Winter Mechanical Dredging of a Stormwater Pond

CASE STUDY

Stormwater Maintenance Series

INTRODUCTION

Stormwater ponds are commonly used in urban settings to control the quantity and quality of stormwater runoff. However, as ponds age, the level of accumulated sediment rises which ultimately displaces the potential volume available for water storage and treatment during storms.

Mechanical dredging is the method often used to clean out stormwater sediments from ponds. This is commonly achieved with an excavator or a clamshell (grab) bucket dredge. In order to conduct mechanical dredging, the pond water volume needs to be pumped out or drained. The remaining muck consists of an unconsolidated mixture that is difficult to dredge and often requires the addition of an absorbing material, such as a polymer, straw or wood chippings. Dredging during the winter can help to simplify the process because the water-based muck is nearly frozen or can rapidly freeze overnight, given favourable winter temperatures. Water in the pond can also be removed as chunks of ice, rather than waiting multiple days for water to be pumped out. These and other advantages can make the removal of sediment from ponds cheaper and quicker than if the same operation were carried out during warm weather. This case study showcases a winter pond dredging operation and provides insight into its benefits and drawbacks.

POND PROFILE

Municipality	City of Vaughan
Cleanout Party	Dynex Construction
Drainage Area Land Use	Mixed residential and commercial
Pond Age at Time of Cleanout	15 years
Drainage Area (ha)	13.4
Permanent Pool Volume (m^3/ha)	99
Water Quality and Erosion Control Volume (m^3/ha)	231
Sediment Removal Method	Mechanical Dredging
Sediment Handling Method	Landfill Disposal

SITE DESCRIPTION

The pond considered for this case study is known as Pond 51, located at the northeast corner of Major Mackenzie Drive and Jane Street in Vaughan, Ontario (Figure 1). A supermarket plaza is situated adjacent to the pond, and is part of the drainage area. Another pond on the other side of the plaza, Pond 50, receives the remaining development runoff. Pond 51 is a wetland facility with a sediment forebay that captures drainage from 13.4 ha of mixed residential and commercial areas with relatively high traffic parking lots (Figure 1). Outflow from the pond discharges into a tributary of the West Don River as part of the Don River Watershed. The surrounding area is mainly industrial, consisting of a Wonderland Amusement Park parking lot, and two large plazas at the northeast and southeast corners of the main intersection. To the west of the pond is a barren short grass field.

Figure 1. Location of Pond 51 in Vaughan.

PROJECT OBJECTIVES

The primary objective of maintaining stormwater ponds is to restore their design flood and quality control capacity by removing sediment that has settled to the pond bottom over the course of its service. Pond 51 was constructed in 1994 when the development was built and has never been dredged. Based on a bathymetric survey carried out in 2003, it was estimated that 468 m^3 of sediment needs to be removed from the detention wetland. This figure indicates that at the time of the survey, Pond 51 was 35% full relative to its original design. Thus, the objectives of this project were to:

- Remove the accumulated sediment;
- Provide improved access for machinery ;
- Minimize ecological disturbance to wildlife through wintertime dredging;
- Provide a larger sediment-drying area when vegetation is dormant.
- Complete the project on time and on budget.

METHODS

Pond Survey

The only known bathymetric survey of Pond 51 was conducted in 2003. A flat disk was attached to a long metal rod, which was submerged in the water until the bottom of the disk was positioned relatively flat on the pond bottom. A total station survey was used to obtain coordinates for the measurement locations so that the survey could be compared to the as-built drawing and future bathymetric surveys. The pond survey revealed that in 2003, there was 468 m^3 of sediment volume that needed to be removed from the detention wetland. Additional sediment would have accumulated in the six years between the survey and the dredging operation.

Sediment Characterization

At the time when the bathymetric survey was conducted in 2003, sediment samples were extracted and submitted to a laboratory for testing. Testing included grain size analysis, general chemistry, nutrients, metals, pesticides and polycyclic hydrocarbons. The results were compared to the contaminant levels to Tables 1,2 and 3 of the *Ontario Ministry of Environment's Soil, Ground Water and Sediment Standards for Use Under Part XV.I of the Environmental Protection Act* (2011) to determine how the sediment should be disposed.

