LAKE WABUKAYNE: INNOVATION IN STORM WATER MANAGEMENT POND MAINTENANCE

TAC Environmental Achievement Award Submission

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The City of Mississauga
In partnership with:
Marshall Macklin Monaghan
McNally Construction Inc.

Executive Summary

Mitigation of the adverse impacts of land development on rivers, creeks, streams and other natural storm drainage systems is a paramount objective in today's municipal world. Stormwater management works in the form of retention ponds offer effective solutions for the promotion of enhanced storm water quality and are common to the transportation and public works community. Proper maintenance of these ponds, including removal of accumulated sediment, is critical to ensure their continued operation. Such maintenance can prove costly for road authorities and municipalities due to the contaminate levels in sediment associated with road runoff, as well as the land and time requirements needed to de-water the sediment prior to disposal. In addition, there may be negative impacts to the aquatic and terrestrial habitat during these maintenance activities. The City of Mississauga has recently undertaken an innovative method for removing accumulated sediment from a large and aging retention pond with minimal impact on the environment and at a competitive cost.

Lake Wabukayne is a 1.8 hectare man-made in-stream storm water retention pond located in Mississauga, Ontario. The lake was constructed in 1976 and continues to serve an important role in controlling the quality and quantity of storm water that enters the downstream river systems. As the lake reaches it sediment containment capacity, its effectiveness in removing suspended sediment and associated environmental toxins is significantly reduced due to the reduction in retention times. In 2004, the City of Mississauga retained Marshall Macklin Monaghan as an engineering consultant and began examining methods for sediment removal and disposal. Hydraulic dredging and the use of large geosynthetic tubes for de-watering were selected as the preferred alternative and is unique in Canada for this type and scale of project.

In 2005, McNally Construction Inc. was selected as the general contractor and began suctioning sediment from the lake bottom using a small hydraulic dredge fitted with a mud shield to minimize the release of sediment into the water column. Sediment was pumped in a slurry form to a sediment de-watering area where it was mixed with a polymer to promote flocculation and decrease de-watering times. The mixture was pumped into a series of high strength geosynthetic tubes (each approximately 3.0m wide by 1.7m high by 50 m long) from which the water was filtered out and drained by gravity back to the lake. As water drained from the sediment mixture in the tubes, additional slurry was pumped in until the tubes were filled with de-watered sediment only. The stored sediment was removed by piercing the tubes, excavating the sediment contained within using standard excavation equipment, and loading the sediment onto trucks for offsite disposal. This initiative removed approximately 5,613 m^3 of sediment from Lake Wabukayne at a final cost of $1.3 million and was fully completed in 2007. The majority of the sediment removed was attributable to winter road maintenance and road debris flushing.

There are many advantages to using this technology for sediment removal including the minimized impact on the natural environment and the reduction in both land and time requirement for de-watering of the sediment.

Introduction

Municipalities and road authorities throughout Canada are currently facing costly maintenance activities to restore SWM pond function.

Since the early 1980's, stormwater management (SWM) ponds have been constructed throughout Canada as an effective means of providing water quality improvement and reduced flooding in a watershed. Typically, the longer the stormwater is detained in a pond, the greater the sediment removal efficiency. With time, the accumulated sediment causes a reduced capacity, and therefore reduced efficiency in pond function. In addition to decreasing pond capacity, the sediment typically exhibits high concentrations of contaminants associated with road runoff, such as heavy metals and polynuclear aromatic hydrocarbons (PAH) and has a high sodium adsorption ratio due to road salt use. At high concentrations, there is a potential that these contaminants may get passed through the food chain by sediment dwelling organisms. Removal of this sediment to restore the pond capacity and reduce any negative impact on the environment is an issue now facing municipalities and road authorities. These maintenance activities can prove costly both financially and environmentally. The City of Mississauga has recently completed a large scale sediment removal project using a unique and innovative technique. This was the first time in Canada that the combination of the hydraulic dredging, geotextile tubes and polymer injection has been used for removing and de-watering sediment from a SWM pond. The project was successful not only in the quantity of sediment removed, but also in the information obtained during the process.

This was the first time in Canada that this method has been used for SWM pond maintenance.

Lake Wabukayne

Lake Wabukayne is a 1.8 hectare man-made in-stream stormwater management pond that was constructed in 1976 when the surrounding subdivision was developed. The inflow to the lake is entirely municipal storm-water originating from the residential road network. Lake Wabukayne has an important role in controlling the quality and quantity of stormwater that enters the downstream river system, especially in terms of reducing erosion and sedimentation of the receiving streams, Mullet Creek and the Credit River. As the lake reached it sediment containment capacity, its ability to control flows and remove suspended sediment was greatly reduced because of the reduction in storm water retention times. In addition, the high level of contaminants measured in sediment samples from the lake became a concern due to the potential impact on the surrounding environment.

