# GOLDEN LAKE PHOSPHORUS LOAD REDUCTION DEMONSTRATION PROJECT

## I. INTRODUCTION / HISTORY

For over 20 years the City of Circle Pines has be actively engaged in improving the quality of water and recreational opportunities in Golden Lake. In the early 1990's, the City installed an aeration system in the lake and undertook a fish management project to improve fishing and water quality in the Lake.

In 2002, the City established a Water Quality Task Force made up of City residents and Council members that along with a consultant, further evaluated on-going water quality problems, developed target water quality goals, and analyzed options that were available to meet these goals. The Task Force then developed an improvement/implementation plan that identified a number of projects that if constructed could result in the water quality goals for the lake being achieved. The Golden Lake Phosphorus Load Reduction Project that utilizes a flocculation treatment process was identified in this plan.

This demonstration project is now being undertaken as a cooperative effort between the City of Circle Pines and the Rice Creek Watershed District to allow for further design and testing of this type of treatment system in this specific location, and evaluate the viability of using this type of stormwater treatment process in other applications.

## II. DESCRIPTION OF PROJECT

The Golden Lake Phosphorus Load Reduction Demonstration Project utilizes a flocculation treatment system process similar to that used to treat drinking water; however, the process has been modified to treat stormwater to very high quality in order to improve the quality of water in Golden Lake,

The system treats water by pumping the dirty water from the water body to be treated through a portable water treatment plant that removes phosphorus from the water through a flocculation/sedimentation process, and then reintroduces the clean water back into the water body, thereby improving its quality. The phosphorus and other pollutants that are removed by the process are discharged into the sanitary sewer as part of the routine system operation. The amount of improvement achieved in the lake is dependent on how long the system is operated. **(See attached schematic)**.

## III. RESULTS

Although operational testing of this system is not yet complete, preliminary results are provided in the table below:

**OPERATIONAL RESULTS THROUGH AUGUST 1, 2009**

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| Pre-Treatment Phosphorus Concentration (ppb) | Post-Treatment TP Concentration (ppb) | Alum Dosage Rate (ml/liter) | Pumping Rate (gpm) | Lbs-P Removed/ Month | Alum Cost/ Month | Estimated Floc Disposal Cost/Month | Alum and Floc Disposal Cost/lb of TP Removed |
|---|---|---|---|---|---|---|---|
| 330 ppb | 80 ppb | 0.5 ml/l | 100 gpm | 9 lbs | $4,300 | $240 | $500.00 |
| 290 ppb | 140 ppb | 0.25 ml/l | 100 gpm | 5 lbs | $2,150 | $240 | $480.00 |

Observations related to the systems' performance reveal:

- The treatment process has the ability to remove soluble phosphorus from and treat stormwater to a higher quality than other storm water treatment techniques commonly utilized.

- The phosphorus and other pollutants that settle out as part of the treatment process can be discharged to the sanitary sewer in concentrations well below the limits established by the Metropolitan Council.

- Based on testing completed to date on this small scale system, the flocculation reagent and disposal costs associated with the removal of a pound of phosphorus has been measured at approximately $500 per pound. Additional fixed costs for construction, operation and maintenance of the system will also apply and this information will be provided as part of the final report. Lower costs would be anticipated using larger scale systems.

- Based on Information provided in a Minnesota Public Works Association Environment Committee Paper on the Cost vs. Benefit of Various Stormwater Management Practices, in selected applications, this process / approach is a cost effective alternative to the utilization of other stormwater treatment practices that would otherwise be utilized.

# A Public Works Perspective on the Cost vs. Benefit of Various Stormwater Management Practices

## I. Introduction and Purpose

Cities across Minnesota are committed to protecting their water resources. Particularly through their Public Works Departments, they play a strong role in financing, designing, constructing and maintaining facilities that manage storm water and protect water resources. Many cities have decades of experience in addressing these issues, and their responsibilities in this area have increased dramatically in recent years.

