MEMORANDUM

To: MCWD Board of Managers

From: Brian Beck, Minnehaha Creek Watershed District

Date: September 24, 2018

Re: Internal Load Management Overview

Background and Purpose

The purpose of this memorandum is to give a high level overview of the internal load management alternatives and research, to assist in determining the Minnehaha Creek Watershed District's (MCWD) response to requests to partner on further researching internal load management techniques.

In Minnesota Lakes, phosphorus has been identified as the primary driver of excess algae blooms, which can lead to other water quality issues such as low clarity, decreased submersed aquatic plant communities, poor water aesthetics, and various other ecological impacts. Generally, there are three major sources of phosphorus to lakes, which include atmospheric deposition, sediment phosphorus release (internal loading), and watershed runoff. Internal phosphorus release from sediments, or internal loading, has been an area of interest in recent years by watershed managers since phosphorus release from sediments can be a large portion of the phosphorus budget.

The identification of internal loading as an important portion of lake phosphorus budgets has led to a substantial effort by university researchers and lake managers to identify cost-effective internal load management options (Mortimer 1971).

Intern Load Management Research Efforts

Currently, there are two general categories of viable internal load management techniques, which include:

1. Chemical sediment inactivation; and
2. Water column aeration/oxygenation.

Over the past 30 years researchers and practitioners have made a concerted effort to research the effectiveness of these internal load management tools (Cooke et al. 1986; Welch and Cooke 1999).

Chemical Sediment Inactivation

Perhaps the most effective tool for controlling internal loading is sediment phosphorus inactivation, where phosphorus is permanently bound in sediments after chemical additions. There are several chemicals that have been researched and used over the past 30 years to reduce phosphorus release from sediments, which include iron, lanthanum (Phoslock ®), and aluminum.

One of the most common chemicals used for phosphorus inactivation is aluminum sulfate (alum), which has proved to be an extremely cost effective tool for reducing internal phosphorus loading in lakes (Welch and Cooke 1999; Huser et al. 2016[a]). Alum has been the recipient of vast academic and applied research by universities and lake management organizations (Cooke and Carlson 1986; Rydin et al. 1999; Welch and Cooke 1999; Lewindowski et al. 2003; James 2011; Berkowitz et al. 2006; Barr 2013). Alum has been used in several Twin Cities metro watershed districts including MCWD, Rice Creek Watershed District, Riley Purgatory Bluff Creek Watershed District, Prior Lake – Spring Lake Watershed District, Capitol Region Watershed District, and many others. Overall, researchers have found alum can result in long term improvements dosed appropriately (Welch and Cooke 1999; Barr 2013; Huser et al. 2016[a]; Huser et al. 2016[b]). More importantly, alum has even been found to be more cost effective than many watershed best management practices by an order of magnitude (Huser 2016[b])

Other chemicals that have been the focus of research in recent years include iron filings (Natarajan et al. 2017) and Phoslock ® (Meis et al 2012). Both iron filings and Phoslock ® appear to be effective method for reducing internal phosphorus release, however, their cost is typically much higher than alum (Wenck 2018). Currently, the University of Minnesota has been heavily researching iron filings as a management technique to determine if it could become a more economical option in the future (Natarajan et al. 2017). In addition, Phoslock ® is being heavily researched primarily in Europe (Reitzel et al. 2013).

Aeration and Oxygenation

Aeration and oxygenation management techniques reduce internal loading in lakes by aerating water that overlay sediments waters (cold, dense water trapped at the bottom of a lake) to maintain oxic (oxygenated) conditions at the sediment surface. It is the anoxic (no dissolved oxygen) condition of the hypolimnetic sediments that contribute to the internal phosphorus load. Aeration has also received decades of research since it is used for several applications that include drinking supply management, fisheries management, and internal load management (Beutel and Horn 1999). Research on aeration as an internal load management technique has

found that it may not be as effective as alum and is typically cost prohibitive due to ongoing operation and maintenance (Wright 1993; Engstrom et al. 2002).

Conclusions

Overall, there is currently a wealth of research on internal load management options since managers and researchers have been using lakes as a living laboratory for internal load management research in recent decades (Welch and Cooke 1999; Barr,2013; Huser et al. 2016[b]). Internal load management techniques have had 40 years of refinement that has resulted in alum being the most cost effective tool in a watershed manager's tool belt (Huser et al. 2016[b]). Applied research will continue to improve internal phosphorus load management techniques, however, further research into new management techniques may not yield more cost effective management tools.

If there are questions in advance of the meeting, please contact Brian Beck at Bbeck@minnehahacreek.org or 952.471.8306

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