Maintenance Strategy

To address the issue of sediment removal from Lake Wabukayne, the City of Mississauga retained Marshall Macklin Monaghan to assist in developing a cost-effective strategy. A review of sediment removal technologies was carried out and a short list of potentially applicable technologies was developed. The short list included excavation-in-the-dry, mechanical dredging and hydraulic dredging. These technologies were further considered within the following criteria: demonstrated effectiveness, potential environmental effects (noise, land atmosphere, aquatic habitat, surface/groundwater, birds/wildlife, continuing use of area by the public, road and traffic, and visual effects), site-specific applicability and community acceptability. As well, there were constraints to be considered during this evaluation process such as the urban setting of the lake that restricted the space available for onsite sediment management and draining of the sediment.

Hydraulic dredging and the use of large geotextile tubes was selected as the preferred alternative for removal of the sediment from Lake Wabukayne.

In 2005, the City of Mississauga awarded the sediment removal contract to McNally Construction Inc. This was first time in Canada that this method was employed for SWM pond maintenance activities.

Advantages to using hydraulic dredging and geotextile tubes:

- *Lake maintains function as SWM facility during construction*
- *Potential for offsite tracking of mud or spillage is minimized*
- *Potential for suspended sediments to be conveyed downstream is limited*
- *Potential effects to the area residents are limited*
- *Overall low potential for environmental effects*

Project Description

De-watering Area

Prior to sediment removal activities, a de-watering area for the sediment was prepared in a nearby park. Although the parkland was small (the grassed area is approximately 60m x 30m), it had many features that were suitable for the use of sediment de-watering. To prepare the area, topsoil was removed and stockpiled. A soil berm was built to control runoff, and ditches and a siltation fence were constructed around the sediment de-watering area as additional environmental protection. A base was constructed using clear stone, and grades were established to facilitate drainage to a collection point. A sump was constructed at the collection point and connected to high-density polyethylene (HDPE) pipes that would return the water from the sediment to Lake Wabukayne by gravity flow.

Hydraulic Dredge

Sediment was suctioned from the lake bottom by a hydraulic dredge. An auger or "cutter bar" located on the head of the machine rotates, broke up the sediment and removed it with high-yield pumps. The sediment, in slurry form, was pumped through a floating HDPE pipe to the de-watering area.

Sediment De-watering

A series of high strength geotextile tubes were placed in the de-watering area. The type of geotxtile tubes used in this project were constructed with a specific weave of polypropylene fabric that gives the tube high tensile strength, as well as the ability to resist long term UV and natural chemicals. The unique design of the tube allows entrained water in the sediment to seep out while retaining even finely grained material. The dimensions of the geotextile tubes used were approximately 50 metres in length, 3 metres in width and 1.7 metres in height. Based on the size of the de-watering area, four tubes could be used at one time.

During the de-watering process, the geotextile tubes were used in a serious of three steps: containment, de-watering and consolidation. The sediment slurry was pumped from the hydraulic dredge in the lake to the geotextile bags located in the de-watering area. In order to further speed up the de-watering process, a chemical polymer that promotes flocculation and consolidation was injected into the line prior to the mixture reaching the tubes. The polymer chosen for this application was based on hanging bag tests using sediment from Lake Wabukayne.

As the water entrained in the sediment drained from the tubes, additional sediment slurry from the hydraulic dredge at the lake was pumped into the tubes to maintain the hydraulic head and decrease the de-watering time further.

