Report to: General Committee Meeting Date: June 15, 2020

SUBJECT: Swan Lake Water Quality Improvement Program
PREPARED BY: R. Grech, P. Eng, x2357

RECOMMENDATION:

1. That the presentation, titled "Swan Lake Water Quality Improvement Program" be received; and,

2. That Council approve the following Swan Lake Water Quality Program:
    a. Continue annual water quality monitoring
    b. Continue with annual geese control
    c. Introduce a new fish management program in 2021
    d. Introduce a chemical treatment program commencing in 2021, established such that chemical treatment be completed when average summer phosphorus concentrations in Swan Lake are above 150 ug/L for two consecutive summers; and,

3. 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,

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

Swan Lake

Water Quality Improvement Program

June 15, 2020

General Committee

Environmental Services
Author: Rob Grech, Manager, Stormwater
Phoebe Fu, Director, Environmental Services

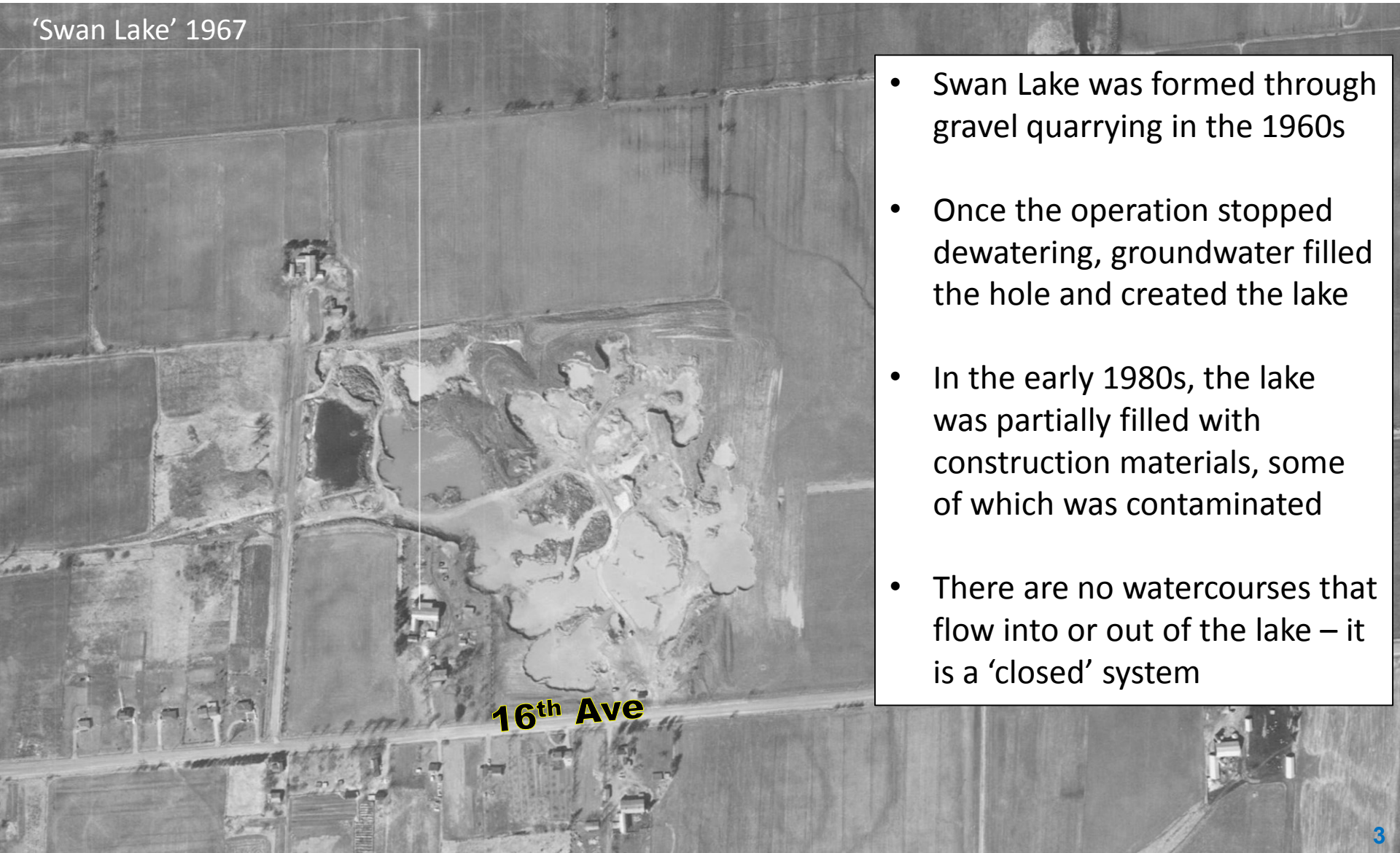
Agenda

- Purpose
- Background, Ownership & Regulatory Requirements
- Water Quality Overview & Measured Conditions
- City Activities
- Proposed Levels of Service
- Summary of Options & Treatment Strategy
- Recommendations & Next Steps

Purpose

- To establish a level of service for the water quality in Swan Lake that will guide the City's activities moving forward

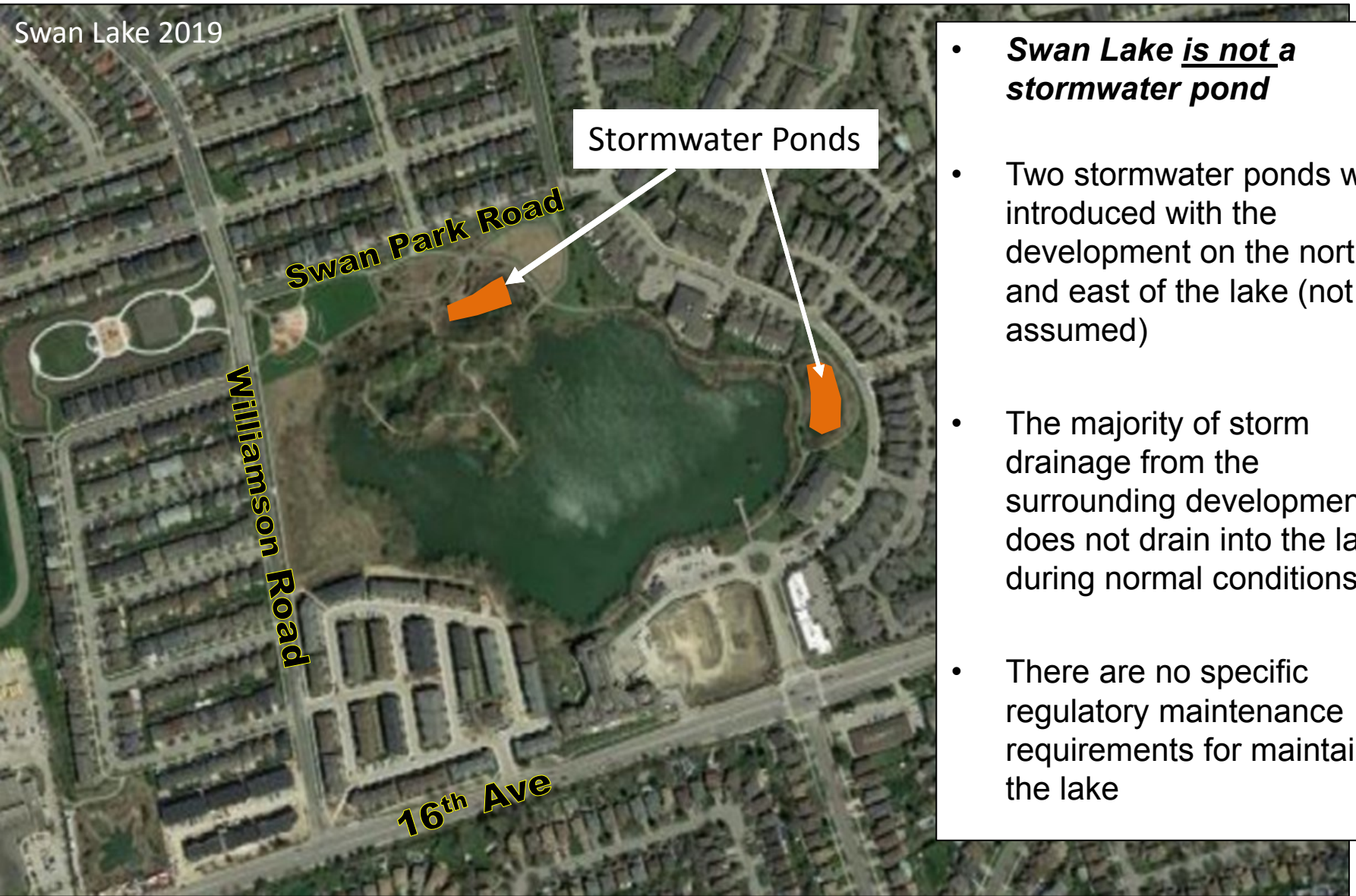
Background



- Swan Lake was formed through gravel quarrying in the 1960s
- Once the operation stopped dewatering, groundwater filled the hole and created the lake
- In the early 1980s, the lake was partially filled with construction materials, some of which was contaminated
- There are no watercourses that flow into or out of the lake – it is a 'closed' system