Results of this initial sediment quality analysis showed that contaminant levels exceeded the Soil, Ground Water and Sediment Standards

for re-use of the sediment on residential, parkland or institutional property. It is presumed that even if the sediment met Table 1 standards, it would still be disposed at a landfill due to its high moisture content, presence of organics and overall visual appearance.

Site Preparation

The site preparation was initiated in December, 2009. The three day process included the installation of erosion and sediment controls, vegetation removal and access road preparation. The pond has two existing access roads - one at the north end of the pond and the other at the southeast end. A new access road was constructed at the south end of the pond to provide easy access to the sediment forebay and to avoid the clearing of vegetation that had grown over the two existing access roads.

Site preparation also involved the installation of erosion and sediment controls, including silt fencing and geotextile filter bags for use during pond dewatering, and the installation or placement of equipment required for the project such as pumps, hoses and heavy machinery. As the cleanout was scheduled for December, it was presumed that the ground would be frozen, providing a sturdy surface for the heavy machinery. Mean temperatures for the month of December, 2009 were -2.4 °C, although the daytime maximum temperature reached 10.5 °C on December 2. This wave of warm temperatures in the beginning of the month resulted in melting of ground frost, limiting site access.

Dewatering and Dredging

At the time of the pond cleanout, some of the water had frozen, which allowed the excavator to physically remove chunks of ice from the pond and place them on the pond banks. To ensure that mechanical dredging of pond sediment was efficient and successful, the pond was pumped out using a 3" pump nozzle and discharged into the receiving watercourse. The duration of the pumping was approximately 5 days, which coincided with dry weather and no antecedent rain events. Since the formation of an ice layer prevented the generation of turbulence in the pond, sediment had settled to the bottom, significantly reducing the turbidity of the water that was being pumped out. Geotextile sediment bags were laid out on a flat part of the ground and used to filter pumped water before it was discharged to the receiving stream. A challenge was presented due to melting snow originating from the pond banks and surrounding drainage area; this delayed the dewatering process.

The dewatering process was completed when it was determined that the remaining water could not be pumped out. It was integrated with the sediment at the bottom of the pond. Two excavators, each with a capacity of 3 tonnes, were used to scoop out the muck. (Figure 2). Due to continuously melting snow from the banks of the pond, the muck was very wet and introduced a challenge during the removal process. In general, to ensure that the clay liner is not damaged during the dredging process, a skilled and experienced worker

Figure 2. (Left) Excavator removing wet sediment at Pond 51; (Right) Close-up view of the wet sediment at the pond bottom. Sub-zero temperatures have contributed to some freezing of the water-based muck.

needs to be designated to operate the machinery. This is essential to the functioning of the pond, as a clay liner retains a minimum pond volume and prevents contaminants from entering the soil and groundwater reservoirs.

Sediment Hauling and Disposal

A designated drying area adjacent to the access road was used to spread the wet sediment out and allow it to dry and freeze. The drying/freezing took place over the span of 4-5 days. The frozen sediment passed the slump test, allowing it to be hauled to an off-site landfill. The total amount of removed sediment was approximately 600 m^3 (80 truck loads), which was hauled to a landfill facility 60 km from the site.

Site Restoration

Vegetation clearing was required for the construction of one new access road. Nevertheless, as the other access roads were under-utilized, it was not necessary to remove any shrubs or trees, thereby greatly minimizing site restoration efforts. The only vegetation that required removal were cattails, which can regrow the following season without any additional restoration efforts. Construction materials that had been in place for an extended period of time were removed from the site, leaving behind noticeable alterations at the site. These materials included erosion and sediment control fencing, which were associated with settled sediment that required cleanup. These areas, as well as other heavily used spots, required topsoil amendment, decompaction and reseeding. Lastly, the heavily used access roads were repaired and cleaned from muck carried over by the machinery.

RESULTS

Removal of approximately 600 m^3

Because the last bathymetric survey was in 2003, which provided an estimated sediment accumulation of 468 m^3, the figure of 600 m^3 is not surprising. Over the 6 years between the survey and cleanout, it is estimated that sediment accumulated at a rate of 22 m^3/year or 1.64 m^3/yr/ha. Over the 14 year life of the pond, sediment accumulated at an average rate of 63 m^3/yr or 3.2 m^3/yr/ha, which suggests that more rapid accumulation occurred during construction when the catchment was not full stabilized.

