Minnehaha Creek Watershed District ***REQUEST FOR BOARD ACTION***

MEETING DATE: February 28, 2019

TITLE: Authorization to Approve Sediment Core Collection for Long Lake Subwatershed Assessment

RESOLUTION NUMBER: 19-023

PREPARED BY: Brian Beck

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REVIEWED BY: ☐Administrator ☐ Counsel ☐ Program Mgr. (Name):______________________
☐ Board Committee ☐ Engineer ☐ Other

WORKSHOP ACTION:

☐ Advance to Board mtg. Consent Agenda. ☐ Advance to Board meeting for discussion prior to action.

☐ Refer to a future workshop (date):________ ☐ Refer to taskforce or committee (date):_______________

☐ Return to staff for additional work. ☐ No further action requested.

☐ Other (specify): _________________________________

PURPOSE or ACTION REQUESTED:

Authorization to execute contract with University of Wisconsin – Stout to measure phosphorus release from sediments in Long, Wolsfeld, Holy Name, Tanager, and School Lake to inform lake management strategies.

PROJECT/PROGRAM LOCATION:

Upper Long Lake Creek Subwatershed

PROJECT TIMELINE:
March 2019 – Collect and submit sediment samples to the University of Wisconsin - Stout
April 2019 – Obtain sediment results from University of Wisconsin - Stout

PROJECT/PROGRAM COST:
Fund name and number: : Research and Monitoring Department: Water Quality Program (500-5001-4520)
Current Budget: $173,550
Expenditures to date: $100
Requested amount of funding: $8,925
Is a budget amendment requested? No
Is additional staff requested? No

PAST BOARD ACTION:

March 9, 2017 – Res. 17-019: Authorization to partner with the Cities of Long Lake, Medina and Orono, and the Long Lake Waters Association, to pursue Hennepin County Natural Resource Opportunity Grant funds, and to provide an in-kind contribution to advance a Long Lake Creek Subwatershed Carp Assessment (*Note – Grant funds were not awarded)*

April 26, 2018 – Res. 18-043: Authorization to execute an agreement with the Cities of Long Lake, Medina and Orono, and the Long Lake Waters Association, to partner on a carp assessment in Long Lake. MCWD's participation is contingent upon all the partners contributing and partnering on the project.

July 12, 2018 – Res. 18-066: Resolution of Support for the Long Lake Creek Subwatershed Partnership. MCWD will act as a technical resource, synthesizing water quality data with carp data to more specifically diagnose issues and drivers within the subwatershed, and to regularly convene partners to identify, recommend and prioritize implementation efforts.

August 23, 2018 – Res. 18-084: Authorization to Apply for BWSR CWF Competitive Grant Funding for Long Lake Creek Subwatershed Assessment. MCWD staff to apply for FY 2019 BWSR CWF Competitive Grant Funding for Long Lake Creek Subwatershed Assessment.

SUMMARY:

Five lakes within the Long Lake Creek subwatershed are impaired for excess nutrients including Holy Name, School, Wolsfeld, Long, and Tanager. In 2014, the Upper Minnehaha Creek Watershed TMDL identified watershed phosphorus loading, internal phosphorus loading, and common carp as potential drivers for poor water quality and ecological integrity within these lakes. However, there has been little diagnostic work completed in this watershed, which makes it difficult to identify cost effective nutrient reduction projects.

In 2018, a system-wide partnership has formed between the cities of Medina, Long Lake, and Orono, the Long Lake Waters Association, and the MCWD to pursue water quality improvements in the Long Lake Creek subwatershed. Work under this partnership was initiated earlier in 2018 by the Cities of Medina and Long Lake, and the Long Lake Waters Association to conduct a small scale carp assessment to begin understanding the impacts carp may be having on Long Lake. Additionally, over the last two years, MCWD has been focusing diagnostic monitoring in the Long Lake Creek Subwatershed to fill data gaps and begin identifying problem areas that may be driving nutrient impairments.

