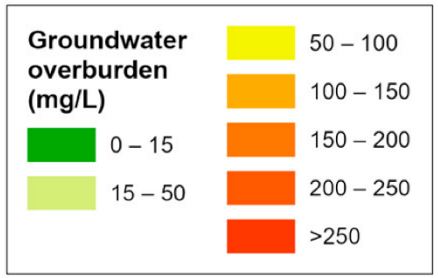
- Lake chloride already below shallow ground water and many urban streams
- 120 mg/L guideline not met in urban water systems nor many rural creeks
- FOSLP goals and interventions are not realistic or practical
- US. EPA long-term guidelines are at 230 mg/L

Chloride Concentrations - Shallow Groundwater 2011-2020



Staff Position:

Chloride concentrations in shallow groundwater in urban areas range from 100-250 mg/L (above long-term guideline)



Source: Figure 5b) - Geospatial Analysis of Chloride Hot Spots and Groundwater Vulnerability in Southern Ontario, Canada Ceilidh Mackie * , Rachel Lackey and Jana Levison, published in Water (2025)

Chloride Treatment - Regulatory and Industry Perspectives

Ministry of Environment, Conservation and Parks

MECP advised that "chloride removal, this is not easy to do even for drinking water, so for stormwater, this is not practical". (per A. Ahmed, Manager, Municipal Water and Wastewater)

Toronto and Region Conservation Authority

"Removal of chloride from stormwater is not an easy task due to its high solubility. I believe that it requires a chemical treatment process. Most research is desalination of sea water for drinking water use and not on stormwater applications." (per D. Young, Program Manager, Sustainable Technologies Evaluation Program (STEP)).

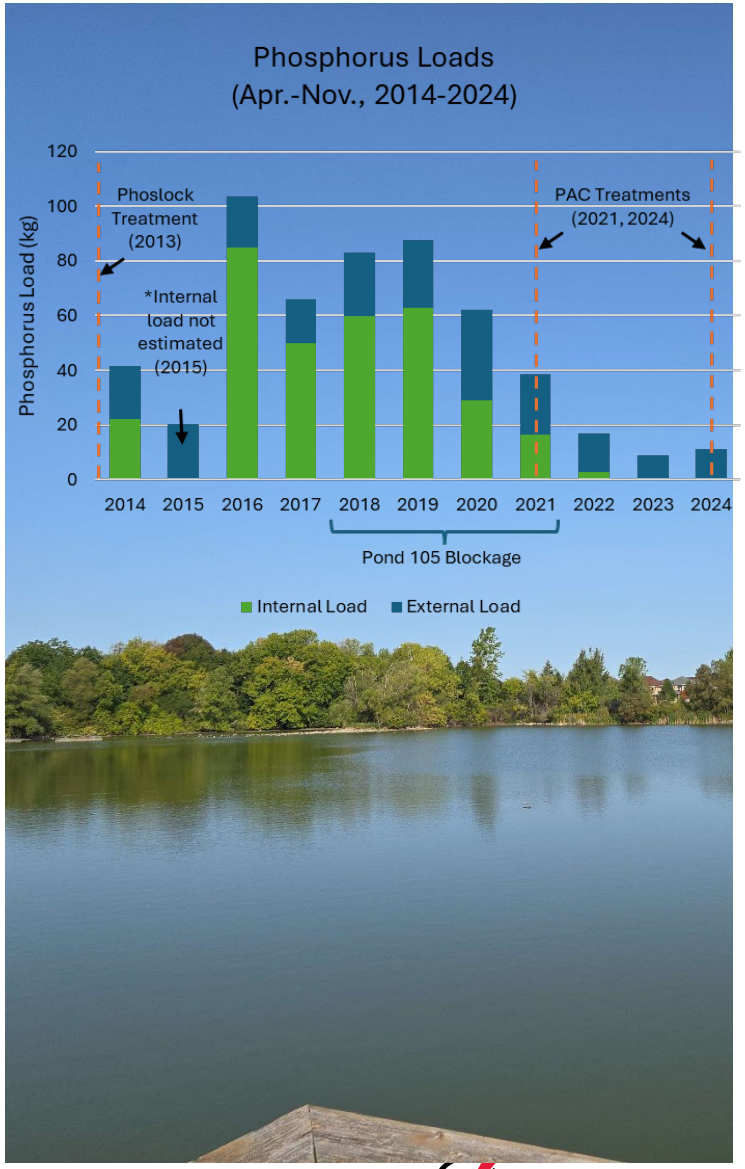
Stormwater Treatment Device Manufacturer

Swan Club OGS manufacturer Rinker advised that "We ourselves do not have any specific examples of this. For a Stormceptor, it would not be possible to retrofit with a treatment system. We do not have any technologies that provide chloride removal …" (per B. O'Leary, P.Eng., Stormwater Specialist, Rinker).