Completion of the project on schedule

The primary activities carried out as part of the clean out were site preparation which took 3 days, dewatering which took 5 days, dredging which took 10 days, and site restoration which occurred over the course of 4 days. Sediment was dried over the course of 4 or 5 days, during which some of these other activities listed above were also underway. In total, this pond cleanout was completed in 3 weeks. Although the project was completed within the expected timeframe, there were delays due to warm weather that increased the temperature of the ground, which made it difficult to mobilize the two 3 tonne hydraulic excavators close to the pond bed. Furthermore, melting snow on the pond banks increased the duration of the dewatering.

Completion of the project over budget

The project was completed over budget mainly as a result of the large time gap between the sediment survey in 2003 and the dredging operation in 2009. The budgeting did not take into account the volume of sediment accumulation that would have occurred within that time period.

Improved pond functioning

While suspended solids levels in pond effluents have not been measured since the dredging operations were complete, visual observation suggest improved pond functioning. Water discharged from the pond is visibly clearer (less turbid) than it was before the pond cleanout project was initiated.

Table 1. Actual project costs for dredging 600 m^3 of sediment from Pond 51. Costs are expressed as $ per m^3 of removed sediment.

Category	Cost (per m^3 of removed sediment)	Details
Preliminary assessment	$16.67	- Bathymetric survey of existing conditions. - Review site information to determine the type & amount of work required. - Calculate sediment volumes and test quality to assess contamination.
Site preparation	$8.67	- Clearing of vegetation as needed. - Install erosion and sediment controls, fencing and access roads. - Installation of equipment (e.g. pumps, hoses).
Dredging and dewatering	$27.50	- dewatering was done by a by-pass outlet
Hauling	$64.17	- 600 m^3 of sediment hauled 60 km
Disposal	$7.50	- Dump fee at $7.50/$m^3$
Site restoration	$10.83	- General site cleanup and removal of fencing. - Re-grading, pond bank seeding and installation of erosion control blankets. - Topsoil addition and decompaction and reseeding
Project Total	$135.33	

CHALLENGES AND LESSONS LEARNED

The time when the pond was cleaned out was selected in order to minimize plant disturbance and take advantage of the cold December weather. However, an unexpected (although not atypical) warm stretch of weather in early December introduced complications. The ground had undergone melting, which made it difficult to mobilize the heavy machinery. This presented delays during the site dredging stage. The warm weather also caused the surrounding snow to melt back into the pond bed, which delayed dewatering and added new water during dredging that diluted the sediment. Additional challenges presented as a result of the timing were shorter day lengths that contributed to less efficient working conditions and the need for more resources (i.e. mobile construction lights).

During the implementation of future winter cleanout projects, it is important to anticipate changes in weather conditions, and if possible, avoid periods when warm conditions are likely to occur. To accomplish this, the initial project budget should include a designated window of time that is considerably longer than the anticipated time frame required for the operation to be completed. Under favourable weather conditions during the winter (i.e. prolonged sub-zero temperatures that result in frozen ground, frozen water, and rapid sediment freezing), the project will likely be completed on schedule and under budget, but flexibility needs to be built in to allow for contingencies. Additionally, conducting a bathymetric survey closer to the cleanout date would provide a better assessment of the amount of sediment that needs to be dredged, hauled and disposed. These factors make up large proportions of the budget and need to be estimated in greater detail.

For information on STEP's other stormwater management initiatives, or to access the new guidance on stormwater pond cleanouts, visit us online at
www.sustainabletechnologies.ca

This case study has been prepared by the Toronto and Region Conservation Authority's Sustainable Technologies Evaluation Program. Dynex Construction carried out the pond clean out project described herein, and as such provided the information and site access required for the development of this document. Funding support for this study was provided by Region of Peel, Region of York, City of Toronto and Government of Canada's Great Lakes Sustainability Fund. The contents of this report do not necessarily represent the policies of the supporting agencies. For more information about this project, please contact STEP@trca.on.ca.

Toronto and Region Conservation *for* The Living City®