Technical Memo

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To: Shingle Creek/West Mississippi WMO Commissioners

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Subject: Shingle Creek SRP Reduction Project Feasibility and Cost Estimate

INTRODUCTION AND BACKGROUND

Wetlands that have received many decades of nutrient and sediment-rich runoff from agricultural and developed land uses are at risk of transforming from nutrient sinks to nutrient sources. The hydrology of these wetlands has also often been altered by inflow from increased runoff volumes and ditching for drainage and flood prevention. This can have the effect of alternately flooding and drying out the wetland soils, making them more susceptible to sediment nutrient release under anoxic conditions. The discharge from these altered wetlands is often high in soluble reactive phosphorus (SRP) and low in dissolved oxygen.

In the Shingle Creek watershed, where nearly all of the remaining wetlands are highly disturbed and altered, these high concentrations of SRP can negatively impact downstream waterbodies. In this watershed, a number of wetlands discharge into conveyances to the ten nutrient-impaired lakes. There are also several large wetlands through which flow Shingle Creek or its tributaries. Both Shingle Creek and its primary tributary, Bass Creek, are impaired streams for DO and biotic integrity.

This SRP Reduction Project targets two high-priority locations to test and implement SRP reduction Best Management Practices (BMPs).

Wetland 639W Outlet Site

The first location is a large wetland known as Wetland 639W, just upstream of nutrient-impaired Upper Twin Lake, which has been the focus of several improvement activities since it was documented in several studies and the 2007 Twin and Ryan Lakes Nutrient TMDL to be a significant exporter of total phosphorus (TP) (Wenck Associates 2011 and 2014a). The goal of the Wetland 639W Outlet Modification project was to reduce the outflow load from the wetland into Upper Twin Lake by an average 300 pounds TP per year. Four years of post-construction monitoring estimates that the TP load was reduced by an average 284 pounds. The current estimated average annual TP load from the wetland to the lake is 257 pounds per year, but a high percentage of that load - an estimated 194 pounds per year - is SRP, the form that fuels algal growth (Shingle Creek WMC unpublished data). The summer average TP concentration at the outlet of Wetland 639W is 257 ug/L, of which 187 ug/L is SRP.

Cherokee Wetland Outlet Site

The second location is at the outlet of Cherokee Wetland, on Bass Creek at Cherokee Drive in Brooklyn Park. That site is just upstream of Bass Creek Park where the Watershed Commission operates an ongoing monitoring station. Average summer TP concentration at the monitoring station is 131 ug/L, of which 84 ug/L is SRP. The Shingle and Bass Creeks Biotic and Dissolved Oxygen TMDL does not include a numerical goal for TP or SRP reduction at this site. However, the DO TMDL for Bass Creek and the upper reaches of Shingle Creek requires a 97% reduction in stream Sediment Oxygen Demand (SOD), the source of which is primarily the aerobic decay of organic materials that settle to the bottom of the stream. Export of SRP from Cherokee Wetland can fuel the growth of algae and other plant matter in Bass Creek, leading to higher SOD and ultimately low DO in the stream.

PROPOSED PROJECT

Iron-enhanced sand filters are an emerging technology that shows promise in reducing SRP discharged from stormwater ponds. However, this technology requires that the medium dry out between applications, and does not work well in anoxic conditions. The project is the installation of filter media at these two locations that will test various combinations of iron-enhanced sand, zeolite-enhanced sand, and a product called Phoslock® mixed with sand.

Iron-sand filters have found wide acceptance for treating soluble phosphorus in stormwater. However, there has been little research on the effectiveness of iron enhanced sand media treating anoxic water (Andy Erickson, personal communication). Iron must be in its oxidized form for phosphorus surface adsorption to occur. Currently, the hypothesis is that anoxic water moving through iron-sand media will convert ferric iron to ferrous iron, which may reduce the phosphorus removal capacity of the iron-sand media.

Zeolite is an aluminosilicate mineral that has been used to remove a variety of metals and nutrients, including phosphorus. Aluminosilicate minerals, unlike iron minerals, are not sensitive to anoxic conditions, therefore are ideal candidates for phosphorus removal under anoxic conditions. This filter will combine zeolite particles wiith sand media.