MCWD, in coordination with the LLWA and Cities, applied and were selected for the Board of Water and Soil Resource (BWSR) Accelerated Implementation Grant in the winter of 2018. The purpose of this grant is to accelerate the development of a comprehensive implementation plan by building a detailed watershed model, strengthening our understanding of carp, and identifying cost-effective best management practices (BMPs). The implementation plan developed using the BWSR grant funding will provide MCWD and its partners a detailed roadmap to improve ecological and water quality conditions in the Long Lake Creek Subwatershed.

One important component that was not included in the BWSR CWF grant was collecting sediment cores to characterize internal phosphorus loading in impaired lakes since this activity is not grant eligible. However, MCWD staff require sediment phosphorus data to develop a complete nutrient budget for Wolsfeld, Long, Holy Name, and School Lake.

Staff are seeking authorization to submit sediment samples to the University of Wisconsin - Stout. Their scope of work includes measuring phosphorus release and chemical characteristics from sediment samples on Wolsfeld Long, Holy Name, and School Lake. The total cost for this activity will not exceed $8,925.

RESOLUTION

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WHEREAS, Long Lake Creek Subwatershed has several waterbodies that are impaired for excess nutrients, and the Upper Minnehaha Creek TMDL lists watershed phosphorus loading, in-lake sediment phosphorus release, and carp as drivers of poor water quality in Long Lake Creek waterbodies; and

WHEREAS, the District has been collecting additional water quality data on lakes and streams within the Long Lake Creek Subwatershed, to better identify issues and drivers in the subwatershed to inform implementation; and

WHEREAS, carp assessment and management has been identified as an initial target of the group, with the Cities of Medina and Long Lake, and Long Lake Waters Association agreeing on a partnership to conduct a small scale carp assessment that will help fill data gaps to better inform management decisions in the subwatershed; and

WHEREAS, a regional partnership has formed between the Cities of Medina, Long Lake and Orono, and the Long Lake Waters Association, to pursue water quality improvements in the Long Lake Creek Subwatershed; and

WHEREAS, the District's watershed management plan acknowledges this regional partnership, with the partnership leveraging the skills and resources of each entity, by collaborating and identifying shared priorities for the implementation of projects and programs to improve water quality in the Long Lake Creek Subwatershed; and

WHEREAS, MCWD has committed to serving as a convener and technical resource for the partnership, synthesizing data to identify issues and drivers within the subwatershed to inform implementation; and

WHEREAS, in August 2018, the MCWD Board of Managers authorized staff to apply for funding to the BWSR Accelerated Implementation Grant to identify best management practices and develop a comprehensive implementation plan for the Long Lake Creek Subwatershed; and

WHEREAS, sediment samples will be collected by District staff and submitted to University of Wisconsin – Stout to assess the impact sediment phosphorus release has on phosphorus cycling in Long, Wolsfeld, Holy Name, Tanager and School Lake; and

WHEREAS, this analysis will help inform future management strategies on Long, Wolsfeld, Holy Name, Tanager, and School Lake to address internal loading

NOW, THEREFORE, BE IT RESOLVED that the Minnehaha Creek Watershed District Board of Managers hereby authorizes the District Administrator to execute a contract with University of Wisconsin - Stout for sediment analysis in Long, Wolsfeld, Holy Name, Tanager and School Lake that is not to exceed $8,925.

Resolution Number 19-023 was moved by Manager _____________, seconded by Manager ____________. Motion to adopt the resolution ___ ayes, ___ nays, ___abstentions. Date: _______________.

____ Date:____________________________
Secretary

Determination of Rates of Phosphorus Release and Sediment Characteristics in Minnehaha Creek Watershed Lakes, Minnesota

PROPOSAL OF RESEARCH

20 February, 2019

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Sustainability Sciences Institute
Center for Limnological Research and Rehabilitation
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1.0 BACKGROUND.