Phase 2 Long-Term Plan Recommendations

Phase 1 - Program Outcomes

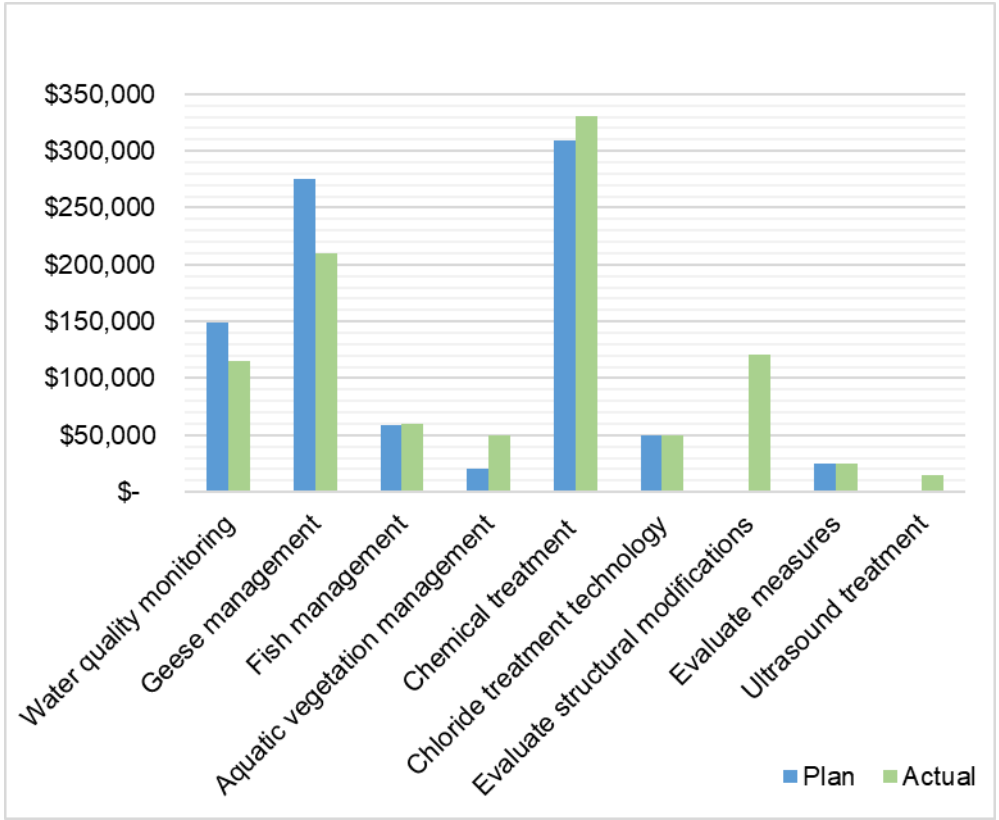
- Significant improvements in water quality and habitat have been realized, including aquatic vegetation and fish community
- Water quality now consistently meets expectations for shallow urban water bodies
- Advanced studies were completed to characterize the system and help with decision-making
- Innovative technologies and academic research are actively being evaluated
- Phase 1 of the Long-Term Management Plan has successfully met all established goals and targets.



Phase 1 Cost

- Capital projects cost was planned at 890K, and actual cost was 975K.
- Significant amount of staff time has been dedicated to achieving the Phase 1 results, and updating the Phase 1 Plan, including careful consideration of external submissions

Phase 1 Planned and Actual Costs



Phase 2 Objectives and Goals

- Science-based, evidence-driven framework, using recent monitoring data and model results
- Consider Swan Lake and watershed characteristics
- Observed response to Phase 1 management measures
- Practical achievability under current conditions
- Advance improvements through phased, adaptive management
- Achieve the best practicable outcome while ensuring responsible use of public resources

Goal Statement:

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

Swan Lake Phase 2 Targets

Parameter	Before 2021	Phase 1 Target	Current Values	Phase 2 Target *	Rationale for Phase 2 Target
Total phosphorus (µg/L)	>200	50-100	≤20	≤20 (<30 for single events)	Maintain concentrations at mesotrophic level; limited further reduction expected
Secchi Depth (m)	<0.5	0.6-0.8	~0.6–0.8	≥0.6	Ensure sufficient light for SAV; no longer directly linked to phosphorus.
Chloride (mg/L)	700	400-500	~200 (2024–2025 average)	200–400	Below levels associated with increased ecological risk while recognizing constraints from ongoing road salt use, background concentrations, and potential groundwater inputs
Frequency of algae blooms	Annual	Every three years	Periodic blooms; densities near guideline thresholds	Reduced frequency, duration, and severity; generally, ≤50,000 cells/mL	Widescale blooms no longer affect the lake. Target supports improved condition based on Health Canada guidelines
Internal phosphorus load (kg/yr)	53	0 - 25	~0	≈0 (negligible)	Both internal and external loads should be controlled to achieve the lake concentration target
External phosphorus load (kg/yr)	30	15	9–17	≤12–15	Same, recognizes hydrologic variability

* Unless otherwise indicated, targets represent open water season (April–November) average conditions.