Phoslock® is a proprietary bentonite clay that contains lanthanum. Lanthanum, like aluminum, is not sensitive to anoxic conditions, which also makes it an ideal candidate for phosphorus removal in wetlands that are discharging soluble phosphorus. This filter will use Phoslock® combined with sand media.

The outflow from each of these filters will be monitored to see which performs the best under field conditions. On conclusion of the testing phase, the lesser-performing media will be removed and replaced with the best-performing medium considering life-cycle costs. Inflow and outflow monitoring will continue post construction to document filter effectiveness at reaching the SRP load reduction goals.

The Commission routinely monitors and will continue to monitor water quality in Upper Twin Lake and flow and water quality at the Bass Lake Park monitoring station just downstream of the Cherokee wetland site following completion of the project.

Phase 1

Phase 1 of this project, the testing phase, will be at the Wetland 639W outlet site. A previous project on Wetland 639W constructed two weirs to control outflow. The primary outlet weir at the bottom of the wetland prevents outflow except under very large rain events or a large spring snowmelt. A small overflow weir higher up in the wetland allows some discharge for smaller rain events. That overflow outlet is a three-sided weir (Figure 1), the interior of which is filled with limestone rock. Flow over the weir filters down through the limestone and into a small channel that outlets back into the wetland below the primary outlet weir.

As part of the proposed project, the limestone will be excavated from the weir box, which will be modified to provide three temporary chambers to test the three different media. Each chamber will be fitted with an outflow pipe to measure the volume of flow through each chamber. Grab samples will be measured for TP, total dissolved phosphorus (TDP), SRP, and total iron concentrations measured at the outflow of each. Just upstream of the overflow weir is a small ponded area, and grab samples taken from that pond will serve as the pre-treatment concentrations for each. Since in most years discharge from the wetland is mainly though the overflow weir, the proposed BMP will treat a very high percent of the annual discharge from the wetland.

Figure 1. The overflow weir at Wetland 639W.

Phase 2

On conclusion of the testing phase, the temporary dividers will be removed from the Wetland 639W overflow weir and the entire box filled with the selected, best-performing filter medium.

At the Cherokee Wetland outlet site, the treatment device will be a constructed metal box containing the filter medium, placed directly in Bass Creek just downstream of the outlet in Bass Creek Park. The filter box will be tied into the banks of the ~12' wide stream, with low to medium stream flows routed through the filter and high flows flowing over the box. SRP concentrations in Bass Creek are elevated during low flow conditions, so the filter will be treating the worst conditions. Monitoring will occur upstream in Bass Creek and at the outlet of the filter box.

Figure 2. Bass Creek outlet from the Cherokee Drive wetland to Bass Creek Park.

ESTIMATED LOAD REDUCTION

Literature estimates of SRP removal efficiency for both Phoslock™ and zeolites range from 60 percent to more than 90 percent (see for example Ballentine 2010, Liu et al. 2009, and Van Oosterhout 2013). The minnesota Stormwater Manual (MPCA 2017) recommends assuming a 60 percent dissolved phosphorus removal rate for iron-enhanced sand filters. This project assumes a conservative 50 percent SRP removal rate.

As noted above, the current estimated average annual TP load from Wetland 639W to Upper Twin Lake is 257 pounds per year, but a high percentage of that load - an estimated 194 pounds per year - is SRP

The SRP Reduction Project goal at this site is to reduce SRP export by at least half, or 97 pounds per year. The Upper Twin Lake nutrient TMDL requires an annual watershed load reduction of 741 pounds TP per year, of which an estimated 538 pounds has already been achieved, leaving 203 pounds yet to be reduced (Wenck Associates 2014b). This SRP reduction goal represents almost 50% of the remaining required load reduction.

The average annual SRP load at the Bass Creek Park monitoring station is 720 pounds pre year. The goal at this site is a 50% reduction in SRP load at the Bass Creek Park monitoring station, or an annual reduction of 360 pounds SRP per year.

PROJECT TASKS, COST AND SCHEDULE

The project has been broken down into five general tasks, which are described below and for which the cost is shown in Table 1. This project has tentatively been awarded a grant EPA/MPCA Section 319 program, and matching funds will be levied in July 2018 for the Commission's share. If this project proceeds in 2019, Table 2 shows an estimated schedule.

