PEER review

A Tale of Two Polymers: Innovative Methods for Consolidating Sediment During Stormwater Detention Pond Dredging

By Lisa Rocha

Lisa Rocha received an Honours B. Sc. in Environmental Analysis and Monitoring from the University of Toronto in 2003. She has been a part of the Toronto and Region Conservation Authority's Sustainable Technologies Evaluation Program since 2005. In her current role as project manager, she has been involved in various monitoring and research projects, including a polymer field evaluation and an application guide for the use of anionic polyacrylamide on construction sites. More recently, she has been working to develop updated guidance on the inspection and maintenance of stormwater management detention facilities. She can be reached at lrocha@trca.on.ca.

The Toronto and Region Conservation Authority's Sustainable Technologies Evaluation Program (STEP) is working on a document to guide municipalities on managing stormwater detention facilities. In developing information for the document, STEP implemented case studies documenting two pond clean out projects in which different types of polymers were applied to help consolidate wet sediment. This article describes these 2013 studies and reports the findings.

The use of polymers to help consolidate sediment during stormwater detention dredging is a new approach garnering significant interest in Ontario, Canada. As many detention facilities, built in the 1990's and early 2000's, reach the point at which they require sediment removal, the municipalities managing them are exploring the potential benefits of these new techniques. While cost effectiveness is often a principal concern, other constraints such as space limitations, tight timelines and the desire to minimize site disturbance often come into play.

The Toronto and Region Conservation Authority's Sustainable Technologies Evaluation Program (STEP) is currently developing a new document intended to guide municipalities through all aspects of inspecting and maintaining stormwater management detention facilities. In gathering information for the guide, STEP has developed case studies documenting two unique pond clean out projects, both carried out in 2013, in which different types of polymers were applied to aid in the consolidation of wet sediment.

In the first case study, an anionic polyacrylamide (PAM) solution was used with hydraulic dredging to help sediment particles bind together so that settling would be enhanced. In the second case study, a superabsorbent polymer product was used following mechanical dredging to help absorb water from the wet sediment, making it easier to handle and haul offsite.

The remote controlled, floating, auger-type hydraulic dredge used in the first study.

As described in the first study, the anionic PAM-dosed slurry is pumped into the Geotube® which allows water to drain out.

Polyacrylamide-Assisted Hydraulic Dredging

This first case study describes the methods used to remove an estimated 1230 cubic metres of sediment from a stormwater management pond located in the City of Vaughan, Ontario. The pond receives runoff from 35 hectares of primarily residential land and drains to a tributary of the Upper East Don River.

As part of the project, the landowner was interested in avoiding the clearing of vegetation on pond embankments and surrounding areas in order to save on restoration costs and minimize disturbance to local residents. Based on these objectives and the specific constraints and opportunities available at the site, it was determined that a polymer-assisted hydraulic dredging process would be used.

Hoses from the remote controlled, floating, auger-type dredge used in this project - a Pit Hog™ - were connected to a trailer which housed the prepared polymer solution and the metering and dosing equipment. The sediment slurry was suctioned by the dredge, pumped to the trailer for inline polymer injection and mixing, and then pumped into Geotubes® for dewatering. Water drained from the Geotubes® was discharged back into the pond forebay via two 6-inch pipes.

This photo from the first study shows the consistency of pond sediment after hydraulic dredging and two months sitting in a Geotube.®

The operation of the dredge was done by remote control, with movements guided by a steel rail system installed at the ends of the pond. The movement of the dredge was determined based on real time measurement of solids levels in the material being suctioned. When the percent solids decreased at a specific spot, this indicated to the operator that the dredge had sufficiently suctioned the sediment in that area, and should be advanced to the next area.

The role of the polymer product used - an anionic PAM based solution - is to promote the binding together of the suspended sediment particles so that they form larger aggregate particles. Once formed, these larger particles are more susceptible to removal by gravitational settling or filtration in the Geotube®. In order to ensure the optimal performance of the polymer as a flocculant, bench tests were carried out to determine (1) the appropriate product formulation, (2) the ideal dosing rate and (3) the minimum amount of mixing time that should be provided.