Property Ownership

Regulatory Requirements

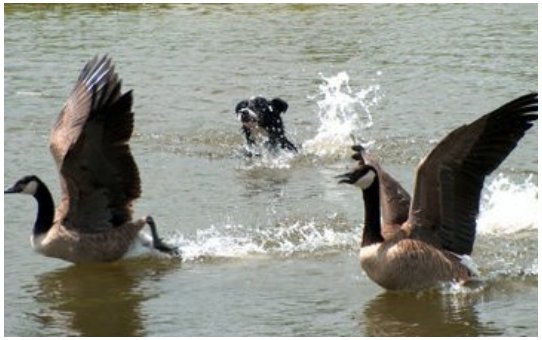


- ***Swan Lake <u>is not</u> a stormwater pond***
- Two stormwater ponds were introduced with the development on the north and east of the lake (not yet assumed)
- The majority of storm drainage from the surrounding development does not drain into the lake during normal conditions
- There are no specific regulatory maintenance requirements for maintaining the lake

Water Quality Overview

- Lakes are classified as follows:
  - Oligotrophic (pristine)
  - Mesotrophic (clear with some submerged plants)
  - Eutrophic (somewhat unclear, lots of plant growth)
  - Hyper-eutrophic (unclear, with frequent algal blooms)

- Swan Lake appears to have had water quality issues since it was formed – unlikely that it was in a mesotrophic state or better since early 90s



- The system is 'closed' – no flushing means that contaminants will build up over time and water quality will get worse

- As water quality worsens, the following occurs:
  - Water clarity decreases
  - Loss of desirable fish species and fish kills
  - Extent and frequency of algae blooms increase