Public Works Departments are dedicated to an approach to stormwater management that addresses multiple community goals, including the following:

- Effective protection of the quality and functions of surface waters and groundwater in the near and long-term
- Cost-effective use of public dollars and resources for construction as well as maintenance of storm water infrastructure
- Maximize value and benefits to the resources, communities and residents

Cities must work with many other organizations to manage water resources--including Federal and state agencies, watershed districts, regional planning agencies, lake associations, advocacy groups, and others. Cities also have a unique perspective on managing water resources. They play a central role in managing water resources and related infrastructure, but they also balance the goals and resources for this task with other community goals--for housing economic development, transportation, parks and open space, police and fire protection, etc. Few governmental organizations in Minnesota are responsible for allocating resources among so many objectives and needs; fewer still are as directly responsible and accessible to citizens and taxpayers as they set priorities and make budget decisions.

Given the unique role that city public works departments play in managing storm water systems and their extensive experience in the day-to-day operation of these systems, the Minnesota Public Works Association identified a need to evaluate the costs and benefits of a variety of Stormwater BMPs from the perspective and experience of its members. This evaluation has these goals:

- Provide practical, objective and empirical information to public works professionals.
- Assist public works professionals to reasonably evaluate the wide range of BMPs available based on the experience of their peers
- Assist public works departments in selecting the methods that best meet goals for protecting water quality and cost effectiveness over the life-cycle of these improvements
- Provide a unique Public Works perspective and a comprehensive approach to storm water management in Minnesota

When selecting the most appropriate Best Management Practice, the life cycle cost vs. benefit of a Best Management Practice is an important consideration, but is not, in many cases, formally considered when selecting a practice. The cost for maintenance and operation of these BMPs to assure they function as designed is also overlooked in many cases.

This document provides the results of a cost vs. benefit analysis that was completed for a wide range of Best Management Practices by public works staff and consultants in the Twin Cities metropolitan area to provide policymakers with their perspectives on what are truly the Best Management Practices available to address these stormwater management considerations.

## II. Procedures and Methods Followed

As part of any analysis that would reasonably evaluate the life cycle cost vs. benefit of various Best Management Practices, it must first be acknowledged that any individual application of a selected Best Management Practice will have a slightly different cost and benefit, and, furthermore, any two independent analyses of an individual application will derive slightly differing conclusions regarding the cost vs. benefit of a selected BMP.

For this reason, a number of procedures and methods were followed during the development and analysis of this information to provide assurances that the information contained herein is generally consistent with perspectives of other Public Works officials regarding the use of these practices. The procedures and methods employed for this purpose are outlined below:

1. The technical analyses completed utilized procedures found in either the Minnesota Stormwater Manual, procedures commonly employed in the preparation of nondegradation plans for cities throughout the Twin Cities metropolitan area, or accepted techniques that are routinely utilized for predicting removal efficiencies in water and wastewater treatment plants. Typical watershed loading values that were estimated for phosphorus, total suspended solids, and water volume loadings are included in Tables 1, 2, and 3.

2. A Public Works Committee reviewed the information collected, as well as obtained input from other public works officials and engineers, and evaluated it for reasonableness. Information that was deemed reasonable was accepted for presentation to the Minnesota Public Works Association Conference in the fall of 2007. It is the intention of the authors of this document to receive input from Public Works staff regarding the findings of this document to continually update the information and conclusions outlined herein.

3. The cost/benefit analyses and/or life cycle cost analyses that were completed for the BMPs outlined herein were based on actual or estimated construction maintenance costs for systems that would be or would have been constructed in the 2007 construction season.

4. The cost for operation and maintenance associated with a given BMP was estimated based on Committee input. It is understood a wide range of operation and maintenance costs could be reasonable for a given BMP in different applications. For this reason, the annualized cost for this activity should be reviewed when evaluating the life cycle costs provided within this document. Maintenances costs were based on labor and equipment rates typically associated with municipal public works projects.