THE PROCESS

HYDRAULIC AUGER IN LAKE BREAKS UP SEDIMENT TO FORM SLURRY

↓

SLURRY PUMPED THROUGH HDPE PIPELINE TO DE-WATERING AREA

↓

POLYMER INJECTED INTO LINE AND MIXED WITH SEDIMENT TO PROMOTE CONSOLIDATION

↓

MIXTURE PUMPED INTO LARGE GEOTEXTILE TUBES FOR DE-WATERING

↓

WATER COLLECTED AT SUM AND DRAINED BY GRAVITY TO LAKE

↓

TUBES PIERCED AND SEDIMENT REMOVED BY EXCAVATING EQUIPMENT

↓

SEDIMENT MIXED WITH ENVIROSTABILIZER AND HAULED OFFSITE

↓

ALL PARK AREA RESTORED TO PRE-CONSTRUCTION CONDITIONS

Lessons Learned

During the initial stages of sediment removal from Lake, the tubes showed a good rate of de-watering. However, as the hydraulic dredge travelled further from the forebay area of the lake, a significant decrease in the rate of de-watering occurred. It was discovered that this was due to the change in sediment particle size to a finer grain material. As well, this finer grain sediment contained a high level of organic material that did not react with the polymer. Consequently, the sediment did not de-water to the expected levels and the moisture content of the sediment in the tubes continued to exceed the levels allowed for disposal. To address this issue, the material in the tubes was re-circulated through a pump system and an envirostabilizer was mixed with the sediment to absorb some of the moisture. The geotextile tubes were opened up to release the sediment mixture and mixed further with the envirostabilizer until it was determined suitable for offsite disposal. Standard excavation equipment ws used for handling the material and loading it onto trucks for hauling.

Based on this unexpected complication in the de-watering process, it would be recommended for future projects that extensive sediment sampling throughout the SWM pond be conducted to allow for different polymers to be used with the varying sediment composition in each area of the pond.

This initiative removed 5,613 m3 of sediment at a cost of $1.3 million, and was fully completed in 2007.

Summary

SWM pond maintenance is an issue that many municipalities and road authorities throughout Canada are challenged with. To address the costly matter of sediment removal from a large and aging SWM pond, the City of Mississauga has recently undertaken an innovative method that is new to Canada. A hydraulic dredge was used to break sediment from the pond bottom into a slurry before pumping it to a large geotextile tubes for de-watering and mixing it with a polymer to increase consolidation time. Although there was a complication with the polymer action as the size and type of sediment particles changed with distance from the forebay, an alternative method of decreasing water content was employed and valuable information was collected for use in future SWM pond maintenance projects.

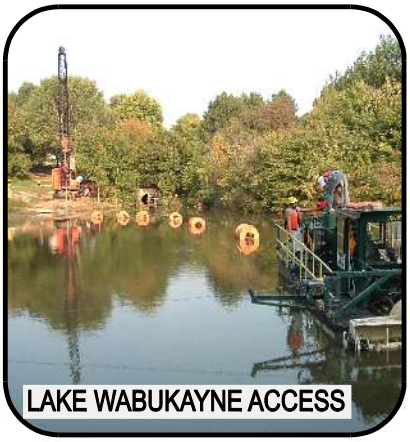
The advantages to using this technology for sediment removal were noteworthy. Most importantly, there was minimal impact on the natural environment compared with the more traditional methods of de-watering the pond and using mechanical dredging, which can significantly affect the aquatic and terrestrial habitats, as well as the surface and ground water systems. As well, the costly issue of land and time requirements for de-watering of the sediment was also minimized through the use of use of the polymer additive and by pumping to the geosynthetic tubes for de-watering.

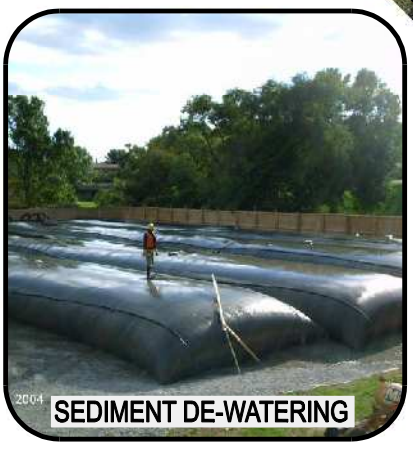
Appendix A

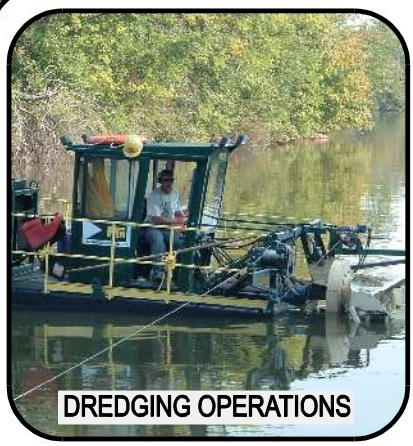
Photos

OVERVIEW


TRUCK ACCESS


LAKE WABUKAYNE ACCESS


SEDIMENT DE-WATERING


DREDGING OPERATIONS

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SITE PREPARATION...