City Activities

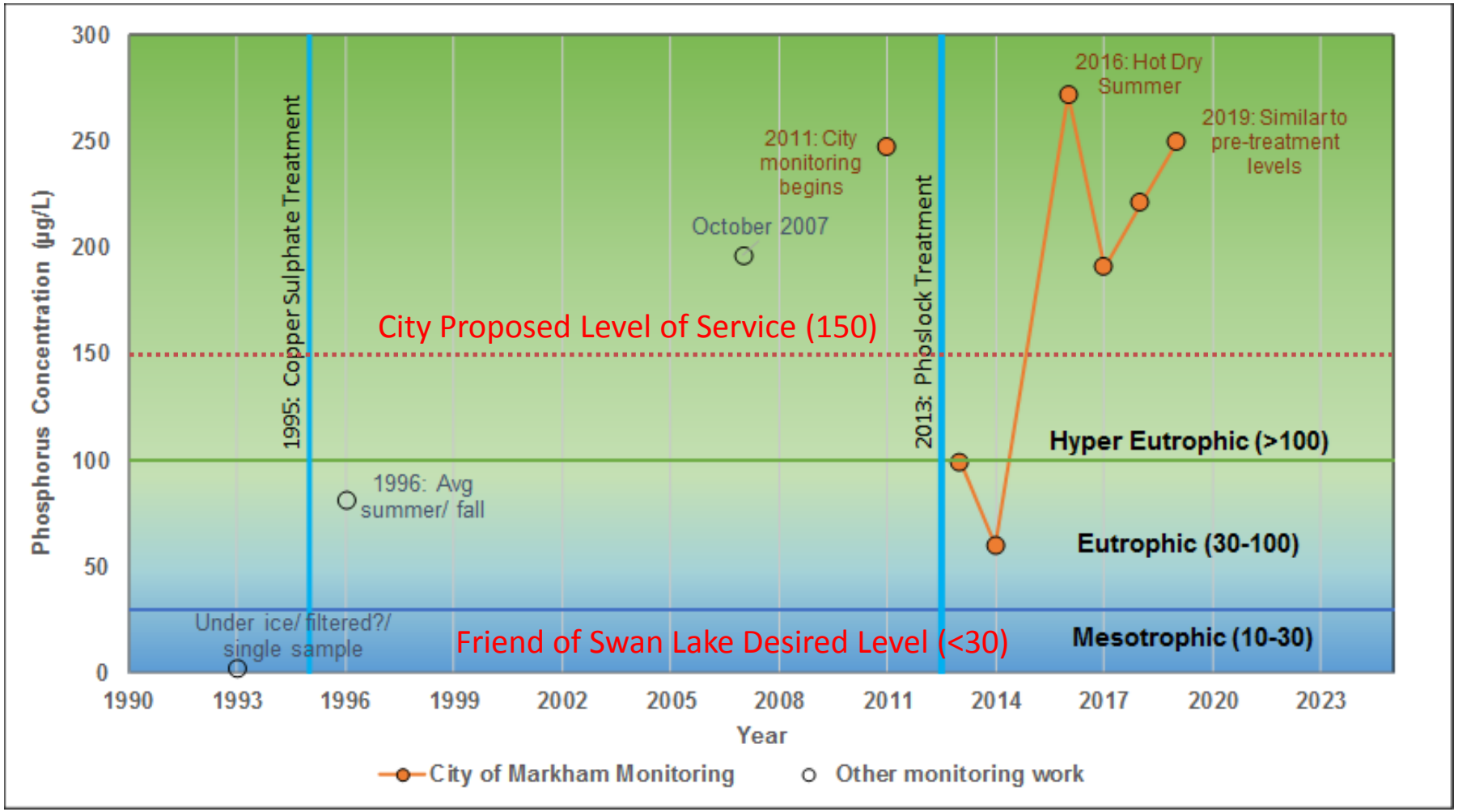
- The City has completed the following activities at Swan Lake
  - 2011 City initiated monitoring – Lake at Hyper-eutrophic level (extremely rich in nutrients)
  - 2013 Phoslock application
  - 2014 Geese control initiated (hazing/egg oiling/shoreline planting)
  - 2019 Water quality strategy study initiated

- To manage the conditions and **slow** the rate of water quality degradation, the following ongoing activities are required:

  - Water Quality Monitoring – to assess the state of the lake and plan future activities (started since 2011)
  - Geese control – to reduce nutrient loading into the lake (started since 2014)
  - Fish Management – to reduce number of bottom feeding fish which stir up sediment containing nutrients (NEW recommendation in this report)
  - Signage maintenance

- The annual cost for these activities are $45,000.

Measured Phosphorus Levels in Swan Lake



Level of Service

Community Request

- Significant improvement to water quality
  - Mesotrophic level (10-30µg/l phosphorus concentration)

City Proposed Level of Service

- Balanced approach to lake management, based on Consultant recommendations
- Maintain water quality at an acceptable level during typical weather conditions
  - Low end Hypereutrophic state in the lake (~150µg/l phosphorus concentration)
  - Complete treatment after 2 summers measured above 150µg/l

Potential Options Explored

Option #	Name	Description
#1	Do Nothing	Suspending all work
#2	Status Quo	Existing water quality monitoring and geese control program
#3	Biological Treatment	Aquatic plantings, fish stocking, etc. to biologically remove phosphorus
#4	Chemical Treatment	Dosing of the lake with aluminum or Phoslock® to reduce nutrient levels which lead to algae growth in the water
#5	Aeration	Using bubblers, fountains, etc. to add oxygen to the water and prevent algae from growing
#6	Withdrawal and Treatment	Pump water out of the lake, treat water, and pump back into lake
#7	Partial Filling	Fill shallow lake areas where algae blooms are most prominent
#8	Complete Filling	Fill lake in and convert area to green space and/or larger park
#9	Inlets/Outlet Modification	Redirect drainage from surrounding subdivisions into the lake to allow flushing of the system through a new outlet
#10	Dredging	Remove the sediment from the bottom of the lake as it is the primary source of nutrients

Option 1 - Do Nothing

Overview of Option

No water quality work at Swan Lake would be pursued in the future

Costs

$0

Technical feasibility & effectiveness	•	High end hyper-eutrophic state with very high nutrient levels and extensive algae growth would be expected – does not meet City or Community Level of Service
Environmental benefits & impacts	•	Environment degradation with severe algae blooms in the short term is expected
Social benefits	•	Lake would become eyesore and emit odour - negative impact to recreational use of surrounding park