At the time of hauling, the Geotubes®, which had been allowed to drain for two months, were cut open and the dried sediment (roughly 60% solids) was scooped out with an excavator. The sediment was hauled to a landfill for disposal, because its petroleum hydrocarbon levels exceeded the standards set out by Ontario's Ministry of Environment.

Mechanical Dredging with Application of a Water Absorbing Polymer for Sediment Consolidation

This second case study describes the mechanical dredging of an older stormwater management pond - the Sisters of St. Joseph pond - located in the east end of Toronto. The pond, which had not been dredged since its construction in 1997, captures stormwater from an 18.3 hectare subdivision and discharges to a branch of the Don River. Based on a sediment survey carried out in the summer of 2013, the pond contained as much as 1320 cubic metres of accumulated sediment.

It was determined that the most appropriate and cost-effective method to remove this sediment would be to dewater the pond, mechanically dredge the sediment, and dry it onsite until it was suitable for hauling. Due to prolonged periods of wet weather experienced during dredging, it was determined that a powder superabsorbent polymer (SAP) product - LiquiSorb 2000® - would be used to absorb water and consolidate the wet sediment. The product contains bentonite clay and is designed to absorb water from slurries or any industrial wastewater with high solids content. SAPs differ substantially from other polymers used for erosion control and water clarification (e.g. linear anionic PAM). While anionic PAM binds sediment particles to one another so that sediment becomes consolidated, SAPs simply absorb water. They are capable of absorbing a large amount of water relative to their own mass,

In the second study, a long reach excavator removes sediment from the Sisters of St. Joseph pond.

and as such, are used in a range of products, including baby diapers and meat packaging.

In order to make the site accessible for construction vehicles, it was necessary to create a clear path to the pond by removing several of the established trees and shrubs onsite. The pond was pumped down, with discharge to the watercourse filtered through geotextile sediment bags as needed. Once the pond was dewatered, a long reach excavator was used to scoop the wet sediment out of the pond, place it on a sediment drying area adjacent to the pond, and mix it with the SAP. Due to the high moisture content of the sediment, a small depression was created within the sediment drying area to contain the sediment slurry during the polymer application and mixing process. The SAP powder was applied to the surface of the wet sediment at the appropriate rate and then mixed through with an excavator. It was left to sit for up to 24 hours, giving the SAP the opportunity to absorb water from the slurry.

Based on sediment quality analysis, the material was found to meet Ontario Ministry of Environment standards for offsite reuse on parkland, residential or institutional land. When the sediment had solidified enough to be transported, it was hauled to conservation lands that are slated for development of recreational multi-use trails in the future.

Conclusions

Both PAMs and SAPs can be highly effective in consolidating wet sediment during pond dredging activities. SAPs are excellent water absorbers, but can only be applied by mixing into wet sediment as part of a mechanical dredging project. Anionic PAM can be applied in the same way - mixed into dredged sediment - but it can also be used to enhance sediment settling via inline injection during hydraulic dredging. While PAM may be more versatile in this way, its efficacy is also more temperature dependent, as its capacity to bind sediment particles declines significantly at temperatures below 10°C (50°F). Ultimately, details like site characteristics, weather conditions, budget and timelines will dictate which

This photo from the second study shows the consistency of sediment after SAP application and mixing, and less than 24 hours of drying time.

type of polymer is more appropriate for a given project.

As polymers and other innovative products and techniques emerge, they provide an expanded range of options available to facilitate sediment removal from ponds, which will hopefully translate into improvements in the cost effectiveness and feasibility of these projects.

This article was graciously submitted by IECA's Stormwater Management Educational Track. This Educational Track, chaired by Rebecca Kauten, CPESC-IT, MPP, covers the far-reaching field of managing stormwater in the post-construction urban environment. Subject matter such as regulatory requirements and compliance, green infrastructure, post-construction stormwater practices, water quality monitoring and water quality modeling are covered in this Educational Track.