BASE MATERIAL PLACED FOR GEOSYNTHETIC TUBE DEWATERING

GEOSYNTHETIC TUBES PLACED WITHIN YARD

HDPE PIPES ARE LAID, WHICH WILL TRANSPORT SEDIMENT IN SLURRY FORM FROM DREDGING EQUIPMENT TO GEOSYNTHETIC TUBE DEWATERING

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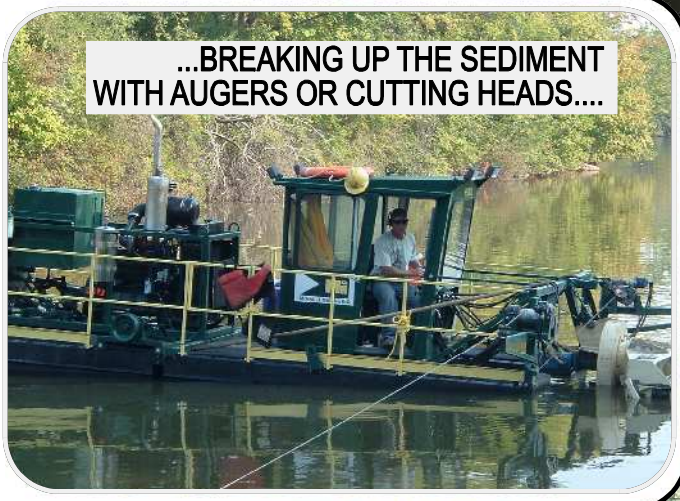
THE EQUIPMENT...

A HYDRAULIC DREDGE OPERATES LIKE A LARGE VACUUM CLEANER...

CONNECTION TO FLOATING PIPELINE



...BREAKING UP THE SEDIMENT WITH AUGERS OR CUTTING HEADS....

...AND PUMPED ALONG A FLOATING PIPELINE.

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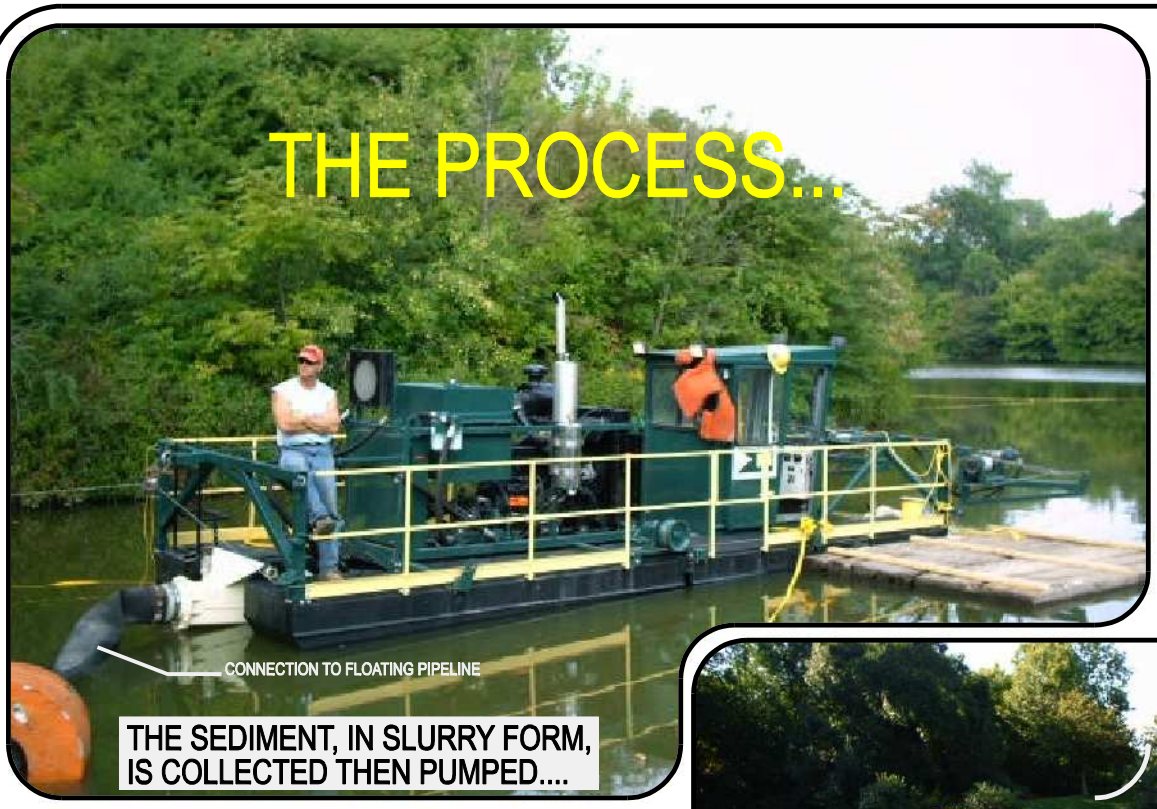
THE PROCESS...



THE SEDIMENT, IN SLURRY FORM, IS COLLECTED THEN PUMPED....