5. The cost for land, and loss of tax revenue was based on typical values within the Minneapolis/St. Paul, seven county, Metropolitan area. Estimates on the cost of land and/or loss of tax revenue were based on an interpretation of the cost associated with the loss of land and tax revenue that would be associated with the application of a given BMP in the area it would be constructed. In some cases, available open space that would not otherwise be utilized for formal building construction was still identified as a cost against the construction of the BMP, as this property could otherwise likely be utilized in lieu of park dedication fees. It is understood that the actual cost associated with utilization of land and the loss of tax revenue may vary widely with a given application and should be taken into consideration when reviewing the life cycle cost analysis results.

6. Information regarding benefits and potential impacts of a given practice were based on generally accepted perspectives of public works officials.

7. Life cycle cost analyses were based on assumptions that each BMP had a 30-year life expectancy, and annualized costs were based on a 30-year amortization of capital at 5% interest.

8. Pollutant loading and pollutant removal efficiency estimates were based on literature values that were found in the Minnesota Stormwater Manual or utilized procedures commonly employed in the preparation of nondegradation plans for cities within the Twin Cities metropolitan area.

## III. Evaluation of Best Management Practices

The Best Management Practices selected for this cost vs. benefit evaluation were those commonly utilized or required for use by Cities, Watershed Districts, or other regulatory agencies. The practices included the following:

A. Treatment basins designed to Nationwide Urban Runoff Program (NURP) Guidelines

B. Raingardens

C. Spray Irrigation Systems

D. Treatment by Municipal Water or Wastewater Treatment Plant

E. On-Site Flocculation Treatment Systems

## IV. Summary

| BMP No. | BMP Description | Estimated Capital Cost | Estimated Life Cycle Cost | Phosphorus Removal Cost/lb. | TSS Removal Cost/lb. | Runoff Volume Removal Cost/ac-ft. |
|---|---|---|---|---|---|---|
| 1 | NURP Basin | $336,000 | $33,840 | $1,554 | $25 | $6,936 |
| 2 | Raingarden | $210,000 | $15,250 | $8,715 | $15 | $5,259 |
| 2a | Raingarden No. 2 | $100,000 | $8,000 | $2,460 | $67 | $2,000 |
| 3 | Water Reuse/Stormwater Irrigation System | $10,000 | $3,150 | $533 | $1.2 | $450 |
| 4 | Wastewater Treatment Plant | * | $10,430 | $220 | $5.70 | No Benefit |
| 5 | On-Site Flocculation | $310,000 | $58,750 | $280 | $0.60 | No Benefit |
| 6 | Underground Treatment Devices | $1,200,000 | $83,000 | $830 | $13 | No Benefit |

* See discussion in Appendix

## V. Findings

Based on a review and analysis of the information developed as part of this study, outlined below are the findings that were observed:

1. The cost effectiveness of a given BMP is strongly influenced by the phosphorus loading that is directed to and treated by the BMP.

2. When selecting a BMP, consideration must be given toward the desired effluent concentration that will be present in the treated stormwater runoff that is routed out of the BMP. In some cases, a high pollutant loading may be directed to the BMP, and a significant amount of phosphorus may be removed by the BMP, but the effluent quality leaving many BMPs still has residual phosphorus concentrations that are too high to restrict algal growth in downstream water bodies.

3. An evaluation of various BMPs indicates the cost effectiveness of a given BMP is very much tied to the amount of time the BMP is physically treating stormwater runoff. If a BMP is limited to treating runoff only during the time runoff is occurring, these passive BMPs can only remove a limited pollutant load.

4. As can be observed from the life cycle cost estimates, utilization of active water treatment systems such as spray irrigation and standard water treatment plant processes can be a very cost effective way to remove pollutants. They also have the potential to achieve the lowest concentration of phosphorus in the treated effluent; low enough to reduce algal concentrations and improve transparencies in lakes and ponds.

5. Many BMPs were identified to have other benefits than simply those associated with removing suspended solids, phosphorus, or runoff volumes. These ancillary benefits need to be evaluated as part of the selection of a given BMP.