Not Recommended – would not improve water quality

Option 2 – Continue Ongoing Activities

Overview of Option

Continue with the existing geese management and water quality monitoring programs

Costs

$45,000 / year

Technical feasibility & effectiveness	• High end hyper-eutrophic state with very high nutrient levels and extensive algae growth would be expected – does not meet City or Community Level of Service
Environmental benefits & impacts	• Environment degradation would be delayed, but severe algae blooms in the medium to long term is expected
Social benefits	• Lake would become eyesore and emit odour - negative impact to recreational use of surrounding park

Not Recommended – would not improve water quality

Option 3 - Biological Treatment

Overview of Option

Filtration of lake contamination by aquatic plants, fish stocking, or injection of live micro-organisms

Costs

$50,000

Technical feasibility & effectiveness	• Technology not well suited to conditions in this lake – successful reduction in phosphorus levels are very low • High end hyper-eutrophic state with very high nutrient levels and extensive algae growth would be expected – does not meet City or Community Level of Service
Environmental benefits & impacts	• Environment degradation with severe algae blooms in the short term is expected
Social benefits & costs:	• Lake would become eyesore and emit odour - negative impact to recreational use of surrounding park

Not Recommended – would not sufficiently improve water quality

Option 4 - Chemical Treatment

Overview of Option

Periodic application of a chemical (Phoslock, aluminum compounds or other) that would reduce the nutrient concentration in the water that leads to algae blooms

Costs

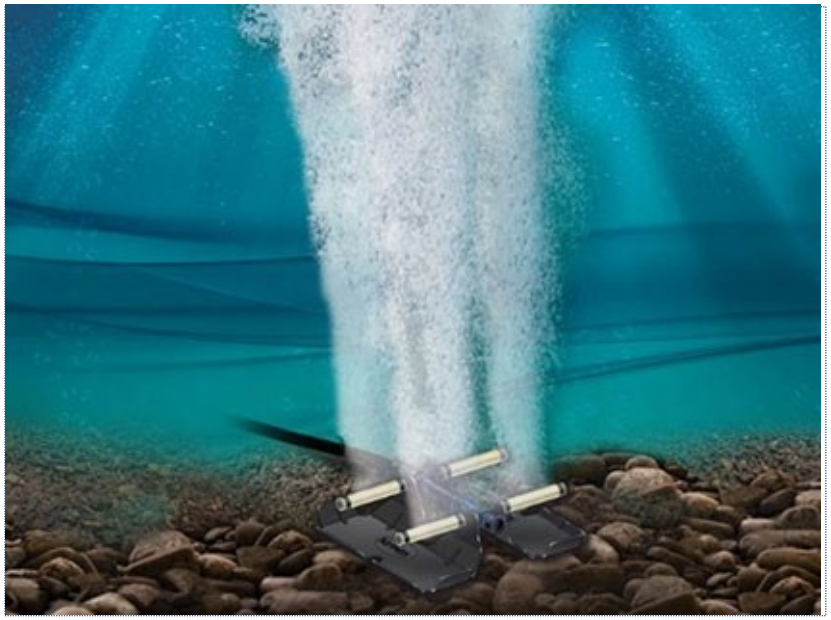
$250,000 per application (Applications at a 3-7 year interval are required to maintain City Level of Service)

Note: Applications required at 2 year interval without ongoing activities

Technical feasibility & effectiveness	• Past chemical treatment has been shown to be effective in improving water quality to eutrophic state • Would be suitable for meeting City Level of Service but not Community Level of Service
Environmental benefits & impacts	• Improves water quality and would be capable of sustaining some aquatic habitat
Social benefits	• With improved water quality, lake would return to a visual amenity, but no direct recreational use would be allowed

Option Suitable in Meeting City Level of Service

Option 5 - Aeration



Overview of Option

Addition of oxygen to the Lake to reduce internal nutrient loading from bottom sediment by underwater aerators

Costs

$100,000

Technical feasibility & effectiveness	• Mixing caused by aeration may result in further resuspension of nutrients, increasing algal growth • High end hyper-eutrophic state with very high nutrient levels and extensive algae growth would be expected – does not meet City or Community Level of Service
Environmental benefits & impacts	• Environment degradation with severe algae blooms in the short term is expected
Social benefits & costs:	• Lake would become eyesore and emit odour - negative impact to recreational use of surrounding park