...ALONG A FLOATING PIPELINE...

...WHERE IT IS MIXED WITH A POLYMER TO INCREASE FLOCCULATION...

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THE PROCESS...

...AND THEN TO FILL THE GEOSYNTHETIC TUBES.

EACH TUBE IS APPROX. 3.0m WIDE by 1.7m high by 50m. THE PROCESS THEN FILTERED THE WATER FROM THE TUBE, WHERE IT WAS DRAINED BY GRAVITY FLOW BACK INTO THE LAKE. ADDITIONAL SLURRY WAS ADDED TO THE TUBES AND WATER DRAINED UNTIL THE TUBES WERE COMPLETELY FILLED WITH DE-WATERED SEDIMENT ONLY.

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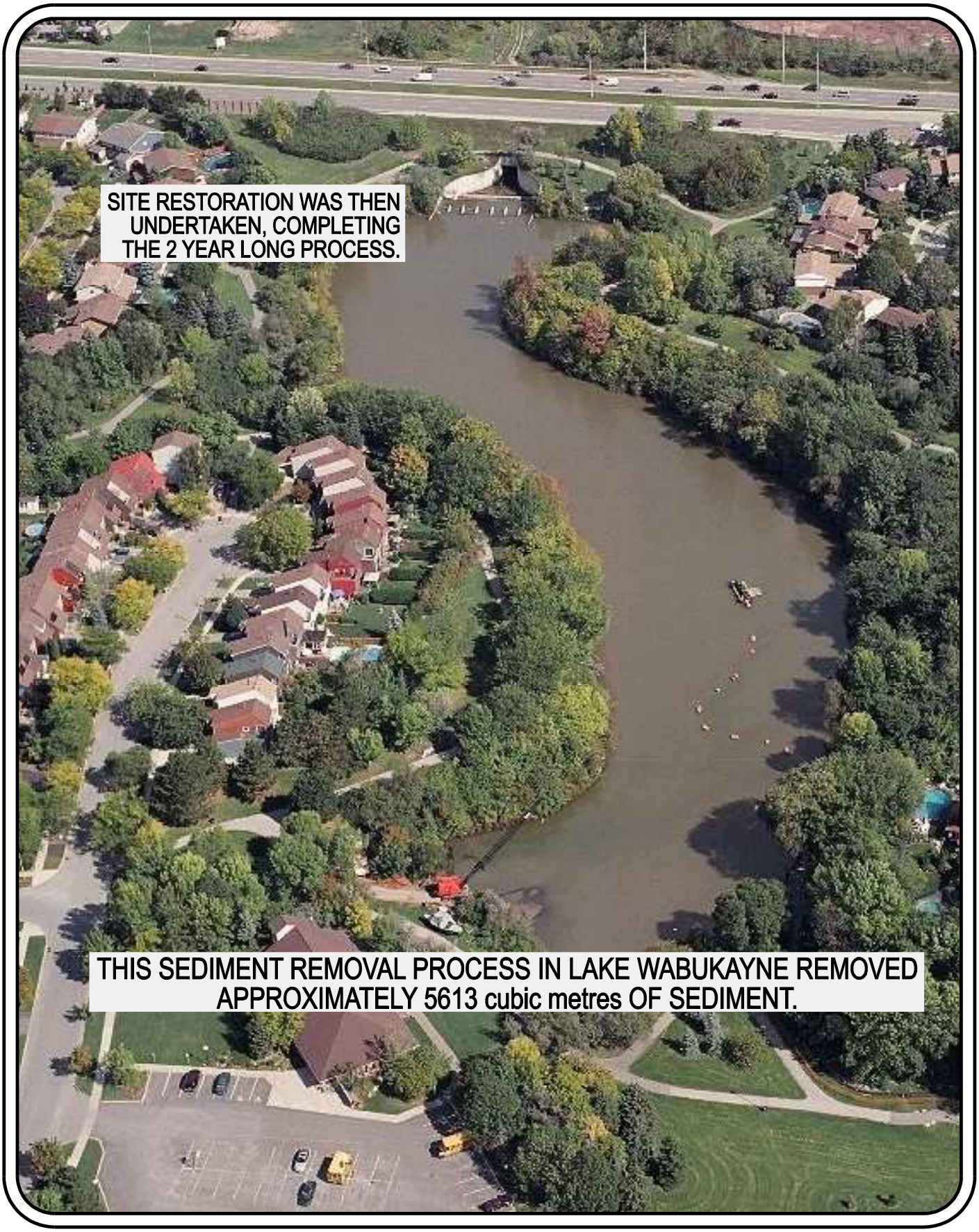

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