Bottom sediments represent an important internal source of phosphorus (P) that can potentially subsidize high algal productivity, even when external P loading from the watershed has been reduced. For sediments containing iron (Fe) compounds, P is usually coupled with Fe dynamics and flux to the water column is regulated by oxidation-reduction (i.e., eH) and pH reactions (Mortimer 1971). A thin oxidized microzone exists in the sediment surface layer when the overlying water column is oxygenated. Under these conditions, Fe is in an oxidized state (i.e., Fe^{+3}) in the microzone as Fe~(OOH) and adsorbs P, thereby controlling its diffusion into the overlying water column. Elevated pH and production of hydroxyl ions (OH^-) during periods of intense photosynthesis can also indirectly enhance rates of P release from sediment under aerobic conditions via ligand exchange (i.e., competition for binding sites by OH^-). Under anoxic conditions at the sediment-water interface, anaerobic bacterial reduction of iron from Fe^{+3} to Fe^{+2} results in P desorption and diffusion into the water column for potential uptake by algae. Internal P loading via these recycling pathways can account for a substantial portion of the P economy of aquatic systems and hinder restoration efforts targeted at reducing algal biomass.

$Fe\sim(OOH)\sim PO_4$ or redox-sensitive P can be quantified via extraction with a strong reducing agent (dithionite-bicarbonate; BD; Nürnberg 1988). Additionally, biologically-labile P in the form of bacterial polyphosphates and labile organic P compounds and can be recycled to the overlying water column via mineralization and metabolic breakdown and is extracted with a basic solution (0.1 to 1.0 N NaOH; Psenner and Puckso 1988). Thus, the size of the biologically-labile P pool (i.e., redox-P and labile organic P; subject to recycling and internal P loading) in surface sediment can be quantified for evaluation and be compared to other systems to assess the potential importance as a source of P recycling in lakes.

2.0 PURPOSE.

The objectives of these investigations are to:

1. measure rates of P release from sediment under anaerobic conditions,
2. examine sediment mobile P fractions that are active in internal P loading for estimation of alum dosage,

3.0 SCOPE OF WORK.

Intact sediment cores will be collected for P flux and sediment characteristics in the deep basin of 5 lakes.

Task 1 - Laboratory-derived rates of P release from sediment under anaerobic conditions:

Triplicate intact sediment cores will be collected by MCWD personnel from a deep basin station in each lake for the determination of rates of P release from sediment under controlled laboratory conditions. All cores will be carefully drained of overlying water in the laboratory and the upper 10 cm of sediment will be transferred intact to a smaller acrylic core liner (6.5-cm dia and 20-cm ht) using a core remover tool. Surface water collected from each lake will be filtered through a glass fiber filter (Gelman A-E), with 300 mL then siphoned onto the sediment contained in the small acrylic core liner without causing sediment resuspension. They will be placed in a darkened environmental chamber and incubated at a constant temperature of ~ 20 ^{o}C to reflect summer conditions. The oxidation-reduction environment in the overlying water will be controlled by gently bubbling nitrogen (anaerobic) through an air stone placed just above the sediment surface in each system. Bubbling action will insure complete mixing of the water column but not disrupt the sediment. For each station, duplicate cores will be subjected to anaerobic conditions.

Water samples for soluble reactive P will be collected from the center of each system using an acid-washed syringe and filtered through a 0.45 µm membrane syringe filter. The water volume removed from each system during sampling will be replaced by addition of filtered lake water preadjusted to the proper oxidation-reduction condition. These volumes are accurately measured for determination of dilution effects. Soluble reactive P is measured colorimetrically using the ascorbic acid method (APHA 2005). Rates of P release from the sediment (mg/m^2 d) are calculated as the linear change in mass in the overlying water divided by time (days) and the area (m^2) of the incubation core liner. Regression analysis is used to estimate rates over the linear portion of the data.