Not Recommended – Would not improve water quality

Option 6 - Withdrawal and Treatment

Overview of Option

Construction of pumping station to remove nutrient rich water from bottom of lake, treat, and return to lake

Costs

Capital cost: $5,000,000

Annual Maintenance: $50,000

Technical feasibility & effectiveness	•	Would require a pumping station, and significant maintenance • Lake conditions are not well suited to this technology - unlikely to be successful in meeting City or Community Level of Service
Environmental benefits & impacts	•	Environment degradation with severe algae blooms in the short term is expected
Social benefits:	•	Lake would become eyesore and emit odour - negative impact to recreational use of surrounding park

Not Recommended – Would not improve water quality

Option 7- Partial Filling

Overview of Option

- Fill the north arm and low-lying wet areas that are most conducive to algae growth and conversion of these areas to bioswales or terrestrial wildlife habitats

Costs

$1,500,000

Technical feasibility & effectiveness	• Removes water from area most prone to dense algae growth and replace with wetland or naturalized area (bioswale) • Significant grading and tree removals required for construction • High end hyper-eutrophic conditions would remain in the remainder of the lake
Environmental benefits & impacts	• Additional wildlife habitat could be created • Removal of large trees and natural area to perform construction would be required
Social benefits & costs:	• Lake would become eyesore and emit odour - negative impact to recreational use of surrounding park

Not Recommended – No benefit to most of lake, and high environmental disturbance required

Option 8 - Complete Filling

Overview of Option

- Lake to be entirely filled in, and park area to be expanded

Costs

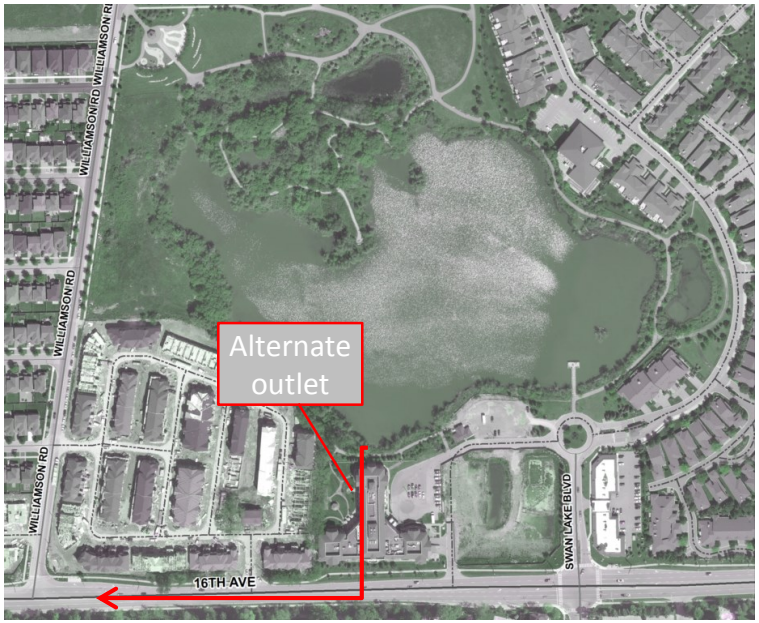
Capital cost: $15,000,000

Annual cost: $45,000 (park maintenance)

Technical feasibility & effectiveness	• Very large scale operation required (Over 1000 trucks full of material would be required) • Water quality issues would no longer exist as lake would be removed
Environmental benefits & impacts	• Significant improvements to terrestrial habitat possible • Loss of aquatic area & associated habitat
Social benefits & costs:	• Loss of the Lake as a community feature • Large space available for park and recreational areas

Not Recommended - Removal of Lake is not desired, and costs are prohibitive

Option 9 - Inlets/Outlet Modification



Overview of Option

- Create a new outlet for the Lake and direct low flows from storm ponds into the Lake for flushing purposes

Costs

Not Applicable – Not Constructable

Technical feasibility & effectiveness	• Significant feasibility issues associated with constructability/ groundwater table impacts • Water from SWM ponds would add nutrients, offsetting any flushing benefit • Hyper-eutrophic state with high nutrient levels and algae growth
Environmental benefits & impacts	• Environment degradation with severe algae blooms in the short term is expected
Social benefits & costs:	• Lake would become eyesore and emit odour - negative impact to recreational use of surrounding park