Review of Additional Management Activities

- Several lake management activities were reviewed through:
  - 2019 Water Quality Strategy
  - 2021 Long-Term Management Plan
  - Ongoing stakeholder consultations, including expert consultation for Phase 2 Plan development (see previous section)
- Additional measures not considered in depth before, include:
  - Planting and harvesting Halophyte plants
  - Habitat assessment and enhancement for fish

Recommendations for Phase 2

- Monitoring and reporting enhancements, including additional parameters in lake and outfalls, groundwater level and chloride concentration
- Continue with geese management, and fish inventory, consider stocking with other more resilient fish species
- Continue with chemical treatment if triggered based on monitoring, including lake sediment characterization for treatment purposes
- Chloride and groundwater characterization through additional data collection
- Review of halophyte plants performance for chloride removal
- Habitat enhancement through shoreline planting and addition of woody debris where macrophytes are missing
- Ultrasound treatment for algae control
- Repeat lake vegetation survey in 5 years (2030)

* Measures not recommended: oxygenation, stormwater diversion, pond sediment studies, biochar treatment (based on preliminary findings)

Cost Estimates for Phase 2

- Estimated cost of Capital projects for Phase 2 (2026-2031) is about 900K
- Staff time for achieving the Phase 2 results

Measure	Phase 1 Plan	*Phase 1 Actual*	Phase 2 (2026-2030)	Phase 3 (2031-2050)	Total (Phases 2 and 3)	Current Life-Cycle (2021)	Increase Over Current Life-Cycle
Continue water quality monitoring	$ 149,000	*$ 140,000*	$ 168,000	$ 866,000	$ 1,034,000	$ 919,000	$ 115,000
Continue geese management and enhanced methods (including	$ 275,000	*$ 210,000*	$ 419,000	$ 2,160,000	$ 2,579,000	$ 2,280,000	$ 299,000
Remove benthic-dwelling fish	$ 39,000	*$ 50,000*					
Fish management plan and fish stocking **	$ 20,000	*$ 10,000*					
Planting of submerged plants **	$ 20,000	*$ 49,000*					
Maintenance of stormwater management facilities	$ 2,000	$ -	$ 6,000	$ 538,000	$ 544,000	$ 537,000	$ 7,000
Chemical treatment with adjusted frequency and dosage *	$ 309,000	*$ 331,000*	$ 287,000	$ 1,040,000	$ 1,327,000	$ 1,380,000	$ (53,000)
New technologies for chloride treatment **	$ 50,000	*$ 50,000*	$ -	$ -	$ -	$ 50,000	$ (50,000)
Investigate dumping areas	$ -	$ -	$ -	$ 20,000	$ 20,000	$ -	$ 20,000
Investigate groundwater **	$ -	$ -	$ 10,000	$ -	$ 10,000	$ -	$ 10,000
Evaluate structural modifications **	$ -	*$ 120,000*	$ -	$ -	$ -	$ 120,000	$ (120,000)
Other measures	$ -	*$ 15,000*	$ -	$ -	$ -	$ -	$ -
Evaluate measures	$ 25,000	*$ 25,000*	$ 28,000	$ 72,000	$ 100,000	$ -	$ 100,000
Total	$ 889,000	*$ 1,000,000*	*$ 908,000*	$ 4,676,000	$ 5,584,000	$ 5,286,000	**$ 298,000**

* Phase 3 extended for five years (20 years duration) to match 25-year life-cycle. Future life-cycle includes Phase 2 and Phase 3
Assumed pond cleanout/retrofit during the period.

Proposed Council resolutions

Proposed Resolutions

- It is proposed that:
  1) That the reports entitled "Swan Lake - 2025 Water Quality Status and Updates" and "Phase 2 Long-Term Management Plan" be received; and,
  2) That the presentation titled "Swan Lake – 2025 Annual Meeting with Markham Subcommittee" be received; and,
  3) That the deputations from [deputants] be received
  4) That Staff implement the Phase 2 Long-term Management Plan; and,
  5) That Staff report back annually on water quality results through Committee (to be determined); and,
  6) That Staff be authorized and directed to do all things necessary to give effect to this resolution.

Swan Lake Long-Term Management Plan
2025 Water Quality Results & Phase 2 Plan

Markham Subcommittee Presentation

April 30, 2026