Task 1: Literature Review and Design. A Technical Advisory Committee (TAC) of city, county and agency staff and other interested persons will be convened to provide review and guidance throughout the duration of the project. Based on input from the literature and TAC, any necessary revisions to the preliminary filter designs and monitoring instrumentation and plan will be made and documented prior to proceeding to installation. *Responsible Party(ies):* Shingle Creek WMC, Shingle Creek WMC TAC, Wenck Associates, Inc.

Task 2: Filter Installation. This task is the fabrication and installation by a contractor of the Wetland 639W filter box in 2019 and the Cherokee Wetland filter box in 2020, and installation of instrumentation. The construction time is expected to be one week. The 639W filter will be placed into service in Spring 2019. After reviewing data collected in Task 3, in Spring 2020, the two lesser-performing media in the 639W filter box will be removed and replaced and the Cherokee Wetland filter box installed with the best-performing medium. The filters will remain in place until approximately November 2021. *Responsible Party(ies):* Shingle Creek WMC, Wenck Associates, Inc., contractor to be determined

Task 3: Performance Monitoring and Evaluation. The Commission has several years of pre-construction data at both sites. Inflow and outflow will be monitored post-construction to evaluate and document removal effectiveness. Data will be uploaded to EQuIS annually. The Commission will confer with the TAC and consultants on the analysis of the data and will summarize and evaluate monitoring data into a technical memo which will become part of the final report. A Quality Assurance Project Plan (QAPP) will be prepared prior to any monitoring to assure that data is collected in accordance with required standard operating procedures. Commission technical staff will coordinate with MPCA as the MPCA staff prepares the QAPP. *Responsible Party(ies):* Shingle Creek WMC, Shingle Creek WMC TAC, Wenck Associates, Inc, MPCA.

Task 4: Information Sharing. Project specifications and results will be shared to a variety of stakeholders, and posted on the Commision's website. It is expected that this topic will be of great interest to multiple stakeholders both locally and regionally. The Commission will prepare articles summarizing and evaluating the research and results and submit them for publication in both industry trade publications and academic journals. The Commission will also submit abstracts for presentations on interim and final findings to the Minnesota Water Resources Conference and other water resources-related conferences. Ongoing and final results and project specifications will be posted on the Commission's website, www.shinglecreek.org. *Responsible Party(ies):* Shingle Creek WMC, Shingle Creek WMC TAC, Wenck Associates, Inc

Task 5: Grant Administration. This task is the completion and timely submittal of required semi-annual and final reports and quarterly invoices. A final report will be submitted to MPCA within 30 days from the end of the Grant. Best Management Practices will be reported each year they are implemented by February 1st to the Statewide eLINK data system. Invoices will be submitted to MPCA at least quarterly. *Responsible Party(ies):* Shingle Creek WMC, Wenck Associates, Inc.

Table 1. Estimated project cost.

Task	Estimated Cost	Grant Share	Commission Share
Literature Review and Design	$14,184	$14,184	
Fabrication and Installation of Filters	52,510		$52,510
Performance Monitoring	42,078	42,078	
Information Sharing	10,957	10,957	
Administration	4,951	4,951	
TOTAL	$124,680	$72,170	$52,510

Table 2. Estimated project schedule.

Activity	Schedule
Literature review and final design	January-March 2019
Fabrication and installation of Wetland 639W site filter and instrumentation	April 2019
Phase 1 performance monitoring	April-October 2019
Data review	November-Mar 2020
Removal of Wetland 639W temporary chambers and retrofit with selected medium and modification of monitoring instrumentation	April 2020
Fabrication and installation of Cherokee Wetland outlet site filter and instrumentation	April 2020
Phase 2 performance monitoring year 1	April-October 2020
Phase 2 performance monitoring year 2	April-October 2021
Data review and final report	January-March 2022

FEASIBILITY

This SRP Reduction Project targets two high-priority locations to test and implement SRP reduction Best Management Practices. There are several other locations in the Shingle Creek watershed where wetlands are likely exporting high levels of SRP into Shingle or Bass Creeks or to the impaired lakes. There are likely additional disturbed wetlands exporting SRP outside of the watershed that could potentially benefit from some type of filter at their outlets. This proposed project is feasible and the results will be informative and bropadly applicable in both urban and rural areas.

REFERENCES

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