Not Recommended - Technically not feasible

Option 10 – Dredging

Overview of Option

- Chemical treatment and dredging of the Lake to remove sediment containing nutrients released into water.
- Construction of a large dewatering facility within park area requiring closure of amenity areas

Costs

$30,000,000 (15 Year Frequency)

Technical feasibility & effectiveness	• Lake is roughly 30x the size of a typical stormwater pond – requires large scale operation and construction of a dewatering facility which would require the closure of significant park space for up to 3 years • Project needs to be repeated every 15 years • At best, would produce fluctuation between Mesotrophic and hyper-eutrophic conditions
Environmental benefits & impacts	• Significant short term improvement to aquatic environment – would allow significant additions of plantings and fish to lake
Social benefits & costs:	• Lake could potentially be used for recreation, and would result in significant amenity improvements to park • Dredging operation would require frequent long term disturbance to park

Not Recommended- Option may meet Community Level of Service, but requires severe park disturbance and has prohibitive cost

Summary of Options Review

Option #	Name	Recommended for Implementation?	Estimated Cost
#1	Do Nothing	☒	$0
#2	Status Quo	☒	$45,000/year
#3	Biological Treatment	☒	$50,000
#4	Chemical Treatment	☑	$250,000 (3-7 year interval required)
#5	Aeration	☒	$100,000
#6	Withdrawal and Treatment	☒	$5,000,000 and $50,000/year maintenance cost
#7	Partial Filling	☒	$1,500,000
#8	Complete Filling	☒	$15,000,000
#9	Inlets/Outlet Modification	☒	N/A – Not Constructible
#10	Dredging	☒	$30,000,000 every 15 years

How Often to Do Chemical Treatment?

Option #	How Often?	Benefits/Impacts	Annualized Lifecycle Cost
1	After one summer measured above 150 ug/L on average (approximately every 4 years)	• Algae growth expected in hot dry years, and **may** be present in isolated locations in other years • No recreational use of the lake permitted	$250,000 every 4 years (Approximately $62,500/year)
2	After two summers measured above 150 ug/L on average (approximately every 5 years)	• Algae growth expected in hot dry years, and **is likely** to be present in isolated areas in other years • No recreational use of the lake permitted	$250,000 every 5 years (Approximately $50,000/year)
3	After three summers measured above 150 ug/L on average (approximately every 6 years)	• Algae growth expected in hot dry years, and **will** be present in isolated areas in other years • No recreational use of the lake permitted	$250,000 every 6 years (Approximately $41,667/year)

Staff Recommendation: Option 2 – two summers measured above City level of service would trigger capital request for the following year

Swan Lake Park

- Friend of Swan Lake have also requested an interest in working with the City on a long term restoration plan associated with:
  - Terrestrial habitat
  - Aquatic habitat

- City focus at this time is on water quality of the lake before further opportunities are explored for the above areas

- Parks staff are currently working with Friends of Swan Lake on opportunities to enhance the park and trail experience at Swan Lake Park

- Parks staff will work with Friends of Swan Lake to establish a stewardship program such as our existing 'Adopt a Park' program

Recommendations
Water Quality Improvement Program

1. **Continue with existing program at $40K a year**:
   - Water Quality Monitoring
   - Geese control
2. **Introduce Fish Management program** in 2021 at a cost of $5K per year,
3. **Introduce a Chemical Treatment** in 2021
   - Cost for chemical treatment is $250,000 per treatment
   - Chemical Treatment to be completed in Spring of 2021
   - 25 year Life Cycle be updated based on 5 year cycle @ $250,000 = $1.25M over 25 years
4. Adopt a balanced approach in maintaining **water quality at an acceptable level during typical weather conditions** with the following level of service:
   - Low end Hypereutrophic state in the lake (~150µg/l phosphorus concentration)
   - Two consecutive summers of exceeding City level of service would trigger another chemical treatment in the following year

Recommendations:

1. That the presentation, titled "Swan Lake Water Quality Improvement Program" be received; and,

2. That Council approve the following Swan Lake Water Quality Program:
    a. Continue annual water quality monitoring
    b. Continue with annual geese control
    c. Introduce a new fish management program in 2021
    d. Introduce a chemical treatment program commencing in 2021, established such that chemical treatment be completed when average summer phosphorus concentrations in Swan Lake are above 150 ug/L for two consecutive summers; and,

3. 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,

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