Task 2 - Evaluation of sediment P characteristics:

The objectives of this task are to quantify sediment physical-textural characteristics and P fractions in the upper 5-cm sediment layer of each lake. Sediment sections will be analyzed for the variables listed in **Table 1**. Subsamples will be dried at 105 °C to a constant weight and burned at 500 °C for determination of moisture content, sediment density, and organic matter content (Håkanson and Jensson 2002). Phosphorus fractionation will be conducted according to Hieltjes and Lijklema (1980), Psenner and Puckso (1988), and Nürnberg (1988) for the determination of ammonium-chloride-extractable P (1 M NH_4Cl; loosely-bound P), bicarbonate-dithionite-extractable P (0.11 M BD; iron-bound P), and sodium hydroxide-extractable P (0.1 N NaOH; aluminum-bound P). A subsample of the sodium hydroxide extract will be digested with potassium persulfate to determine nonreactive sodium hydroxide-extractable P (Psenner and Puckso 1988). Labile organic P is calculated as the difference between reactive and nonreactive sodium hydroxide-extractable P.

Table 1. Textural-physical variables and biologically-labile sediment phosphorus pools.
Moisture content (%)
Sediment wet and dry bulk density (g/cm^3)
Organic matter content (%)
Loosely-bound P (mg/g)
Iron-bound P (mg/g)
Labile organic P (mg/g)
Aluminum-bound P (mg/g)

The loosely-bound (Loose-P) and iron-bound P (Fe-P) fractions are readily mobilized at the sediment-water interface under anaerobic conditions that result in desorption of P from bacterially-reduced iron compounds (i.e., Fe^{+3} to Fe^{+2}) in the sediment and diffusion into the overlying water column (Mortimer 1971, Boström 1984, Nürnberg 1988). The sum of the Loose-P and Fe-P fractions are referred to as redox-sensitive P (i.e., redox-P; the P fraction that is active in P release under anaerobic and reducing conditions). In addition, labile organic P (LOP) can be converted to soluble P via bacterial mineralization (Jensen and Andersen 1992) or hydrolysis of bacterial polyphosphates to soluble phosphate under anaerobic conditions (Gächter et al. 1988; Gächter and Meyer 1993; Hupfer et al. 1995). The sum of redox-P and LOP is collectively referred to a biologically-labile P. This fraction is generally active in recycling pathways that result in exchanges of phosphate from the sediment to the overlying water column and potential assimilation by algae.

4.0 REFERENCES.

APHA (American Public Health Association). 2005. Standard Methods for the Examination of Water and Wastewater. 21th ed. American Public Health Association, American Water Works Association, Water Environment Federation.

Boström B. 1984. Potential mobility of phosphorus in different types of lake sediments. Int. Revue. Ges. Hydrobiol. 69:457-474.

Gächter R., Meyer JS, Mares A. 1988. Contribution of bacteria to release and fixation of phosphorus in lake sediments. Limnol. Oceanogr. 33:1542-1558.

Gächter R, Meyer JS. 1993. The role of microorganisms in mobilization and fixation of phosphorus in sediments. Hydrobiologia 253:103-121.

Håkanson L, Jansson M. 2002. Principles of lake sedimentology. The Blackburn Press, Caldwell, NJ USA

Hjieltjes AH, Lijklema L. 1980. Fractionation of inorganic phosphorus in calcareous sediments. J. Environ. Qual. 8: 130-132.

Hupfer M, Gächter R., Giovanoli R. 1995. Transformation of phosphorus species in settling seston and during early sediment diagenesis. Aquat. Sci. 57:305-324.

Mortimer CH. 1971. Chemical exchanges between sediments and water in the Great Lakes – Speculations on probable regulatory mechanisms. Limnol. Oceanogr. 16:387-404.

Nürnberg GK. 1988. Prediction of phosphorus release rates from total and reductant-soluble phosphorus in anoxic lake sediments. Can. J. Fish. Aquat. Sci. 45:453-462.

5.0 COST ANALYSIS

Sediment Chemistry Price List						
Variable		Unit	Cost			
			Each	Quantity	Total	
Textural and Physical Characteristics	Moisture Content-Bulk Density-organic matter	per sediment section	$30	5	$150
Sediment Phosphorus Extractions	Biologically-labile Phosphorus	per sediment section	$135	5	$675
Sediment Flux or Internal Loading	Incubation for rates of soluble reactive P release	per 10 cm core	$540	15	$8,100
Total					$8,925